INSTALLATION INSTRUCTIONS: MCD MODBUS MODULE

Order Code: 175G9000

1. Introduction

Danfoss soft starters can be controlled and monitored across an RS485 serial communication network using the Modbus RTU and AP ASCII protocols.

For users requiring simple control of MCD 200 and MCD 500 soft starters using Modbus RTU or AP ASCII, the instructions below describe the installation and operation of the Modbus Module.

MCD 3000 soft starters have AP ASCII protocol support built in - see the MCD 3000 Users Manual for details of message formats. The MCD 3000 supports Modbus RTU control when used in conjunction with a Remote Operator.

This document describes Modbus and AP ASCII messaging and *Appendix A* describes how to connect the Remote Operator and use it as a Modbus RTU or AP ASCII slave device.

2. Installation

1. Remove control power and mains supply from the soft starter.

2. Attach the Modbus Module to the starter as shown.

3. Apply control power to the soft starter.

MCD 200

MCD 500
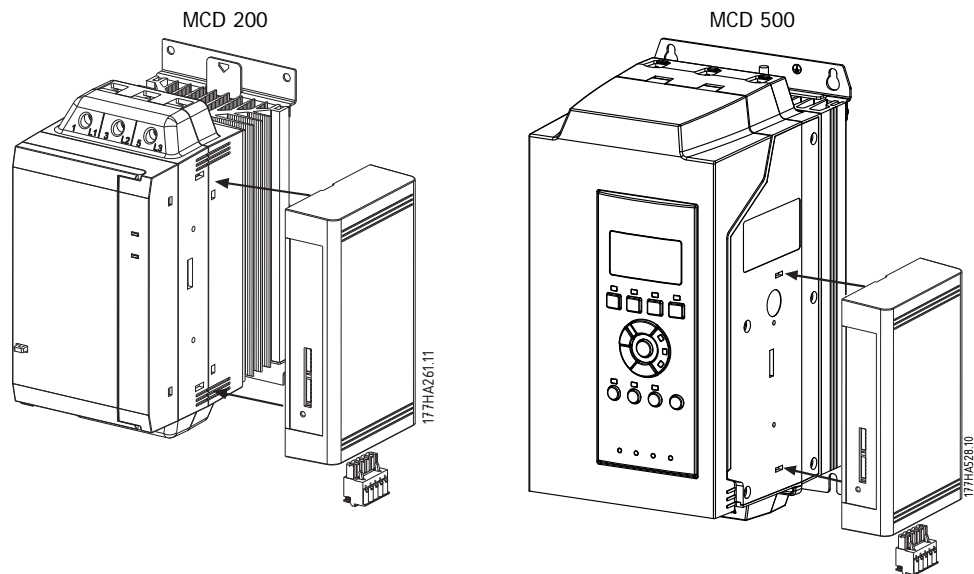
Remove the Modbus Module using the following procedure:

1. Disconnect the RS485 cable from the module.

2. Remove control power and mains supply from the soft starter.

3. Push a small flat-bladed screwdriver into the slots at the top and bottom of the module and depress the retaining clips.

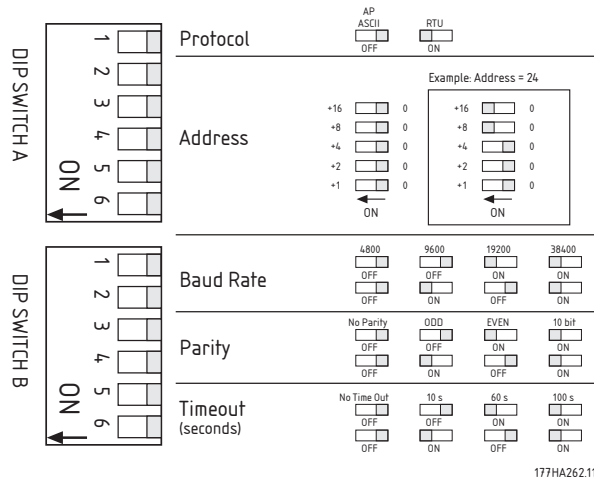4. Pull the module away from the soft starter.

!
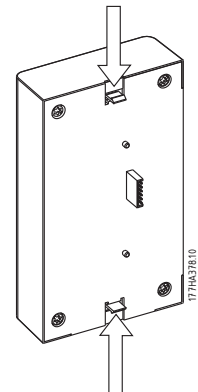
CAUTION

Remove mains and control voltage from the soft starter before attaching or removing accessories. Failure to do so may damage the equipment.

3. Adjustment

Network communication parameters must be set on the Modbus Module. DIP switch settings take effect on the power-up of the Modbus Module via the soft starter.


4. Connection

For the Modbus Module to accept serial commands, a link must be fitted across terminals A1-N2 on MCD 200 Series starters.

In order for the MCD 500 to accept commands from the serial network, the soft starter must be in Auto On mode and links must be fitted to terminals 17 and 25 to 18.

In Hand On mode, the starter will not accept commands from the serial network but the starter's status can still be monitored.
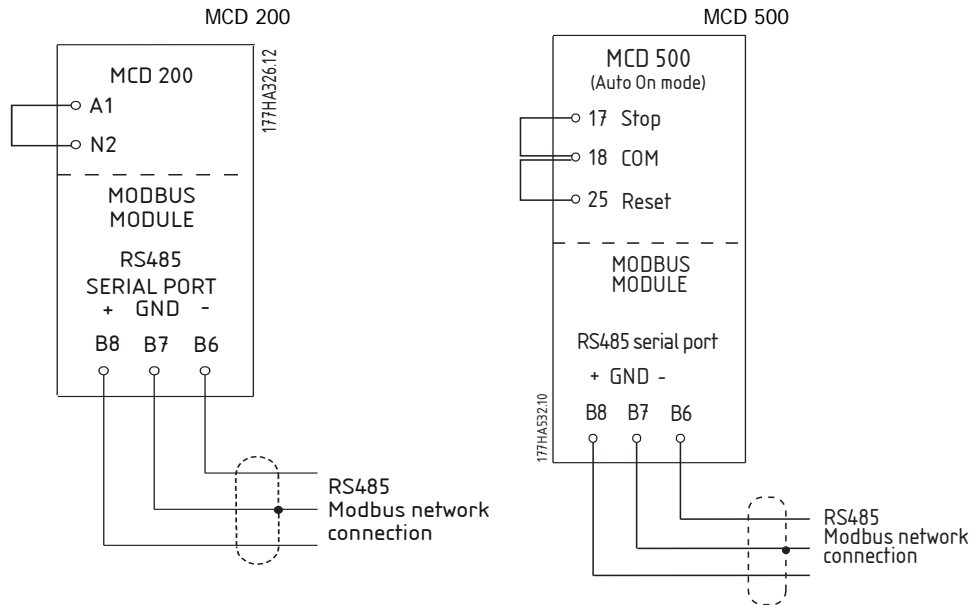

N.B.!:
If MCD 500 parameter 3-2 *Comms in Remote* is set to Disable Comms in Remote, the starter will not accept start or stop commands from the serial network (the starter will still accept reset commands and allow status monitoring).

5. Network Status LED

The Network Status LED indicates the state of the
communications link between the module and the network.
LED operation is as follows:

LED

177HA263.11
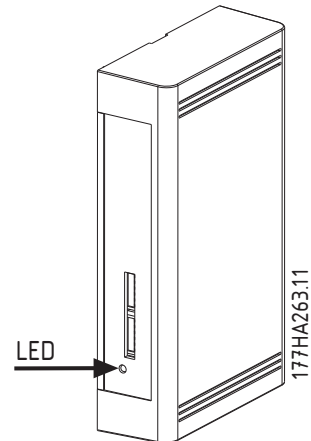
Off	On	Flashing
No connection or soft starter not powered up	Communication active	Communication inactive

N.B.!:
If communication is inactive, the soft starter may trip if the Communications Timeout
function has been set on the module. When communication is restored, the soft starter
will require a Reset.

6. Modbus Register

Register Address	Type	Description			MCD 201	MCD 202	MCD 500	MCD 3000
40002 Command	Single Write	1 = Start			■	■	■	■
		2 = Stop			■	■	■	■
		3 = Reset			■	■	■	■
		4 = Quick stop (coast to stop)			■	■	■	■
		5 = Forced communication trip			■	■	■	■
40003 Starter status	Multiple Read	Bit	Description					
		0 to 3	1 = Ready		■	■	■	■
			2 = Starting		■	■	■	■
			3 = Running		■	■	■	■
			4 = Stopping (including braking)		■	■	■	■
			5 = Restart delay (including Temperature check)				■	■
			6 = Tripped		■	■	■	■
			7 = Program mode				■	■
			8 = Jog forward				■	
			9 = Jog reverse				■	
		4	1 = Positive phase sequence (only valid if bit 6 = 1). Always = 0					
		5	1 = Current exceeds FLC			■	■	
		6	0 = Uninitialised 1 = Initialised			■	■	■
		7	Always = 0					
40004 Trip Code	Multiple Read	See Trip Code table.						
40005 [1] Motor current	Multiple Read	Average 3 phase motor current (A)				■	■	■
40006 Motor temperature	Multiple Read	Motor temperature (thermal model)				■	■	■
40007 Product Type and Version	Multiple Read	Bit	Description					
		0 to 2	Product parameter list version		■	■	■	■
		3 to 7	1= MCD 3000 4= MCD 200 7= MCD 500		■	■	■	■
40008 Serial Protocol Version	Multiple Read				■	■	■	■
40009 [2] ~ Parameter management	Single Write and Multiple Read	Parameter 1-A (Motor FLC) to: • MCD 500 Par. 20-6 (Pedestal Detect) • MCD 3000 Par. 60 (Min Run Frequency)					■ ■	■ ■

[1] For MCD 500 models MCD5-0068B and smaller this value will be 10 times greater than the value displayed on the LCP.

[2] See the relevant soft starter literature for a complete parameter list. The first product parameter is always allocated to register 40009. The last product parameter is allocated to register 40XXX, where XXX = 008 plus total number of available parameters in the product.

N.B.!:
The numbering of parameter options via serial communications differs slightly from the numbering displayed on the LCP. Numbering via the Modbus Module starts at 0, so for Par. 2-1 Phase Sequence, the options are 1~3 on the LCP but 0~2 via the module.

7. Trip Codes

Trip Code	Trip Name	MCD 201	MCD 202	MCD 500	MCD 3000
1	Excess start time		■	■	■
2	Motor overload (thermal model)		■	■	■
3	Motor thermistor		■	■	■
4	Current imbalance		■	■	■
5	Frequency (Mains supply)	■	■	■	■
6	Phase sequence		■	■	■
7	Instantaneous overcurrent			■	■
8	Power loss (Power circuit)	■	■	■	■
9	Undercurrent			■	■
10	Heatsink overtemperature			■	■
11	Motor connection			■	■
12	Input A trip (Auxiliary input A)			■	
13	FLC too high (FLC out of range)			■	■
14	Unsupported option (Not available in 6-wire)			■	
15	Starter communication	■	■	■	■
16	Network communication	■	■	■	■
17	Internal fault			■	
23	EEPROM fail			■	
26	L1 phase loss			■	
27	L2 phase loss			■	
28	L3 phase loss			■	
29	L1-T1 Shorted			■	
30	L2-T2 Shorted			■	
31	L3-T3 Shorted			■	
33	Time-overcurrent (Bypass overload)		■	■	
35	Battery/clock			■	
36	Thermistor circuit			■	
255	No trip	■	■	■	■

8. Modbus Functions

The Modbus Module supports the following Modbus functions:

■ 03 Read multiple registers

■ 06 Write single register

Modbus broadcast functions are not supported.

MCD 200 soft starters (including Remote Operator):

■ Read multiple registers 40003 to 40008

■ Write single register 40002

MCD 500 soft starters:

■ Read multiple registers starting from 40003 up to a maximum of 125 register blocks

■ Write single register 40002 or 40009 to 40599

N.B.!:
A multiple read across register boundary 40008/40009 will result in a Modbus Error code 05 at the Master.
Modbus Module version 3 and earlier (serial number xxxxxx-3) can read a maximum of 119 register blocks.

8.1. Master Configuration

For standard Modbus 11-bit transmission, the Master must be configured for 2 stop bits with No Parity and 1 stop bit for odd or even parity.

For 10-bit transmission, the Master must be configured for 1 stop bit.

In all cases, the Master baud rate and slave address must match those set on the Modbus Module DIP switches.

Command: Start

Message	Starter Address	Function Code	Register Address	Data	CRC
In	20	06	40002	1	CRC1, CRC2
Out	20	06	40002	1	CRC1, CRC2

Starter status: Running

Message	Starter Address	Function Code	Register Address	Data	CRC
In	20	03	40003	1	CRC1, CRC2
Out	20	03	2 (bytes)	3	CRC1, CRC2

Trip code: Motor overload

Message	Starter Address	Function Code	Register Address	Data	CRC
In	20	03	40004	1	CRC1, CRC2
Out	20	03	2 (bytes)	2	CRC1, CRC2

Download parameter from starter

MCD 500: Read Parameter 1, Motor FLC (Parameter 1-1), 100 A

Message	Starter Address	Function Code	Register Address	Data	CRC
In	20	03	40009	1	CRC1, CRC2
Out	20	03	2 (bytes)	100	CRC1, CRC2

Upload parameter to starter

MCD 500: Write Parameter 4, Current Limit (Parameter 1-4), set = 400% FLC

Message	Starter Address	Function Code	Register Address	Data	CRC
In	20	06	40012	400	CRC1, CRC2
Out	20	06	40012	400	CRC1, CRC2

9. Modbus Error Codes

Code	Description	Example
01	Illegal function code	Function other than 03 or 06
02	Illegal data address	Register number invalid
03	Not readable data	Register not allowed for data reading
04	Not writable data	Register not allowed for data writing
05	Data boundary fault	Multiple data transfer across data boundary or data size more than 125
06	Invalid command code	e.g. writing "6" into 40003
07	Illegal parameter read	Invalid parameter number
08	Illegal parameter write	Invalid parameter number, read only, or hidden parameter
09	Unsupported command	Sending a serial command to MCD 500 with parameter 3-2 = Disable control in RMT.
10	Local communication error	Communication error between Modbus slave and starter

N.B.!:

Some of the above codes are different from those defined in the Modbus Application Protocol Specification available on www.modbus.org.

10. AP ASCII Protocol

The message fragments used to communicate with the Modbus Module as an AP ASCII slave device are shown below. The message fragments may be assembled into complete messages as described in the sections that follow.

N.B.!:
Data must be transmitted in 8-bit ASCII, no parity, one stop bit.

Message Fragment Type	ASCII Character String or (Hexadecimal Character String)			
Send address	EOT (04h	[nn] [nn]	[lrc] [lrc]	ENQ or 05h)
Send command Send request	STX (02h	[ccc] [ccc]	[lrc] [lrc]	ETX or 03h)
Receive data	STX (02h	[dddd] [dddd]	[lrc] [lrc]	ETX or 03h)
Receive status	STX (02h	[ssss] [ssss]	[lrc] [lrc]	ETX or 03h)
ACK (acknowledge)	ACK (06h	or		
NAK (negative acknowledge)	NAK (15h	or		
ERR (error)	BEL (07h	or		

nn = two byte ASCII number representing the soft starter address where each decimal digit is represented by n.

lrc = two byte longitudinal redundancy check in hexadecimal.

ccc = three byte ASCII command number where each character is represented by c.

dddd = four byte ASCII number representing the current or temperature data where each decimal digit is represented by d.

ssss = four byte ASCII number. The first two bytes are ASCII zero. The last two bytes represent the nibbles of a single byte of status data in hexadecimal.

10.1. Commands

Commands can be sent to the soft starter using the following format:

Send address	ACK	Send command	ACK

Possible error responses:

NAK	(Invalid LRC)

	= Master		= Slave (soft starter)

Command	ASCII	Comment
Start	B10	Initiates a start
Stop	B12	Initiates a stop
Reset	B14	Resets a trip state
Quick stop	B16	Initiates an immediate removal of voltage from the motor. Any soft stop settings are ignored.
Forced communication trip	B18	Causes a communications trip

10.2. Status Retrieval

Soft starter status can be retrieved using the following format:
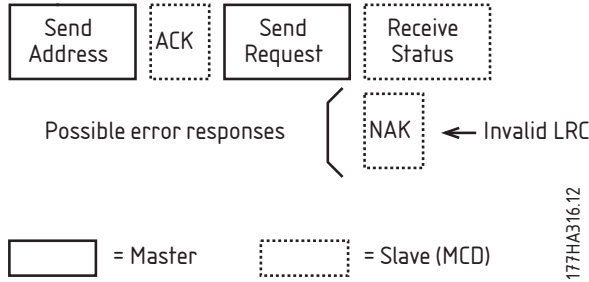
Request	ASCII	Receive Status (ssss)	
Trip code	C18	See the trip code table.	
Starter status	C22	Bit	Description
		0 to 3	1 = Ready
			2 = Starting
			3 = Running
			4 = Stopping (including braking)
			5 = Restart delay (including Temperature check)
			6 = Tripped
			7 = Program mode
		4	1 = Positive phase rotation (only valid if bit 6 = 1)
		5	1 = Current exceeds FLC
		6	0 = Uninitialised
			1 = Initialised
		7	0 = Communications are OK
			1 = Communications device fault

10.3. Data Retrieval

Data can be retrieved from the soft starter using the following format:
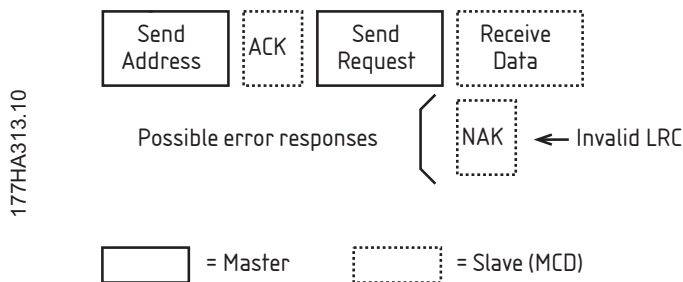
Request	ASCII	Receive Data (dddd)
Motor current	D10	Requests motor current. The data is four byte decimal ASCII. Minimum value 0000 A, maximum value 9999 A.
Motor temperature	D12	Requests the calculated value of the motor thermal model as a % of motor thermal capacity. The data is four byte decimal ASCII. Minimum value is 0000%. Trip point is 0105%.

10.4. Calculating the Checksum (LRC)

Each command string sent to and from the starter includes a checksum. The form used is the longitudinal redundancy check (LRC) in ASCII hex. This is an 8-bit binary number represented and transmitted as two ASCII hexadecimal characters.

To calculate LRC:

1. Sum all ASCII bytes
2. Mod 256
3. 2's complement
4. ASCII convert

For example Command String (Start):

ASCII	STX	B	1	0
or	02h	42h	31h	30h

ASCII	Hex	Binary	
STX	02h	0000 0010	
B	42h	0100 0010	
1	31h	0011 0001	
0	30h	0011 0000	
	A5h	1010 0101	SUM (1)
	A5h	1010 0101	MOD 256 (2)
	5Ah	0101 1010	1's COMPLEMENT
	01h	0000 0001	+ 1 =
	5Bh	0101 1011	2's COMPLEMENT (3)
ASCII	5	B	ASCII CONVERT (4)
or	35h	42h	LRC CHECKSUM

The complete command string becomes:

ASCII	STX	B	1	0	5	B	ETX
or	02h	42h	31h	30h	35h	42h	03h

To verify a received message containing an LRC:

1. Convert last two bytes of message from ASCII to binary
2. Left shift 2nd to last byte four bits
3. Add to last byte to get binary LRC
4. Remove last two bytes from message
5. Add remaining bytes of message
6. Add binary LRC
7. Round to one byte
8. The result should be zero

Response or status bytes are sent from the starter as an ASCII string:

STX	[d1]h	[d2]h	[d3]h	[d4]h	LRC1	LRC2	ETX

d1 =   30h
d2 =   30h
d3 =   30h plus upper nibble of status byte right shifted by four binary places
d4 =   30h plus lower nibble of status byte

For example status byte = 1Fh, response is:

STX	30h	30h	31h	46h	LRC1	LRC2	ETX

# 11. Appendix A - Modbus Control via Remote Operator

To control a soft starter via an RS485 serial communications network using the Remote Operator, connect the Remote Operator to the network as described in the following sections.

11.1. Grounding and Shielding

Twisted pair data cable with earth shield is recommended. The cable shield should be connected to a GND device terminal at both ends and one point of the site protective earth.

11.2. Termination Resistors

In long cable runs prone to excessive noise interference, termination resistors should be installed between the data lines at both ends of the RS485 cable. This resistance should match the cable impedance (typically 120 Ω). Do not use wire wound resistors.
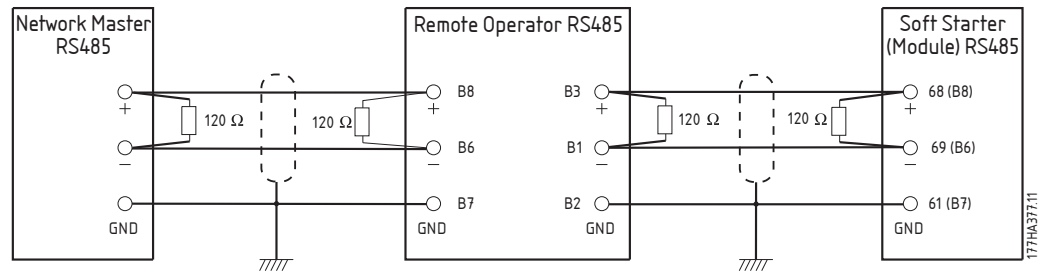

11.3. RS485 Data Cable Connection

Daisy chain connection is recommended. This is achieved by parallel connections of the data cable at the actual device terminals.

11.4. Remote Operator RS485 Network Connection Specifications

|	
Input impedance:	12 kΩ
Common mode voltage range:	- 7 V to + 12 V
Input sensitivity:	± 200 mV
Minimum differential output voltage:	1.5 V (with max loading of 54 Ω)

11.5. Using the Remote Operator with MCD 200
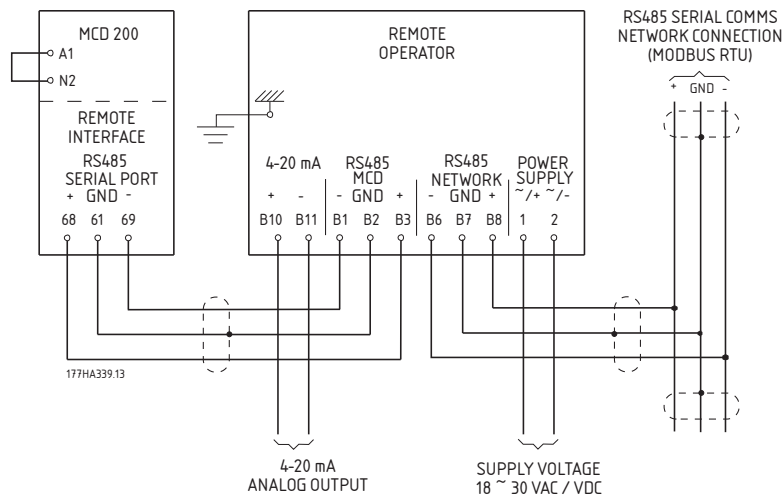
11.6. Using the Remote Operator with MCD 500

In order for the MCD 500 to accept commands from the serial network, the soft starter must be in Auto On mode and links must be fitted to terminals 17 and 25 to 18.

The Modbus Module must be used as an interface between the soft starter and the Remote Operator. The DIP switches on the Modbus Module must be set as follows:
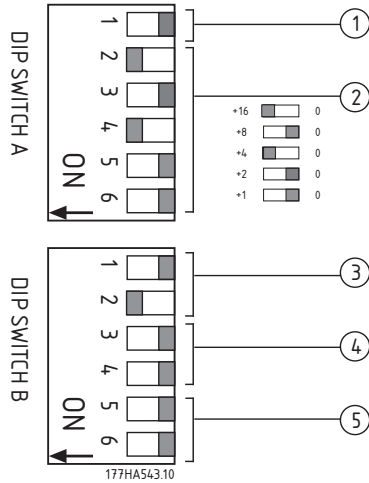
|	
1	Protocol = AP ASCII
2	Address = 20
3	Baud Rate = 9600
4	Parity = No parity
5	Timeout = No timeout

The Remote Operator internal parameters must be set as follows:

Parameter 1 (RS485 network baud rate) = set to match Modbus master
Parameter 2 (RS485 network address) = unique number between 1 ~ 99
Parameter 3 (RS485 network timeout) = set as required
Parameter 4 (RS485 network protocol) = Modbus RTU
Parameter 5 (Modbus protocol parity) = set to match Modbus master
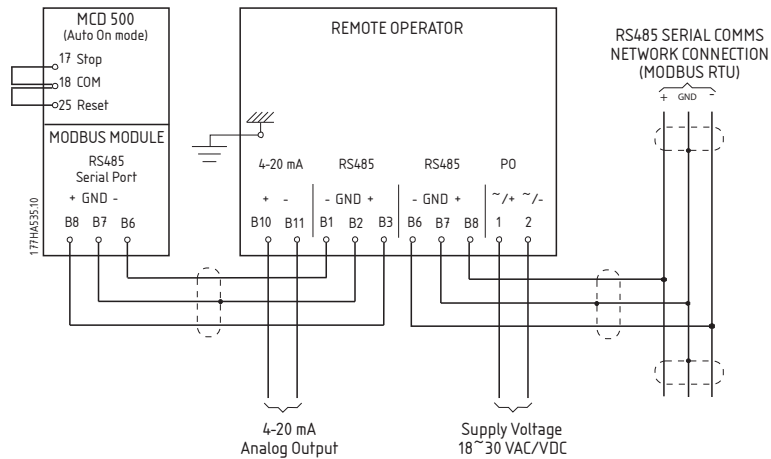
11.7. Using the Remote Operator with MCD 3000

In order to operate correctly on the network, the MCD 3000 must be set for local operation only (i.e. set Parameter 20 = 2). The Remote Operator's default communications protocol setting is AP ASCII. This must be changed to Modbus RTU.

The RS485 Network Timeout setting on the Remote Operator applies to the link between the Remote Operator and the network. This can be set to any value between 0 and 100 seconds.
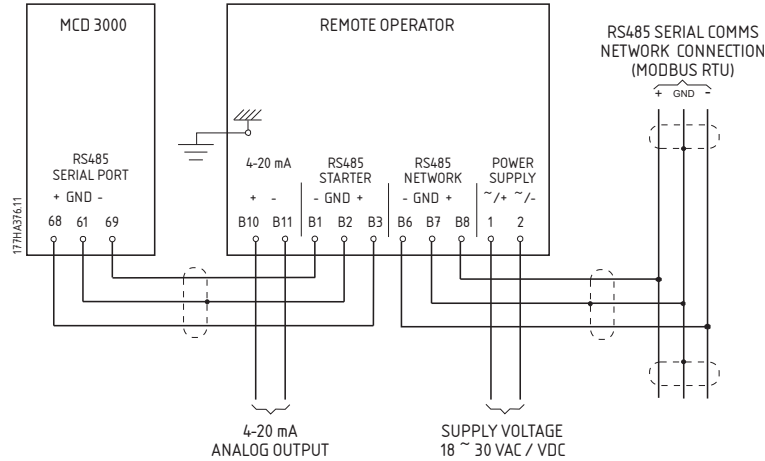
The Serial Timeout setting on the MCD 3000 (Parameter 24) applies to communications between the Remote Operator and the MCD 3000. See the MCD 3000 Operating Instructions for soft starter configuration details.

11.8. Programming

The Remote Operator must be configured to operate on the network. In order to access Programming Mode, the Remote Operator must be powered up when the soft starter is not running.

11.8.1. Programming Procedure

1. To enter Programming Mode, hold down the Data/Prog pushbutton for four seconds. The default value of the first parameter will be displayed.
2. Use the Data/Prog pushbutton to advance to the next parameter.
3. Use the Stop/+ and Reset/- pushbuttons to adjust parameter values.

Programming Mode closes when the Data/Prog pushbutton is pressed after Parameter 8.

N.B.!:
There is a 20 second timeout when the Remote Operator is in Programming Mode. Programming Mode will automatically close if no input is registered for 20 seconds. Any changes already made will be saved.

11.8.2. Programmable Parameters

The Remote Operator offers the following programmable parameters:

Parameter Number	Description	Default Setting	Adjustable Range
1	RS485 network baud rate	4 (9600 baud)	2 = 2400 baud 3 = 4800 baud 4 = 9600 baud 5 = 19200 baud 6 = 38400 baud
2	RS485 network satellite address	20	1 to 99
3	RS485 network timeout	0 seconds (= off)	0 to 100 seconds
4	RS485 network protocol	1 (AP ASCII)	1 = AP ASCII protocol 2 = Modbus RTU protocol
5	Modbus protocol parity	0 (no parity)	0 = no parity 1 = odd parity 2 = even parity 3 = 10-bit transmission
6	Motor FLC (A)	10	1 to 2868
7	Analog output 4 mA offset (%)	100	80 to 120
8	Start, Stop, Quick stop function disable	0	0 = Remote Operator and Network start, stop, quick stop function enabled. 1 = Remote Operator start, stop, quick stop function enabled. Network start, stop, quick stop function disabled. ★★ 2 = Remote Operator start, stop, quick stop function disabled. Network start, stop, quick stop function enabled. ★ 3 = Remote Operator start, stop, quick stop function disabled. Network start, stop, quick stop function disabled. ★, ★★
9	Current ÷ 10	0	0 = off (required for models MCD5-0084B ~ MCD5-1600C) 1 = on (required for models MCD5-0021B ~ MCD5-0068B)

★ Remote Operator Reset pushbutton is always enabled.
★★ RS485 Network reset and forced communication trip functions are always enabled.

N.B.!:
Remote Operator Par. 9 *Current ÷ 10* normalises the displayed current and analog output for models MCD5-0021B ~ MCD5-0068. Use Par. 9 in conjunction with Par. 6 *Motor FLC* as follows:

1. Set Par. 6 to a value 10 times greater than the actual motor nameplate FLC (e.g. for actual FLC = 4.6 A, set Par. 6 to 46).

2. Set Par. 9 = 1.

11.9. Troubleshooting

The Remote Operator display and status indication LEDs can indicate abnormal operating and system conditions.

Display Indication	Problem	Possible Solution
nEt on display	A loss of communication has been detected on the RS485 link to the network.	The Remote Operator has an RS485 Network Timeout Protection setting (Parameter 3). This error is reported when no communication occurs for longer than the timeout setting. The system will become active as soon as communication is restored. To clear **nEt** from the display, press the Data/Prog pushbutton momentarily or send a Reset command from the network Master.
SP flashing on display	Soft starter is off and being programmed from the serial network.	Finish soft starter network programming procedure and exit Programming Mode.

12. Appendix B - Specifications

Enclosure	
Dimensions	35 mm (W) x 157 mm (H) x 90 mm (D)
Weight	250 g
Protection	IP20

Mounting
Spring-action plastic mounting clips (x 2)

Connections	
Soft starter	6-way pin assembly
Network	5-way male and unpluggable female connector (supplied)
Maximum cable size	2.5 mm^2

Settings	
Protocol	Modbus RTU, AP ASCII
Address range	0 to 31
Data rate (bps)	4800, 9600, 19200, 38400
Parity	None, Odd, Even, 10-bit
Timeout	None (off), 10 s, 60 s, 100 s

Certification	
C✓	IEC 60947-4-2
CE	IEC 60947-4-2