



SLM3 – A00920

Signal Line Monitor for use with
Addressable Nodes

Operation Manual

SLM3 Manual
Part number: A00920

Version: 1.3
Date: May 2010

Copyrights

All rights reserved. This document may not, in whole or part, be copied, photocopied, reproduced, translated, or reduced to any electronic medium or machine readable form without the express written permission of Bramco Electronics.

Disclaimer

Bramco electronics has made every attempt to ensure that the information contained in this document is accurate and complete. Bramco electronics makes no representation or warranties of merchantability or fitness for any particular purpose. Bramco Electronics reserves the right to make changes to the system and/or document at any time without notice.

Bramco Electronics

Unit 2&3 Callistemon Close,
Warabrook NSW 2304
Australia
www.bramco.com.au

Ph: +61 2 4014 4444
Fax: +61 2 4967 4100
Email: sales@bramco.com.au

Index

OVERVIEW.....	5
1. FEATURES.....	5
1.1. CONNECTIONS.....	6
2. OPERATION.....	9
2.1. OPERATION - OVERVIEW.....	9
2.2. CONTINUOUS MONITORING MODE.....	9
2.2.1. CONTINUOUS MODE LED OPERATION.....	9
2.2.2. CONTINUOUS MODE RELAY OPERATION.....	10
2.3. SLCM MODE.....	10
2.3.1. SLCM MODE LED OPERATION.....	10
2.3.2. SLCM MODE RELAY OPERATION.....	11
2.4. RS-485 MODBUS ASCII PORT.....	12
2.4.1. REGISTER 4001 – ADDRESS OF LAST TRIP.....	12
2.4.2. REGISTER 4002 – TRIP SINCE LAST READ.....	12
2.4.3. REGISTER 4003 – MODULE STATUS.....	12
2.4.4. REGISTER 4004 – LINE VOLTAGE.....	13
2.4.5. REGISTER 4005 – OPERATIONAL MODE.....	13
2.4.6. REGISTER 4006 – SIGNAL LINE QUALITY.....	13
2.5. MODBUS PACKET STRUCTURE.....	13
2.5.1. MODBUS REQUEST PACKET STRUCTURE.....	13
2.5.2. MODBUS RESPONSE PACKET STRUCTURE.....	16
2.5.3. MODBUS ERROR PACKET STRUCTURE.....	17
2.5.4. NOTES.....	18
2.5.5. CONNECTIONS.....	18
3. SPECIFICATIONS.....	19
4. INSTALLATION.....	20
4.1. GENERAL RECOMMENDATIONS.....	20
4.2. DC SUPPLY.....	20
4.3. CONNECTIONS.....	20
4.4. FOR SLCM MODE OPERATION.....	20

4.5.	FOR CONTINUOUS MODE OPERATION	20
5.	FAULT DIAGNOSIS	21
5.1.	TROUBLESHOOTING	21
6.	ASCII TABLE	22
7.	SLCM INSTALLATION.....	23
7.1.	CONTINUOUS MODE INSTALLATION.....	24

Overview

The SLM3 is designed for use in 2 wire trip detection applications. The SLM3 is capable of identifying up to 256 unique trip locations via the 2 wire signal line of stop switches, wander switches and blocked chute switches. Alternatively the module can be used to monitor long line health.

The SLM3 uses Digital Signal Processing (DSP) techniques to detect the A00921 Addressable Node's address when it is transmitted on a signal wire. This transmission/detection method is very robust, even in noisy and high impedance lines.

1. Features

The SLM3 module can be used for **two** separate functions.

1. The SLM3 can identify up to 256 unique trip locations on a two wire system. This function requires the use of one switch and one A00921 SLM3 Addressable node per trip location. The BK300 or BK400 are recommended for use as the switching device. In this mode of operation the A00718B SLC2 module is used to detect signal line discontinuities and activate the SLM3's trip location detection function.
2. The SLM3 can monitor the health of a two wire system. This function requires the use of **one** A00921 SLM3 Addressable node. In this mode the SLM3 can operate as a standalone unit without the use of the A00718B SLC2.

The SLM3 has one RS-485 MODBUS ASCII port to interface to monitoring systems. Via this port all pertinent information to the SLM3's operating status can be obtained.

1.1. Connections

Terminal Number	Description
1	POS 24VDC
2	0V
3	NO CONNECTION
4	NO CONNECTION
5	FAULT RELAY 1 OUT
6	FAULT RELAY 2 OUT
7	FAULT COMMON INPUT
8	NO CONNECTION
9	SIGNAL LINE POS
10	TO TERM 10 ON SLC2 (If Required)
11	RS485 0V
12	SYNCH - TO TERM 12 ON SLC2
13	RS485 DB
14	RS485 DA
15	SIGNAL LINE NEG
16	NO CONNECTION

Table 1.1-1

1.2. Face Plate Front View



1.3 Basic Enclosure Dimensions

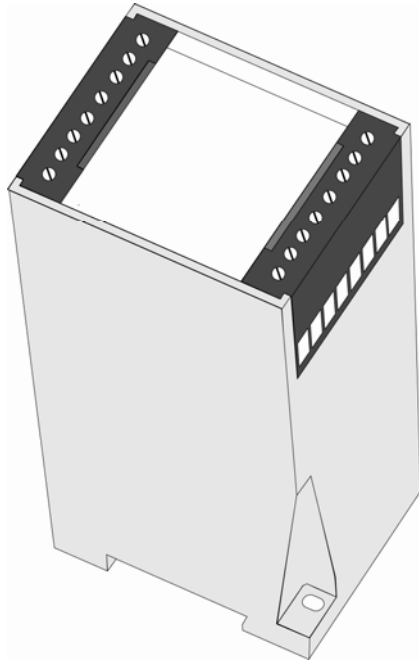


Figure 1 - Enclosure

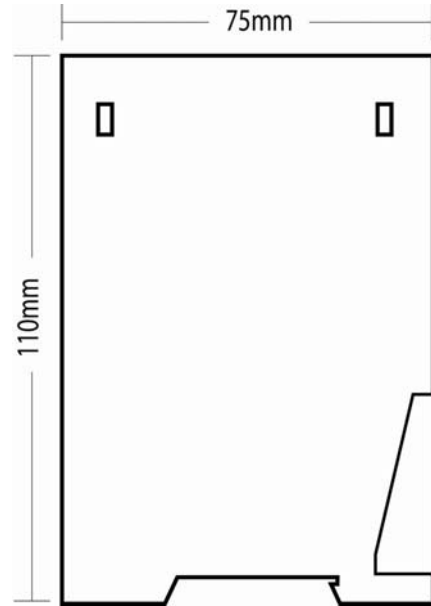


Figure 3 - Side Dimensions 2

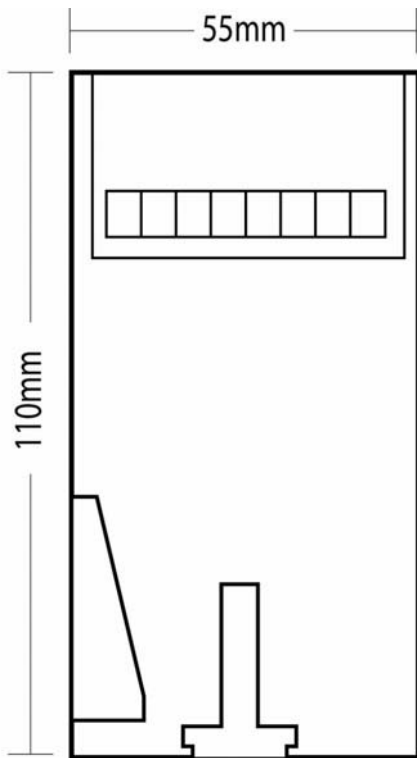


Figure 2 - Side Dimensions 1

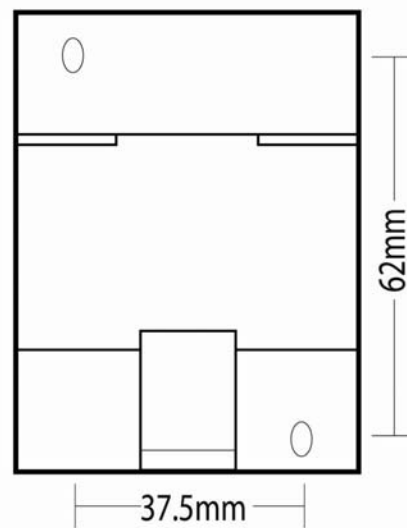


Figure 4 - Bottom Mounting Dimensions

2. Operation

2.1. Operation - Overview

This section is divided into three main subsections; the first two describe the operating modes of the SLM3. Contained within each operating mode subsection is the description of the LED operation and the Fault Relay operation. The third subsection describes the RS-485 MODBUS ASCII port.

To allow for the use of a 2 digit display, the address values displayed by the SLM3 are in hexadecimal format. Hexadecimal is a base 16 number system that uses the traditional 0 to 9 and adds an additional 6 (A, B, C, D, E, F) to allow for 16 unique characters per digit. In this manual hexadecimal values are preceded with a '0x', for example 0x01 is the hexadecimal value for 1.

The SLM3 address range is from 0x00 to 0xFF, from 0 to 255 in decimal.

The module starts up in SLCM mode. Only after a few seconds is the module able to determine the mode of operation for its installation. During the first 6 seconds after power up, the module is performing internal configuration and should not be used for safety critical decisions.

2.2. CONTINUOUS Monitoring Mode

This mode exists when no A00718B SLC2 is connected to the SLM3 (See [Section 7.1](#) below). Screw terminal 12 on the SLM3 is connected to 0v. In this mode the module continuously scans the signal line and expects to receive an address every 2.5 seconds. While the module is detecting an address it indicates that it is healthy. If two consecutive address transmissions are missed, the module will indicate a trip.

2.2.1. CONTINUOUS Mode LED Operation

In CONTINUOUS mode the module starts up tripped, indicating that no address has been detected. After the first successful detection, the module will display the detected address and that it is healthy. When two consecutive address transmissions are missed, the module indicates a trip.

The LEDs on the front of the module are as follows:

LED	Description
2 Digit Display	Displays the Address of the node detected.
DC	24v DC detected from terminal 1 to 2
Healthy	The SLM3 is detecting a node.
Trip	The SLM3 is not detecting a node.
Rx	RS-485 Receive activity
Tx	RS-485 Transmit activity

Table 2.2.1-1

The following table describes the possible LED combinations for the healthy and tripped indication.

LED	Healthy	Tripped
2 Digit Display	Node Address	'- -'
Healthy LED	ON	OFF
Tripped LED	OFF	ON

Table 2.2.1-2

2.2.2. CONTINUOUS MODE RELAY OPERATION

There are two fault relays, Fault Relay 1 and Fault Relay 2. In Continuous mode Fault Relay 1 closes upon successful detection of any node. Fault Relay 2 closes upon detection of address 0xFF.

Address Detected	Fault Relay 1 State	Fault Relay 2 State
None	Open	Open
Any (Except 0xFF)	Closed	Open
0xFF	Closed	Closed

Table 2.2.2-1

2.3. SLCM Mode

This mode exists when the SLM3 is connected to an A00718B SLC2 (see [section 7](#) below). In this mode the module sits idle until it receives an activation signal from the SLC2. The SLC2 will activate an SLM3 only when it detects that the signal line resistance is very high, indicating that the line may have a discontinuity. When this happens, the SLM3 takes control of the signal line for 4 seconds and attempts to detect a node on the system by reversing the line polarity and activating the connected A00921 node. After the 4 seconds, the SLC2 takes back control of the signal line and determines if there is still a discontinuity. If the SLM3 is unable to detect a node for two consecutive active cycles from the SLC2 it will display '- -' on the 2 digit display.

2.3.1. SLCM Mode LED Operation

The module starts up healthy and indicating that no address has been detected on the dim 2 digit display. When the SLC2 module activates SLM3 the 2 digit display becomes bright, and the module will indicate a trip via the TRIP LED. During this time one address detection is attempted. Upon successful detection, the module will display the detected address. The 2 digit display will remain bright until the SLC2 detects that the line no longer has a discontinuity. If for two consecutive cycles the SLM3 is unable to detect a node the 2 digit display will show '- -'.

When the SLC2 detects that the line is no longer discontinuous, the SLM3 becomes inactive and the 2 digit display dims and the module indicates that it is healthy.

The LEDs on the front of the module are as follows:

LED	Description
-----	-------------

Bright 2 Digit Display	SLM3 is active and this is the current address of a trip.
Dim 2 Digit Display	SLM3 is inactive and this was the last address detected.
DC	Voltage from terminal 1 to 2 exists.
Healthy	The SLM3 is inactive.
Trip	The SLM3 is actively detecting a node.
Rx	RS-485 Receive activity
Tx	RS-485 Transmit activity

Table 2.3.1-1

The following table describes the possible led combinations for the healthy and tripped indication.

	Active	Inactive
2 Digit Display	Bright: Node Address or '- -' *	Dim: Node Address or '- -' *
Healthy LED	OFF	ON
Tripped LED	ON	OFF

Table 2.3.1-2

*Note that in either Active or Inactive mode the 2 digit display may read '- -', indicating that no node was found.

2.3.2. SLCM Mode Relay Operation

There are two fault relays, Fault Relay 1 and Fault Relay 2. In SLCM mode both relays operate in unison. They mimic the state of screw terminal 12, the input of the SLC2 SYNC signal.

SYNC State (Terminal 12)	Fault Relay 1 State	Fault Relay 2 State
Vdd	Open	Open
0v	Closed	Closed

Table 2.3.2-1

2.4. RS-485 MODBUS ASCII Port

Protocol

MODBUS ASCII
7 Data bits, 1 Stop bit, Even Parity
9600 Baud

MODBUS Request

Slave ID: **04**
Maximum Delay for response: 1500ms
Minimum Poll Period: 500ms
Accepted Requests: 03 Read Holding Registers

Register	Description	Interpretation of Data
4001	Address of Last Trip	Address from 0 to 255
4002	Tripped Since Last Modbus Read	0 = Not Tripped 1 = Tripped
4003	Module Status	Healthy = 0 Tripped = 1
4004	Line Voltage	Signal Line Voltage * 100
4005	Operational Mode	CONTINUOUS Mode = 0 SLCM Mode = 1
4006	Data Packet Quality	Value from 0 to 6500 indicating signal line quality

Table 2.4-1

2.4.1. Register 4001 – Address of Last Trip

This register contains the address displayed on the module's two digit display. When the display is showing '- ', this register holds the value 0xFFFF.

2.4.2. Register 4002 – Trip Since Last Read

This register contains a one if a trip occurred since the last MODBUS read request was processed. This allows the user to determine when the trip occurred. After a MODBUS read of this register it is reset to 0.

2.4.3. Register 4003 – Module Status

This register contains the status of the module. A value of 1 indicates that the module is tripped and a value of 0 indicates that the module is healthy.

2.4.4. Register 4004 – Line Voltage

This register holds the current voltage * 100 of the signal line. The signal line voltage will vary when an addressable node is transmitting on it. This is because the addressable node uses the signal line as its power source. During times of node transmission the signal line voltage will drop and then recover when the node stops transmitting.

2.4.5. Register 4005 – Operational Mode

This register holds the current operational mode. A value of 1 indicates CONTINUOUS mode and a value of 0 indicates SLCM mode.

2.4.6. Register 4006 – Signal Line Quality

This register contains the quality of the data packet received from the node. In noisy installations and/or high impedance installations this value can be used to determine signal line quality. The value can range from 6500 to 0, normal installations and operating conditions puts the value around 3000. After installation of the system this value should be recorded. During operation it can be periodically checked to determine line degradation and/or noise addition to the system.

The larger the value of this number, the higher the quality of the signal line.

2.5. MODBUS Packet Structure

This section describes the MODBUS packet structure required to request data from the SLM3 and the packet structure that the SLM3 responds with.

2.5.1. MODBUS Request Packet Structure

The SLM3 is able to respond to a requested read of any or all of the valid registers. It is possible to request any consecutive range of holding registers or a single register.

The following 3 step example shows how to build a request packet to read all 6 registers.

1. The first step is to fill out 9 of the following 10 bytes.

Byte	Valid Value	Description
Start	Colon	Always the start byte of a packet.
To	4	Address of SLM3 module, always 4.
Function	3	Function 3 to read holding registers.
Start Address High	0	Always 0 for SLM3
Start Address Low	0, 1, 2, 3, 4, 5	Address for first register to be read. 4001 = 0, 4002 = 1, etc.
Quantity High	0	Always 0 for SLM3
Quantity Low	1,2,3,4,5,6	Number of registers to be read.
Checksum	To be calculated	Calculated Checksum
Carriage Return	CR	ASCII code for Carriage Return
Line Feed	LF	ASCII code for Line Feed.

In this example we will request all 6 holding registers from the SLM3 Module. The following values are used to construct the packet.

Byte	Decimal Value
Start	:
To	4
Function	3
Start Address High	0
Start Address Low	0
Quantity High	0
Quantity Low	6
Checksum	To be calculated
Carriage Return	CR
Line Feed	LF

2. Next compute the checksum (LRC).

The checksum is computed by the following 3 steps.

1. First sum all of the bytes in the packet **except for** the Start, Checksum, Carriage Return, and Line Feed bytes.

$$\text{sum} = 4 + 3 + 0 + 0 + 0 + 6 = \mathbf{13}$$

Since the computed checksum must fit within a byte, it is restricted to values from 0 to 255. Sometimes it may be necessary to reduce this first sum to fit within these values. If this is necessary one must use the Modulus operation.

If the sum had been calculated to 312, we would modulo that value with 256. The modulus operation is defined as the value of the remainder in an integer division. We are dividing 256 into 312. Since 256 fits once within 312 and has 56 left over, $312 \text{ modulo } 256 = 56$. Thus 56 would be our new sum and is within 0 to 255.

2. Subtract the sum from 255.

$$255 - \text{sum} = \mathbf{242}$$

3. Checksum = sum + 1

Checksum = Sum + 1 = 243 = **0xF3**

3. Convert All Bytes to Hexadecimal values.

Byte	Decimal Value	Hexadecimal Value
Start	:	0x3A
To	4	0x04
Function	3	0x03
Start Address High	0	0x00
Start Address Low	0	0x00
Quantity High	0	0x00
Quantity Low	6	0x06
Checksum	243	0xF3
Carriage Return	CR	0x0D
Line Feed	LF	0x0A

4. In this step we start by splitting the hex values into two parts. Then we convert each part into its corresponding Hex ASCII codes using the ASCII table in section 6. Note that the splitting is not done for the start character and the Carriage Return and Line Feed; these are already Hex ASCII Codes.

Byte	Original	Value 1	Value 2	Code 1	Code 2
Start	0x3A				
To	0x04	0	4	0x30	0x34
Function	0x03	0	3	0x30	0x33
Start Address High	0x00	0	0	0x30	0x30
Start Address Low	0x00	0	0	0x30	0x30
Quantity High	0x00	0	0	0x30	0x30
Quantity Low	0x06	0	6	0x30	0x36
Checksum	0xF3	F	3	0x46	0x33
Carriage Return	0x0D				
Line Feed	0x0A				

The final packet is almost twice as long as before and now looks like this:

Byte Name	Byte Value
Start	0x3A
To High	0x30
To Low	0x34
Function High	0x30
Function Low	0x33
Start Address High	0x30
Start Address Low	0x30
Quantity High	0x30
Quantity Low	0x36
Checksum High	0x46
Checksum Low	0x33

Carriage Return	0x0D
Line Feed	0x0A

2.5.2. MODBUS Response Packet Structure

Each Holding Register is represented by two bytes in the response packet, a high byte and a low byte. The following example is a response to the request to read the first 6 holding registers of the SLM3. Notice that since the response is sent as ASCII codes each holding register is composed of 4 ASCII code bytes.

Byte Name	Byte Value
Start	0x3A
To High	0x30
To Low	0x34
Function High	0x30
Function Low	0x33
Number Bytes High	0x30
Number Bytes Low	0x43
Register 4001 Upper High	0x30
Register 4001 Upper Low	0x30
Register 4001 Lower High	0x44
Register 4001 Lower Low	0x46
Register 4002 Upper High	0x30
Register 4002 Upper Low	0x30
Register 4002 Lower High	0x30
Register 4002 Lower Low	0x30
Register 4003 Upper High	0x30
Register 4003 Upper Low	0x30
Register 4003 Lower High	0x30
Register 4003 Lower Low	0x30
Register 4004 Upper High	0x30
Register 4004 Upper Low	0x38
Register 4004 Lower High	0x33
Register 4004 Lower Low	0x41
Register 4005 Upper High	0x30
Register 4005 Upper Low	0x30
Register 4005 Lower High	0x30
Register 4005 Lower Low	0x31
Register 4006 Upper High	0x30
Register 4006 Upper Low	0x44
Register 4006 Lower High	0x43
Register 4006 Lower Low	0x35
Checksum High	0x46
Checksum Low	0x39
Carriage Return	0x0D
Line Feed	0x0A

Use the following procedure to reconstruct the value contained in a register.

1. Convert the ASCII codes into their ASCII characters using the ASCII table in section 7.

Byte	Code	Character
Register 4001 Upper High	0x30	0
Register 4001 Upper Low	0x30	0
Register 4001 Lower High	0x44	D
Register 4001 Lower Low	0x46	F

2. Combine the ASCII characters into a four nibble Hexadecimal number.
3. **0x00DF** is the 16 bit value for the 4001 register

The checksum can be used to verify the integrity of the data packet. Using the process described in step 2 of section 2.5.1 MODBUS Request Packet Structure compute the checksum of the received packet. Then convert the ASCII codes from the received Checksum High and Checksum Low bytes. In this example 0x46 converts to F and 0x39 converts to 9 creating the hexadecimal checksum of 0xF9. If the computed checksum of the received packet equals 0xF9 then the data within the packet should be considered free of errors.

2.5.3. MODBUS Error Packet Structure

The MODBUS Error response packet from the SLC2 is composed as follows.

Byte Name	Byte Value
Start	0x3A
To High	0x30
To Low	0x34
Function High	0x38
Function Low	0x33
Error Number High	0x30
Error Number Low	0x31
Checksum High	0x30
Checksum Low	0x42
Carriage Return	0x0D
Line Feed	0x0A

The “To” bytes consist of the ASCII codes for the hex value of the SLM3’s address 0x04. In general terms these bytes hold the ASCII codes for the address of the device that sends the error response.

The “Function” bytes are created from the function code in the request that created the error + 0x80. For example if the error was created on a request for holding registers (code 03) the returned function code would be 0x83. This would translate to Function High equal to the ASCII code for 8 (0x38) and Function Low equal to the ASCII code for 3 (0x33).

The “Error Number” bytes describe why the error is being returned. The possible values are in the following table. It follows that in ASCII codes the error number 01 is represented with Error Number High as 0x30 and Error Number Low as 0x31.

Error Number	Meaning
01	Invalid Function requested
02	Invalid Register Location requested
03	Invalid Quantity of registers requested

The “Checksum” bytes are the LRC of the packet and are created exactly as in step 2 of section 2.5.1 MODBUS Request Packet Structure.

2.5.4. Notes

It is recommended that the SLM3 module be polled at intervals greater than 3 seconds to ensure the module has had time to reset before being read again. (Poll periods of longer than 5 seconds would be sensible).

The SLM3 will ignore Broadcast messages and packets that are not addressed as “0x04”.

The SLM3 will also ignore packets with invalid CRC.

2.5.5. Connections

Terminal 14 is connected to DA,
Terminal 13 is connected to DB,
Terminal 11 is RS-485 0V.

3. Specifications

Physical	
Supply Voltage	External 24VDC +- 10%
Dimensions	Din Rail or Screw Mounted Enclosure. High impact resistant polycarbonate. 55W x 75H x 110D (mm) Weight: 250g
Operating Temperature	0 - 60°C
Fault Relays	Two (2) 5A 240VAC Rated (See section 2. Operation)
Serial RS-485	6 Registers accessible via MODBUS ASCII Protocol 9600 Baud 7 Data Bits Even Parity 1 Stop Bit (See 2.4 MODBUS ASCII Port)
Signal Line Resistance	Up to 1000 Ohms
Operational Modes	
CONTINUOUS Mode	Continuous Monitoring of Signal Line, used to verify line continuity.
Node Detection	Max: 12 seconds to detect discontinuity of line (2x 6s intervals)
SLCM Mode	SLM3 works in conjunction with SLC2. When SLC2 detects a discontinuity in the signal line, SLM3 is activated and attempts to locate the discontinuity.
Node Detection	The SLM3 will detect a connected node within 2.5s of being activated by the SLC2.
Accessories	
SLM3 Addressable Node	Up to 256 per installation, used to identify trip points along the signal line.
SLM2 Remote Display	A00724 96 x 96 x 90 mm (H x W x D) IP65 Front Facia Supplied with 2m ribbon cable to connect to front of SLM3 (Note that the SLM2 remote display works with SLM2 and SLM3.)

Table 3-1

4. Installation

4.1. General Recommendations

Mount the SLC2 Module and the 24VDC Power Supply Module close to each other. A typical connection diagram is included in Section 7 Installation.

4.2. DC Supply

Wire the 24VDC circuit as per the typical connection diagram. See Section 7 Installation.

0V is wired to **terminal 2** on SLM3 Module.

+24V is wired to **terminal 1** on the SLM3 Module.

4.3. Connections

The connections for the SLM3 depend on the mode of operation that is desired.

4.4. For SLCM Mode Operation

For SLCM mode operation wire as described in Section 7 Installation.

4.5. For Continuous Mode Operation

For Continuous mode operation wire as described in Section 7 Installation.

5. Fault Diagnosis

5.1. Troubleshooting

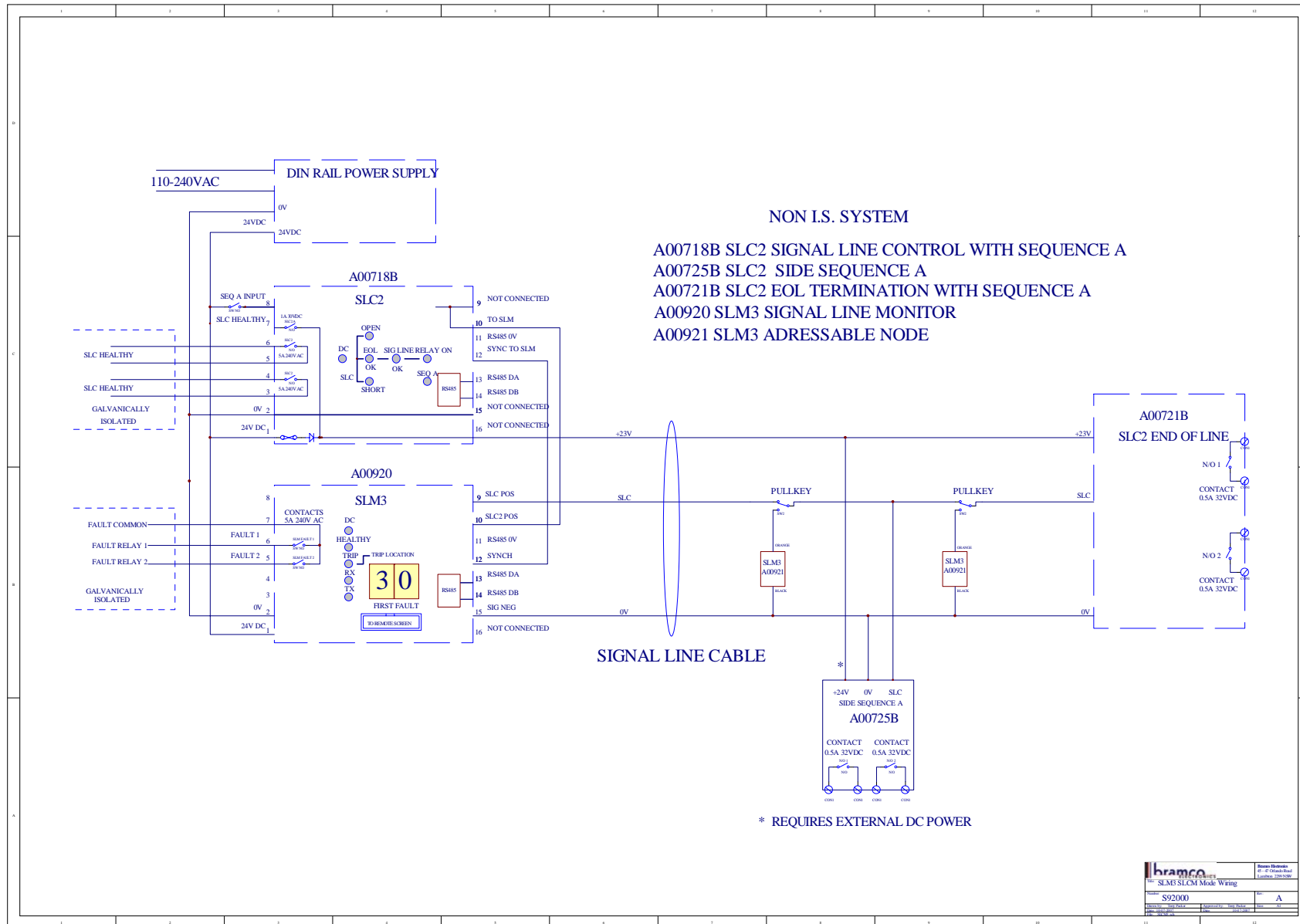
Indication	Possible condition/suggestion
No Node Detected	<ol style="list-style-type: none">1. The signal line is not connected from the SLM3 to the Node.2. The signal line resistance is larger than 1000 Ohms.3. The environment is noisy.4. Verify that the node is connected correctly across the signal line. (Nodes wired backwards will NOT transmit any data.)
Unable to get a MODBUS response	<ol style="list-style-type: none">1. Check that Data A and Data B are connected correctly. (The voltage on the Data A line should be at least 0.2 volts larger than the Data B line.)2. Verify the address in the request packet is 0x04.

Table 5.1-1

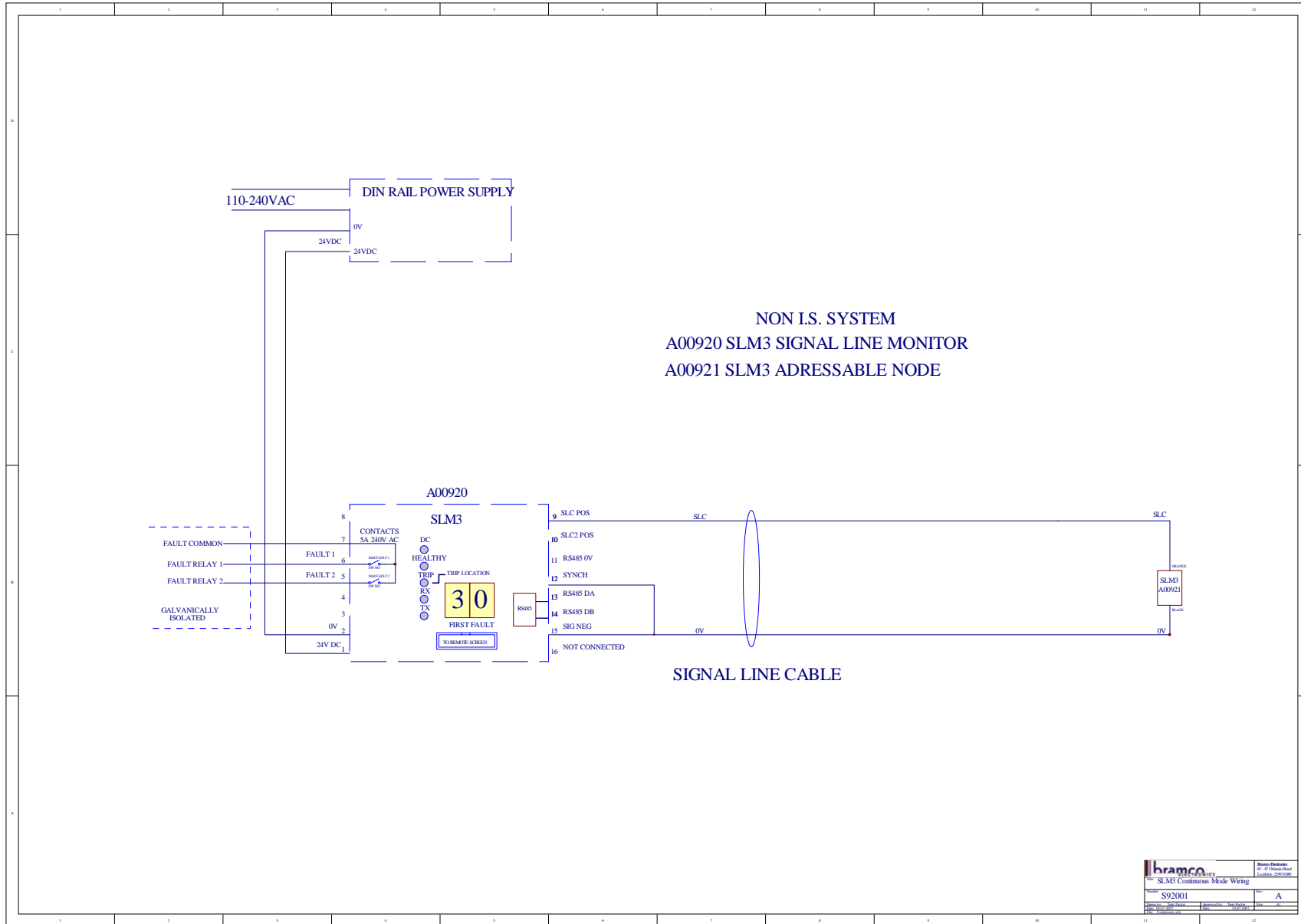
6. ASCII Table

Symbol	ASCII Code
:	0x3A
CR	0x0D
LF	0x0A
0	0x30
1	0x31
2	0x32
3	0x33
4	0x34
5	0x35
6	0x36
7	0x37
8	0x38
9	0x39
A	0x41
B	0x42
C	0x43
D	0x44
E	0x45
F	0x46

7. SLCM3 Installation



7.1. SLM3 Continuous Mode Installation



bramco		Shore Electronics
SLM3 Continuous Mode Wiring		27-07 Grande Road
S92001		London, ON N6G 1Y9
Rev: A		