MODBUS INTERFACE INSTALLATION INSTRUCTIONS

Part: PIM-MB-01

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 a CSX Series starter using Modbus RTU or AP ASCII, without the Remote Operator, the instructions below describe the installation and operation of the Modbus Interface.

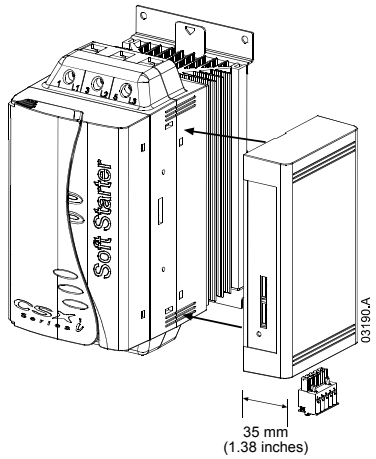
IMS2 soft starters have Modbus RTU and AP ASCII protocol support built in – please refer to the IMS2 Users Manual for details of message formats.

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

2. Installation

To install the Modbus Interface for use with CSX Series starters:

1. Remove control power and mains supply from the CSX.
2. Attach the Modbus Interface to the starter as shown in the diagram below.
3. Apply control power to the CSX.

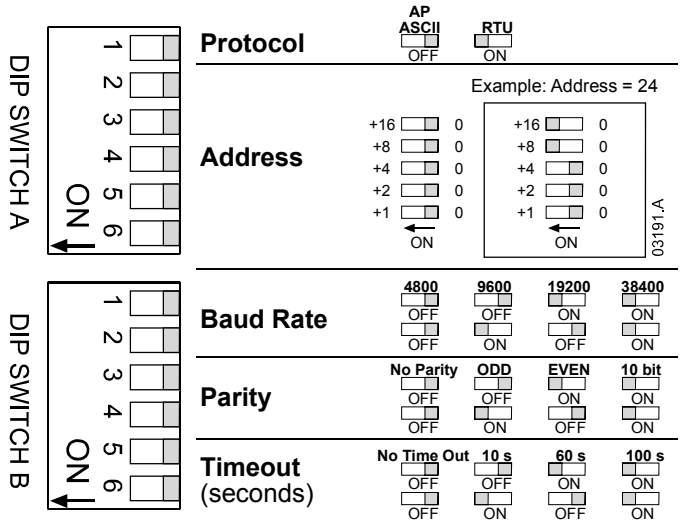


NOTE

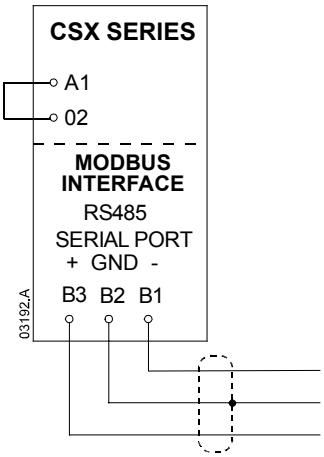
Control power and mains supply must be removed from the CSX before attachment or removal of accessories. Failure to do so may result in equipment damage.

3. Adjustment

Network communication parameters must be set on the Modbus Interface.

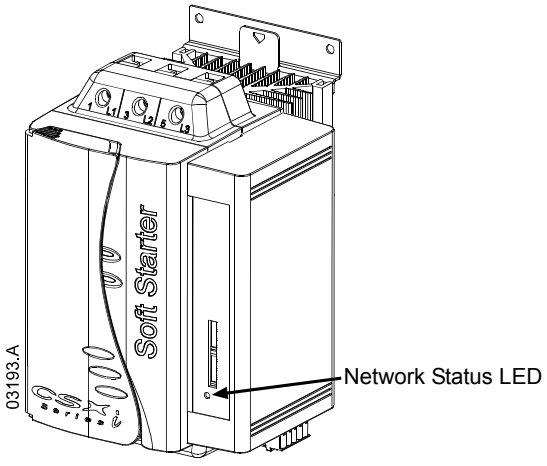


4. Connection



NOTE
For the Modbus Interface to operate correctly, a link must be fitted across terminals A1 and 02 on the starter.

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	Healthy communications	Communication failure

NOTE
If a communications failure occurs, the CSX will trip if the Communications Timeout function has been set. When communication is restored, the CSX will require an independent Reset.

6. Modbus Register

Address	Function	Type	Description	
40002	Command	Write	1 = Start 2 = Stop 3 = Reset 4 = Quick Stop 5 = Forced Comms Trip	
40003	Starter Status	Read	**Bit**	**Description**
			0 to 3	1 = Ready 2 = Starting 3 = Running 4 = Stopping 6 = Tripped
			4	1 = Positive Phase Sequence
			5	*Unallocated*
			6	*Unallocated*
			7	*Unallocated*
40004	Trip Code	Read	255 = No Trip 1 = Excess Start Time [1] 2 = Motor Overload [1] 3 = Motor Thermistor [1] 4 = Phase Imbalance [1] 5 = Supply Frequency 6 = Phase Sequence [1] 8 = Power Circuit 15 = Comms Failure between starter and interface 16 = Comms Failure between interface and network	
40005	Current	Read	[1]	
40006	Temperature	Read	[1]	

[1] Only available on CSX*i* units.

7. Modbus Hex Functions

CSX Series starters support two functions:

- 03 (Multiple Read)
- 06 (Single Write)

The CSX Series does not support broadcast functions.

NOTE
Command, Starter Status, Trip Code, Motor Current and Motor Temperature must be sent individually (ie one data word request at a time).

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: CSX 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 CSX Series soft starter are shown below. The message fragments may be assembled into complete messages as described in the sections that follow.

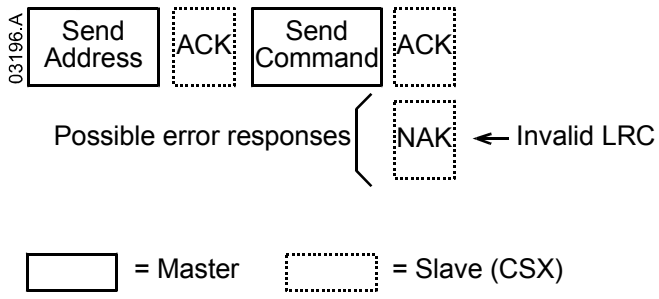
NOTE
Data transmitted to and from the starter must be in 8 bit ASCII, no parity, 1 stop bit.

Message Fragment Type	ASCII Character String or (Hexadecimal Character String)
Send Address	EOT [nn] [lrc] ENQ or (04h [nn] [lrc] 05h)
Send Command	STX [ccc] [lrc] ETX or
Send Request	(02h [ccc] [lrc] 03h)
Receive Data	STX [dddd] [lrc] ETX or (02h [dddd] [lrc] 03h)
Receive Status	STX [ssss] [lrc] ETX or (02h [ssss] [lrc] 03h)
ACK (acknowledge)	ACK or (06h)
NAK (negative acknowledge)	NAK or (15h)
ERR (error)	BEL or (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

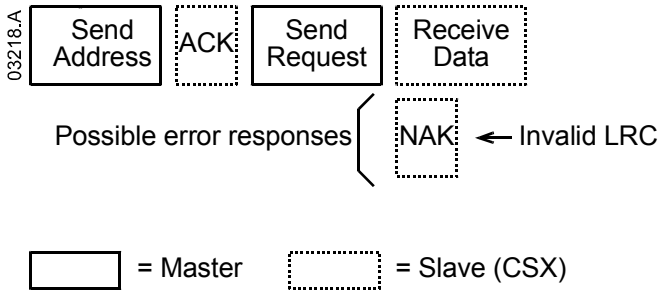
Commands can be sent to the CSX using the following format:



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

Status Retrieval

Starter status can be retrieved using the following format:

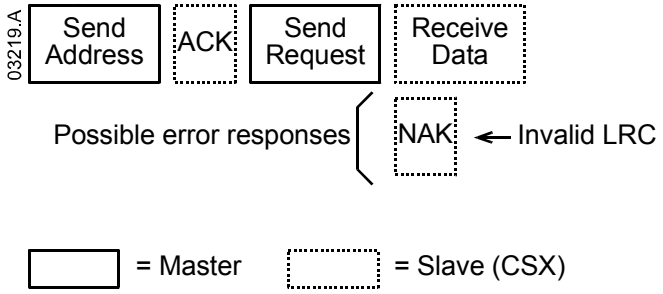


Request	ASCII	Receive Status (ssss)	
Trip Code	C18	Requests the trip status of the starter. 255 = No Trip 1 = Excess Start Time [1] 2 = Motor Overload [1] 3 = Motor Thermistor [1] 4 = Phase Imbalance [1] 5 = Supply Frequency [1] 6 = Phase Sequence [1] 7 = Electronic Shearpin [1] 8 = Power Circuit Fault 15 = Comms Failure between starter and interface 16 = Comms Failure between interface and network	
Starter Status	C22	**Bit**	**Description**
		0 to 3	0 = Not used 1 = Waiting 2 = Starting (including Pre-start tests) 3 = Running 4 = Stopping 6 = Tripped
		4	1 = Forward phase sequence detected
		5	*Unallocated*
		6	*Unallocated*
		7	*Unallocated*

[1] Only available from CSX*i* models.

Data Retrieval

Data can be retrieved from the CSX using the following format: [1]



Request	ASCII	Receive Data (dddd)
Current	D10	Requests motor current. The data is four byte decimal ASCII. Minimum value 0000 A, maximum value 9999 A.
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%.

[1] Data retrieval is only supported on CSX*i* units.

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

10. Appendix A – Modbus Control via Remote Operator

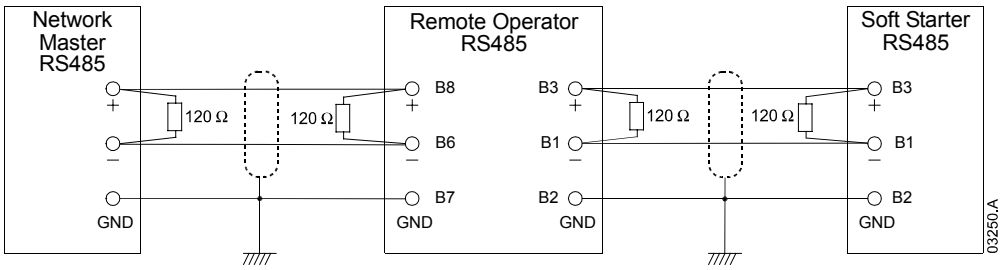
To control a soft starter via an RS485 serial communications network using the Remote Operator, connect the Remote Operator to the network as described in the following sections.

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.



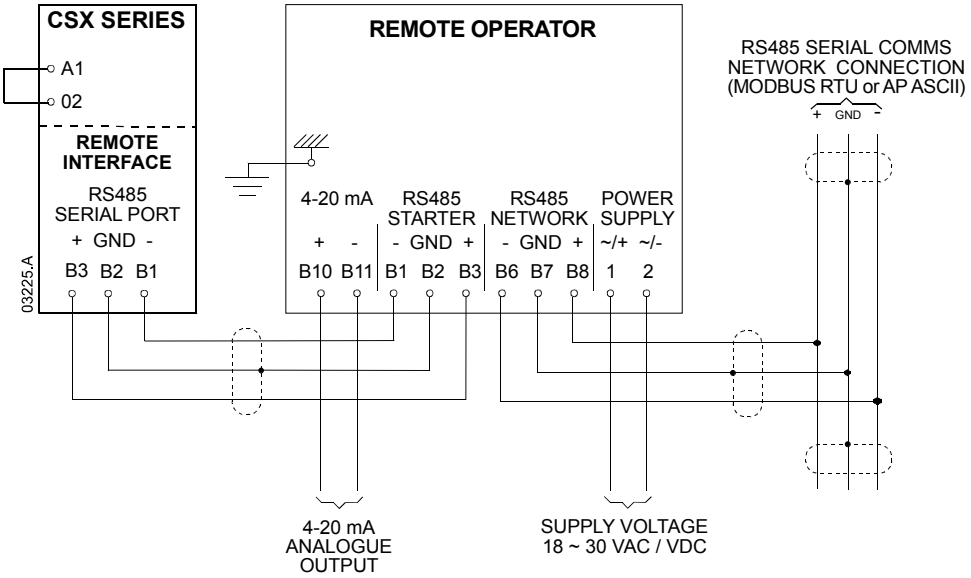
RS485 Data Cable Connection

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

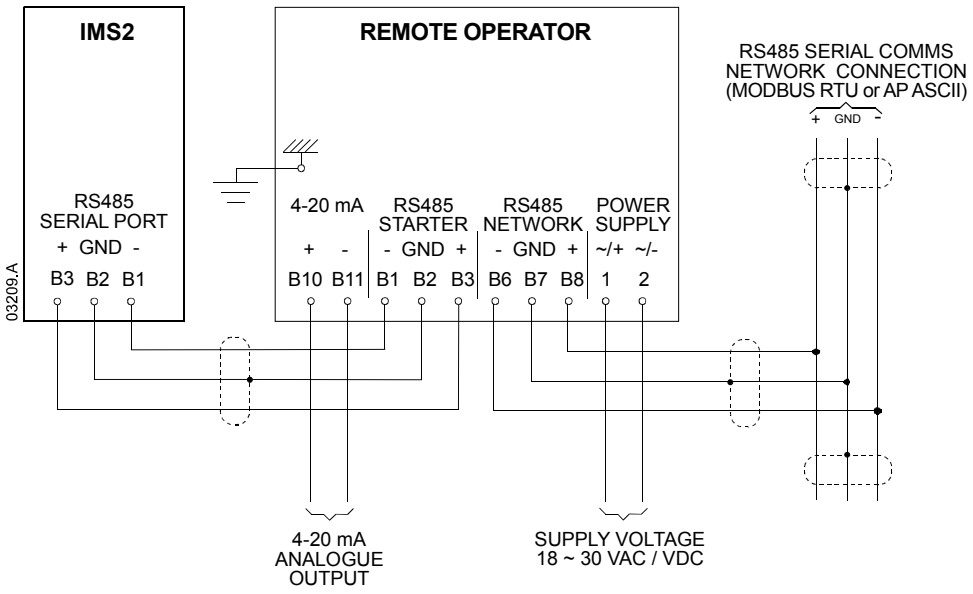
Remote Operator RS485 Network Connection Specifications

Input Impedance:	12 kΩ
Common Mode Voltage Range:	- 7 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 a CSX Series Starter



Using the Remote Operator with an IMS2 Series Starter



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. Please refer to the IMS2 Users Manual for soft starter configuration details.

Configuration

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 in “off” mode.

- Enter Programming Mode by holding down the Data/Prog Pushbutton for four seconds. The value of the first parameter will be displayed.
- If required, use the Stop/+ and Reset/- pushbuttons to adjust parameter values.
- Use the Data/Prog Pushbutton to confirm the setting and advance to the next parameter.

The Remote Operator will exit Programming Mode 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 Time Out	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:

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.
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.