

SOFTSTARTER TYPE PSE

Fieldbus Communication

Internal Modbus RTU



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1. Modbus RTU

Modbus is a master-slave protocol and only one device can transmit on the line at any time. The master (which in most cases is a PLC) manages the exchanges and only it can take the initiative. It interrogates each of the slaves in succession and no slave can send a message unless it is invited to do so. The master repeats the question when there is an incorrect exchange, and declares the interrogated slave absent if no response is received within a given time period. If a slave does not understand a message, it sends an exception response to the master who may or may not repeat the request.

The Modbus protocol provides full control and status information of the Softstarter, reading as well as writing of parameters. Through the fieldbus it is possible to start and stop the motor, read out currents and frequency, get information of faults and protections and read device identification.

See chapter 8 in the PSE Softstarter Installation and commissioning manual, document 1SFC132057M0201, for fieldbus related settings.

Before the Modbus RTU can be taken in operation following parameters must be set in the Softstarter:

- Parameter Fieldbus interface type set to internal Modbus RTU
- Parameter Fieldbus control shall be set to On if the motor shall be controlled by Modbus. Otherwise if only reading values from the Softstarter is required, set this parameter to OFF
- Parameter Internal Modbus RTU baud rate shall be set to a value matching existing Modbus network. Supported baud rates are 9.6, 19.2, 38.4, 57.6, and 76.8 kBaud
- Parameter Internal Modbus RTU frame format shall be set to a value matching existing Modbus network. Supported frame formats are 8O1, 8E1, 8N2 and 8N1
- Parameter Fieldbus address shall be set to an available Modbus slave id. In the examples (section 4) the fieldbus address is set to 47, but this parameter can be set to any value between 1-247.



Caution!

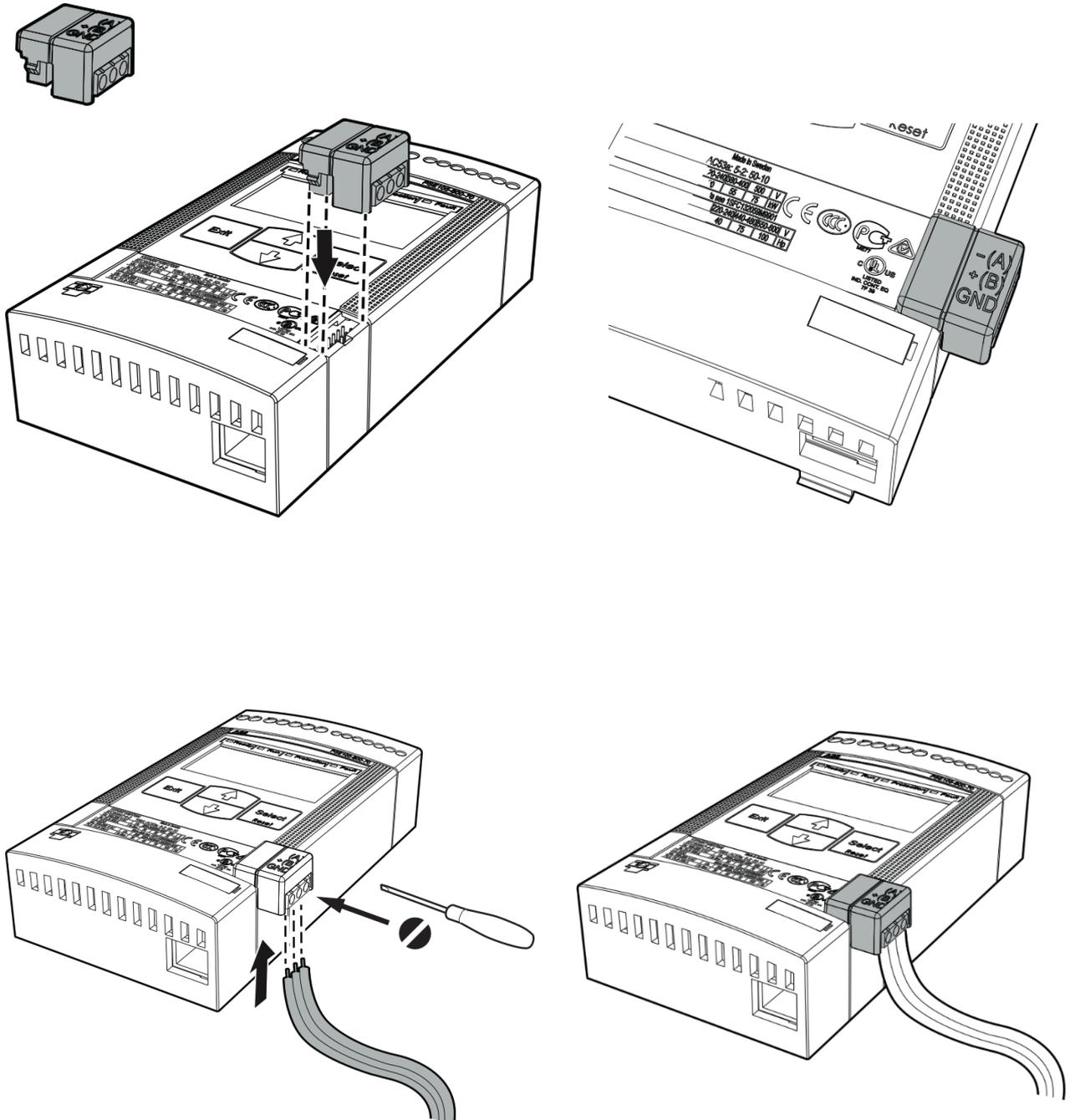
The motor may start unexpectedly if there is a start signal present when doing any of the actions listed below.

- Switching from one type of control to another (fieldbus control/hardwire control)
- Reset all Settings

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2. PSE Modbus RTU Adaptor

Below is displayed how to connect the Modbus RTU adaptor to the PSE Softstarter



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3. PSE Data

3.1. Digital input telegram

To PLC from the Softstarter.

To read the digital input telegram, use Modbus function code 1

Read Coil Status or 2 Read Discrete Inputs

Protocol Address	Data	Description
0000h	Reserved	
0001h	Motor stopped status	0 = Motor running 1 = Motor stopped
0002h	Run status	0 = Motor stopped 1 = Motor running
0003h	Reserved	
0004h	Reserved	
0005h	Auto mode status ¹	0 = Local control 1 = Modbus master control
0006h	Fault status	0 = No active fault 1 = One or more active faults
0007h	Reserved	
0008h	Reserved	
0009h	Reserved	
000Ah	Reserved	
000Bh	Start status	Hardwire DI Start input signal state 0 = DI Start signal inactive 1 = DI Start signal active
000Ch	Stop status	Hardwire DI Stop input signal state 0 = DI Stop signal inactive 1 = DI stop signal active
000Dh	Reset status	Hardwire DI Reset input signal state 0 = DI Reset signal inactive 1 = DI Reset signal active
000Eh	TOR status	0 = Softstarter is not in top of ramp 1 = Softstarter is in top of ramp (bypass closed)
000Fh	Ready to start status	0 = Fault is active or control supply voltage is not stable and motor will not start when start command is given 1 = No faults are active, control supply voltage is stable and motor will start when start command is given

¹Auto mode reflects the control state of the Softstarter. This is affected by a combination of:

- The Auto mode input signal from the Modbus master (protocol address 0105h in the digital output telegram or bit 5 in the control word).
- The parameter "Fieldbus control".

Digital input telegram is also available as a status word on protocol address 0300h (see section 3.3.1).

3.2. Digital output telegram

From PLC to the Softstarter.

To write the digital output telegram, use Modbus function code 5

Write Single Coil or 15 (0Fh) Force Multiple Coils.

To read the digital output telegram, use Modbus function code 1

Read Coil Status or 2 Read Input Status.

Protocol Address	Data	Description
0100h	Reserved	
0101h	Stop	Commence a stop when this coil is set (this coil has higher priority than the start coil). The stop coil is only acknowledged if the Auto mode coil is set.
0102h	Start	Commence a start when this coil is set. The start coil is only acknowledged if the Auto mode coil is set.
0103h	Reserved	
0104h	Reserved	
0105h	Auto mode	This coil must be set for controlling the motor.
0106h	Fault reset	Reset an active fault or protection when this coil is set.
0107h	Reserved	
0108h	Reserved	
0109h	Reserved	
010Ah	Reserved	
010Bh	Reserved	
010Ch	Clear active diagnostics	Clear active diagnostics when this coil is set (register 2000h and 2003h will be cleared). See section 3.5.1
010Dh-011Fh	Reserved	

Digital output telegram is also available as a control word on protocol address 0400h (see section 3.3.2).

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3.3. Status word and Control word

3.3.1. Status word

The status word register is used to monitor the motor. This register can be used as an alternative to using the digital input telegram (section 3.1).

Read status word using Modbus function code 3

Read Holding Registers or 4 Read Input Registers

Protocol Address	Bit	Data	Description
0300h	0	Reserved	
	1	Motor stopped status	0 = Motor running 1 = Motor stopped
	2	Run status	0 = Motor stopped 1 = Motor running
	3	Reserved	
	4	Reserved	
	5	Auto mode status ¹	0 = Local control 1 = Modbus master control
	6	Fault status	0 = No active fault 1 = One or more active faults
	7	Reserved	
	8	Reserved	
	9	Reserved	
	10	Reserved	
	11	Start status	Hardwire DI Start input signal state 0 = DI Start signal inactive 1 = DI Start signal active
	12	Stop status	Hardwire DI Stop input signal state 0 = DI Stop signal inactive 1 = DI stop signal active
	13	Reset status	Hardwire DI Reset input signal state 0 = DI Reset signal inactive 1 = DI Reset signal active
	14	TOR status	0 = Softstarter is not in top of ramp 1 = Softstarter is in top of ramp (bypass closed)
	15	Ready to start status	1 = No faults are active, control supply voltage is stable and motor will start when start command is given 0 = Fault is active or control supply voltage is not stable and motor will not start when start command is given

¹⁾ Auto mode reflects the control state of the Softstarter. This is affected by a combination of:

- The Auto mode input signal from the Modbus master (protocol address 0105h in the digital output telegram or bit 5 in the control word).
- The parameter "Fieldbus control".

3.3.2. Control word

The control word register is used to control the motor. This registers can be used as an alternative to using the digital output telegram (section 3.2).

Read control word using Modbus function code 3

Read Holding Registers or 4 Read Input Registers

Write control word using Modbus function code 6

Write Single Register or 16 (10h) Preset Multiple Registers.

Protocol Address	Bit	Data	Description
0400h	0	Reserved	
	1	Stop	Commence a stop when this bit is set (this bit has higher priority than the start coil). The stop bit is only acknowledged if the Auto mode bit is set.
	2	Start	Commence a start when this bit is set. The start is only acknowledged if the Auto mode bit is set.
	3	Reserved	
	4	Reserved	
	5	Auto mode	This bit must be set for controlling the motor.
	6	Fault reset	Reset an active fault or protection when this coil is set.
	7	Reserved	
	8	Reserved	
	9	Reserved	
	10	Reserved	
	11	Reserved	
	12	Clear active diagnostics	Clear active diagnostics when this coil is set (register 2000h and 2003h will be cleared). See section 3.5.1
	13	Reserved	
	14	Reserved	
	15	Reserved	

It is recommended to give the start/stop commands to the Softstarter using bit 1, 2 in the control word or protocol address 0101h, 0102h. Which of these registers that will be acknowledged by the device depends on the auto mode configuration.

If auto mode is set using protocol address 0105h, then the start/stop commands can be given using protocol address 0101h, 0102h. But if bit 5 in the control word (protocol address 0400h) is set, then the start/stop commands can be given using bit 1, 2 in the control word.

However if auto mode is set in both protocol address 0105h and bit 5 in the control word, then start/stop commands will not be acknowledged by the device due to incorrect configuration.

3.4. Analog input telegram

To PLC from the Softstarter.

All analog input telegram data values are represented as 16-bit values.

To read the analog input telegram, use Modbus function code 3

Read Holding Registers or 4 Read Input Registers.

Protocol Address	Data	Representation
0200h	Motor current in % of I _e (0%-800%)	Value = 1 ⇒ 1%
0201h	Thermal load in % of trip temperature (0%-100%)	Value = 1 ⇒ 1%
0202h	Phase current L1	Value = 1 ⇒ 1A
0203h	Phase current L2	Value = 1 ⇒ 1A
0204h	Phase current L3	Value = 1 ⇒ 1A
0205h	Max phase current	Value = 1 ⇒ 1A
0206h	Measured frequency	Value = 1 ⇒ 1Hz
0207h	Measured power factor	Value = 100 ⇒ 1
0208h	Output voltage in % of line voltage	Value = 1 ⇒ 1%
0209h	Counted number of starts	Value = 1 ⇒ 100
020Ah	Run time in hours	Value = 1 ⇒ 10h
020Bh	Modbus failure register (the address from which data could not be read from or written to)	Value = 1 ⇒ 1
020Ch	Modbus toggle bit (value toggles at every read)	Value = 1 ⇒ 1

3.5. Diagnostics

3.5.1. Diagnostic data

To PLC from the Softstarter.

To read the diagnostics data, use Modbus function code 3

Read Holding Registers or 4 Read Input Registers.

Protocol Address	Bit	Data	Description
2000h	0	Reset possible on active event	Current fault or protection can be reset
	1	Software fault	Internal fault
	2	Shunt fault	Current is flowing when it should not
	3	By-pass open	By-pass does not close
	4	Softstarter overload	Too high thyristor- or heat sink temperature
	5	Phase loss	No voltage in one or more phases on the line side
	6	Bad network quality	Bad network quality on the line side
	7	Current loss	Current is not flowing when it should

Protocol Address	Bit	Data	Description
	8	Fieldbus fault	Fieldbus communication failure
	9	Low supply voltage	Too low control supply voltage
	10	High current	Too high current
	11	Motor overload	Too high motor temperature
	12	Locked rotor protection	Current is higher than settable value during top of ramp
	13	Underload protection	Current is lower than settable value during top of ramp
	14	Reserved	
	15	Reserved	
2001h	0..15	Reserved	
2002h	0..15	Reserved	
2003h	0	Reserved	
	1	Reserved	
	2	Reserved	
	3	Reserved	
	4	Parameter is read-only	This bit is set if a parameter write operation failed due to the parameter being read-only.
	5	Parameter is not settable	This bit is set if a parameter write operation failed due to the parameter not being settable (such as during a soft start or soft stop).
	6	Parameter value is out of range	This bit is set if a parameter write parameter operation failed due to the set value being out of range.
	7	Extended diagnostic available	If set, fault code provides extended diagnostics.
	8..15	Fault code	This can be additional info for a fault such as in which phase the fault occurred or the parameter number of the latest read/write parameter operation failure.

The diagnostic data is composed of a bit map of all potential faults and protections, as well as a flag, which indicates if the active fault or protection can be reset. If “Parameter is read-only”, “Parameter not settable in current state” or “Parameter out of range” bits are set, “Fault code” contains the parameter number. “Parameter not settable in current state” can occur if the motor is running.

If “Extended diagnosis is available” is set, “Fault code” contains the Event information for the current event. For events that can occur on a specific line, e.g., Phase loss, the value of the fault code will indicate the line number the event occurred on. A “4” indicates the line cannot be determined or the problem exists on all three phases.

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3.5.2. Modbus diagnostic data

To PLC from the Softstarter.

To read Modbus diagnostic data, use Modbus function code 3

Read Holding Registers or 4 Read Input Registers.

Protocol Address	Words	Data	Description
4000h	2	Vendor name	ABB
4002h	6	Product code	1SFA8971xx
4008h	2	Major Minor revision	3.6
400Ah	6	Vendor URL	www.abb.com
4010h	8	Product Name	PSE
4018h	8	Reserved	
4020h	8	Reserved	
4028h	7	Reserved	
402Fh	1	Modbus CRC-Error count	Number of Modbus CRC errors (note: this value will reset after a power cycle)
4030h	1	Modbus Request Slave Exception Error Count	Number of slave exception errors (note: this value will reset after a power cycle)
4031h	1	Modbus slave address	Slave id
4032h	1	Modbus baud rate	Unit is (baud rate / 100). E.g. 192 == 19200 baud

3.5.3. Device identification data

To PLC from the Softstarter.

To read the device identification data, use Modbus function code 43(2Bh)

Read Device Identification

Basic and regular categories are available. Use category 01h to get the basic device identification, category 02h to get the basic and regular device identification and category 04h to request a single specific id.

Id	Name	Description	Category
00h	Vendor Name	ABB	Basic
01h	Product Code	PSEXXX-600-70	01h
02h	Major Minor Revision	3.6	
03h	Vendor URL	http://www.abb.com	Regular
04h	Product Name	Softstarter	02h
05h	Model Name	PSE	
06h	User Application Name	Motor	
07h...7Fh	Reserved		

3.6. Parameters

Parameter registers begin at protocol address 3000h and consist of one register of one word for each parameter. They are subject to both writing and reading, either a single register or multiple registers at the same request.

To write parameters, use Modbus function code 6

Write Single Register or 16 (10h) Preset Multiple Registers.

To read parameters, use Modbus function code 3

Read Holding Registers or 4 Read Input Registers.

When programming parameters, high bytes shall come before low bytes.

Protocol Address	Type	Parameter Name	Representation	Default value
3000h	Read/Write	Motor rated current ¹	0 – 3700 = 0.0 – 370.0 [A]	Individual
3001h	Read/Write	Start ramp time	1 – 30 [s]	10
3002h	Read/Write	Stop ramp on	0 = Off, 1 = On	0
3003h	Read/Write	Stop ramp time	1 – 30 [s]	1
3004h	Read/Write	Initial voltage	30 – 70 [%]	40
3005h	Read/Write	End voltage	30 – 70 [%]	30
3006h	Read/Write	Current limit	15 – 70 = 1.5 – 7.0 [xIe]	70
3007h	Read/Write	Torque control start	0 = Off, 1 = On	0
3008h	Read/Write	Torque control stop	0 = Off, 1 = On	0
3009h	Read/Write	Kick start on	0 = Off, 1 = On	0
300Ah	Read/Write	Kick start time	1 – 10 = 0.1 – 1.0 [s]	2
300Bh	Read/Write	Kick start voltage	30 – 100 [%]	50
300Ch	Read/Write	EOL protection on	0 = Off, 1 = On	1
300Dh	Read/Write	EOL trip class	0 = 10A, 1 = 10, 2 = 20, 3 = 30	1
300Eh	Read/Write	EOL protection reset type	0 = Hand, 1 = Auto	0
300Fh	Read/Write	Underload protection on	0 = Off, 1 = On	0
3010h	Read/Write	Underload protection level	2 – 10 = 0.2 – 1.0 [xIe]	5
3011h	Read/Write	Underload protection reset type	0 = Hand, 1 = Auto	0
3012h	Read/Write	Locked rotor protection on	0 = Off, 1 = On	0
3013h	Read/Write	Locked rotor protection level	5 – 70 = 0.5 – 7.0 [xIe]	12
3014h	Read/Write	Locked rotor protection reset type	0 = Hand, 1 = Auto	0
3015h	Read/Write	Bad network fault reset type	0 = Hand, 1 = Auto	0

Protocol Address	Type	Parameter Name	Representation	Default value
3016h	Read only	Fieldbus control enabled	0 = Off, 1 = On	0
3017h	Read only	Fieldbus address	0 – 255	255
3018h	Read only	Fieldbus download parameter	0 = dPOff , 1 = dPOn	1
3019h	Read only	Fieldbus fault reaction	0 = Trip, 1 = Switch to local	0
301Ah	Read only	Fieldbus fault reset type	0 = Hand, 1 = Auto	0
301Bh	Read only	Fieldbus interface type	0 = Fieldbus plug, 1 = Modbus RTU	0
301Ch	Read only	Internal Modbus RTU timeout	5 – 600 = 0.5 – 60.0 [s]	5
301Dh	Read only	Internal Modbus RTU Baud rate	0 = 9600, 1 = 19200, 2 = 38400, 3 = 57600, 4 = 76800	1
301Eh	Read only	Internal Modbus RTU frame format	0 = 8o1, 1 = 8e1, 2 = 8n2, 3 = 8n1	1

¹⁾ A specific softstarter size in itself will have a much more narrow range defined by its rated current and only values within that range will be accepted.

3.6.1. Configure baud rate

Register at protocol address 4064h contains the fieldbus baud rate parameter which can be both read and written.

To write this parameter, use Modbus function code 6

Write Single Register or 16 (10h) Preset Multiple Registers.

To read this parameter, use Modbus function code 3

Read Holding Registers or 4 Read Input Registers.

Response data or data to write is (baud rate / 100) and consists of two bytes.

Note that after changing the baud rate, communication with the slave will no longer work until the baud rate of the Modbus master has also been changed to the same value.

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4. Modbus RTU - A set-up example

4.1. Softstarter PSE Built-in Modbus RTU communication

This document describes an application example between a Modbus RTU master (PLC CPU, PC, etc.) and the ABB Softstarter PSE using the built-in Modbus RTU interface. In these examples the slave Id of the Softstarter is 47.

Please always use the actual Softstarter manuals. In this particular example following documents has been used:

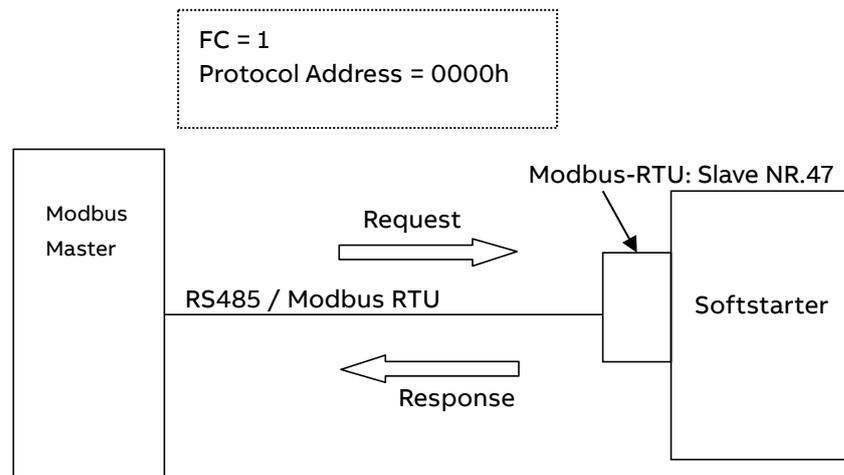
- Softstarter PSE Installation and commissioning manual, document 1SFC132057M0201

4.2. Settings

1. Set the Softstarter address and field bus communication
Change the address of the Softstarter to 47 (Fieldbus Address) and enable fieldbus control (Fieldbus control = On)
2. Set the communication parameters
Change the communication parameters baud rate and frame format to match the Modbus network settings.
3. Select the Modbus RTU interface
Change parameter Fieldbus interface type to Modbus RTU.

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4.3. Read digital input telegram



E.g: Read 16 coils starting at the address: 0000h

Request:

2F 01 00 00 00 10 3B 88

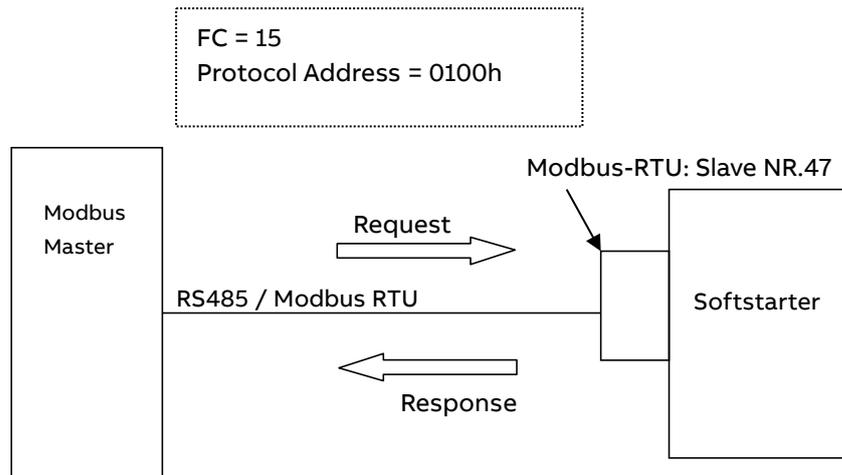
Slave 47 FC = 01 Address 16 coils CRC

Response:

2F 01 02 00 00 51 FA

Slave 47 FC = 01 2 Bytes 1st Byte 2nd Byte CRC

4.4. Write digital output telegram



E.g: Write 16 coils starting at address 0100h

Request:

2F 0F 01 00 00 10 02 00 00 27 41

Slave 47
FC = 15

Address 16 coils
 2 bytes Output CRC

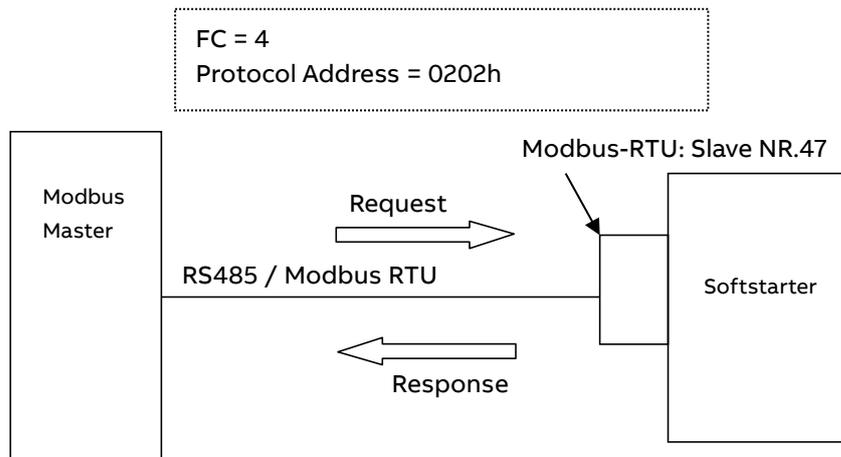
Response:

2F 0F 01 00 00 10 53 B5

Slave 47
FC = 15

Address 16 coils CRC

4.5. Read analog input telegram



E.g: Read phase L1 current and phase L2 current.

Request:

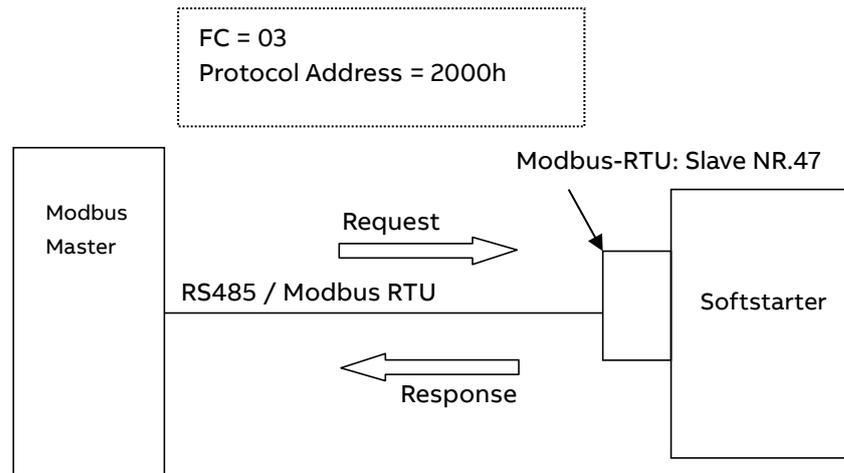
2F 04 02 02 00 02 27 FD
 Slave 47 FC = 4 Address 2 words CRC

Response:

2F 04 04 00 00 00 00 35 86
 Slave 47 FC = 4 4 Byte W0 W1 CRC

W0: Phase L1 current
 W1: Phase L2 current

4.6. Read diagnostic data



E.g: Read 4 words starting at the address: 2000h

Request:

2F 03 20 00 00 04 49 87

Slave 47
FC = 03
Address
4 words
CRC

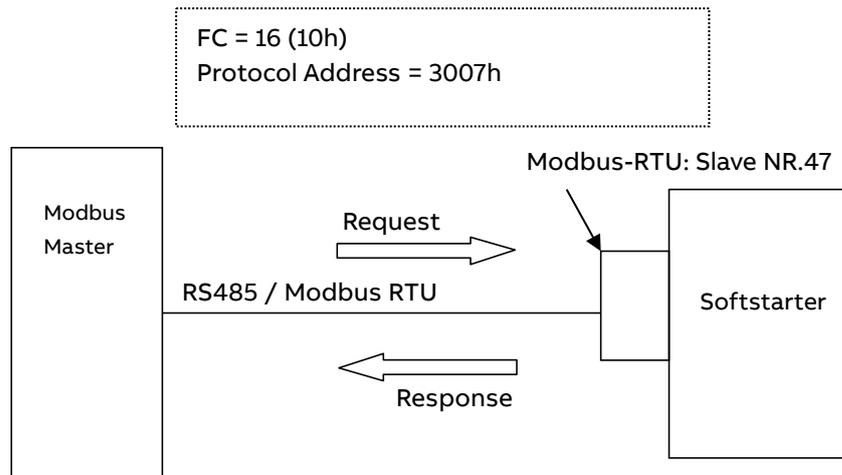
Response:

2F 03 08 01 00 00 00 00 00 80 CA 93

Slave 47
FC = 03
8 Bytes
W0
W1
W2
W3
CRC

Indicating “Fieldbus fault” and “Extended diagnostic available” flags are set.

4.7. Write parameters



E.g: Disable torque control start and enable torque control stop

Request:

2F 10 30 07 00 02 04 00 00 00 01 B8 A0

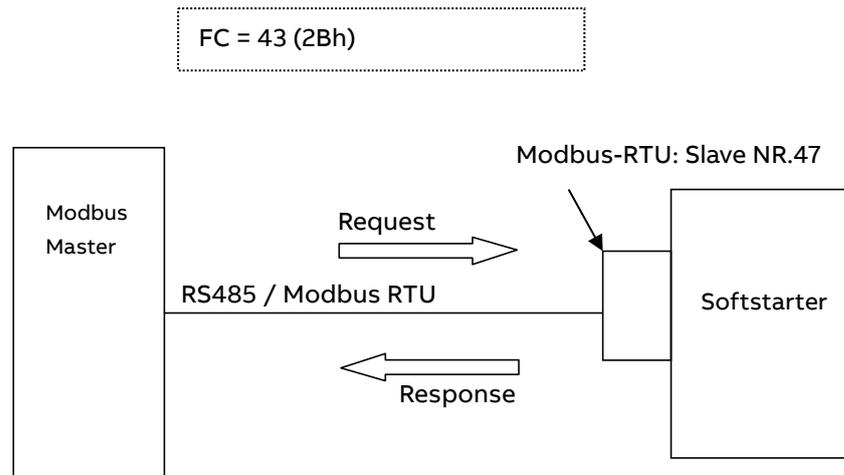
Slave 47
FC = 16
Address
2 words
4 bytes
W0
W1
CRC

Response:

2F 10 30 07 00 02 F9 47

Slave 47
FC = 16
Address
2 words
CRC

4.8. Read device identification



E.g: Read a single specific Id which is the vendor name

Request:

2F 2B 0E 04 00 9B 21

Slave 47
FC = 2B
Interface
Category
Id Offset
CRC

Response:

2F 2B 0E 04 83 00 00 01 00 03 41 42 42 ED FB

Slave 47
FC = 2B
Interface Type
Category
Conformity level
More follows
Next Object Id
Number of ob-
Object 1 Id
Object Id length
Object value
CRC

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5. Troubleshooting

5.1. Modbus slave does not respond to requests

RS485

- Are the termination resistors placed at the end of the line?
- Only 2 termination resistors in one segment?
- Are 2 termination resistors placed at each bus segment?
- Are bias resistors connected in each bus segment?
- Is the line polarity correct? Are the lines by accident swapped?
- Never place any termination resistors on a drop cable.
- Is the maximum line length exceeded?

Modbus Parameters

- Check that fieldbus interface type parameter is set to Internal Modbus-RTU (Int on display).
- Check that you are using the correct Modbus address, baud rate and frame format.
- Note that the slave will not respond to broadcasts (requests to address 0), only act upon them.

Modbus slave

- Has the device a unique Modbus address?
- Is the function code supported by the device?
- Has the request a valid address?
- Has the request a valid quantity of coils, inputs, registers?
- Is the power supply turned on?

Modbus master

- Is the Modbus master in RTU mode?
- Is the request to response timeout correct?
- Is the Modbus silent interval between two telegrams > 3.5 character times?
- Notice that the slave device will not give any response when it is addressed with a broadcast (slave address = 0).
- Check if PLC is in run mode.

5.2. PSE trips on fieldbus fault (EF40)

- The purpose of the fieldbus fault function is to detect any communication problems between the Modbus master and the Softstarter.
- Fieldbus fault will be enabled if the Fieldbus control parameter is set to On and Operation when fault parameter is set to "trIP". In case the Operation when fault parameter is set as "LocC", there will be a switch to local "hardwire" control.

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- If the Modbus master has not written any data to the PSE softstarter or read any data from the PSE softstarter for more than the configured timeout time, there will be a trip on fieldbus fault (EF40). This fieldbus fault communication timeout parameter can have a value between from 0.5 to 60 seconds and can be set from the HMI or with the SoftstarterCare™ Service Engineer Tool PC program via USB. If there has been a trip on fieldbus fault for some reason, the communication has to afterwards be continuously stable for 10s before the PSE softstarter accepts commands from the Modbus master and when it is possible to reset the fault.
- If the fault code is EF41, this means a parity error has occurred and in most cases this is due to the parity being incorrectly configured. Check the Modbus frame format parameter and the Modbus master's parity configuration.

5.3. Motor does not start

- If fieldbus fault reaction is set to “switch to local” control and fieldbus communication is lost and/or timeout is reached, the Softstarter can only be controlled with hard-wire signals. When communication is re-established, there is a 10 second delay before fieldbus control is possible.
- Check if the fieldbus control parameter is set to ON.
- Make sure the auto mode is enabled in order to control the motor with Modbus. Either the data value in protocol address 0105h or bit 5 in the control word (protocol address 0400h) shall be set.
- Check if the stop coil/bit is set since it has higher priority than the start coil/bit.
- Motor will not start if there is an active fault (check the ready to start coil/bit).

5.4. Parameter write does not work

- Check if the parameter download parameter is enabled (set to dPon).
- Check if the parameter is read-only.
- Check if the value to be written is correctly scaled (see the representation column in section 3.6).
- Check if the value to be written is out of range.
- Parameter write operation will not work during a soft start or soft stop. It will only work in the standby state and top of ramp state.
- Check bits 4-15 in protocol address 2003h for diagnostic information related to the latest parameter write operation failure (see section 3.5.1).

6. Contact us

For more information, please contact your local ABB representative or visit <https://new.abb.com/drives/softstarters>

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