User manual

ADA-4040PC3

SunMaster to MODBUS-RTU protocol converter

Contents

1. GENERAL INFORMATION

Thank you for your purchase of **CEL-MAR Company** product. This product has been completely tested and is covered by a two year warranty on parts and operation from date of sale.
If any questions or problems arise during installation or use of this product, please do not hesitate to contact Technical Support at +48 41 362-12-46 or e-mail support@cel-mar.pl.

1.1. WARRANTED INFORMATION

ADA-4040PC3 converter is covered by a two year warranty from date of sale. In case of being damaged it will be repair or the damaged component will be replace. The warranty does not cover damage caused from improper use, materials consumption or any unauthorized changes. If the product does not function (is damaged), or not operate in accordance with the instructions, will be repaired or replaced.
All warranty and no warranty repairs must be returned with paid transport and insuring to the **CEL-MAR Company.**
CEL-MAR Company under no circumstances won't be responsible for ensuing damage from improper using the product or as a result of random causes: the lightning discharge, the flood, the fire and the like.
CEL-MAR Company is not be held responsible for damages and loss including: loss of profits, loss of data, pecuniary losses ensuing from using or the impossibility of using this product.
In specific cases **CEL-MAR Company** discontinue all warranties and in particular do not follow the user manual and do not accept terms of warranty by the user.

1.2. GENERAL CONDITIONS FOR SAFE USE

The device should be installed in a safe and stable places (eg, electroinstallation cabinet), the powering cable should be arranged so as not to be exposed to trampling, attaching, or pulling out of the circuit.
Do not put device on the wet surface.
Do not connect devices for nondescript powering sources,
Do not damage or crush powering wires.
Do not make connection with wet hands.
Do not adapt, open or make holes in casings of the device!
Do not immerse device in water or no other liquid.
Do not put the fire opened on device sources: candles, an oil lamps and the like.
Complete disable from the supply network is only after disconnecting the power supply circuit voltage.
Do not carry out the assembly or disassembly of the device if it is enabled. This may result to short circuit and damage the device.
The device can not be used for applications that determine human life and health (eg. Medical).

1.3. CE LABEL

CE

The CE symbol on the device CEL-MAR means compatibility with electromagnetic compatibility Electromagnetic Compatibility Directive **EMC 2014/30/WE.**
Declaration of Conformity is delivered with purchased device.

1.4. ENVIRONMENTAL PRESERVATION

This sign on the device inform about putting expended device with other waste materials. Device should send to the recycling. (In accordance with the act about the Electronic Appliance Expended from day 29 of July 2005)

1.5. SERVICE AND MAINTENANCE

Converter ADA-4040PC3 does not require the servicing and maintenance.
Technical support is available at number +48 41 362-12-46 in 8.00-16.00, from Monday to Friday or e-mail support@cel-mar.pl.

1.6. PACK CONTENTS

ADA-4040PC3 converter; user manual; CE declaration; Line terminators 120Ω; CD with ADAConfig software.

2. PRODUCT INFORMATION

2.1. PROPERTIES

- Conversion of protocols SunMaster to MODBUS-RTU and inversely,
- Baud rate and data format conversion between SunMaster and MODBUS-RTU.
- Operating on 2 or 4 wire buses in RS485/RS422 standard,
- Baud rate, set on RS485/RS422 interfaces (bps): 300, 600, 1200, 1800, 2400, 4800, 7200, 9600, 14400, 19200, 28800, 38400, 57600, 76800, 115200, 230400.
- Data format RS485/422 :
  - Data bit: 5, 6, 7, 8,
  - Parity: None, Odd, Even,
  - Number of stop bits: 1, 2,
- Power supply 10 - 30 VDC stable min. 2W,
- ~3kV= optoizolation in signal channel between RS485/422 (MODBUS-RTU) and RS485/422 (SunMaster) interface,
- 1kV= or 3kV= galvanic isolation between RS485/RS422 (MODBUS-RTU, SunMaster) interfaces and power supply,
- Connection RS485/RS422 network and power supply via screw terminal block 2.5 mm^2.
- Implemented short circuit protection and over-voltage protection on RS485 / RS422 network,
- Implemented protection against power supply reverse connection,
- Cover compatible with DIN 43880 standard– mounting in typical electro-installation unit,
- Cover adapt to rail mounting according to DIN35 / TS35 standard,
- Cover dimensions (W x D x H) 53mm x 62mm x 90mm,

2.2. DESCRIPTION

Protocol converter SunMaster to MODBUS-RTU ADA-4040PC3 is a device solves a problem of connection Inverters of MASTERVOLT* company, communicate by SunMaster protocol, to multipoint RS-485 bus with devices communicate by MODBUS-RTU protocol. Simultaneously, the converter can convert baud rate and format of transmitted data between port of SunMaster protocol and port of MODBUS-RTU protocol. Depending on configurations, can be set baud rate, data bits, parity, number of stop bits. The setting can be different for SunMaster port and MODBUS-RTU port. Additionally, ADA-4040PC3 separates SunMaster Inverter from RS485 bus. Galvanic isolation of ADA-4040PC3, protect the system structured on RS422/485 bus and increases its reliability.
ADA-4040PC3 supports the asynchronous baud rate up to 230.4 kbps through four or two pairs of twisted-pair cables connected to screw terminals. The converter use RX+, RX-, TX+/A, TX-/B lines for functioning. It is possible to connect 32 devises to RS485/RS422 network constructed on base of ADA-4040PC3, working at the half duplex or full duplex mode. Over-voltage protection on each RS485/RS422 line was made on base of 600W over-voltage led and fuses.

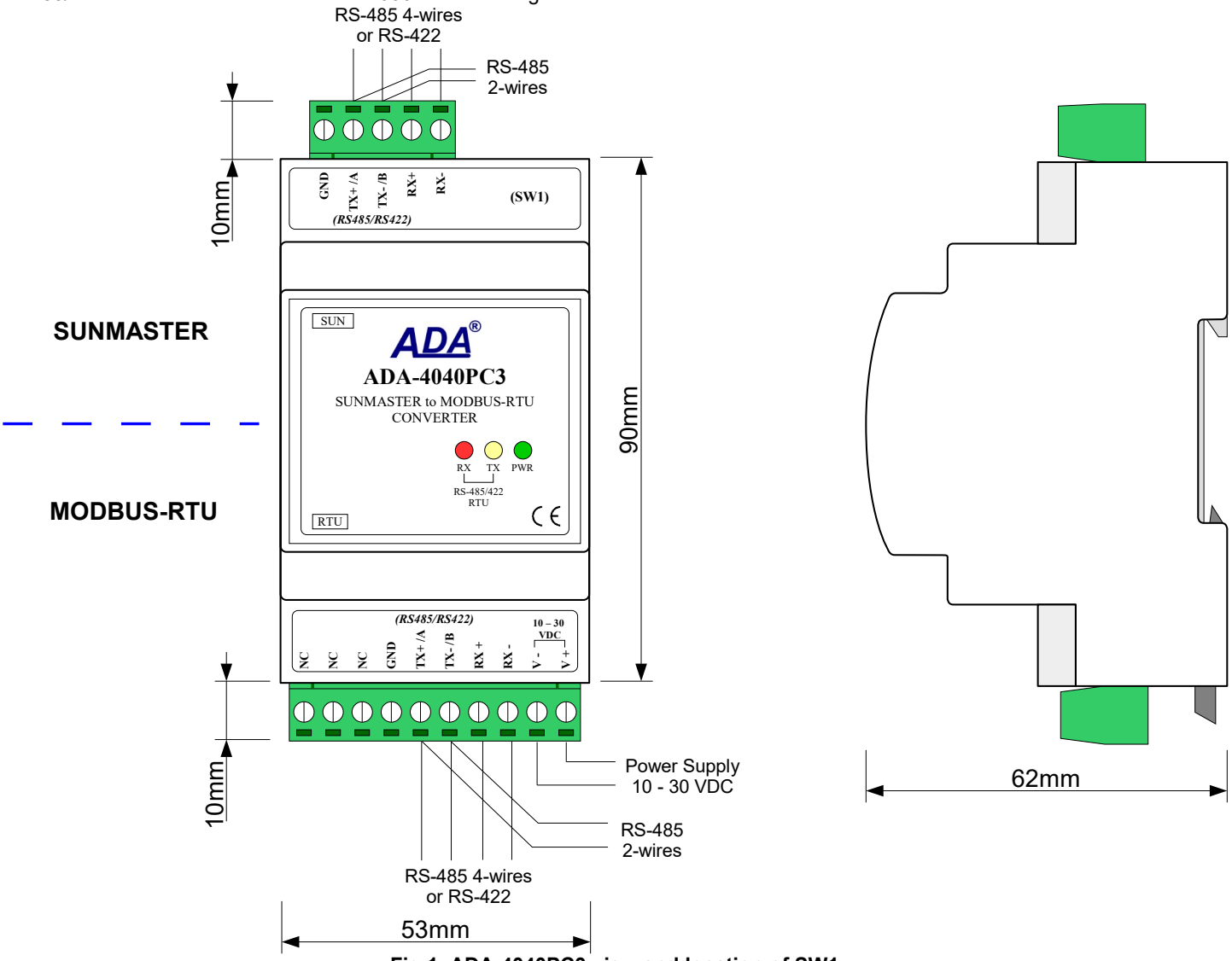

Fig 1. ADA-4040PC3 view and location of SW1

2.3. SUPPORTED INVERTERS OF MASTERVOLT* COMPANY

ADA-4040PC3 converter supports inverters MASTERVOLT* company like:
a/ XS series. Type: 6500 4300 3200 2000
b/ WM series. Type: 1500
c/ XL series. Type: 5000 3300 3300+
d/ QS series. Type: 6400 3200 2000 1200 1500 2500
e/ CS TL series. Type: 15k 20k 30k 100k
f/ ES series. Typ: 2,2TL, 3.0TL, 3,6TL, 4,6TL, 5,0TL

2.4. ISOLATION

Converter ADA-4040PC3 has 3-way galvanic isolation on the levels 1kV= or 3kV=, depend on version described in section VERSIONS.

3-WAY ISOLATION

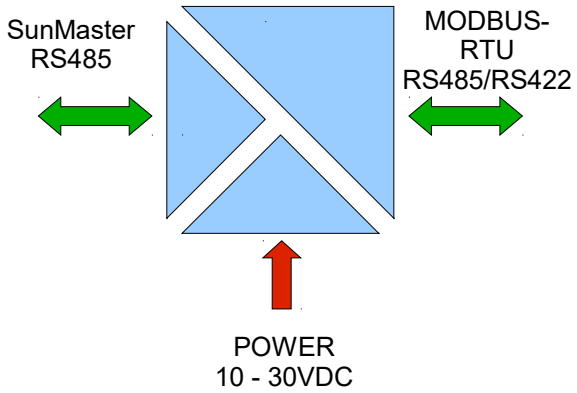

Fig 2. Isolation structure

3. INSTALLATION

This chapter will show how to use and connect ADA-4040PC3 to SumMaster inverters of MASTERVOLT* company, equipped with RS485 interface, to RS485 / RS422 bus and to power supply.
In the purpose of minimization of disruptions from environment is being recommended to:
- apply multipair type shielded cables, which shield can be connected to the earthing on one end of the cable,
- arrange signal cables in the distance not shorter than 25 cm from powering cables.
- apply cable of adequate cross-section due to voltage drops for converter powering,
- use suppression filters for powering converters that are installed within a single object.
- not supply converter from power circuit device that generates large impulse interference such as transmitters, contactors.

3.1. ASSEMBLING

The cover of ADA-4040PC3 converter is adapted to assembly on TS-35 (DIN35) rail. To install the converter, should be mounted on the rail upper part of the cover then press bottom part to hear characteristic „Click” sound.

3.2. COMPUTER CONNECTION

To connect ADA-4040PC3 to computer, is needed additional converter e.g. ADA-I1040 RS232 to RS485/RS422 converter or ADA-I9140 USB to RS485/RS422 converter; connected to SUN (5-pin connector) port of ADA-4040PC3.
Typical connections of ADA- 4040PC3 to PC are shown bellow.

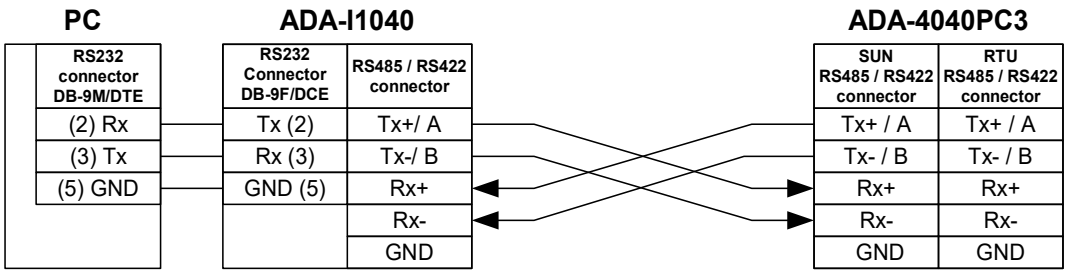

Fig 3. 4-Wires connection of ADA-4040PC3 to PC with the use of ADA-I1040 - RS232 to RS485/RS422 converter

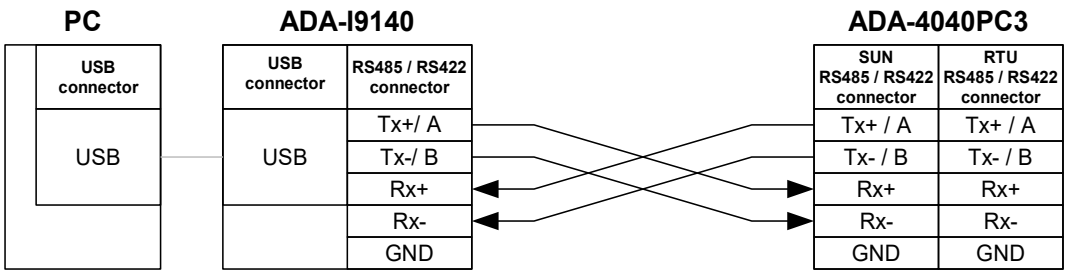

Fig 4. 4-Wire connecting ADA-4040PC3 to PC with the use of ADA-I9140 USB to RS485/RS422

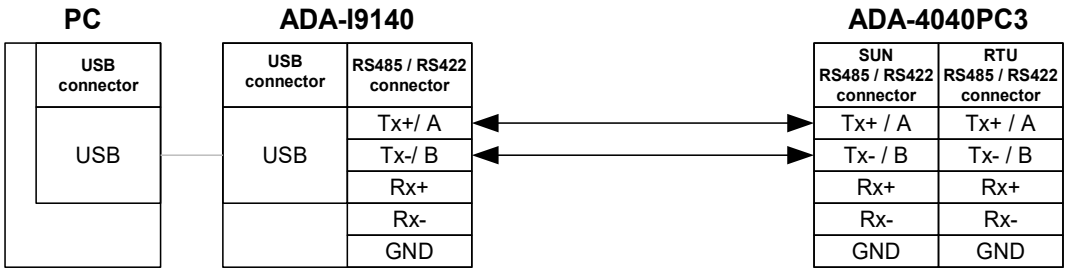

Fig 5. 2-Wire connecting ADA-4040PC3 to PC with the use of ADA-I9140 USB to RS485/RS422

3.3. RS485 NETWORK CONNECTION

RS485/RS422 interface in ADA-4040PC3 converter is described as: Tx+/A, Tx-/B, Rx+, Rx-. Connection of ADA-4040PC1 to RS485(4W) and RS485(2W) network are shown bellow.

3.3.1. CONNECTION OF SUNMASTER INVERTER TO RS485(4W) BUS MODBUS-RTU

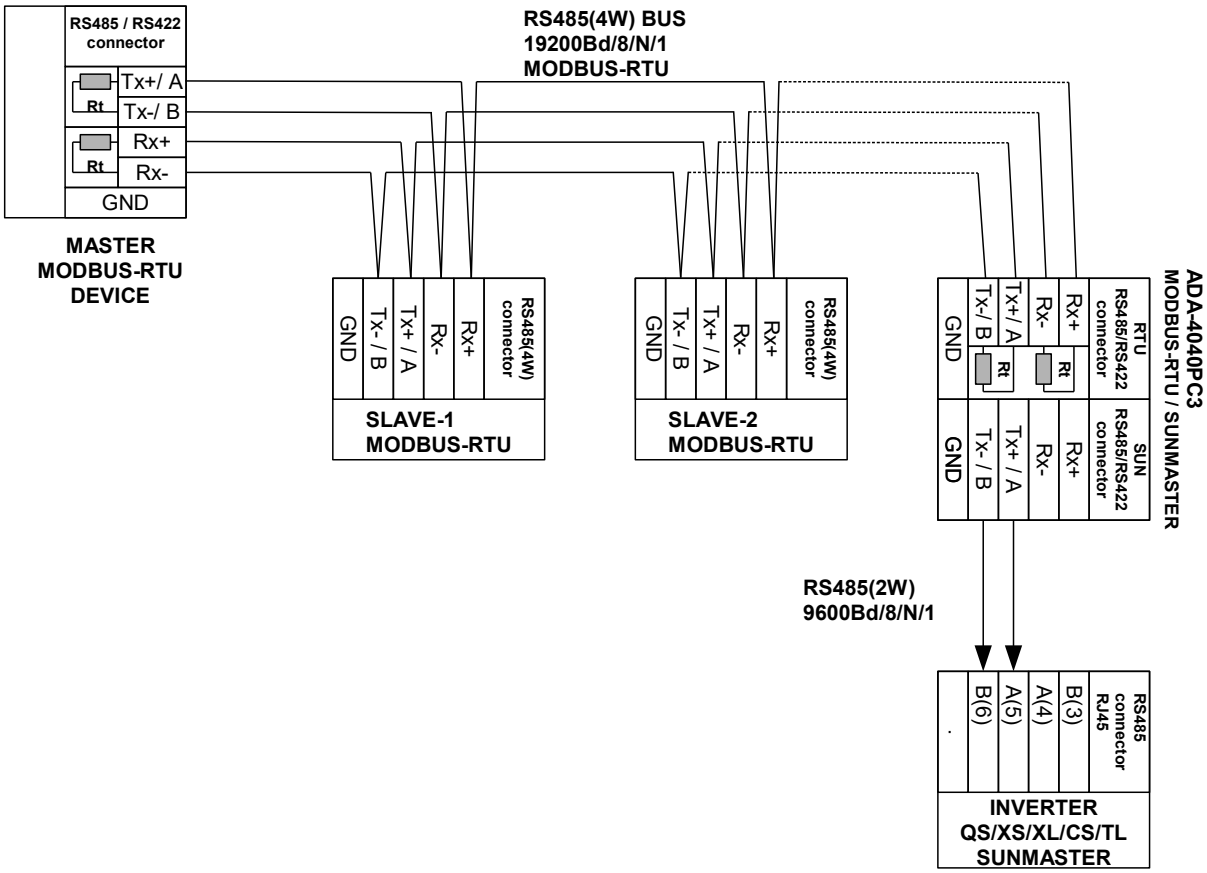

Fig 6. Example connection of ADA-4040PC3 to RS485(4W) 4-wire bus and SunMaster Inverter to ADA-4040PC3

3.3.2. CONNECTION OF SUNMASTER INVERTER TO RS485(2W) BUS MODBUS-RTU

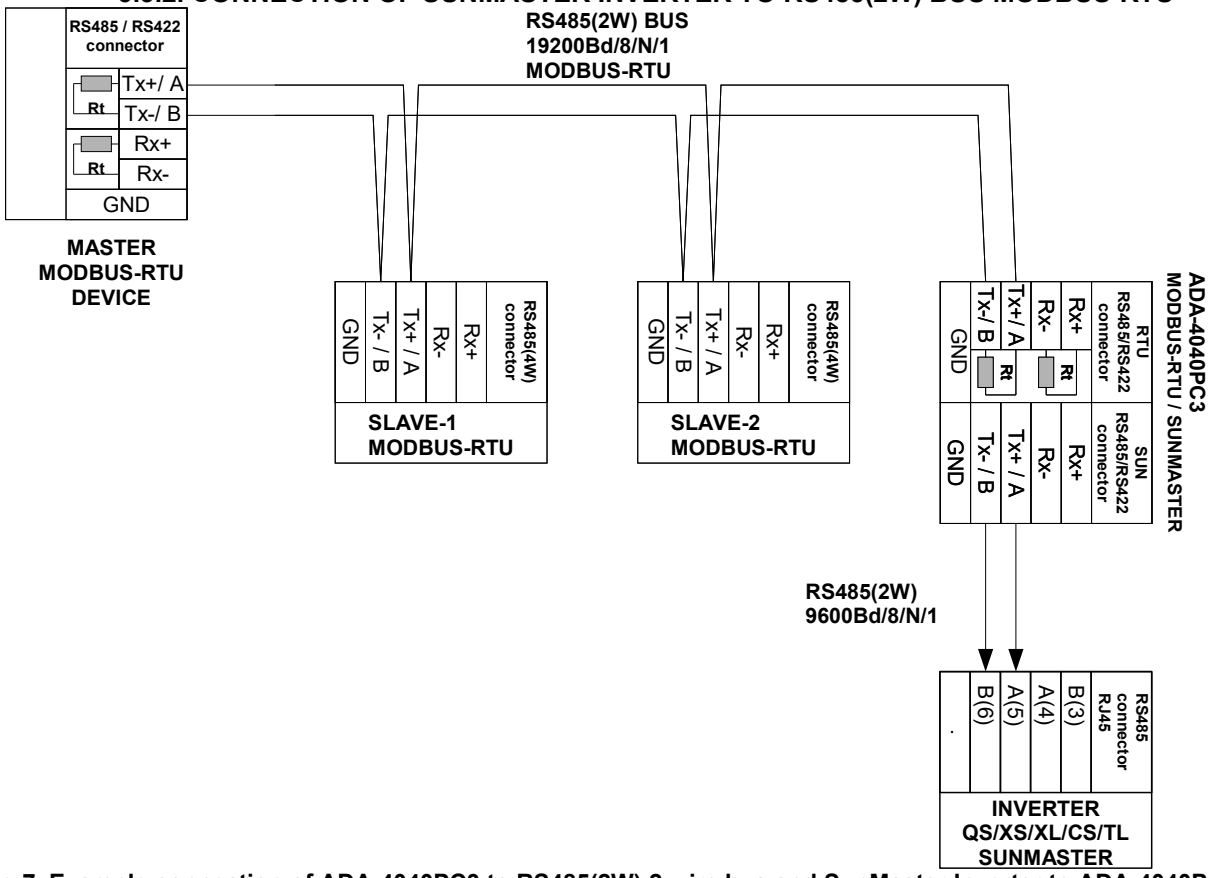

Fig 7. Example connection of ADA-4040PC3 to RS485(2W) 2-wire bus and SunMaster Inverter to ADA-4040PC3

3.3.3. LINE TERMINATION Rt

The application of Line Termination (terminator) Rt = 120 ohms will reduce electrical reflection in data line at high baud rate. It is not needed below 9600Bd. Should be used the Line Termination resistor if the distance is over 1000m @ 9600Bd or 700m @ 19200Bd, and if the disturbance in transmission will appear.
Example connection of Rt are shown on Fig. 6 & 7. Four Rt=120 Ω , 5%, 0,25W are delivered with the converters.

3.4. POWER SUPPLY CONNECTION

To connect power supply to the converter, should have DC power supplies (regulated) output voltage from 10 V= to 30V=, min. nominal power 2W, e.g. HDR-15-24. Power cable from DC power supplies to device can not be longer than 3m. Should connect positive (+) end of DC power supplies to V+ device terminal and negative (-) end to V- on terminal block. ADA-4040PC1 has protection against power supply reverse connection. If after power connection the green LED PWR on front panel is not lit, check correctness of power supply connection (polarisation).

4. ACTIVATION

The converter can be power on after properly connection according to section above.
If after connection power supply on front panel will not light green led PWR, check correctness of power supply connecting (polarization). When data is present the LEDs Tx and Rx should blink

ATTENTION!
AT BAUD RATE ABOVE 38.4 KBPS THE LED'S TX, RX WILL LIGHT WEAKLY DURING DATA TRANSMISSION

4.1. DESCRIPTION OF SIGNALLING LEDS

LED	*Description*
PWR	Signalling of Power Supply
RX	Signalling of data receiving through ADA-4040PC3 from RTU RS485/RS422 port
TX	Signalling of data transmitting from ADA-4040PC3 through RTU RS485/RS422 port
Yellow LED by SW1	Not light – signalling of normal operating mode (RUN)
	Blinking at frequency 1 Hz - signalling of configuration mode or data flow of software to the converter.
	Blinking at frequency 2 Hz - signalling of factory default mode
	Lit continuously – signalling of emergency firmware update

4.2. TROUBLESHOOTING

Problem	Solutions
PWR LED is not light	Check polarization and parameters of connected power supply.
Rx LED lights continuously	RS485(4W) /422 network. Wrong polarization on terminals: Rx+, Rx- of RTU port; change polarization.
No transmission Tx LED is blinking	RS485(4W) / RS422 network. Check correctness of connection to terminals Tx, Rx; according to point 3 and the converter configuration.

5. CONFIGURATION

5.1. OPERATION MODE

The ADA-4040PC3 converter can operates in a few modes :
- RUN mode,
- configuration mode,
- factory default
- emergency firmware update mode,

Those modes can be set by use SW1 located by terminal block RS455/RS422 (SUN). To set the switch section, should remove terminal cover marked as SW1 and make the appropriate settings by the use a small, flat screwdriver.
All available adjusting the SW1 switch are shown in table below.

Converter operation modes

SW1- 1	***SW1- 2***	***Mode***
OFF	OFF	Run
ON	OFF	Configuration
OFF	ON	Factory default
ON	ON	Emergency firmware update

5.2. CONFIGURATION BY USING ADACONFIG

The configuration of ADA-4040PC3 converter can be made by the use of *ADAConfig* Software - selling with converter.
To make the configuration, connect converter to computer (see pt. 3.2) and power supply. If after power, on the front panel is not lit green LED PWR, check the power connection (polarity). If the PWR LED lights, set the section of SW1 switch to configuration mode as in table below.

SW1-1	**SW1-2**
ON	OFF

In the configuration mode yellow LED located by SW1 micro-switch will blink with frequency 1 Hz. Start the ADAConfig Software and make the configuration of transmission parameters for each converter interfaces. First, should be set the number of COM port for communication with the converter, then readout the configuration from ADA-4040PC3 memory using the button ***[Read converter configuration]*** and make the proper changes of each interfaces setting, as below:

– setting of the converter address from the side of RS485 MODBUS-RTU bus – in group **[Converter Address]** select field **[Enable]** and enter address MODBUS-RTU in field [***Address***] (scope 1-247),

– setting of address SunMaster inverter, connected to RS485 port, field [***Mapped address***] (scope 1-255),

If SunMaster inverter address is known, in group **[Converter Address]** select field **[Address mapping]** and enter address of SunMaster inverter in the field **[Mapped address]**.
If SunMaster inverter address is unknown, in group **[Converter Address]** unselect field **[Address mapping]** and in the field **[Mapped address]** don't enter any data.

– baud rate (kbps): 0.3, 0.6, 1.2, 1.8, 2.4, 4.8, 7.2, 9.6, 14.4, 19.2, 28.8, 38.4, 57.6, 76.8, 115.2, 230.4,

– number of data bites: 5, 6, 7, 8,

– control parity: no control, parity control, control of none parity,

– number of stop bits : 1, 2,

– frame spacing – range from 4 to 255 (time silence as frame's end),

After configuration, the setting should be saved on converter memory by using button ***[Write converter configuration].***
Return to work in RUN mode is made by using SW1 switch as below.

SW1-1	**SW1-2**
OFF	OFF

In the RUN mode the yellow LED (located near the SW1), will turn off.

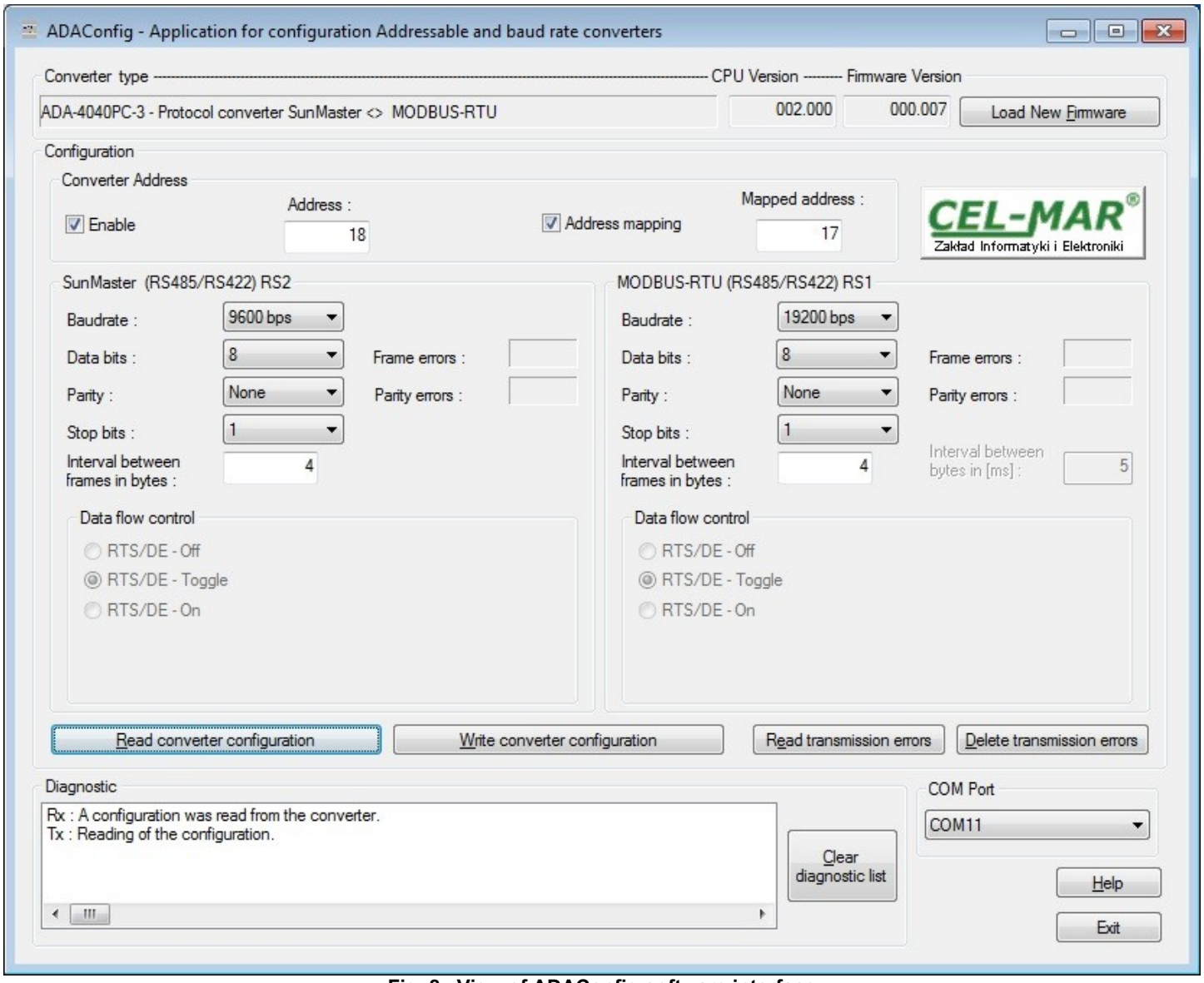

Fig. 8. View of ADAConfig software interface

5.3. FACTORY DEFAULT

In case of faulty functioning ADA-4040PC3, can be restored the factory default setting of the converter internal registers.
Set SW1 microswitch mode as in the table below.

SW1-1	SW1-2
OFF	ON

Disconnect the power and after while **connect** again the power. After that, will be loaded the factory default setting to the converter internal registers.
After this operation, the converter parameters should be set again for operating in the application.
Set micro switch SW1 to run mode as shown in the table below.

SW1-1	SW1-2
OFF	OFF

In the RUN mode the yellow LED (located near the SW1), will turn off.

5.4. FIRMWARE UPDATE

Set SW1 micro switch to configuration mode as in table below.

SW1-1	SW1-2
ON	OFF

In the configuration mode the yellow LED will blink with frequency 1Hz. Press a button ***[Load New Firmware]*** to change the software delivered by manufacturer. The Select File window will open (fig. below) and select the *.bin file then click ***[Open]*** - software will be load to *ADAConfig* buffer storage and will be checked. If the *ADAConfig* not detect errors in loaded file, change converter software. Process of updating is visualized by *ADAConfig* in use Progress Window and after proper changing confirmed by correct message.

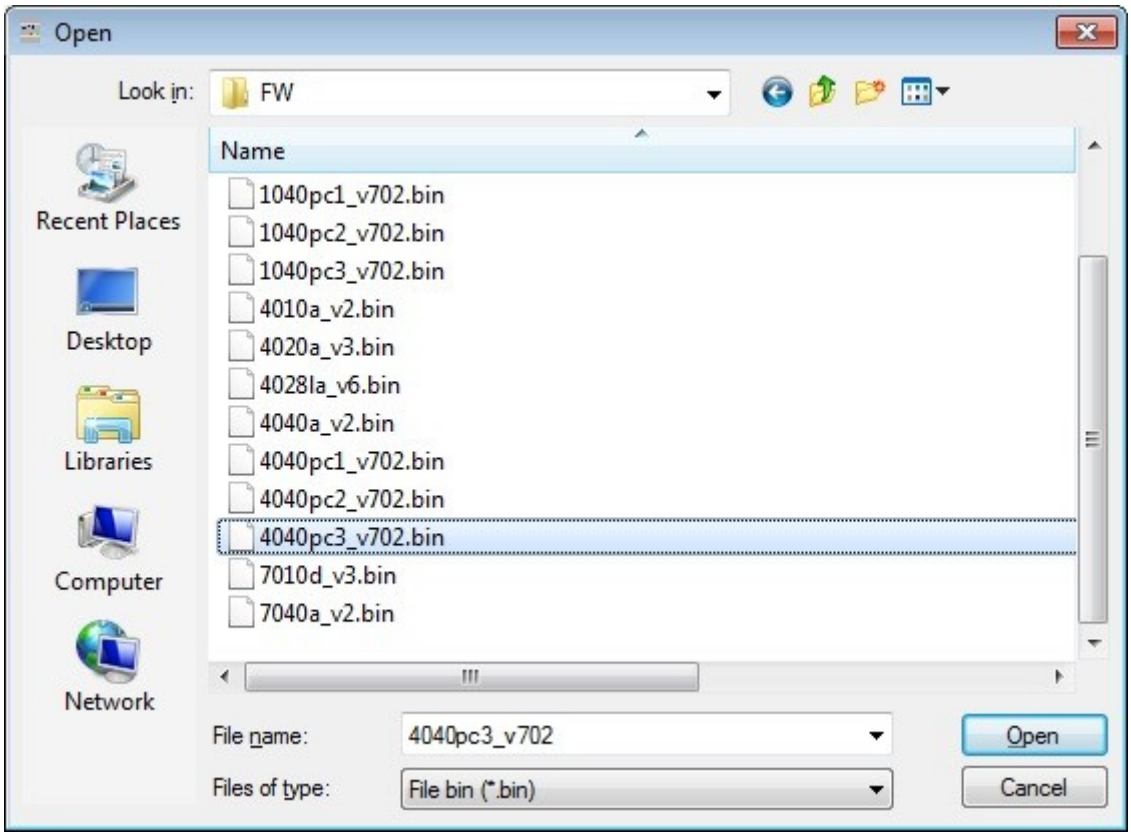

Fig 9. Selection of firmware file

During loading software the yellow LED located beside SW1 micro-switch will blink, showing data flow to the converter. If the software was loaded correctly yellow LED will be blink again with frequency 1 Hz.
After that, set microswitch SW1 to RUN mode as shown in the table below.

SW1-1	SW1-2
OFF	OFF

In the RUN mode the yellow LED (located near the SW1), will turn off.

5.5. EMERGENCY FIRMWARE UPDATE

In case of the unsuccessful update of the converter software, try again according to description in the above point. If the update is still incorrect use emergency firmware update. Set SW1 microswitch mode as in the table below.

SW1-1	SW1-2
ON	ON

After microswitch setting, should be restarted ADA-4040PC3, by turning OFF and then ON the power supply. The yellow LED will light continuously and the converter will be in Emergency Firmware Update mode. Now follow the description in the above point.
After successful software update, set microswitch SW1 to the RUN mode as shown in the table below.

SW1-1	SW1-2
OFF	OFF

In the RUN mode the yellow LED (located near the SW1), will turn off.

6. DATA TRANSMISSION DIAGNOSTICS

To readout diagnostics, the SW1 microswitch should be set to the configuration mode.

SW1-1	SW1-2
ON	OFF

In the configuration mode the yellow LED will blink with frequency 1Hz.
Correctness of transmission proceed on SUN(RS485) and RTU(RS485) interfaces, can be checked by readout the errors list by *ADAConfig* Software from the converter memory. Frames error counter will be increased, in case of: improper speed set compared to real speed of data transmission. Parity error counter will be count the errors which can arise in case of misrepresent bytes in transmitted sign. This counter will not work in case of disable control parity
To check those counters press the button ***[Read transmission errors],*** and to delete (zeroing of counters in the memory of the converter) press ***[Delete transmission errors].*** In case of parity errors or frame errors, should be checked the ADA-4040PC3 converter's configuration and correctness connection of RS485 bus to RTU and SUN converter's ports.
After finishing the diagnostics, the SW1 microswitch should be set to the run mode as shown in the table below.

SW1-1	SW1-2
OFF	OFF

In the RUN mode the yellow LED (located near the SW1), will turn off.

7. OPERATION

ADA-4040PC3 is bidirectional protocol converter of SunMaster to MODBUS-RTU protocol, **with possibility of conversion a baud rate, a data format (number of data bits, parity bit, stop bits) and interface type RS485 to RS422.** Additionally, is a separator of SunMaster port from MODBUS-RTU port.
ADA-4040PC3 reads data from SunMaster inverter and than properly processed write to registers of MODBUS-RTU protocol (described in pt. *IMPLEMENTATION OF MODBUS-RTU PROTOCOL*).
Frames of MODBUS protocol having the errors CRC are rejected by the converter.
Frames of SunMaster having the errors CRC are also rejected by the converter.
In case of no respond from SunMaster inverter ADA-4040PC3 converter responds exception MODBUS protocol (described in pt. *EXCEPTIONS OF MODBUS-RTU PROTOCOL*)

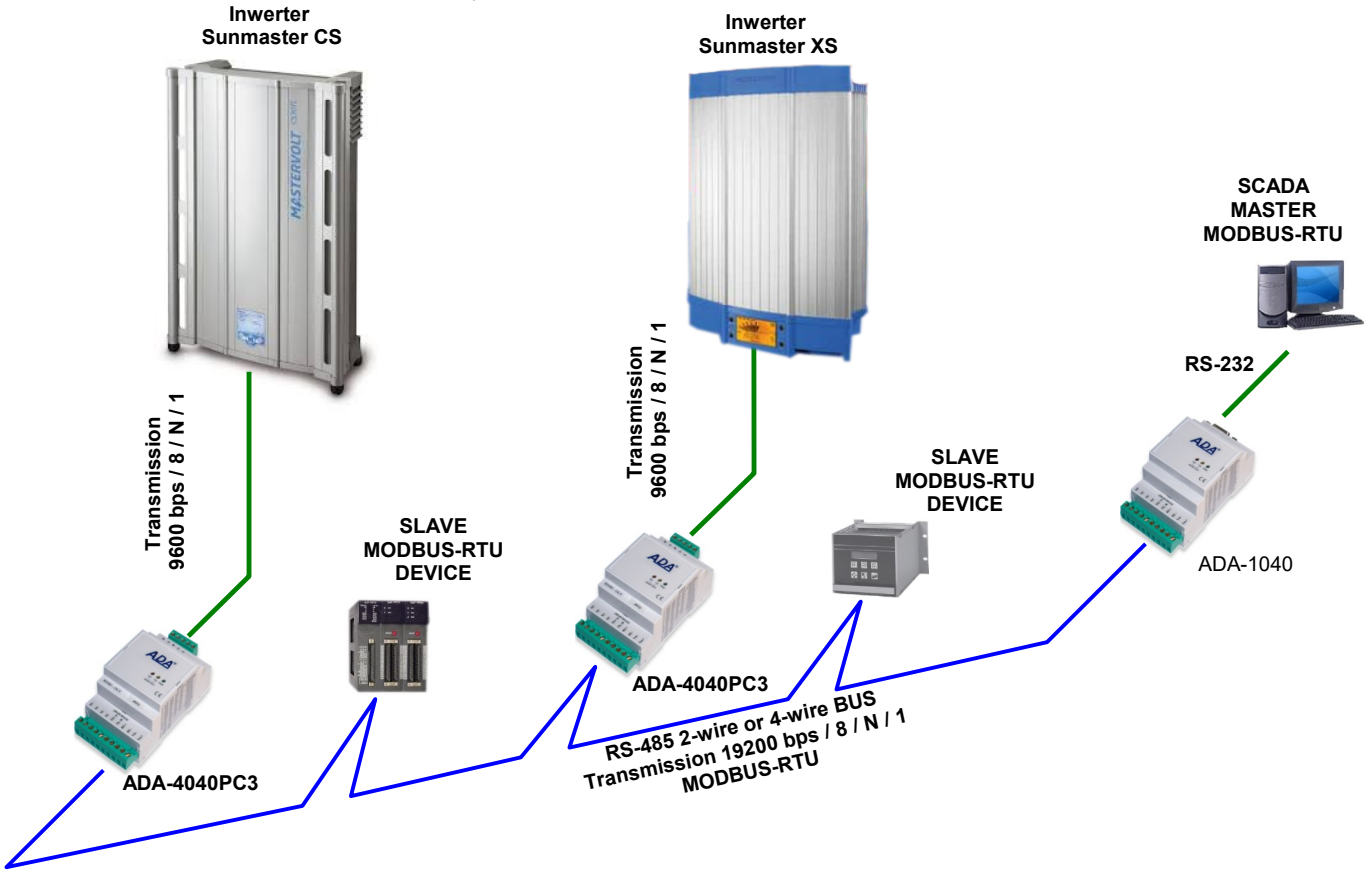

Fig 10. Connection of SunMaster inverters to RS485 MODBUS-RTU bus.

8. IMPLEMENTATION OF MODBUS-RTU PROTOCOL

ADA-4040PC3 protocol converter allows connecting Inverters with SunMaster-Soladin protocol as SLAVE to RS485 MODBUS-RTU bus. The length of RS485 bus can be extended by the use of ADA-4040 repeaters or ADA-4044H HUBs RS485
The MODBUS-RTU protocol used for communication between ADA-4040PC3 converters and SCADA-type system or PLC controller enable easy integration of SunMaster-Soladin inverters in existing automation systems BMS.

8.1. TABLE OF MODBUS-RTU ADDRESSES

8.1.1. REGISTERS ACTUAL VALUE MEASUREMENTS AND CONDITION INVERTER, READOUT BY FUNCTION 04 (3X – REFERENCES) INPUT REGISTERS

Address 3X	Registers Address	Registers description	Attribute	Value
30001	0	TypeIDH = 0x00 TypeIDL 8-bit inverter type	R	16-bit register
30002	1	Status1 Status0 16-bit inverter status	R	16-bit register
30003	2	UsolH UsolL 16-bit solar panel voltage DC measurement	R	16-bit register

Address 3X	Registers Address	Registers description	Attribute	Value
30004	3	IsolH IsolL 16-bit solar panel current DC measurement	R	16-bit register
30005	4	FacH FacL 16-bit network voltage AC frequency measurement	R	16-bit register
30006	5	UacH UacL 16-bit network voltage AC measurement	R	16-bit register
30007	6	IacH IacL 16-bit network current AC measurement	R	16-bit register
30008	7	PacH PacL 16-bit network power AC measurement	R	16-bit register
30009	8	Hi = 0x00 EacH (Low)	R	16-bit register
30010	9	EacM EacL 24-bit energy counter - kWh	R	16-bit register
30011	10	TempH=0x00 TempL 8-bit internal temperature	R	16-bit register
30012	11	Hi=0x00 TonH (Lo)	R	16-bit register
30013	12	TonM TonL 24-bit operating hour counter	R	16-bit register
30014	13	Trecl/UocH Status1, bit4=1 : Trecl/UocL Status1, bit4=0 : 16-bit time from reclosing / 16-bit open terminal voltage	R	16-bit register
30015	14	Hi = 0x00 Rac/Phase network impedance measurement	R	16-bit register

8.1.2. REGISTERS ACTUAL VALUES MEASUREMENTS AND CONDITION INVERTER , READOUT BY FUNCTION 03 (4X – REFERENCES) HOLDING REGISTERS

Address 4X	Registers Address	Registers description	Attribute	Value
40001	0	TypeIDH = 0x00 TypeIDL 8-bit inverter type	R	16-bit register
40002	1	Status1 Status0 16-bit inverter status	R	16-bit register
40003	2	UsolH UsolL 16-bit solar panel voltage measurement DC	R	16-bit register
40004	3	IsolH IsolL 16-bit solar panel current measurement DC	R	16-bit register
40005	4	FacH FacL 16-bit network voltage frequency measurement AC	R	16-bit register
40006	5	UacH UacL 16-bit network voltage measurement AC	R	16-bit register
40007	6	IacH IacL 16-bit network current measurement AC	R	16-bit register
40008	7	PacH PacL 16-bit network power measurement AC	R	16-bit register
40009	8	Hi = 0x00 EacH (Low)	R	16-bit register
40010	9	EacM EacL 24-bit energy counter - kWh	R	16-bit register

Address 4X	Registers Address	Registers description	Attribute	Value
40011	10	TempH=0x00 TempL 8-bit inverter's internal temperature	R	16-bit register
40012	11	Hi=0x00 TonH (Lo)	R	16-bit register
40013	12	TonM TonL 24-bit operating hour counter	R	16-bit register
40014	13	Trecl/UocH Status1, bit4=1 : Trecl/UocL Status1, bit4=0 : 16-bit time from reclosing / 16-bit open terminal voltage	R	16-bit register
40015	14	Hi = 0x00 Rac/Phase network impedance measurement	R	16-bit register

8.2. FRAME STRUCTURE OF MODBUS-RTU PROTOCOL

Device address (1-byte)	*Function (1-byte)*	*Dane (n-bytes)*	*CRC-16Lo (1-byte)*	*CRC-16Hi (1-byte)*

8.3. USED FUNCTIONS OF MODBUS-RTU PROTOCOL

Function code	Description
03 (0x03)	Readout measurement values and Inverter state from registers MODBUS-RTU
04 (0x04)	Readout measurement values and Inverter state from registers MODBUS-RTU

8.3.1. FUNCTION 0x03 / 0x04 - READOUT VALUE MEASUREMENTS AND STATUS FROM INVERTER

8.3.1.1. READOUT OF CURRENT MEASURED VALUE STORED IN 16-BIT REGISTER [4X / 3X-REFERENCES]

Function 0x03 / 0x04 are used for readout of status and measurement values from the INVERTER.
The measurement values readout form MODBUS-RTU register is presented by a 16-bit register.
The registers with the measurement value are in the integer format of 16-bit sign (in C/C++ type short int).

The actual measurement value is obtained from the read register using the following algorithms, using the appropriate factor value DW (see table below).

Table of divider values DW

Measurement	Register Description	Unit of measure	DW factor value
Solar panel voltage	Usol	[V] DC	10
Solar panel current	Isol	[A] DC	100
AC network voltage frequency	Fac	[Hz]	100
AC network voltage	Uac	[V] AC	1
AC network current	Iac	[A] AC	100
AC network power	Pac	[W] AC	1
AC network energy meter	Eac	[kWh] AC	100
Inverter's internal temperature	Temp	[°C]	1
Operating hour counter	Ton	[h]	60
Time from reclosing	Trec	[s]	1
Network impedance measurement	Rac	[Ω]	100

Algorithm 1. Readout register is saved to regular type variable (float) and then divide it by the factor **DW**

```
// Fragment of code in C language (VS6.0) presenting above algorithm
short int siMeasurementReg;
float      fMeasurmentValue
.....
fMeasurmentValue = (float)siMeasurementRegister;
fMeasurmentValue = fMeasurmentValue / DW;
```

Algorithm 2. Readout register is saved to regular type variable 16-bit (short int) and then divide by the factor **DW**, received change of the dividing it is a number of the hundredth parts of the measurement value.

```
// Fragment of code in C language (VS6.0) presenting above algorithm
short int siMeasurementReg;
div_t     div_MeasurmentValue;
......
div_MeasurmentValue = div((int)siMeasurementRegister, DW)
printf( "Total measurement value =  %d\n, hundredth parts of the measurement value = %d\n",
          div_MeasurmentValue.quot, div_MeasurmentValue.rem );
```

Query of register Usol

Byte no	*Designation*	*Size*	*Value [hex]*
00	Inverter address	1 byte	**11 [11 to F7]**
01	Function code	1 byte	**03 / 04**
02	Registry address Hi	1 byte	**00**
03	Registry address Lo	1 byte	**02**
04	Registry number Hi	1 byte	**00**
05	Registry number Lo	1 byte	**01**
06	CRC-Lo	1 byte	**---**
07	CRC-Hi	1 byte	**---**

Example. Query of solar panel voltage **Usol** from registry address 40003 / address 30003

11-03-00-02-00-01-CRCLo-CRCHi
11-04-00-02-00-01-CRCLo-CRCHi

Response with register value Usol

Byte no	Designation	Size	Value [hex]
00	Inverter address	1-byte	**11 [11 to F7]**
01	Function code	1-byte	**03 / 04**
02	Number of data bytes	N-byte	**02**
03	Dane1-Hi	1-byte	**09**
04	Dane1-Lo	1-byte	**60**
05	CRC-Lo	1-byte	**---**
06	CRC-Hi	1-byte	**---**

Example. Readout of solar panel voltage **Usol** from registry address 40003 / address 30003

11-03-02-09-60-CRCLo-CRCHi
11-04-02-09-60-CRCLo-CRCHi

In respond solar panel voltage **Usol** is presented as 2-byte with values:
Usol = 0x0960 => 2400/100 => 24,00 V

Response - in case of error

Byte no	Designation	Size	Value [hex]
00	Inverter address	1-byte	**11 [11 to F7]**
01	Function code	1-byte	**83 / 84**
02	Error code	1-byte	**01 – unknown function** **02 – unknown data address** **03 – unknown data value** **04 – SunMaster inverter not respond or is faulty**
03	CRC-Lo	1-byte	
04	CRC-Hi	1-byte	

8.3.1.2. READOUT OF CURRENT MEASURED VALUE STORED IN TWO 16-BIT REGISTERS [4X / 3X-REFERENCES]

Function 0x03 / 0x04 are used for readout of status and measurement values from the INVERTER.
The measurement values readout form MODBUS-RTU register is presented by two 16-bit registers.

The registers with the measurement value are in the integer format of 32-bit sign (in C/C++ type int).

The actual measurement value is obtained from the read register using the following algorithms, using the appropriate factor value **DW** (see table above)

Algorithm 1. Readout register is saved to regular type variable (float) and then divide it by the factor **DW**.

```
// Fragment of code in C language (VS6.0) presenting above algorithm
int       iMeasurementReg;
float     fMeasurmentValue
......
fMeasurmentValue = (float)iMeasurementRegister;
fMeasurmentValue = fMeasurmentValue / DW;
```

Algorithm 2. Readout register is saved to regular type variable 32-bit (int) and then divide by the factor **DW**, received change of the dividing it is a number of the hundredth parts of the measurement value.

```
// Fragment of code in C language (VS6.0) presenting above algorithm
int       iMeasurementReg;
div_t     div_MeasurmentValue;
......
div_MeasurmentValue = div((int)iMeasurementRegister, DW)
printf( "Total measurement value =  %d\n, hundredth parts of the measurement value  = %d\n",
          div_MeasurmentValue.quot, div_MeasurmentValue.rem );
```

Query of register Eac

Byte no	Designation	Size	Value [hex]
00	Inverter address	1 byte	**11 [11 to F7]**
01	Function code	1 byte	**03 / 04**
02	Registry address Hi	1 byte	**00**
03	Registry address Lo	1 byte	**08**
04	Registry number Hi	1 byte	**00**
05	Registry number Lo	1 byte	**02**
06	CRC-Lo	1 byte	**---**
07	CRC-Hi	1 byte	**---**

Example. Query of AC network energy meter **Eac** from registry address 40009 / address 30009

11-03-00-08-00-02-CRCLo-CRCHi
11-04-00-08-00-02-CRCLo-CRCHi

Response with register value Eac

Byte no	Designation	Size	Value [hex]
00	Inverter address	1-byte	**11 [11 to F7]**
01	Function code	1-byte	**03 / 04**
02	Number of data bytes	N-byte	**04**
03	Dane1-Hi	1-byte	**00**
04	Dane1-Lo	1-byte	**00**
05	Dane2-Hi	1-byte	**0B**
06	Dane2-Lo	1-byte	**90**
07	CRC-Lo	1-byte	**---**
08	CRC-Hi	1-byte	**---**

Example. Readout of AC network energy meter Eac from registry address 40009 / address 30009

11-03-04-00-00-0B-90-CRCLo-CRCHi
11-04-04-00-00-0B-90-CRCLo-CRCHi

In respond the value of AC network energy meter **Eac** is presented as 4-byte with values:
Eac = 0x00000B90 => 2960/100 => 29,60 kWh

Response - in case of error

Byte no	Designation	Size	Value [hex]
00	Inverter address	1-byte	**11 [11 do F7]**

Byte no	Designation	Size	Value [hex]
01	Function code	1-byte	**83 / 84**
02	Error code	1-byte	**01 - unknown function** **02 - unknown data address** **03 - unknown data value** **04 - SunMaster inverter not respond or is faulty**
03	CRC-Lo	1-Bajt	
04	CRC-Hi	1-Bajt	

8.3.1.3. READOUT OF SOLAR PANEL VOLTAGE VALUE Usol FROM INVERTER [4X / 3X-REFERENCES]

The measurement value of solar panel voltage, readout from 16-bit register **Usol** MODBUS-RTU (see p.8.1.) is presented in the format integer 16-bit with sign (in C/C++ type short int).

Query of solar panel voltage **Usol** from registry address 40003 / address 30003

11-03-00-02-00-01-CRCLo-CRCHi
11-04-00-02-00-01-CRCLo-CRCHi

Readout of solar panel voltage **Usol** from registry address 40003 / address 30003

11-03-02-00-F0-CRCLo-CRCHi
11-04-02-00-F0-CRCLo-CRCHi

In respond the solar panel voltage **Usol** is presented as 2-byte with values: 0x00F0.

The actual measurement value expressed in [V] DC is obtained from the read register according to the above algorithms, using the appropriate factor value **DW** for register **Usol** (*see the **Table of divider values DW*** above).

Usol = 0x00F0 => 240/10 => 24,00 [V] DC

8.3.1.4. READOUT OF SOLAR PANEL CURRENT VALUE Isol FROM INVERTER [4X / 3X-REFERENCES]

The measurement value of solar panel current, readout from 16-bit register **Isol** MODBUS-RTU (see p.8.1.) is presented in the format integer 16-bit with sign (in C/C++ type short int).

Query of solar panel current **Isol** from registry address 40004 / address 30004

11-03-00-03-00-01-CRCLo-CRCHi
11-04-00-03-00-01-CRCLo-CRCHi

Readout of solar panel current **Isol** from registry address 40004 / address 30004

11-03-02-00-F0-CRCLo-CRCHi
11-04-02-00-F0-CRCLo-CRCHi

In respond the solar panel current **Isol** is presented as 2-byte with values: 0x00F0 .

The actual measurement value expressed in [A] DC is obtained from the read register according to the above algorithms, using the appropriate factor value **DW** for register **Isol** (see the ***Table of divider values DW*** above).

Isol = 0x00F0 => 240/100 => 2,40 [A] DC

8.3.1.5. READOUT OF FREQUENCY VALUE Fac ALTERNATING VOLTAGE NETWORK, CONNECTED TO INVERTER [4X / 3X-REFERENCES]

The measurement value of frequency alternating voltage network to inverter, readout from 16-bit register **Fac** MODBUS-RTU (see p.8.1.) is presented in the format integer 16-bit with sign (in C/C++ type short int).

Query of frequency network **Fac** from registry address 40005 / address 30005

11-03-00-04-00-01-CRCLo-CRCHi
11-04-00-04-00-01-CRCLo-CRCHi

Readout of frequency network Fac from registry address 40005 / address 30005

11-03-02-13-88-CRCLo-CRCHi
11-04-02-13-88-CRCLo-CRCHi

In respond the frequency network **Fac** is presented as 2-byte with values: 0x1388 .

The actual measurement value expressed in [Hz] is obtained from the read register according to the above algorithms, using the appropriate factor value **DW** for register **Fac** (see the ***Table of divider values DW***).

Fac = 0x1388 => 5000/100 => 50,00 [Hz]

8.3.1.6. READOUT OF VOLTAGE VALUE Uac ALTERNATING VOLTAGE NETWORK,

CONNECTED TO INVERTER [4X / 3X-REFERENCES]

The measurement value of network voltage and alternating voltage connected to the inverter, readout from 16-bit register **Uac** MODBUS-RTU (see p.8.1.) is presented in the format integer 16-bit with sign (in C/C++ type short int).

Query of network voltage **Uac** from registry address 40006 / address 30006

11-03-00-05-00-01-CRCLo-CRCHi
11-04-00-05-00-01-CRCLo-CRCHi

Readout of network voltage **Uac** from registry address 40006 / address 30006

11-03-02-00-DF-CRCLo-CRCHi
11-04-02-00-DF-CRCLo-CRCHi

In respond the network voltage **Uac** is presented as 2-byte with values: 0x00DF

The actual measurement value expressed in [V] AC is obtained from the read register according to the above algorithms, using the appropriate factor value **DW** for register **Uac** (see the ***Table of divider values DW*** above).

Uac = 0x00DF => 223/1 => 223 [V] AC

8.3.1.7. READOUT OF CURRENT VALUE Iac ALTERNATING VOLTAGE NETWORK, CONNECTED TO INVERTER [4X / 3X-REFERENCES]

The measurement value of network current alternating voltage connected to the inverter, readout from 16-bit register **Iac** MODBUS-RTU (see p.8.1.) is presented in the format integer 16-bit with sign (in C/C++ type short int).

Query of network current **Iac** from registry address 40007 / address 30007

11-03-00-06-00-01-CRCLo-CRCHi
11-04-00-06-00-01-CRCLo-CRCHi

Readout of network current **Iac** from registry address 40006 / address 30006

11-03-02-00-DF-CRCLo-CRCHi
11-04-02-00-DF-CRCLo-CRCHi

In respond the network current **Iac** is presented as 2-byte with values: 0x00DF

The actual measurement value expressed in [A] AC is obtained from the read register according to the above algorithms, using the appropriate factor value **DW** for register **Iac** (see the ***Table of divider values DW*** above).

Iac = 0x00DF => 223/100 => 2,23 [A] AC

8.3.1.8. READOUT OF POWER VALUE Pac ALTERNATING VOLTAGE NETWORK OF INVERTER [4X / 3X-REFERENCES]

The measurement value of network power alternating voltage connected to the inverter, readout from 16-bit register **Pac** MODBUS-RTU (see p.8.1.) is presented in the format integer 16-bit with sign (in C/C++ type short int).

Query of inverter power network **Pac** from registry address 40008 / address 30008

11-03-00-07-00-01-CRCLo-CRCHi
11-04-00-07-00-01-CRCLo-CRCHi

Readout of inverter power network **Pac** from registry address 40008 / address 30008

11-03-02-00-06-CRCLo-CRCHi
11-04-02-00-06-CRCLo-CRCHi

In respond the inverter power network **Pac** is presented as 2-byte with values: 0x0006

The actual measurement value expressed in [W] AC is obtained from the read register according to the above algorithms, using the appropriate factor value **DW** for register **Pac** (see the ***Table of divider values DW*** above).

Pac = 0x0006 => 6/1 => 6 [W] AC

8.3.1.9. READOUT OF ENERGY VALUE Eac TRANSFERRED TO ALTERNATING VOLTAGE NETWORK, CONNECTED TO INVERTER [4X / 3X-REFERENCES]

The measurement value of energy transferred to alternating voltage network connected to the inverter, readout from two 16-bit registers **Eac** MODBUS-RTU (see p.8.1.) is presented in the format integer 32-bit with sign (in C/C++ type int).

Query of energy transferred to network **Eac** from registry address 40009 / address 30009

11-03-00-08-00-02-CRCLo-CRCHi
11-04-00-08-00-02-CRCLo-CRCHi

Readout of energy transferred to network **Eac** from registry address 40009 / address 30009

11-03-04-00-00-00-DF-CRCLo-CRCHi
11-04-04-00-00-00-DF-CRCLo-CRCHi

In respond the energy transferred to network **Eac** is presented as 4-byte with values: 0x000000DF .

The actual measurement value expressed in [kWh] AC is obtained from the read register according to the above algorithms, using the appropriate factor value **DW** for register **Eac** (see the ***Table of divider values DW*** above).

Eac = 0x000000DF => 223/100 => 2,23 [kWh] AC

8.3.1.10. READOUT OF VALUE INVERTER TEMPERATURE [4X / 3X-REFERENCES]

The measurement value of inverter temperature, readout from 16-bit register **Temp** MODBUS-RTU (see p.8.1.) is presented in the format integer 16-bit with sign (in C/C++ type short int).

Query of inverter temperature Temp from registry address 40011 / address 30011

11-03-00-0A-00-01-CRCLo-CRCHi
11-04-00-0A-00-01-CRCLo-CRCHi

Readout of inverter temperature Temp from registry address 40011 / address 30011

11-03-02-00-20-CRCLo-CRCHi
11-04-02-00-20-CRCLo-CRCHi

In respond the inverter temperature **Temp** is presented as 2-byte with values: 0x0020 .

The actual measurement value expressed in [°C] is obtained from the read register according to the above algorithms, using the appropriate factor value **DW** for register **Temp** (see the ***Table of divider values DW*** above).

Temp = 0x0020 => 32/1 => 32 [°C]

8.3.1.11. READOUT OF VALUE INVERTER'S RUNNING TIME [4X / 3X-REFERENCES]

The value of inverter's running time, readout from 16-bit register **Ton** MODBUS-RTU (see p.8.1.) is presented in the format integer 32-bit with sign (in C/C++ type int).

Query of inverter's running time Ton from registry address 40012 / address 30012

11-03-00-08-0B-02-CRCLo-CRCHi
11-04-00-08-0B-02-CRCLo-CRCHi

Readout of inverter's running time Ton from registry address 40012 / address 30012

11-03-04-00-00-F0-DF-CRCLo-CRCHi
11-04-04-00-00-F0-DF-CRCLo-CRCHi

In respond the inverter's running time **Ton** is presented as 4-byte with values: 0x0000F0DF .

The actual measurement value expressed in [h] is obtained from the read register according to the above algorithms, using the appropriate factor value **DW** for register **Ton** (see the ***Table of divider values DW*** above).

Ton = 0x0000F0DF => 61663/60 => 1027.72 [h]

8.3.1.12. READOUT OF INVERTER'S STATUS [4X / 3X-REFERENCES]

The value of inverter's status, readout from 16-bit register **Status** MODBUS-RTU (see p.8.1.) is presented in the format integer 16-bit with sign (in C/C++ type short int).

Query of inverter's status **Status** from registry address 40002 / address 30002

11-03-00-01-00-01-CRCLo-CRCHi
11-04-00-01-00-01-CRCLo-CRCHi

Readout of inverter's status **Status** from registry address 40002 / address 30002

11-03-02-00-2A-CRCLo-CRCHi
11-04-02-00-2A-CRCLo-CRCHi

In respond the inverter's status **Status** is presented as 2-byte with values: 0x002A, Bin = 00000000:00101010 .

Inverter's status can be read from table bellow.

Table register of inverter's status

Bit	*High byte of State Inverter*	*Bit*	*Low byte of State Inverter*
0	Insulation fault 0 - NO 1 - YES	0	Panel voltage Usol - High 0 - NO 1 - YES
1	Reserved (0)	1	Panel voltage - Low 0 - NO 1 - YES
2	Shutdown by any hardware failure 0 - NO 1 - YES	2	No network / Shutdown by any network error (ENS) 0 - NO 1 - YES
3	Reserved (0)	3	Network voltage Uac - High 0 - NO

Bit	*High byte of State Inverter*	*Bit*	*Low byte of State Inverter*
			1 - YES
4	Reserved (0)	4	Network voltage Uac - Low 0 - NO 1 - YES
5	Reserved (0)	5	Network frequency Fac - High 0 - NO 1 - YES
6	Inverter remotely off 0 - NO 1 - YES	6	Network frequency Fac - Low 0 - NO 1 - YES
7	Inverter on 0 - NO 1 - YES	7	Inverter temperature - High 0 - NO 1 - YES

8.4. EXCEPTIONS OF THE MODBUS-RTU PROTOCOL

ADA-4040PC-3 in case of received MODBUS-RTU frame, includes:
- unsupported function,
- unknown data address,
- unknown data value
- or when SunMaster inverter not respond on inquiries

returns to MASTER type device the frame containing the appropriate exception – described below.

Response – in case of error

Byte no	Designation	Size	Value [hex]
00	Inverter address	1-Byte	**11 [11 to F7]**
01	Function code	1-Byte	**83 / 84**
02	Error code	1-Byte	**01 – unknown function** **02 – unknown data address** **03 – unknown data value** **04 – SunMaster inverter not respond or is faulty**
03	CRC-Lo	1-Byte	
04	CRC-Hi	1-Byte	

9. VERSIONS

ADA- 4040PC3 - [ ] - [ ]

Version:	
Standard	**1**
3-way galvanic isolation:	
1kV=	**23**
3kV=	**33**

Order example:
Product Symbol: **ADA-4040PC3-1-23**
1 – standard version,
23 – 1kV=, 3-way galvanic isolation,

10. SPECIFICATION

TECHNICAL DATA		
Transition Parameters		
Interface	**RS-485/RS-422 (SUN)**	**RS-485/RS-422 (RTU)**
Connector	Screw terminal, wire max. Ø 2,5mm^2	Screw terminal, wire max. Ø 2,5mm^2
Line length	1200m (depends on baud rate)	1200m (depends on baud rate)
Max. number of connected device	Up to 32 devices	
Baud rates (bps)	300, 600, 1200, 1800, 2400, 4800, 7200, 9600, 14400, 19200, 28800, 38400, 57600, 76800, 115200, 230400,	
Data formats	Data bits 5, 6, 7, 8, Parity: None, Parity, Odd, Number of stop bits: 1, 2,	
Transmission line	Twisted cable 1-pair or 2-pair, UTP Nx2x0,5 (24AWG), shield inside large interferences STP Nx2x0,5(24AWG).	
Transmission type	Asynchronism full duplex, half duplex.	

Standards	EIA-485, CCITT V.11	
Protocol	**SunMaster**	**Modbus-RTU**
Optical signalisation	• PWR – green LED power supply, • RX - red LED data receiving from RTU port – RS485/RS422, • TX - yellow LED data transmission through RTU port – RS485/RS422.	
Electrical Parameters		
Power requirements	10 - 24 – 30 V DC	
Power Cable	Recommended length of power cable – up to 3m.	
Power	<2W	
Protection from reverse power polarization	YES	
Galvanic Isolation	1kVDC or 3kVDC between power circuit and RS-485/RS-422 SUN and RTU signal line – depend on version.	
Optoisolation	~3kV - between signal line RS-485/RS-422 (SUN) and RS-485/RS-422 (RTU)	
Electromagnetic compatibility	Resistance to disruptions according to the standard PN-EN 55024. Emission of disruptions according to the standard PN-EN 55022.	
Safety requiring	According to the PN-EN60950 norm.	
Environment	Commercial and light industrial.	
Environmental Parameters		
Operating temperature	- 30°C ÷ 60°C	
Humidity	5 ÷ 95% - non-condensing	
Storage temperature	-40 ÷ 70 °C	
Casing		
Dimensions	53 x 90 x 62 mm	
Material	PC/ABS	
Degree of casing protection	IP40	
Degree of terminal protection	IP20	
Weight	0,10 kg	
According to standard	DIN EN50022, DIN EN43880	
Location during work	Free	
Mounting method	On the rail compliant with DIN35 / TS35 standard.	

* - Names of companies and logotypes have been used only for informational purposes.

Dear Customer,

Thank you for purchasing **CEL-MAR Company** products.

We hope that this user manual helped connect and start up the **ADA-4040PC3 converter**. We also wish to inform you that we are a manufacturer of the widest selections of data communications products in the world such as: data transmission converters with interface RS232, RS485, RS422, USB, Current Loop, Fibre-Optic Converters and Ethernet or Wi-Fi.
Please contact us to tell how you like our products and how we can satisfy you present and future expectation.

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