Lexium Motion Module

Programmable motion controller

Product hardware manual

Intelligent motion systems

Schneider Electric

Lexium Motion Module Manual		
Date	**Revision**	**Changes**
04/06/2016	V1.00.04.2016	Initial Release
08/13/2018	V1.00.04.2016	Added California Proposition 65 warning

This page intentionally left blank

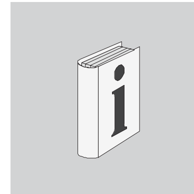
Table of Contents

V1.00, 04.2106

List of Figures

List of Tables

Writing conventions and symbols



Work steps

If work steps must be performed consecutively, this sequence of steps is represented as follows:

■ Special prerequisites for the following work steps
▶ Step 1
◁ Specific response to this work step
▶ Step 2

If a response to a work step is indicated, this allows you to verify that the work step has been performed correctly.

Unless otherwise stated, the individual steps must be performed in the specified sequence.

Bulleted lists

The items in bulleted lists are sorted alphanumerical or by priority. Bulleted lists are structured as follows:

- Item 1 of bulleted list
- Item 2 of bulleted list
  - Subitem for 2
  - Subitem for 2
- Item 3 of bulleted list

Making work easier

Information on making work easier is highlighted by this symbol:

Sections highlighted this way provide supplementary information on making work easier.

Parameters

Parameters are shown as follows

```
RC      Motor Run Current
```

Units of measure

Measurements are given US units, metric values are given in SI units in parenthesis.

Examples”

1.00 in (25.4 mm)
100 oz-in (70 N-cm)

Page intentionally left blank

1 Introduction

1

1.1 About this manual

This manual is valid for all Lexium Motion Module standard products. This chapter lists the part number for this product. The part number may be used to identify whether your product is a standard product or a customized model.

1.2 Unit overview

The Lexium Motion Module is a miniature electronics device designed to provide motion control and drive capability for a variety of stepper motors ranging from NEMA 8 (20mm) to NEMA 17 (42mm). It's design in based on the control electronics of SEM USA's Lexium MDrive products and provides a subset of the MCode motion control language developed for the Lexium MDrive product line.

Operating modes

The "Lexium Motion Module" is a fully programmable modular motion control system allowing for complex program and I/O interaction. Operating modes may be used interchangeably:

- **Immediate mode:** In immediate mode, also known as streaming commands, the device will respond to 1 and 2 character ASCII commands sent via the RS-422/485 serial interface
- **Program mode:** In program mode the device may be programmed with multiple functions, subroutines and process interactions using the MCode programming language, which is made up of 1 and 2 character ASCII mnemonics. Stored programs may be executed using an input, by labeling a program `SU` to run it on start up, or via an immediate mode command.

1.3 Interface requirements

CAUTION
UNEXPECTED BEHAVIOR AND DESTRUCTION OF SYSTEM COMPONENTS The Lexium Motion Module (LMM) is a modular component. Additional interface circuitry IS REQUIRED to access and use the I/O and communications functions of the device **Failure to follow these instructions can result in equipment damage.**

The Lexium Motion Module (LMM) is a complete modular motion control system consisting of a 1.5 A (RMS) stepper motor driver and a feature rich motion controller with advanced motion, mathematics, program and I/O functionality.

Additional interface circuitry is required to access and operate some of the functional blocks of the LMM.

1.3.1 Development boards

Development boards are available in either single or four (4) axis configurations for application development with the LMM. These boards provide the necessary interface circuitry required to safely operate the LMM in prototyping situations with isolated communications and I/O and robust pluggable spring-clamp connectors.

Single axis

The single axis development board (LMM-INT1-M) supports interfacing a single LMM to a power supply, a motor and peripheral I/O and communications hardware. It is included in the LMM Starter Kit (LMM-KIT1), which also includes an LMM, a NEMA 17 (42 mm) motor+encoder, a 24 VDC power supply and a USB to RS-422/485 communications converter.

Four axis

The four axis development board (LMM-INT4-M) supports interfacing one (1) to four (4) Lexium Motion Modules. Multidrop addressing is accomplished via on-board switches for each axis.

1.3.2 Interface circuit requirements

The following function blocks may require that additional circuitry be designed into the user's system.

Reference circuit designs and schematics are provided in this document.

The LMM uses a standard 98-position PCI Express edge card connector. The recommended mating receptacle:

- Molex P/N 0877159206

Supply voltages

The LMM requires two supply voltages in order to operate:

- **Motor supply:** +12 to +48 VDC. Supply must be able to provide a maximum of 1.25 A per LMM.
- **Logic supply:** +4.8 to +5.2 VDC. Supply must be able to provide a maximum of 200 mA per LMM.

Communications

The Lexium Motion Module offers three communications ports for developing a communications interface:

- **UART:** interface serial communications protocols such as RS-232, 422 or 485.
- **CAN:** CAN bus interface. (An LMM with a CANopen application stack is available: LMM-15-A)
- **SPI:** allows for direct microprocessor/microcontroller interface. ***NOTE: Advanced topic not covered in this document.***

Programmable I/O

The Lexium Motion Module provides four (4) programmable inputs and three (3) programmable outputs. While not strictly required, we recommend isolation and protective circuitry be designed into the user's system board.

Enable input

Hardware bridge $\overline{\text{enable}}$/disable input. By default (open/disconnected) the driver bridge is disabled and must be connected to ground to enable the bridge. Once disabled, a power cycle or software reset is required to re-enable the output bridge.

Analog input

If used, an interface circuit may be built to make the input respond to a voltage or current signal.

Motor

The Lexium Motion Module may be connected directly to the motor phases. However, for lower inductance motors, a common mode choke should be placed between the PHASE and $\overline{\text{PHASE}}$ lines.

1.4 Part number identification

Lexium Motion Module	**1.5 Amp**	**Motion Control, serial communication**	**LMM-15-M**
		CANopen	**LMM-15-A**
Development boards	**1-axis**	**Motion Control, serial communication**	**LMM-INT1-M**
		CANopen	**LMM-INT1-A**
	4-axis	**Motion Control, serial communication**	**LMM-INT4-M**
		CANopen	**LMM-INT4-A**
Accessories		**1-axis starter kit**	**LMM-KIT1**
		serial communication cable with DB9 connector	**MD-CC404-000**

Table 1.1: Part numbering

1.5 Documentation and literature references

This document should be used in conjunction with the MCode Programming and Reference software manual. MCode is an ASCII language used to commission, parameterize, program and control the Lexium Motion Module.

Source product manuals

The current product manuals are available for download from the Internet.

http://motion.schneider-electric.com

2 Before you begin - safety information

2

The information provided in this manual supplements the product manual. Carefully read the product manual before using the product.

2.1 Qualification of personnel

Only appropriately trained persons who are familiar with and understand the contents of this manual and all other pertinent product documentation are authorized to work on and with this product. In addition, these persons must have received safety training to recognize and avoid hazards involved. These persons must have sufficient technical training, knowledge and experience and be able to foresee and detect potential hazards that may be caused by using the product, by changing the settings and by the mechanical, electrical and electronic equipment of the entire system in which the product is used.

All persons working on and with the product must be fully familiar with all applicable standards, directives, and accident prevention regulations when performing such work.

2.2 Intended use

This product is a programmable motion controller intended for industrial use according to this manual.

The product may only be used in compliance with all applicable safety regulations and directives, the specified requirements and the technical data.

Prior to using the product, you must perform a risk assessment in view of the planned application. Based on the results, the appropriate safety measures must be implemented.

Since the product is used as a component in an entire system, you must ensure the safety of persons by means of the design of this entire system (for example, machine design).

Operate the product only with the specified cables and accessories. Use only genuine accessories and spare parts. The product must NEVER be operated in explosive atmospheres (hazardous locations, Ex areas).

Any use other than the use explicitly permitted is prohibited and can result in hazards.

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel.

2.3 Hazard categories

Safety instructions to the user are highlighted by safety alert symbols in the manual. In addition, labels with symbols and/or instructions are attached to the product that alert you to potential hazards.

Depending on the seriousness of the hazard, the safety instructions are divided into 4 hazard categories.

⚠ DANGER
DANGER indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury.

⚠ WARNING
WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death, serious injury, or equipment damage.

⚠ CAUTION
CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

CAUTION
CAUTION used without the safety alert symbol, is used to address practices not related to personal injury (e.g. **can result** in equipment damage).

2.4 Basic information

⚠ DANGER

UNINTENDED CONSEQUENCES OF EQUIPMENT OPERATION

When the system is started, the drives are usually out of the operator's view and cannot be visually monitored.

- Only start the system if there are no persons in the hazardous area.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

UNEXPECTED MOVEMENT

Drives may perform unexpected movements because of incorrect wiring, incorrect settings, incorrect data or other errors.

Interference (EMC) may cause unpredictable responses in the system.

- Carefully install the wiring in accordance with the EMC requirements.
- Ensure the `BRIDGE ENABLE` input is inactive to avoid an unexpected restart of the motor before switching on and configuring the drive system.
- Do NOT operate the drive system with unknown settings or data.
- Perform a comprehensive commissioning test.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop, overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical functions.
- System control paths may include communication links. Consideration must be given to the implication of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines. 1)
- Each implementation of the product must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death or serious injury.

1) For USA: Additional information, refer to NEMA ICS 1.1 (latest edition), “Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control” and to NEMA ICS 7.1 (latest edition), “Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems”.

⚠CAUTION

UNEXPECTED BEHAVIOR AND DESTRUCTION OF SYSTEM COMPONENTS

When you work on the wiring and when you unplug or plug in connectors, this may cause unexpected behavior and destruction of system components.

- Switch the power supply off before working on the wiring.

Failure to follow these instructions can result in injury or equipment damage.

2.5 Standards and terminology

Technical terms, terminology and the corresponding descriptions in this manual are intended to use the terms or definitions of the pertinent standards.

In the area of drive systems, this includes, but is not limited to, terms such as “safety function”, “safe state”, “fault”, “fault reset”, “failure”, “error”, “error message”, “warning”, “warning message”, etc.

Among others, these standards include:

- IEC 61800 series: “Adjustable speed electrical power drive systems”
- IEC 61800-7 series: “Adjustable speed electrical power drive systems - Part 7-1: Generic interface and use of profiles for power drive systems - Interface definition”
- IEC 61158 series: “Industrial communication networks - Fieldbus specifications”
- IEC 61784 series: “Industrial communication networks - Profiles”
- IEC 61508 series: “Functional safety of electrical/electronic/programmable electronic safety-related systems”

California Proposition 65 Warning—Lead and Lead Compounds
Advertencia de la Proposición 65 de California—Plomo y compuestos de plomo
Avertissement concernant la Proposition 65 de Californie—Plomb et composés de plomb

⚠ **WARNING:** This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to: www.P65Warnings.ca.gov.

⚠ **ADVERTENCIA**: Este producto puede exponerle a químicos incluyendo plomo y compuestos de plomo, que es (son) conocido(s) por el Estado de California como causante(s) de cáncer y defectos de nacimiento u otros daños reproductivos. Para mayor información, visite : www.P65Warnings.ca.gov.

⚠ **AVERTISSEMENT**: Ce produit peut vous exposer à des agents chimiques, y compris plomb et composés de plomb, identifiés par l'État de Californie comme pouvant causer le cancer et des malformations congénitales ou autres troubles de l'appareil reproducteur. Pour de plus amples informations, prière de consulter: www.P65Warnings.ca.gov.

Schneider Electric USA, Inc.
800 Federal Street
Andover, MA 01810 USA
888-778-2733
www.schneider-electric.us

Importado en México por:
Schneider Electric México, S.A. de C.V.
Av. Ejercito Nacional No. 904
Col. Palmas, Polanco 11560 México, D.F.
55-5804-5000
www.schneider-electric.com.mx

Schneider Electric Canada, Inc.
5985 McLaughlin Road
Mississauga, ON L5R 1B8 Canada
800-565-6699
www.schneider-electric.ca

3 Technical data

3

This chapter contains information on the ambient conditions and on the mechanical and electrical properties of the device family and the accessories.

3.1 Certifications

Product certifications:

Certification	Regulation #	Validity
RoHS	2011/65/EU	**TBD**
EMC	2004/108/EC	**TBD**
REACH	EC 1907/2006	12/19/2012

Table 3.1: Standards and certifications

3.2 Environmental conditions

Ambient operating conditions

The maximum permissible ambient temperature during operation depends on the distance between the devices and the required power. Observe the pertinent instructions in the chapter Installation.

The following relative humidity is permissible during operation.

Operating temperature 1)	[°C]	-40 ... 50 (no icing)
Temperature variation	[°C/min]	0.5
Humidity	[%]	5 ... 95 (non-condensing)

1) If the product is to be used in compliance with UL 508C, note the information provided in chapter 3.6 “Conditions for UL 508C”.

Table 3.2: Ambient operating conditions

Ambient conditions: transportation and storage

The environment during transport and storage must be dry and free from dust. The maximum vibration and shock load must be within the specified limits.

Temperature	[°C]	-20 ... 100
Temperature variation	[°C]	-25 ... 30
Humidity	[%]	5 ... 95 (non-condensing)

Table 3.3: Ambient storage and transportation conditions

Maximum operating temperatures

Power stage 1)	[°C]	85

1) May be read via parameter

Table 3.4: Maximum operating conditions

Installation altitude

The installation altitude is defined as height above sea level

Installation altitude 3)	[ft (m)]	3280 (1000)

2) Installation above 3280 (1000) may require derating output current and maximum ambient temperature.

Table 3.5: Installation altitude

Vibration and shock

Vibration, sinusoidal	m/s^2	**TBD**	IEC 60721-3-2
Shock, non-sinusoidal	m/s^2	**TBD**	IEC 60721-3-2

Table 3.6: Vibration and shock

EMC

Emission	**TBD**
Noise immunity	**TBD**

Table 3.7: EMC and noise immunity

3.3 Mechanical data

3.3.1 Degree of protection

IP degree of protection

The product has the following IP degree of protection as per EN 60529.

Degree of protection	IP00

The total degree of protection is determined by the component with the lowest degree of protection.

Table 3.8: Ingress protection rating

IP degrees of protection overview

First digit Protection against intrusion of objects		Second digit Protection against intrusion of water	
0	No protection	0	No protection
1	External objects >50 mm	1	Vertically falling dripping water
2	External objects >12 mm	2	Dripping water falling at an angle (75 ° ... 90 °)
3	External objects >2.5 mm	3	Spraying water
4	External objects >1 mm	4	Splashing water
5	Dust-protected	5	Water jets
6	Dust-tight	6	Heavy sea
		7	Immersion
		8	Submersion

Table 3.9: IP rating overview

3.3.2 Dimensions inches (mm)

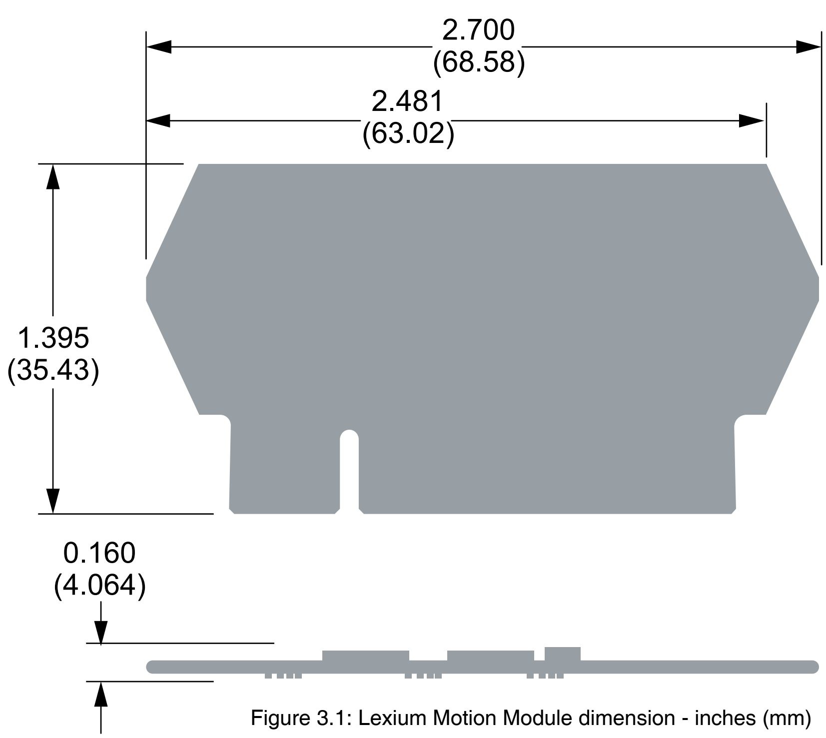


Figure 3.1: Lexium Motion Module dimension - inches (mm)

V1.00, 04.2106

3.4 Electrical data

3.4.2 Supply voltage VDC

		LMM-15-M/A
Limit values min/max [1), 2)]	[+V_{dc}]	12/48
Ripple at nominal voltage	[+V_{pp}]	4.8
Max. current input (per LMM)	[A]	1.25

1) UL 508C rating to 48VDC, posted max ratings conforms to CE low voltage directive.
2) The actual power requirement is often significantly lower, because the maximum possible motor torque is usually not required for operation of a system.

Table 3.10: Motor supply voltage maximum ratings

3.4.3 Logic supply voltage

		LMM-15-M/A
Limit values min/max	[+V_{dc}]	4.8/5.2
Max. current input (per LMM)	[mA]	201

Table 3.10: Motor supply voltage maximum ratings

3.4.4 I/O

Input signals The specifications apply to the following input signals: All inputs are sinking.

Programmable inputs,Axis selection and SPI			
INPUT 1	INPUT 4	AXIS SELECT 3	SPI SCLK
INPUT 2	AXIS SELECT 1	AXIS SELECT 4	SPI SSEL
INPUT 3	AXIS SELECT 2	SPI MOSI	

	units	min	typ	max
Input voltage (V_{IN})	volts	-0.3	3.3	3.6
Voltage High Level (V_{IH})	volts	2.64	—	—
Voltage Low Level (V_{IL})	volts	—	—	0.66

Table 3.11: General input specifications

Analog input
ANALOG INPUT

	units	min	typ	max
Input voltage (V_{AN})	volts	-0.3	3.3	3.6

Table 3.12: Analog input specifications

V1.00, 04.2106

Bridge Enable and Encoder			
ENABLE	ENCODER A	ENCODER B	ENCODER I

	units	min	typ	max
Input voltage (V_{IN})	volts	-0.5	3.3	3.75
Voltage High Level (V_{IH})	volts	2.0	—	3.6
Voltage Low Level (V_{IL})	volts	—	—	0.8

Table 3.13: Enable and encoder input specifications

UART Receive input
UART RX INPUT

	units	min	typ	max
Input voltage (V_{IN})	volts	-0.03	5.0	6.5
Voltage High Level (V_{IH})	volts	2.64	—	3.60
Voltage Low Level (V_{IL})	volts	—	0.66	0.66

Table 3.14: UART RX input specifications

Reset input
RESET

	units	min	typ	max
Input voltage (V_{IN})	volts	-0.3	—	3.6
Voltage High Level (V_{IH})	volts	2.31	—	—
Voltage Low Level (V_{IL})	volts	—	—	0.99
Pull up resistance (R_{PU})	kΩ	2.49	—	2.85
Min pulse width	µSec	1	—	—
Glitch immunity	nSec	—	100	—
Reset delay	nSec	—	200	—

Table 3.15: Reset input specifications

Output signals

The specifications apply to the following output signals:

Programmable outputs, UART transmit and SPI			
OUT1	OUT2	EN_TX	TX
MISO			

	units	min	typ	max
Voltage High Level (V_{OH})	volts	2.8	—	—
Voltage Low Level (V_{OL})	volts	—	—	0.5
Current High Level (I_{OH})	mA	—	2	4
Current Low Level (I_{OL})	mA	—	2	4

Table 3.16: Output, UART TX and SPI specifications

OUTPUT 3 (Trip)			
OUT3			

	units	min	type	max
Voltage High Level (V_{OH})	volts	2.9	—	—
Voltage Low Level (V_{OL})	volts	—	—	0.4
Current High Level (I_{OH})	mA	—	—	16
Current Low Level (I_{OL})	mA	—	—	16

Table 3.17: Output 3 / trip output specifications

3.5 Connector pin locations and assignment

3.5.1 Connector Style

PCI Express X8

3.5.2 Recommended mating socket

PCI Express 98 position receptacle

Molex P/N 0877159206

Digikey P/N WM9002-ND

V1.00, 04.2106

3.5.3 Pin numbering and location

Note: All signals are paired i.e A8:B8 - Analog input, A44:B44 - Encoder index.

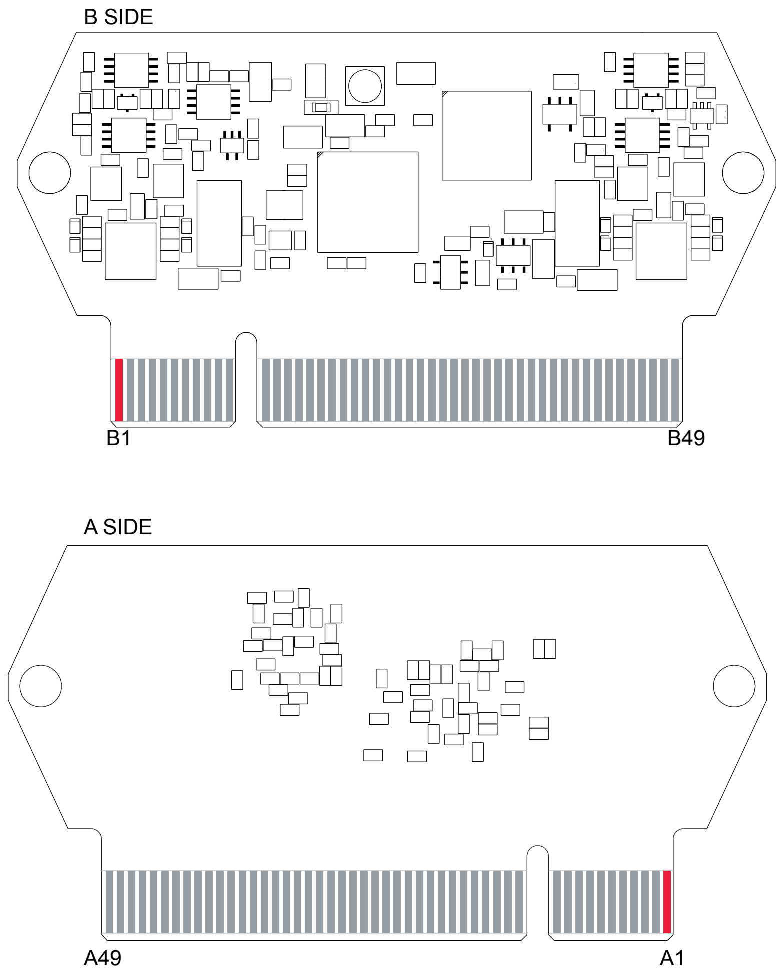


Figure 3.2: Pin numbering and location

3.5.4 Pin number and description: logic and I/O signals

Pins		Signal	Description	I/O
Signals and I/O				
A5	B5	N/C	Not connected	—
A6	B6	$\overline{\text{RESET}}$	Reset module, same as power cycle	I
A7	B7	ANA_GND	Analog input ground reference	I
A8	B8	ANA_IN	Analog sensor / variable voltage input	I
A9	B9	ANA_GND	Analog input ground reference	I
A10	B10	IN1	General purpose logic input 1	I
A11	B11	IN2	General purpose logic input 2	I
A12	B12	IN3	General purpose logic input 3	I
A13	B13	IN4	General purpose logic input 4	I
A14	B14	N/C	Not connected	—
A15	B15	MISO	SPI Master In / Slave Out	O
A16	B16	MOSI	SPI Master Out / Slave In	I
A17	B17	SCLK	SPI Master clock	I
A18	B18	SSEL	SPI Master select	I
A19	B19	EN_TX	Enables serial transmission, UART or CAN protocol	O
A20	B20	RX	Serial receive input, UART or CAN	I
A21	B21	TX	Serial transmit input, UART or CAN	O
A22	B22	OUT2	General purpose logic output 2	O
A23	B23	OUT1	General purpose logic output 2	O
A24	B24	N/C	Not connected	—
A29	B29	N/C	Not connected	—
A30	B30	N/C	Not connected	—
A35	B35	N/C	Not connected	—
A36	B36	AXIS_SEL4	Address select line 4	I
A37	B37	AXIS_SEL3	Address select line 3	I
A38	B38	AXIS_SEL2	Address select line 2	I
A39	B39	AXIS_SEL1	Address select line 1	I
A40	B40	OUT3	General purpose output 3 / Trip output	O
A41	B41	$\overline{\text{ENABLE}}$	Motor bridge $\overline{\text{enable}}$ / disable	I
A42	B42	ENC_A	Encoder A channel	I
A43	B43	ENC_B	Encoder B channel	I
A44	B44	ENC_I	Encoder Index	I
A45	B45	N/C	Not connected	—

Table 3.18: Logic and I/O signals

3.5.5 Pin number and description: power and motor signals

Pins		Signal	Description	I/O
Power				
A25	B25	+V	Motor power supply input +12 to +48 VDC	I
A26	B26			
A31	B31	+5 V	Logic power supply input	I
A32	B32			
A27	B27	GND	Motor power supply return	I
A28	B28			
A33	B33	GND	Logic power supply return	I
A34	B34			
Motor phases				
A46	B46	PHASE A	Motor θA	O
A47	B47			
A48	B48	$\overline{\text{PHASE A}}$	Motor θA return	O
A49	B49			
A1	B1	PHASE B	Motor θB	O
A2	B2			
A3	B3	$\overline{\text{PHASE B}}$	Motor θB return	O
A4	B4			

Table 3.19: Power and motor signals

3.6 Conditions for UL 508C

If the product is used to comply with UL 508C, the following conditions must be met:

Ambient temperature during operation

Surrounding air temperature	[°C]	0 ... +50

Pollution degree

Use in an environment with pollution degree 2.

Power supply

Use only power supply units that are approved for over-voltage category III.

Wiring

Use only 60/75 °C copper conductors.

SIL	PFH at high demand or continuous demand
4	$\geq 10^{-9}$ ... $<10^{-8}$
3	$\geq 10^{-8}$ ... $<10^{-7}$
2	$\geq 10^{-7}$ ... $<10^{-6}$
1	$\geq 10^{-6}$ ... $<10^{-5}$

HFT and SFF

Depending on the SIL for the safety system, the IEC 61508 standard requires a specific hardware fault tolerance HFT in connection with a specific proportion of safe failures SFF (safe failure fraction). The hardware fault tolerance is the ability of a system to execute the required safety function in spite of the presence of one or more hardware faults. The SFF of a system is defined as the ratio of the rate of safe failures to the total failure rate of the system. According to IEC 61508, the maximum achievable SIL of a system is partly determined by the hardware fault tolerance HFT and the safe failure fraction SFF of the system.

SFF	HFT type A subsystem			HFT type B subsystem		
	0	1	2	0	1	2
< 60%	SIL1	SIL2	SIL3	—	SIL1	SIL2
60% ... <90%	SIL2	SIL3	SIL4	SIL1	SIL2	SIL3
90% ... < 99%	SIL3	SIL4	SIL4	SIL2	SIL3	SIL4
≥99%	SIL3	SIL4	SIL4	SIL3	SIL4	SIL4

Fault avoidance measures

Systematic errors in the specifications, in the hardware and the software, usage faults and maintenance faults of the safety system must be avoided to the maximum degree possible. To meet these requirements, IEC 61508 specifies a number of measures for fault avoidance that must be implemented depending on the required SIL. These measures for fault avoidance must cover the entire life cycle of the safety system, i.e. from design to decommissioning of the system.

4 Basics

4

4.1 Functional safety

Automation and safety engineering are two areas that were completely separated in the past but recently have become more and more integrated.

Engineering and installation of complex automation solutions are greatly simplified by integrated safety functions.

Usually, the safety engineering requirements depend on the application. The level of the requirements results from the risk and the hazard potential arising from the specific application.

4.1.1 Working with IEC 61508

IEC 61508 standard

The standard IEC 61508 “Functional safety of electrical/electronic/programmable electronic safety-related systems” covers the safety-related function. It is not only one single component but the entire function chain (e.g. from the sensor through the logical processing unit to the actuator) that is considered as one single unit. This function chain must meet the requirements of the specific safety integrity level as a whole. Systems and components that can be used in various applications for safety tasks with comparable risk levels can be developed on this basis.

SIL, Safety Integrity Level

The standard IEC 61508 defines 4 safety integrity levels (SIL) for safety functions. SIL1 is the lowest level and SIL4 is the highest level. A hazard and risk analysis serves as a basis for determining the required safety integrity level. This is used to decide whether the relevant function chain is to be considered as a safety function and which hazard potential it must cover.

PFH, Probability of a dangerous hardware failure per hour

To maintain the safety function, the IEC 61508 standard requires various levels of measures for avoiding and controlling faults, depending on the required SIL. All components of a safety function must be subjected to a probability assessment to evaluate the effectiveness of the measures implemented for controlling faults. This assessment determines the PFH (probability of a dangerous failure per hour) for a safety system. This is the probability per hour that a safety system fails in a hazardous manner and the safety function cannot be correctly executed. Depending on the SIL, the PFH must not exceed certain values for the entire safety system. The individual PFH values of a function chain are added; the total PFH value must not exceed the maximum value specified in the standard.

Page intentionally left blank

5 Engineering

5

This chapter contains information on the application of the product that is vital in the design phase.

CAUTION

MULTI-MODE OPERATION

This device will operate differently in each mode of operation. It is critical that all documentation be read completely. A clear understanding of how the device is to be employed must be present before attempting to install or commission the device.

Failure to follow these instructions can result in equipment damage.

5.1 External power supply units

⚠ DANGER

ELECTRIC SHOCK CAUSED BY INCORRECT POWER SUPPLY UNIT

The `VDC` and `LOGIC (+5V)` supply voltages are connected with many exposed signal connections in the drive system.

- Use a power supply unit that meets the PELV (Protective Extra Low Voltage) requirements.
- Connect the negative output of the power supply unit to PE (ground).

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

GENERAL POWER SUPPLY PRACTICE

Do not connect or disconnect the power supply while power is applied.

Disconnect the AC side to power down the DC supply.

For battery operated systems connect a “transient suppressor” across the switch to prevent arcs and high-voltage spikes.

Failure to follow these instructions may result in damage to system components!

5.1.1 Supply voltage +VDC

General

The power supply unit must be rated for the power requirements of the drive. The input current can be found in the technical data.

The actual power requirements are often significantly lower because the maximum possible motor torque is usually not required for normal operation of a system.

When designing the system, note that the input current of the drive is higher during the motor acceleration phase than during constant movement.

Regeneration condition (back EMF)

Note the following for drives with large external mass moments of inertia or for highly dynamic applications:

Motors return regeneration energy during deceleration. The DC bus can store a limited amount of energy in the capacitors. Connecting additional capacitors to the DC bus increases the amount of energy that can be stored.

If the capacity of the capacitors is exceeded, the excess energy must be discharged via internal or external braking resistors.

Overvoltage conditions can be limited by adding a braking resistor with a corresponding braking resistor controller. This converts the regenerated energy to heat energy during deceleration.

⚠CAUTION

LOSS OF CONTROL DUE TO REGENERATION CONDITION

Regeneration conditions resulting from braking or external driving forces may increase the VDC supply voltage to an unexpected level. Components not rated for this voltage may be destroyed or cause malfunctions.

- Verify that all VDC consumers are rated for the voltage occurring during regeneration conditions (for example limit switches).
- Use only power supply units that will not be damaged by regeneration conditions.
- Use a braking resistor controller, if necessary.

Failure to follow these instructions can result in injury or equipment damage.

Power supply cabling

⚠ **CAUTION**

EMI and RFI

These recommendations will provide optimal protection against EMI and RFI. The actual cable type, wire gauge, shield type and filtering devices used are dependent on the customer's application and system.

The length of the DC power supply cable to an MDrive should not exceed 50 feet (15.2 m).

Always use shielded/twisted pairs for the Lexium MDrive DC supply cable.

Failure to follow these instructions may result in damage to system components!

Cable length, wire gauge and power conditioning devices play a major role in the performance of your Lexium MDrive.

Figure 5.1 illustrates the recommended cable configuration for DC power supply cabling under 50 feet (15.2 m) long. If cabling of 50 feet (15.2 m) or longer is required, the additional length may be gained by adding an AC power supply cable (see Figures 5.2 and 5.3).

Correct AWG wire size is determined by the current requirement plus cable length.

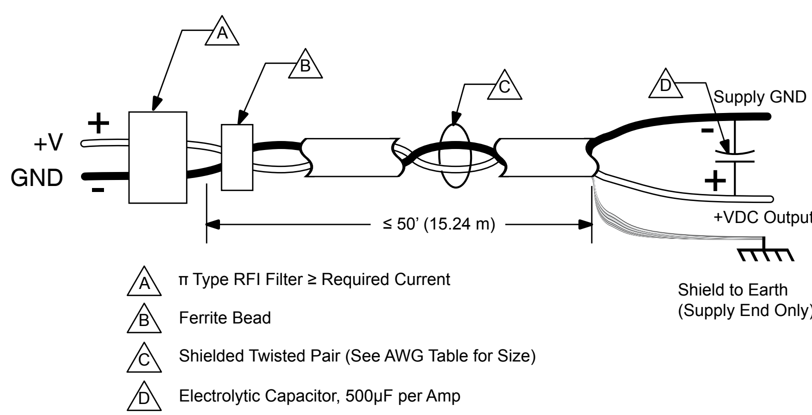


Figure 5.1: DC power supply cabling under 50' (15.24 m)

V1.00, 04.2106

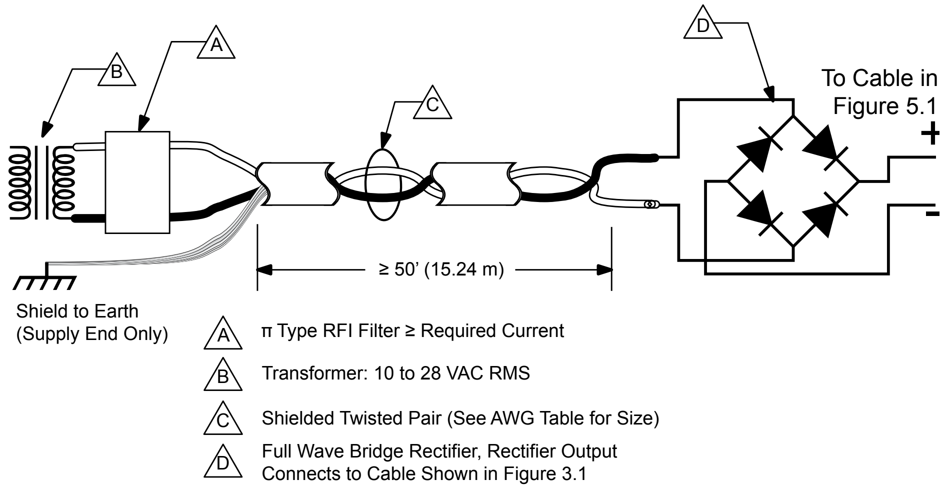


Figure 5.2: AC power to full wave bridge

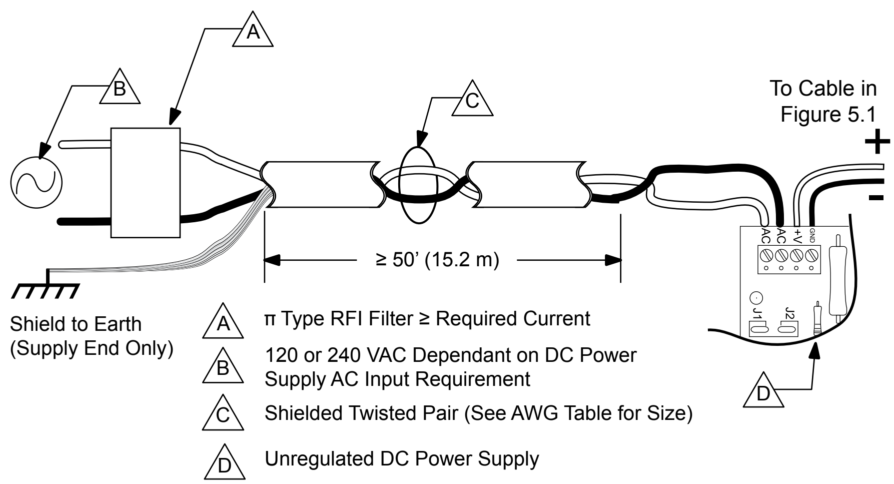


Figure 5.3: AC power to DC supply

Recommended AWG (mm^2) per current and distance

Length [ft (m)]	10 (3.0)	25 (7.6)	50 (15.2)	75 (22.9)	100 (30.5)
Amps (peak)	**Minimum AWG (mm^2)**				
1	20 (0.5)	20 (0.5)	18 (0.75)	18 (0.75)	18 (0.75)
2	20 (0.5)	18 (0.75)	16 (1.5)	14 (2.5)	14 (2.5)
3	18 (0.75)	16 (1.5)	14 (2.5)	12 (4.0)	12 (4.0)
4	18 (0.75)	16 (1.5)	14 (2.5)	12 (4.0)	12 (4.0)

5.1.2 Wiring and shielding

Noise is always present in a system that involves high power and small signal circuitry. Regardless of the power configuration that you use in your system, there are some wiring and shielding rules that you should follow to keep your noise-to-signal ratio as small as possible.

Rules of wiring

- Power Supply and Motor wiring should be shielded twisted pair, and these lines should not run parallel to signal carrying wires.
- Motor should be shielded twisted pairs using 20 gauge wire.
- A common mode choke may be required in each of the motor phase lines to reduce shield current levels.
- Power ground return should be as short as possible.
- Power Supply wiring should be shielded twisted pairs. Use 18 gauge wire.
- Never use a "daisy-chain" power supply wiring scheme to system components. This type of power distribution will result in degraded system reliability and performance as a result of poor EMC and ground-loop issues. In cases where 'daisy-chaining" is unavoidable, the systems engineer is responsible for final system reliability and performance. The use of conservatively selected wire gauge and the use of decoupling capacitors (i.e. a combination of capacitors to provide for acceptable low frequency and high frequency noise reduction) at each electronic drive should be considered as a minimum.

Rules of shielding

- The shield must be tied to zero-signal reference potential. In order for shielding to be effective, it is necessary for the shield to be earthed or grounded.
- The shield must be connected so that shield currents drain to signal-earth connections.
- The shield should be tied to a single point to prevent ground loops

5.2 Ground design

The ground connections of all interfaces are galvanically connected, including the ground for the VDC supply voltage.

The multifunction interface is an exception to this in the case of devices with galvanic isolation.

The following points must be considered when you wire the drives in a system:

- The voltage drop in the VDC power supply lines must be kept as low as possible (less than 1 V). At higher ground potential differences between different drives, the communication / control signals may be affected.
- If the distance between the system components is greater, it is recommended to use decentralized power supply units close to the individual drives to supply the VDC voltage. However, the ground connections of the individual power supply units must be connected with the largest possible conductor cross section.
- If the master controller (e.g. PLC, IPC etc.) does not have galvanically isolated outputs for the drives, you must verify that the current of the VDC supply voltage has no path back to the power supply unit via the master controller. Therefore, the master controller ground may be connected to the VDC supply voltage ground at a single point only. This is usually the case in the control cabinet. The ground contacts of the various signal connectors in the drive are therefore not connected; there is already a connection via the VDC supply voltage ground.
- If the controller has a galvanically isolated interface for communication with the drives, the ground of this interface must be connected to the signal ground of the first drive. This ground may be connected to a single drive only to avoid ground loops. This also applies to a galvanically isolated CAN connection.

Equipotential bonding conductors

Potential differences can result in excessive currents on the cable shields. Use equipotential bonding conductors to reduce currents on the cable shields. The equipotential bonding conductor must be rated for the maximum current flowing. Practical experience has shown that the following conductor cross sections can be used:

- AWG 4 (16 mm^2) for equipotential bonding conductors up to a length of 650 ft (200 m)
- AWG 4 (20 mm^2) for equipotential bonding conductors with a length of more than 650 ft (200 m)

6 Installation

⚠ WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are EMERGENCY STOP, overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical functions.
- System control paths may include communication links. Consideration must be given to the implication of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines. 1)
- Each implementation of the product must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death or serious injury.

1) For USA: Additional information, refer to NEMA ICS 1.1 (latest edition), “Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control” and to NEMA ICS 7.1 (latest edition), “Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems”

Chapter 5, Engineering, contains basic information that you should now before starting the installation.

6.1 Mechanical installation

CAUTION

INSTALLING WHEN POWERED (HOT PLUGGING)

- Do not inset the Lexium Motion Module into a PCIe socket if PC board is powered. Ensure that all power supply voltages are removed from interface board before inserting the LMM module.

Failure to follow these instructions can result in equipment damage.

Heat dissipation

The LMM, when used at published specifications and with regard to ambient temperature and airflow within the system does not require additional heat sinking.

- Verify that the maximum temperature is not exceeded.
- Verify that there is sufficient heat dissipation, e.g. by means of good ventilation.

Mounting

The LMM is designed to be plugged into a PCI Express socket. Additional mounting may be required depending on the demands of the application.

Mounting distances

No minimum clearances are required for installation. However, note that the motor can become very hot. Observe the bending radii of the cables used.

Ambient conditions

Observe the permissible ambient conditions.

Mating connector

PCI Express 98 position receptacle

Molex P/N 0877159206

Digikey P/N WM9002-ND

6.2 Electrical installation

The Lexium Motion Module is designed to be socketed into a user-developed printed circuit assembly (PCA) The LMM offers flexibility in its interface requirements, with the interface circuitry developed being based upon the features used by the end user application.

The following illustration details the functional blocks needed to access the characteristics of the LMM.

Throughout this remainder of this section reference circuit examples for each of these features, where applicable, are given.

Note that these example circuits are for example purposes only and are not tested or verified for safety or any particular function.

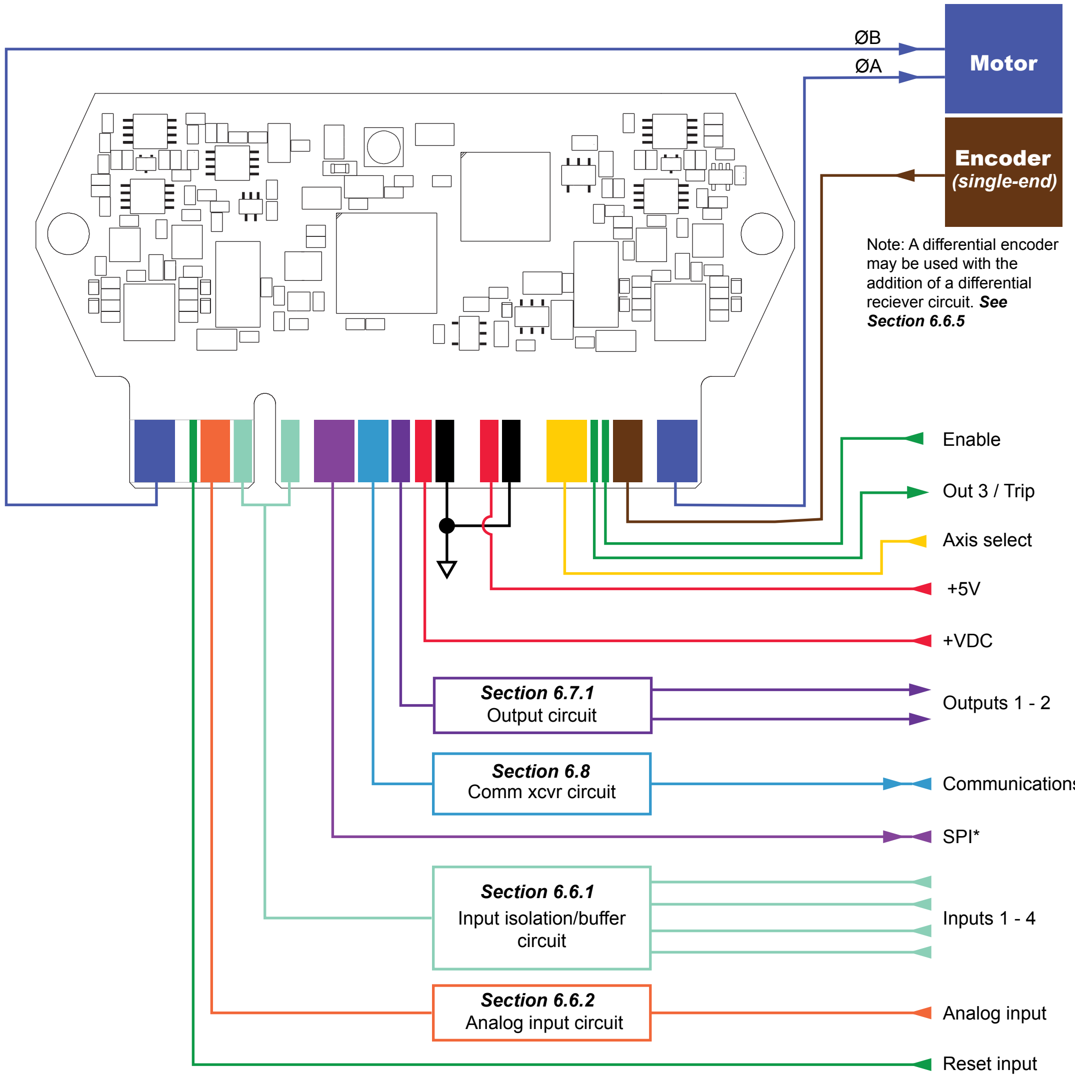
6.2.1 LMM electrical interface

Figure 6.1 diagrams the various electrical interfaces associated with the Lexium Motion Module. Some features of the LMM are directly interfaced while others require additional circuitry external to the device to define the operation of the feature and provide protection.

Interfaces

Interface	Requirements	Details
Required to operate		
+VDC motor power	Electrolytic capacitor (330µF)	Section 6.3.1
+5V logic	4.7µF capacitor	Section 6.3.2
Motor	Common mode choke may be required for low inductance motors	Section 6.4
Comm	Transceiver and optional isolation circuitry for desired communications interface ie: RS232, RS485, CAN	Section 6.7
Bridge enable	Must be connected to 0 VDC (ground) to enable the output bridges.	Section 6.5
Available (not required)		
Prog inputs	Input buffering and optional isolation components	Section 6.5.1
Prog outputs	Protection and optional isolation components	Section 6.6
Dedicated inputs (Reset, Axis_Sel)	Components as required to toggle state, ie: mechanical switch etc.	Section 6.5
Encoder inputs	Differential input driver circuit if using a differential. encoder.	Section 6.5.3
Analog input	Circuitry to define the sense and range of the input	Section 6.5.2

Table 6.1: Electrical interface requirements



*Interface and use of SPI is beyond the scope of this document

Figure 6.1: LMM interface circuitry block diagram

6.3 Motor and logic power

⚠ CAUTION

DAMAGE TO SYSTEM COMPONENTS AND LOSS OF CONTROL

Interruptions of the negative connection of the controller supply voltage can cause excessively high voltages at the signal connections.

- Do not interrupt the negative connection between the power supply unit and load with a fuse or switch.
- Verify correct connection before switching on.
- Do not connect or change wiring while the supply voltage is present.

Failure to follow these instructions can result in injury or equipment damage.

Chapter 5, Engineering, contains basic information that you should know before starting the installation.

⚠ DANGER

ELECTRIC SHOCK CAUSED BY INCORRECT POWER SUPPLY UNIT

The supply voltages are connected with many exposed signal connections in the drive system.

- Use a power supply unit that meets the PELV (Protective Extra Low Voltage) requirements.
- Connect the negative output of the power supply unit to PE (ground).

Failure to follow these instructions will result in death or serious injury.

⚠ CAUTION

LOSS OF CONTROL DUE TO REGENERATION CONDITION

Regeneration conditions resulting from braking or external driving forces may increase the `VDC` supply voltage to an unexpected level. Components not rated for this voltage may be destroyed or cause malfunctions.

- Verify that all `VDC` consumers are rated for the voltage occurring during regeneration conditions (for example limit switches).
- Use only power supply units that will not be damaged by regeneration conditions.
- Use a braking resistor controller, if necessary.

Failure to follow these instructions can result in injury or equipment damage.

The Lexium Motion Module (LMM) requires two voltage levels in order to operate: +12 to + 48 VDC motor power and +5 VDC logic power.

Signal	Function	Pin number(s)
VDC	Motor power supply voltage	A25, B25, A26, B26
GND	Reference potential to VDC	A27, B27, A28, B28
+5V	Logic supply voltage	A31, B31, A32, B32
GND	Reference potential to +5V	A33, B33, A34, B34

Table 6.2: Motor and logic power supply pins

6.3.1 Motor power (VDC)

The motor power supply must be an unregulated linear or switching power supply with an output voltage range of +12 to +48 VDC, and capable of supplying 1.25 amps per LMM device in the system.

A low impedance aluminum electrolytic capacitor valued at 330 µF 63V should be placed between +V and GND to absorb potential over-voltages resultant from motor back EMF.

A second ceramic capacitor, valued at 0.1 µF 100V, should be placed as close to the power pins as possible between +V and GND as a high-frequency filter.

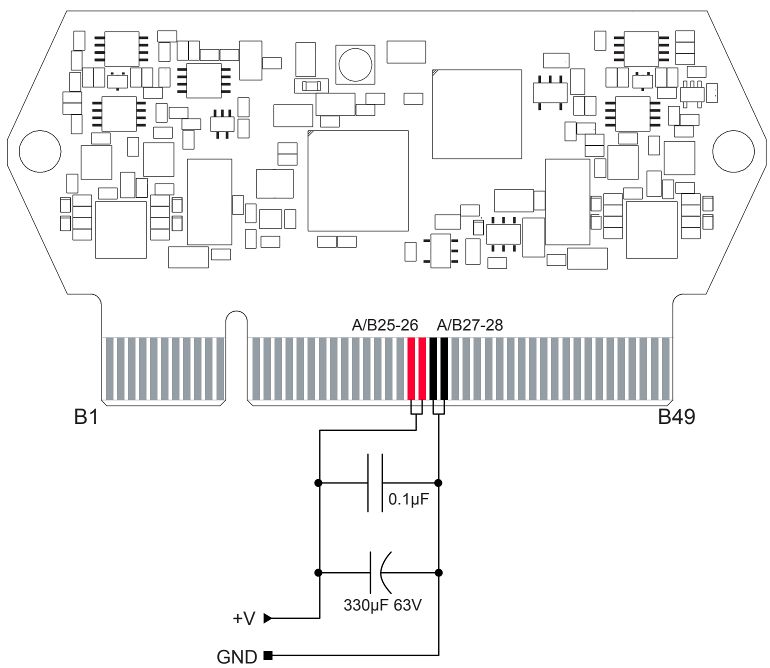


Figure 6.2: Motor power supply voltage input capacitors

6.3.2 Logic power (+5 V)

Logic power must range between 4.8 and 5.2 VDC and be able to deliver 201 mA per LMM device in the system.

A 4.7 µF 25 VDC ceramic capacitor is recommended between +5V and GND, A second ceramic capacitor, valued at 0.1 µF 50V, should be placed as close to the logic supply pins as possible between +5V and GND as a high-frequency filter.

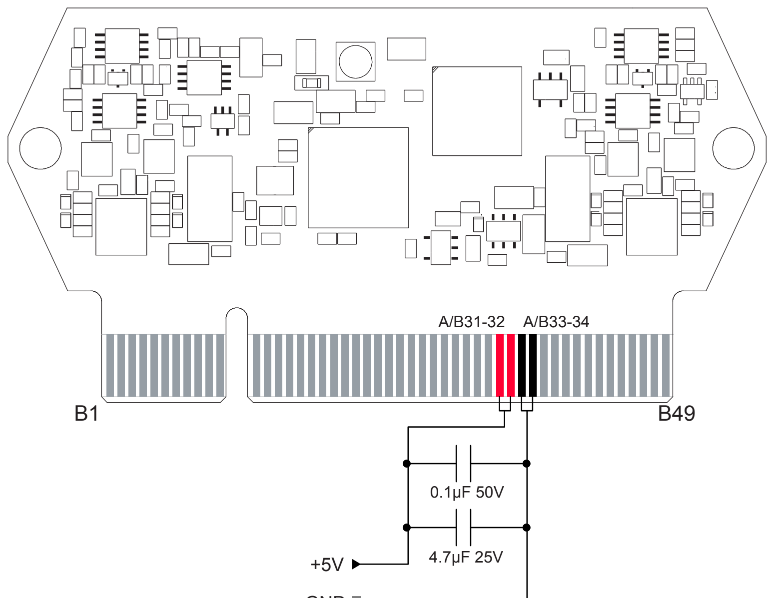


Figure 6.3: Logic power supply input capacitor

6.3.3 Example PCB layout for power

Place capacitors as close to the input pins of the LMM as possible.

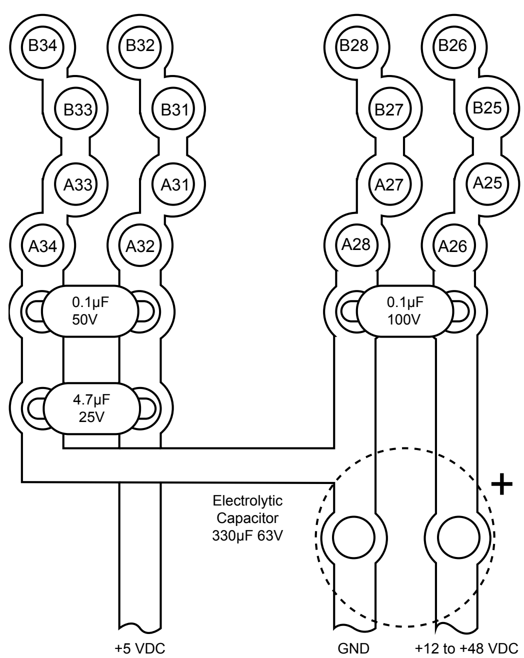


Figure 6.4: Motor and logic supply PCB layout recommendations

V0.90, 12.2015

6.4 Motor phases

The Lexium Motion Module (LMM) can output up to 1.5A RMS (2.1 A peak) to drive motor sizes NEMA 11 (26 mm), NEMA 14 (36 mm) and NEMA 17 (42 mm).

Signal	Function	Pin number(s)
θA	Motor phase A output	A46, B46, A47, B47
$\overline{\theta A}$	Motor phase A return	A48, B48, A49, B49
θB	Motor phase B output	A1, B1, A2, B2
$\overline{\theta B}$	Motor phase B return	A3, B3, A4, B4

Table 6.3: Motor phase output pins

6.4.1 Motor phase output

We recommend placing a common mode choke between the phase and $\overline{\text{phase}}$ lines when using low inductance motors.

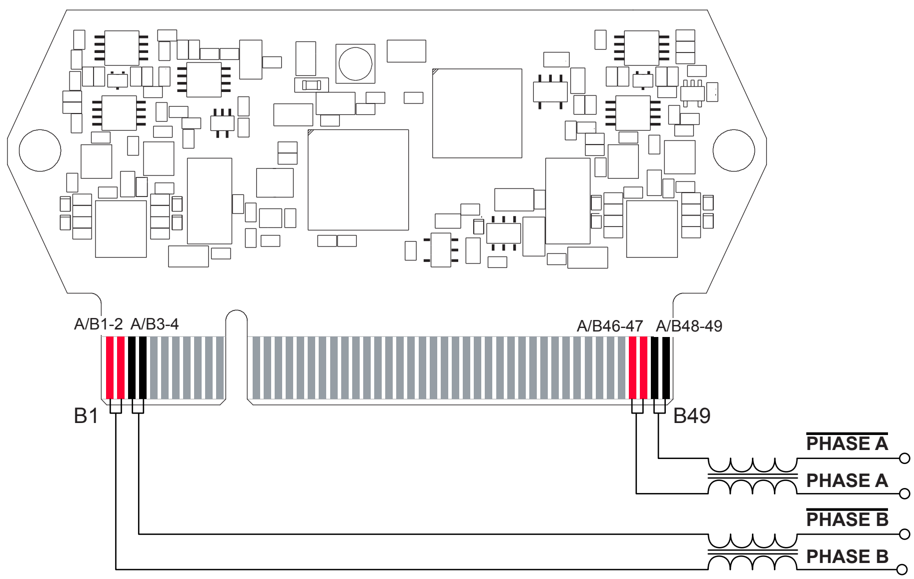


Figure 6.5: Motor phase connection

6.5 Logic inputs

The LMM features the following logic inputs which may be interfaced according to functions:

- 4 general purpose programmable inputs
- 1 analog input
- Bridge enable input (REQIURED!)
- Reset input
- 3 encoder inputs
- 4 axis selection inputs

6.5.1 General purpose programmable inputs

Signal	Function	Pin number(s)
IN1	General purpose logic input 1	A10, B10
IN2	General purpose logic input 2	A11, B11
IN3	General purpose logic input 3	A12, B12
IN4	General purpose logic input 4	A13, B13

Table 6.4: General purpose programmable inputs

The circuit example below illustrates the basic circuit and components for adding optical isolation to an input on the LMM.

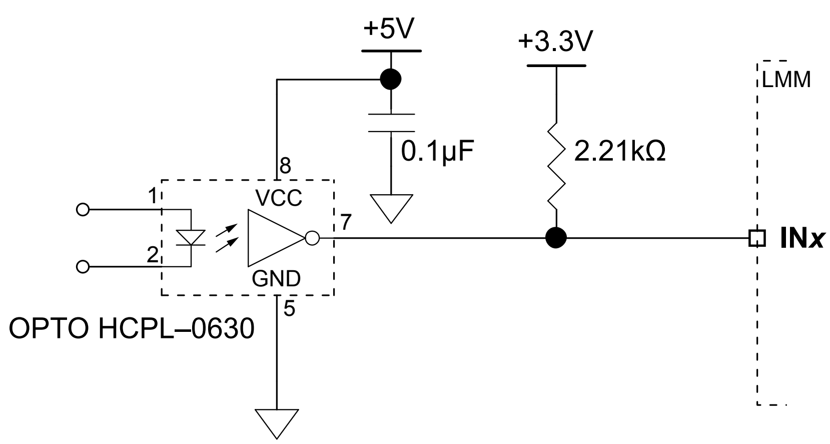


Figure 6.6: Example optical isolation input circuit

Note that the general purpose logic input functions, parameters and active state are configured using the MCode input setup command (Is).

Parts list

Open-collector opto-coupler ....

Avago Technologies. HCPL-0630

Digi-Key Part Number... 516-1487-2-ND

V0.90, 12.2015

6.5.2 Interfacing the analog input

Signal	Function	Pin number(s)
ANALOG_IN	Analog input	A8, B8
ANALOG_GND	Analog ground reference	A7, B7, A9, B9

Table 6.5: Analog input pins

The following circuit example interfaces the analog input that is jumper-selectable to be in current or voltage mode.

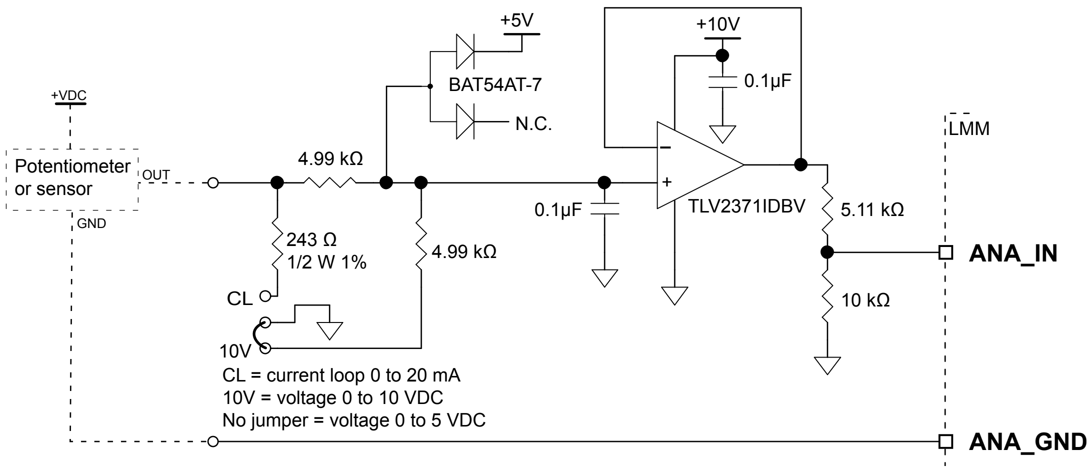


Figure 6.7 Analog input reference circuit

Parts list

General purpose op-amp

Texas Instruments. TLV2371IDBV

Digi-Key Part Number.. 96-13057-2-ND

Schottky diode

Diodes Inc.. BAT54AT-7

Digi-Key Part Number.................................... BAT54AT-FDITR-ND

V0.90, 12.2015

6.5.3 Bridge enable / disable

Signal	Function	Pin number(s)
ENABLE/DISABLE	Bridge enable/disable input	A41, B41

Table 6.6: Bridge enable/disable input pins

NOTE: This input MUST be connected to ground in order for the output bridges to function and motion to occur.

When disabled, a power cycle or software reset (CTRL+C) is required to re-enable.

The ENABLE / DISABLE input is used to control directly the ON/OFF state of the output driver H-bridges. When left disconnected (floating) the output bridge is enabled, and the axis will move when commanded.

The example circuit below shows the input configured as an ESTOP.

Note that there are no software parameters associated with the bridge ENABLE / DISABLE input. It is either enabled/active, (closed/grounded) or disabled/inactive (open/floating).

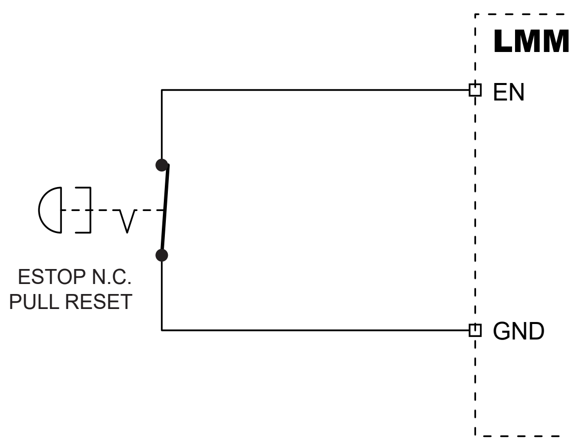


Figure 6.8: Example enable input usage

6.5.4 Reset input

Signal	Function	Pin number(s)
RESET	Reset axis input	A6, B6

Table 6.7: Reset input pins

The RESET input may be used to reset the LMM by pulsing the input low for one µsec, thus re-initialize the LMM to its startup state. The RESET input event may also be replicated in software by sending a ^C [CTRL+C] over the communications channel.

Note that any programs labeled with the execute on power-up keyword, SU, which executes the program on reset.

Note that there are no software parameters associated with the RESET input. It is either inactive, (open/floating) or active (closed/grounded).

Note that any unsaved data is lost on reset.

V0.90, 12.2015

6.5.5 Encoder inputs

Signal	Function	Pin number(s)
`ENC_A`	Encoder channel A input	A42, B42
`ENC_B`	Encoder channel B input	A43, B43
`ENC_IDX`	Encoder index input	A44, B44

Table 6.8: Encoder inputs

The encoder inputs to the LMM are unbuffered, LVCMOS33 inputs used specifically to bring in single-end quadrature encoder inputs.

An example circuit is shown below in Figure 6.9 illustrating a differential encoder interface.

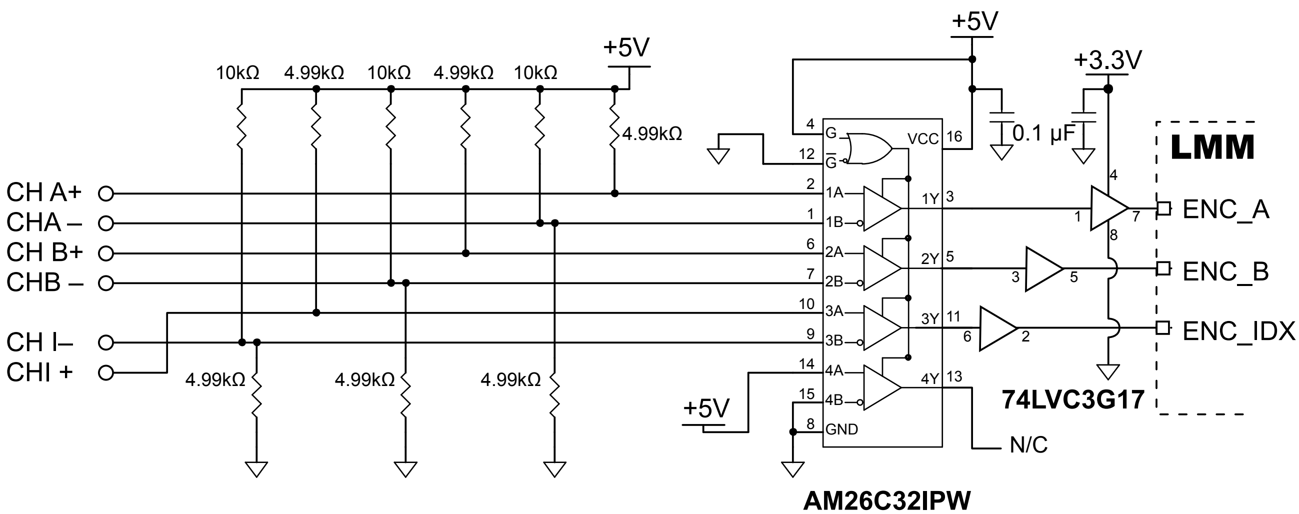


Figure 6.9: Example differential encoder input interface

Parts list

RS422 Quadrature differential line receiver

Texas Instruments...AM26C32IPWR

Digi-Key Part Number.. 296-30088-2-ND

Buffer, triple schmitt trigger

Texas Instruments.. 74LVC3G17

Digi-Key Part Number.. 296-18818-1-ND

6.5.6 Axis select inputs

Signal	Function	Pin number(s)
AXIS_SEL1	Axis address select input 1	A39, B39
AXIS_SEL2	Axis address select input 2	A38, B38
AXIS_SEL3	Axis address select input 3	A37, B37
AXIS_SEL4	Axis address select input 4	A36, B36

Table 6.9: Axis selection inputs

The AXIS SELECT inputs are unbuffered inputs used to provide a hardware interface for address selection for multi-drop serial communications applications.

Setting the inputs following the truth table in Table 6.10 defines the ASCII node addresses A-O for party mode operation.

To use the MCode DN (Device Name) command to set party mode addresses in software, connect all inputs to common. Note that the hardware address always take precedence over the DN command.

For use in single mode the inputs may be left floating, provided the MCode PY (Party Flag), is set to zero, or in its default state (PY=0)

Address	AXIS_SEL1	AXIS_SEL2	AXIS_SEL3	AXIS_SEL4
A	1	0	0	0
B	0	1	0	0
C	1	1	0	0
D	0	0	1	0
E	1	0	1	0
F	0	1	1	0
G	1	1	1	0
H	0	0	0	1
I	1	0	0	1
J	0	1	0	1
K	1	1	0	1
L	0	0	1	1
M	1	0	1	1
N	0	1	1	1
O	1	1	1	1
Use DN	0	0	0	0

Table 6.10: Axis selection input Address truth table

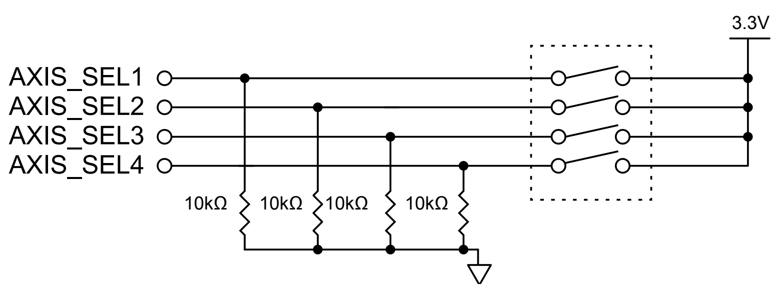


Figure 6.10: Axis_Select input interface

6.6 Logic outputs

6.6.1 Interfacing the logic outputs

Signal	Function	Pin number(s)
OUT_1	Output 1	A23, B23
OUT_2	Output 2	A22, B22

Table 6.11: General purpose programmable outputs

The logic outputs 1 and 2 have a maximum source/sink current of 4mA. In circuit example given in Figure 6.10, a FET is used with and opto-coupler device to boost the output current and place an isolation barrier between the output point and external devices.

The example shows an isolated dry-contact style power output capable of delivering 600mA to drive inductive loads such as relays or solenoids up to 24 volts.

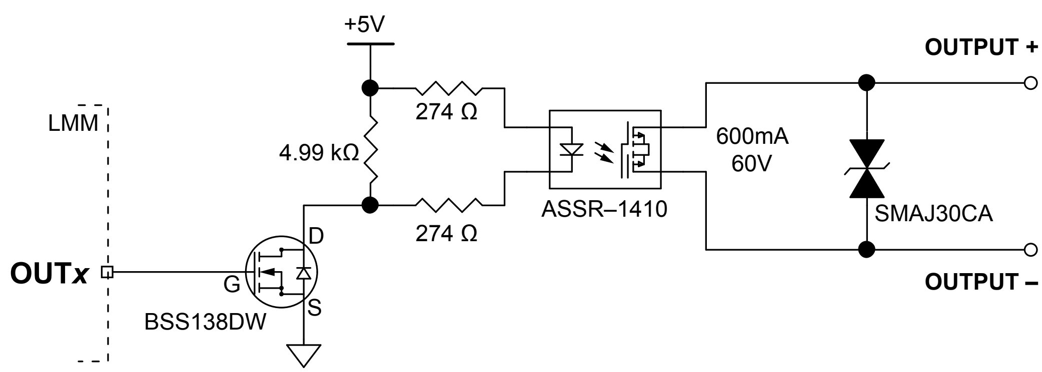


Figure 6.11: Isolated power output circuit

6.6.2 Interfacing the trip output

Signal	Function	Pin number(s)
OUT_3	Output 3 / Trip output	A40, B40

Table 6.12: Output 3 / trip output

Logic output 3 is high-speed, with a 16mA source/sink capability with the equivalent function as a trip output that can fire on the various trip conditions available in the MCode programming language.

The circuit example given in Figure 6.11 shows a low-current optocoupler used to interface the output as a low-current signal output which can drive an LED or SSR.\

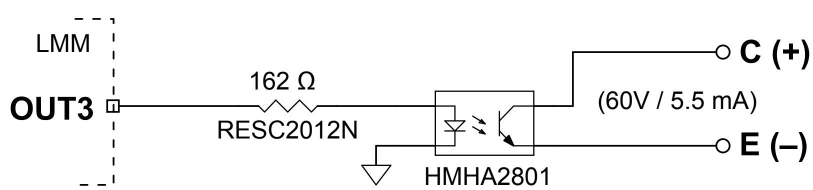


Figure 6.12: Isolated trip output circui

V0.90, 12.2015

6.7 Communications

6.7.1 Interfacing RS-422/485 communications

Nonisolated

The example circuit below shows an non-isolated RS-422/485 transceiver and supporting components

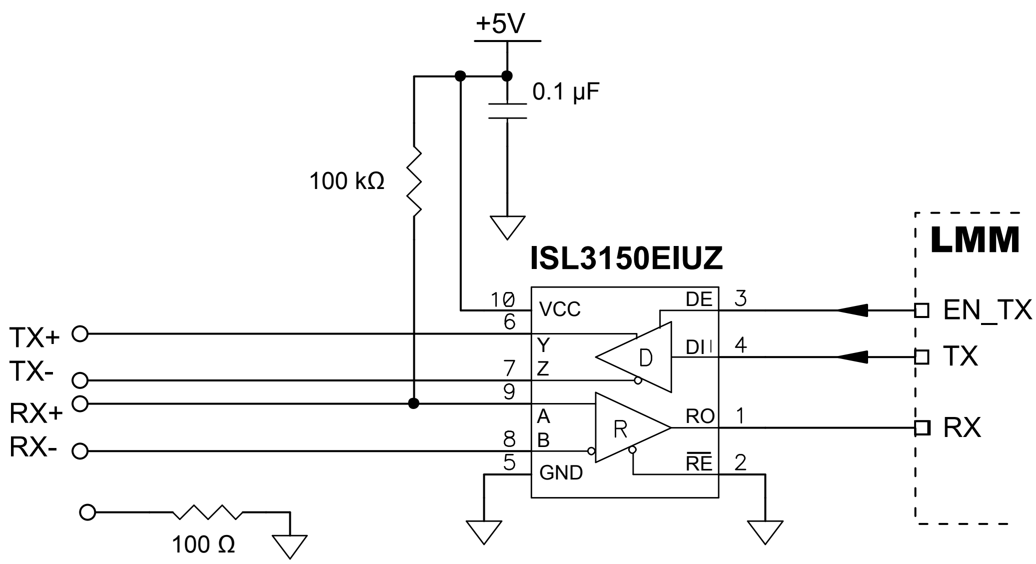


Figure 6.13: RS-422/485 communications interface

Intersil ISL3150EIUZ-T

Digi-Key Part Number................................... ISL3150EIUZ-TTR-ND

V0.90, 12.2015

Isolated The example circuit below shows an isolated RS-422/485 transceiver and supporting components

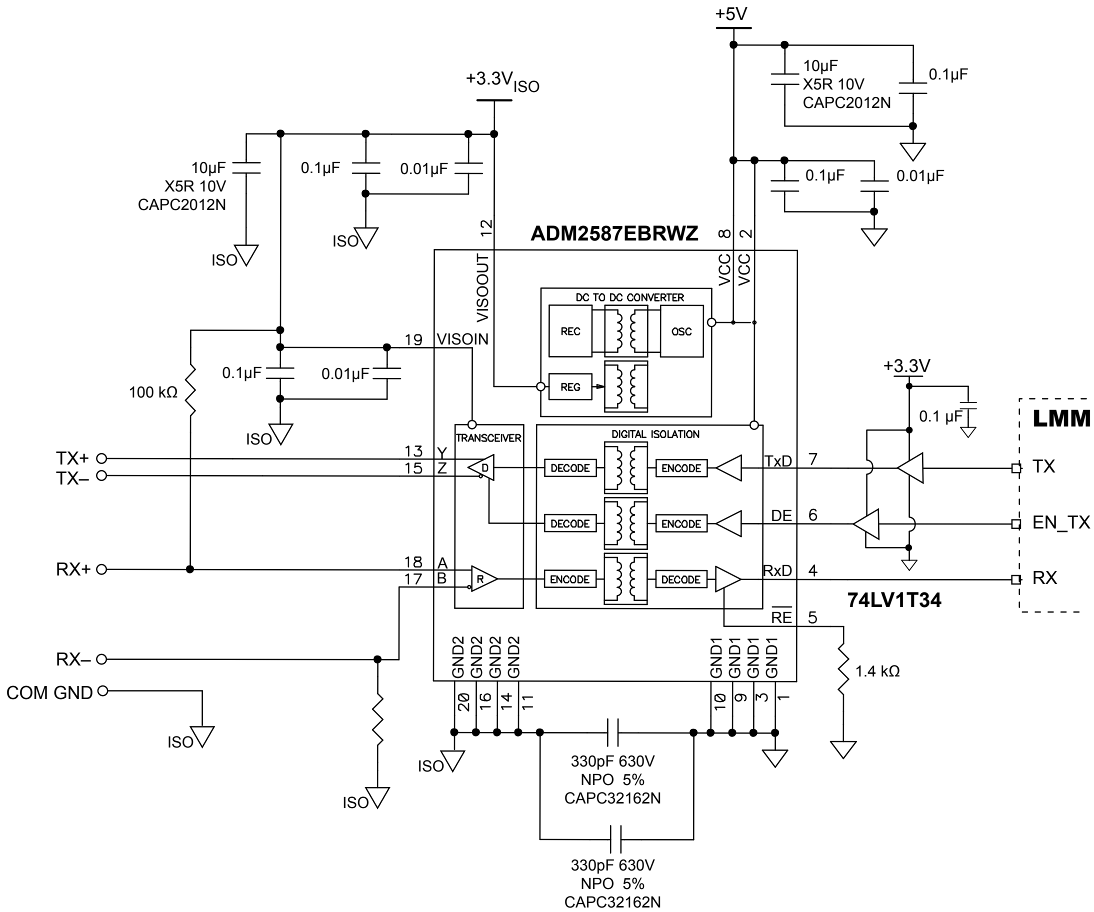


Figure 6.14: Isolated RS-422/485 communications interface

Parts list **Digital isolated RS-422/RS485 transceiver**

Analog Devices Inc. ADM2587EBRWZ

Digi-Key Part Number... ADM2587EBRWZ

Non-inverting buffer/driver

Texas Instruments. SN74LV1T34

Digi-Key Part Number.. 296-37177-2-ND

6.7.2 Interfacing CAN communications

The example circuit below shows a CAN transceiver, isolation transformer and supporting components in a self powered configuration.

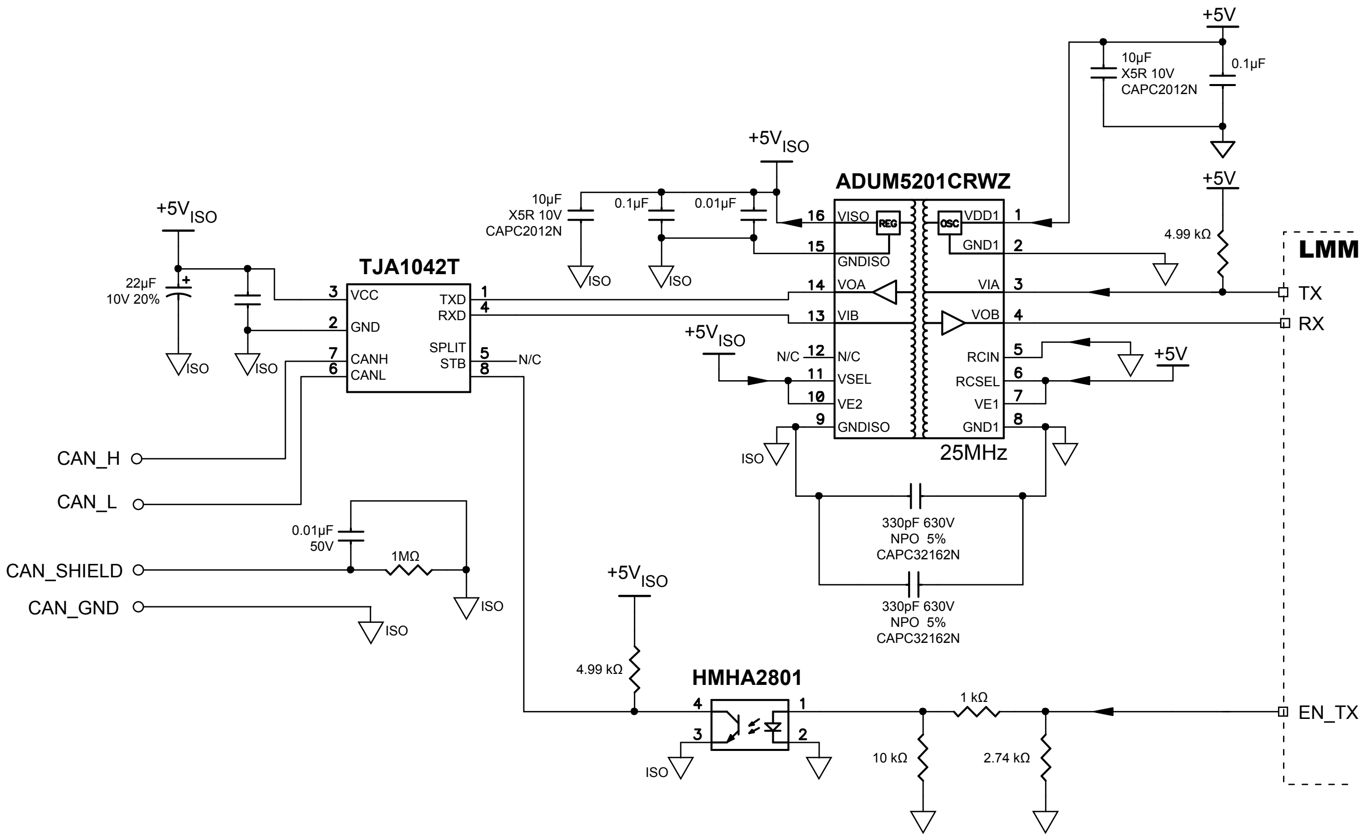


Figure 6.15: Isolated CAN interface

Parts list

Digital CAN transceiver

NXP Semiconductor. TJA1042TK/3,118

Digi-Key Part Number.. 568-8679-2-ND

Isolation transformer

Analog Devices Inc...ADUM5201CRWZ

Digi-Key Part Number.................................. ADUM5201CRWZ-ND

Optocoupler

Fairchild Semiconductor...HMHA2801R2

Digi-Key Part Number...................................HMHA2801R2TR-ND

V0.90, 12.2015

Page intentionally left blank

7 Configuration

7

⚠WARNING

UNEXPECTED MOVEMENT

Drives may perform unexpected movements because of incorrect wiring, incorrect settings, incorrect data or other errors.

Interference (EMC) may cause unpredictable responses in the system.

- Carefully install the wiring in accordance with the EMC requirements.
- Do NOT operate the drive system with unknown settings or data.
- Perform a comprehensive Configuration test.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

UNINTENDED BEHAVIOR

The behavior of the drive system is governed by numerous stored data or settings. Unsuitable settings or data may trigger unexpected movements or responses to signals and disable monitoring functions.

- Do NOT operate the drive system with unknown settings or data.
- Verify that the stored data and settings are correct.
- When Configuration, carefully run tests for all operating states and potential fault situations.
- Verify the functions after replacing the product and also after making changes to the settings or data.
- Only start the system if there are no persons or obstructions in the hazardous area.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

ROTATING PARTS

Rotating parts may cause injuries and may catch clothing or hair. Loose parts or parts that are unbalanced may be flung.

- Verify correct mounting and installation of all rotating parts.
- Use a cover to help protect against rotating parts.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

MOTOR WITHOUT BRAKING EFFECT

If power outage and faults cause the power stage to be switched off, the motor is no longer stopped by the brake and may increase its speed even more until it reaches a mechanical stop.

- Verify the mechanical situation.
- If necessary, use a cushioned mechanical stop or a suitable brake.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

FALLING PARTS

The motor may move as a result of the reaction torque; it may tip and fall.

- Mount the motor securely so it will not break loose during strong acceleration.

Failure to follow these instructions can result in death or serious injury.

⚠CAUTION

HOT SURFACES

Depending on the operation, the motor surface may heat up to more than 100°C (212°F).

- Do not allow contact with the hot surfaces.
- Do not allow flammable or heat-sensitive parts in the immediate vicinity.
- Consider the measures for heat dissipation described.
- Check the temperature during test runs.

Failure to follow these instructions can result in injury or equipment damage.

7.1 Preparing for configuration

The following tests are required before Configuration:

- The device may be commissioned in system or out of system.
- Only motor power, logic supply voltages and a communications interface connections are required for configuration, programming and use..

For Configuration and programming, a PC with the Lexium MDrive Software Suite or equivalent terminal emulator is required.

NOTE: Detailed usage instructions and screen captures of the Lexium MDrive Software Suite are found in the Lexium MDrive Software Suite software manual, which is available on the internet at:

http://motion.schneider-electric.com

NOTE: All parameters may be read/written using 2-character ASCII mnemonics via terminal emulation.

7.1.1 Installing the Lexium MDrive Software Suite

- PC running Windows XP SP3 or greater.
- Communications interface circuitry to LMM and communications converter, if required.
- Reference the Lexium MDrive Software Suite product manual for installation and configuration information.

Page intentionally left blank

8 Operation

The chapter “Operation” describes the basic functions of the drive.

8.1 Basics

8.1.1 Overview

Modes of operation

The “Lexium Motion Module” moves the stepper motor in a fashion dictated by it’s programming and or configuration:

- **Immediate (streaming command) mode:** The device will respond to motion, position and I/O commands in real-time as commanded via a HMI or host PC over the RS485 bus.
- **Program mode:** The device will move the motor, control outputs and respond to inputs in such a fashion as dictated by the programming. Programs may be executed via immediate mode execution command or I/O interactions.

Immediate and program modes may be used interchangeably as programs may be halted to issue immediate commands and then resumed.

8.1.2 Block diagram

The Lexium Motion Module consists of three major functional blocks:

1. µController: Communications, programming, I/O, motion control
2. FPGA: motion control, bridge control
3. Driver H-bridges

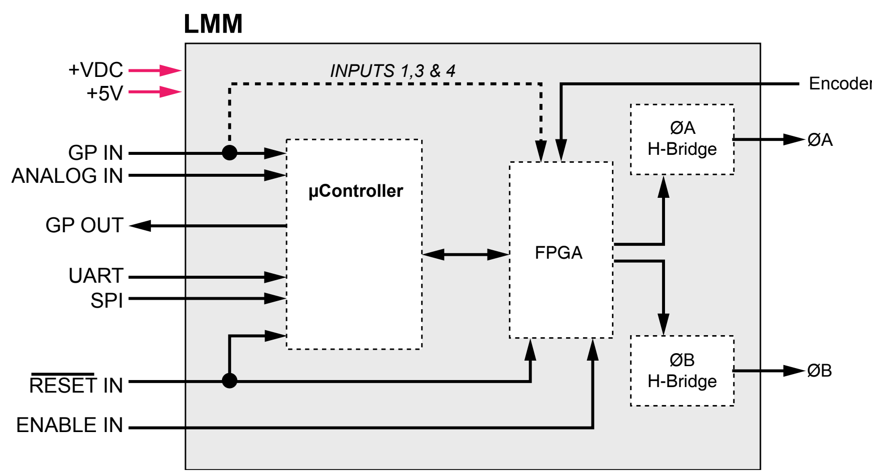


Figure 8.1: Lexium Motion Module block diagram

8.2 Software operation modes

The Lexium MDrive is controlled and programmed using the MCode language which consists of 1 and 2 character mnemonics.

Details are available in the MCode Programming and Reference manual which may be downloaded from the internet at:

http://motion.schneider-electric.com

8.2.1 Immediate mode

In immediate mode the device will respond to streaming commands via the service interface.

If used solely in this mode the device will will operate as a slave in a master-slave relationship with a communication host in a centralized control system.

In immediate mode the device will respond to motion commands, will respond to queries for register data, read the state of inputs or set the state of outputs based upon instructions from the system master.

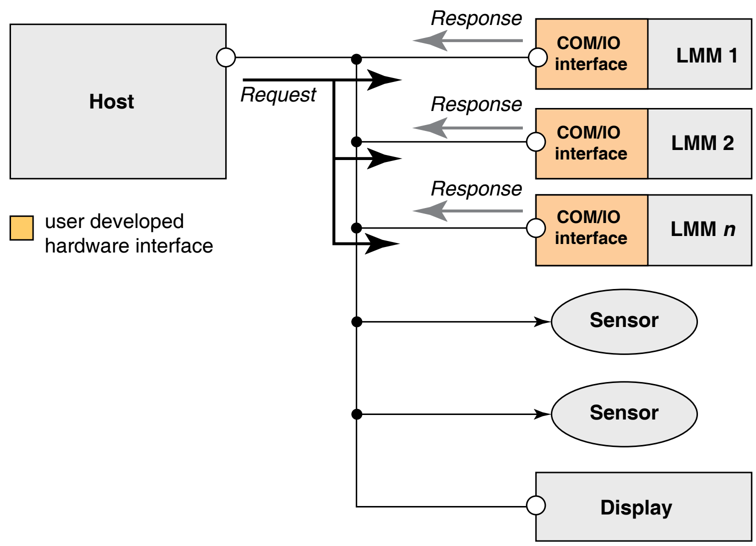


Figure 8.3: Master-slave network architecture (immediate mode application)

The network architecture shown in Figure 8.3 is an example of immediate mode operation. All system control is dictated by the programming of the host.

V1.00, 04.2106

8.2.2 Program mode

In program mode the device may operate as a standalone controller. The LMD will respond programmatically to inputs, set outputs based on flag states or register values, and send register values over the network as instructed by the programming of the device.

Program mode functionality allows the device to be used to initiate and respond to process events in a distributed intelligence system.

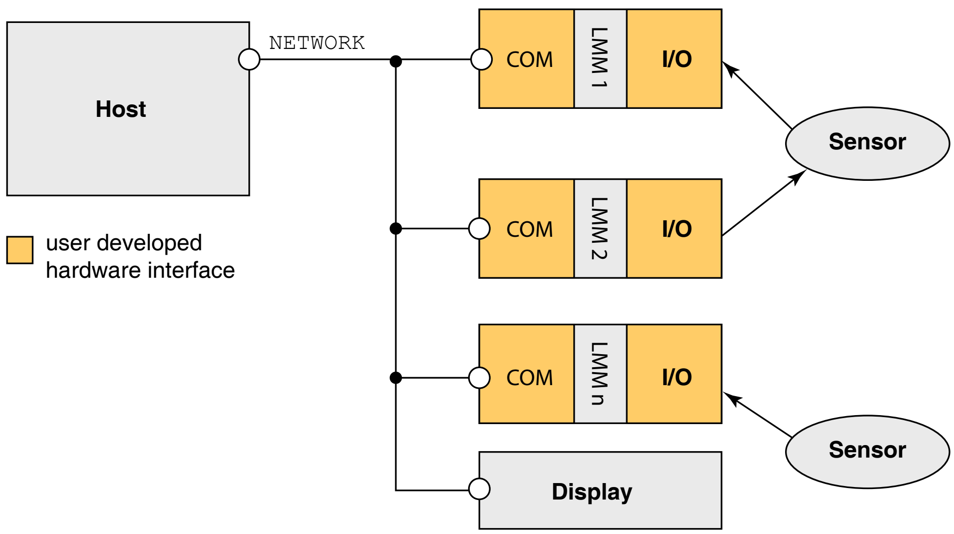


Figure 8.4: Distributed control architecture (program mode application)

The network architecture shown in Figure 8.4 is an example of program mode operation. All system control is dictated by the programming of the individual Lexium Motion Modules, which can be used perform system process actions based up I/O events. The host is in place for monitoring the system.

8.3 Programmable I/O operation

The Lexium Motion Module features the following I/O points:

- Four programmable general purpose inputs
- Three programmable outputs
- One 12-bit analog input

All of the I/O points are functionally configured in software using MCode. For detailed descriptions of each I/O configuration parameter, please reference the MCode Programming and Reference Manual at:

http://motion.schneider-electric.com

8.3.1 General purpose inputs

The general purpose inputs (IN1 - IN4) are unbuffered, directly connected to the LMM microcontroller. Additional circuitry

The function and active logic state is defined using the `INPUT_SETUP` parameter (`IS`) as:

```
IS=[POINT],[FUNCTION],[ACTIVE]
```

<table>
<tr><th>Point</th><th>Function</th><th>Alternate Dedicated Function</th><th>Active</th></tr>
<tr><td>1</td><td rowspan="4">0 = User defined
1 = Home
2 = Limit +
3 = Limit –
4 = G0
5 = Soft stop
6 = Pause program
7 = Jog +
8 = Jog –
11 = Reset</td><td>12 = Capture</td><td rowspan="4">0 = Low True
1 = High True</td></tr>
<tr><td>2</td><td>—</td></tr>
<tr><td>3</td><td>13 = Step Clock
14 = Encoder A
15 = Step up</td></tr>
<tr><td>4</td><td>13 = Direction
14 = Encoder B
15 = Step down</td></tr>
</table>

Table 8.1: Programmable input functions

The logic state of the inputs are read using the `I1, I2, I3`, and `I4` flags. The inputs may be read as a 4-bit word using the `IT` variable

8.3.2 General purpose outputs (1 & 2)

The function and active logic state is defined using the `OUTPUT_SETUP` parameter (`OS`) as:

```
OS=[POINT],[FUNCTION],[ACTIVE]
```

<table>
<tr><th>Point</th><th>Function</th><th>Alternate Dedicated Function</th><th>Active</th></tr>
<tr><td>1</td><td rowspan="2">16 = User defined
17 = Moving
18 = Software error
20 = Velocity changing
23 = Changing position
29 = Attention</td><td>26 = Encoder A</td><td rowspan="2">0 = Low True
1 = High True</td></tr>
<tr><td>2</td><td>27 = Encoder B</td></tr>
</table>

Table 8.2: Programmable output functions

The logic state of the outputs may be set using the `O1 and O2` command. The outputs may be set as BCD using the `OT` command.

8.3.3 Analog input

The analog input is not software configurable.

8.3.4 Output 3 / Trip

The signal output is an isolated high speed output primarily used to monitor trip events. The output may be programmed to trigger on a single trip event or any combination of events. The available events are:

- Trip on input
- Trip on absolute position
- Trip on capture
- Trip on time
- Trip on relative position

The output may also be set to any other output function supported by the LMM. The function and active logic state is defined using the `OUTPUT_SETUP` parameter (`OS`) as:

`OS=[3],[FUNCTION],[ACTIVE]`

Point	Function	Alternate Function	Active
3	28 = Trip	16 = User defined 17 = Moving 18 = Software error 20 = Velocity changing 23 = Changing position	0 = Low True 1 = High True

Table 8.3: Programmable output 3 functions

The logic state of the signal output may be set by a programmed trip event or using the `O3` command.

V1.00, 04.2106

Page intentionally left blank.

9 Diagnostics and troubleshooting

9

9.1 Error indication and troubleshooting

9.1.1 Operation state and error indication

Temperature monitoring

Sensors in the drive measure the temperature of the power stage.

If the permissible maximum temperature is exceeded, the power stage switches off. Indication can be read by:

- Setting an output to `ATTENTION_OUT` function and configure it to activate on over-temperature.
- Reading the error code `(71)` over the communications channel.

Stall detection

Detecting a stall condition may be accomplished by monitoring the encoder index outputs via the multifunction interface.

An encoder must be connected and encoder functions enabled (EE=1)

This status may be read using:

- Setting the `ATTENTION_OUT` to activate on stall.
- An error 86, stall detected will assert, PR ER, ER=0 or ER 0 to clear
- The ST (Stall) flag will activate. PR ST will return as 1. ST=0 or ST 0 to clear

9.2 Error codes

Error codes may be read by querying the device via a terminal emulator using:

`PR ER`

The response will come in the form of the error code. Table 9.1 below lists possible errors and their definition.

V1.00, 04.2106

Code	Error condition
0	No error

Table 9.1: No error

9.2.1 I/O error conditions

Code	Error condition
1	Output 1 over-current fault condition
2	Output 2 over-current fault condition
6	An I/O point is already set to this I/O type
7	Reserved
8	Tried to set I/O point to an incorrect I/O type
9	Tried to write a value to an input or output point that is configured to output type other than general purpose.
10	Attempted to address an illegal I/O point number
11	Incorrect clock type
12	Attempted capture with `INPUT 1` not set as capture input type
13	Motor phase over current fault detected
14	Bridge enable/disable pin in disabled state. Cycle power or CTRL+C to clear to re-enable

Table 9.2: I/O errors

9.2.2 Data error conditions

Code	Error condition
20	Attempting to assign a value to an unknown variable or flag
21	Attempting to assign an incorrect or out of range value
22	Attempting to assign a value to VI (Initial Velocity) that is greater than or equal to VM (Maximum Velocity)
23	Attempting to assign a value to VM (Maximum Velocity) that is less than or equal to VI (Initial Velocity)
24	Illegal data entered.
25	Attempting to write to a read-only variable or flag
26	Attempting to illegally increment or decrement a variable or flag, such as a a variable or flag with read-only accessibility.
27	Attempting to enable a trip function that is undefined.
28	Attempting to redefine a program label or variable. This can be caused when you download a program over a program already saved. Before downloading a newer edited program, enter <FD> (Restore Factory Default Settings) and press ENTER to return the device to its factory condition. You may also type <CP> (Clear Program Memory) and press ENTER to clear user program space.
29	Attempting to redefine a built in command, variable or flag.
30	Attempting to address an unknown or undefined program label or user variable
31	Program label/user variable table is full. Limit restricted to 336 user labels and/or user variables.
32	Attempting to assign a value to a program label

33	Attempting to assign a value to an instruction
34	Attempting to execute a variable or flag.
35	Attempting to print an illegal variable or flag
36	Illegal motor count to encoder count ratio
37	Instruction, variable or flag not available in drive
38	Missing parameter separator
39	Trip on position and trip on relative distance are not allowed together

Table 9.2: Data errors

9.2.3 Program error conditions

Code	Error condition
40	Program not running
41	Program running
42	Illegal program address
43	Tried to overflow program stack
44	Program locked
45	Trying to overflow program space
46	Not in program mode
47	Tried to write to illegal flash address
48	Program execution stopped by input configured as input type 5: Soft Stop input type.

Table 9.3: Program errors

9.2.4 Communications error conditions

Code	Error condition
60	Tried to enter unknown command
61	Trying to set illegal BAUD rate
62	An input is already pending
63	Character over run
64	Reserved
65	SPI bus error.

Table 9.4 Communications errors

9.2.5 System error conditions

Code	Error condition
70	Flash check sum error
71	Internal temperature warning
72	Internal over temp error. Disabling drive.
73	Attempting to issue a S (Save), FD (Factory Defaults) or PG (Program Mode) while axis is in motion
74	Attempting to issue a IP (Initialize Parameters) or CP (Clear Program Memory) while axis is in motion
75	Enable input is disabled.
77	Value of VI (Initial Velocity), VM (Maximum Velocity) or SL (Slew at Velocity) set to high for selected MS (Microstep Resolution)
79	DC input voltage out of range limit error - either below +12 VDC or above +48 VDC

Table 9.5 System errors

9.2.6 Motion error conditions

Code	Error condition
80	Input for HOME switch is undefined. Configure using IS=<input#>,1,<active>
81	HOME input type is undefined. Ensure that the designated home input is configured as type 1 using IS=<input#>,1,<active>
82	HOME switch not detected following limit moves in both directions
83	Positive (+) LIMIT reached and activated
84	Minus (—) LIMIT reached and activated
85	Motion commands not allowed while homing or attempting to HOME while in motion.
86	Stall detected
90	Value of VI (Initial Velocity)or VM (Maximum Velocity) is set too low.
91	Motion stopped by input configured as input type 5: Soft Stop input
92	Position error
93	New MR (Move Relative) or MA (Move Absolute) not allowed while correcting position at end of previous MR or MA
94	Motion commanded while the drive is disabled.
95	Not allowed to change RD (Rotation of Direction) while in motion
96	Not allowed to start motion with input poer VDC out of range.
97	Calculated final velocity less than VI (Initial Velocity).
98	Move generates illegal S-Curve Acceleration data.
99	Move generates illegal S-Curve Deceleration data

Table 9.6 Motion errors

10 Accessories and spare parts

10

10.1 Developer's kit

The Lexium Motion Module is available as a developer's kit, which includes:

Lexium Motion Module LMM-15-M

Single Axis Development board LMM-INT1-M

USB to RS-422/485 converter........................... MD-CC404-000

NEMA 17 (42 mm) motor and single-end encoder................TBD

24 VDC power supply

Development board schematic

The developer's kit contains everything needed to begin developing Lexium Motion Module applications right away.

Single Axis starter kit LMM-KIT1

10.2 Development boards

We offer two (2) development boards to facilitate rapid prototyping and development of LMM applications.

Single axis

The single axis board provides an interface to the major features of the LMM, which include:

- Isolated RS-422/485 communications
- Four (4) isolated programmable inputs (24VDC tolerant)
- One (1) isolated bridge enable input
- Six (6) non-isolated TTL tolerant differential encoder inputs
- Two (2) 100 mA isolated power outputs
- One (1) 5.5 mA isolated signal / trip output
- One (1) 12-bit analog input, jumper selectable to current or voltage sense
- Protection against over-voltage, regeneration voltage (back EMF)
- Pluggable connectors for power, I/O, and motor
- DB9 connector for communications

Four axis The four axis board is ideal for developing multi-axis LMM applications and features the same isolation and interfaces as the single axis board.

Each axis also features a 4 switch DIP that provides a hardware method to set the device address. The MCode software also provides a method, using the MCode DN (Drive Name) command. Note the hardware switch takes precedence over an address (DN) assigned in software.

The connector pinning and placement of each axis are identical to the single axis board, but for a single power and communications connector

10.2.1 Mechanical specifications

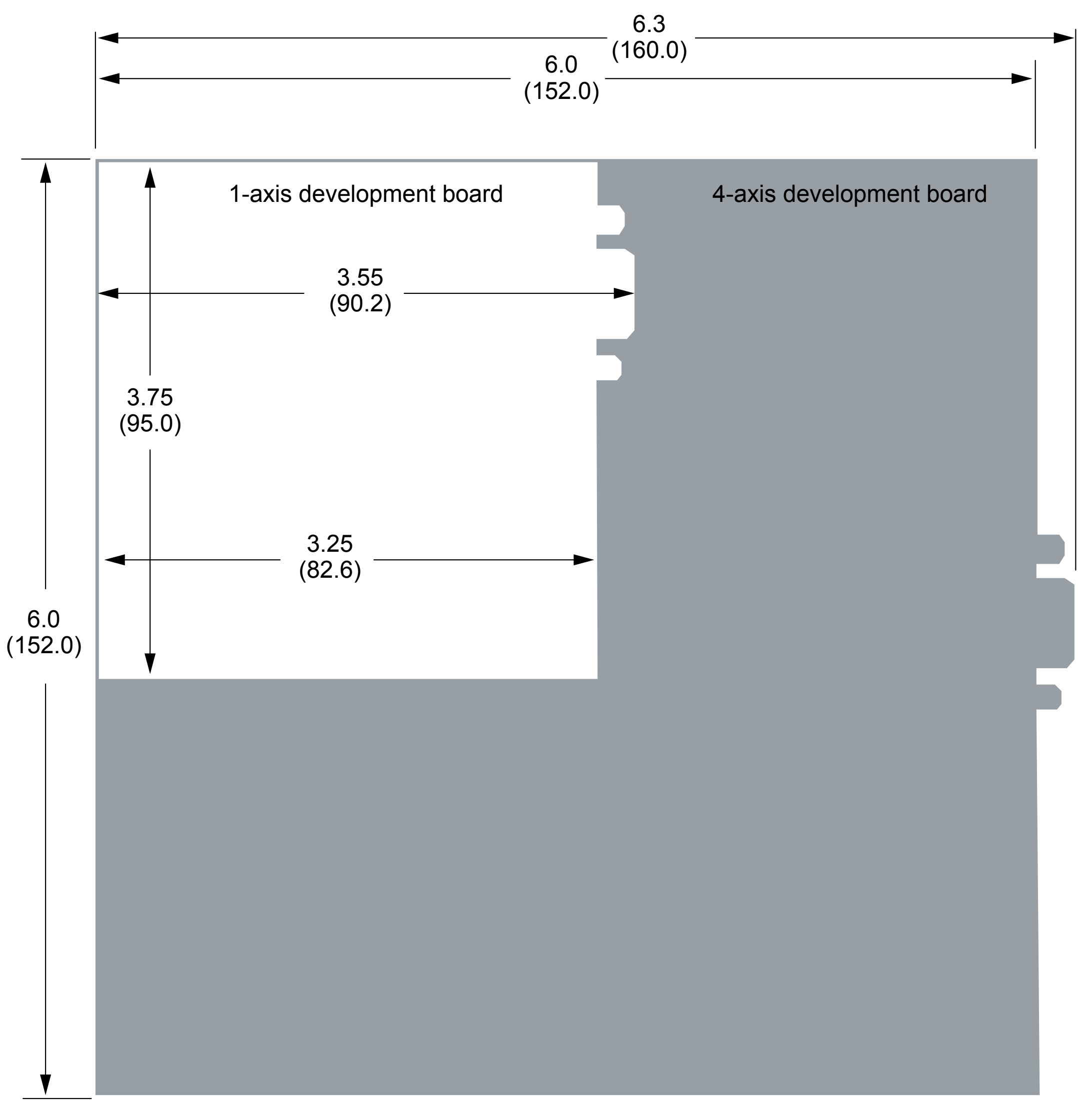


Figure 10.1: Development board mechanical dimensions

10.2.2 Development Board electrical specifications

Supply voltage VDC at P1

Specification	Value	LMM-15-M
Limit values min/max [1), 2)]	[+V_{dc}]	12/48
Ripple at nominal voltage	[+V_{pp}]	4.8
Max. current input (per axis)	[A]	1.25

1) UL 508C rating to 48VDC, posted max ratings conforms to CE low voltage directive.
2) The actual power requirement is often significantly lower, because the maximum possible motor torque is usually not required for operation of a system.

Table 10.1: Input voltage specifications

Programmable inputs/Enable input

Voltage range	[+V_{dc}]	5 ... 24
Input current (5V)	[mA]	8.7
Input current (24V)	[mA]	14.6
Input frequency	[kHz]	5
Isolation		Galvanic
Protection class		III

Table 10.2: General purpose isolated input specifications

Analog input

Voltage mode 0 - 5	[V_{dc}]	0 ... 5
Voltage mode 0 - 10	[V_{dc}]	0 ... 10
Current loop mode	[mA]	0 ... 20
Resolution	[Bits]	12
Impedance by mode		
0 - 10V	[MΩ]	5
0 - 10 V	[kΩ]	1.25
0 - 20 mA	[Ω]	243
Isolation		None

Table 10.3: Analog input specifications

Encoder inputs

Channel frequency	[MHz]	1.25
Phase shift A->B, B->A	[ns]	800
Cycle duration	[ns]	400
Pulse duration	[ns]	200
Input-output delay	[ns]	125
Isolation		None

Table 10.4: Encoder input specifications

Outputs 1 and 2

Voltage rating	[V_{dc}]	-24 ... +24
Current rating	[mA]	-100 ... +100
RDS_{ON}	[Ω]	11 ... 14
T_{ON} (hardware)	[mS]	0.08 ... 2
T_{OFF} (hardware)	[mS]	0.03 ... 0.5
O/C Level (±)	[mA]	230 ... 350
S/C Peak (+ or - @24V)	[mA]	2.2 (max)
Clamp voltage	[V_{dc}]	32 ... 38

Table 10.5: Power output specifications

Output 3

Voltage open-collector	[V_{dc}]	60
Voltage open-emitter	[V_{dc}]	7
Current open-collector	[mA]	5.5
Current open-emitter	[mA]	5.5
Isolation		Galvanic

Table 10.6: Signal / trip output specifications

RS-422/485

RS-422/485 serial communications bus. Interface can be half-duplex (2 wire RS485) in party mode or full-duplex (4 wire RS422) in both single and party mode. Multi-drop addressable to 62 nodes. Bus is optically isolated.

Characteristic of serial data lines		RS485
Baud rate	[kbps]	4.8 ... 115
Isolation		Galvanic

Table 10.7: Serial communications specifications

10.2.3 Board layout and connector locations

The interface boards are functionally identical regarding connectivity requirements, pin numbering, and locations.

Both the single and the quad axis boards have single connectors for power and communications, with each axis having a motor/encoder, I/O connectors, LMM PCIe socket and address selection switch.

Connector designations

The connectors are designated as follows, with the number following the ID character identifying the axis: i.e., M1 designates the motor and encoder connector on the single axis board, or for AXIS 1 on the four axis development board.

Designation	Function	Style	Mate P/N
P1	Motor power	2-pin pluggable (screw-lock)	Phoenix
J1	RS-422/485	DB9 (male) X 2	MD-CC404-000 USB to serial
M*n*	Motor and encoder	16-pin pluggable (tab-lock)	Phoenix
IO*n*	Logic and I/O	14-pin pluggable (tab-lock)	Phoenix
X*n*	LMM socket	PCIe X8	N/A
SW*n*	Address switch	4-position switch	N/A

Table 10.8: Connector designations and identification

Single axis developer's board

SEM Part # LMM-INT1-M

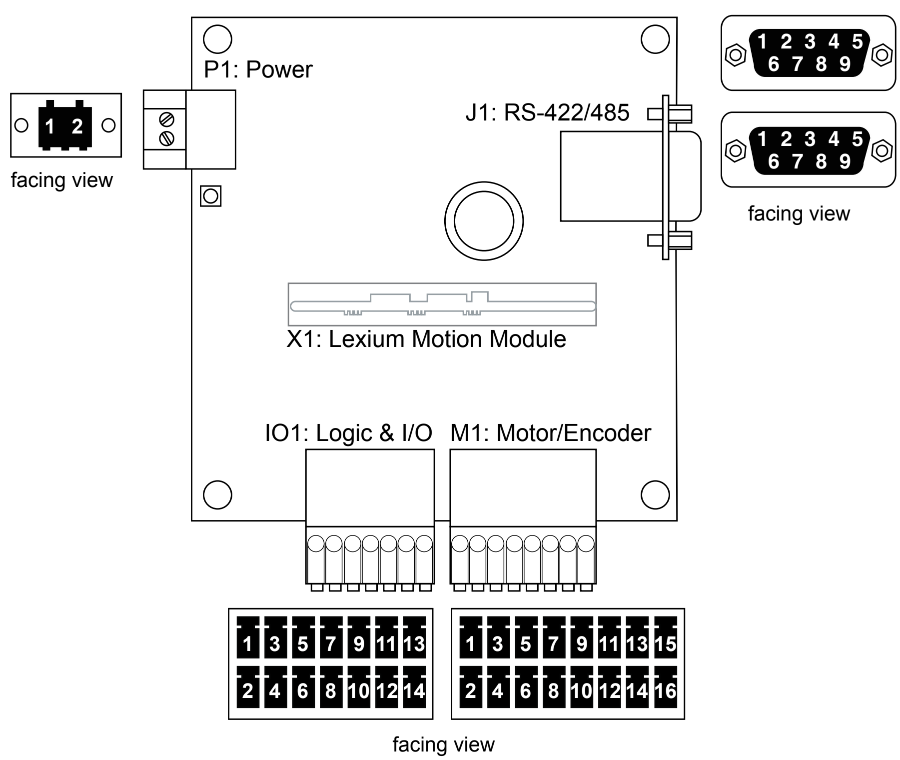


Figure 10.2: Connector pinning and placement - single axis developer's board

Four axis developer's board

SEM Part # LMM-INT4-M

When using the four axis developer's board with multiple LMM devices, the multi-drop addresses must be set prior to use, either by the switch, or by using the DN (Device Name) command in MCode. Not that the switch setting takes precedence over the software assigned address. See Section 10.2.8: Switch settings.

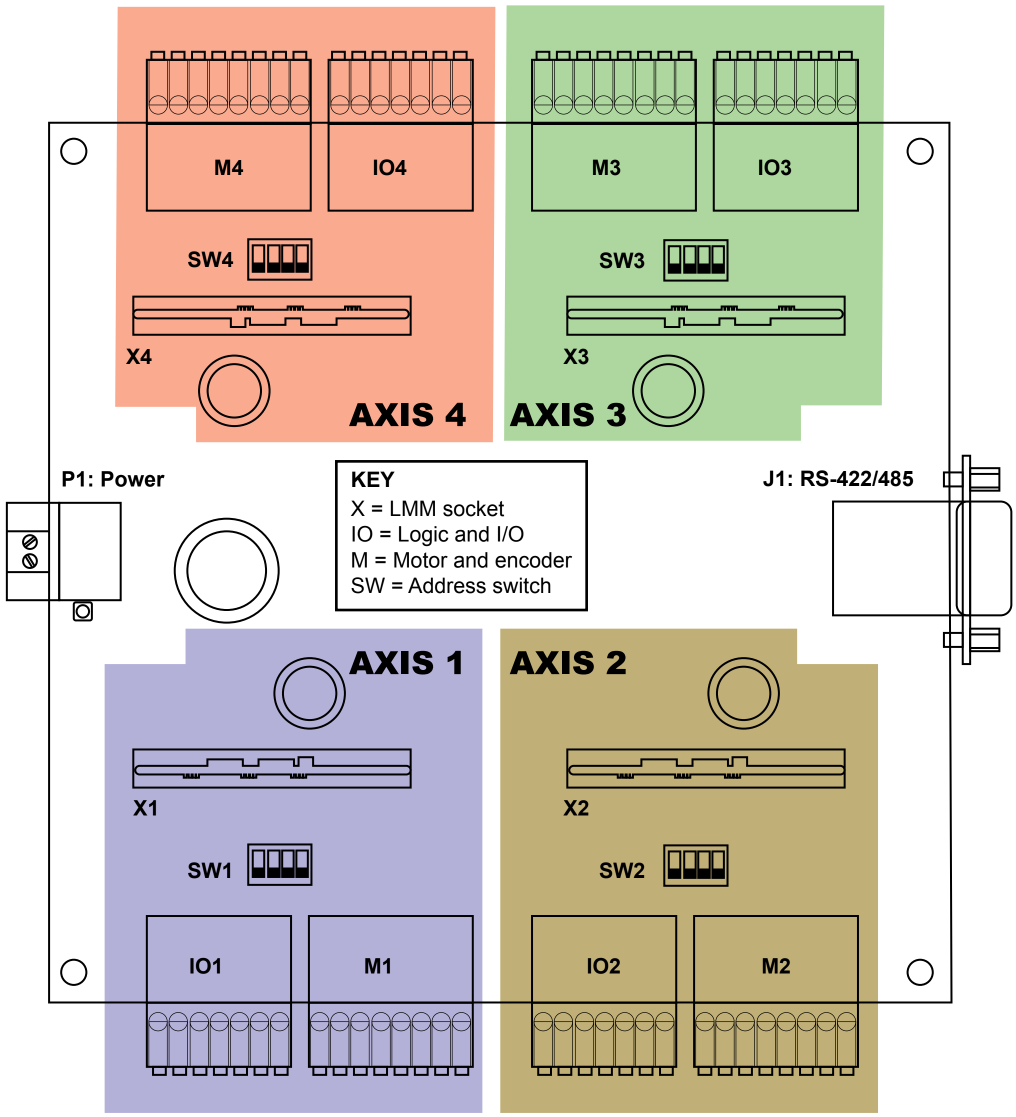
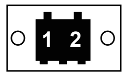


Figure 10.3: Connector placement - four axis developer's board

10.2.4 Power connector (P1) pinning

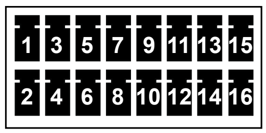


facing view

Pin #	Signal	Function
1	VDC	Supply voltage +12 to +48
2	0VDC	Reference potential to VDC

Table 10.9: Power connector (P1) pinning

10.2.5 Motor and encoder connector (M1-M4) pinning

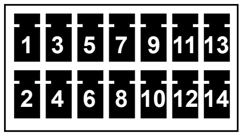


facing view

Pin #	Signal	Function
1	ENC A+	Encoder A+ channel
2	ENC A–	Encoder A— channel
3	ENC B+	Encoder B+ channel
4	ENC B–	Encoder B— channel
5	ENC I+	Encoder index +
6	ENC I–	Encoder index —
7	+5VDC	+5VDC power for encoder ONLY
8	GND	Encoder ground
9	NC	Not connected
10	NC	Not connected
11	GND	Ground
12	GND	Ground
13	PH A	Motor Phase A output
14	$\overline{PH\ B}$	Motor Phase B return
15	$\overline{PH\ A}$	Motor Phase A return
16	PH B	Motor Phase B output

Table 10.10: Motor and encoder connector (M*n*) pinning

10.2.6 Logic and I/O connector (IO1-IO4) pinning



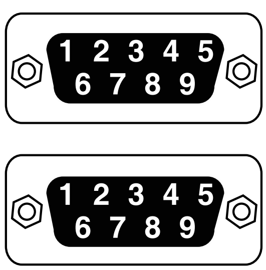
facing view

Pin #	Signal	Function
1	IN1	Isolated programmable input 1
2	IN2	Isolated programmable input 2
3	IN3	Isolated programmable input 3
4	IN4	Isolated programmable input 4
5	IN REF	Input reference - bias the input as sink or source
6	$\overline{\text{ENA}}$	Isolated bridge $\overline{\text{enable}}$ input. Must be switched or connected to ground to enable output bridge operation.
7	OUT1+	Programmable power output 1 +
8	OUT1—	Programmable power output 1 —
9	OUT2+	Programmable power output 2 +
10	OUT2—	Programmable power output 2 —
11	OUT3+	Programmable signal output 3 +
12	OUT3—	Programmable signal output 3 —
13	AGND	Analog ground
14	AIN	Analog input

Table 10.11: Logic and I/O connector (IO*n*) pinning

10.2.7 Communications connector (JP1) pinning

The upper and lower connectors are placed to facilitate daisy chaining multiple interface boards in a party-mode multi-axis configuration. Either connector may be used with a communications converter, and the pinouts are identical.



facing view

Pin	Signal	Function
1	N/C	Not connected
2	TRANSMIT-	Minus transmit, or channel A- line
3	RECEIVE+	Plus receive, or channel B+ line
4	COMM_GND	Isolated communication ground
5	N/C	Not connected
6	COMM_GND	Isolated communication ground
7	TRANSMIT +	Plus transmit, or channel A+ line
8	RECEIVE-	Minus receive, or channel B- line
9	N/C	Not connected

Table 10.12: RS-422/485 connector (IO*n*) pinning

Note: The shell of the DB-9 is connected to system ground. A location is provided for a surface mount (1210 package, 120ΩΩ) termination resistor if needed.

10.2.8 Address switch (SW1-SW4) configuration

The Lexium Motion Module addressing for multidrop networks follows the MCode serial addressing scheme in which the device may be given a unique “name” consisting of viewable ASCII characters (a-z A-Z, 0-9). The default character is the exclamation mark (!).

The LMM address may be assigned one of two ways:

- Set the hardware switch for addresses A - O
- Use the MCode naming command (DN) to set on of the full range of addresses

For use with the development boards, the easiest method is to use the hardware switches and set the addresses for each device before powering and using.

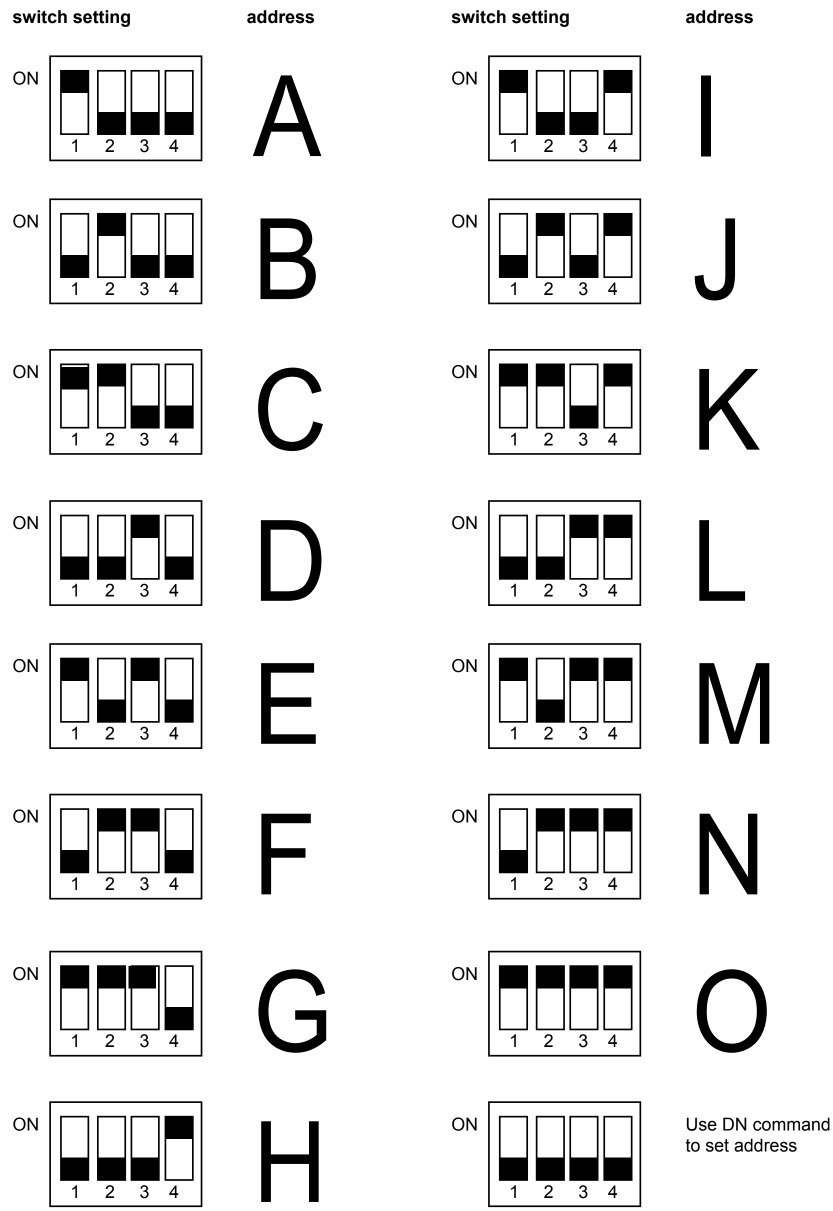


Figure 10.4: Address switch settings

10.3 Stepper motors

We offer a 1.8-degree stepper motors for use with the LMM and interface boards in the following NEMA sizes and stack lengths.

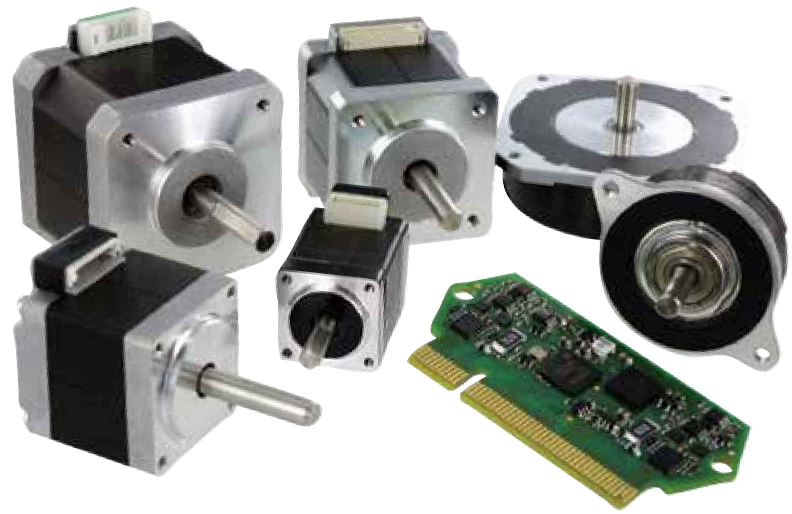


Figure 10.5: LMM and motors

NEMA (mm)	Length	Holding torque oz-in (N-cm)	Part #
08 (20)	1	3.0 (2.01)	M-0812-0.4S
	2	6.0 (4.24)	M-0818-0.4S
11 (26)	1	13 (9.20)	M-1112-1.0S
	2	18 (12.71)	M-1116-1.0S
	3	24 (16.95)	M-1120-1.0S
14 (36)	1	18 (13)	M-1410-0.75[S/D]
17 (42)	1	32 (23)	M-1713-1.5[S/D]
	2	60 (42)	M-1715-1.5[S/D]
	3	75 (53)	M-1719-1.5[S/D]

Table 10.13: Lexium Motion Module recommended stepping motors

10.4 Communications converter

USB-pluggable converter to set/program communication parameters in 32- or 64-bit. Includes pre-wired DB9 mating cable.

Description	Part number
USB to RS-422/485 communication converter	MD-CC404-000

Figure 10.10: MD-CC404-000 USB to RS422/485 converter

V1.00, 04.2106

This page intentionally left blank

11 Service, maintenance and disposal

11

⚠CAUTION

DAMAGE TO SYSTEM COMPONENTS AND LOSS OF CONTROL

Interruptions of the negative connection of the controller supply voltage can cause excessively high voltages at the signal connections.

- Do not interrupt the negative connection between the power supply unit and load with a fuse or switch.
- Verify correct connection before switching on.
- Do not connect or change wiring while the supply voltage is present.

Failure to follow these instructions can result in injury or equipment damage.

⚠CAUTION

RISK OF INJURY WHEN REMOVING CIRCUIT BOARD PLUGS

- When removing them note that the connectors must be unlocked.
  - Supply voltage VDC: unlock by removing locking screws
  - Multifunction interface: unlock with locking tabs
- Always hold the plug to remove it (not the cable).

Failure to follow these instructions can result in injury or equipment damage.

The product may only be repaired by a certified customer service center. No warranty or liability is accepted for repairs made by unauthorized persons.

11.1 Service address

If you cannot resolve an error yourself please contact your sales office. Have the following details available:

- Nameplate (type, identification number, serial number, DOM, ...)
- Type of error (such as LED flash code or error number)
- Previous and concomitant circumstances
- Your own assumptions concerning the cause of the error

Also include this information if you return the product for inspection or repair. Note that units being returned for inspection or repair must be accompanied by a Return Material Authorization (RMA).

Technical or applications support is available via the internet at:

http://motion.schneider-electric.com

11.2 Maintenance

Check the product for pollution or damage at regular intervals, depending on the way you use it.

11.3 Replacing units

⚠ WARNING

UNINTENDED BEHAVIOR

The behavior of the drive system is governed by numerous stored data or settings. Unsuitable settings or data may trigger unexpected movements or responses to signals and disable monitoring functions.

- Do NOT operate the drive system with unknown settings or data.
- Verify that the stored data and settings are correct.
- When commissioning, carefully run tests for all operating states and potential fault situations.
- Verify the functions after replacing the product and also after making changes to the settings or data.
- Only start the system if there are no persons or obstructions in the hazardous area.

Failure to follow these instructions can result in death or serious injury.

Only start the system if there are no persons or obstructions in the hazardous area.

- ▶ Switch off all supply voltages. Verify that no voltages are present (safety instructions).
- ▶ Label all connections and uninstall the product.
- ▶ Note the identification number and the serial number shown on the product nameplate for later identification.
- ▶ Install the new product as per chapter 6 “Installation”
- ▶ Commission the product as per chapter 7 “Commissioning”.

11.4 Shipping, storage, disposal

Removal Removal procedure:

- ▶ Switch off the power supply.
- ▶ Disconnect the power supply.
- ▶ Pull out all plugs.
- ▶ Remove the product from the system.

Shipping The product must be protected against shocks during transportation. If possible, use the original packaging for shipping.

Storage The product may only be stored in spaces where the specified permissible ambient conditions for room temperature and humidity are met. Protect the product from dust and dirt.

Disposal The product consists of various materials that can be recycled and must be disposed of separately. Dispose of the product in accordance with local regulations.

Page intentionally blank

12 Glossary

12

12.1 Units and conversion tables

The value in the specified unit (left column) is calculated for the desired unit (top row) with the formula (in the field).

Example: conversion of 5 meters [m] to yards [yd]
5 m / 0.9144 = 5.468 yd

12.1.1 Length

	in	ft	yd	m	cm	mm
in	—	/ 12	/ 36	* 0.0254	* 2.54	* 25.4
ft	* 12	—	/ 3	* 0.30479	* 30.479	* 304.79
yd	* 36	* 3	—	* 0.9144	* 91.44	* 914.4
m	/ 0.0254	/ 0.30479	/ 0.9144	—	* 100	* 1000
cm	/ 2.54	/ 30.479	/ 91.44	/ 100	—	* 10
mm	/ 25.4	/ 304.79	/ 914.4	/ 1000	/ 10	—

12.1.2 Mass

	lb	oz	slug	kg	g
lb	—	* 16	* 0.03108095	* 0.4535924	* 453.5924
oz	/ 16	—	* $1.942559*10^{-3}$	* 0.02834952	* 28.34952
slug	/ 0.03108095	* $1.942559*10^{-3}$	—	* 14.5939	* 14593.9
kg	/ 0.453592370	/ 0.02834952	/ 14.5939	—	* 1000
g	/ 453.592370	/ 28.34952	/ 14593.9	/ 1000	—

12.1.3 Force

	lb	oz	p	dyne	N
lb	—	* 16	* 453.55358	* 444822.2	* 4.448222
oz	/ 16	—	* 28.349524	* 27801	* 0.27801
p	/ 453.55358	/ 28.349524	—	* 980.7	* $9.807*10^{-3}$
dyne	/ 444822.2	/ 27801	/ 980.7	—	/ $100*10^3$
N	/ 4.448222	/ 0.27801	/ $9.807*10^{-3}$	* $100*10^3$	—

12.1.4 Power

	HP	W
HP	—	* 745.72218
W	/ 745.72218	—

12.1.5 Rotation

	min^{-1} (RPM)	rad/s	deg./s
min^{-1} (RPM)	—	* π / 30	* 6
rad/s	* 30 / π	—	* 57.295
deg./s	/ 6	/ 57.295	—

12.1.6 Torque

	lb·in	lb·ft	oz·in	Nm	kp·m	kp·cm	dyne·cm
lb·in	—	/ 12	* 16	* 0.112985	* 0.011521	* 1.1521	* 1.129*10^{6}
lb·ft	* 12	—	* 192	* 1.355822	* 0.138255	* 13.8255	* 13.558*10^{6}
oz·in	/ 16	/ 192	—	* 7.0616*10^{-3}	* 720.07*10^{-6}	* 72.007*10^{-3}	* 70615.5
Nm	/ 0.112985	/ 1.355822	/ 7.0616*10^{-3}	—	* 0.101972	* 10.1972	* 10*10^{6}
kp·m	/ 0.011521	/ 0.138255	/ 720.07*10^{-6}	/ 0.101972	—	* 100	* 98.066*10^{6}
kp·cm	/ 1.1521	/ 13.8255	/ 72.007*10^{-3}	/ 10.1972	/ 100	—	* 0.9806*10^{6}
dyne·cm	/ 1.129*10^{6}	/ 13.558*10^{6}	/ 70615.5	/ 10*10^{6}	/ 98.066*10^{6}	/ 0.9806*10^{6}	—

12.1.7 Moment of inertia

	lb·in^2	lb·ft^2	kg·m^2	kg·cm^2	kp·cm·s^2	oz·in^2
lb·in^2	—	/ 144	/ 3417.16	/ 0.341716	/ 335.109	* 16
lb·ft^2	* 144	—	* 0.04214	* 421.4	* 0.429711	* 2304
kg·m^2	* 3417.16	/ 0.04214	—	* 10*10^{3}	* 10.1972	* 54674
kg·cm^2	* 0.341716	/ 421.4	/ 10*10^{3}	—	/ 980.665	* 5.46
kp·cm·s^2	* 335.109	/ 0.429711	/ 10.1972	* 980.665	—	* 5361.74
oz·in^2	/ 16	/ 2304	/ 54674	/ 5.46	/ 5361.74	—

12.1.8 Temperature

	°F	°C	K
°F	—	(°F - 32) * 5/9	(°F - 32) * 5/9 + 273.15
°C	°C * 9/5 + 32	—	°C + 273,15
K	(K - 273.15) * 9/5 + 32	K - 273.15	—

12.1.9 Conductor cross section

AWG	1	2	3	4	5	6	7	8	9	10	11	12	13
mm²	42.4	33.6	26.7	21.2	16.8	13.3	10.5	8.4	6.6	5.3	4.2	3.3	2.6

AWG	14	15	16	17	18	19	20	21	22	23	24	25	26
mm²	2.1	1.7	1.3	1.0	0.82	0.65	0.52	0.41	0.33	0.26	0.20	0.16	0.13

12.2 Terms and Abbreviations

AC Alternating current

Acceleration The time rate of change of velocity with respect to a fixed reference frame. The commanded step rate is started at a base velocity and accelerated at a slew velocity at a defined and controlled rate or rate of changes.

ASCII American Standard Code for Information Interchange. Standard for coding of characters.

Back Electro-Motive Force (Back EMF) Also known as regeneration current, the reversed bias generated by rotation of the magnetic field across a stator’s windings. Sometimes referred to as counter EMF.

CAN (Controller Area Network), standardized open fieldbus as per ISO 11898, allows drives and other devices from different manufacturers to communicate.

CANopen CANopen is a CAN-based higher layer protocol. It was developed as a standardized embedded network with highly flexible configuration capabilities. CANopen was designed motion oriented machine control networks, such as handling systems. It is used in many various fields, such as medical equipment, off-road vehicles, maritime electronics, public transportation, building automation, etc

Closed Loop System In motion control, this term describes a system wherein a velocity or position (or both) sensor is used to generate signals for comparison to desired parameters. For cases where loads are not predictable, the closed loop feedback from an external encoder to the controller may be used for stall detection, position maintenance or position verification.

Daisy Chain This term is used to describe the linking of several devices in sequence, such that a single signal stream flows through one device and on to another

DC Direct current

Deadband A range of input signals for which there is no system response.

Default value Factory setting.

Detent Torque The periodic torque ripple resulting from the tendency of the magnetic rotor and stator poles to align themselves to positions of minimal reluctance. The measurement is taken with all phases de-energized.

Direction of rotation Rotation of the motor shaft in a clockwise or counterclockwise direction of rotation. Clockwise rotation is when the motor shaft rotates clockwise as you look at the end of the protruding motor shaft.

DOM The Date of manufacturing on the nameplate of the device is shown in the format DD.MM.YY,
e.g. 31.12.06 (December 31, 2006).

Duty Cycle For a repetitive cycle, the ratio of on time to total cycle time.

EMC Electromagnetic compatibility

Encoder Sensor for detection of the angular position of a rotating component. The motor encoder shows the angular position of the rotor.

Error class Classification of errors into groups. The different error classes allow for specific responses to faults, e.g. by severity.

Fatal error In the case of fatal error, the drive is no longer able to control the motor, so that an immediate switch-off of the drive is necessary.

Fault Operating state of the drive caused as a result of a discrepancy between a detected (computed, measured or signaled) value or condition and the specified or theoretically correct value or condition.

Fault reset A function used to restore the drive to an operational state after a detected fault is cleared by removing the cause of the fault so that the fault is no longer active (transition from state “Fault” to state “Operation Enable”).

Forcing Forcing switching states of inputs/outputs. Forcing switching states of inputs/outputs.

Full Duplex The transmission of data in two directions simultaneously. For example, a telephone is a full-duplex device because both parties can talk at the same time.

Ground Loop A ground loop is any part of the DC return path (ground) that has more than one possible path between any two points.

Half Duplex The transmission of data in just one direction at a time. For example, a walkie-talkie is a half-duplex device because only one party can talk at a time.

Half Step This term means that the motor shaft will move a distance of 0.9 degree (400 steps per shaft revolution) instead of moving 1.8 degree per digital pulse.

hMTechnology™ (hMT) A motor control technology representing a new paradigm in brushless motor control. By bridging the gap between stepper and servo performance, hMT offers system integrators a third choice in motion system design.

Hybrid Motors Hybrid stepper motors feature the best characteristics of PM and VR motors. Hybrid steppers are best suited for industrial applications because of high static and run torque, a standard low step angle of 1.8°, and the ability to Microstep. Hybrid stepper motors offer the ability to precisely position a load without using a closed-loop feedback device such as an encoder.

Holding Torque The maximum torque or force that can be externally applied to a stopped, energized motor without causing the rotor to rotate continuously. This is also called “static torque”.

I/O Inputs/outputs

Inc Increments

Index pulse Signal of an encoder to reference the rotor position in the motor. The encoder returns one index pulse per revolution.

Inertia A measure of an object’s resistance to a change in velocity. The larger an object’s inertia, the greater the torque required to accelerate or decelerate it. Inertia is a function of an object’s mass and shape. For the most efficient operation, the system-coupling ratio should be selected so that the reflected inertia of the load is equal to or no greater than 10 times the rotor inertia of the stepper motor.

Inertia (Reflected) Inertia as seen by the stepper motor when driving through a speed change, reducer or gear train.

Lag The amount (in full motor steps) that the rotor lags the stator. Lag conditions are caused by loading on the motor shaft, as during transient loading or rapid acceleration.

Lead The amount (in full motor steps) that the rotor leads the stator. Lead conditions are caused by an overhauling load, as during periods of rapid deceleration.

Limit switch Switch that signals overtravel of the permissible range of travel.

Load Any external resistance (static or dynamic) to motion that is applied to the motor.

Locked rotor When the lag/lead limit is reached, a timer starts a countdown that is determined by the user. The locked rotor will assert itself by triggering a flag and, depending on the selected mode, by disabling the output bridge.

Loss of synchronization In traditional stepper systems, when the lead/lag relationship of the rotor and stator reaches two full motor steps, the alignment of the magnetic fields is broken and the motor will stall in a freewheeling state. hMTechnology eliminates this.

Microstepping A control electronic technique that proportions the current in a stepper motor's windings to provide additional intermediate positions between poles. Produces smooth rotation over a wide range and high positional resolution. Typically, step resolutions range from 400 to 51,200 steps per shaft revolution.

Motor phase current The available torque of a stepper motor is determined by the motor phase current. The higher the motor phase current the higher the torque.

Multidrop A communications configuration in which several devices share the same transmission line, although generally only one may transmit at a time. This configuration usually uses some kind of polling mechanism to address each connected device with a unique address code.

NEMA The acronym for the National Electrical Manufacturer's Association, an organization that sets standards for motors and other industrial electrical equipment.

Node guarding Monitoring of the connection with the slave at an interface for cyclic data traffic.

Open Loop System An open loop motion control system is where no external sensors are used to provide position or velocity feedback signals, such as encoder feedback of position.

Opto-Isolated A method of sending a signal from one piece of equipment to another without the usual requirement of common ground potentials. The signal is transmitted optically with a light source (usually a Light Emitting Diode) and a light sensor (usually a photo-sensitive transistor). These optical components provide electrical isolation.

Parameter Device data and values that can be set by the user.

Persistent Indicates whether the value of the parameter remains in the memory after the device is switched off.

PLC Programmable logic controller

Position lead/lag The hMT circuitry continually tracks the position lead or lag error, and may use it to correct position.

Position make-up When active, the position make-up can correct for position errors occurring due to transient loads. The lost steps may be interleaved with incoming steps, or reinserted into the profile at the end of a move.

Power stage The power stage controls the motor. The power stage generates currents for controlling the motor on the basis of the positioning signals from the controller.

Pull-In Torque This is the maximum torque the stepper motor can develop when instantaneously started at that speed.

Pull-Out Torque This is the maximum torque that the stepper can develop once an acceleration profile has been used to “ramp” it to the target speed.

Quick Stop Function used to enable fast deceleration of the motor via a command or in the event of a malfunction.

Resolution The smallest positioning increment that can be achieved.

Resonance The frequency that a stepper motor system may begin to oscillate. Primary resonance frequency occurs at about one revolution per second. This oscillation will cause a loss of effective torque and may result in loss of synchronism. The designer should consider reducing or shifting the resonance frequency by utilizing half step or micro-step techniques or work outside the primary resonance frequency.

Rotor The moving part of the motor, consisting of the shaft and the magnets. These magnets are similar to the field winding of a brush type DC motor

Rotor Inertia The rotational inertia of the rotor and shaft.

RS485 Fieldbus interface as per EIA-485 which enables serial data transmission with multiple devices.

Sinking Current Refers to the current flowing into the output of the chip. This means that a device connected between the positive supply and the chip output will be switched on when the output is low.

Slew The position of a move profile where the motor is operating at a constant velocity

Sourcing Current Refers to the current flowing out of the output of the chip. This means that a device connected between the chip output and the negative supply will be switched on when the output is high.

Stall detection Stall detection monitors whether the index pulse is always correctly triggered at the same angle position of the motor shaft.

Stator The stationary part of the motor. Specifically, it is the iron core with the wire winding in it that is pressed into the shell of the frame. The winding pattern determines the voltage constant of the motor.

Torque ramp Deceleration of the motor with the maximum possible deceleration, which is only limited by the maximum permissible current. The higher the permissible braking current, the stronger the deceleration. Because energy is recovered up depending on the coupled load, the voltage may increase to excessively high values. In this case the maximum permissible current must be reduced.

Variable current control When active, variable current control will control the motor current as such to maintain the torque and speed on the load to what is required by the profile. This leads to reduced motor heating and greater system efficiency.

Warning If not used within the context of safety instructions, a warning alerts to a potential problem detected by a monitoring function. A warning is not a fault and does not cause a transition of the operating state. Warnings belong to error class 0.

Watchdog Unit that monitors cyclic basic functions in the product. Power stage and outputs are switched off in the event of faults.

Zero crossing The point in a stepper motor where one phase is at 100% current and the other is at 0% current.

Index

WARRANTY

Reference the web site at www.motion.schneider-electric.com for the latest warranty and product information.

USA SALES OFFICES

East Region
Tel. 610-573-9655
e-mail: e.region@imshome.com

Northeast Region
Tel. 860-368-9703
e-mail: n.region@imshome.com

Central Region
Tel. 630-267-3302
e-mail: c.region@imshome.com

Western Region
Tel. 602-578-7201
e-mail: w.region@imshome.com

EUROPEAN SALES MANAGEMENT
Tel. +33/4 7256 5113 – Fax +33/4 7838 1537
e-mail: europe.sales@imshome.com

TECHNICAL SUPPORT
Tel. +00 (1) 860-295-6102 – Fax +00 (1) 860-295-6107
e-mail: etech@imshome.com

Schneider Electric Motion USA

370 N. Main Street
Marlborough, CT 06447 USA

www.motion.schneider-electric.com

Print: Schneider Electric Motion USA
Photos: Schneider Electric Motion USA

Date : 08/2018