PIM-MB-01 Modbus Interface

1. Introduction

IMS2 and CSX Series 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 CSX, CSXi, EMX3 and MVS soft starters using Modbus RTU or AP ASCII, the instructions below describe the installation and operation of the Modbus Interface.

IMS2 soft starters have Modbus RTU and AP ASCII protocol support built in - refer to the IMS2 Users Manual for details of message formats.

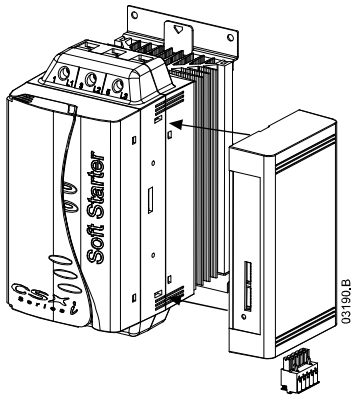
IMS2 and CSX Series soft starters can also connect to the network via a correctly configured Remote Operator - refer to *Appendix A* for details.

2. Installation

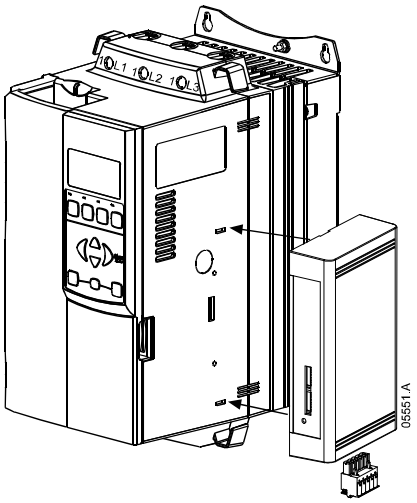
Install the Modbus Interface using the following procedure:

1. Remove control power and mains supply from the soft starter.
2. Attach the Interface to the starter as shown.
3. Apply control power to the soft starter.

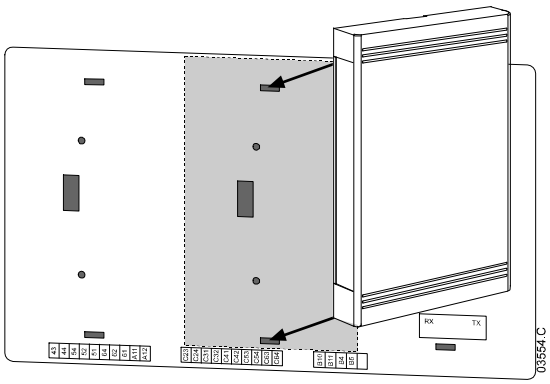
CSX Series
Plug the interface onto the side of the soft starter.



EMX3:
Plug the interface onto the side of the soft starter.

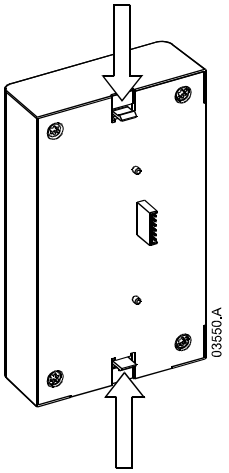


MVS:
Plug the interface onto the back of the MVS Controller.



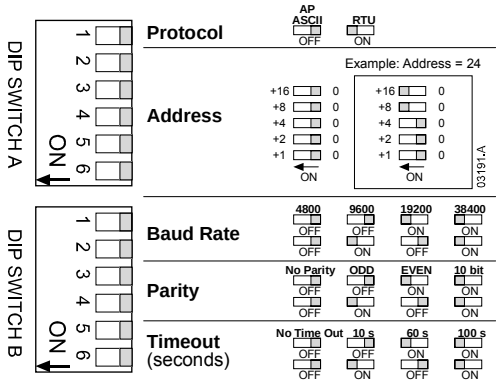
CAUTION
Remove mains and control voltage from the soft starter before attaching or removing accessories. Failure to do so may damage the equipment.

Remove the Modbus Interface using the following procedure:
1. Take the interface off-line.
2. Remove control power and mains supply from the soft starter.
3. Disconnect all field wiring from the interface.
4. Push a small flat-bladed screwdriver into the slots at the top and bottom of the interface and depress the retaining clips.
5. Pull the interface away from the soft starter.

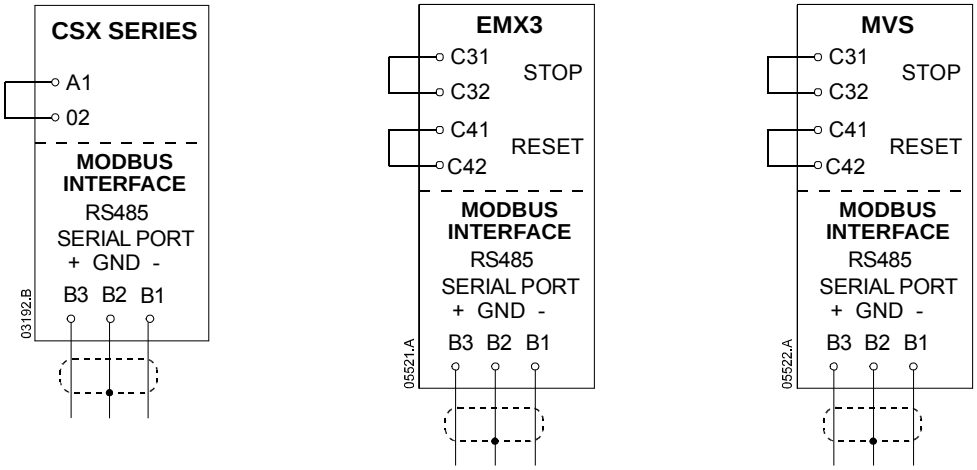


3. Adjustment

Network communication parameters must be set on the Modbus Interface. DIP switch settings take effect on the power-up of the Modbus Interface.



4. Connection

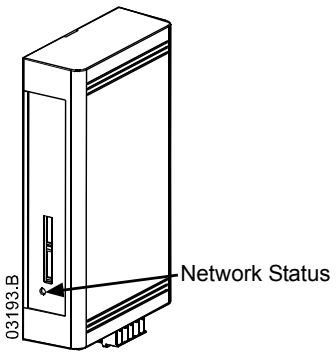


For the Modbus Interface to operate correctly, a link must be fitted across terminals A1-02 on CSX Series starters.

Input links are required across terminals C31-C32 and C41-C42 if the EMX3 or MVS soft starter is being operated in Remote mode. In Local mode, links are not required.

5. Network Status LED

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



Off	On	Flashing
No connection	Communication active	Communication inactive

NOTE
If communication is inactive, the soft starter may trip if the Communications Timeout function has been set on the interface. When communication is restored, the soft starter will require an individual Reset.

6. Modbus Register

Register Address	Type	Description		CSX	CSX*i*	EMX3	MVS	Remote Operator
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)	●	●	●	●	●
		5	1 = Current exceeds FLC		●	●	●	●
		6	0 = Uninitialised 1 = Initialised	●	●	●	●	●
		7	0 = Communications are OK 1 = Communications device fault					●
40004 Trip code	Multiple Read	Refer to Trip Code table						
40005 Motor current	Multiple Read	Average 3 phase motor current (A)			●	●	●	●
40006 Motor temperature	Multiple Read	Thermal model motor temperature (%)			●	●	●	●
40007	Multiple	Bit	Description					
Product type and version	Read	0 to 2	Product parameter list version	●	●	●	●	●
		3 to 7	4= CSX/CSXi 5 = MVS 6 = EMX3	●	●	● ●	●	●
40008 Serial Protocol Version	Multiple Read			●	●	●	●	●
40009 Parameter management	Single Write and Multiple Read	Parameter 1-A (Motor FLC) to: • MVS Maximum register address: 40123 Parameter 21-S (Time overcurrent) • EMX3 Maximum register address: 40159 Parameter 16-U (RTD G overtemperature)				● ● ●	● ●	

NOTE

Refer to 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.

Trip Code	Trip Name	CSX	CSX*i*	EMX3	MVS
255	No trip	●	●	●	●
1	Excess start time		●	●	●
2	Motor overload (M1)		●	●	●
3	Motor thermistor		●	●	●
4	Current imbalance		●	●	●
5	Supply frequency	●	●	●	●
6	Phase sequence		●	●	●
7	Instantaneous overcurrent			●	●
8	Power loss	●	●	●	●
9	Undercurrent			●	●
10	Starter overtemperature			●	
11	Motor connection			●	●
12	Input A trip			●	●
13	FLC too high			●	
15	Starter communications	●	●	●	●
16	Network communications	●	●	●	●
17	Internal Error			●	●
18	Overvoltage			●	●
19	Undervoltage			●	●
20	Ground fault			●	●
21	RTD trip				●
22	RTD communications failure				●
23	EEPROM fail			●	●
24	Input B trip			●	●
25	Bypass fail			●	●
26	L1 phase loss			●	●
27	L2 phase loss			●	●
28	L3 phase loss			●	●
29	L1 Shorted SCR			●	●
30	L2 Shorted SCR			●	●
31	L3 Shorted SCR			●	●
32	Motor overload (M2)			●	
33	Bypass overload		●		
34	SCR temperature[1]			●[1]	●
35	Battery/clock fail			●	●
36	Thermistor fail			●	
37	RTD A overtemperature			●	
38	RTD B overtemperature			●	
39	RTD C overtemperature			●	
40	RTD D overtemperature			●	
41	RTD E overtemperature			●	
42	RTD F overtemperature			●	
43	RTD G overtemperature			●	
44	RTD H overtemperature			●	
45	RTD Fail			●	
46	Analog input trip			●	

[1]Bypass overload protection is only available with internally bypassed EMX3 soft starter models.

Refer to the Remote Operator Users manual for displayed Trip Code details.

7. Modbus Functions

Modbus products support the following Modbus functions:

- 03 Read multiple registers
- 06 Write single register

Modbus broadcast functions are not supported.

CSX Series soft starter (including Remote Operator):

- Read multiple registers 40003 to 40008
- Write single register 40002

CSX Series soft starters do not support broadcast functions.

EMX3 and MVS soft starters:

- Read multiple registers from 40003 up to a maximum of 127 registers
- Write single register 40002 and 40009 onwards

NOTE
A multiple read across register boundary 40008 and 40009 will result in a Modbus Error code at the Master.

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 via the Modbus Interface DIP switches.

Examples

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	xxxx0011	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	00000010	CRC1, CRC2

8. Modbus Error Codes

Code	Description	Example
01	Illegal function code	Function other than 03 or 06
02	Illegal data address	Not in range 40002 to 40255
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 127
06	Invalid command code	Writing "6" into 40002
07	Illegal parameter read	Invalid parameter number
08	Illegal parameter write	Invalid parameter number, read only, or hidden parameter
09	Unsupported command	Writing parameter with starter running (not applicable for CSX Series)
10	Local communication error	Communication error between Modbus slave and starter

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

9. AP ASCII Protocol

The message fragments used in communicating with the soft starter in AP ASCII are shown below. The message fragments may be assembled into complete messages as described in the sections that follow.

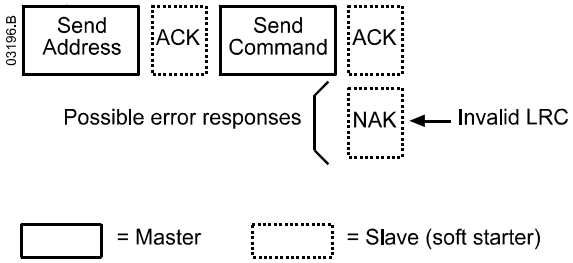
NOTE
Data must be transmitted in 8-bit ASCII, no parity, one stop bit.

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]	
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.

Commands

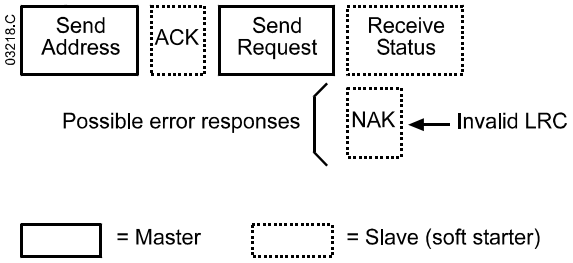
Commands can be sent to the soft starter using the following format:



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

Status Retrieval

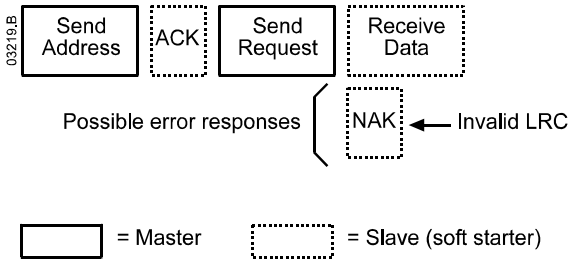
Soft starter status can be retrieved using the following format:



Request	ASCII	Receive Status (ssss)	
Trip code	C18	Refer to the trip code table (section 6)	
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 sequence (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

Data Retrieval

Data can be retrieved from closed loop CSX*i* models 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%.

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	02h42h	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	35h42h		LRC CHECKSUM		

The complete command string becomes:

ASCII	STX	B	1	0	5	B	ETX
or	02h42h	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

10. Appendix A - Modbus Control via Remote Operator

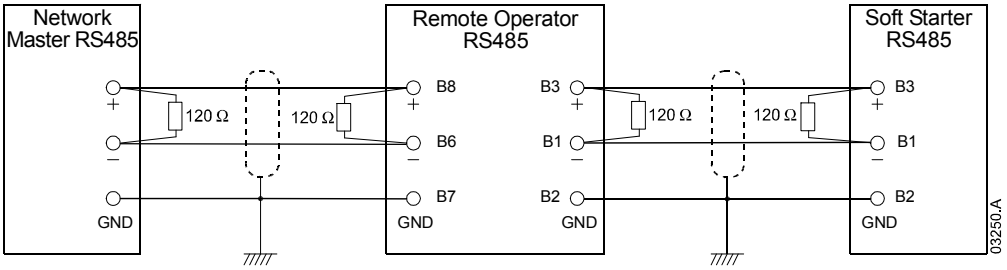
To control a soft starter via an RS485 serial communications network using the Remote Operator, connect the Remote Operator to the network as described in the following sections.

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.

Termination Resistors

In long cable runs prone to excessive noise interference, termination resistors should be installed between B1 (-) and B3 (+) of the soft starter and the Remote Operator. This resistance should match the cable impedance (typically 120 Ω). Do not use wire wound resistors.



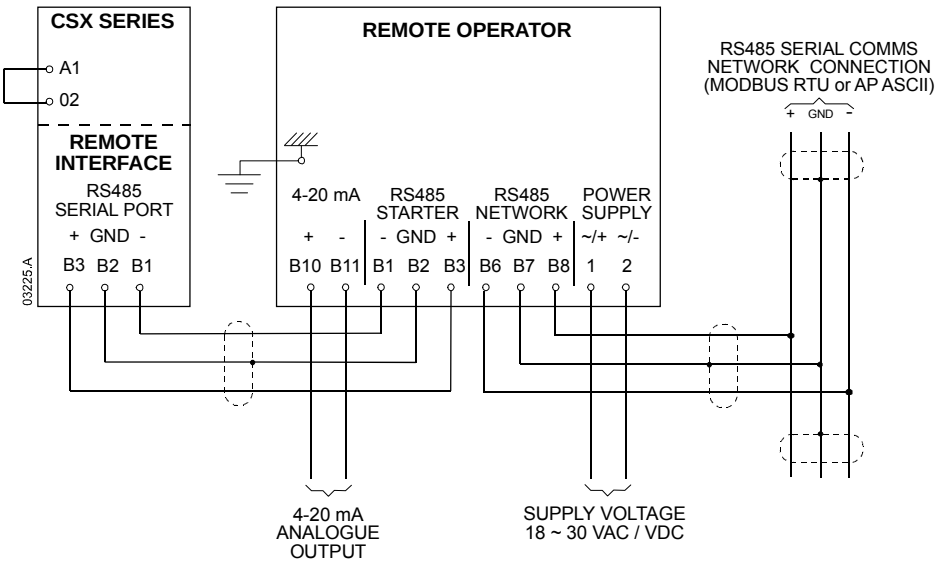
RS485 Data Cable Connection

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

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)

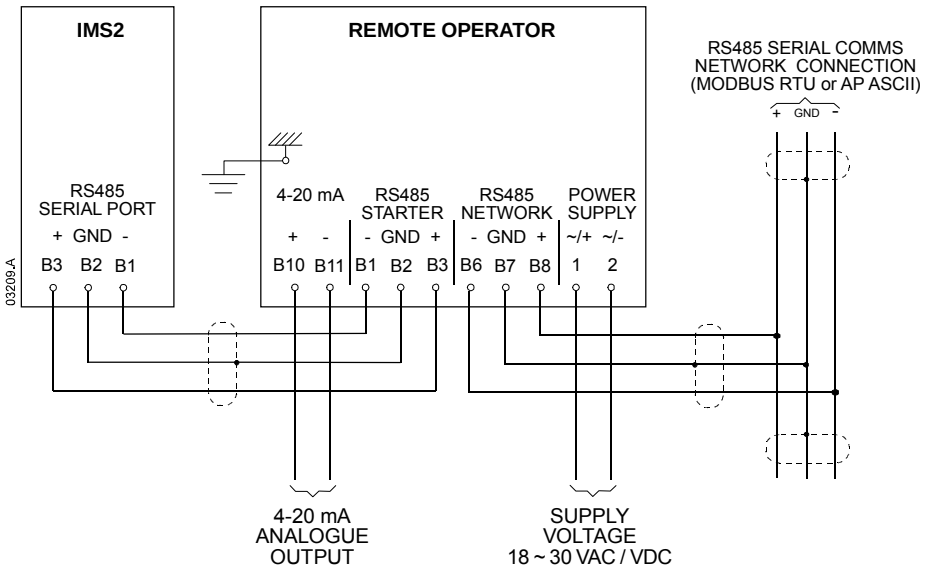
Using the Remote Operator with CSX



Using the Remote Operator with IMS2

In order to operate correctly on the network, the IMS2 must be set for local operation only (ie set Parameter 20 = 2). The Remote Operator's default communications protocol setting is AP ASCII.

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 IMS2 (Parameter 60) applies to communications between the Remote Operator and the IMS2. Refer to the IMS2 Users Manual for soft starter configuration details.

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.

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.

NOTE
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.

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	Analogue 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] 2 = Remote Operator start, stop, quick stop function disabled. Network start, stop, quick stop function enabled. [1] 3 = Remote Operator start, stop, quick stop function disabled. Network start, stop, quick stop function disabled. [1, 2]

[1] Remote Operator Reset/- pushbutton is always enabled.
[2] RS485 Network reset and forced communication trip functions are always enabled.

Troubleshooting

The Remote Operator display and status indication LEDs can indicate abnormal operating and system conditions. The following messages indicate an error in the Remote Operator's link to the RS485 network:

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.