PIM-MB-01 | Modbus Interface

1. Introduction

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

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

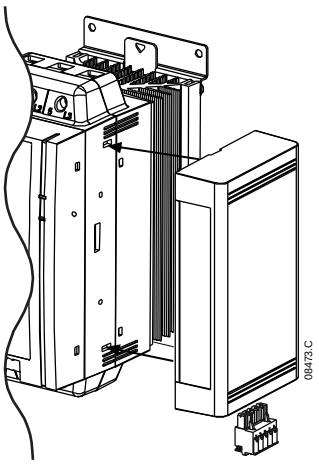
For users requiring simple control of CSX, MVS/MVX, EMX3 soft starters using Modbus RTU or AP ASCII, the instructions below describe the installation and operation of the Modbus Interface.

EMX3, IMS2 and CSX Series soft starters can also connect to the network via a correctly configured Remote Operator - refer to *Modbus Control via Remote Operator* for details.

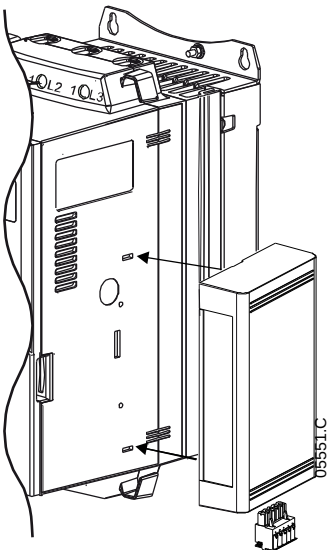
2. Installation

1. Plug the interface onto the side of the soft starter.
2. Line up the interface with the comms port slot.
3. Press the top retaining clip of the interface into the soft starter chassis.
4. Press in the bottom retaining clip.
5.

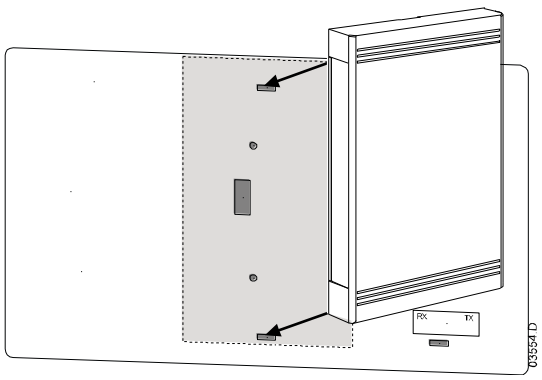
CSX Series



EMX3



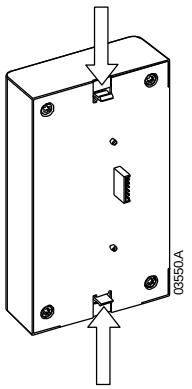
MVS and MVX:
Plug the interface onto the back of the controller.



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

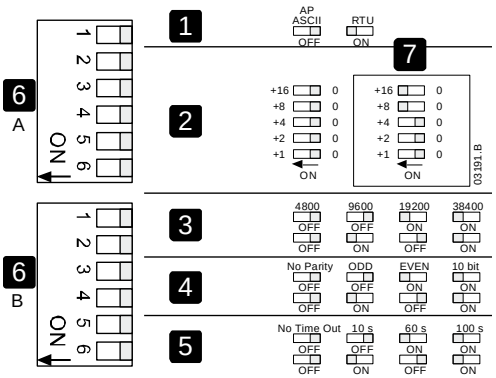
Remove the Modbus Interface using the following procedure:

1. Remove power from the interface.
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.



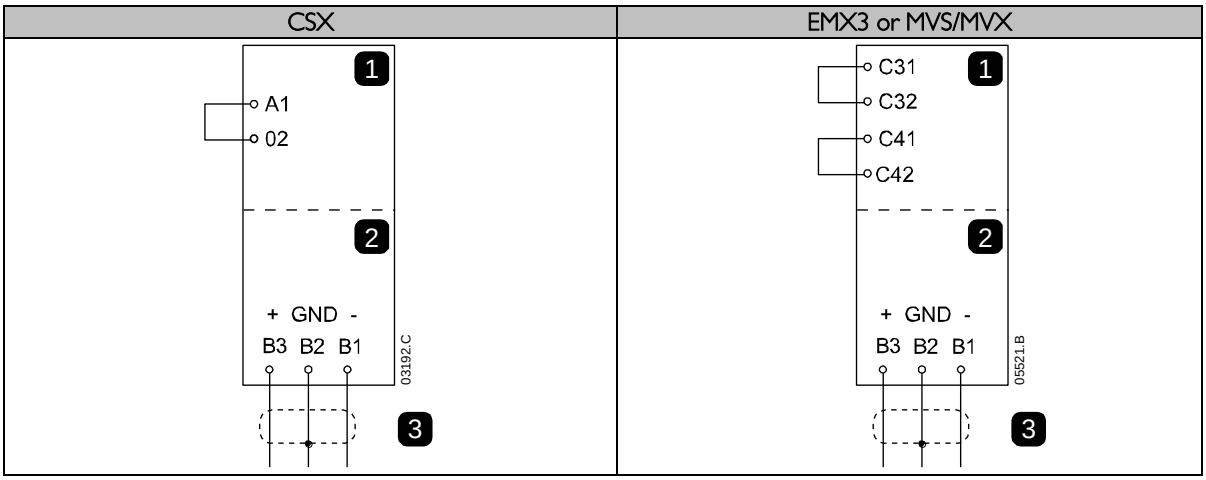
3. Adjustment

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



1	Protocol	5	Timeout (seconds)
2	Address	6	DIP switch
3	Baud rate	7	Example: Address = 24
4	Parity		

4. Connection



1	CSX
2	Modbus Interface – RS485 serial port
3	RS485 connection onto Modbus network

1	EMX3 or MVS/MVX (Remote mode) C31, C32: Stop C41, C42: Reset
2	Modbus Interface – RS485 serial port
3	RS485 connection onto Modbus network

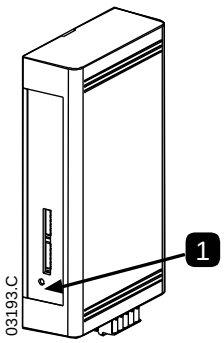
For the Modbus Interface to accept serial commands, a link must be fitted across terminals A1-02 on CSX starters.

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

NOTE
EMX3 parameter 6R and MVS/MVX parameter 4-B select whether the soft starter will accept Start and Stop commands from the Serial Network Master while in Remote Mode. Refer to the soft starter user manual for parameter details.

5. Network Status LED

The Network Status LED (1) indicates the state of the communications link between the interface and the network. LED operation is as follows:



1	Off	No connection or soft starter not powered up
	On	Communication active
	Flashing	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 a Reset.

6. Modbus Register

Register Address	Type	Description		CSX	CSX*i*	EMX3	MVS/MVX	Remote Operator
40002 Command	Single Write	1 = Start		●	●	●	●	●
		2 = Stop		●	●	●	●	●
		3 = Reset		●	●	●	●	●
		4 = Quick stop (coast to stop)		●	●	●	●	●
		5 = Forced communication trip		●	●	●	●	●
		6 = Start using Parameter Set 1 [4]				●	●	
		7 = Start using Parameter Set 2 [4]				●	●	
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 [1] Motor current	Multiple Read	Average 3 phase motor current (A)			●	●	●	●
40006 Motor temperature	Multiple Read	Motor 1 temperature (thermal model)			●	●	●	●
40007 Product Type and Version	Multiple Read	Bit	Description					
		0 to 2	Product parameter list version	●	●	●	●	●
		3 to 7	4= CSX/CSX*i* 5 = MVS/MVX 6 = EMX3	●	●	●	●	●
40008 Serial Protocol Version	Multiple Read			●	●	●	●	●
40009 [3] Parameter management	Single Write and Multiple Read	Parameter 1-A (Motor FLC) to: • MVS/MVX Maximum register address: 40125 Parameter 21-S (Time-overcurrent) • EMX3 Maximum register address: 40158 Parameter 16-U (RTD G overtemperature)				● ●	● ●	
40600 [1]	Multiple Read	L1 current (A)				●	●	

40601 [1]	Multiple Read	L2 current (A)			●	●	
40602[1]	Multiple Read	L3 current (A)			●	●	
40603	Multiple Read	L1 voltage (V)			●	●	
40604	Multiple Read	L2 voltage (V)			●	●	
40605	Multiple Read	L3 voltage (V)			●	●	
40606 [2]	Multiple Read	Powerscale and Power (W or kW)			●	●	
40607	Multiple Read	Power factor % (100 = Power factor of 1)			●	●	
40608	Multiple Read	Motor 2 Temperature (thermal model)			●		

[1] For EMX3 models EMX3-0076B and smaller this value will be 10 times greater than the value displayed on the keypad.

[2] Register 40606 contains Powerscale in bits 7 to 4 of the high byte and Power in bits 3 to 0 of the high byte plus the total low byte value.

Powerscale functions as follows:

0 = multiply Power by 10 to get W
1 = multiply Power by 100 to get W
2 = Power is represented in kW
3 = multiply Power by 10 to get kW

[3] 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.

[4] Ensure that the programmable input is not set to Motor Set Select before using this function.

Trip Code	Trip Type	CSX	CSXi	EMX3	MVS and MVX
1	Excess start time		●	●	●
2	Motor overload (thermal model)		●	●	●
3	Motor thermistor		●	●	●
4	Phase imbalance		●	●	●
5	Frequency (Mains supply)	●	●	●	●
6	Phase sequence		●	●	●
7	Instantaneous overcurrent			●	●
8	Power loss/Power circuit	●	●	●	●
9	Undercurrent			●	●
10	Heatsink (starter) overtemperature			●	●
11	Motor connection			●	●
12	Input A trip/Auxiliary Trip A			●	●
13	FLC too high/FLC out of range			●	●
14	Unsupported option (function not available in inside delta)			●	
15	Starter communication (between interface and soft starter)	●	●	●	●
16	Network communication (between interface and network)	●	●	●	●
17	Internal fault/error			●	●
18[1]	Overvoltage			●	●
19[1]	Undervoltage			●	●
20[1]	Ground fault			●	●
23	Parameter out of Range			●	●
24	Input B trip/Auxiliary Trip B			●	●
25	Bypass fail (bypass contactor)			●	●
26	L1 phase loss			●	●
27	L2 phase loss			●	●
28	L3 phase loss			●	●
29	L1-T1 shorted			●	●
30	L2-T2 shorted			●	●
31	L3-T3 shorted			●	●
32	Motor 2 overload (thermal model)			●	●
33[2]	Time-overcurrent (Bypass overload)		●	●	
34	SCR overtemperature				●
35	Battery/clock			●	●
36	Thermistor circuit			●	
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 A overtemperature			●	
45	RTD circuit fail			●	
46	Analog input trip			●	●
255	No trip	●	●		●

[1] Available with EMX3 only if appropriate option cards are fitted.

[2] For EMX3, time-overcurrent protection is only available on internally bypassed models.

7. Modbus Functions

The Modbus Interface supports the following Modbus functions:

- 03 Read multiple registers
- 06 Write single register

Modbus broadcast functions are not supported.

CSX soft starters (including Remote Operator):

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

EMX3 and MVS/MVX soft starters:

- Read multiple registers starting from 40003 up to a maximum of 119 register blocks.
- Write single register 40002 or 40009 to 40599.

NOTE
A multiple read across register boundary 40008/40009 will result in a Modbus Error code 05 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 on 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

Download parameter from starter
EMX3 and MVS/MVX: Read Parameter 3, Locked Rotor Current (Parameter 1C), 600%

Message	Starter Address	Function Code	Register Address	Data	CRC
In	20	03	40011	1	CRC1, CRC2
Out	20	03	2	600	CRC1, CRC2

Upload parameter to starter
EMX3 and MVS/MVX: Write Parameter 12, Stop Mode (Parameter 2H), set = 10

Message	Starter Address	Function Code	Register Address	Data	CRC
In	20	06	40020	10	CRC1, CRC2
Out	20	06	40020	10	CRC1, CRC2

8. 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	eg 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 EMX3 with parameter 6R = Disable control in RMT or to MVS/MVX with parameter 4-B = Disable in Remote.
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 to communicate with the Modbus Interface 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.

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 [05h]
Send command	STX [02h]	ccc ccc	lrc lrc	ETX [03h]
Send request				
Receive data	STX [02h]	dddd dddd	lrc lrc	ETX [03h]
Receive status	STX [02h]	ssss ssss	lrc lrc	ETX [03h]
ACK (acknowledge)	ACK [06h]			
NAK (negative acknowledge)	NAK [15h]			
ERR (error)	BEL [07h]			

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:

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

Status Retrieval

Soft starter status can be retrieved using the following format:

Send address	ACK	Send request	Receive status

Possible error responses: NAK (Invalid LRC)

	= Master		= Slave (soft starter)

Request	ASCII	Receive Status (ssss)	
Trip code	C18	Refer to 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 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 the soft starter using the following format:

Send address	ACK	Send request	Receive data

Possible error responses: NAK (Invalid LRC)

	= Master		= Slave (soft starter)

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	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:

5. Convert last two bytes of message from ASCII to binary
6. Left shift 2nd to last byte four bits
7. Add to last byte to get binary LRC
8. Remove last two bytes from message
9. Add remaining bytes of message
10. Add binary LRC
11. Round to one byte
12. 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. Modbus Control via Remote Operator

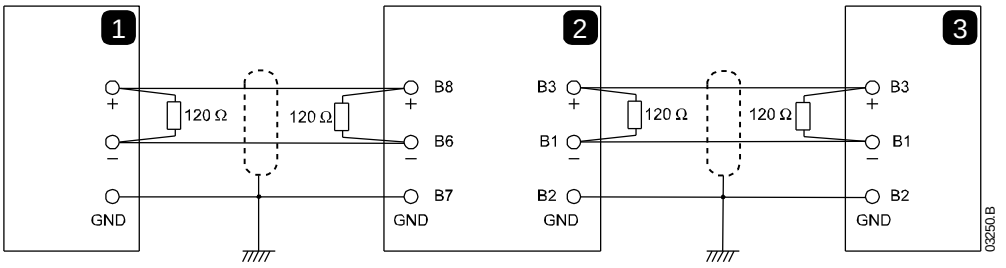
To control a soft starter via an RS485 serial communications network using the Remote Operator, connect the Remote Operator to the network as described in the following sections.

Grounding and Shielding

Twisted pair data cable with earth shield is recommended. The cable shield should be connected to the 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 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.



1	Network master RS485
2	Remote Operator RS485
3	Soft starter RS485

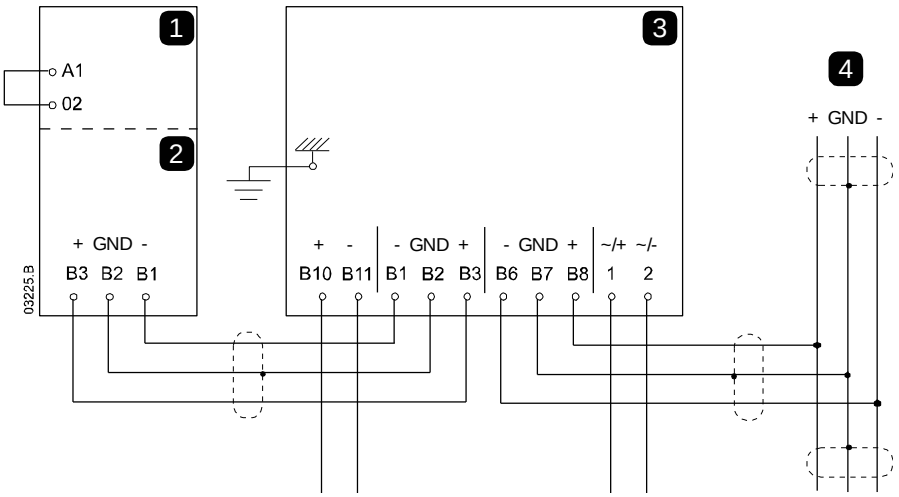
RS485 Data Cable Connection

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



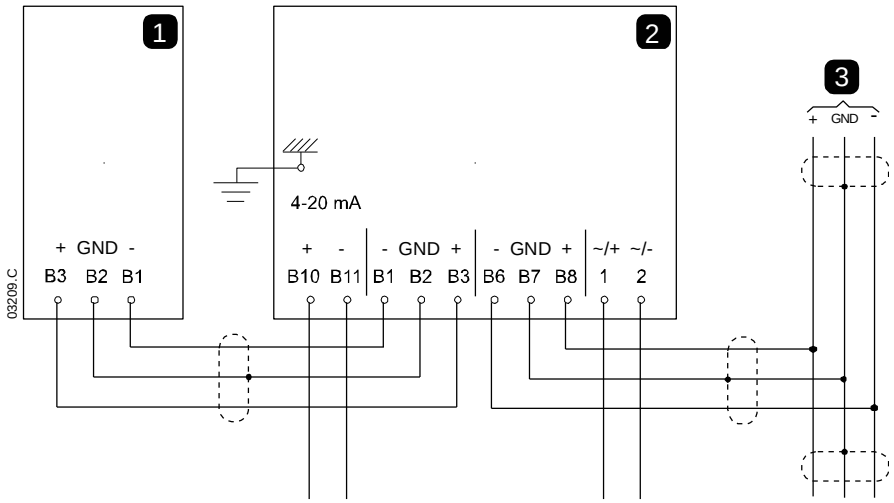
1	CSX
2	Modbus Interface – RS485 serial port

3	Remote Operator
	B10, B11 - 4~20 mA analog output
	B1, B2, B3 - RS485 starter connection
	B6, B7, B8 - RS485 network connection
	1, 2 - Supply voltage (18~30 VAC/VDC)
4	RS485 Serial communication network connection (Modbus RTU or AP ASCII)

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 communication 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.

1	IMS2 (Modbus built in)
2	Remote Operator B10, B11 - 4~20 mA analog output B1, B2, B3 - RS485 starter connection B6, B7, B8 - RS485 network connection 1, 2 - Supply voltage (18~30 VAC/VDC)

3	RS485 Serial communication network connection (Modbus RTU or AP ASCII)

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 9.

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	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] 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]
9	Current ÷ 10	0	0 = off (required for CSX and EMX3 models EMX3-0097B~EMX3-1600C) 1 = on (required for models EMX3-0023B~EMX3-0076B)

[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.

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.

11. 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 mm2
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
RoHS	Compliant with EU Directive 2002/95/EC