NOKIAN CAPACITORS

NC-12 Modbus Application

USER'S MANUAL

Modbus application
USER'S MANUAL

1 Table of Contents

2 Glossary

PFC	Power Factor Controller, type NC-12.
MCU	Modbus Coupler Unit, RS-485 adapter for fiber or RS-232.
CCA	Controller Communication Adapter, fiber output module for PFC.
PSU	Power Supply Unit.
RS-232	Serial communication standard. Typically used in short distances. Used to connect a PC.
RS-485	Serial communication standard. Designed for longer distances and for noisy environments (industrial use).
SCADA	Supervisory Control And Data Acquisition software is a control room software.
NC	Nokian Capacitors

3 NC-12 Modbus in general

This manual describes the Modbus feature of the PF, its installation and operation.

A PFC has a remote control feature using serial communications. The communication port requires an external CCA module installed on the PFC. The CCA provides the fiber a connection port. Remote control protocol is Modbus. The PFC is a Modbus slave device. With additional MCUs, a fiber port may be adapted to an RS-485 bus for long distances or for bus architecture. With an MCU, a PCs serial port can be adapted to the RS-485 bus. The PC acts as master of the Modbus bus and it needs the necessary software to read PFC slaves. Typically SCADA systems are used to collect data and display it.

Version of the manual:

Version 0.01	25.08.2004
Version 0.02	05.11.2004 (Proof read)

4 Entire system

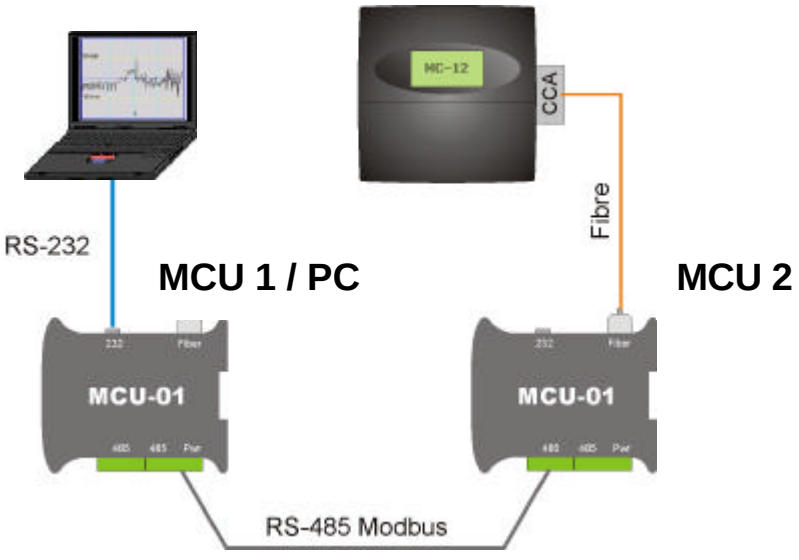
In the following chapters there are two alternatives for connections between the MCU to PFC and the MCU to PC. The selection depends on the distances between modules and the number of PFCs in the system.

4.1 PFC to PC connection alternatives

The PFC always needs a CCA module when a remote control is used. The CCA module has a dedicated connector on the PFC. The CCA and MCU have fiber connectors.

4.1.1 One PFC

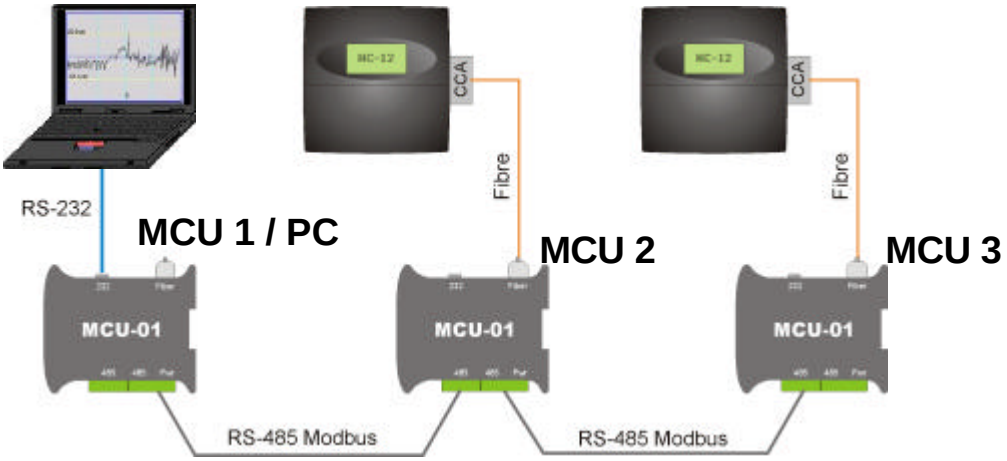
A fiber is adapted to an RS-485 bus connecting the MCU module. Maximum length of the RS-485 bus is 1 km. Additional PFC modules can be easily connected to the bus. MCU 1 / PC adapts the RS-485 bus to the RS-232 port.



Picture 1: One PFC system

4.1.2 Many PFCs system

In the following picture is a two PFC system. The same architecture is useable for 1 to 128 PFCs in the system.



Picture 2: Two PFCs in the system

5. Physical connections

All cables and connectors used are described in this chapter.

5.1 Fiber optic connection

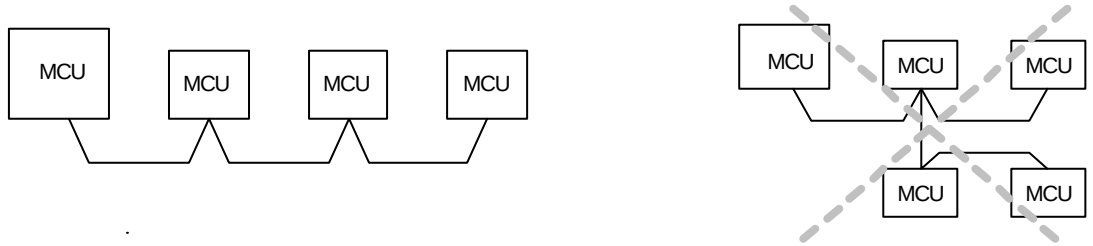
The fiber optic cable is used to connect the CCA and the MCU. The fiber type used is 1 mm POF (Polymer Optic Fiber) duplex fiber or equivalent. Plugs on the fiber ends prevent the fiber from being wrongly assembled. The fiber connection is a so-called crossover connection, where the transmitter (gray) is connected to the receiver (blue). Maximum length of the fiber is 30 m (90 ft). Minimum bending radius for this type of fiber is 17 mm.

5.2 RS-485 interface

The PFC is connected to an RS-485 bus with an MCU module. All MCU modules are connected in parallel to a bus and the PC acts as the master of

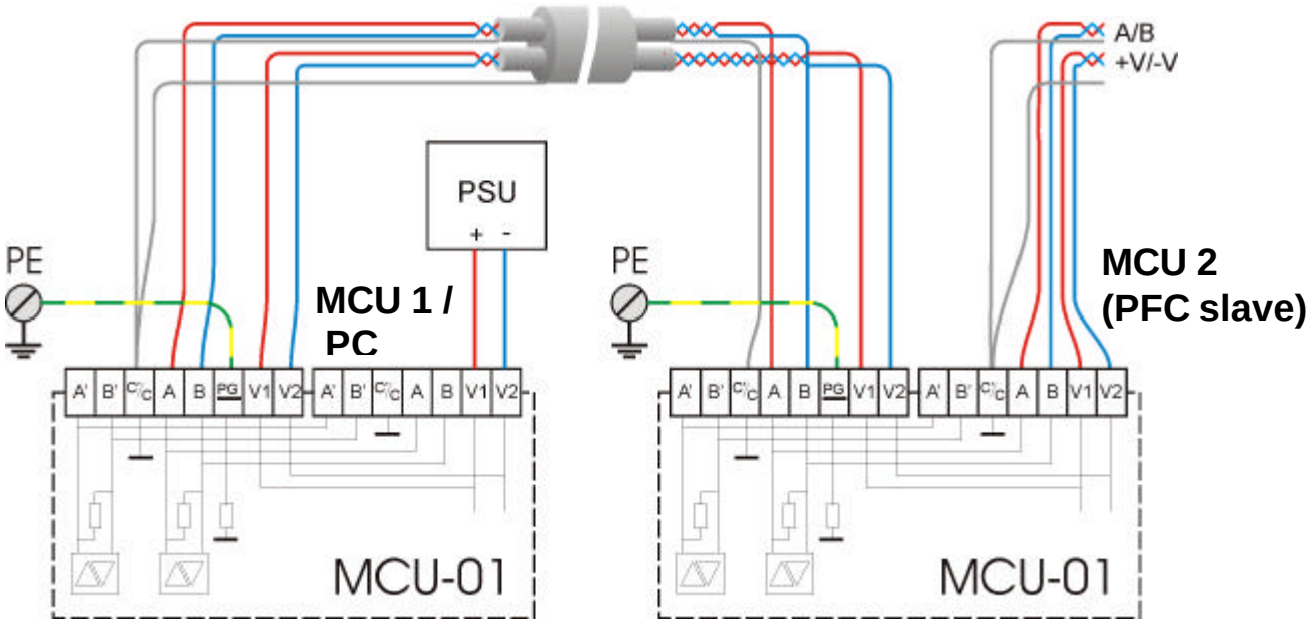
the bus. A parallel connection means that the same pair of cables is connected to the same connectors in all modules. A bus master is connected using a crossover connection (transmitter to receiver pair). A crossover connection is used only in a 4-wire connection. An RS-485 connection is either a 2- or 4-wire connection.

Modules are connected sequentially, branches on the cable are not allowed. The bus is completed with terminator resistors. One terminator is at each end of the bus. One module feeds biasing voltages to the bus. A PC connector grounds each module.



Picture 3: Correct structure of an RS-485 bus

5.3 2-wire connection in an RS-485 bus



Picture 4: 2-wire connection in an RS-485 bus

The cable type used is **Jamak 2x(2+1)x0,5**.

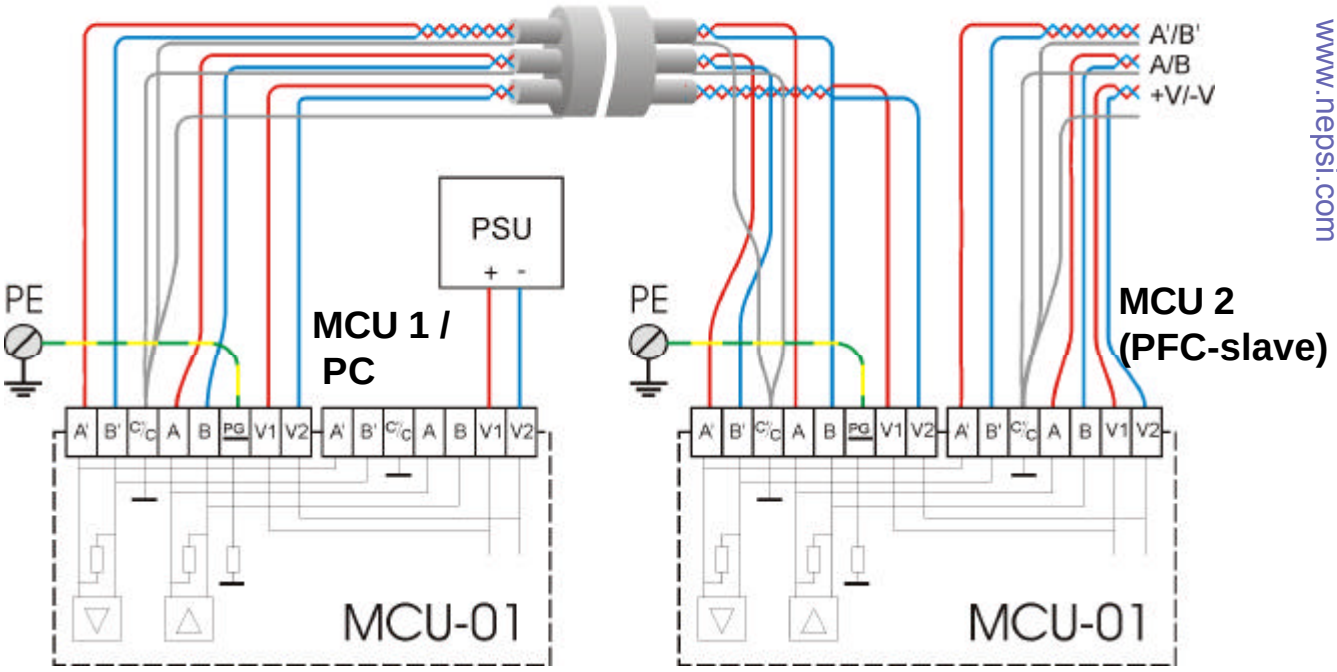
In the following table all pins in the same row are connected together.

MCU #1 / PC	MCU #2	MCU #3	MCU #4	MCU #n
A	A	A	A	A
B	B	B	B	B
C/C'	C/C'	C/C'	C/C'	C/C'

Table 1: RS-485 bus connections using 2-wire cabling

Note: The PC can be placed in any position on the RS-485 bus

5.4 4-wire connection in an RS-485 bus



Picture 5: 4-wire connection in an RS-485 bus

The cable type used is **Jamak 2x(2+1)x0,5**.

In the following table all pins in the same row are connected together.

MCU #1 / PC	MCU #2	MCU #3	MCU #4	MCU #n
A	A'	A'	A'	A'
B	B'	B'	B'	B'
C/C'	C/C'	C/C'	C/C'	C/C'
A'	A	A	A	A
B'	B	B	B	B

Table 2: RS-485 bus connections using 4-wire cabling

Note: The cross over connection between the MCU #1 / PC and MCU #2 (PFC slaves).

5.5 RS-232 connector on the MCU

The connector type is **RJ-22 4P4C**. Pin descriptions:

MCU pin	Id	Description	PC pin
1	TX	Transmit	2
2	GND	Ground	5
3	RX	Receiver	3
4	GND	Ground	5

Table 3: RS-232 cable between the MCU and PC

5.6 Power supply

The MCU has dedicated power supply pins on the RS-485 connectors. The voltage is +10…+30 V DC or 10…20 V AC. Power consumption is about 2 W / module.

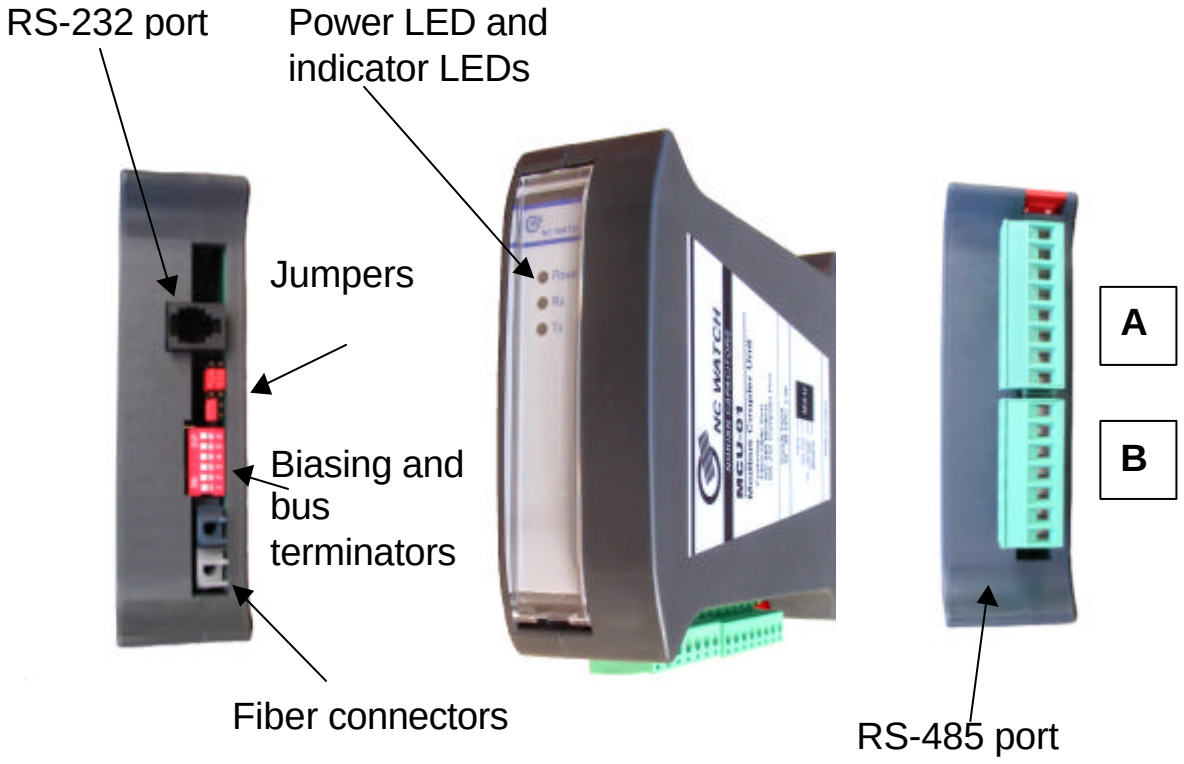
The power supply can be common for all modules or every module may have its own power supply. Power from the common supply is fed to modules using an extra pair of RS-485 cabling. Total power consumption depends on the power requirements of all modules plus power loss of cabling. A decrease in voltage will be noticed with longer cables. Power pins in the MCU are

equipped with a rectifier. None of the pins are directly connected to the ground.

6 Device descriptions

6.1 MCU

The MCU has an RS-485 port (dual connectors A and B, for cascading purposes), fiber connectors and an RS-232 port. Used ports are selected with jumpers in an MCU. Bias voltages and bus terminators have their own DIP switches. In the front panel there is a power LED and status indication LEDs for communication. The MCU is DIN rail mountable.



Picture 6: Connectors in MCU

6.1.1 RS-485 port and power supply

Connector A: Connector type is Phoenix Contact MSTB 2,5/8-ST-5,08.

Pin	Id	Description
A1	A'	+ Rx RS-485 4-wire bus
A2	B'	- Rx RS-485 4-wire bus
A3	C/C'	Ground
A4	A	+ Tx/Rx RS-485 2-wire bus
A5	B	- Tx/Rx RS-485 2-wire bus
A6	PG	1 Mς to ground. Protective ground.
A7	V1 +	Power supply + 10 …+ 30 VDC or 10…20 VAC (2 W)
A8	V2 -	Power supply

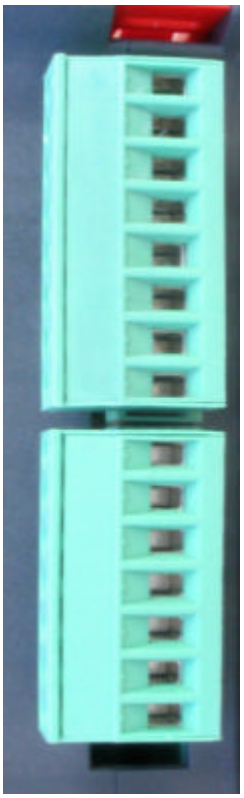
Table 4a: RS-485 port A pins

Connector B: For cascading **purposes and** it is connected parallel with connector A. Connector type is Phoenix Contact MSTB 2,5/7-ST-5,08.

Pin	Id	Description
B1	A'	+ Rx RS-485 4- wire bus
B2	B'	- Rx RS-485 4- wire bus
B3	C/C'	Ground
B4	A	+ Tx/Rx RS-485 2- wire bus
B5	B	- Tx/Rx RS-485 2- wire bus
B6	V1 +	Power supply + 10 …+ 30 VDC or 10…20 VAC
B7	V2 -	Power supply

Table 4b: RS-485 port B pins

Note: The difference in pin counts and pin order.



Picture 7: RS-485 pin numbers

6.1.2 RS-232 port

Connector type is **RJ-22 4P4C**.

Pin order:

Pin	Id	Description
1	TX	Transmit
2	GND	Ground
3	RX	Receive
4	GND	Ground

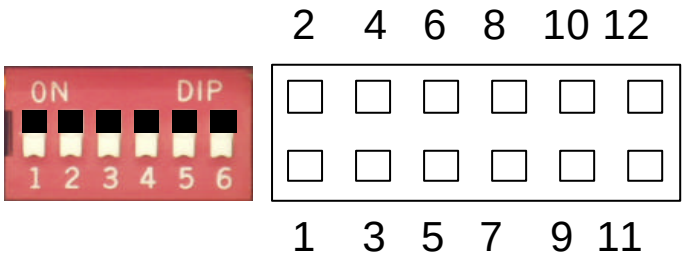
Table 5: RS-232 port pins

6.1.3 Fiber connector

Fiber connector types are HFBR-1522 (transmit, gray) and HFBR-2522 (receiver, blue). Socket type is HFBR-4506. Fiber type is 1 mm POF (Polymer Optic Fiber) duplex fiber or equivalent.

6.1.4 Jumpers on MCU

In the following table are all the legal jumpering alternatives on an MCU.

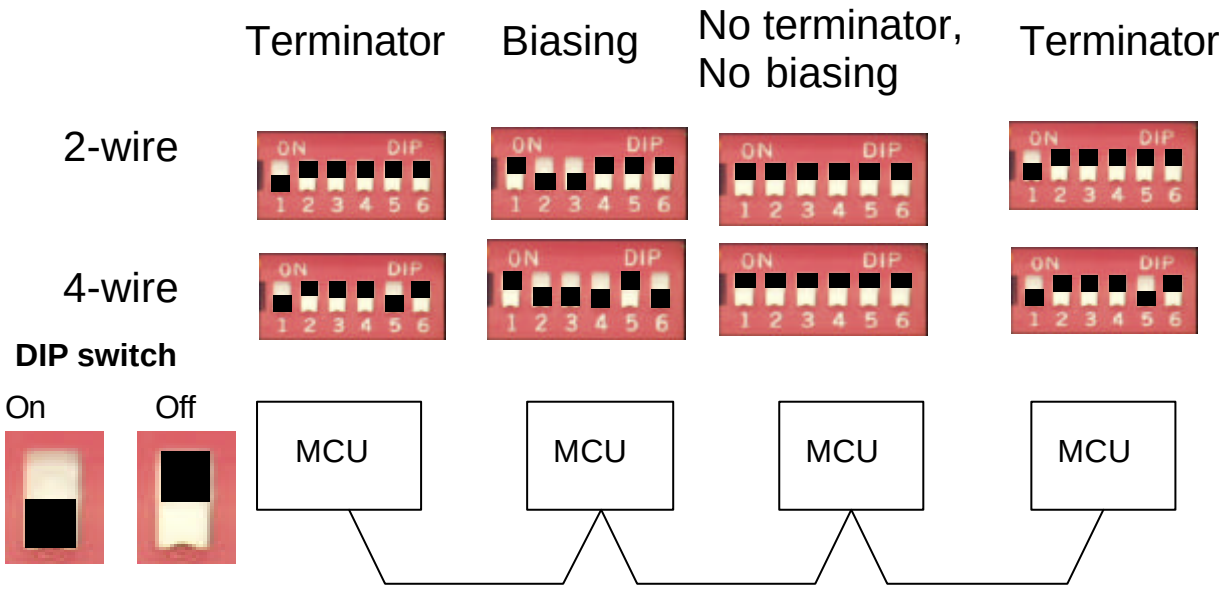


Picture 8: Jumpers on an MCU

Modbus	PFC	Jumpers
RS-485 2-wire	Fiber	
RS-485 2-wire	RS-232	
RS-485 4-wire	Fiber	
RS-485 4-wire	RS-232	

Table 6: Jumpers on MCU

6.1.5 Terminators and biasing on an RS-485 bus



Picture 9: Terminators and biasing on an RS-485 bus

Set the DIP switches according to the picture above in the MCU to connect terminators and biasing voltages to an RS-485 bus. Terminators are connected to both ends of the bus. Bias voltages are fed from only one device in the bus. When a 2-wire bus is used, terminators and biasing is needed only for the used pair.

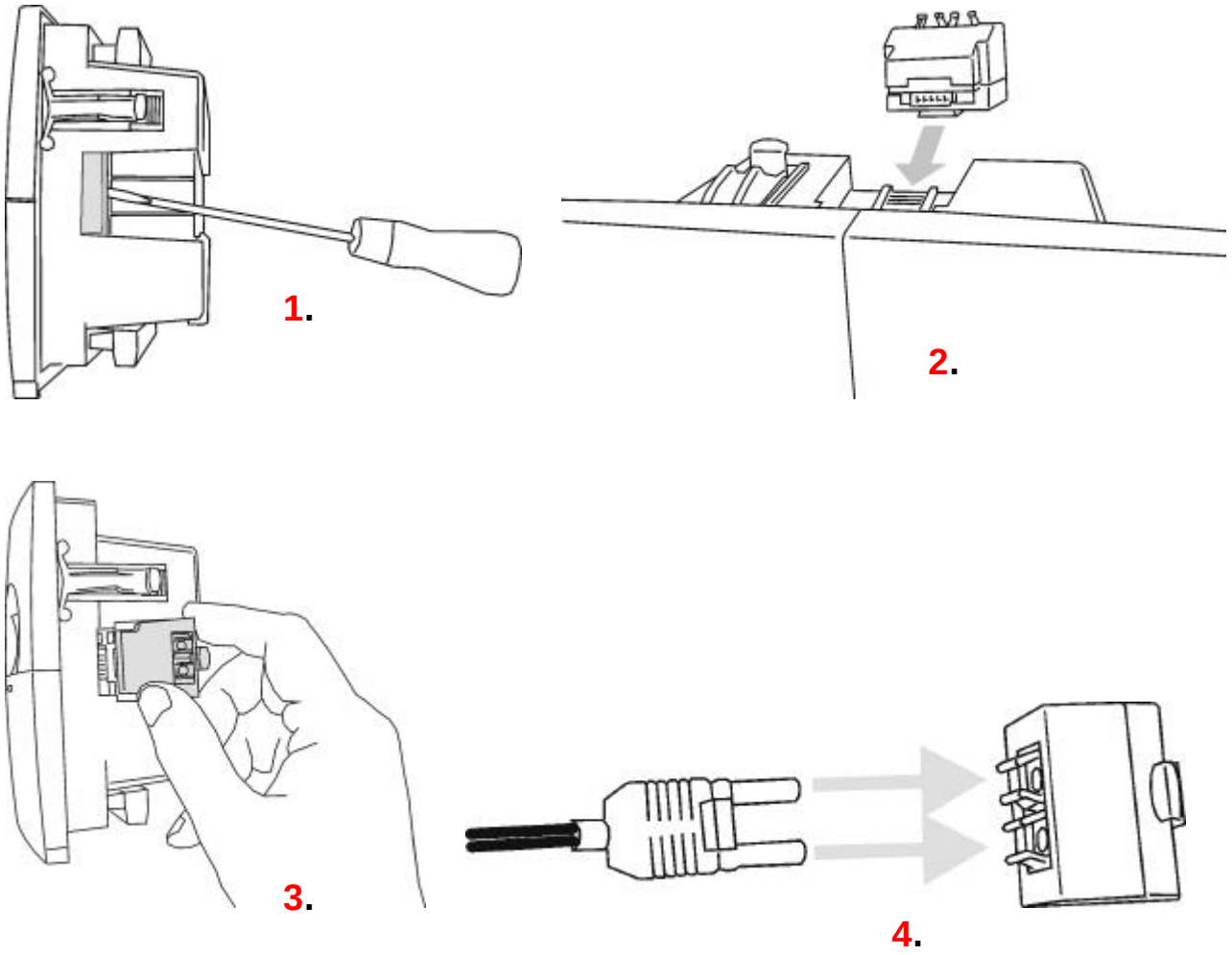
Switch	Signal	Effect
DIP1	AB	Terminator
DIP2	B	- Bias voltage
DIP3	A	+ Bias voltage
DIP4	B'	- Bias voltage
DIP5	A'B'	Terminator
DIP6	A'	+ Bias voltage

Table 7: Terminators and biasing on an RS-485 bus

6.2 PFC and CCA

A remote application needs a PFC and CCA. See manufacturer's manual for more information.

6.2.1 How to connect the CCA to the PFC



Picture 10: Installing procedure for CCA

1. Remove the cover of the connector
2. Slide the CCA into the connector track
3. Check that the CCA is properly installed
4. Remove the protect plugs and connect the fiber cable

7 Modbus register map for NC-12 PFC

7.1 Modbus function 4

- 32-bit values reserve two consecutive registers.
- Most significant part of a 32-bit value is the first register (lower index).
- 8-bit values are stored into 16-bit registers

Type	
S32	Signed 32-bit value
U32	Unsigned 32-bit value
S16	Signed 16-bit value
U16	Unsigned 16-bit value
S8	Sign extended 8-bit value
U8	Unsigned 8-bit value

Table 8: Value types

Index	Name	Unit	Type
1	Active Power	W	S32
3	Reactive Power	var	S32
5	Apparent Power	VA	S32
7	Active Current	mA	S32
9	Reactive Current	mA	S32
11	Apparent current	mA	S32
13	Voltage	V	U32
15	Step 1: Number of connections		U32
17	Step 2: Number of connections		U32
19	Step 3: Number of connections		U32
21	Step 4 Number of connections		U32
23	Step 5 Number of connections		U32
25	Step 6 Number of connections		U32
27	Step 7 Number of connections		U32
29	Step 8 Number of connections		U32
31	Step 9 Number of connections		U32
33	Step 10 Number of connections		U32
35	Step 11 Number of connections		U32
37	Step 12 Number of connections		U32

Index	Name	Unit	Type
39	Operation time of the regulator	h	U32
41	Serial Number		U32
43	Software version		U16
44	Voltage distortion	0,1%	U16
45	Cos f : Pos=Ind, Neg=Cap 100=1.00	0,01	S16
46	Status of steps: bit/relay 1=ON		U16
47	Latched alarms (alarms in memory) bits in table 13		U16
48	Internal temperature	°C	S8
49	External temperature	°C	S8
50	Voltage harmonics 3rd	0,1%	U16
51	Voltage harmonics 5th	0,1%	U16
52	Voltage harmonics 7th	0,1%	U16
53	Voltage harmonics 9th	0,1%	U16
54	Voltage harmonics 11th	0,1%	U16
55	Voltage harmonics 13th	0,1%	U16
56	Voltage harmonics 15th	0,1%	U16
57	Voltage harmonics 17th	0,1%	U16
58	Voltage harmonics 19th	0,1%	U16
59	Voltage harmonics 21st	0,1%	U16
60	IRMS/I1	0,01	U16
61	Broken status of steps: bit/relay 1=ON		U16
62	Active alarms: see table 13		U16
63	Alarm table, last alarm (alarm code, 0=no alarm)		U8
64	Alarm table, 2nd alarm in alarm log		U8
65	Alarm table, 3rd alarm in alarm log		U8
66	Alarm table, 4th alarm in alarm log		U8
67	Alarm table, 5th (earliest) alarm		U8
68	Detected frequency 1=50Hz, 2=60Hz		U8
69	Cos f sign: Flow of power 0=Direct, -1=Reverse (generator)		S8
70	Status of fan relay 1=ON 0=OFF		U8

Table 9: Modbus registers, function 4

7.2 Modbus functions 6 and 3

Number	Name	Unit	MIN	MAX	Type
1	Latched alarms (alarms in memory) bits in table 13		0	0	U16
2	Alarm mask. 1=enabled. See table 13 for special function.				U16 mask
3	Step shutdown mask of alarms. 1=enabled. See table 13 for special function.				U16 mask
4	Temperature limit (temperature alarm)	°C	20	60	U8
5	Fan offset limit	°C	0	50	U8
6	Voltage distortion limit (Alarm 10)	0,01%	50	200	U16
7	Irms/I1 limit	0,01	100	150	U16
8	Application 1=2Q 2=4Q		1	2	U8
9	Current transformer: If secondary 1A, primary*5	A	25	30000	U16
10	Input voltage	V	80	800	U16
11	Wiring, see table 14		1	54	U8
12	Target cos f 1: 100=1.00	0,01	80	100	U8
13	Target cos f 1 sign: 0=ind, -1=cap		-1	0	S8
14	Target cos f 2: 100=1.00	0,01	80	100	U8
15	Target cos f 2 sign: 0=ind, -1=cap		-1	0	S8
16	Inductive response value	0,01	1	199	U16
17	Capacitive response value	0,01	1	199	U16
18	Reconnection delay	s	10	900	U16
19	Step program: see table 12		1	5	U8
20	Number of steps		1	12	U8
21	Step sequence: see table 11		1	10	U8
22	Step size monitoring: step 1	kvar	0	400	U16
23	step 2	kvar	0	400	U16
24	step 3	kvar	0	400	U16
25	step 4	kvar	0	400	U16
26	step 5	kvar	0	400	U16
27	step 6	kvar	0	400	U16
28	step 7	kvar	0	400	U16

Number	Name	Unit	MIN	MAX	Type
29	step 8	kvar	0	400	U16
30	step 9	kvar	0	400	U16
31	step 10	kvar	0	400	U16
32	step 11	kvar	0	400	U16
33	step 12	kvar	0	400	U16
34	Step size monitoring: nominal voltage of steps (phase to phase voltage)	V	200	800	U16
35	Current transformer, secondary current 1=1A,2=5A	A	1	2	U8

Table 10: Modbus registers for function 3 and 6

7.2.1 Parameter value tables

Value	Step sequences
1	1.1.1.1.1.1.
2	1.1.2.2.2.2.
3	1.1.2.3.3.3.
4	1.1.2.4.4.4.
5	1.2.2.2.2.2.
6	1.2.3.3.3.3.
7	1.2.3.4.4.4.
8	1.2.3.6.6.6.
9	1.2.4.4.4.4.
10	1.2.4.8.8.8.

Table 11: Step sequences

Number	Step programs	Allowed sequences
1	NORMAL	SEQ 1.2.4.
2	CIRCULAR 1.1.1	SEQ 1.1.1.
3	CIRCULAR 1.2.2	SEQ 1.1.2.
4	STACK	SEQ 1.1.1.
5	OPTIMAL	All sequences

Table 12: Stepping program

Alarm, alarm mask & shut down mask bit	PFC alarm	Step shut down mask effect	
		Read	Write
1	9	as set	1 / 0
2	10	as set	1 / 0
3	11	1	not changed
4	12	0	not changed
5	- (*)	0	not changed
6	- (*)	0	not changed
7	- (*)	0	not changed
8	- (*)	0	not changed
9	1	0	not changed
10	2	as set	1 / 0
11	3	0	not changed
12	4	1	not changed
13	5	0	not changed
14	6	0	not changed
15	7	0	not changed
16	8	1	not changed

(*) Always 0 when read

Table 13: Alarm bits

Wiring	Current measured	Voltage measuring	Current measuring polarity
1	L1	L2-L3	direct
2	L1	L3-L1	direct
3	L1	L1-L2	direct
4	L1	L1-N	direct
5	L1	L2-N	direct
6	L1	L3-N	direct
7	L1	L2-L3	reverse
8	L1	L3-L1	reverse
9	L1	L1-L2	reverse
10	L1	L1-N	reverse
11	L1	L2-N	reverse
12	L1	L3-N	reverse

Wiring	Current measured	Voltage measuring	Current measuring polarity
13	L1	L2-L3	auto detection
14	L1	L3-L1	auto detection
15	L1	L1-L2	auto detection
16	L1	L1-N	auto detection
17	L1	L2-N	auto detection
18	L1	L3-N	auto detection
19	L2	L2-L3	direct
20	L2	L3-L1	direct
21	L2	L1-L2	direct
22	L2	L1-N	direct
23	L2	L2-N	direct
24	L2	L3-N	direct
25	L2	L2-L3	reverse
26	L2	L3-L1	reverse
27	L2	L1-L2	reverse
28	L2	L1-N	reverse
29	L2	L2-N	reverse
30	L2	L3-N	reverse
31	L2	L2-L3	auto detection
32	L2	L3-L1	auto detection
33	L2	L1-L2	auto detection
34	L2	L1-N	auto detection
35	L2	L2-N	auto detection
36	L2	L3-N	auto detection
37	L3	L2-L3	direct
38	L3	L3-L1	direct
39	L3	L1-L2	direct
40	L3	L1-N	direct
41	L3	L2-N	direct
42	L3	L3-N	direct
43	L3	L2-L3	reverse
44	L3	L3-L1	reverse
45	L3	L1-L2	reverse
46	L3	L1-N	reverse
47	L3	L2-N	reverse
48	L3	L3-N	reverse
49	L3	L2-L3	auto detection
50	L3	L3-L1	auto detection

Wiring	Current measured	Voltage measuring	Current measuring polarity
51	L3	L1-L2	auto detection
52	L3	L1-N	auto detection
53	L3	L2-N	auto detection
54	L3	L3-N	auto detection

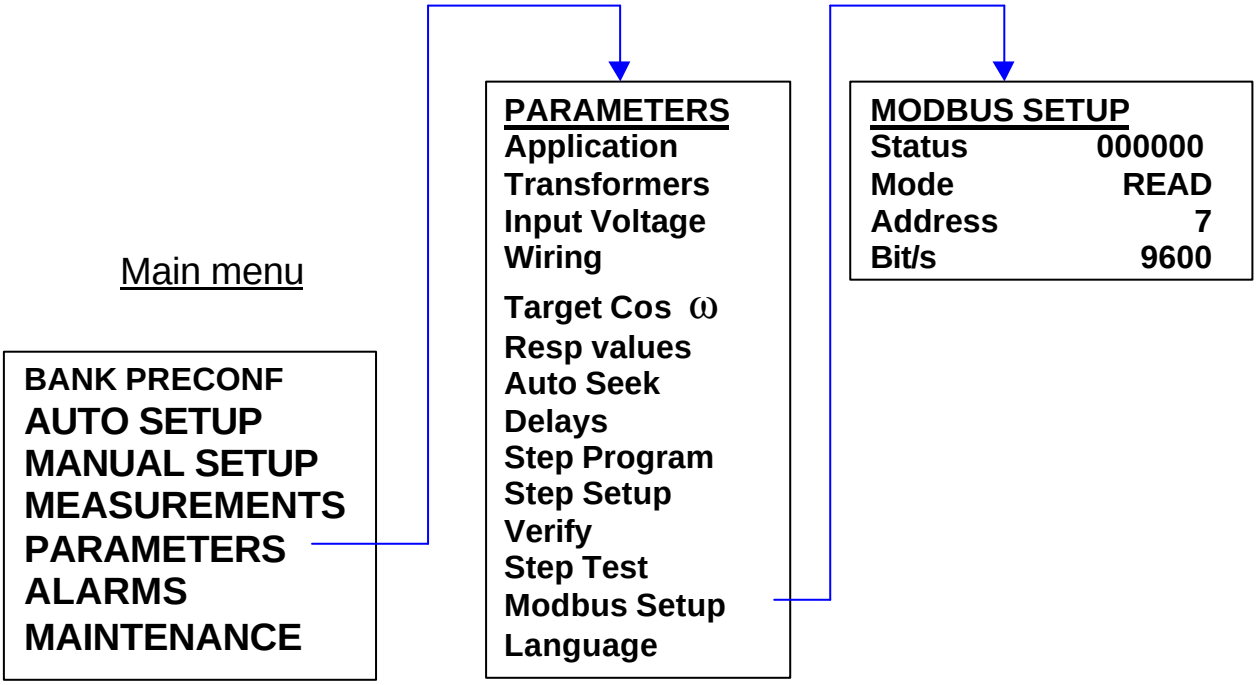
Table 14: Wiring

7.3 Modbus settings in the PFC

Picture 11: Modbus settings in the PFC

Required settings for the PFC are: mode, Modbus address and baud rate.

Menu structure:



Picture 12: Menu structure of the PFC

Select **PARAMETERS** from the main menu. Access to the parameters menu is locked To unlock the parameter menu, press both arrow keys and the PFC simultaneously for 2 sec. Then select **MODBUS SETUP.** See the PFCs manual for detailed instructions.
The Modbus setup has the following parameters:

Status **(not for set)**	2 digits for correct frame counter + 2 digits for error counter + 2 digits for answer counter
Mode	The use of PFCs communication: NONE = Communication disabled READ = Communication is read only READ/RESET = Communication is read only except when resetting alarms is allowed. READ/WRITE = Both read and write are allowed.
Address	Modbus address of the PFC. Value between 1 … 247
Bit/s	Communication baud rate (1200 … 38400 bit/s).

Table 15: Modbus parameters in PFC

For more information, see the PFCs manual.

8 Technical specifications

8.1 Safety

The following precautions must be taken into account when installing the NC-WATCH system.

- A qualified electrician must do the installation of the NC-WATCH system.
- Ensure that the power supply is switched off before touching any parts in the NC-WATCH system. Do not touch the connectors when the system is energized.
- Do not open NC-WATCH modules, there are no serviceable parts inside.

8.2 Environmental conditions

Modules of NC-WATCH system are designed for the following environmental conditions:

- Indoor use
- Altitude up to 2000 m
- Ambient temperature within -10BC…+60BC
- Maximum relative humidity of 95% for temperatures up to +40BC
- Category IP 20.

9 Pictures

10 Tables