# Compact Sercos Motion Controller LMC078

## System User Guide

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The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.



All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

# Table of Contents

# Safety Information

## Important Information

### NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

**⚠ DANGER**

**DANGER** indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

**⚠ WARNING**

**WARNING** indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

**⚠ CAUTION**

**CAUTION** indicates a hazardous situation which, if not avoided, **could result** in minor or moderate injury.

***NOTICE***

***NOTICE*** is used to address practices not related to physical injury.

## PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

## BEFORE YOU BEGIN

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

### ⚠ WARNING

**UNGUARDED EQUIPMENT**

- Do not use this software and related automation equipment on equipment which does not have point-of-operation protection.
- Do not reach into machinery during operation.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

This automation equipment and related software is used to control a variety of industrial processes. The type or model of automation equipment suitable for each application will vary depending on factors such as the control function required, degree of protection required, production methods, unusual conditions, government regulations, etc. In some applications, more than one processor may be required, as when backup redundancy is needed.

Only you, the user, machine builder or system integrator can be aware of all the conditions and factors present during setup, operation, and maintenance of the machine and, therefore, can determine the automation equipment and the related safeties and interlocks which can be properly used. When selecting automation and control equipment and related software for a particular application, you should refer to the applicable local and national standards and regulations. The National Safety Council's Accident Prevention Manual (nationally recognized in the United States of America) also provides much useful information.

In some applications, such as packaging machinery, additional operator protection such as point-of-operation guarding must be provided. This is necessary if the operator's hands and other parts of the body are free to enter the pinch points or other hazardous areas and serious injury can occur. Software products alone cannot protect an operator from injury. For this reason the software cannot be substituted for or take the place of point-of-operation protection.

Ensure that appropriate safeties and mechanical/electrical interlocks related to point-of-operation protection have been installed and are operational before placing the equipment into service. All interlocks and safeties related to point-of-operation protection must be coordinated with the related automation equipment and software programming.

**NOTE:** Coordination of safeties and mechanical/electrical interlocks for point-of-operation protection is outside the scope of the Function Block Library, System User Guide, or other implementation referenced in this documentation.

## START-UP AND TEST

Before using electrical control and automation equipment for regular operation after installation, the system should be given a start-up test by qualified personnel to verify correct operation of the equipment. It is important that arrangements for such a check be made and that enough time is allowed to perform complete and satisfactory testing.

**⚠ WARNING**

**EQUIPMENT OPERATION HAZARD**

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters, and debris from equipment.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

Follow all start-up tests recommended in the equipment documentation. Store all equipment documentation for future references.

**Software testing must be done in both simulated and real environments.**

Verify that the completed system is free from all short circuits and temporary grounds that are not installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:

- Remove tools, meters, and debris from equipment.
- Close the equipment enclosure door.
- Remove all temporary grounds from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

## OPERATION AND ADJUSTMENTS

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.

# About the Book

## At a Glance

### Document Scope

This document describes a generic architecture based on Modicon LMC078 Motion Controller.

This document is intended to provide a quick introduction to the described system.

It is not intended to replace any specific product documentation, nor any of your own design documentation. On the contrary, it offers additional information to the product documentation for installing, configuring, and implementing the system.

The architecture described in this document is not a specific product in the normal commercial sense. It describes an example of how Schneider Electric and third-party components may be integrated to fulfill an industrial application.

A detailed functional description or the specification for a specific user application is not part of this document. Nevertheless, the document outlines some typical applications where the system could be implemented.

Your specific application requirements may be different and will require additional and/or different components. In this case, you will have to adapt the information provided in this document to your particular needs. To do so, you will need to consult the specific product documentation of the components that you are substituting in this architecture.

Pay particular attention in conforming to any safety information, different electrical requirements, and normative standards that would apply to your adaptation.

There are some major components in the architecture described in this document that cannot be substituted without completely invalidating the architecture, descriptions, instructions, wiring diagrams, and compatibility between the various software and hardware components specified herein.

Be aware of the consequences of component substitution in the architecture described in this document as substitutions may impair the compatibility and interoperability of software and hardware.

### Validity Note

This document has been updated with the release of SoMachine V4.2.

### Related Documents

| Title of Documentation | Reference Number |
|---|---|
| PowerPact Multistandard, Catalogue | LVPED212023EN |
| The essential guide for power supplies and transformers | DIA3ED2070412EN |

| Title of Documentation | Reference Number |
|---|---|
| Multi 9 System, Catalog | 0860CT0201 |
| Phaseo power supplies and transformers, Catalogue Pages | 14082-EN |
| PM3200 series, Power Meters, User Manual | DOCA0006EN |
| TI current transformers, Catalogue Pages | 92068EN |
| Control and protection components | MKTED210011EN |
| Preventa, Machine Safety Products | MKTED208051EN |
| XPS-MP Instruction Sheet | S1A2876601 |
| Preventa solutions for efficient machine safety - catalogue | MKTED2140201EN |
| The essential guide: Preventa machine safety | DIA4ED2041204EN |
| ATV32 - Safety integrated functions manual | S1A45606 |
| Magelis GTO, User Manual | EIO0000001133 (ENG) |
| Magelis XBT GC/XBT GK/XBTGT, SoMachine - Combo and Network Drivers | EIO00000000219 (ENG) |
| Control and signaling components | MKTED208031EN |
| Modicon LMC078 Motion Controller, Hardware Guide | EIO0000001925 |
| Modicon LMC078 Motion Controller, Programming Guide | EIO0000001909 |
| Modicon LMC078 Motion Controller, PLCSystem Library Guide | EIO0000001917 |
| Modicon LMC078 Motion Controller, Communication Modules, Hardware Guide | EIO0000001933 |
| ConneXium Ethernet Switches, TCSESU0••F•N0, Quick Reference Guide | 31007950 |
| Modicon TM5 Sercos III, Interface, Hardware Guide | EIO0000001941 |
| Modicon TM5, Expansion Modules Configuration, Programming Guide | EIO0000000420 (ENG) |
| Modicon TM5, Digital I/O Modules, Hardware Guide | EIO0000000444 (ENG) |
| Modicon TM5, Analog I/O Modules, Hardware Guide | EIO0000000450 (ENG) |
| Modicon TM5 - Transmitter and Receiver Modules, Hardware Guide | EIO0000000468 |
| Modicon TM5 / TM7 Flexible System, System Planning and Installation Guide | EIO0000000426 (ENG) |
| Modicon TM7, Digital I/O Blocks, Hardware Guide | EIO0000000703 |
| TeSys U LULC08 CANopen, Communication Module, User's Manual | 1744084 (ENG) |
| TeSys U, Starter-controllers, Catalogue | DIA1ED2081003EN |
| Altivar 32, Variable speed drives for synchronous and asynchronous motors, Installation manual | S1A28686 (ENG) |
| Altivar 32, Variable speed drives for synchronous and asynchronous motors, Programming manual | S1A28692 (ENG) |

| Title of Documentation | Reference Number |
|---|---|
| BMH, Servo motor, Motor manual | 0198441113749 (ENG) |
| BSH, Servo motor, Motor manual | 0198441113837 (ENG) |
| LXM32iCAN BMi, Lexium 32 Integrated, Product manual | 0198441113950 (ENG) |
| LXM32S, AC servo drive, Product manual | 0198441114060 (ENG) |
| Electromechanical and solid-state relays, Zelio relay, Catalog | DIA5ED2120404EN |
| Detection for automation solutions OsiSense | MKTED210041EN |
| OsiSense XCC, Rotary Encoders, Catalog | 9006CT1101 |
| The essential guide of Detection | DIA4ED2041203EN |
| Transparent Ready, User Guide | 31006929 |
| Modbus Serial Line, Planning and Installation Guide | 33003925 |
| SoMachine Programming Guide | EIO0000000067 (ENG) |

You can download these technical publications and other technical information from our website at http://download.schneider-electric.com

## Product Related Information

**⚠⚠ DANGER**

**HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH**

- Disconnect all power from all equipment including connected devices prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires except under the specific conditions specified in the appropriate hardware guide for this equipment.
- Always use a properly rated voltage sensing device to confirm the power is off where and when indicated.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

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

This equipment has been designed to operate outside of any hazardous location. Only install this equipment in zones known to be free of a hazardous atmosphere.

**⚠ DANGER**

**POTENTIAL FOR EXPLOSION**

Install and use this equipment in non-hazardous locations only.

**Failure to follow these instructions will 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 control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines.[1]
- Each implementation of this equipment must be individually and thoroughly tested for proper operation before being placed into service.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

[1] For 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" or their equivalent governing your particular location.

## ⚠ WARNING

**UNINTENDED EQUIPMENT OPERATION**

- Only use software approved by Schneider Electric for use with this equipment.
- Update your application program every time you change the physical hardware configuration.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

### Terminology Derived From Standards

The technical terms, terminology, symbols and the corresponding descriptions in this manual, or that appear in or on the products themselves, are generally derived from the terms or definitions of international standards.

In the area of functional safety systems, drives and general automation, this may include, but is not limited to, terms such as *safety*, *safety function*, *safe state*, *fault*, *fault reset*, *malfunction*, *failure*, *error*, *error message*, *dangerous*, etc.

Among others, these standards include:

| Standard | Description |
|---|---|
| EN 61131-2:2007 | Programmable controllers, part 2: Equipment requirements and tests. |
| ISO 13849-1:2008 | Safety of machinery: Safety related parts of control systems. General principles for design. |

| Standard | Description |
|---|---|
| EN 61496-1:2013 | Safety of machinery: Electro-sensitive protective equipment.<br>Part 1: General requirements and tests. |
| ISO 12100:2010 | Safety of machinery - General principles for design - Risk assessment and risk reduction |
| EN 60204-1:2006 | Safety of machinery - Electrical equipment of machines - Part 1: General requirements |
| EN 1088:2008<br>ISO 14119:2013 | Safety of machinery - Interlocking devices associated with guards - Principles for design and selection |
| ISO 13850:2006 | Safety of machinery - Emergency stop - Principles for design |
| EN/IEC 62061:2005 | Safety of machinery - Functional safety of safety-related electrical, electronic, and electronic programmable control systems |
| IEC 61508-1:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems: General requirements. |
| IEC 61508-2:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems: Requirements for electrical/electronic/programmable electronic safety-related systems. |
| IEC 61508-3:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems: Software requirements. |
| IEC 61784-3:2008 | Digital data communication for measurement and control: Functional safety field buses. |
| 2006/42/EC | Machinery Directive |
| 2014/30/EU | Electromagnetic Compatibility Directive |
| 2014/35/EU | Low Voltage Directive |

In addition, terms used in the present document may tangentially be used as they are derived from other standards such as:

| Standard | Description |
|---|---|
| IEC 60034 series | Rotating electrical machines |
| IEC 61800 series | Adjustable speed electrical power drive systems |
| IEC 61158 series | Digital data communications for measurement and control – Fieldbus for use in industrial control systems |

Finally, the term *zone of operation* may be used in conjunction with the description of specific hazards, and is defined as it is for a *hazard zone* or *danger zone* in the *Machinery Directive* (*2006/42/EC*) and *ISO 12100:2010*.

**NOTE:** The aforementioned standards may or may not apply to the specific products cited in the present documentation. For more information concerning the individual standards applicable to the products described herein, see the characteristics tables for those product references.

# Chapter 1
# General Information

## What Is in This Chapter?

This chapter contains the following topics:

# Introduction

## Overview

With **Tested Validated Documented Architectures** (TVDAs), Schneider Electric provides complete controlling system proposals applicable for a wide range of applications.

TVDAs are meant to help you to

- quickly find cost efficient controlling solutions,
- optimize the system implementation time,
- gain a competitive advantage and optimize overall costs for your machine.

With detailed component lists, wiring diagrams, commissioning guides, controller, and HMI applications the effort to assemble and setup the system becomes significantly reduced.

For a high level of reliability and robustness each TVDA is subjected to extensive system validation. Specific performance requirements as well as installation constraints are considered in the system design.

TVDAs provide a high level of openness for adaptations. With a clear separated project template structure and dedicated functions embedded in SoMachine and SoMachine Basic, required modifications can be realized quickly.

**⚠ WARNING**

**UNINTENDED EQUIPMENT OPERATION**

Thoroughly read and understand any and all device manuals for the characteristics and properties of the devices employed before attempting to modify parameters that may alter those characteristics and properties.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

# Deliverables

## SoMachine Project Template

The SoMachine Project Template is comprised of a ready-to-use controller project covering the complete system configuration. Within the project template, you can find preconfigured application code to operate field devices, to monitor the system status, and to handle errors that are detected.

## HMI Application

The HMI application is a ready-to-use interface that can:

- Control the main functionalities of the system
- Indicate the system status
- Visualize the system errors that are detected

## System User Guide (SUG)

The System User Guide provides:

- System documentation with a focus on installation, commissioning, and adaptation of the system
- Bill of Material (BOM), including power distribution components
- Detailed installation information for each component
- Guidance on how to commission the complete system
- Introduction of available ranges and key features of each component used within the architecture
- Guidance on how to adapt the system efficiently by making use of dedicated functions provided within SoMachine software

## Wiring Diagram

The wiring diagrams provide detailed guidance on the system wiring, and are reusable as a base to generate final technical documentation of the controlling system.

The wiring diagrams are provided for download on the Schneider Electric web page *www.schneider-electric.com* and are available in the following file formats:

- EPLAN Electric P8 V2.4 project archive
- **.pdf* (generated with EPLAN)
- **.dwg* (generated with EPLAN)

# Chapter 2
# System Architecture

## What Is in This Chapter?

This chapter contains the following topics:

## Architecture Related Safety Information

### Remote Devices

Remote control operating devices may lead to unintended equipment operation by:

- incorrect operation
- insufficient view on the machine during operation
- unintentional manipulation

Care must be taken and provisions made for use of this product as a control device to avoid inadvertent consequences of commanded machine operation, controller state changes, or alteration of data memory or machine operating parameters.

**⚠ WARNING**

**UNINTENDED EQUIPMENT OPERATION**

- Place operator devices of the control system near the machine or in a place where you have full view of the machine.
- Protect operator commands against unauthorized access.
- If remote control is a necessary design aspect of the application, ensure that there is a local, competent, and qualified observer present when operating from a remote location.
- Configure and install the Run/Stop input for the application so that local control over the starting or stopping of the controller can be maintained regardless of the remote commands sent to the controller.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

### Wireless Devices

Data transmission between wireless devices can be influenced by environmental conditions. Especially for portable devices, such as wireless and batteryless push-buttons, the quality of the wireless communication is changing depending on the position of the device to the receiver.

**⚠ WARNING**

**LOSS OF CONTROL**

- Do not use wireless equipment as the only means of control for critical control functions such as motor start/stop or power disconnect.
- Provide separate or redundant control paths for critical control functions.
- Provide a means to achieve a safe state during and after a path failure for critical control functions such as emergency stop and overtravel stop.
- Improve the reliability of the wireless network by the use of repeater(s).

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

## Communication

Fieldbusses or network communication may lead to loss of control by:

- Communication disturbance by external influences (for example wiring or EMC)
- Delay during communication
- Interruption of communication
- Inaccurate communication

**⚠ WARNING**

**LOSS OF CONTROL**

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

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

[1] For 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" or their equivalent governing your particular location.

# System Architecture

## Overview

The architecture is arranged into the upper performance class and is distinguished by the following characteristics:

- Modicon LMC078 Motion Controller
- Magelis touch-panel HMI GTO 5310
- Energy metering
- CANopen fieldbus with 4 nodes
- Sercos motion bus with 7 nodes
- Modbus serial line communication
- Ethernet connectivity
- Application of machine safety
- 44 digital inputs (12 local and 32 distributed)
- 40 digital outputs (8 local and 32 distributed)
- 4 analog inputs (distributed)
- 4 analog outputs (distributed)
- 1 motion encoder

The following devices are linked to the CANopen fieldbus and are controlled and monitored by the controller:

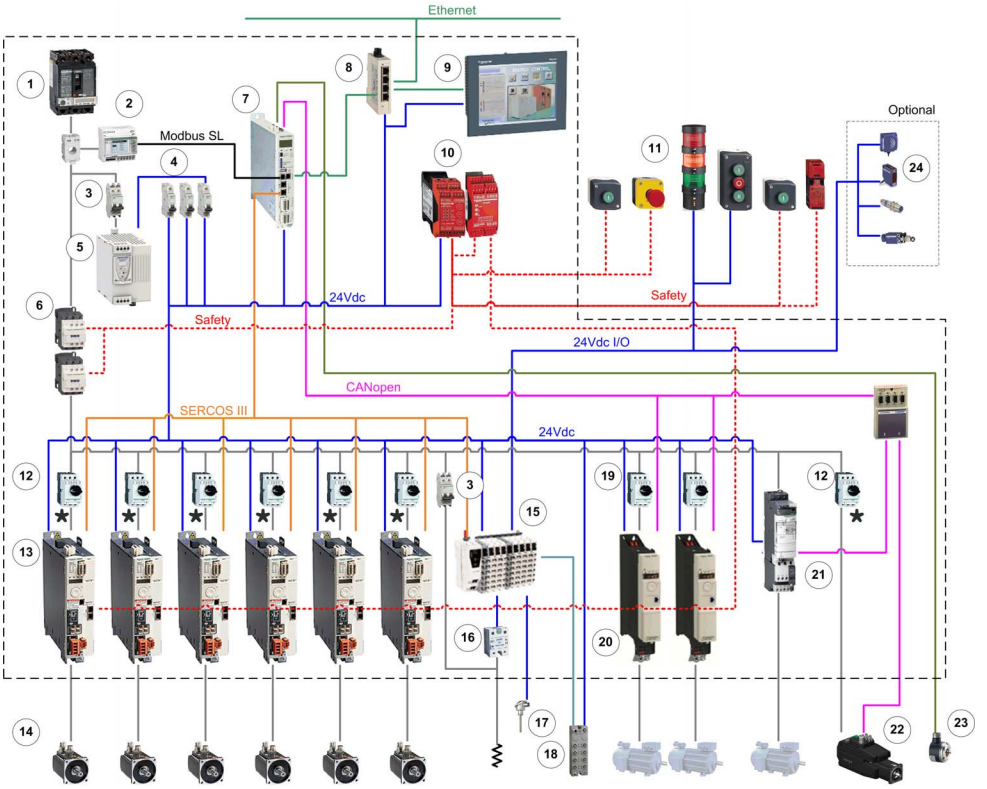
- 4 coordinated drives:
  - 2 Altivar 32
  - 1 TeSys U
  - 1 Lexium 32i

The following devices are linked to the Sercos motion bus and are controlled and monitored by the controller:

- 6 synchronized drives of type Lexium 32S
- 1 distributed TM5 I/O island
  - 1 distributed TM7 IP 67 I/O block linked to the TM5 I/O island via the TM7 I/O bus

## Layout

### Main cabinet H1




| | | | |
|---|---|---|---|
| 1 | PowerPact H-Frame circuit breaker | 13 | Lexium 32S servo drive |
| 2 | Power Meter PM3250 + 3 current transformers | 14 | Servo motor BSH |
| 3 | Multi9 circuit-breaker C60N (UL489) | 15 | TM5 I/O Island |
| 4 | Multi9 circuit-breaker C60N (UL1077) | 16 | Solid state relays - heating control |
| 5 | Phaseo power supply ABL8 | 17 | Temperature sensor |
| 6 | TeSysD Contactor | 18 | TM7 I/O block IP67 |
| 7 | Modicon LMC078 Motion Controller | 19 | TeSys motor circuit-breaker GV2P |
| 8 | ConneXium Ethernet switch unmanaged | 20 | Altivar 32 variable speed drive |

*Conformance to UL standards requires that fuses are used for the branch circuit protection in place of the motor circuit breakers depicted above in front of the Lexium servo drives. For more information, refer to LXM32S, AC servo drive, Product manual 0198441114060 (ENG).

| | | | |
|---|---|---|---|
| 9 | Magelis touch panel HMI GTO | 21 | TeSys U motor starter controller |
| 10 | Preventa safety controller + expansion module | 22 | Lexium 32i integrated servo drive |
| 11 | Harmony signaling/control devices | 23 | Incremental encoder (5V-RS422 / 500-8000 inc) |
| 12 | TeSys motor circuit-breaker GV2L | 24 | Optional sensors |
| *Conformance to UL standards requires that fuses are used for the branch circuit protection in place of the motor circuit breakers depicted above in front of the Lexium servo drives. For more information, refer to LXM32S, AC servo drive, Product manual 0198441114060 (ENG). | | | |

# Chapter 3
# Safety & Safety Requirements

## What Is in This Chapter?

This chapter contains the following topics:

# Safety Evolution Structure for the System User Guides

## Overview

1. Evolution of legal framework *(see page 29)*
2. Risk assessment *(see page 32)*
3. Functional safety standards overview *(see page 36)*
4. Standard EN ISO 13849-1 machinery safety *(see page 37)*
5. Standard EN/IEC 62061 machinery safety *(see page 45)*
6. Selecting the applicable standard *(see page 52)*
7. Where to get more information regarding safety *(see page 53)*
   a. Safety guide
   b. Sistema
   c. Sistema library
8. Concept used on specific TVDA

# Evolution of Legal Framework

## EC Directive

Legal instrument to harmonize the legislation of the European member states

- Defines the essential health and safety requirements (EHSRs).
- Transposed into national law (act, decree, order, regulations).

## Standard

A standard is a technical specification approved by a recognized standardization body for repeated or continuous application, with which compliance is not compulsory.

## Harmonized Standard

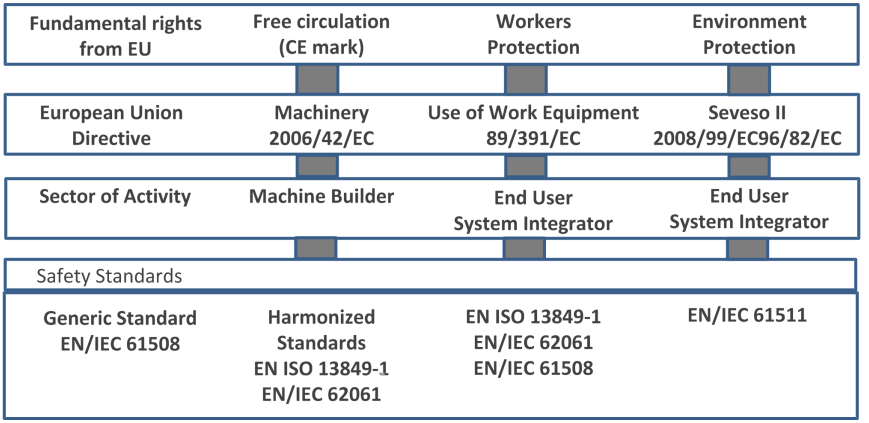
A standard becomes harmonized when published throughout the member states.

## Presumption of Conformity

- When a product conforms to a harmonized European standard, the reference to which has been published in the official journal of the European Union for a specific directive, and which covers one or more of the essential safety requirements, the product is presumed to comply with those essential safety requirements of the directive.
- In many cases European standards (ENs) are technically similar to international (IEC or ISO) standards. However only European standards include a list of which EHSRs are covered, so only European standards can confer a presumption of conformity.

## European Directives and Safety Standards

Link between some of the main safety standards and the European directives according with the sectors of activity.



A list of such standards can be accessed at:

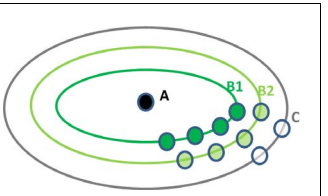
*http://www.newapproach.org/Directives/DirectiveList.asp*

## A, B and C Standards

When a type C standard deviates from one or more provisions dealt with by a type A standard or by a type B standard, the type C standard takes precedence. EN ISO 12100 is type A standards.

European standards for the machinery safety form the following structure:

| |
|---|
| **Type A standards**<br>Basic safety standards giving basic concepts, principles for design, and general aspects that can be applied to all machinery. |
| **Type B standards**<br>Generic safety standards dealing with one safety aspect or one type of safeguard that can be used across a wide range of machinery:<br>● Type B1 standards on particular safety aspects (for example, safety distances, surface temperature, noise)<br>● Type B2 standards on safeguards (for example, two-hand controls, interlocking devices, pressure sensitive devices, guards) |
| **Type C standards**<br>Machine safety standards dealing with detailed safety requirements for a particular machine or group of machines. |




Some examples of these types of standards are:

| Name | Type | Description |
|---|---|---|
| EN ISO 12100 | A | 2010 Safety of machinery - General principles for design - Risk assessment and risk reduction |
| EN ISO 13850 | B | Emergency stop - Principles for design |
| EN/IEC 62061 | B | Functional safety of safety-related electrical, electronic, and electronic programmable control systems |
| EN ISO 13849-1 | B | Safety of machinery - safety-related parts of control systems - Part 1 general principles for design |
| EN 349 | B | Minimum gaps to avoid crushing of parts of the human body |
| EN ISO 13857 | B | Safety of machinery - safety distances to prevent hazard zones being reached by upper and lower limbs |
| EN 60204-1 | B | Safety of machinery - Electrical equipment of machines - Part 1: General requirements |
| EN 1088/ISO 14119 | B | Interlocking devices associated with guards - Principles for design and selection |

## Manufacturers' Responsibilities

Manufacturers placing machines on the market within the European Economic Area (EEA) must comply with the requirements of the machinery directive. Note that "placing on the market" includes an organization supplying a machine to itself, that is, building or modifying machines for its own use, or importing machines into the EEA.

## Users' Responsibilities

Users of machines need to ensure that newly purchased machines are CE marked, and accompanied by a declaration of conformity to the machinery directive. Machines must be used in accordance with the manufacturer's instructions.

Existing machines taken into service before the machinery directive came into force do not need to comply, although they need to comply with the regulations resulting from the use of work equipment directive and be safe and fit for purpose.

Modification of machines can be considered as manufacture of a new machine, even if for use in-house, and the company modifying a machine needs to be aware that it might need to issue a declaration of conformity and CE marking.

# Risk Assessment

## European Legislation

Machines are sources of potential risk and the machinery directive requires a risk assessment to ensure that any potential risk is reduced to less than the acceptable risk.

Standard EN/ISO 12100 defines risk as follows: risk is the severity multiplied by the possibility of occurrence. It defines an iterative process for achieving machine safety, which states that the risks for each potential hazard can be determined in 4 stages.

1. Risk assessment
2. Determination of machine limits
3. Identification of the potential hazard
4. Risk evaluation

This method provides the basis for the requisite risk reduction.

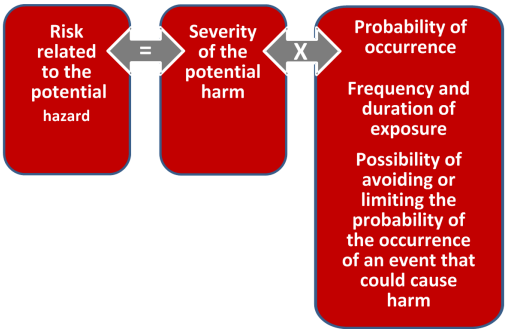
## Risk Assessment

Risk assessment consists of a series of logic steps which make it possible to analyze and evaluate machinery-related risks systematically.

Risk assessment is followed, whenever necessary, by a reduction of the risk.

This definition taken from standard EN/ISO 12100 is based on an iterative process represented in the diagram opposite.

Definition of risk




## Determination of Machine Limits

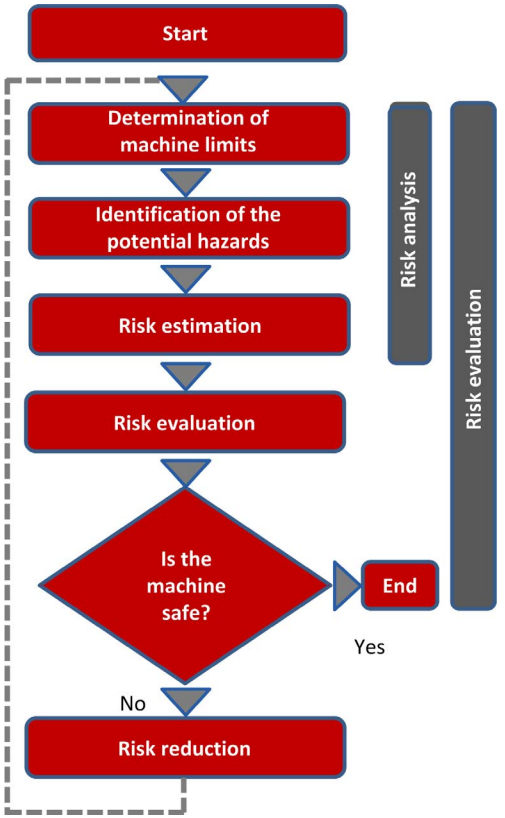
Risk assessment starts by determining the limits of the machine at all stages of its life cycle:

- Transport, assembly, installation
- Commissioning
- Use
- De-commissioning, dismantling

The use limitations must then be specified:

- Operating modes
- Level of training required
- Space limits (amplitude, movement...)
- Time limits (life cycle, frequency of maintenance...)

Logic steps for risk analysis




## Identification of the Potential Hazard

If a potential hazard exists, a hazardous phenomenon will cause harm if measures are not taken. All the tasks associated with the life cycle of a machine must be identified, such as:

- Assembly, transport, and installation
- Adjustment, testing
- Learning, programming
- Tool changing
- Feeding, removal of product from the machine

- Starting, stopping
- Emergency stops, restarting after an unexpected stop
- Maintenance, cleaning, and so on.

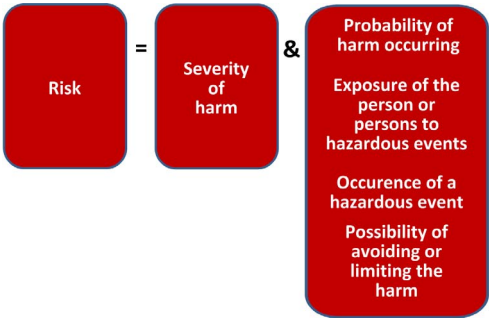
The risk is a function of the severity of the harm and the probability that this harm will occur. The severity of the harm takes into account:

- The severity of injuries (slight, serious, death)
- The extent of the harm (number of persons)

The probability of the harm occurring takes into account:

- Exposure to the hazard (nature of access, time spent in the hazardous zone, number of persons exposed, frequency of access)
- The occurrence of a hazardous event (accident history, comparison of risks, ...)
- The possibility of avoiding or limiting the harm (experience, awareness of the risk, ...)

Elements of the risk




## Risk Evaluation

Based on the risk assessment, the designer has to define the safety-related control system. To achieve that, the designer will choose one of the 2 standards appropriate to the application:

- either standard EN ISO 13849-1, which defines performance levels (PL)
- or standard EN/IEC 62061, which defines safety integrity level (SIL)

## Risk Reduction

The process of risk reduction for dangerous events starts by:

- intrinsic prevention (inherently safe design)
- definition of the appropriate protective means (guards, carters, fix fences, ...)
- personnel training

If the selected preventive measure depends on a safety-related control system, the designer has to perform an iterative process for the design of the safety relative control system. The first stage is to define the necessary safety-related control functions:

- either through the choice of components
- or by adapting the control system architecture. Redundancy (double circuit components), for example, significantly increases the reliability of the solution

Once the limits of available technologies have been reached; it will not be possible to further reduce the rate of dangerous failures. To achieve the required level of safety, it will be necessary to use a diagnostic system that allows dangerous failures to be detected.

# Functional Safety Standards

## Overview

The functional safety standards are intended to encourage designers to focus more on the functions that are necessary to reduce each individual risk, and on the performance required for each function, rather than simply relying on particular components. These standards make it possible to achieve greater levels of safety throughout the life of a machine.

- Under the previous standard, EN 954-1, categories (B, 1, 2, 3 and 4) dictated how a safety-related electrical control circuit must behave under fault conditions. Designers can follow either EN ISO 13849-1 or EN/IEC 62061 to demonstrate conformity with the machinery directive. These 2 standards consider not only whether a fault will occur, but also how likely it is to occur.
- This means that there is a quantifiable, probabilistic element in compliance: machine builders must be able to determine whether their safety circuit meets the required safety integrity level (SIL) or performance level (PL). Panel builders and designers should be aware that manufacturers of the components used in safety circuits (such as safety detection components, safety logic solvers, and output devices like contactors) must provide detailed data on their products.

# Standard EN ISO 13849-1 Machinery Safety - Safety-Related Parts of Control System

## Overview

Standard EN ISO 13849-1 is an evolution of standard EN 954-1.

## Field of Application of the Standard

This standard gives safety requirements and advice relating to principles for the design and integration of safety-related parts of control systems (SRP/CS), including software design.

For these parts, it specifies the characteristics, including the performance level, needed to achieve these safety functions. It applies to the SRP/CS of all types of machine, regardless of the technology and type of energy used (electric, hydraulic, pneumatic, mechanical, and so on).

## Process

The risk assessment leads to decisions on risk reduction measures.

It defines a 6-stage design process:

1. Selection of the essential safety functions that SRP/CS must perform. For each safety function, specify the required characteristics.
2. Determine the required performance level (PLr).
3. Design and technical creation of safety functions: identify the parts that perform the safety function.
4. Evaluate the performance level PL for each safety-related part.
5. Check that the performance level PL achieved is greater than or equal to the required level (PLr).
6. Check that all requirements are satisfied.

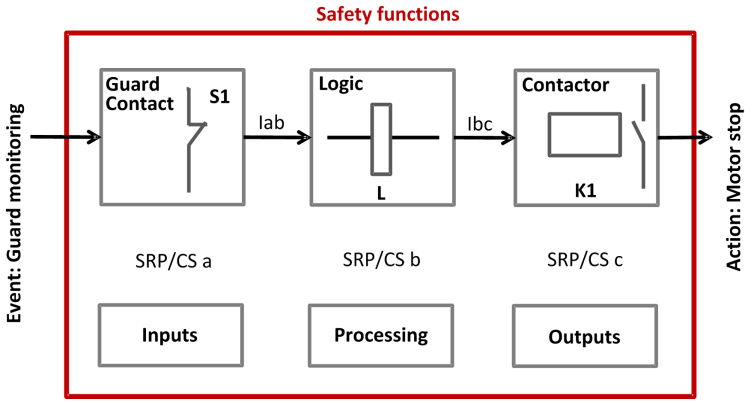
The above 6 stages will be illustrated taking as an example a safety function where a severe injury can be caused by a horizontal movement on a machine not stopping where an operator maybe exposed to this dangerous situation. The machine is sometimes accessed by production workers and monitored during operation.

## Stage 1 - Selection of Safety Functions

The diagram below shows a safety function which consists of several parts:

- The input actuated by opening of the guard (SRP/CSa)
- The control logic, limited in this example to opening or closing of a contactor coil (SRP/CSb)
- The power output that controls the motor (SRP/CSc)
- The connections (Iab, Ibc)

Representation of the safety function




## Stage 2 - Estimation of Required Performance Level (PLr)

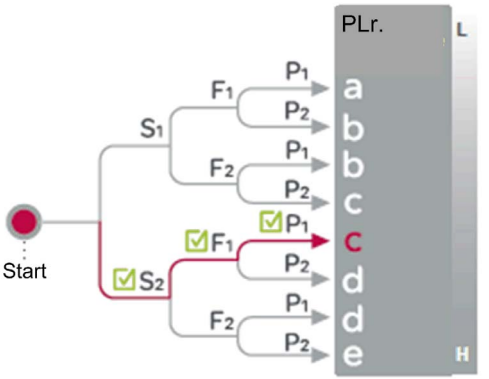
Considering the example of the person coming into area where the machine is operating, the risk is estimated using the risk graph.

The parameters to be considered are:

**S**: Severity of the injury
- **S1**: Slight injury, normally reversible
- **S2**: Serious, normally irreversible, including death

**F**: Frequency and/or duration of exposure to the hazardous phenomenon
- **F1**: Rare to fairly frequent and/or short duration of exposure
- **F2**: Frequent to permanent and/or long duration of exposure

**P**: Possibility of avoiding the hazardous phenomena or limiting the harm
- **P1**: Possible under certain circumstances
- **P2**: Virtually impossible




**Start** Starting point for the evaluation
**PLr** Required performance level
**L** Low contribution to risk reduction
**H** High contribution to risk reduction

For the example: a serious injury **S2** can be caused by being exposed near the machine as if there is no safe guarding to ensure that the movement will stop the horizontal movement with a load may continue until collision.

After considering the severity of the injury investigate the frequency and/or duration of the possible entry to the dangerous area. Here you define the frequency of exposure to the hazard is low **F1** (occasional presence).

The last step is based upon the possibility to avoid the hazard and limiting the harm. To evaluate this, take into consideration that it is possible to avoid the harm as the visibility around the dangerous machine is monitored by the operator and in this case there is a possibility to avoid the harm under certain conditions so define it as **P1**.

The result of the estimation gives a required performance level **PLr = c**.

## Stage 3 - Design and Creation of the Safety Functions

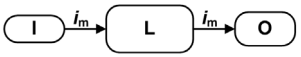
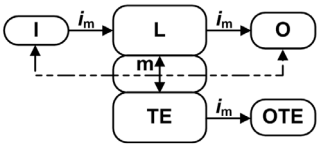
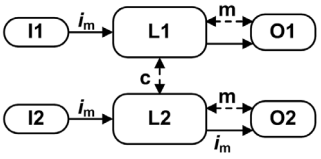
There is a need to describe the PL (performance level) calculation method.

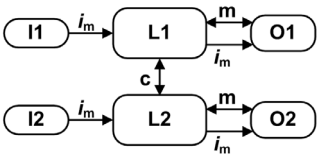
For a SRP/CS (or a combination of SRP/CS), PL could be estimated with the figure after estimation of several factors such as:

- Hardware and software system structure (categories)
- Mechanism of failures, diagnostic coverage (DC)
- Components reliability, mean time to dangerous failure ($MTTF_d$)
- Common cause failure (CCF)

### Categories (Cat.) and designated architectures

Summarized system behavior in the event of a failure and the principles used to achieve the safety, for the 5 categories defined.

| Category | System Behavior | Designated Architecture |
|---|---|---|
| B | A fault can lead to loss of the safety function. |  |
| 1 | As for category B but the probability of this occurrence is lower than for the category B. | |
| 2 | A fault can lead to loss of the safety function between 2 periodic inspections and loss of the safety function is detected by the control system at the next test. |  |
| 3 | For a single fault, the safety function is always ensured. Only some faults will be detected. The accumulation of undetected faults can lead to loss of the safety function. |  |

| Category | System Behavior | Designated Architecture |
|---|---|---|
| 4 | When faults occur, the safety function is always ensured. Faults will be detected in time to prevent loss of the safety function. |  |



**Im** Interconnecting means
**C** Cross monitoring
**I, I1, I2** Input device, for example sensor
**L, L1, L2** Logic
**m** Monitoring
**O, O1, O2** Output device, for example main contactor
**TE** Test equipment
**OTE** Output of TE

### $MTTF_d$ (mean time to dangerous failure)

The value of the $MTTF_d$ of each channel is given in 3 levels (see table below) and shall be taken into account for each channel (for example, single channel, each channel of a redundant system) individually.

Reliability levels of components

| Index | Range |
|---|---|
| Low | 3 years ≤ $MTTF_d$ < 10 years |
| Medium | 10 years ≤ $MTTF_d$ < 30 years |
| High | 30 years ≤ $MTTF_d$ < 100 years |

A $MTTF_d$ of less than 3 years should never be found, because this would mean that after 1 year in operation, 30% of all those components in use would have failed to a dangerous state. The maximum value is limited to 100 years because devices dealing with a significant risk should not depend on the reliability of a single component. Additional measures such as redundancy and tests are required.

### Diagnostic coverage (DC)

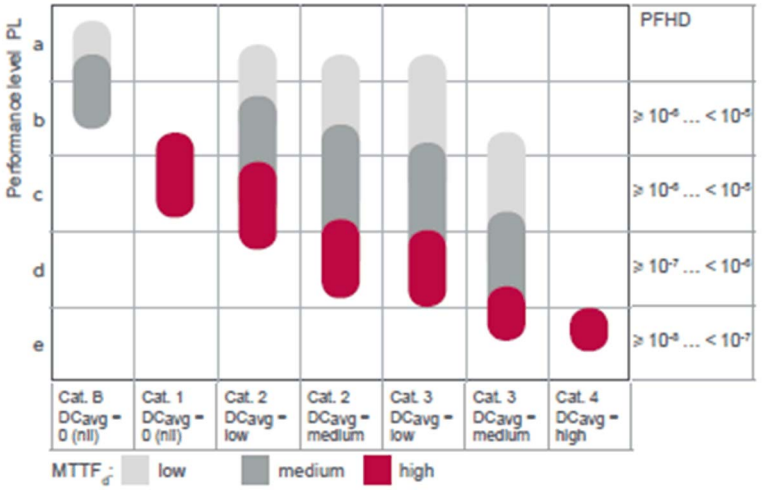
This term is expressed as a percentage and quantifies the ability to diagnose a dangerous failure.

For example, in the event of welding of a N/C contact in a relay, the state of the N/O contact could incorrectly indicate the opening of the circuit, unless the relay has mechanically linked N/O and N/C contacts, when the fault can be detected.

The standard recognizes 4 levels:

| Denotation | Range |
|---|---|
| Nil | DC < 60% |
| Low | 60% ≤ DC <90% |
| Medium | 90% ≤ DC < 99% |
| High | 99% ≤ DC |

The relationship between categories, DC and $MTTF_d$ of each channel and PL.

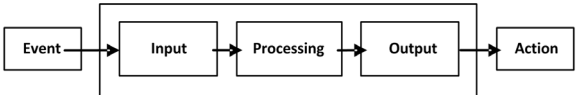



Using the above chart you can now select the most appropriate architecture, the required diagnostic coverage as well as ensure the products selected have the right $MTTF_d$ values.

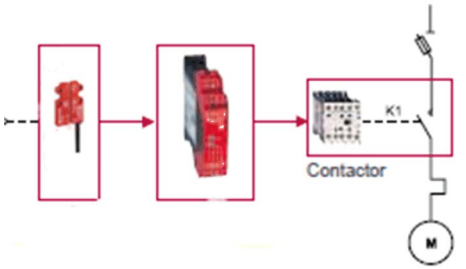
As the example requires PL=c the chart states as a minimum a category 1 architecture with a diagnostic coverage of 0 (Nil) and a $MTTF_d$ of high is required.

It is possible to use architectures with higher categories to solve the safety function needs.

You start with determining the architecture required to solve the function. Use the following category 1 architecture:

| Category | System Behavior | Designated Architecture |
|---|---|---|
| 1 | As for category B but the probability of this occurrence is lower than for the category B. |  |

Knowing the architecture it is now possible to select the most appropriate products. Using the offer catalogs you define the products as illustrated below.




The selection of the right products may take several iterations as it is only possible to ensure that the right products are selected after calculations have been made.

## Stage 4 - Evaluate the Performance Level (PL) for Each Safety-Related Part

Typically the data needed for the calculation of the performance level is being provided by the components supplier.

For safety processing devices the $MTTF_d$, DC and performance level values are provided.

For other non-safety components such as contactors, limit switches, and so on, which wear primary as a result of their mechanical actuation, B10d values are provided by the supplier in some cases. When the B10d values are not available, the annex C from the 13849-1 standard can be used.

| Example | $B_{10d}$ (Where 10% of the Population Fail to Dangerous Failure Mode) | $MTTF_d$ | DC |
|---|---|---|---|
| $SRP/CS_a$: Magnetic switch | 50000000 | 1578.28 | - |
| $SRP/CS_b$: XPS AXE safety module | - | 457 | 99.99% |
| $SRP/CS_c$: TeSys contactor | 1369863 | 194 | 99% |

To estimate the performance level of a safety function, the condition is that the $MTTF_d$, the DC, and the category from each component are known. The procedure to follow:

- Calculation of $MTTF_d$ and DC of the complete system
- Analysis of the category

For electromechanical products:

- The $MTTF_d$ is calculated based on the total number of operations that the product can perform, using $B_{10d}$ values.

In this case, the machine operates for 220 days per year, 8 hours per day with a cycle of 90 s

- N = 220 x 8 x (3600 / 90) = 70,400 operations/year
- $MTTF_d = B_{10d} / (0.1 \times N)$

For the magnetic switch:

- The $MTTF_d$= 1578 years

For the contactors:

- The $MTTF_d$ = (1,369,863) / (0.1) x 70,400 = 194 yearsThe $MTTF_d$ for each channel will then be calculated using the formula:

$$\frac{1}{MTTFd} = \frac{1}{MTTFda} + \frac{1}{MTTFdb} + \frac{1}{MTTFdc}$$ that is, 284 years

A similar formular is used to calculate the diagnostic capability:

$$DCavg = \frac{\frac{DCa}{MTTFda} + \frac{DCb}{MTTFdb} + \frac{DCc}{MTTFdc}}{\frac{1}{MTTFda} + \frac{1}{MTTFdb} + \frac{1}{MTTFdc}}$$

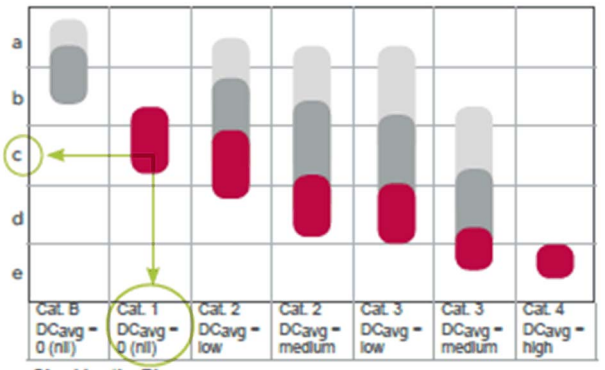
The DC in the example is < 60%, for example nil.

## Stage 5 - Checking That Required Performance Level Is Achieved

The result of the above calculations is summarized below:

- An architecture: category 1
- A mean time to failure > 30 years:
  high $MTTF_d$ >> a diagnostic capability < 60% (nil)

Looking at this table, confirms that PL level c is achieved:




*Checking the PL*

### Stage 6 - Validation of the Required Performance Level

The design of SRP/CS must be validated and must show that the combination of SRP/CS performing each safety function satisfies all the applicable requirements of EN/ISO 13849.

# Standard EN/IEC 62061 Machinery Safety - Safety-Related Parts of Control System

## Overview

This standard is specific to the machine sector according to EN/IEC 61508. It gives rules for the integration of subsystems designed in accordance with EN/ISO 13849. It does not specify the operating requirements of non-electrical control components in machines (for example: hydraulic, pneumatic).

## Functional Approach to Safety

As with EN/ISO 13849-1, the process using the EN/IEC 62061 starts with analysis of the risks (EN/ISO 12100) in order to be able to determine the safety requirements.

A particular feature of this standard is that it prompts you to make a functional analysis of the architecture; then split it into subfunctions and analyze their interactions before deciding on a hardware solution for them (the SRECS).

A functional safety plan must be drawn up and documented for each design project. It must include a specification of the safety requirements for the safety functions (SRCF) that is in 2 parts:

- Description of the functions and interfaces, operating modes, function priorities, frequency of operation, and so on.
- Specification of the safety integrity requirements for each function, expressed in terms of SIL (safety integrity level).

The structured and documented design process for safety-related electrical control systems (SRECS):

- The procedures and resources for recording and maintaining appropriate information.
- The process for management and modification of the configuration, taking into account organization and authorized personnel.
- The verification and validation plan

The decisive advantage of this approach is that of being able to offer a failure calculation method that incorporates all the parameters that can affect the reliability of electrical systems, whatever the technology used.

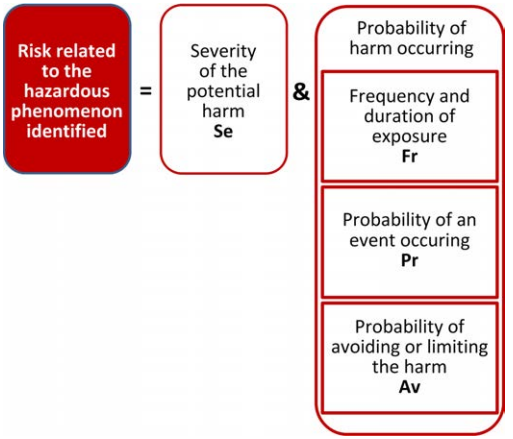
The method consists of assigning a SIL to each function, taking into account the following parameters:

1. The probability of a dangerous failure of the components ($PFH_d$)
2. The type of architecture; with or without redundancy, with or without diagnostic device making it possible to avoid some of the dangerous failures
3. Common cause failures (power cuts, overvoltage, loss of communication network, and so on) (CCF)
4. The probability of a dangerous transmission error where digital communication is used
5. Electromagnetic interference (EMC)

## Process

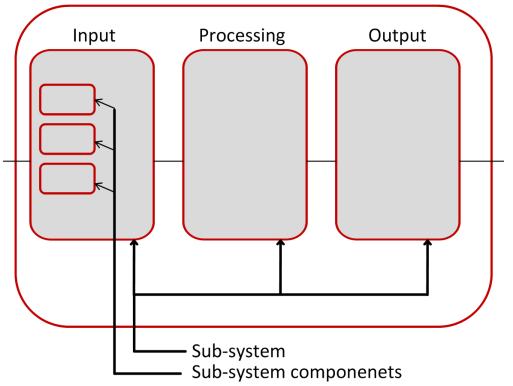
Designing a system is split into 5 stages after having drawn up the functional safety plan:

1. Based on the safety requirements specification (SRS), assign a safety integrity level (SIL) and identify the basic structure of the safety-related electrical control system (SRECS), describe each related function (SRCF)
2. Break down each function into a function block structure (FB)
3. List the safety requirements for each function block and assign the function blocks to the subsystems within the architecture
4. Select the components for each subsystem
5. Design the diagnostic function and check that the specified safety integrity level (SIL) is achieved



## Stage 1 - Assign a Safety Integrity Level (SIL) and Identify the Structure of the SRECS

Based on the risk assessment performed in accordance with standard EN/ISO 12100, estimation of the required SIL is performed for each hazardous phenomenon and is broken down into parameters, see illustration below.




### Severity Se

The severity of injuries or damage to health can be estimated by taking into account reversible injuries, irreversible injuries, and death.

| Consequence | Severity Se |
|---|---|
| Irreversible: death, loss of an eye or an arm | 4 |
| Irreversible: shattered limb, loss of a finger | 3 |
| Reversible: requires the attention of a medical practitioner | 2 |
| Reversible: requires first aid | 1 |

### Probability of the harm occurring

Each of the 3 parameters Fr, Pr, Av must be estimated separately using the most unfavorable case. It is strongly recommended that a task analysis model is used in order to ensure that estimation of the probability of the harm occurring is correctly taken into account.

### Frequency and duration of exposure Fr

The level of exposure is linked to the need to access the hazardous zone (normal operation, maintenance ...) and the type of access (manual feeding, adjustment...). It must then be possible to estimate the average frequency of exposure and its duration.

| Frequency of Dangerous Exposure | Fr |
|---|---|
| ≤ 1 hour | 5 |

| Frequency of Dangerous Exposure | Fr |
|---|---|
| > 1 hour...≤ 1 day | 4 |
| >1 day=< 2 weeks | 3 |
| 2 weeks ≤1 year | 2 |
| > 1 year | 1 |

### Probability of occurrence of a hazardous event Pr

2 basic concepts must be taken into account:

- The predictability of the dangerous components in the various parts of the machine in its various operating modes (normal, maintenance, troubleshooting), paying particular attention to unexpected restarting
- The behavior of the persons interacting with the machine, such as stress, fatigue, inexperience, and so on.

| Probability of Occurrence of a Dangerous Event | Pr |
|---|---|
| Very High | 5 |
| Probable | 4 |
| Possible | 3 |
| Almost impossible | 2 |
| Negligible | 1 |

### Probability of avoiding or limiting the harm Av

This parameter is linked to the design of the machine. It takes into account the suddenness of the occurrence of the hazardous event, the nature of the dangerous component (cutting, temperature, electrical) and the possibility for a person to identify a hazardous phenomenon.

| Probability of Avoiding or Limiting the Harm | Av |
|---|---|
| Impossible | 5 |
| Almost impossible | 3 |
| Probable | 1 |

### Assignment of the SIL

Estimation is made with the help of the table below. In the example, the degree of severity is 4 because there is a risk of death; this value is shown in the first column of the table.

All the other parameters must be added together in order to select one of the classes (vertical columns in the table below), which gives:

- Fr = 5; access between 1 hour and a day
- Pr = 2; low probability of occurrence of the hazardous event (for example, operator monitoring)
- Av = 3; probability of avoiding almost impossible

Therefore a class CI = 5 + 2 + 3 = 10

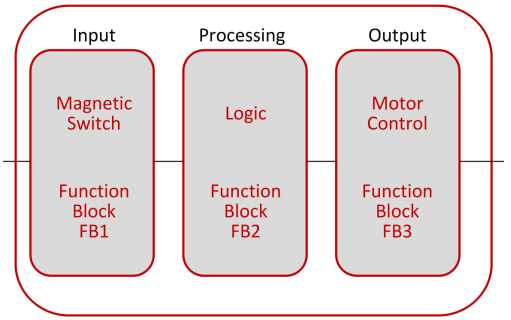
A level of SIL 2 must be achieved by the safety-related electrical control systems (SRECS) on the machine.

| Se | Class CI | | | | |
|---|---|---|---|---|---|
| | 3-4 | 5-7 | 8-10 | 11-13 | 14-15 |
| 4 | SIL 2 | SIL 2 | SIL 2 | SIL 3 | SIL 3 |
| 3 | - | - | SIL 1 | SIL 2 | SIL 3 |
| 2 | - | - | - | SIL 1 | SIL 2 |
| 1 | - | - | - | - | SIL 1 |

### Basic structure of the SRECS

Without going into detail about the hardware components to be used, the system is broken down into subsystems. In the example, you find the 3 subsystems that will perform the input, processing, and output functions.

The figure below illustrates this stage, using the terminology given in the standard.




## Stage 2 - Break down Each Function into a Function Block Structure (FB)

A function block (FB) is the result of a detailed breakdown of a safety-related function. The function block structure gives an initial concept of the SRECS architecture. The safety requirements of each block are deduced from the specification of the safety requirements of the system's function.

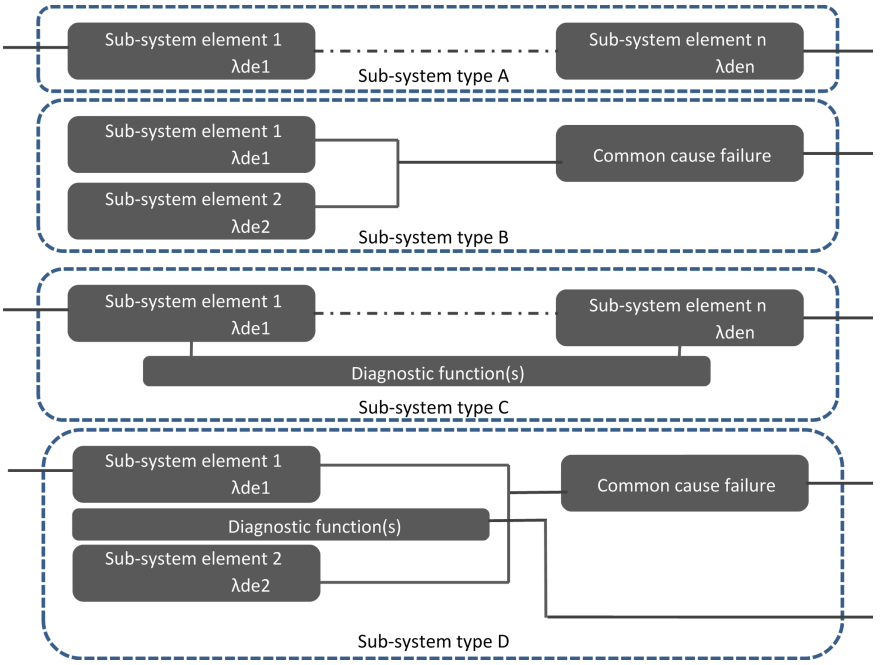
## Stage 3 - List the Safety Requirements for Each Function Block and Assign the Function Blocks to the Subsystems

Each function block is assigned to a subsystem in the SRECS architecture. A failure of any subsystem will lead to the failure of the safety-related control function.

More than one function block may be assigned to each subsystem. Each subsystem may include subsystem elements and, if necessary, diagnostic functions in order to ensure that anomalies can be detected and the appropriate action taken.

These diagnostic functions (D) are considered as separate functions; they may be performed within the subsystem, by another internal or external subsystem.

Types of subsystem architectures




## Stage 4 - Select the Components for Each Subsystem

As the safety integrity level required in the example mentioned above is SIL 2, each of the components must achieve this level.Once the targeted SIL is determined, the components constructing the system from safety-related subsystems (sensor/switch, logic, actuator) have to be selected. The components must have $PFH_d$ (probability of dangerous failure per hour) equal to the required SIL rating needed.

## Stage 5 - Design the Diagnostic Function

The SIL of the subsystem depends not only on the components, but also on the architecture selected. In EN 62061, a safety integrity requirement is expressed as a target failure value for the probability of dangerous failure per hour ($PFH_d$) of each safety-related control function (SRCF).

This can be calculated from reliability data for each component or subsystem, and is related to the SIL as shown in table 3 of the standard.

Relationship between SIL and $PFH_d$ values

| SIL | Probability of Dangerous Failures Per Hour ($PFH_d$) |
|---|---|
| 3 | $\geq 10^{-8} < 10^{-7}$ |
| 2 | $\geq 10^{-7} < 10^{-6}$ |
| 1 | $\geq 10^{-6} < 10^{-5}$ |

For each of the 4 logical architectures A to D presented above, there is a different formula to calculate the $PFH_d$. The calculation method is complex and will not be presented here (see EN/IEC 62061 for the formula and the parameters taken into account).

# Selecting the Applicable Standard

## Overview

In order to be able to select the applicable standard, a common table in both standards gives indications which are summarized below:

| Technology Used | EN ISO 13849-1 Maximum PL | EN/IEC 62061 Maximum SIL |
|---|---|---|
| Non-electric only, for example, hydraulic | e | Not covered |
| Including some electromechanical, example: relays, and/or complex electronics | e (for designated architectures only) | 3 |
| Including complex electronics, for example programmable | D | 3 |

Relationship between the performance level (PL) and the safety integrity level (SIL):

| PL | SIL | Probability of Dangerous Failures Per Hour (1/h) |
|---|---|---|
| a | No correspondence | $\geq 10^{-5} < 10^{-4}$ |
| b | 1 | $\geq 3x10^{-6} < 10^{-5}$ |
| c | 1 | $\geq 10^{-6} < 3x10^{-6}$ |
| d | 2 | $\geq 10^{-7} < 10^{-6}$ |
| e | 3 | $\geq 10^{-8} < 10^{-7}$ |

# More Information Regarding Safety

## Overview

To know more about the relevant regulations, take a look to the safety guide:


*http://www.schneider-electric.com/download/ww/en/details/10101698-Machine-safety-guide/?reference=DIA4ED1100102EN*

## Sistema

For support in creating the safety-related calculations in accordance to EN ISO 13849-1, refer to the free software as well as the related Schneider Electric Sistema offer library.

Sistema:

*http://www.dguv.de/bgia/en/pra/softwa/sistema/index.jsp*

Sistema library:

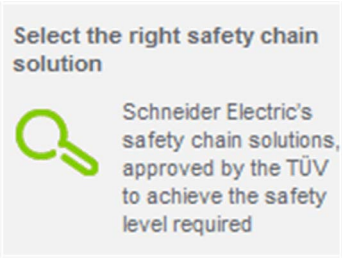
*http://www2.schneider-electric.com/documents/original-equipment-manufacturers/SCHNEIDER-ELECTRIC-SAFETY-EN_2012_09.zip*

## Safety Chain Solutions

Schneider Electric offers a library of certified safety chain solutions.

Safety chain solutions provide you with a complete document explaining the concept, the used cases, the architecture, wiring diagram as well the complete calculation.

Each of the safety chain solutions is certified by TÜV enabling you to reuse the architectures for your machine and reusing the Sistema calculations as well as the documentation to help certify the machine to the European legislation.




To find more information regarding the safety chain solutions:

*http://www2.schneider-electric.com/sites/corporate/en/solutions/oem/machine-safety/safety-selector.page*

Using the safety chain solutions provided by Schneider Electric to solve the existing architecture:

| Step | Action | Comment |
|---|---|---|
| 1 | Perform a risk assessment of your machine. | A required performance level (**PLr**) must be specified for each intended safety function following a risk assessment in accordance to the standard EN ISO 12100. |
| 2 | Use the **Safety Chain Selector*** to find the most appropriated pre-certified architecture. | By answering the questions the most appropriated architectures will be proposed by the tool. |
| 3 | Adapt the proposed architecture to meet the needs of your machine risk assessment. | Select other devices to substitute those in the proposed architecture by examining the safety catalog. |
| 4 | Create the **Systema** file based on the used architecture within the **Systema** tool. | Each architecture, which is provided with the **Safety Chain Selector** is available as a template in the **Systema** tool. |
| 5 | Adapt the template in the **Systema** tool based on the adaptations to the architecture and/or substitution of devices done in step 3. | The safety library within the **Systema** tool contains numerous devices with all required parameters for the calculation. |
| 6 | Adapt the number of machine operations within the **Systema** file for your machine. | Within the template, default values were set and these have to be adapted in order to match the machine requirements. |
| 7 | Re-evaluate the achieved performance level. | Verify that the attained performance level by the control system is greater than or equal to the required performance level resulting from the risk assessment in step 1. |
| * **Safety Chain Selector**: *http://www2.schneider-electric.com/sites/corporate/en/solutions/oem/machine-safety/safety-selector.page* | | |

| Step | Action | Comment |
|---|---|---|
| 8 | Document the relevant changes in the **Systema** file. | Specific information about the machine, the author, and so on, must be documented. |
| 9 | Print the **Systema** file to be used as part of the machine documentation. | It is necessary to provide the documentation about the risk assessment and the calculation of the machine. |
| * **Safety Chain Selector**: *http://www2.schneider-electric.com/sites/corporate/en/solutions/oem/machine-safety/safety-selector.page* | | |

# Functional Safety Measures Implemented in this Architecture

## Overview

Within the described architecture, there are 2 safety functions covering different risks. These will be described in the following sections.

**NOTE:** The safety functions proposed in this architecture do not provide a preferred safety chain solution for your machine. These are proposals as to how a safety function could be realized.

| ⚠ WARNING |
| --- |
| **UNINTENDED EQUIPMENT OPERATION**<br>Ensure that a risk assessment is conducted and respected according to EN/ISO 12100 during the design of your machine.<br>**Failure to follow these instructions can result in death, serious injury, or equipment damage.** |

## Emergency Stop

In this TVDA, the safety function emergency stop is applied to disconnect the main power supply of all drives.

This safety architecture is conforming to category 4 EN ISO 13849-1:2008 and is using the stop category 0 in accordance with the standard IEC/EN 60204-1.

The architecture achieves a performance level (PL) of **e** and a safety integrity level (SIL) of **3**.

Used devices:

| Device | Description | Comment |
| --- | --- | --- |
| Input | 2 channel emergency stop button Harmony XAL K | – |
| Logic | Preventa safety module XPS MP | Safety controller for monitoring two independent safety functions simultaneously. Function 1 is used for this safety function. |
| Output | 2 redundant contactors with feedback loop LC1D | – |

## Interlocking Guard for Door Monitoring

In this TVDA, the safety function interlocking guard for door monitoring is applied to stop the motors driven by two Altivar 32 and six Lexium 32S. The uncontrolled stop of the motors is realized using the safety-related inputs STO (Safe Torque Off) of the Altivar 32 and the Lexium 32S.

The safety function STO (Safe Torque Off) only removes power to the motor. However, the drive itself remains under power. Further, the DC bus voltage is still present. If the door monitoring has been triggered because of, for example, the intention to do maintenance, you will need to remove main power even though power has been removed from the motor.

**⚠ ⚠ DANGER**

**ELECTRIC SHOCK, EXPLOSION OR ARC FLASH**

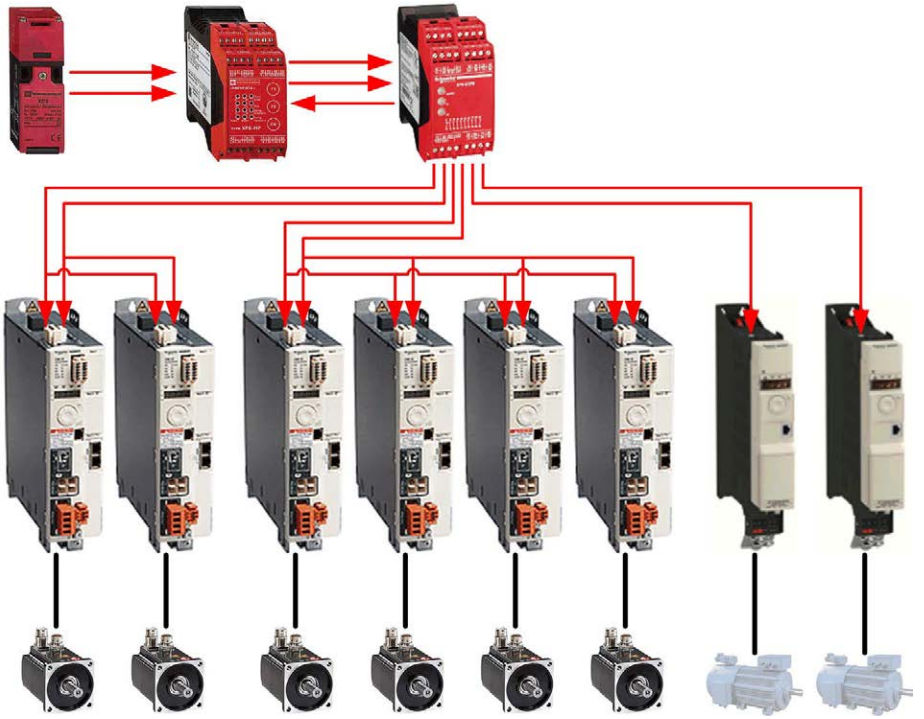
- Turn off the mains voltage using an appropriate switching device to remove power from the drive.
- After removing power, wait for 15 minutes to allow the DC bus capacitors to discharge in the drives.

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

This architecture is conforming to category 3 EN ISO 13849-1:2008 and is using the stop category 0 in accordance with the standard IEC/EN 60204-1.

The architecture achieves a performance level (PL) of **d** and a safety integrity level (SIL) of **2**.

## Used devices



| Device | Description | Comment |
|---|---|---|
| Input | 2 channel guard switch<br>Preventa XCS | – |
| Logic | Preventa safety controller XPS MP | Safety controller for monitoring two independent safety functions simultaneously. Function 2 is used for this safety function. |
| | Preventa safety module XPS ECPE | Safety module used to extend the number of safety output contacts of the base module XPS MP. |
| Outputs | 6x servo drive Lexium 32S with two safety-related inputs. | STO (Safe Torque Off) inputs (2 channel) of Lexium 32S to disconnect the power stage of the drive. |
| | 2x variable speed drive Altivar 32 with one safety-related input. | STO (Safe Torque Off) input of Altivar 32 to disconnect the power stage of the drive. |

**NOTE:** For the wiring of the safety-related inputs on the Lexium 32S, use a safety-related signal cable in accordance with ISO 13849-2.

For more information, refer to LXM32S, AC servo drive, Product manual, 0198441114060 (ENG).

**NOTE:** In this architecture, the single channel input STO with safety function on the Altivar 32 is used. In order to reach a category 3 architecture, it is necessary to use a shielded cable for the wiring. The cable shield must be connected to the protective earth ground. Follow the wiring guidelines from the drive user manual.

The Altivar 32 drive incorporates additional safety-related functions which are not applied in this TVDA. For more information, refer to ATV32 - Safety integrated functions manual, S1A45606.

# Chapter 4
# Hardware

## Overview

This chapter provides general information about the hardware.

## What Is in This Chapter?

This chapter contains the following sections:

# Section 4.1
## Electrical Distribution and Monitoring

### What Is in This Section?

This section contains the following topics:

# PowerPact H-Frame Circuit Breaker - Hardware

## Front View

PowerPact H-Frame circuit breaker (15...150 A)


## Description

The PowerPact multistandard circuit breakers are designed to help protect electrical systems from damage caused by overloads and short circuits.

Multistandard circuit breakers are available with either thermal-magnetic or Micrologic electronic trip units. Multistandard circuit breakers with thermal-magnetic trip units contain individual thermal (overload) and immediate (short circuit) sensing elements in each pole.

PowerPact multistandard circuit breakers offer high performance and a wide range of interchangeable trip units to protect most applications. Electronic trip units provide highly accurate protection with wide setting ranges and can integrate measurement, metering, and communication functions. They can be combined with the front display module (FDM121) to provide functions similar to a power meter.

Industry-leading multistandard-compliant circuit breakers provide unrivalled reliability for heavy-duty applications. Common catalog numbers, standardized ratings, and a full range of field-installable accessories make product selection, installation, and maintenance easier than ever.

| | |
|---|---|
| Features | • Rated current 15...600 A<br>• Breaking capacity from 18...65 kA at 480 Vac<br>• 3-pole versions<br>• 3 frame sizes: PowerPact H (15...150 A), PowerPact J (150...250 A), and PowerPact L (250...600 A)<br>• Thermal-magnetic and electronic protection available for the entire range<br>• Common accessories and auxiliaries with Compact NSX range<br>• Suitable for isolation<br>• Switch-disconnector versions available<br>• Compliance with IEC 60947-2 and UL 489<br>• Certifications: UL, CSA, CCC |
| Benefits | • Multistandard compliant: IEC, UL, CSA, CCC<br>• Worldwide available with unique global part numbers<br>• Flexible and simple offer, with proven performance<br>• With direct access to energy metering and energy efficiency thanks to the Micrologic control units |
| Applications | Feeder protection and circuit disconnect solutions when a multistandard approach for one global design machine is needed.<br>• International & global multi-site OEMs applications<br>• Regional OEMs exporting to USA, with production in different countries, and in need of local support/maintenance. |

For more information, refer to PowerPact Multistandard, Catalogue, LVPED212023EN.

# Multi-9 C60 (UL 1077) Circuit Breaker - Hardware

## Front View

Multi-9 C60 (UL 1077) miniature supplementary protectors


## Description

The Multi-9 supplementary protector line from Schneider Electric is a modular system of supplementary protectors, accessories, and installation equipment that makes up the most complete product offering in its class.

These UL 1077 recognized supplementary protectors provide overcurrent protection in applications where branch circuit protection is either already provided or is not required.

- 0.5...63 A at 480Y/277 Vac
- Up to 10 k AIR
- 1-, 2-, 3-, and 4-pole versions
- Common tripping of all poles
- B-curve 3...5 in. (76.2...127 mm), C-curve 7...10 in.(177.8...254 mm), D-curve 10...14 in. (254...355.6 mm)
- Current limiting capability is standard
- Full line of accessories
- Only 0.71 in. (18 mm) width per pole
- Flush, surface, or DIN rail mountable
- UL 1077, IEC 60947-2, and CE marked

New accessories with UL ratings include the following:

- Comb bus bars - UL recognized comb bus bars for UL 1077 supplementary protectors simplify wiring. They are available in 1-, 2-, and 3-phase versions. They are fixed length of 12 poles and cannot be cut. (A wide variety of IEC rated comb bus bars is also available).
- Tooth caps for the unused teeth of the comb bus Bar are also available. They come in bags of 4 strips of 5 (for a total of 20 poles), but can be snapped apart to be used individually.
- Ring tongue terminal Kit: A field-installable kit provides isolation barriers and ring terminals to convert a standard box lug Multi-9 C60 (UL 1077) miniature supplementary protector.

For more information, refer to  Multi 9 System, Catalog, 0860CT0201.

# Multi-9 C60 (UL 489) Circuit Breaker - Hardware

## Front View

Multi-9 C60 (UL 489) miniature circuit breakers

## Description

The Multi-9 C60 (UL 489) miniature circuit breaker is a UL 489 version of the Schneider Electric Multi-9 C60 family of DIN rail mountable circuit protection devices.

UL 489 devices provide branch circuit protection while UL 1077 supplementary protectors do not.

Designed to meet global applications and code requirements, the UL listed Multi-9 breakers are the first product to carry UL 489, IEC 947-2, and CSA C22.2 ratings as well as the CE mark.

The Multi-9 breaker family features an extensive array of accessories.

- 1-, 2-, and 3-pole configurations
- 17 UL 489 ratings 0.5 A...35 A
- 2 trip curves available: C curve (7...10 times handle rating); D curve (10...14 times handle rating)
- Small size: less than 19.05 mm (0.75 in.) wide per pole
- Interrupting ratings 10 K AIR standard
- System voltages include 120/240 Vac and 240 Vac; also DC ratings of 60 Vdc (1P) and 125 Vdc (2P)
- Ring terminals available (with finger-safe option)
- Padlock attachments for locking in the "OFF" position only
- Common tripping of all poles
- Variety of accessories including shunt trip, auxiliary switch, and under-voltage release. Same accessories can be used on both UL 1077 and UL 489 devices.
- Mounting base for 12...60 poles.

For more information, refer to  Multi 9 System, Catalog, 0860CT0201.

# Phaseo Power Supply Universal - Hardware

## Front View

Phaseo ABL8RPS24100 power supply

## Description

The Phaseo electronic switch mode power supply is designed to provide the DC voltage necessary for the controller and automation system equipment control circuits.

Conforming to IEC standards and UL, CSA, TÜV and C-Tick certified, they are suitable for industrial use.

The ABL8RPS/8WPS range of Phaseo power supplies covers power ratings 72...960 W in 24 Vdc and adapts to most power distribution systems used throughout the world. The same power supply can thus be connected phase to neutral or phase to phase for line supplies ranging 100...500 Vac nominal.

- Local or remote diagnostic functions
- Current limiting or stop in event of an overload
- Function modules to ensure continuity of service
- Power reserve for absorbing the transient current peaks

| | |
|---|---|
| Standards and certifications | UL, CSA, TÜV, C-Tick |
| Power range | 72…960 W |
| Voltage range | Input: 100…500 Vac<br>Output: 24 Vdc |
| Degree of protection | IP 20 conforming to IEC 60529 |

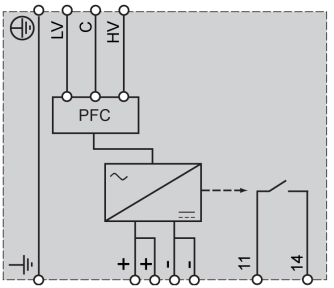
| | |
|---|---|
| Dimensions | 6 different types (W x H x D):<br>44…165 x 143 x 120…155 mm (1.73…6.5 x 5.63 x 4.72…6.1 in.) |

For more information, refer to :

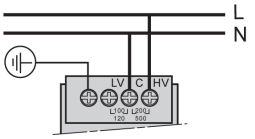
- The essential guide for power supplies and transformers, DIA3ED2070412EN
- Phaseo power supplies and transformers, Catalogue Pages, 14082-EN

## Wiring

Connection overview ABL8RPS24100




Wiring example: 200…500 V single phase



# PM3200 Series Power Meter - Hardware

## Front View

PM3250 power meter


## Description

The PM3200 series power meters are a cost-attractive and competitive range of DIN rail-mounted power meters ideal for power metering and network monitoring applications in addition to sub billing and cost allocation applications.

The PM3200 series power meters are fully compatible with the Acti 9 communication system, which makes it easy to integrate electrical distribution into the facility management system of your customer.

The meters can be included in main switch boards or subcabinets for industrial applications.

- Backlight, graphical display for easy viewing
- Accuracy class 0.5 s
- Modbus SL RS-485 2-wire communication (only PM325•)
- Save installation time, costs, and space
- Commissioning with ease
- Compact size

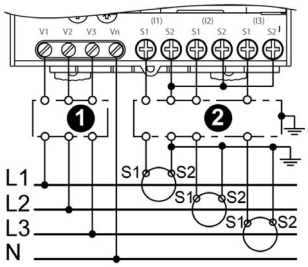
| | |
|---|---|
| Standards and certifications | IEC 61557-12, IEC 62053-21/22, IEC 62053-23, CE, UL |
| Power supply | 110…415 V (L-N, L-L) |

| | |
|---|---|
| Functions | Depends on the model:<br>● Electrical parameters monitoring such as I, U, Hz, THD<br>● Power/current demand, peak demand<br>● Time stamped alarms<br>● Minimum/maximum<br>● Up to 4 tariff managements<br>● Up to 2 digital inputs and 2 digital outputs |
| Degree of protection | ● Front panel: IP 40<br>● Casing: IP 20 |
| Dimensions | W x H x D: 90 x 95 x 70 mm (3.54 x 3.74 x 2.76 in.) |

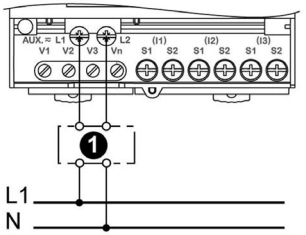
For more information, refer to PM3200 series, Power Meters, User Manual, DOCA0006EN.

## Wiring

Wiring example with three-phase system with 3 CTs (current transformers)




Power supply wiring: 100...277 Vac, 45...65 Hz




**1** Protection containing a voltage disconnect switch with a fuse or disconnect circuit breaker
**2** Shorting switch unit

# Section 4.2
## Safety Modules

### What Is in This Section?

This section contains the following topics:

# Preventa XPS MP Safety Controller - Hardware

## Front View

Preventa XPS MP safety controller


## Description

Preventa safety controller modules XPS MP are designed for a Performance Level of up to PL e/Category 4 conforming to standard EN/ISO 13849-1. They enable two independent safety functions (selected from a choice of 15 pre-defined configurations) to be performed using the same product. Configuration selection is easily made using three buttons on the front face of the module.

These 15 pre-programmed safety functions provide a solution for most safety applications, for example: monitoring emergency stops, limit switches, safety mats and sensing edges, enabling switches, coded magnetic switches, type 4 safety light curtains conforming to EN/IEC 61496-1.

Safety controllers XPS MP incorporate six safety outputs (three per function) and three solid-state signaling outputs for signaling to the process controller.

To aid diagnostics, the modules are equipped with LEDs on the front face which provide information on the monitoring circuit status. They also indicate and assist selection of the two required configurations.

| | |
|---|---|
| Maximum achievable safety level | PL e/Category 4 conforming to EN/ISO 13849-1<br>SILCL3 conforming to EN/IEC 61508 and EN/IEC 62061 |
| Standards and certifications | EN / IEC 60204-1, EN ISO / ISO 13849-1, EN ISO/ISO 13850, EN/IEC 60947-1, EN/IEC 60947-5-1, UL, CSA, TÜV |
| Power supply | 24 Vdc |
| Response time on input opening | < 30 ms |
| Degree of protection | Terminals: IP 20<br>Enclosure: IP 40 |
| Dimensions | W x H x D: 45 x 99 x 114 mm (1.77 x 3.9 x 4.49 in.) |

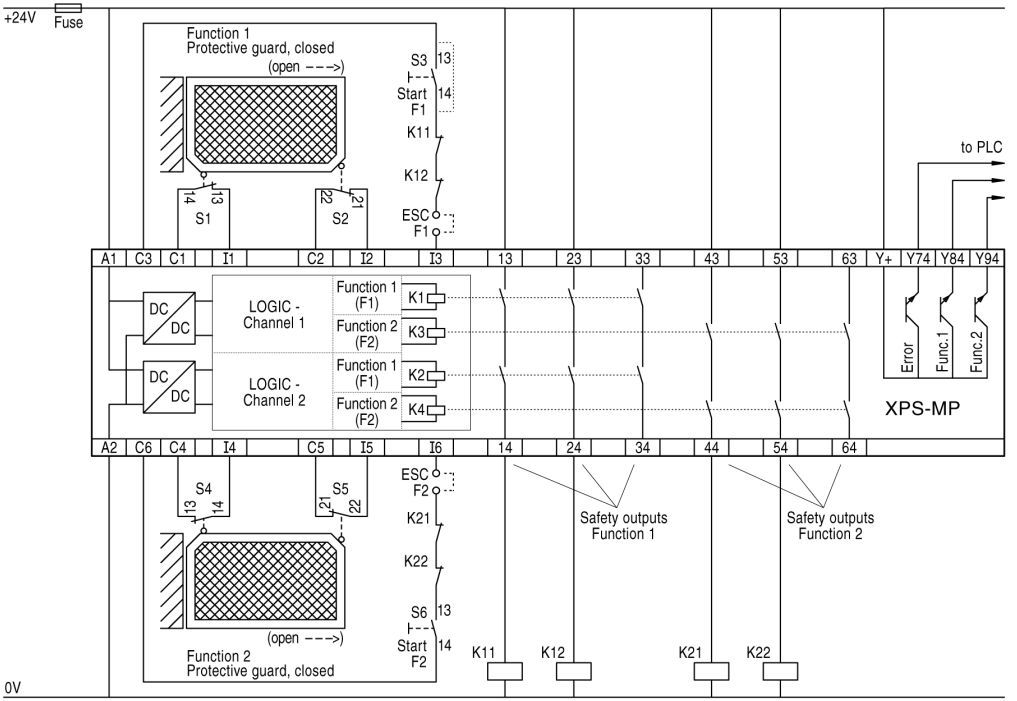
| | |
|---|---|
| Options | Safety relay modules XPS ECME and XPS ECPE (for increasing the number of safety contacts) |

For more information, refer to

- XPS-MP Instruction Sheet, S1A2876601
- Preventa solutions for efficient machine safety - catalogue, MKTED2140201EN

## Wiring

XPS MP for protective guard with start interlock and time window



# Preventa XPS ECPE Safety Module - Hardware

## Front View

Preventa XPS ECPE safety module

## Description

Safety modules Preventa XPS ECME and XPS ECPE, for extending the number of safety contacts, are available as additions to Preventa XPS base modules (such as emergency stop, limit switch, two-hand control). They are used to extend the number of safety output contacts of the base modules.

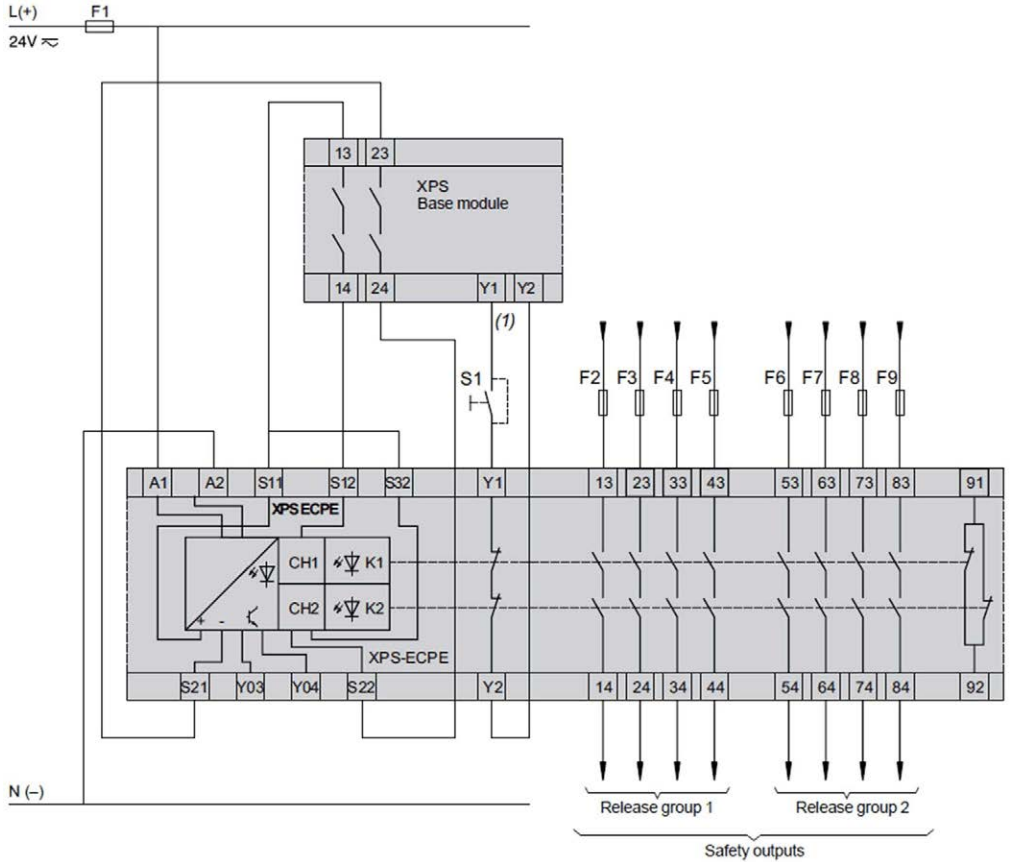
| | |
|---|---|
| Maximum achievable safety level | PL e/Category 4 conforming to EN/ISO 13849-1<br>SILCL3 conforming to EN/IEC 61508 and EN/IEC 62061 (when connected to the appropriate module) |
| Standards and certifications | EN/IEC 60204-1, EN/IEC 60947-1, EN/IEC 60947-5-1, UL, CSA, TÜV (XPS ECPE), BG (XPS ECME) |
| Power supply | 24 Vdc / 24 Vac<br>115 Vac, 230 Vac (only XPS ECPE) |
| Circuits | Number of safety circuits: 4 NO (XPS ECME), 8 NO (XPS ECPE)<br>Number of additional outputs: 2 NC (XPS ECME), 1 NC (XPS ECPE) |
| Response time on input opening | < 25 ms |
| Degree of protection | Terminals: IP 20<br>Enclosure: IP 40 |
| Dimensions | W x H x D:<br>XPS ECME: 22.5 x 99 x 114 mm (0.89 x 3.9 x 4.49 in)<br>XPS ECPE: 45 x 99 x 114 mm (1.77 x 3.9 x 4.49 in) |

For more information, refer to

- Preventa, Machine Safety Products, MKTED208051EN-US-SUP2011
- Preventa solutions for efficient machine safety - catalogue, MKTED2140201EN

## Wiring

Wiring diagram for a Preventa XPS ECPE module




**S1** Start button
**(1)** Feedback loop

# Preventa Detection and Dialog - Hardware

## Front View

Preventa product range

## Description

Schneider Electric is the provider of the safety chain covering the safety functionality and scalability for your machine. Preventa offers an extensive range of safety-related products, compliant with international standards, designed to provide protection for personnel and equipment.

For more information, refer to Preventa solutions for efficient machine safety - catalogue, MKTED2140201EN.

Complementary safety-related products like light curtains, emergency stop rope pull switches or switches are offered by Telemecanique Sensors; brand of Schneider Electric.

Telemecanique Sensors proposes a number of ranges of safety-related products:

- Discover this offer on the website: *http://www.tesensors.com/global*
- Access to the catalog by product at this URL: *http://www.tesensors.com/global/en/product/catalog/*

# Section 4.3
# HMI

## What Is in This Section?

This section contains the following topics:

# Magelis HMI GTO - Hardware

## Front View

Magelis HMI GTO product range


## Description

Magelis HMI GTO displays are advanced HMIs with optimized features to improve communication quality. The displays are easy to install and adapt to your environment. Different screen sizes and a complete dimming functionality are available for specific applications. Industry machines for the integration of the Magelis HMI GTO for example are: Compact machines, material handling systems, food and beverage machines, pharmaceutical industry, and so on.

- TFT 65 K colors for all screen sizes with energy saving LED backlight
- Easy connectivity via Ethernet
- Up-to-date interfaces (USB 2.0, SD cards) to allow easy maintenance and good peripheral links
- Unique fast connection power plug for the whole range
- Addition of function keys on the 3.5" and 7" (wide) displays
- Worldwide certifications including hazardous locations and marine "Bridge and deck"
- Operating up to 55° C (151° F) for hot environment
- Stainless steel panel for food and beverage applications available

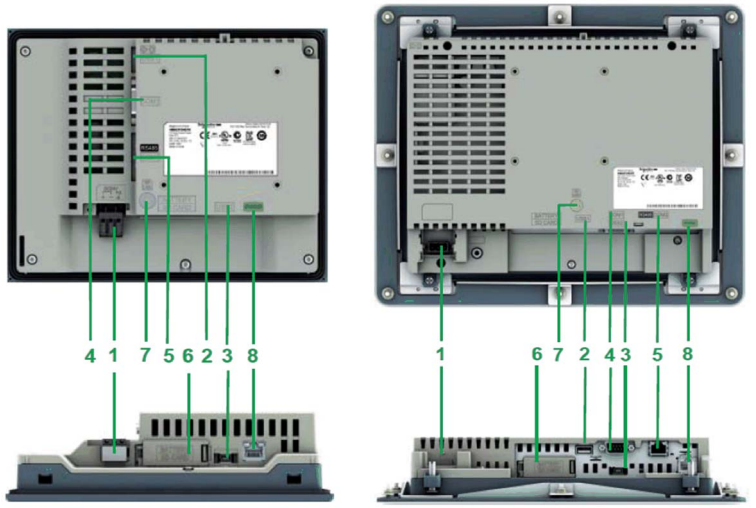
| | |
|---|---|
| Standards and certifications | EN 61000-6-4, EN 61000-6-2, UL508, CSA C22.2 n°142 |
| Power supply | 24 ± 4.4 Vdc |
| Degree of protection | Depends on the type:<br>● IP 65 (IP 67 with addition of a cover)<br>● IP 66 K (front panel with stainless steel frame) |

| | |
|---|---|
| Dimensions | 8 different types (W x H x D)<br>● Min.: 132 x 106 x 42 mm (5.2 x 4.2 x 1.65 in.)<br>● Max.: 359 x 285 x 56 mm (14.1 x 11.2 x 2.2 in.) |
| Screen sizes and resolutions | ● 3.5" and 5.7": 320 x 240 pixels (QVGA)<br>● 7.0" (wide): 800 x 480 pixels (WVGA)<br>● 7.5" and 10.4": 640 x 480 pixels (VGA)<br>● 12.1": 800 x 600 pixels (SVGA) |
| Options | Screen protection sheet, environment cover |

For more information, refer to  Magelis GTO, User Manual, EIO0000001133 (ENG).

## Wiring

Connector overview GTO3510/4310 and GTO5310/5315




| | | | |
|---|---|---|---|
| 1 | Removable screw terminal block for the 24 Vdc power supply | 5 | RJ45 connector for RS 485 serial link (COM2) |
| 2 | Type A USB host connector for connecting peripherals, transferring applications | 6 | Slot for SD memory card, with hinged cover |
| 3 | Mini-B USB connector for application transfer | 7 | LED indicating presence of the SD memory card |
| 4 | 9-way male SUB-D connector for RS 232C serial link (COM1) | 8 | RJ45 connector for Ethernet TCP/IP link, 10 BASE-T/100BASE-TX with an activity LED |

# Harmony Control and Signaling - Hardware

## Front View

Harmony product range

## Description

Schneider Electric offers a comprehensive range for control and signaling in industrial and commercial applications. All aspects of control and signaling needs are catered for including pilot devices such as push-buttons, indicator lamps, selector switches, and joysticks for standard hole cutouts.

For more information, refer to  Control and signaling components, MKTED208031EN.

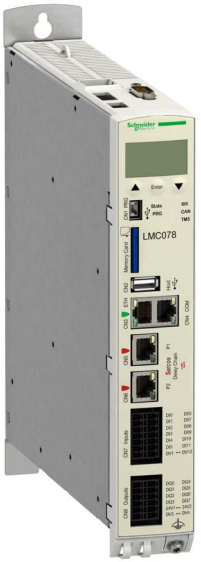
# Section 4.4
# Controller

## What Is in This Section?

This section contains the following topics:

# Modicon LMC078 Motion Controller - Hardware

## Front View




## Description

The Schneider Electric Modicon LMC078 Motion Controller is conceived for economical, but at the same time scalable, automation solutions. It can control a wide range of applications. This controller is the optimized solution for axis positioning thanks to the SoMachine software platform, which includes embedded automation functions and an ergonomic interface for axis configuration. Combined with Lexium 32S servo drives this lets you easily design and commission your applications.

The SoMachine software supports the following IEC61131-3 programming languages for use with these controllers:

- IL: Instruction list
- LD: Ladder diagram
- ST: Structured text
- FBD: Function block diagram
- SFC: Sequential function chart

SoMachine software can also be used to program this controller using CFC (Continuous Function Chart) language.

The Modicon LMC078 Motion Controller supports the following fieldbusses:
- With embedded communication interfaces:
  - Sercos III
  - CANopen Master
  - Ethernet
  - Serial line
- With optional communication modules:
  - EtherNet/IP
  - Profibus DP

The Modicon LMC078 Motion Controller supports the following I/O types:
- Master encoder input (Hiperface or RS422)
- Embedded I/Os:
  - Digital I/Os
  - Advanced digital inputs (touchprobe and interrupt inputs)
- Distributed I/Os on CANopen and Sercos (TM5/TM7 flexible I/O system)

| | |
|---|---|
| Standards and certifications | EN 61131-2:2007 (Zone B), UL 508: Industrial control equipment, CSA 22.2 No. 142 - 1987: Process control equipment |
| Rated voltage | 24 Vdc (20.4...30 Vdc) |
| Degree of protection | IP 20 |
| Dimensions | W x H x D: 44 x 270 x 222 mm (1.73 x 10.63 x 8.74 in.) |

For more information, refer to :
- Modicon LMC078 Motion Controller, Hardware Guide, EIO0000001925
- Modicon LMC078 Motion Controller, Programming Guide, EIO0000001909

## Interfaces

| Controller | SERCOS III | CAN | USB A | USB Prg | Ethernet | Serial line | Encoder |
|---|---|---|---|---|---|---|---|
| Modicon LMC078 Motion Controller | 1 dual port | 1 | 1 | 1 | 1 | 1 | 1 |

## Embedded I/Os

| Controller | Digital inputs | Digital outputs | Touchprobe + Interrupt inputs |
|---|---|---|---|
| Modicon LMC078 Motion Controller | 8 | 8 | 4 |

## Performance

The Modicon LMC078 Motion Controller has the following performance:

- Speed of the CPU: as little as 2 ns per instruction
- Up to 8 axes on Sercos motion bus synchronized in 1 ms
- Up to 16 axes on Sercos motion bus synchronized in 2 ms
- Up to 24 axes, with a minimum synchronization time of 4 ms (available with product hardware version greater than or equal to RS02)
- Minimum task cycle time: 250 µs

To display the hardware version, either:

1. Display the configuration parameters *(see Modicon LMC078, Motion Controller, Programming Guide)* of the controller.
2. Verify that the first 2 characters of the `HW_Code` parameter are “0” and “2” respectively.

or:

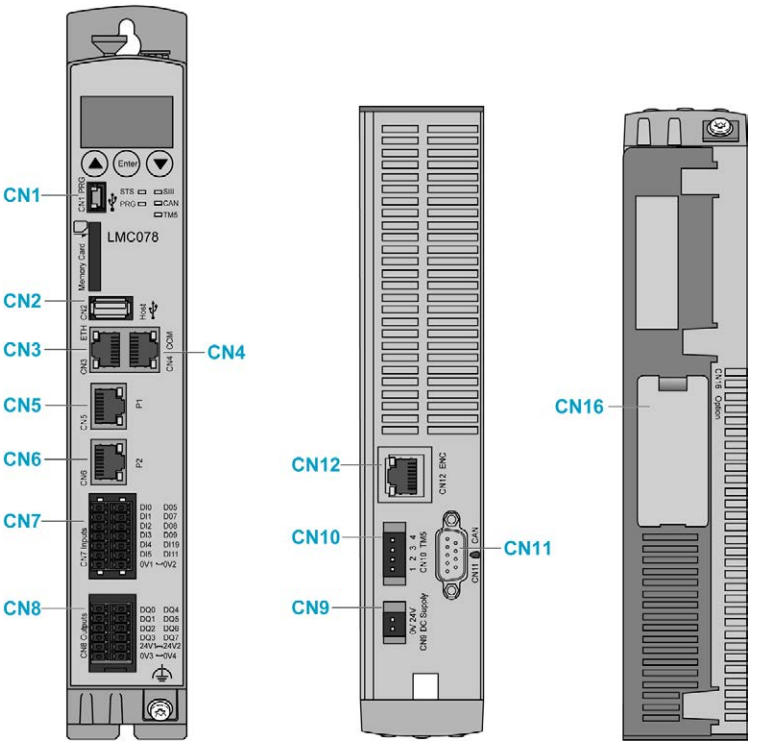
1. Consult the LC Display *(see Modicon LMC078, Motion Controller, Hardware Guide)* of the controller.
2. Use the menu buttons to display the `HwCode` menu item.
3. Verify that the first 2 characters of the `HwCode` parameter are “0” and “2” respectively.

Example `HW_Code` or `HwCode` parameter for hardware version RS02:

**02**24013000000000

## Physical Description

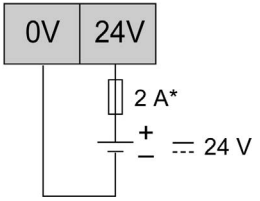
The figure shows the front view, top view, bottom view (from left to right) of the Modicon LMC078 Motion Controller




| | | | |
|---|---|---|---|
| CN1 | Programming port (USB mini-B) | CN8 | Digital outputs |
| CN2 | USB A | CN9 | 24 Vdc |
| CN3 | Ethernet connection | CN10 | TM5, not active |
| CN4 | Serial line (COM) | CN11 | CAN |
| CN5 | Sercos, port 1 | CN12 | Master encoder input |
| CN6 | Sercos, port 2 | CN16 | Slot for optional communication module |
| CN7 | Digital inputs | – | – |

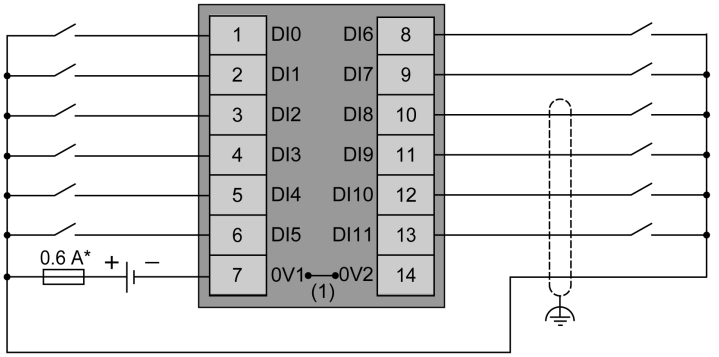
## Wiring

### Wiring example power supply




* Type T fuse

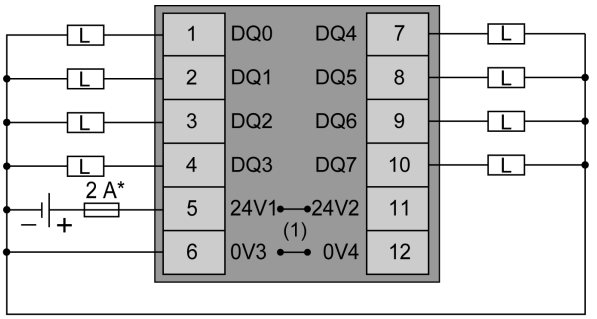
### Wiring example inputs




* Type T fuse

**(1)** The **0 V1** and **0 V2** terminals (7 and 14) are connected internally.

### Wiring example outputs




* Type T fuse

**(1)** The **24 V1** and **24 V2** terminals (5 and 11) are connected internally. The **0 V3** and **0 V4** terminals (6 and 12) are connected internally.

Pin assignment of the encoder interface (CN12) depending on the configuration of the controller:

| Type | Pin | Designation | Description |
|---|---|---|---|
| Hiperface encoder | 1 | COS | Cosine track |
| | 2 | REFCOS | Reference signal cosines |
| | 3 | SIN | Sinusoidal trace |
| | 4 | RS485+ | Parameter channel + |
| | 5 | RS485- | Parameter channel - |
| | 6 | REFSIN | Reference signal sine |
| | 7 | - | Reserved |
| | 8 | - | Reserved |
| | A | 10 Vdc | Encoder power supply |
| | B | GND | Ground |
| Incremental encoder | 1 | B+ | Track signal B+ |
| | 2 | B- | Track signal B- |
| | 3 | A+ | Track signal A+ |
| | 4 | A- | Track signal A- |
| | 5 | Z+ | Track signal Z+ |
| | 6 | Z- | Track signal Z- |
| | 7 | - | Reserved |
| | 8 | - | Reserved |
| | A | 5 Vdc | Encoder power supply |
| | B | GND | Ground |

# Modicon TM5 Sercos III Interface Module - Hardware

## Front View

Modicon TM5 Sercos III interface module with power supply and expansion modules.

## Description

The Modicon TM5 Sercos interface module allows the connection of distributed I/O islands like sensors and actuators that are distributed over machines via the Sercos fieldbus.

The TM5 Sercos III interface module offer consists of 4 parts.

- Bus base (TM5ACBN1)
- Sercos III electronic interface module (TM5NS31)
- Removable terminal block (TM5ACTB12PS)
- Power distribution electronic module (TM5SPS3)

The modules can be mechanically assembled on the bus base before mounting on a symmetrical rail. These modules offer the following advantages:

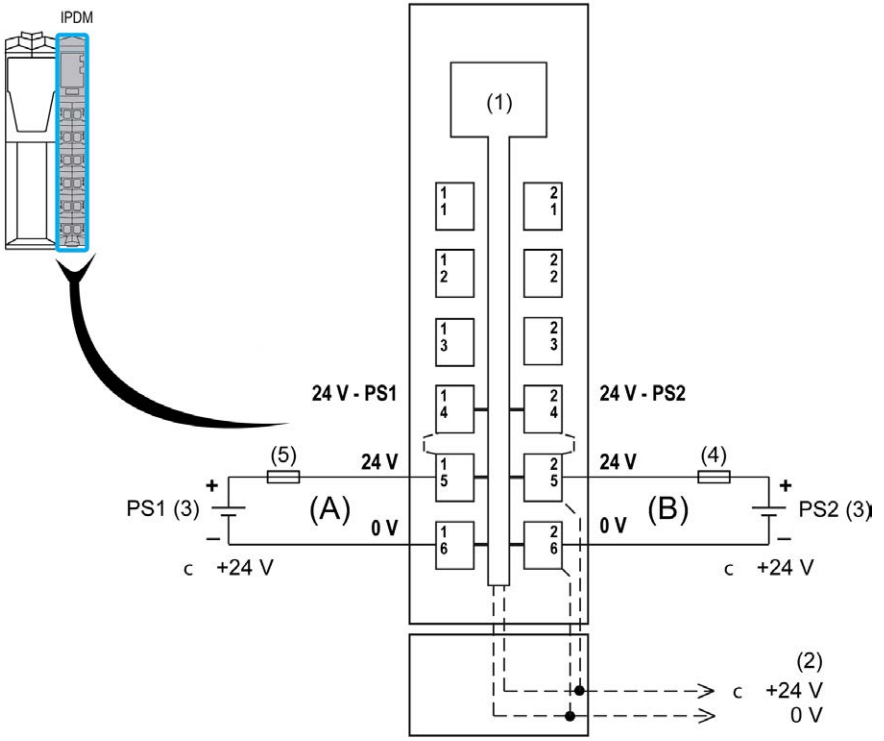
- Removable terminal block
- Spring terminals for connecting the power supply of the interface module and the I/O expansion modules quickly, with no tools required. In addition, the quality of the spring terminals avoids the need for periodic retightening.

| | |
|---|---|
| Standards and certifications | UL508, CSA 22.2 No. 142, EC Machinery Directive 2006/42/EC, cULus |
| Power supply | 24 Vdc |
| Degree of protection | IP 20 conforming to IEC 61131-2 |
| Dimensions | W x H x D:<br>25 x 103.35 x 58.85 mm (0.98 x 4.1 x 2.32 in.) |

For more information, refer to :

- Modicon TM5 / TM7 Flexible System, System Planning and Installation Guide, EIO0000000426 (ENG).
- Modicon TM5 Sercos III, Interface, Hardware Guide, EIO0000001941.
- Modicon TM5, Expansion Modules DTM Configuration, Programming Guide, EIO0000000679.

## Wiring




**A** 24 Vdc main power
**B** 24 Vdc I/O power segment
**1** Internal electronics
**2** 24 Vdc I/O power segment integrated in the bus bases
**3** PS1/PS2: External, potential-separated power supply 24 Vdc
**4** External fuse, type T slow blow, 10 A maximum, 250 V
**5** External fuse, type T slow blow, 1 A, 250 V

The Sercos electronic interface module provides two RJ45 ports for the connection to the Sercos fieldbus.

# Modicon TM5 Modules - Hardware

## Front View

Modicon TM5 Modules

## Description

The Modicon TM5 modular I/O system provides flexible and scalable configuration of expansions or distributed I/O islands by direct connection with Modicon M258 Logic Controller and Modicon LMC058 Motion Controller or via the TM5 interface modules for CANopen and Sercos. Characterized by easy wiring and maintenance, this modular I/O system offers a wide variety of modules that enables you to meet exactly their desired configuration for reducing costs and simplification.

Flexible and scalable I/O configuration:

- Distributed I/Os via the CANopen or Sercos interface modules
- Local or remote expansion via the local TM5 expansion bus on Modicon M258 and Modicon LMC058 controllers
- Wide range of I/O expansion modules: digital, analog, expert, non-functioning dummy, remote I/O module, and so on.

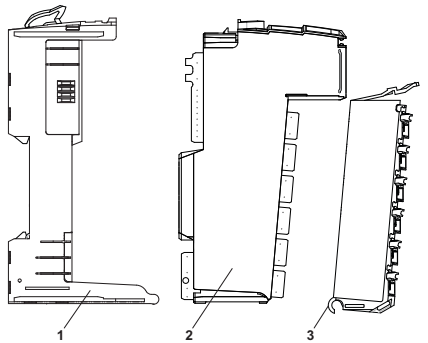
Simplified maintenance installation:
- Embedded diagnostics for local and distant supervision
- Hot swapping of I/O modules
- Wiring simplicity: spring terminals, removable terminal blocks

Save engineering time:
- Fully compatible with SoMachine software
- Certified FDT/DTM technology for all compatible automation software systems (on CANopen and Sercos)

| | |
|---|---|
| Standards and certifications | IEC 61131-2 ed. 3 2007, UL 508, CSA 22.2 No. 142-M1987, CSA 22.2 No. 213-M1987 |
| Power supply | 24 Vdc (white housings)<br>100…240 Vac (black housings) |
| Degree of protection | IP 20 conforming to IEC 61131-2 |
| Dimensions | One assembled integral module (W x H x D):<br>12.5 x 99 x 75 mm (0.49 x 3.9 x 2.95 in.) |

For more information, refer to :
- Modicon TM5 / TM7 Flexible System, System Planning and Installation Guide, EIO0000000426 (ENG).
- Modicon TM5, Digital I/O Modules, Hardware Guide, EIO0000000444 (ENG).
- Modicon TM5, Analog I/O Modules, Hardware Guide, EIO0000000450 (ENG).
- Modicon TM5, Expansion Modules DTM Configuration, Programming Guide, EIO0000000679.

## Module Components



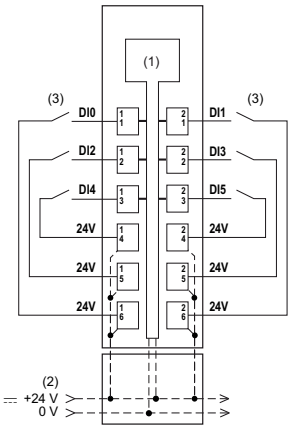

1 Bus base
2 Electronic module
3 Terminal block

When assembled, the three components form an integral module.

## Wiring

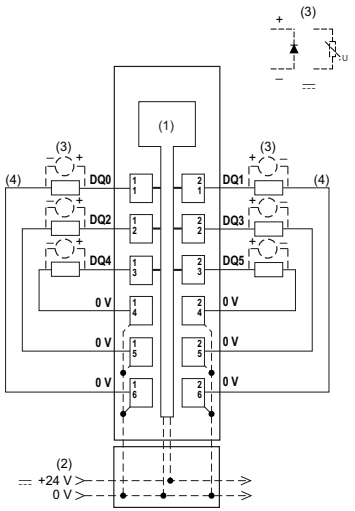
For a brief overview, refer to the 2 wiring examples below.

Wiring example TM5SDI6D




**(1)** Internal electronics
**(2)** 24 Vdc I/O power segment integrated into the bus bases
**(3)** 2-wire sensor

Wiring example TM5SDO6T



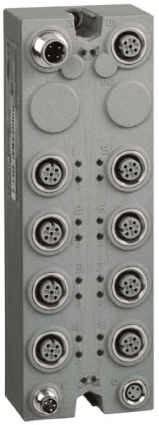

**(1)** Internal electronics
**(2)** 24 Vdc I/O power segment integrated into the bus bases

**(3)** Inductive load protection
**(4)** 2-wire load

# Modicon TM7 Digital I/O Block - Hardware

## Front View

TM7BDM16A



## Description

To enhance its "Flexible machine control" concept, Schneider Electric offers Modicon TM7 IP 67 I/O blocks for mounting outside electrical cabinets, directly on the installation. The IP 67 degree of protection of these blocks enables them to be used within processes or machines in harsh environments (splashing water, oil, dust, and so on).

They have the following characteristics:

- Dust and damp proof
- Robust and compact
- Rapid wiring, economical to use

The TM7 offer consists of fieldbus interface I/O blocks, expansion blocks, and accessories conforming to IP 67 (splashing water, oil, dust, and so on).

The range of TM7 IP 67 I/O blocks includes:

- TM7 CANopen interface I/O blocks
- TM7 digital I/O blocks
- TM7 analog I/O blocks
- TM7 power distribution blocks

Modicon TM7 IP 67 I/O blocks are available in various compositions and for different functions.

The following table describes the TM7 digital I/O block references available for your TM7 system:

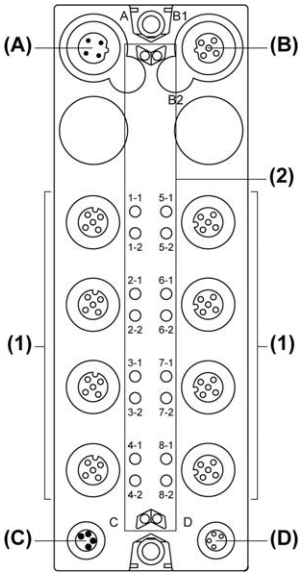
| Device | Digital I/O channels | | |
|---|---|---|---|
| | Number | Type | Connector |
| TM7BDI8B | 8 | Inputs | 8 x M8, 3 pin |
| TM7BDI16B | 16 | Inputs | 16 x M8, 3 pin |
| TM7BDI16A | 16 | Inputs | 8 x M12, 5 pin |
| TM7BDO8TAB | 8 | Outputs | 8 x M8, 3 pin |
| TM7BDM8B | 8 | Configurable I/Os | 8 x M8, 3 pin |
| TM7BDM16A | 16 | Configurable I/Os | 8 x M12, 5 pin |
| TM7BDM16B | 16 | Configurable I/Os | 16 x M8, 3 pin |

| | |
|---|---|
| Standards and certifications | IEC 61131-2, UL 508, CSA 22.2 No.142-M1987, CSA 22.2 No.213-M1987, CE, cURus, GOST-R and c-Tick, ATEX (II 3g EEx nA II T5, IP 67, Ta = 0…60°C/32...140°F) |
| Power supply | 24 Vdc |
| Degree of protection | IP 67 conforming to EN/IEC 60529 |
| Dimensions | 2 sizes available (W x H): 53 x 85 mm or 53 x 155 mm (2.1 x 3.35 mm or 2.1 x 6.1 in) |

For more information, refer to :

- Modicon TM5 / TM7 Flexible System, System Planning and Installation Guide, EIO0000000426 (ENG).
- Modicon TM7, Digital I/O Blocks, Hardware Guide, EIO0000000703.

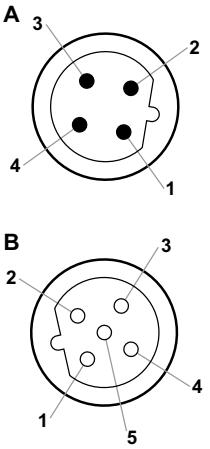
## Physical Description TM7BDM16A



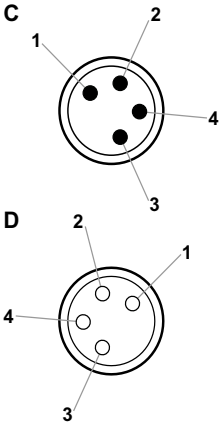

**A** TM7 bus IN connector
**B** TM7 bus OUT connector
**C** 24 Vdc power IN connector
**D** 24 Vdc power OUT connector
**1** Input/output connectors
**2** Status LEDs

## Wiring

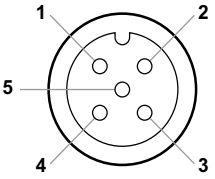
Pin assignments of the TM7 bus IN (A) and OUT (B) connectors of the TM7 IP 67 I/O block

| Connection | Pin | Designation |
|---|---|---|
|  | 1 | TM7 V+ |
| | 2 | TM7 bus data |
| | 3 | TM7 0 Vdc |
| | 4 | TM7 bus $\overline{\text{data}}$ |
| | 5 | N.C. |

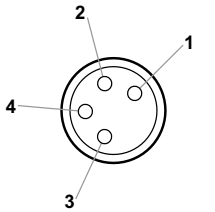
Pin assignments of the 24 Vdc power IN (C) and OUT (D) connectors of the TM7 IP 67 I/O block

| Connection | Pin | Designation |
|---|---|---|
|  | 1 | 24 Vdc I/O power segment |
| | 2 | 24 Vdc I/O power segment |
| | 3 | 0 Vdc |
| | 4 | 0 Vdc |

Pin assignments for the I/O connectors of the TM7BDM16A block

| Connection | Pin | Designation |
|---|---|---|
|  | 1 | 24 Vdc sensor / actuator supply |
| | 2 | DI/DO: input/output signal channel 1 |
| | 3 | 0 Vdc |
| | 4 | DI/DO: input/output signal channel 2 |
| | 5 | N.C. |

Configuration of the power cable TCSXCN•FNX••V, used for the power supply of a TM7 IP 67 I/O block

| Female connector | Pin | Designation | Wire color | Open |
|---|---|---|---|---|
|  | 1 | 24 Vdc | White | For custom wiring |
| | 2 | 24 Vdc | Brown | |
| | 3 | 0 Vdc | Blue | |
| | 4 | 0 Vdc | Black | |

# Section 4.5
# Communication

## ConneXium Ethernet Switch (Unmanaged) - Hardware

### Front View

5-port TCSESU053FN0 Ethernet switch (unmanaged)

### Description

The ConneXium unmanaged Ethernet switch range offers you a smart and flexible way to integrate Ethernet solutions into your operation, from the device level to the control network and to your corporate network.

Unmanaged devices are those which there is no possibility to configure or control any of the parameters of the devices. They support Ethernet 10 Mbit/s and Fast Ethernet 100 Mbit/s.

Furthermore the switch modules support switched Ethernet networks in accordance with IEEE standard 802.3 or 802.3u using copper and fiber optic technology.

All switches are mounted on a standard DIN rail.

- Multi-address capability
- Storage and rerouting of received data
- Data packets with VLAN tags are transmitted unchanged (IEEE 802.1 Q)
- Automatic negotiation of 10/100 Mbit/s and duplex mode

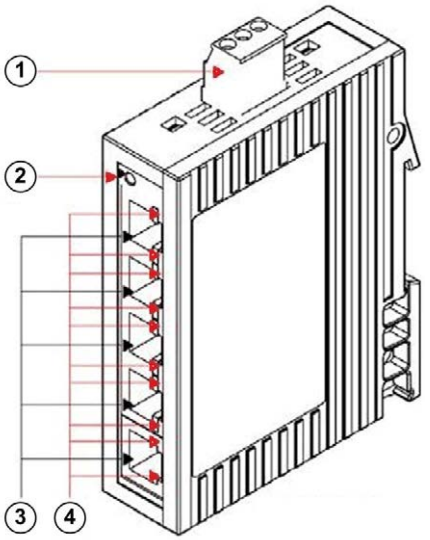
- Automatic change of polarity
- Low-cost wiring solution

| | |
|---|---|
| Standards and certifications | UL508, CSA 22.2 No.142, CE |
| Power supply | 24 Vdc |
| Operating voltage | 9.6...32 Vdc |
| Ports | 3, 4, 5,8 |
| Degree of protection | IP 30 |
| Dimensions | W x H x D: 25 x 114 x 79 mm (0.98 x 4.49 x 3.1 in.) (TCSESU053FN0) |

For more information, refer to ConneXium Ethernet Switches, TCSESU0••F•N0, Quick Reference Guide, 31007950.

## Wiring

TCSESU053FN0 connector overview




**1** 3-pin terminal block for power supply
**2** Power indicator
**3** 10/100 base-TX (RJ45 connectors)
**4** Port ACT/LNK LEDs

# Section 4.6
## Motor Control

### What Is in This Section?

This section contains the following topics:

# TeSys D Contactor - Hardware

## Front View

TeSys D-LC1D contactor

## Description

TeSys D-LC1D contactors are designed for all power switching, control applications, and integration into control systems.

They conform to standard IEC 60947-4-1, for utilization categories AC6b, as well as to UL/CSA standards.

This product constitutes a ready-to-use solution and offers you quick simple setup.

TeSys D contactors can be used to create motor starters for any type of application.

- AC, DC, and low-consumption DC control circuit
- All types of starter: reversing or non-reversing, star/delta, by auto-transformer, and so on.
- Various connectors: spring terminal, EverLink terminal block, screw clamp, ring-type connection, faston connector
- Easy and simple direct mounting between contactor and circuit breaker, according to EverLink terminal block (40...65 A)

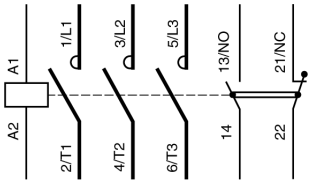
| | |
|---|---|
| Standards and certifications | IEC/EN 60947-4-1, IEC/EN 60947-5-1, UL 508,<br>CSA C22.2 n°14, UL, CSA, CCC, GOST, GL, DNV, RINA, VB, LROS |
| Rated operational current (Ie)I in AC-3 (Ue max. 440 V) | 9…150 A |
| Rated control circuit voltage (Uc) | 12(24*)…690(500*) Vac<br>12(24*)…440 Vdc<br>*D115 and D150 |
| Degree of protection (front face) | IP 20 (conforming to IEC 60529) |

| | |
|---|---|
| Protective treatment | "TH" (conforming to IEC 60068-2-30) |
| Dimensions | 19 different types without add-on blocks or cover (WxHxD): 45…155 x 77…158 x 84…132 mm (1.77…6.1 x 3.0…6.22 x 3.3…5.2 in.) |
| Options | Various connector types, wide range of auxiliary contact blocks and modules, power connection accessories, suppressor modules |

For more information, refer to  Control and protection components, MKTED210011EN.

## Wiring

TeSys D09…150 3-pole contactors wiring diagram



# TeSys U LU2B Motor Starter- Hardware

## Front View

TeSys U LU2B•• motor starter

## Description

The TeSys U starter-controller is a Direct On Line (D.O.L.) starter which performs the following functions:

- Protection and control of single-phase or three-phase motors:
  - isolation and breaking function
  - overload and short-circuit protection
  - thermal overload protection
  - power switching
- Control of the application:
  - protection function indication
  - application monitoring (running time, number of errors detected, motor current values, and so on)
  - logs (last five errors detected are saved, along with motor parameter values)

These functions can be added by selecting control units and function modules which clip into the power base. This late customization is also possible after power and control circuit wiring has been completed.

From design through to operation, TeSys U offers advantages and simplifies the selection of components in comparison with a traditional solution.

- The braking, isolation, and contactor functions are incorporated in a single block. Therefore, there are fewer references to be ordered and selection is easy because a single reference covers most needs up to 15 kW.
- The control unit has a wide setting range. It can operate on a DC or an AC supply.

The compact components in the TeSys U range are mounted on a single rail, optimizing the amount of space required in enclosures. As power wiring between the circuit-breaker and contactor is not needed, TeSys U reduces installation times.

Setting-up accessories simplify or eliminate wiring between components, and allow easy selection and ordering.

With a capacity of up to 32 A/15 kW, TeSys U consists of:

- One 45 mm (1.77 in.) power base: two ratings, reversing or non-reversing, circuit-breaker function, and built-in interference suppression
- One clip-on control unit:
  - Standard CU: protection against overloads and short-circuits
  - Expandable CU: additional alarm and error differentiation
  - Multifunction CU: real-time control of motor load, local or remote diagnostics and parameter setting
- One clip-on automation control module: Modbus SL RS-485 2-wire, CANopen, AS-Interface, PROFIBUS DP, Ethernet, DeviceNet, Fipio, Interbus S via Advantys STB module or a simple parallel link
- Two optional 45 mm (1.77 in.) power functions: limiter-isolator and changeover relay

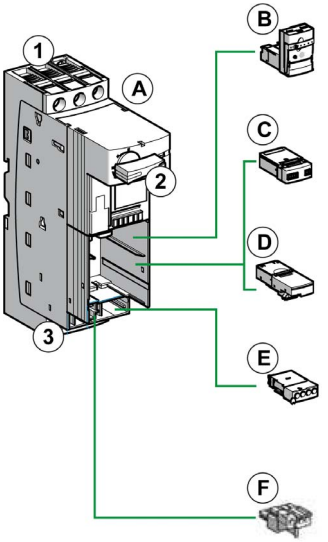
| | |
|---|---|
| Standards and certifications | IEC/EN 60947-6-2, CSA C22-2 N°14, Type E, UL508 type E: with phase barrier LU9SP0, UL, CSA, CCC, Gost, ASEFA, ABS, BV, DNV, GL, LROS, ATEX |
| Power range | 0…15 kW at 400 V |
| Rated insulation voltage | • Conforming to IEC/EN 60947-1, overvoltage category III: 690 V<br>• Conforming to UL508, CSA C22-2 n°14: 600 V |
| Degree of protection | • Front panel outside connection zone: IP 40<br>• Front panel, wired terminals, and other faces IP 20 |
| Dimensions | W x H x D: LUB: 45 x 154 (224*) x 135 mm (1.77 x 6.1 (8.8*) x 5.3 in.)<br>*LU2B (reversible) |

| | |
|---|---|
| Options | • Four different control units<br>• Error signaling modules<br>• Communication modules<br>• Auxiliary contact modules<br>• Load level modules<br>• Reverser block<br>• Plug-in terminal blocks<br>• Control circuit pre-wiring system |

For more information, refer to :
- Control and protection components, MKTED210011EN
- TeSys U, Starter-controllers, Catalogue, DIA1ED2081003EN

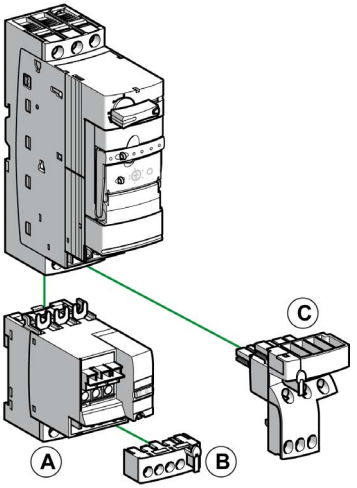
## Components

TeSys U - non-reversing




**1** Power supply terminal block
**2** On/Off/Reset control handle
**3** "Motor" terminal block
**A** Power base
**B** Control units
**C** Auxiliary contact modules (LUF), thermal overload signaling, error signaling modules, or load level modules
**D** Communication modules
**E** Auxiliary contact module (LUA)
**F** Terminal block

TeSys U - reversing

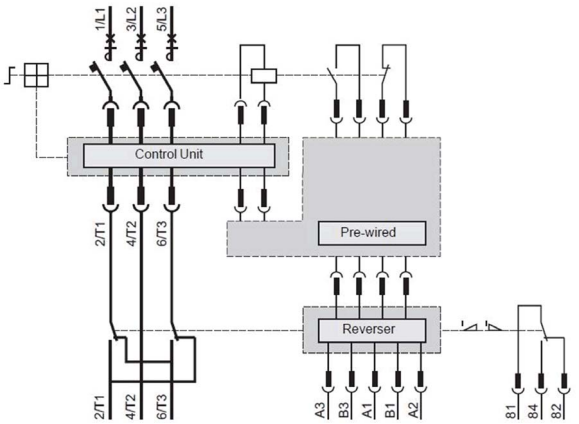



**A** Reverser block
**B** Plug-in terminal blocks
**C** Control circuit pre-wiring system

A preassembled reversing power base can be ordered by a specific part number.

## Wiring

TeSys U - reversing



# TeSys GV2 Motor Circuit Breakers - Hardware

## Front View

TeSys GV2 P motor circuit breaker

## Description

The large TeSys motor circuit-breakers range GV2, GV3 and GV7 is categorized according to their level of performance and functions. Due to its diverse characteristics, only the GV2 P is presented and integrated into the TVDA.

The TeSys GV2 P motor circuit-breakers are three-pole thermal-magnetic circuit-breakers designed for the control and protection of motors.

The motor protection is provided by the thermal-magnetic elements incorporated in the industrial motor circuit-breaker.

The magnetic elements (short-circuit protection) have a non-adjustable tripping threshold, which is equal to 13 times the maximum setting current of the thermal trips.

The thermal elements (overload protection) include automatic compensation for ambient temperature variations. The addition of an under voltage trip allows the circuit-breaker to be de-energized in the event of an under voltage condition.

- Motor and personnel protection
- Live parts are protected from direct finger contact
- Compact size
- Easy to install: screw mounting or clip-on mounting
- Control by rotary knob
- Connection by screw clamps

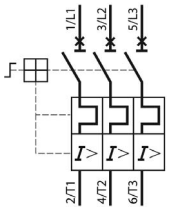
| | |
|---|---|
| Standards and certifications | IEC 60947-1, 60947-2, 60947-4-1, EN 60204, UL508, CSA C 22.2 n° 14-05, NF C 63-650, 63-120, 79-130, VDE 0113, 0660, UL*, CSA, PTB, EZU, GOST, TSE, DNV, LROS, GL, BV, RINA, CCC, ATEX<br><br>*UL508 type E for GV2 P••H7 (line spacer included) |

| | |
|---|---|
| Operational voltage | 690 V |
| Degree of protection | IP 20 |
| Dimensions | W x H x D: 44.5 x 89 x 97 mm (1.75 x 3.5 x 3.82 in.) |
| Options | • Combination block<br>• Sets of 3-pole busbars<br>• Protective end cover<br>• Terminal blocks<br>• Padlock able external operator<br>• Contact blocks: Error signaling contact and immediate auxiliary contacts<br>• Undervoltage/Shunt trips<br>• Padlocking devices |

For more information, refer to  Control and protection components, MKTED210011EN.

## Wiring

TeSys GV2 P contactors wiring diagram



# Altivar 32 Variable Speed Drive - Hardware

## Front View

Altivar 32 variable speed drive

## Description

The Altivar 32 drive is a frequency inverter for 200…500 V three-phase asynchronous and synchronous motors rated from 0.18 kW to 15 kW which includes a various motor control profile.

In combination with synchronous motors, Altivar 32 variable speed drives offer optimized energy efficiency.

It features more than 150 functions. It is robust, compact, and easy to install.

The Altivar 32 drive incorporates functions which are suitable for the most common applications, including: hoisting, material handling, packaging, and special machines (like wood working machines, metal processing, and so on).

- Compact book format
- Integrated Modbus SL RS-485 2-wire
- Open: communication cards available as options
- integrated protection
- Simple setup
- Integrated programmable logic functions
- Energy saving: control of energy efficient permanent magnet synchronous motors

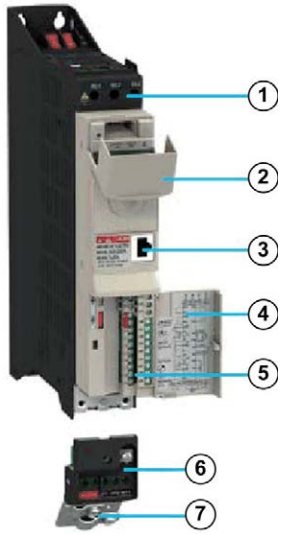
| | |
|---|---|
| Standards and certifications | IEC 61800-5-1, IEC 61800-3 (environments 1 and 2, category C2), ISO/EN13849-1/-2 (category 3, PL d), IEC 61508 (parts 1 & 2), IEC 60721-3-3 (environments 3C3 and 3S3, classes 3C3 and 3S2), UL508c, CSA, NOM, GOST, C-Tick |
| Power range | 0.18…15 kW |
| Voltage range | • single-phase 200…240 V (0.18 to 2.2 kW)<br>• three-phase 380…500 V (0.37 to 15 kW) |
| Output frequency | 0.1…599 Hz |
| Transient overtorque | 170…200 % of the nominal motor torque |
| Communication | • integrated: Modbus SL RS-485 2-wire and CANopen, Bluetooth link<br>• optional: DeviceNet, PROFIBUS DP V1, Modbus SL RS-485 2-wire, EtherNet/IP, Modbus TCP, EtherCAT |
| Functions | • standard or customizable configurations<br>• factory or OEM settings<br>• application-specific functions<br>• adjustable switching frequency<br>• HMI and dialog or configuration tools<br>• uploads and downloads with drive on or off |
| Protections | • STO: Safe Torque Off<br>• SLS: Safely Limited Speed<br>• SS1: Safe Stop 1 |
| I/Os | • 3 analog inputs - response time: 3 ms, resolution 10 bits<br>• 6 logic inputs - response time: 8 ms, configurable in PTC and IN PWM<br>• 1 analog input - updating time: 2 ms<br>• 1 logic output - sampling time: 2 ms, configurable as voltage or current<br>• 2 relay outputs |
| Degree of protection | IP 20 |
| EMC filter | • integrated: C2 EMC<br>• optional: C1 EMC |
| Dimensions | 4 types (WxHxD)<br>• 45 x 317 x 245 mm (1.77 x 12.48 x 9.65 in.)<br>• 60 x 317 x 245 mm (2.36 x 12.48 x 9.65 in.)<br>• 150 x 308 (232*) x 232 mm (5.9 x 12.13 (9.13*) x 9.13 in.)<br>• 180 x 404 (330*) x 232 mm (7.1 x 15.9 (13*) x 9.13 in.)<br>* = EMC plate not installed |

| | |
|---|---|
| Options | • SoMove and SoMove Mobile setup software<br>• simple and multi-loader configuration tool<br>• remote display terminals<br>• communication cards in cassette format<br>• optimized offer for connection to the CANopen bus<br>• quick connect for a TeSys GV2 circuit breaker |

For more information, refer to :
- Altivar 32, Variable speed drives for synchronous and asynchronous motors, Installation manual, S1A28686 (ENG).
- Altivar 32, Variable speed drives for synchronous and asynchronous motors, Programming manual, S1A28692 (ENG).

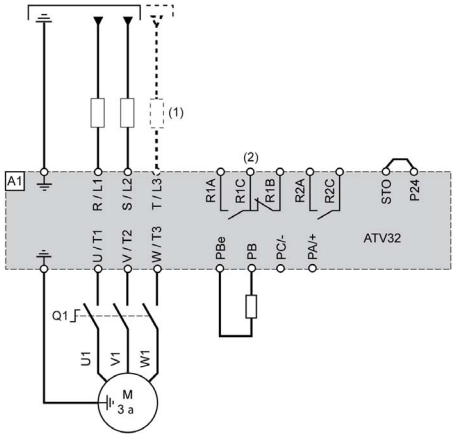
## Wiring

Altivar 32 connector overview



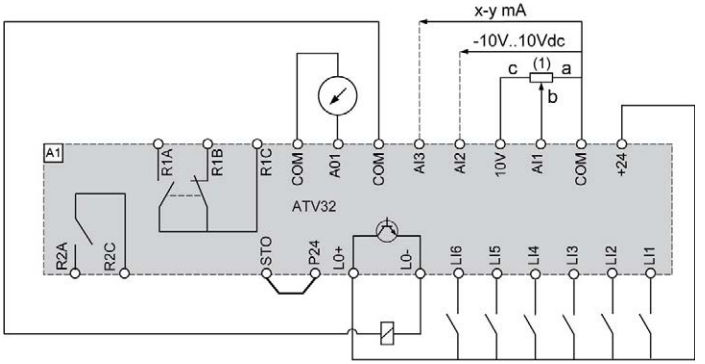

**1** Power terminals
**2** Protective cover
**3** RJ45 Modbus SL RS-485 2-wire
**4** Protective cover
**5** Control terminals
**6** Removable motor power terminal block
**7** EMC mounting plate

Wiring example power supply and motor




**(1)** Line choke (if used)
**(2)** Relay contacts signifying detected errors

Wiring example control terminals




**(1)** Reference potentiometer SZ1RV1202 (2.2 kΩ) or similar (10 kΩ maximum)

# Lexium 32S Servo Drive - Hardware

## Front View

Lexium 32S servo drive


## Description

The Lexium 32 product family consists of various servo drive models that cover different application areas. Together with Lexium BMH or BSH servo motors as well as a comprehensive portfolio of options and accessories, the drives are ideally suited to implement compact, high-performance drive solutions for a wide range of power requirements.

Simplicity throughout the entire life cycle of your machine:

- Fast engineering with powerful integration and design software (motor sizing, CAD, and cabinet drawings, support for PLCopen libraries, commissioning software SoMove) reduces time-tomarket.
- Simplified installation with easy access to removable, color-coded connectors, memory cards, and multi-loader.
- *Safe Torque Off* function on board

Openness and modularity:
- I/O module with additional analog and digital inputs and outputs.
- 3 encoder modules for machine encoder/second motor encoder.
- eSM module for additional safety-related functions.

Power and performance:
- Easy auto-tuning for different levels of expertise.
- Superior motor control.
- Intelligent vibration and jerk suppression for long machine life.
- Two powerful motor ranges: The versatile medium-inertia Lexium BMH and the dynamic low-inertia Lexium BSH.

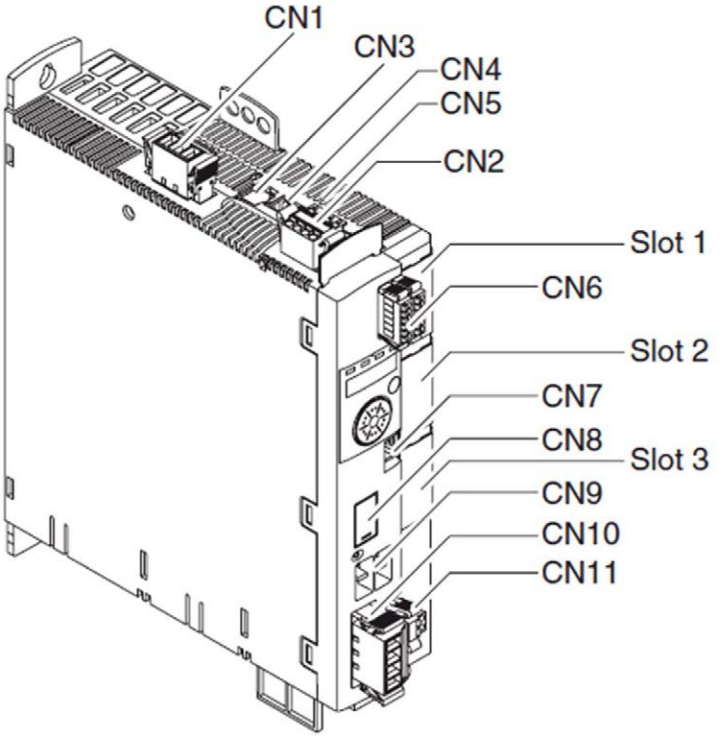
| | |
|---|---|
| Standards and certifications | IEC 61800-5-1, IEC 61800-3 (environments 1 and 2, categories C2 and C3), IEC 61000-4-2/4-3/4-4/4-5, ISO/EN13849-1 (PL e), IEC 61508 SIL 3 level, CE, UL, CSA |
| Power range | 0.15…7 kW |
| Voltage range | 115/230 Vac single-phase:<br>● 100-15%...120+10% Vac<br>● 200-15%...240+10% Vac<br>208/400/480 Vac three-phase:<br>● 200-15%...240+10% Vac<br>● 380-15%...480+10% Vac |
| Speed | up to 8000 rpm |
| Torque | up to 84 Nm |
| Communication | Integrated, exchangeable Sercos III interface module |
| Operating modes | ● homing<br>● manual mode (JOG)<br>● motion sequence<br>● electronic gearbox<br>● speed control<br>● current control<br>● position control |
| Functions | ● auto-tuning, monitoring, stopping, conversion<br>● stop window<br>● rapid entry of position values<br>● rotary axis<br>● position register |
| I/Os | ● 4 logic inputs (24 Vdc)<br>● 2 capture input (24 Vdc)<br>● 3 logic outputs (24 Vdc)<br>● Optional: I/O module with additional analog and digital inputs and outputs |

| | |
|---|---|
| Pulse control input | ● RS422 link<br>● 5 V or 24 V push-pull<br>● 5 V or 24 V open collector |
| ESIM (Encoder SIMulation) PTO (Pulse Train Output) output | RS422 link |
| Safety-related Functions | ● Integrated: STO (Safe Torque Off)<br>● Optional: Safe Stop 1 (SS1) and Safe Stop 2 (SS2), Safe Operating Stop (SOS), Safe Limited Speed (SLS) |
| Sensor interface | ● Integrated: SinCos Hiperface sensor<br>● Optional: Resolver encoder, analog encoder, digital encoder |
| Dimensions | 2 types (W x H x D)<br>● 68 x 270 x 225 mm (2.68 x 10.63 x 8.86 in.)<br>● 108 x 274 x 225 mm (4.25 x 10.79 x 8.86 in.) |
| Options | ● SoMove setup software<br>● Multi-Loader configuration tool<br>● IP 54 remote graphic display terminal<br>● filters, braking resistors, line chokes<br>● Memory card for backup and copying parameters and fast device replacement. |

For more information, refer to LXM32S, AC servo drive, Product manual, 0198441114060 (ENG).

## Wiring

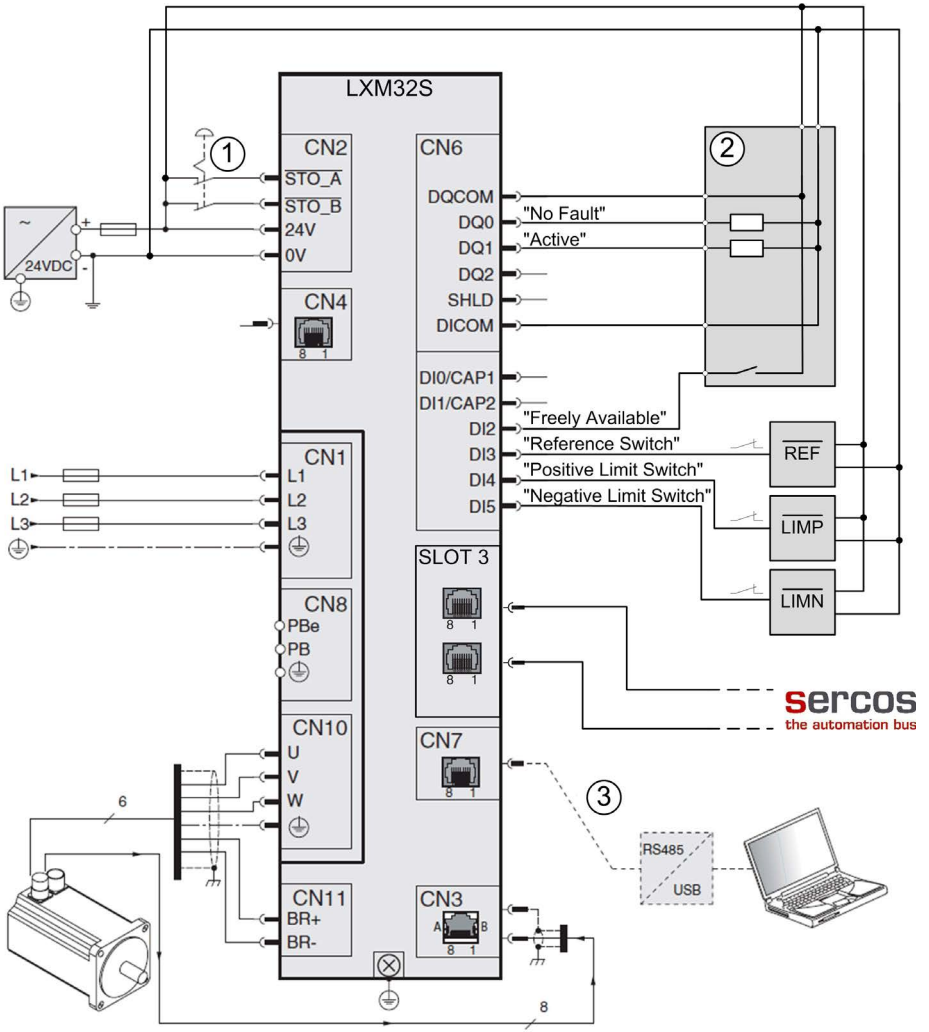
Lexium 32S connector overview




| Connector | Description |
|---|---|
| CN1 | power stage supply |
| CN2 | 24 controller power supply and STO function |
| CN3 | motor encoder (encoder 1) |
| CN4 | PTO (encoder simulation ESIM) |
| CN5 | PTI (A/B signals, P/D signals, CW/CCW signals) |
| CN6 | digital inputs/outputs |
| CN7 | Modbus SL RS-485 2-wire (commissioning interface) |
| CN8 | external braking resistor |
| CN9 | DC bus connection for parallel operation |
| CN10 | motor phases |
| CN11 | holding brake |

| Connector | Description |
|---|---|
| Slot 1 | safety module or I/O module |
| Slot 2 | encoder module (encoder 2) |
| Slot 3 | exchangeable Sercos module |

The wiring example shows the basic wiring of the Lexium 32S servo drive with optional I/O signals linked to a controller. Thanks to the flexibility of the Lexium 32S servo drive the device can be adapted to a wide variety of tasks with numerous modules. The Sercos communication, which is provided by the exchangeable Sercos III module in slot 3, allows high-performance and motion applications.




1 Emergency stop
2 Controller
3 Commissioning accessories

# Lexium BSH/BMH Servo Motors - Hardware

## Front View

Lexium BSH/BMH servo motors

BSH BMH

## Description

The Lexium BSH/BMH servo motor movements are controlled by Lexium 32 servo drives.

BSH servo motors are the ideal choice to meet requirements for dynamics and precision. With 4 flange sizes and various lengths, there is a suitable solution for most applications, covering a continuous stall torque range from 0.5 Nm to 33.4 Nm for speeds up to 9000 rpm.

BMH servo motors provide unequaled power density values to meet the requirements of most compact machines. With 5 flange sizes and 3 different lengths for each flange size, they are suitable for most applications, covering a continuous stall range from 1.2 Nm to 84 Nm for speeds up to 8000 rpm. With their medium inertia motor, the BMH servo motors are ideal for high-load applications and enable more robust adjustment of the movement, making for easier installation and adjustment.

BSH and BMH servo motors are certified as "Recognized" by the UL (underwriters laboratories) and conform to UL 1004 standards as well as to European directives (CE marking).

They are available with the following variants:

- 4 (BSH) and 5 (BMH) flange sizes (mm): 55, 70, 100, 140 and 205 (BMH)
- 2 degrees of protection for the shaft end: IP 50 or IP 65 in accordance with standard IEC/EN 60529
  The degree of protection of the casing is IP 65 (IP 67 with the conformity kit, which is available as an option).
- With or without holding brake
- Straight or angled connectors for power and encoder connection
- Integrated SinCos Hiperface single turn or multiturn encoder (medium or high resolution)
- Untapped or keyed shaft end

BSH and BMH servo motors have been developed to comply with the following main specifications:

- The ambient operating temperature is –20...+ 40 °C (–4...+ 104 °F) without derating, in accordance with standard IEC 60721-3-3, category 3 K3 and up to 55 °C (131 °F) with derating of 1% of the nominal output power per additional 1 °C (1.8 °F) above 40 °C (104 °F).
- The maximum operating altitude is 1000 m (3281 ft) without derating, 2000 m (6562 ft) with k = 0.86 and 3000 m (9843 m) with k = 0.8.
- The relative humidity that the servo motor can withstand is in line with standard IEC 60721-3-3, categories 3 K3, 3Z12 and 3Z2.
- The windings are insulation class F (maximum temperature for windings 155 °C/311 °F) in accordance with standard IEC 60034-1.
- All mounting positions are permitted (horizontal mounting (IMB5) or vertical mounting (IMV1 with shaft end at the top and IMV3 with shaft end at the bottom) in accordance with standard IEC 60034-7.

For more information, refer to :

- BMH, Servo motor, Motor manual, 0198441113749 (ENG)
- BSH, Servo motor, Motor manual, 0198441113837 (ENG)

## Wiring

Schneider Electric provides a wide range of preformed cables for motor and encoder connections between the servo motor and the Lexium 32 drive. An overview about the offer is provided in the appropriate catalog and in the product manual of the Lexium BSH respectively BMH servo motors.

# Lexium 32i Servo Drive - Hardware

## Front View

Lexium 32i servo drive

## Description

With servo motor, servo drive, power supply connector, and I/O and fieldbus module integrated in one housing, the compact Lexium 32i (integrated) is designed for application areas requiring high precision and advanced motor control.

The modular components of the product family Lexium 32i (integrated) can be composed to meet the requirements of a large variety of applications. Minimum wiring as well as a comprehensive range of options and accessories allowing to implement compact, high-performance drive solutions for a wide range of power requirements. Typical application areas for the integration of the Lexium 32i (integrated) are: Material handling, material working, packaging, printing, and so on.

- Easy selection of the catalog components using the on-line configurator
- Easy to integrate with standard fieldbusses and software
- No cabinet space needed for the drive
- Reduce costs by up to 30%
- Easy to assemble and to maintain
- Memory cards allow for copying of parameters and fast device replacement

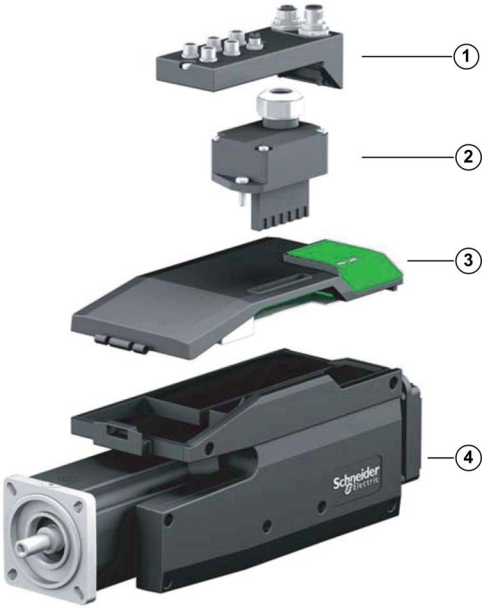
| | |
|---|---|
| Standards and certifications | TÜV Nord, UL, CSA, CiA (CAN in automation) |
| Power range | 0.6 (0.8*)…1.3 (2.2*) kW<br>*3-phase |

| | |
|---|---|
| Voltage range | • 1-phase, 115...240 Vac<br>• 3-phase, 400...480 Vac |
| Speed | up to 3600 rpm |
| Torque | up to 7.8 Nm |
| Communication | Modbus serial link, CANopen, CANmotion, EtherCAT |
| Operating modes | Homing, manual mode (JOG), speed control, current control, position control |
| Functions | • Auto-tuning, monitoring, stopping, conversion<br>• Stop window<br>• Rapid entry of position values |
| I/Os | 4 logic inputs (24 Vdc)<br>2 logic outputs (24 Vdc) |
| Protections | "Safe Torque Off" (STO) |
| Degree of protection | • Casing: IP 65<br>• Shaft end: IP 54 or IP 65 |
| Flange size | 70/100 mm (2.76/3.94 in.) |
| Options | • 2 drive control units<br>• 18 motors with power stage<br>• various connector modules<br>• SoMove setup software<br>• Memory card<br>• Sealing ring<br>• External braking resistors |

For more information, refer to LXM32iCAN BMi, Lexium 32 Integrated, Product manual, 0198441113950 (ENG).

## Assembly

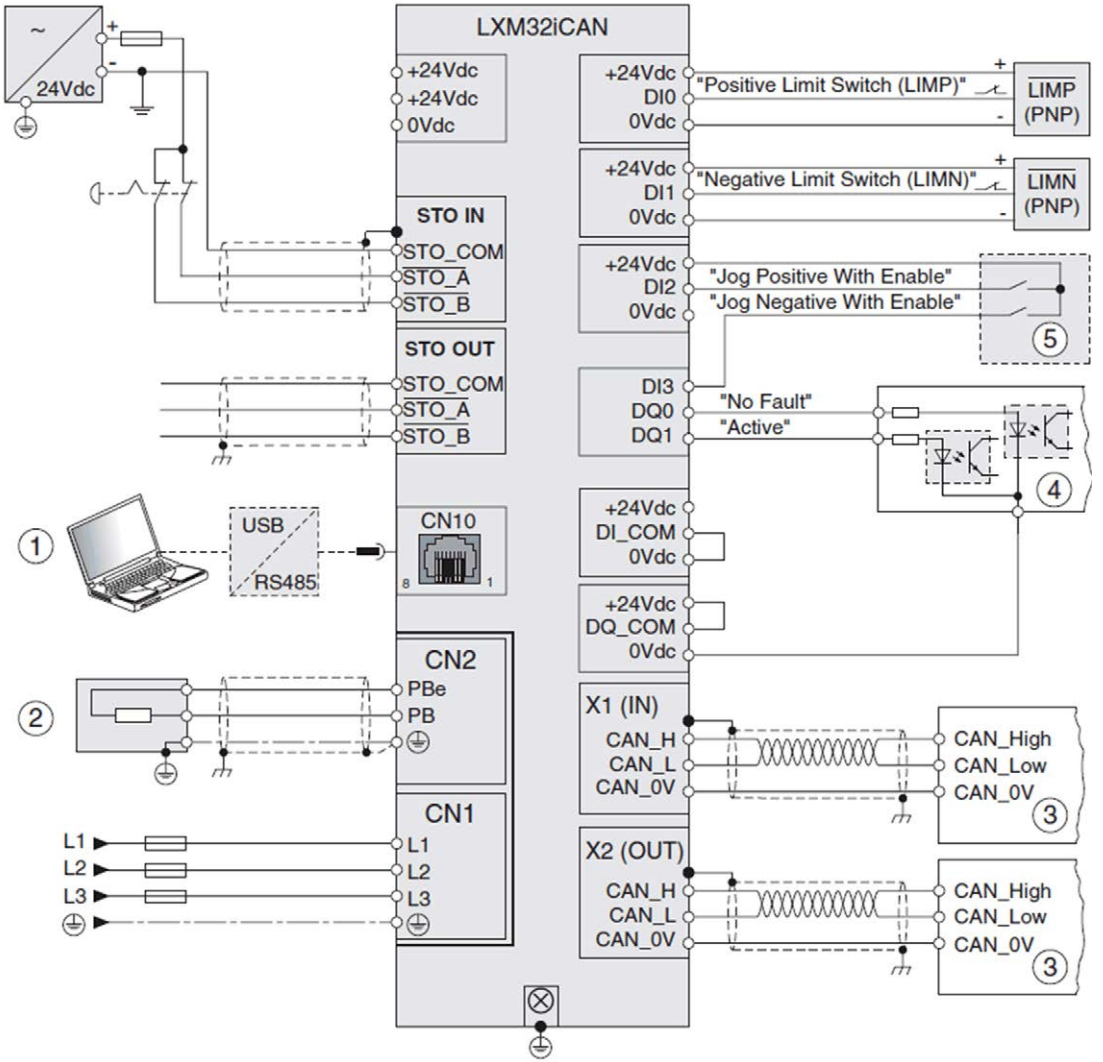
Lexium 32i components




**1** I/O and fieldbus connector module
**2** Power supply connector module
**3** Drive control unit
**4** Motor with power stage

## Wiring

Wiring example




1 Commissioning accessories
2 Standard or external braking resistor
3 CANopen bus device
4 Signal lights or inputs of the controller
5 Test box for commissioning

# Zelio SSR - SSRP Solid-State Relay - Hardware

## Front View

Zelio SSR - SSRP solid-state relay


## Description

Zelio SSR - SSRP solid-state relays are designed for heating control, motion control, lighting control, and switching applications.

They conform to standard IEC 62314, IEC 60950-1, UR E258297, and CSA LR 40787 standards.

SSRP range of solid-state relays are panel mounted. They can be used either on their own or combined with a heat sink for applications requiring considerable heat exchange.

As solid-state switching, SSRP offers:

- Extended service life - offering more reliability
- Complete silence when switching - providing suitability for buildings and hospital applications
- High switching frequency - particularly on packaging and textile machines.

| | |
|---|---|
| Rated operational current (AC) | 10...125 A |
| Rated operational current (DC) | 12…40 A |
| Control voltage range (AC) | 90...280 V |
| Control voltage range (DC) | 3...32 V |
| Load voltage range (AC) | • 24…280 V<br>• 48…530 V<br>• 48…600 V |
| Load voltage range (DC) | 3…100 V |
| Degree of protection | IP 20 |
| Operating temperature range | -40...+80 °C (-40...+176° F) |

| | |
|---|---|
| Dimensions | W x H x D: 47.2 x 58.4 x 35.5 mm (1.86 x 2.23 x 1.4 in.) |

- SSRP offers SCR (semiconductor controlled rectifier) outputs
- SSRP offers combination of DC control and AC, DC load voltage.
  AC control and AC load voltage.

For more information, refer to  Electromechanical and solid-state relays, Zelio relay, Catalog, DIA5ED2120404EN.

## Wiring

Wiring example

# Section 4.7
# Detection

## What Is in This Section?

This section contains the following topics:

# OsiSense XCC Encoder - Hardware

## Front View

OsiSense XCC encoders

## Description

The rotary encoder is an angular position sensor, which is mechanically coupled to a driving spindle of a machine. A wide range of opto-electronic rotary encoder types is offered under the Telemecanique Sensors brand. These are the incremental encoders and the absolute encoders in single-turn and multi-turn model.

Incremental encoders provide counting indication (A, B and index signal) and can be applied for counting, positioning by counting and speed evaluation.

Absolute encoders provide an absolute position within each revolution in terms of binary or Gray code. The multi-turn encoders indicate in addition to the position value the number of revolutions. They can be applied for absolute positioning.

Encoders are offered with M23 connectors or as pre-cabled versions with 2 m long shielded cables. Preferred machines for the integration of the encoders are: Packaging, cranes, automatic dispensers, and so on.

| | |
|---|---|
| Certifications | CE |
| Output type | Incremental encoders:<br>● 5 Vdc output driver RS422<br>● Push-pull output driver (based on supply voltage)<br>Single-turn absolute encoders:<br>● Push-pull output driver, 11…30 Vdc, binary code, or gray code<br>● SSI output without parity, 13-bit clock, 11…30 Vdc, binary code, or gray code<br>Multi-turn absolute encoders:<br>● SSI output without parity, 25-bit clock, 11…30 Vdc, binary code, or gray code |

| | |
|---|---|
| Supply voltage | Incremental encoders:<br>● Push-pull: 5 or 11…30 Vdc<br>● RS422: 4.5...5.5 Vdc or 4.75...30 Vdc<br>Absolute encoders:<br>● 11…30 Vdc |
| Degree of protection | Based on the selected type:IP 52, IP 54, IP 66, IP 67 or IP 69 K |
| Maximum resolution | Incremental encoders:<br>● 100…10.000 points<br>Absolute encoders:<br>● 8192 points/4096 turns<br>● 4096 points/8192 turns |
| Maximum rotational speed | Diameter of shaft <12 mm (0.47 in.): 9000 rpm<br>Diameter of shaft ≥12 mm (0.47 in.): 6000 rpm |
| Type of shaft | Solid shaft or through shaft |
| Diameter of shaft | 6…30 mm (0.24…1.18 in.) |
| Diameter of housing | 40 mm*, 58 mm, or 90 mm (1.57 in.*, 2.28 in., or 3.54 in.)<br>*only incremental encoders |
| Options | Cables, connectors, deserialization jumper cables, mounting and mounting accessories |

For more information, refer to OsiSense XCC, Rotary Encoders, Catalog, 9006CT1101.

# OsiSense Industrial Sensors - Hardware

## Front View

OsiSense industrial sensors product range


## Description

Under the Telemecanique Sensors brand, the latest innovations in the field of sensors for industrial detection operations are offered.

The OsiSense product range consists of safety and limit switches, pressure control sensors, ultrasonic sensors, inductive and capacitive proximity sensors, and so on.

For more information, refer to  Detection for automation solutions OsiSense, MKTED210041EN.

# Chapter 5
# Communication Topology and Wiring Guide

## What Is in This Chapter?

This chapter contains the following sections:

# Section 5.1
# Introduction to System Communication

## Introduction

### Overview

The TVDA (Tested Validated Documented Architecture) includes five different communication networks.

- CANopen
  The CANopen fieldbus is defined with the Modicon LMC078 Motion Controller as CANopen master. The Altivar 32 drives, Lexium 32i integrated drive, and TeSys U are CANopen slave nodes.
  The CANopen transmission rate is 500 kbps.
- Sercos
  The Sercos fieldbus is defined with the Modicon LMC078 Motion Controller as master. The Lexium 32S servo drives and Modicon TM5 I/O island are slave nodes.
  The network structure of the Sercos fieldbus is realized as a ring structure. The ring structure provides full media redundancy in case of one cable interruption within the ring.
- Ethernet
  The Ethernet network is used for the communication between the Modicon LMC078 Motion Controller and the Magelis panel HMI GTO. The communication is based on the SoMachine network protocol. Both devices are connected via an Ethernet switch.In addition, a PC can be connected to the Ethernet for downloading and online monitoring of the application.
- Modbus SL
  The Modbus SL RS-485 2-wire network is used for the communication between the Modicon LMC078 Motion Controller (Master) and the power meter PM3250 (Slave).
- TM7 I/O bus
  The TM7 I/O bus is used for the expansion of the TM5 I/O island with a TM7 I/O block. The data of the modules within the TM5/TM7 distributed I/O system are exchanged with the Modicon LMC078 Motion Controller through the TM5 Sercos III interface module.

# Section 5.2
## CANopen Network

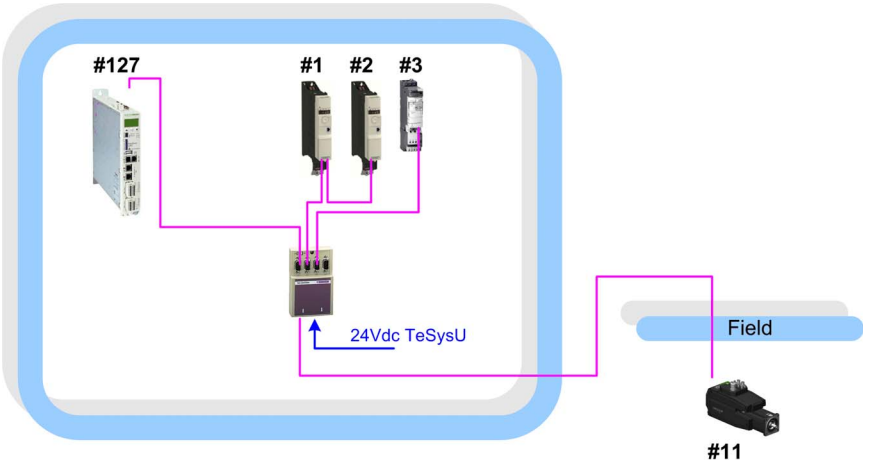
### What Is in This Section?

This section contains the following topics:

# CANopen Network Topology

## CANopen Topology

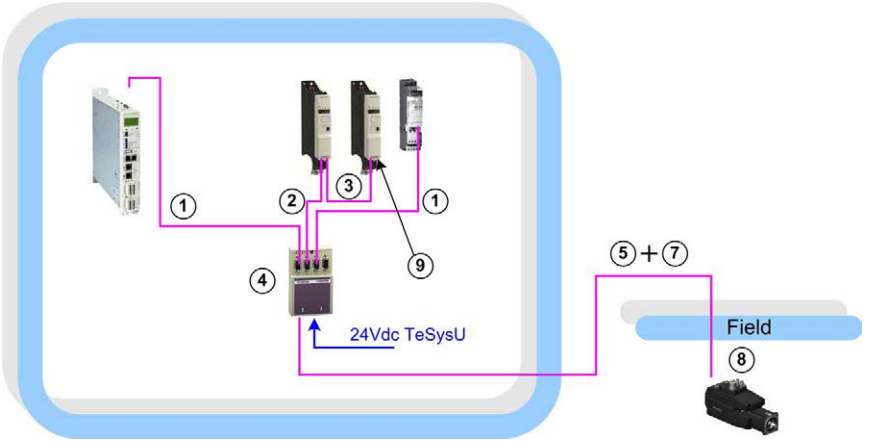
The baud rate used is 500 kbps.




**#...** Node address

# CANopen Wiring

## CANopen Overview




For the position numbers, refer to table below *(see Distributed CANmotion Motion Controller LMC058, System User Guide)*.

For more information, refer to CANopen, Hardware Setup Manual, 35010857.

## CANopen Wiring

| Reference | Designation | Description | Position | Cable Length |
|---|---|---|---|---|
| TSX CAN CADD03 | preformed cordset standard, CE marking: low smoke emission, zero halogen. flame-retardant (IEC 60332-1) | one 9-way female SUB-D connector at each end | 1 | 0.3 m (0.98 ft) |
| TSX CAN CADD1 | | | | 1.0 m (3.28 ft) |
| TSX CAN CADD3 | | | | 3.0 m (9.84 ft) |
| TSX CAN CADD5 | | | | 5.0 m (16.40 ft) |
| TCS CCN 4F3M05T | preformed cordset | one 9-way SUB-D connector, one RJ 45 connector | 2 | 0.5 m (1.64 ft) |
| TCS CCN 4F3M1T | | | | 1.0 m (3.28 ft) |
| TCS CCN 4F3M3T | | | | 3.0 m (9.84 ft) |
| VW3 CAN CARR03 | preformed cordset | one RJ 45 connector at each end | 3 | 0.3 m (0.98 ft) |
| VW3 CAN CARR01 | | | | 1.0 m (3.28 ft) |
| TSX CAN TDM4 | IP20 CANopen tap junction | 4 SUB-D ports, screw terminal block for connecting the trunk cables, line termination | 4 | - |

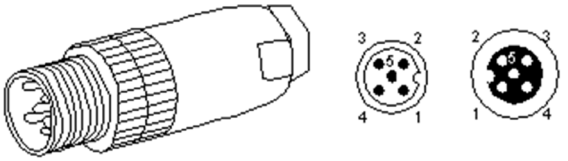
| Reference | Designation | Description | Position | Cable Length |
|---|---|---|---|---|
| TSX CAN CA••• | dedicated to the European market<br>low smoke emission, zero halogen, fire retarding | CANopen cable | 5 | 50 m (164 ft) |
| TSX CAN CB••• | dedicated to the American market, UL and CSA certified, fire retarding | | | 100 m (328 ft) |
| TSX CAN CD••• | flexible cable for severe environments, very good chemical resistance to oil and grease, low smoke emission, zero halogen, fire retarding and ready for mobile applications | | | 300 m (984 ft) |
| FTX CN 3203 | preformed cordset | two 5-way M12 A-coded angled connectors (one male connector and one female connector) | – | 0.3 m (0.98 ft) |
| FTX CN 3206 | | | | 0.6 m (1.96 ft) |
| FTX CN 3210 | | | | 1.0 m (3.28 ft) |
| FTX CN 3220 | | | | 2.0 m (6.56 ft) |
| FTX CN 3230 | | | | 3.0 m (9.84 ft) |
| FTX CN 3250 | | | | 5.0 m (16.40 ft) |
| FTX CN 12F5 | IP67 M12 connectors | 5-way M12 A-coded connectors female | 7 | – |
| TM7ACTLA | IP67 line terminator | with one M12 connector (for end of bus) | 8 | – |
| TCS CAR 013M120 | IP20 line terminator | RJ 45 termination resistor (for end of bus) | 9 | – |
| VW3 M38 05 R010 | preformed cordset | one 9-way SUB-D connector,<br>one RJ 45 connector with termination resistor | – | 1.0 m (3.28 ft) |
| TCS CTN 023F13M03 | IP20 daisy-chain connector | one RJ 45 plug and 2 RJ 45 sockets | – | 0.3 m (0.98 ft) |
| TSX CAN KCDF90T | IP20 connectors CANopen female 9-way SUB-D, switch for line termination | 90° angled | – | – |
| TSX CAN KCDF180T | | straight | | |
| TSX CAN KCDF90TP | | right angle with 9-way SUB-D for connecting a PC or diagnostic tool | | |

## IP67 M12 Cable Connector

Schneider Electric provides 2 types of IP67 M12 connectors:

| | |
|---|---|
| male | FTX CN 12M5 |
| female | FTX CN 12F5 |

IP67 M12 cable connector (5-pin M12 male BUS IN, female BUS OUT):




Pin assignment of the BUS IN and BUS OUT connector pins:

| Pin | Signal | Meaning |
|---|---|---|
| 1 | (CAN_SHLD) | optional CAN shield |
| 2 | (CAN_V+) | optional CAN external positive supply |
| 3 | CAN_GND | CAN ground |
| 4 | CAN_H | CAN_H bus line |
| 5 | CAN_L | CAN_L bus line |

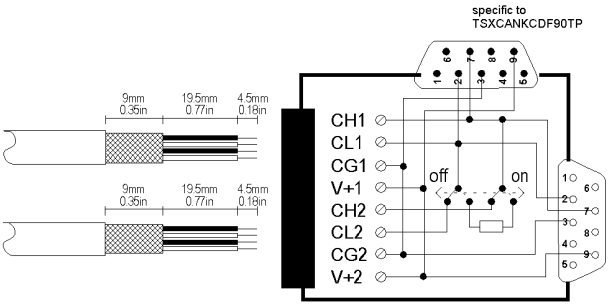
The wiring connections has to comply with the combinations described in the table above.

## SUB-D 9 Cable Connectors

Schneider Electric provides the following types of SUB-D 9 cable connectors:

| Schneider Electric Cable Connector | Characteristics |
|---|---|
| TSX CAN KCDF90T | 90° cable |
| TSX CAN KCDF180T | 180° cable |
| TSX CAN KCDF90TP | • 90° lead<br>• male connector available for temporary connection of a diagnostic tool |

The figure below shows the wiring of TSX CAN KCDF90T, TSX CAN KCDF180T and TSX CAN KCDF90TP:




When using the Schneider Electric standard CANopen cable (TSX CAN CA•••, TSX CAN CB••• or TSX CAN CD•••),comply with the wiring combinations (signal, wire color) described in the table below.

The table shows terminal block wiring depending on the signal:

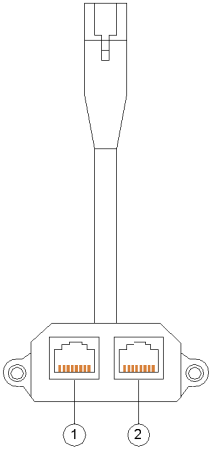
| Pin | Signal | Terminal Block 1, Incoming Cable | Terminal Block 2, Outgoing Cable | Wire Color | Description |
|---|---|---|---|---|---|
| 1 | N.C. | – | – | – | not connected |
| 2 | CAN_L | CL1 | CL2 | blue | CAN_L bus line |
| 3 | CAN_GND | CG1 | CG2 | black | CAN ground |
| 4 | N.C. | – | – | – | not connected |
| 5 | (CAN_SHLD) | – | – | – | optional CAN shield |
| 6 | GND | – | – | – | ground, connection to pin 3 |
| 7 | CAN_H | CH1 | CH2 | white | CAN_H bus line |
| 8 | N.C. | – | – | – | not connected |
| 9 | (CAN_V+) | V+1 | V+2 | red | optional CAN external positive supply |

The wiring connections has to comply with the combinations described in the table above.

## Daisy-Chain Connector

The TCS CTN 023F13M03 provides a Y-junction for RJ45 connectors, thus allowing to daisy chain the CAN cable.

The figure below shows the mechanical view of the daisy chain connector:




**1** in connector
**2** out connector

Even though the visible cable length of this connector is 0.30 m (0.98 ft) you have to consider an absolute length of 0.60 m (1.97 ft) when calculating the maximum cable length due to its electrical wiring.

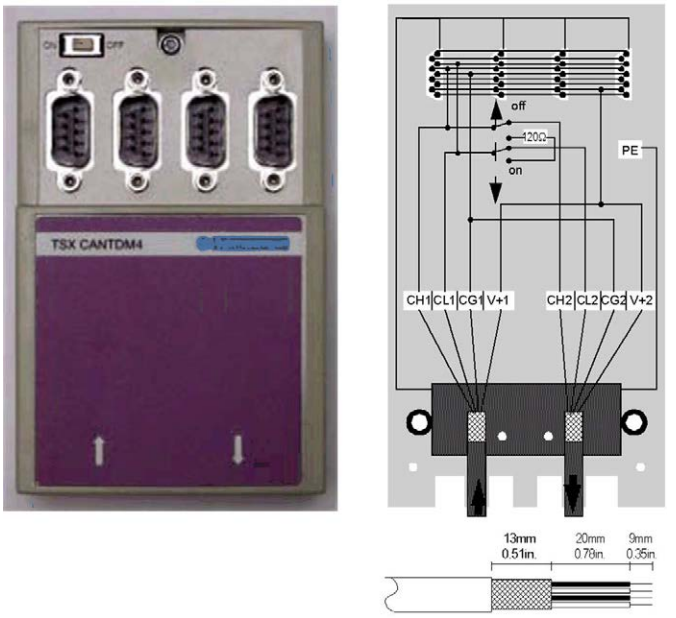
The pins used for Modbus SL signals, which are provided by ATV31, ATV71, Lexium05 and VWCANTAP2 only, are wired through the daisy-chain connector.

## TSX CAN TDM4

The TSX CAN TDM4 tap allows connection of 4 devices by branching the drop cable to the 4 male SUB-D 9 plugs.

A line termination switch is provided to switch a built-in termination resistor. If the line termination switch is switched ON, the signals `CAN_H` and `CAN_L` of the outgoing cable are disconnected.

TSX CAN TDM4 with line termination switch




The wiring connections has to comply with the combinations described in the following table.

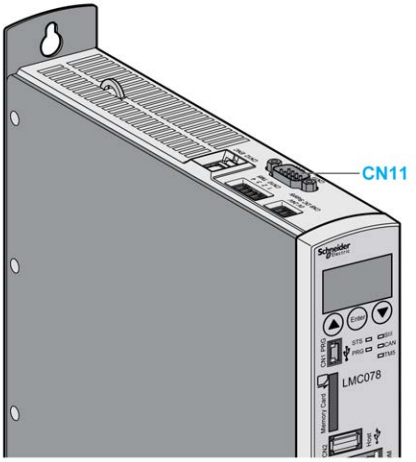
The table shows terminal block wiring depending on the signal:

| Signal | Terminal Block 1 | Terminal Block 2 | Wire Color | Description |
|---|---|---|---|---|
| CAN_H | CH1 | CH2 | white | CAN_H bus line |
| CAN_L | CL1 | CL2 | blue | CAN_L bus line |
| CAN_GND | CG1 | CG2 | black | CAN ground |
| CAN_V+ | V+1 | V+2 | red | optional CAN external positive supply |

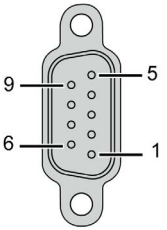
**NOTE:** When using devices which require a 24 Vdc power supply on CANopen line (such as TeSys U) the 24 Vdc power has to be wired (V+1: 24 Vdc, CG1: 0 Vdc).

# Modicon LMC078 Motion Controller - CANopen Wiring

## CANopen Port




## Pin Assignment



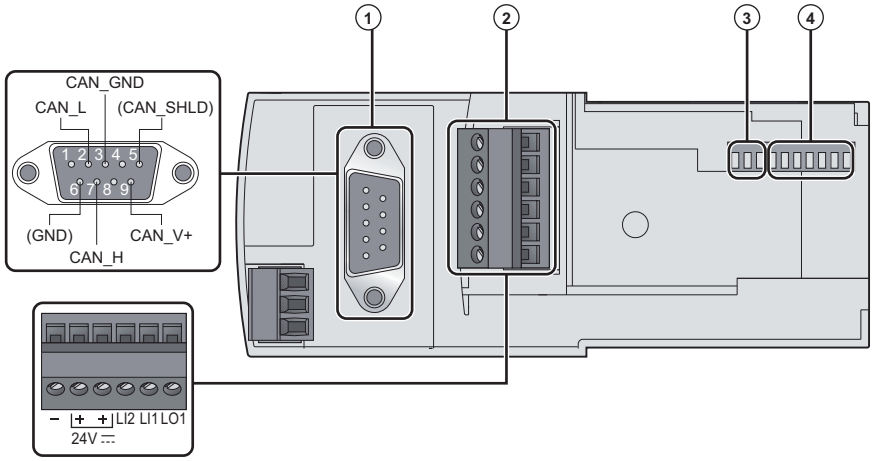

| Pin | Signal | Description |
|---|---|---|
| 1 | N.C. | not connected |
| 2 | CAN_L | CAN_L bus line (low) |
| 3 | CAN_GND | CAN ground |
| 4 | N.C. | not connected |
| 5 | N.C. | not connected |
| 6 | GND | 0 Vdc |
| 7 | CAN_H | CAN_H bus line (high) |

| Pin | Signal | Description |
|---|---|---|
| 8 | N.C. | not connected |
| 9 | N.C. | not connected |

# TeSys U Communication Module LULC08 - CANopen Wiring

## Bottom View

Bottom view of a TeSys U communication module LULC08




1 CANopen SUB-D 9 connector
2 Input/output terminal block and 24 Vdc
3 Baud rate
4 Address

**NOTE:** The 24 V power supply of the LULC08 is internally connected to the CAN_V+ pin of the CANopen connector and must be provided with the CAN link. If you do not use the CANopen sensor power supply for your application, do not connect the CAN_V+ wire of the outgoing CAN cable to the pin 9 of the LULC08 communication module.

## Address Setting

The address of the communication module on the CANopen bus is the node ID. The system allows you to assign an address from 1 to 127, using the 7 right-most switches (SW1 to SW7). Address 0 (zero) is not allowed and is considered as an invalid configuration.

Example: Node address = 21 ($2^4+2^2+2^0$)

| SW7 ($2^6$) | SW6 ($2^5$) | SW5 ($2^4$) | SW4 ($2^3$) | SW3 ($2^2$) | SW2 ($2^1$) | SW1 ($2^0$) |
|---|---|---|---|---|---|---|
| OFF | OFF | ON | OFF | ON | OFF | ON |

## Baud Rate

The system allows you to assign a baud rate using the 3 left-most switches (SW8 to SW10). The baud rate is according to the decimal value of the switches and will be interpreted as follows: 0 = 10, 1 = 20, 2 = 50, 3 = 125, 4 = 250, 5 = 500, 6 = 800 and 7 = 1000 kbps.

Example: Baud rate = 500 kbps ($2^2+2^0$)

| SW10 ($2^2$) | SW9 ($2^1$) | SW8 ($2^0$) |
|---|---|---|
| ON | OFF | ON |

# Altivar 32 Variable Speed Drive - CANopen Wiring

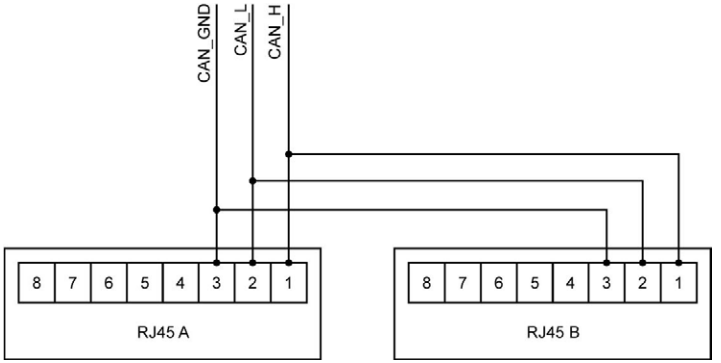
## Altivar 32 with Dual RJ45 Connector (VW3 A36 08)

For this architecture, the Altivar 32 variable speed drive has been equipped with the CANopen communication adapter VW3 A36 08 (dual RJ45 connector).

Using this adapter allows to daisy chain the CAN bus between the Altivar 32 drives.

**NOTE:** Maximum bus length are divided by 2 with the communication adapter (VW3 A36 08)

Both RJ45 are interconnected internally as on the diagram below:



## Pin Assignment

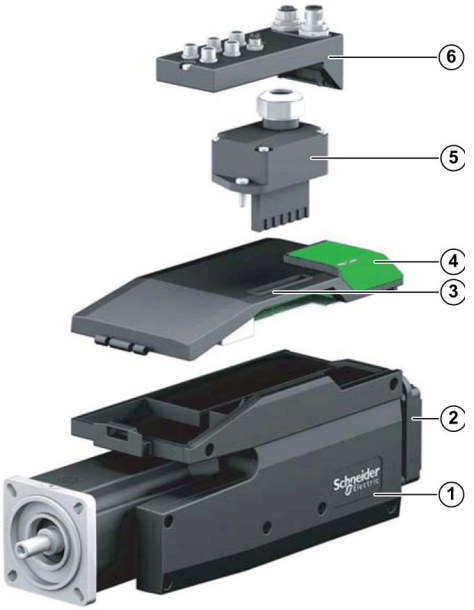
| Pin | Signal | Description |
|---|---|---|
| 1 | CAN_H | CAN_H bus line |
| 2 | CAN_L | CAN_L bus line |
| 3 | CAN_GND | CAN ground |
| 4 | N.C. | not connected |
| 5 | N.C. | not connected |
| 6 | N.C. | not connected |
| 7 | N.C. | not connected |
| 8 | N.C. | not connected |

## Communication Settings

The Altivar 32 has to be configured for the operation on the CANopen fieldbus (node address, baud rate, and control channel). This can be done either via the local HMI on the front or via a commissioning software, for example, SoMove.

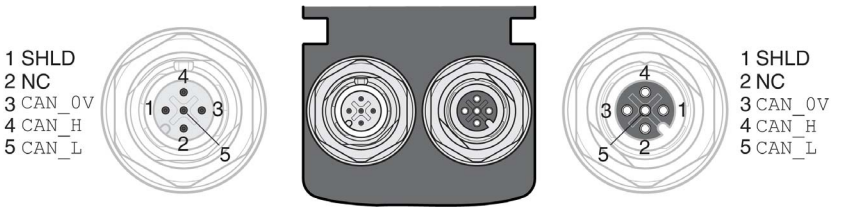
# Lexium 32i Servo Drive - CANopen Wiring

## Overview




1 BMi servomotor with integrated power stage
2 Standard braking resistor or connection module for external braking resistor
3 Lexium 32i control unit for CAN fieldbus
4 Cover of commissioning interface
5 Connection module for supply voltage
6 I/O module / connection module for fieldbus, inputs/outputs and STO, versions with terminal box or industrial connector

## I/O Module with Industrial Connectors

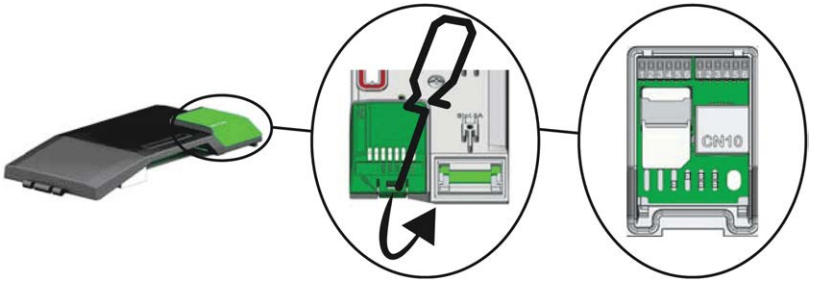


## Commissioning Interface

The following components can be found below the cover of the commissioning interface:

- DIP switch for address and baud rate
- card holder for the memory card
- commissioning interface CN10

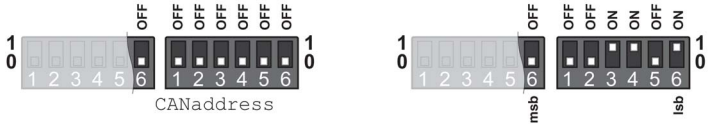
The cover of the commissioning interface can be opened with a flat blade screwdriver.




With the factory settings active, the address and the baud rate can be set via the parameters CANbaud and CANaddress. It is also possible to set the address and the baud rate via the DIP switches located below the cover of the commissioning interface. If the DIP switches are used, the values set via the parameters are ignored.

## Address Setting

DIP switch device address (example to the right: device address 13 with DIP switches)

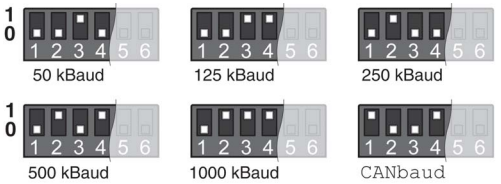



Example: Node address = 13 ($2^3+2^2+2^0$)

| Switch | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Address bit | 6 ($2^6$) | 5 ($2^5$) | 4 ($2^4$) | 3 ($2^3$) | 2 ($2^2$) | 1 ($2^1$) | 0 ($2^0$) |
| State | OFF | OFF | OFF | ON | ON | OFF | ON |

## Baud Rate

The following DIP switch settings to assign the baud rate are possible. The settings for CANbaud means the baud rate has to be set by the commissioning software via the parameter CANbaud.


1
0
1 2 3 4 5 6
50 kBaud
125 kBaud
250 kBaud
500 kBaud
1000 kBaud
CANbaud

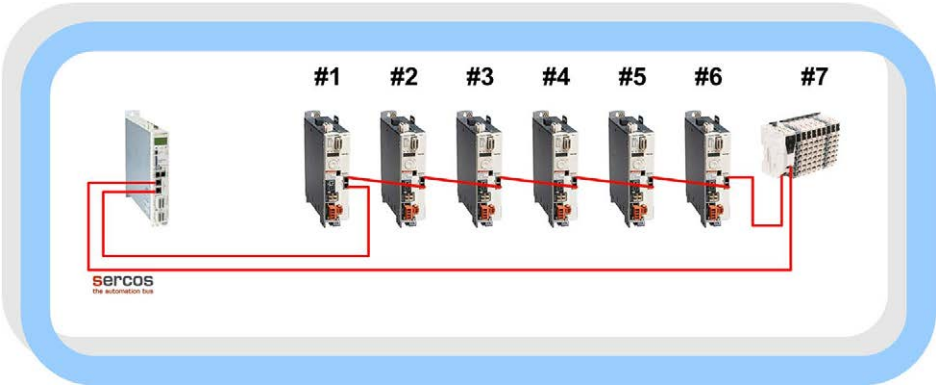
# Section 5.3
## Sercos Network

### What Is in This Section?

This section contains the following topics:

# Sercos Network Topology

## Sercos Topology

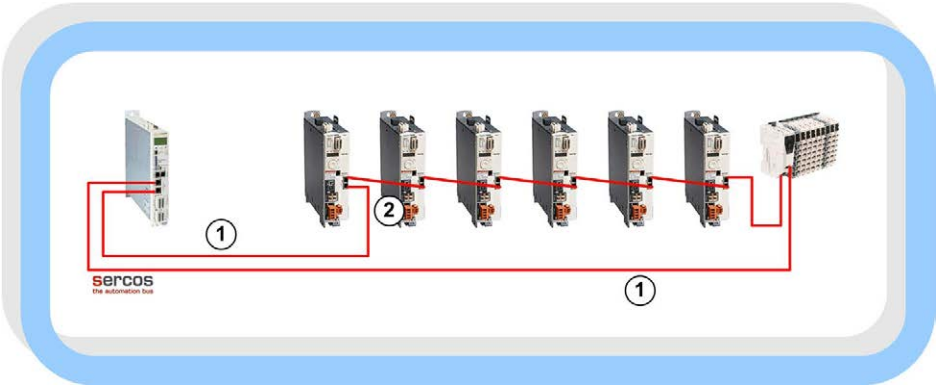



**#...** Sercos address

The Sercos ring topology offers bidirectional full-duplex Ethernet communication. There is full media redundancy in the event of a cable break. There is no interruption of communications even if the ring is disconnected by pulling the plug.

# Sercos Wiring

## Sercos Overview




For the position numbers, refer to table below *(see Distributed CANmotion Motion Controller LMC058, System User Guide)*.

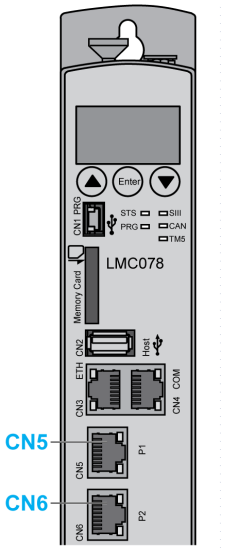
## Sercos Wiring

| Reference | Designation | Description | Position | Cable length |
|---|---|---|---|---|
| VW3E5001R••• | Sercos patch cable | One RJ45 connector at each end | 1 | 0.5…10 m (1.64…32.8 ft) |
| VW3E5001S018 | | | 2 | 0.18 m (0.59 ft) |

# Modicon LMC078 Motion Controller - Sercos Wiring

## Sercos Ports

This illustration shows the location of the Sercos ports of the controller:

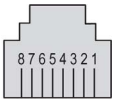



**CN5** Sercos, port 1 (**P1**)
**CN6** Sercos, port 2 (**P2**)

| Characteristic | Description |
|---|---|
| Standard | Sercos (Master) |
| Connector type | RJ45 |
| Supported devices | • Up to 8 LXM32S synchronized at 1 ms<br>• Up to 16 LXM32S synchronized at 2 ms<br>• Up to 10 TM5 Sercos III bus interfaces |

## Pin Assignment

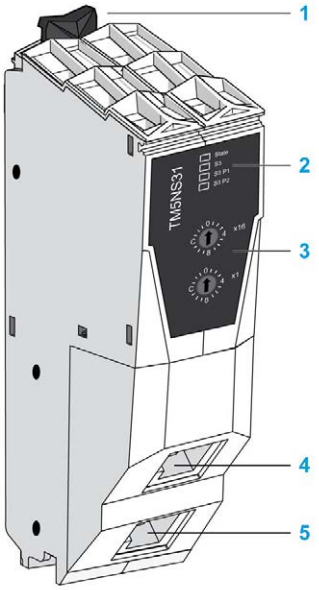
RJ45 Sercos connector



| RJ45 Pin | Signal | Description |
|---|---|---|
| 1 | TD+ | Transmit data + |
| 2 | TD- | Transmit data - |
| 3 | RD+ | Received data + |
| 4 | - | No connection |
| 5 | - | No connection |
| 6 | RD- | Received data - |
| 7 | - | No connection |
| 8 | - | No connection |

# Modicon TM5NS31 Sercos Interface Module - Sercos Wiring

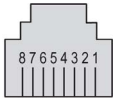
## Overview




**1** Locking clip
**2** Status LEDs
**3** Sercos address setting rotary switches
**4** Sercos connectors (RJ45)

## Pin Assignment

RJ45 Sercos connector



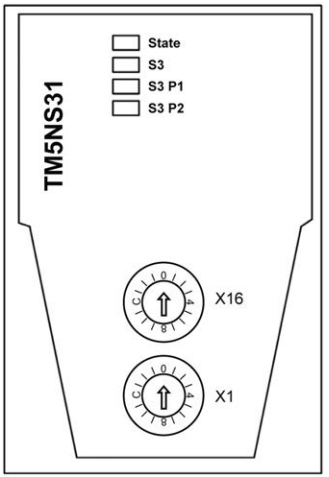

| RJ45 pin | Signal | Description |
|---|---|---|
| 1 | TD+ | Transmit data + |
| 2 | TD- | Transmit data - |
| 3 | RD+ | Received data + |
| 4 | - | No connection |

| RJ45 pin | Signal | Description |
|---|---|---|
| 5 | - | No connection |
| 6 | RD- | Received data - |
| 7 | - | No connection |
| 8 | - | No connection |

## Address Settings

The Sercos interface module address (1...255, decimal) is configured using the two rotary switches at the front of the device. The factory setting of the rotary switches is 0.

The Sercos address is represented in hexadecimal code at the rotary switches at the front of the bus interface. Thereby the upper rotary wheel represents the four most significant bits and the lower rotary switch represents the four least significant bits of the address. For example, the address 134 is represented in hexadecimal code by 86 h. For the address 134, the rotary switches must be set to 8 (upper) and 6 (lower).



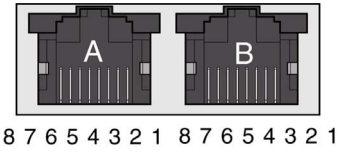
# Lexium 32S - Sercos Wiring

## Lexium 32S with Dual Port Sercos Communication Module (VW3 M3619)

For more information, refer to the LXM32S, AC servo drive, Product manual, 0198441114060 (ENG).

### Pin Assignment

The VW3 A3 619 option card is equipped with two RJ45 female sockets for the Sercos connection.



| RJ45 pin | Signal | Description |
|---|---|---|
| 1 | TD+ | Transmit data + |
| 2 | TD- | Transmit data - |
| 3 | RD+ | Received data + |
| 4 | - | No connection |
| 5 | - | No connection |
| 6 | RD- | Received data - |
| 7 | - | No connection |
| 8 | - | No connection |

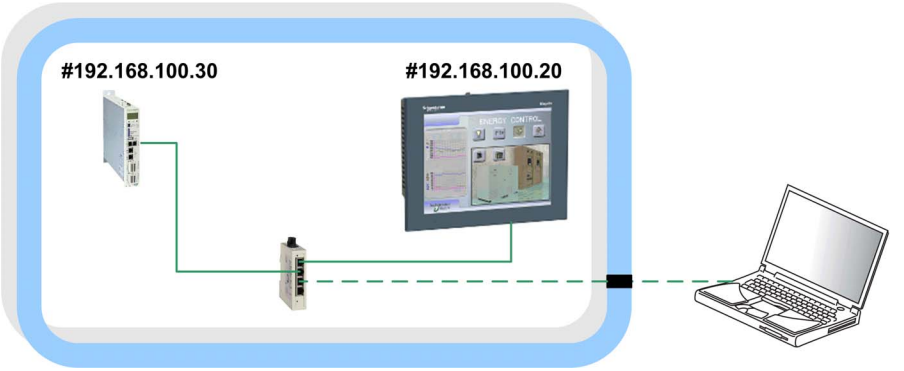
# Section 5.4
## Ethernet Network

### What Is in This Section?

This section contains the following topics:

# Ethernet Network Topology

## Ethernet Topology




**#...** node address

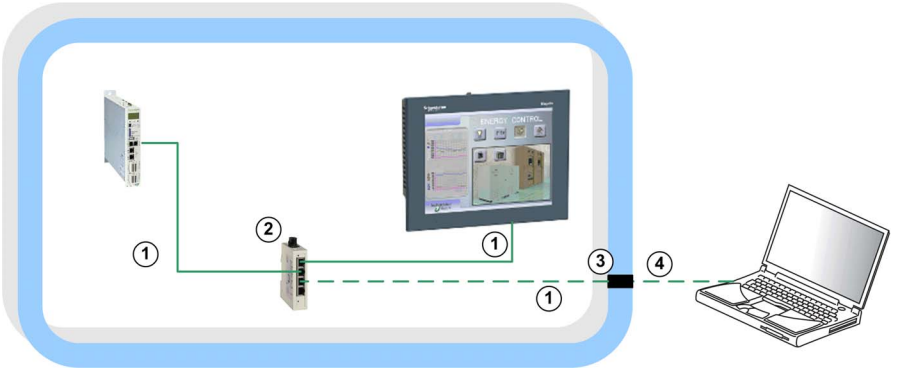
The subnet mask is: 255.255.255.0.

Optionally a PC can be linked to the Ethernet network.

**NOTE:** The Ethernet address of the controller must be outside the address range of the Sercos network. The Sercos network is defined with 172.20.0.0/22 (172.20.0.1 ... 172.20.3.255) and cannot be changed.

# Ethernet Wiring

## Overview Ethernet




For more information, refer to  Transparent Ready, User Guide, 31006929.

## Wiring Accessories

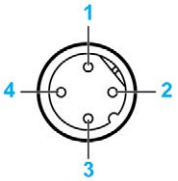
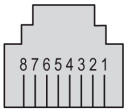
| Reference | Designation | Description | Position | Cable length |
|---|---|---|---|---|
| 490NTW00002 | Ethernet patch cable - shielded twisted-pair straight cord | One RJ45 connector at each end | 1 | 2.0 m (6.56 ft) |
| 490NTW00005 | | | | 5.0 m (16.40 ft) |
| TCSEAAF11F13F00 | ConneXium M12 to RJ45 Ethernet adapter | Adapter for panel mounting | 3 | - |
| TCSECL1M3M3S2 | Ethernet patch cable - shielded twisted pair | One IP 67, M12, 4-pin (D-coded) connector and one RJ45 connector | 4 | 3.0 m (9.84 ft) |

## Switch

| Reference | Designation | Description | Position |
|---|---|---|---|
| TCSESU053FN0 | ConneXium Ethernet TCP/IP unmanaged switch | 5x 10BASE-T/100BASE-TX ports (copper cable), RJ45 shielded connectors | 2 |

## ConneXium Ethernet Adapter

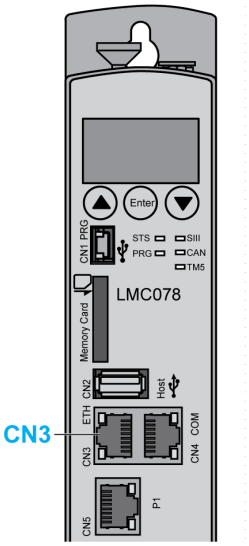
TCSEAAF11F13F00

| M12 connector (D-Coded) | M12 pin | Signal | Description | RJ45 pin | RJ45 connector |
|---|---|---|---|---|---|
|   | 1 | TD+ | Transmit data + | 1 |   |
| | 2 | RD+ | Received data + | 3 | |
| | 3 | TD- | transmit data - | 2 | |
| | 4 | RD- | Received data - | 6 | |
| | - | - | Not connected | 4 | |
| | - | - | Not connected | 5 | |
| | - | - | Not connected | 7 | |
| | - | - | Not connected | 8 | |

# Modicon LMC078 Motion Controller - Ethernet Wiring

## Ethernet Port

Ethernet port of the controller (**CN3** port)

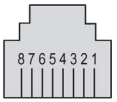



| Characteristic | Description |
|---|---|
| Standard | Ethernet |
| Connector type | RJ45 |
| Baud rate | Supports Ethernet 10/100/1000 Base-T with auto-negotiation |
| Auto-crossover | MDI / MDIX |
| Protocol supported | • SoMachine protocol<br>• Modbus TCP client/server<br>• FTP server<br>• HTTP server<br>• SNMP |
| IP address negotiation type supported | • DHCP<br>• BOOTP<br>• Configured IP |
| Supplied current | No |

For more information, refer to Modicon LMC078 Motion Controller, Hardware Guide, EIO0000001925.

## Pin Assignment

RJ45 Ethernet connector




| RJ45 pin | Signal | Description |
|---|---|---|
| 1 | TD+ | Transmit data + |
| 2 | TD- | Transmit data - |
| 3 | RD+ | Received data + |
| 4 | - | No connection |
| 5 | - | No connection |
| 6 | RD- | Received data - |
| 7 | - | No connection |
| 8 | - | No connection |

**NOTE:** The controller supports the MDI/MDIX auto-crossover cable function. It is not necessary to use special Ethernet crossover cables to connect devices directly to this port (connections without an Ethernet hub or switch).

# Magelis HMI GTO5310 - Ethernet Wiring

## Ethernet Port

The Ethernet connection is used for the communication between the controller and the HMI. The Magelis panel HMI GTO provides an RJ45 port for Ethernet TCP/IP link, 10BASE-T/100BASE-TX with an activity LED to communicate with the controller and the PC.


**1** RJ45 connector

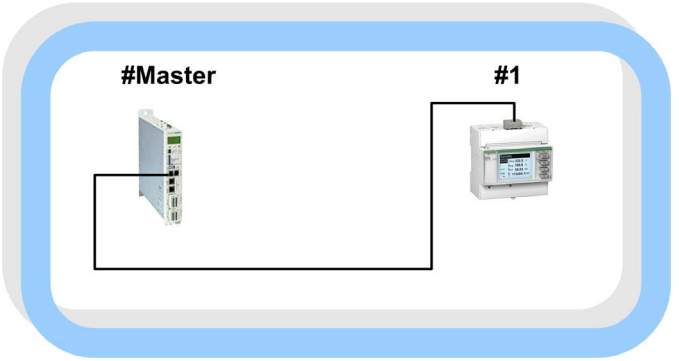
# Section 5.5
## Modbus Serial Line Network

### What Is in This Section?

This section contains the following topics:

# Modbus SL Network Topology

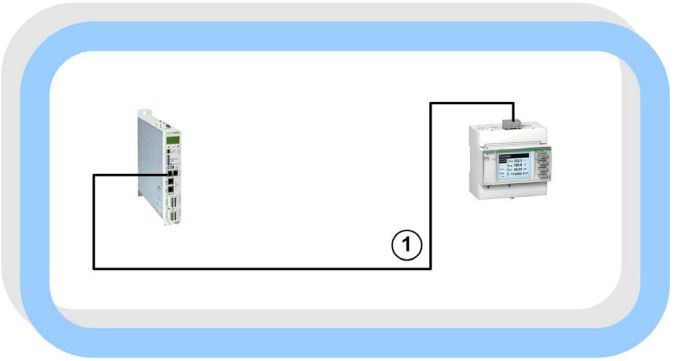
## Modbus SL Topology




**#...** node address

# Modbus SL Wiring

## Modbus SL Overview




For more information, refer to  Modbus Serial Line, Planning and Installation Guide, 33003925.

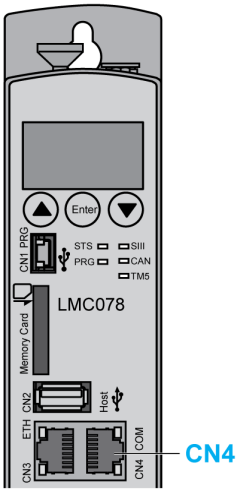
## Cable

| Reference | Designation | Description | Position | Cable Length |
|---|---|---|---|---|
| VW3A8306D30 | Modbus SL drop cable | 1 RJ45 connector and one end stripped | 1 | 3.0 m (9.8 ft) |

# Modicon LMC078 Motion Controller - Modbus SL Wiring

## Modbus SL Port

Serial line port of the controller (**CN4** port)




The serial line

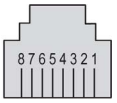
- is used to communicate to Modbus SL devices via RS-485/RS-232
- supports master and slave mode
- supports ASCII protocol (for example printer or modem)
- supports SoMachine protocol (for example HMI)

For more information, refer to Modicon LMC078 Motion Controller, Hardware Guide, EIO0000001925.

## Pin Assignment

For this architecture, the port is configured as an RS-485.

Pins for RS-485




| Pin | Signal RS-485 | Description |
|---|---|---|
| 1 | - | Reserved |

| Pin | Signal RS-485 | Description |
|---|---|---|
| 2 | - | Reserved |
| 3 | - | Reserved |
| 4 | D1 | Modbus SL: D1 (+/B) RS-485 2-wire |
| 5 | D0 | Modbus SL: D0 (-/A) RS-485 2-wire |
| 6 | - | Reserved |
| 7 | - | Reserved |
| 8 | 0 Vdc | Common |

**NOTE:** The pin assignment for the RS-232 connections differs from other Modicon controllers. For more information, refer to the Modicon LMC078 Motion Controller, Hardware Guide, EIO0000001925.

**⚠ WARNING**

**UNINTENDED EQUIPMENT OPERATION**

Do not connect wires to unused terminals and/or terminals indicated as “No Connection (N.C.)”.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

## Communication Settings

The Modbus SL port of the controller has to be configured within SoMachine.

- Baud rate: 19.2 kbps
- Parity: even
- Stop bit: 1
- Physical medium: RS-485 2-wire

## Line Polarization

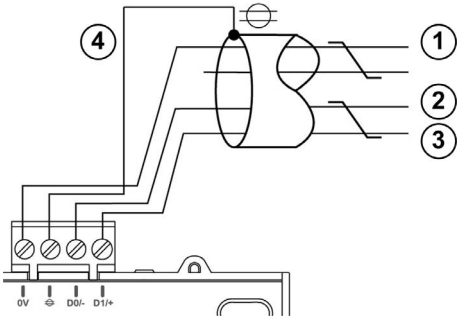
Line polarization is provided by the controller.

# PM3250 Power Meter - Modbus SL Wiring

## Modbus SL Port


1 Modbus SL RS-485 2-wire port

## Pin Assignment




| Item | Signal | Description |
|---|---|---|
| 1 | SNG | Modbus SL signal ground |
| 2 | D0 | Modbus SL: D0 (-/A) RS-485 2-wire |
| 3 | D1 | Modbus SL: D1 (+/B) RS-485 2-wire |
| 4 | SHLD | Modbus SL shield |

## Communication Settings

The Modbus SL port of the controller has to be configured via the local HMI on the front.

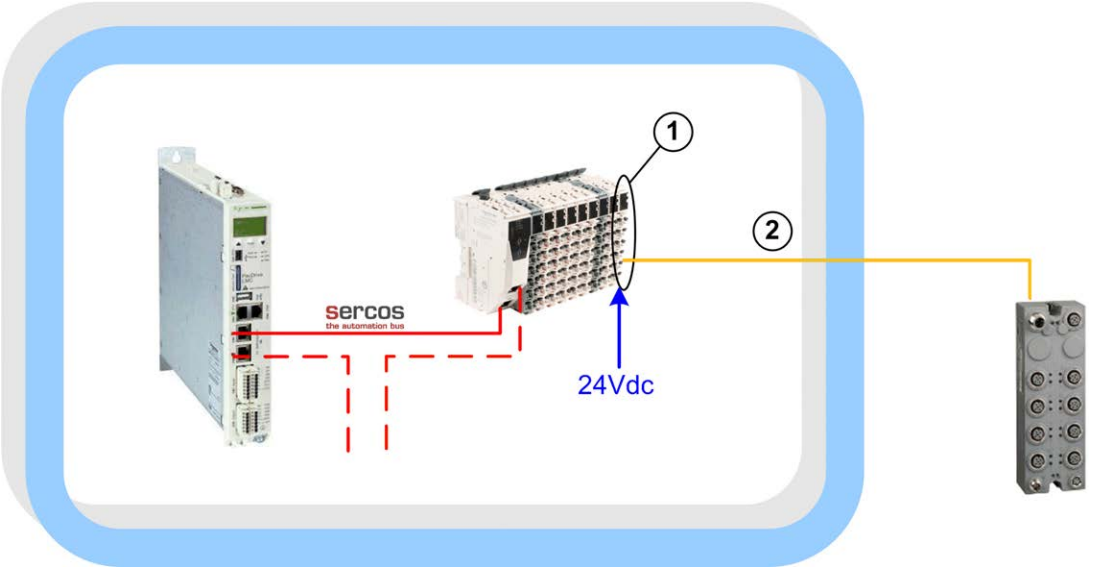
# Section 5.6
## TM7 I/O Bus

### What Is in This Section?

This section contains the following topics:

# TM7 I/O Bus Network Topology and Wiring

## TM7 I/O Bus Overview




For the position numbers, refer to table below.

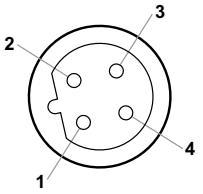
For more information, refer to the Modicon TM5 / TM7 Flexible System, System Planning and Installation Guide, EIO0000000426 (ENG).

## TM7 I/O Bus Wiring Accessories

| Reference | Designation | Description | Position | Cable length |
|---|---|---|---|---|
| TM5SBET7 | TM7 bus transmitter module | Transmits the TM7 data bus and provides the TM7 power bus to the TM7 expansion I/O blocks. | 1 | – |
| TCSXCN2FNX1E | TM7 expansion bus cable | For the TM7 bus link between the TM5SBET7 (TM7 bus transmitter module) and a TM7 IP 67 I/O block. | 2 | 1 m (3.28 ft) |
| TCSXCN2FNX3E | | | | 3 m (9.84 ft) |
| TCSXCN2FNX10E | | | | 10 m (32.8 ft) |
| TCSXCN2FNX25E | | | | 25 m (82 ft) |

## TCSXCN2FNX••E - Expansion Bus Cable

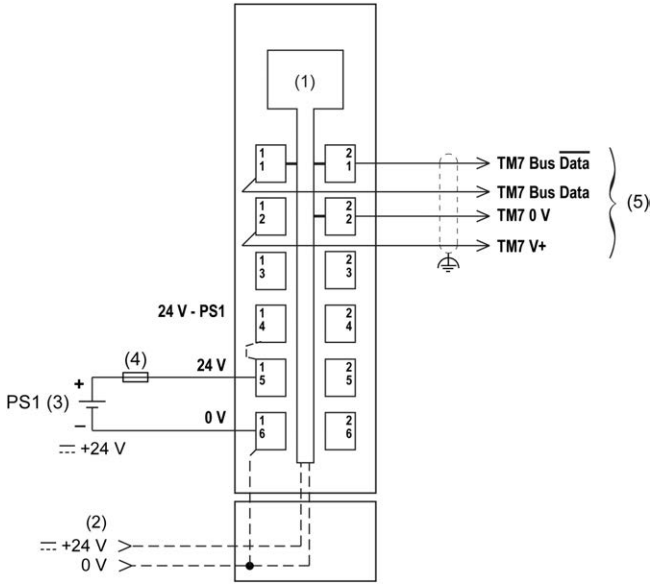
Configuration of the expansion bus cable TCSXCN•FNX••E, used for the TM7 bus link between the TM5SBET7 (TM7 bus transmitter module) and a TM7 IP 67 I/O block

| Female connector | Pin | Designation | Wire color | Open |
|---|---|---|---|---|
|  | 1 | TM7 V+ | Red | For custom wiring |
| | 2 | TM7 bus data | White | |
| | 3 | TM7 0 V | Black | |
| | 4 | TM7 bus $\overline{\text{data}}$ | Blue | |
| | M12[1] | SHLD | Shield | |
| **1** Shielding 360 ° around M12 knurled screw. | | | | |

# Modicon TM5SBET7 TM7 Bus Transmitter Module - TM7 Bus Wiring

## TM5SBET7

The following figure shows the wiring diagram for the TM5SBET7:




**(1)** Internal electronics
**(2)** 24 Vdc I/O power segment integrated into the bus bases
**(3)** PS1: External isolated power supply 24 Vdc
**(4)** External fuse, Type T slow-blow: 1 A max., 250 V
**(5)** TM7 Expansion bus cable (TCSXCN•FNX••E)

**⚠ WARNING**

**UNINTENDED EQUIPMENT OPERATION**

Properly ground the cable shields as indicated in the related documentation.

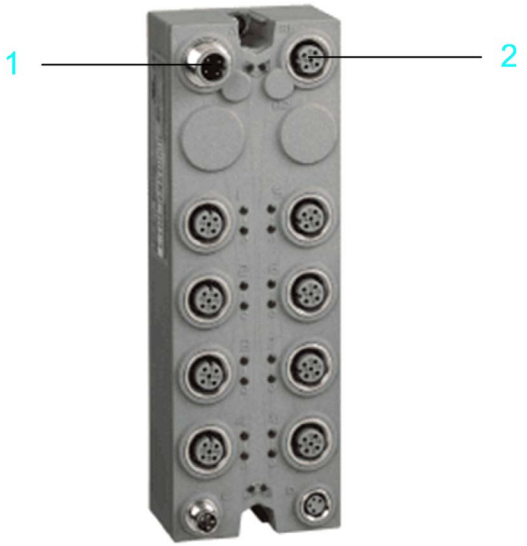
**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

For more information, refer to the Modicon TM5 - Transmitter and Receiver Modules, Hardware Guide, EIO0000000468.

# Modicon TM7 I/O Blocks - TM7 Bus Wiring

## TM7 I/O Bus Ports

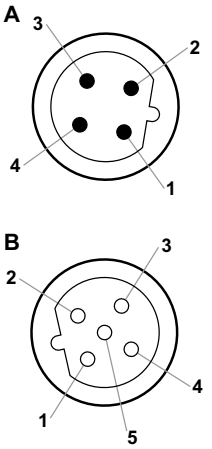
The following figure shows TM7 bus connectors of the TM7BDM16A digital I/O block:




**1** TM7 bus IN connector
**1** TM7 bus OUT connector

## Wiring

Pin assignments of the TM7 bus IN (A) and OUT (B) connectors of the TM7 IP 67 I/O block

| Connection | Pin | Designation |
|---|---|---|
|  | 1 | TM7 V+ |
| | 2 | TM7 bus data |
| | 3 | TM7 0 Vdc |
| | 4 | TM7 bus $\overline{\text{data}}$ |
| | 5 | N.C. |

# Chapter 6
# Implementation

## What Is in This Chapter?

This chapter contains the following sections:

# Section 6.1
# Software Requirements

## Software Requirements

### Overview

The software required to open and to edit the project template is SoMachine V4.1 including the LMC078 add-on or later.

The following components must be installed together with SoMachine:

- SoMachine components
  - Logic Builder, including Logic Builder LMC078
  - Vijeo-Designer
  - Gateway
- Auxiliary tools
  - Controller Assistant
  - Diagnostics
- Controllers
  - LMC078
  - Modicon TM5NS31
- Devices
  - TM5 - TM7 (DTM)
- Repository
  - OptimizedRepository
  - PerformanceRepository
- Documentation
  - Tested, Validated and Documented Architecture, including TVDA for LMC078

The SoMachine Configuration Manager, which is part of the SoMachine installation, allows you to verify the current installation. In addition you can add, remove, or update components of your SoMachine installation.

# Section 6.2
# Access the SoMachine Project Template

## Access the SoMachine Project Template

### Overview

The SoMachine project related to the described architecture is available in terms of a project template.

It is tested and validated and includes the complete and executable application with program code and device configurations.

Also part of the SoMachine project is the Vijeo-Designer application which is ready to run on the defined Magelis panel for this architecture.

You can use the project template as basis for your own application.

### Procedure

You can access the project template as described below.

| Step | Action |
|---|---|
| 1 | Launch SoMachine.<br>The **Get started** dialog box of SoMachine Central is displayed. |
| 2 | Click **New**.<br>The **New Project** dialog box is displayed. |
| 3 | Click **Templates**.<br>The **New Project Assistant - Templates** dialog box is displayed. |
| 4 | Enter a **Project Name** of your choosing. |
| 5 | Select a template from the list. The template that you choose will have the same name as the title of the present document. |
| 6 | Click the **Create Project** button.<br>A new project based on the selected template is opened in SoMachine Logic Builder. |
| 7 | Now you can adapt *(see page 224)* your new project according to your requirements. |

# Section 6.3
# Project

## What Is in This Section?

This section contains the following topics:

# Controller

## Overview

The controller in this architecture is the LMC078CECS20T, which is assigned to the category of Performance Motion Controller of Schneider Electric.

The mandatory settings for the controller are described below.

All parameter values depicted in this document relate to the template project and the test equipment used during development.

## Ethernet

The Ethernet network in this architecture is used for the communication between the HMI and the controller.

In addition, the network provides the possibility for a remote connection with the controller and the HMI.

The parameters displayed in the device editor of the Ethernet interface are read-only and are updated during online mode. The Ethernet settings of the LMC078 controller are not configured in the project, they are stored directly in the controller. To configure the Ethernet settings, refer to the chapter *Setup Controller and HMI* *(see page 203)*.

For more information about the Ethernet settings, refer to the document Modicon LMC078 Motion Controller, Programming Guide/Ethernet configuration, EIO0000001909.

## Serial Line

The serial line in this architecture is used for the communication between the controller and the power meter.

Therefore a Modbus manager has been added under the serial line of the controller.

The serial line settings for this architecture are:
- Baud rate: 19200
- Parity: even
- Data bits: 8
- Stop bits: 1
- Physical medium:
  - Modbus SL RS-485 2-wire
  - Polarization resistor: No

The configuration of the Modbus manager is:
- Transmission mode: RTU
- Addressing: Master
- Time between frames: 10 ms

For more information about the serial line configuration, refer to the document Modicon LMC078 Motion Controller, Programming Guide/Serial line configuration, EIO0000001909.

## Sercos

The Sercos III interface is automatically added to the **Devices tree** under the **LMC078** node when adding the LMC078 controller to the project. You can adapt the cycle time of the Sercos bus in the device editor of the Sercos III interface. In this application, the default value of 1,000,000 ns has been kept.

For more information about the Sercos configuration, refer to the document Modicon LMC078 Motion Controller, Programming Guide/Sercos configuration, EIO0000001909.

## CANopen

This architecture includes a CANopen fieldbus which has to be configured in the project. Therefore, the fieldbus interface **CAN_Bus** has been added to the **Devices tree** under the **LMC078** node. Furthermore, the **CANopen_Manager** has been added under the **CAN_Bus** node.

The settings for the CANbus interface are:

- Baud rate (bit/s): 500,000
- Activate the check box labeled **Block SDO, DTM and NMT access while application is running**.

The settings for the **CANopen_Manager** are:

- General
  - Node ID: 127
  - Activate the check box labeled **Autostart CANopenManager**.
  - Activate the check box labeled **Polling of optional slaves**.
  - Activate the check box labeled **Start slaves**.
  - Deactivate the check box labeled **NMT Start All (if possible)**.
- Sync
  - Deactivate the check box labeled **Enable Sync Producing**.
  - Deactivate the check box labeled **Enable Sync Consuming**.
- Heartbeat
  - Activate the check box **Enable Heartbeat Producing**.
  - Node ID: 127
  - Producer time (ms): 200
- Time
  - Deactivate the check box labeled **Enable Time Producing**.
- Bus cycle options
  - Bus cycle task: MAST

For more information about the CANopen configuration, refer to the document Modicon LMC078 Motion Controller, Programming Guide/CANopen configuration, EIO0000001909.

## Digital Outputs

The controller LMC078 provides an OpenLoad diagnostic for the embedded digital outputs. In this application, the embedded digital outputs are not used. Therefore, the OpenLoad diagnostics was disabled.

The settings for the **Digital Outputs** are:

- **OpenloadDiagMask**: 2#00000000

Each bit of the parameter **OpenloadDiagMask** activates (TRUE) or deactivates (FALSE) the OpenLoad diagnostic of the embedded digital outputs DQ0...DQ7.

# HMI

## Overview

The HMI in this architecture is a Magelis panel of type HMI GTO 5310.

The mandatory settings for the HMI device are described below.

All parameter values depicted in this document relate to the template project and the test equipment used during development.

## Ethernet

The Ethernet network in this architecture is used for the communication between the HMI and the controller.

In addition, the network provides the possibility for a remote connection with the controller and the HMI.

The Ethernet settings for the panel are:

- Fixed IP address
  - IP address: 192.168.100.20
  - Subnet mask: 255.255.255.0

For all other parameters, the default settings have been kept.

## I/O Manager

The communication between HMI and controller is realized via SoMachine network protocol based on Ethernet.

The SoMachine network driver on the panel accesses variables in the controller by a named reference. Therefore, the node name (equipment address) of the connected controller must be set in the SoMachine network configuration dialog in Vijeo-Designer.

The node name of the controller is per default a combination of controller type and MAC address, but you can change it to a user-defined name like *machine 1*.

In this application, the default node name of the controller has been set within the Vijeo-Designer configuration.

For more information about the SoMachine network driver, refer to the document Magelis XBT GC/XBT GK/XBTGT, SoMachine - Combo and Network Drivers, EIO00000000219 (ENG).

# Devices

## Overview

In this chapter, all devices configured within the SoMachine project are described.

## Motion Encoder

The controller LMC078 has a specific hardware encoder interface that can support:
- Incremental encoder
- SSI absolute encoder

In this architecture, an incremental encoder of type XCC1510PSM05X is linked to the hardware encoder interface of the controller.

The encoder interface of the LMC078 controller must be configured in the **Devices tree** in SoMachine. Therefore an **Incremental Encoder Input** has been added to the **Devices tree** under the **LMC078** node. With the device **Incremental Encoder Input**, a device **SoftMotion Encoder** is added to the **Devices tree**. The settings for the **SoftMotion Encoder** are performed in the associated device editor in accordance with the connected encoder and the application.

The settings for the **SoftMotion Encoder** are:
- Encoder general settings:
  - Activate the check box **Modulo**
  - Modulo value: 360.0
- Scaling
  - 5000 increments **<=>** encoder turns 1
  - 1 encoder turn **<=>** units in application: 360
- Bus cycle options
  - Bus cycle task: Motion

For more information about the encoder configuration, refer to the document Modicon LMC078 Motion Controller, PLCSystem Library Guide/Encoder, EIO0000001917.

## Power Meter PM3250

The architecture implements 1 power meter of type PM3250 for energy measurement. The energy data are read from the power meter via Modbus serial line.

The device itself is not configured in the application. The Modbus communication is realized by system functions as part of the function block `FB_PowerMeter` out of the **ModbusEnergyEfficiencyToolbox** library.

The program code to read and to process the data of the power meter was created in the application by adding the Device Module MED_PM3250_ModbusSL which is represented as a function template within the **TVDA Device Module Library** *(see page 228)*.

The only configuration is the assignment of the slave address and the network ID to the associated variables (CONSTANTS) within the **Add Function From Template** dialog box.

## Altivar 32

The architecture implements two variable speed drives of type Altivar 32 which are controlled via CANopen.

These devices must be configured within the SoMachine project.

Therefore, the devices were added under the **CANopen Manager** in the **Devices tree**.

Each device was added with the use of the Device Module ATV32_CANopen, which is represented as a function template within the **TVDA Device Module Library** *(see page 228)*.

The name of each device corresponds with the name which was assigned within the **Add Function From Template** dialog box.

The devices are preconfigured, so the only configuration is the selection of the node ID within the **Add Function From Template** dialog box.

The following devices were added under the CANopen manager of the CAN0 interface:

| Device name | Node ID configuration |
|---|---|
| ATV32_CANopen01 | 1 |
| ATV32_CANopen02 | 2 |

## TeSys U

The architecture implements 1 motor starter controller of type TeSys U which is controlled via CANopen.

The TeSys U is equipped with a standard control unit. The TeSys U device must be configured within the SoMachine project.

Therefore, the device was added under the **CANopen Manager** in the **Devices tree**.

The device was added with the use of the Device Module TeSysU_CANopen_Standard, which is represented as a function template within the **TVDA Device Module Library** *(see page 228)*.

The name of the device corresponds with the name which was assigned within the **Add Function From Template** dialog box.

The device is preconfigured, so the only configuration is the selection of the node ID within the **Add Function From Template** dialog box.

The following device was added under the CANopen manager of the CANbus interface:

| Device name | Node ID configuration |
|---|---|
| TeSysU_CANopen03 | 03 |

## Lexium 32i

The architecture implements 1 integrated servo drive of type Lexium 32i which is controlled via CANopen.

This device must be configured within the SoMachine project.

Therefore, the device was added under the **CANopen Manager** in the **Devices tree**.

The device was added with the use of the Device Module Lexium_32i_CANopen, which is represented as a function template within the **TVDA Device Module Library** *(see page 228)*.

The name of the device corresponds with the name which was assigned within the **Add Function From Template** dialog box.

The device is preconfigured, so the only configuration is the selection of the node ID within the **Add Function From Template** dialog box.

The following device was added under the CANopen manager of the CAN0 interface:

| Device name | Node IC configuration |
|---|---|
| LXM32i_CANopen04 | 4 |

**NOTE:** The device provided with the Device Module Lexium_32i_CANopen differs to the standard device **Lexium 32i** provided with SoMachine device repository. The device in this example uses the second and third transmit PDO (TPDO). The actual position value (second TPDO) and the actual velocity value (third TPDO) of the drive are transmitted in an event driven way. The event time for these TPDOs is set per default to 10 ms. In addition, the inhibit time for both TPDOs is set to 10 ms. These additional PDOs increase the bus load.

For more information, refer to the documents:
- SoMachine online help **Programming with SoMachine → Device Editors → CAN bus Configuration Editor → CANopen Device → PDO Mapping**
- LXM32iCAN BMi, Lexium 32 Integrated, Product manual, 0198441113950 (ENG)

After the device has been added, an additional configuration via SDO (Service Data Object) has been done within the **Device Editor** tab. In this example application, an SDO has been added to deactivate the input monitoring of the drive.

Service data object added:

| Index:Subindex | Name | Value | Comment |
|---|---|---|---|
| 16#3006:16#10 | `Motion global.IOsigLIMP` | 0 | Deactivates the monitoring input for positive limit switch |
| 16#3006:16#0F | `Motion global.IOsigLIMN` | 0 | Deactivates the monitoring input for negative limit switch |

**NOTE:** The monitoring inputs have been disabled because the drive is applied in modulo motion mode (endless movements). If your application requires the end of travel limits, then set the value for `Settings.SignEnabl` to your needs or respectively delete this SDO from the list and make the configuration via another channel.

For more information about the SDO configuration, refer to the documents:
- SoMachine online help **Programming with SoMachine → Device Editors → CANbus Configuration Editor → CANopen Device → Service Data Object**
- LXM32iCAN BMi, Lexium 32 Integrated, Product manual, 0198441113950 (ENG)

## TM5/TM7 Distributed I/Os

The architecture implements distributed I/Os on the Sercos fieldbus. The distributed I/Os consist of one TM5 I/O island and one TM7 IP67 I/O digital block. The TM5 I/O island includes the Sercos interface module for the data exchange with the controller. The TM5 and TM7 I/O expansion modules are linked to the Sercos interface module via the TM5 respectively the TM7 bus.

These distributed I/Os must be configured within the SoMachine project.

| Step | Action | Comment |
|---|---|---|
| 1. | Right-click the **Sercos III interface** in the **Devices tree** and select **Add Device**. | The dialog box **Add Device** opens and the compatible devices for adding are listed.<br>**NOTE:** The option **Vendor** must be set to **Schneider Electric** (default). |
| 2. | Select the device **TM5NS31** in the **Add Device** dialog box, and click **Add Device**. | The TM5 Sercos interface module is added to the **Devices tree**. |
| 3. | Select the previously added device **TM5NS31** in the **Devices tree**. | The list of the compatible devices in the still open dialog box **Add Device** is updated. |
| 4. | Select the device **TM5SPS3** and click **Add Device**. | The TM5SPS3 module is the interface power distribution module. It must be added directly under the **TM5NS31** interface module. |
| 5. | Select the device **TM5SPS3** in the **Devices tree** again. | The list of the compatible devices in the still open dialog box **Add Device** is updated. |
| 6. | Select the device **TM5SDI12D** in the **Add Device** dialog box and click **Add Device**. | – |
| 7. | Repeat steps 5 and 6 for the following devices:<br>● TM5SDI12D<br>● TM5AI4PH<br>● TM5SPS2<br>● TM5SDO12T<br>● TM5SDO12T<br>● TM5SAO4L<br>● TM5SBET7<br>● TM7BDMI16A | – |
| 8. | Close the **Add Device** dialog box. | – |

Each device previously added provides the possibility for an individual configuration if the default settings do not meet the requirements of your application. Double-click the device in the **Devices tree** to open the associated device editor. The configuration for each module, which was done in this architecture, is described in the table:

| Device | Module type | Configuration |
|---|---|---|
| TM5NS31 | Sercos interface module | Sercos address with the parameter **ConfiguredSercosAddress**: 7 |

| Device | Module type | Configuration |
|---|---|---|
| TM5SPS3 | Interface power distribution module | Activate the check box **Always update variables**. |
| TM5SDI12D | Module with 12 digital inputs 24 Vdc, sink | Activate the check box **Always update variables**. |
| TM5SDI12D | | Activate the check box **Always update variables**. |
| TM5SAI4PH | Module with 4 resistor temperature inputs | Activate the check box **Always update variables**. |
| TM5SPS2 | 24 Vdc power supply module for internal I/O supply and bus | Activate the check box **Always update variables**. |
| TM5SDO12T | Module with 12 digital outputs 24 Vdc / 0.5 A | Activate the check box **Always update variables**. |
| TM5SDO12T | | Activate the check box **Always update variables**. |
| TM5SAO4L | Module with 4 analog 4 outputs ±10 V / 0...20 mA, resolution 12 bits | Activate the check box **Always update variables**. |
| TM5SBET7 | Bus transmitter, I/O supply 24 Vdc, TM7 supply | Activate the check box **Always update variables**. |
| TM7BDM16A | Module with 16 configurable I/O channels | • Activate the check box **Always update variables**.<br>• Configure **Channel** 0...7 as output with the parameter **Direction0x**: output. |

**NOTE:** By default, the outputs of the TM5 and TM7 modules behind the Sercos interface module are deactivated. The parameter for activation of the outputs is accessible only during runtime from the application code. Therefore, you need to implement a code line in the program to set the parameter `<Module name TM5NS31>.OutputsActivateSet` to TRUE.

Code example:

```
BC_TM5NS31_Sercos07.OutputsActiveSet := GVL.xTM5ComOk;
```

## Lexium 32S

The architecture implements 6 servo drives of type Lexium 32S which are controlled via Sercos motion bus.

These devices must be configured within the SoMachine project.

Therefore, the devices were added under the **Sercos III interface** in the **Devices tree**.

Each device was added with the use of the Device Module Lexium_32S_Sercos, which is represented as a function template within the **TVDA Device Module Library** *(see page 228)*.

The name of each device corresponds with the name which was assigned within the **Add Function From Template** dialog box.

The devices are preconfigured, so the only configuration is the selection of the Sercos address within the device editor of the respective Lexium 32S device. In comparison to other device modules, the configuration of the Sercos address is not supported within the **Add Function From Template** dialog.

The following devices were added under the **Sercos III interface** in the **Devices tree**:

| Device name | Sercos address |
|---|---|
| LXM32S_Sercos01 | 01 |
| LXM32S_Sercos02 | 02 |
| LXM32S_Sercos03 | 03 |
| LXM32S_Sercos04 | 04 |
| LXM32S_Sercos05 | 05 |
| LXM32S_Sercos06 | 06 |

For more information about the Lexium 32S configuration, refer to the documents:

- LXM32S, AC servo drive, Product manual, 0198441114060 (ENG)

# Application

## Library Manager

The library manager is a standard object of the application.

Within the library manager, you can add or remove libraries.

All libraries in this example application were loaded automatically on adding devices or Device Modules.

## Symbol Configuration

The symbol configuration functionality allows to create symbol descriptions, via which project variables can be accessed from external, for example when exchanging variables with HMI via Vijeo-Designer or via OPC server.

All variables for control and monitor functions on the Magelis HMI were published within the symbol configuration editor.

By publishing the variable(s) in SoMachine, they will automatically be available for use in the Vijeo-Designer HMI application as SoMachine variables. For the manual export of the variables, use the command **Export Variables to Vijeo Designer** from the context menu of the **Symbol Configuration** in the **Tools tree**.

For more information, refer to the following chapters of the SoMachine Programming Guide:

- *Symbol Configuration Editor (see SoMachine, Programming Guide)*
- *SoMachine Controller - HMI Data Exchange (see SoMachine, Programming Guide)*

## Cam Table

The application includes an example for the synchronization of several axes. In this example, the encoder is used as master axis, and a Lexium 32S servo drive is the slave axis. While the master (encoder) covers one turn forward, the slave (servo drive) covers four turns forward and four turns backwards, back to the origin position. This synchronization model is defined in a **Cam table** which was added to the **Tools tree** in SoMachine.

To add a **Cam table** to the **Tools tree**, proceed as follows:

| Step | Action | Comment |
|---|---|---|
| 1 | Right-click the **Application** in the **Tools tree** and select **Add Object → Cam table**. | The Cam table is added to the **Tools tree**. |
| 2 | Double-click the previously added object **Cam** in the **Tools tree**. | The associated cam table editor opens. |

In the **Cam table** tab of the Cam table editor, the master positions and their associated slave positions are defined.

The configuration of the Cam table in this application is:

| X | Y | V | A | Segment type |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | – |
| – | – | – | – | Poly 5 |
| 180 | 4 | 0 | 0 | – |
| – | – | – | – | Poly 5 |
| 360 | 0 | 0 | 0 | – |
| X = Master position<br>Y = Slave position<br>V = Speed of the slave<br>A = Acceleration of the slave | | | | |

For more information, refer to **Programming with SoMachine → SoftMotion → Object Editors → Cam Editor** in the SoMachine online help.

## Task Configuration

The **Task Configuration** defines one or several tasks for controlling the processing of an application program.

Thus it is an essential resource object for an application and is automatically added to the application node.

In this example application 2 tasks are configured:

| Task | Type | Watchdog | Comment |
|---|---|---|---|
| MAST | Cyclic:<br>10 ms | Enabled<br>Time: 50 ms<br>Sensitivity: 3 | This task includes all program calls related to the CANopen devices, Modbus communication and general application code. |
| MOTION | External:<br>MDT_WRITE_ACCESS | Enabled<br>Time: 750 µs<br>Sensitivity: 5 | This task is triggered by the sync messages of the Sercos manager. It includes all program calls related to the motion devices. |

For more information, refer to the description of task configuration in the SoMachine Programming Guide *(see SoMachine, Programming Guide)*.

## Task Deployment

In applications with more than one task, it must be considered that I/O channels are not used several times in different tasks. In general, it is ill-advised to read inputs respectively to write outputs in more than one task, as it makes the program difficult to debug and may lead to unintended results in the operation of your machine or process.

- If an input is used in several tasks, it may occur that the state is changed within a task cycle because this task is interrupted by a task with higher priority and the input is read again.
- If an output is used by several tasks its state is undefined, because it can be overwritten by another task.

Within the tab **Task Deployment** of the device editor of the controller, you can verify the assignment of each I/O channel in your application. In the **Task Deployment** view in the device editor of the controller, a table is shown with all I/O channels of the application and their assignment to the different tasks.

In this application, all I/O channels are used in the MAST task, only.

For more information, refer to chapter *Task Deployment* of the SoMachine Programming Guide *(see SoMachine, Programming Guide)*.

## Program Code

The program code is divided into several POUs (Program Organization Units) and GVLs (Global Variable Lists).

Each POU is called separately within the associated task.

The execution of several POUs is interlocked until the restart process of the controller has been completed because the application can change to run mode although the initialization of the system is not yet complete. Until the completion of restart process, the initialization of the system is not considered as complete and all objects (for example, logical encoders) and all parameters are not valid. To help to prevent the execution of the application with invalid parameters, the system function `FC_GetBootState` is used to control the execution of several POUs in the application.

The POUs and GVLs which are related to the devices or functional units were created on adding the respective Device Modules. Hence, they are placed in folders (with the corresponding names) under the **Application** node.

The following folders including the respective POUs and GVLs are available:

- 1 x **PM3250_MbSL**
- 2 x **ATV32_CANopen0x**
- 1 x **LXM32i_CANopen0x**
- 1 x **TeSysU_CANopen0x**
- 6 x **LXM32S_Sercos0x**

The program code of the POUs listed above differs from the origin program code of the respective Device Module provided with the TVDA Device Module Library. An additional variable `xEnable` was created. In the program, this variable is used to interlock the execution of the program until the restart process of the controller has been completed.

Further POUs and the related GVLs for equipment control, which are not available as a Device Module, are listed in the following:

- **Incremental_Encoder**
  - Control and monitoring of the **SoftMotion_Encoder**

- **Heating**
  - Simple 2-point-controller for each of the four heatings
  - Simulation of the temperature sensors
- **AxisSync**
  - Example of synchronization of two axis using a Cam table

For the general programming part, additional POUs are available. In these POUs, the processing of HMI commands, a summary of information about devices, the communication state, and state of the safety functions is realized in relation to the different functional units of the application. The following POUs are available:

- **Init**
  - Obtaining the boot state of the controller with control of the execution of the POUs which are interlocked.
  - Pulse generator for the blink function of indicators.
  - Activating the outputs of the expansion modules behind the TM5 Sercos interface module.
  - Reset the controller diagnostic messages.
  - Restart the Sercos motion bus.
  - Date and time handling of the RTC of the controller.
- **Preprocessing**
  - Processing of command signals for the devices (for example, operator push buttons, HMI commands, and so on).
- **MAIN**
  - Processing of summary information about device and communication state.
- **AlarmManager**
  - Processing of alarm management of the architecture.
- **Output_Mapping**
  - Processing of output signals for tower light, operator push-button lighting, and analog outputs.

# Vijeo-Designer

## Overview

The HMI application is created with the configuration software Vijeo-Designer, which is integrated in SoMachine.

This architecture implements a Magelis HMI panel of type HMI GTO.

The application is executed on this panel and provides extensive monitoring and control functions of the architecture.

## Start Page

The start page provides general information about the state of the architecture:

- Device state
- Communication state
- Safety state

## Alarm Page

The alarm page provides detailed alarm messages sorted by time of occurrence.

## LMC078 Page

The LMC078 page provides information about the state of the controller and the acknowledgement of diagnostic messages of the controller.

## CANopen Overview

The CANopen overview provides information about the fieldbus topology and the communication state of CANopen devices.

## Sercos Overview

The Sercos overview provides information about the fieldbus topology and the communication state of Sercos devices. In addition, it allows restarting the Sercos. A restart becomes necessary if the Sercos was entered into error state in case of a disturbance on a Sercos slave or in the network wiring.

## Date and Time Page

The date and time page provides the current value of the real time clock on the controller. In addition, it allows you to set the real time clock of the controller and the HMI.

## Energy Pages

The energy pages provide information about the energy data of the architecture.

## Device Pages

The device pages provide monitor and control functions for each device grouped by products:

- Altivar
- TeSys U
- Lexium
- Encoder
- I/Os

## AxisSync

The **AxisSync** page provides the control and the monitoring of the axis synchronization.

## Heating

The heating page provides the control and the monitoring of the four heatings. In addition, the simulation mode can be controlled.

# Chapter 7
# System Setup

## Overview

This chapter describes the steps necessary to set the architecture in operational mode. It is not intended to replace any specific product documentations or manuals.

The setup procedure depicted in this document is relevant only for the proposed architecture.

Before using any device in this application, perform the following steps:

- Thoroughly read this manual and the respective related documents before running this application.
- Install the drives according to their usage and configure the connected motors.
- Thoroughly verify your installation.
- Set up the communication parameters of the devices.

**⚠ WARNING**

**LOSS OF CONTROL**

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

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

[1] For 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" or their equivalent governing your particular location.

## What Is in This Chapter?

This chapter contains the following sections:

# Section 7.1
# Setup Controller and HMI

## Setup Controller and HMI

### Overview

You must download the applications from the PC to the controller and to the HMI to run the applications.

There are several possibilities to perform the application download:
- Via a USB cable (linked to the integrated mini USB port on the devices)
- With a USB key (linked to the integrated USB port on the HMI)
- Via an Ethernet connection (linked to the Ethernet network)

By using a USB connection or an Ethernet connection between controller and PC, additional features like monitoring of the application in online mode are available.

**NOTE:** SoMachine V4.1 including the LMC078 add-on and the associated Vijeo-Designer configuration software are required on the PC.

### Communication Settings

To set up the communication between controller and HMI, it is mandatory to configure the communication settings using SoMachine and Vijeo-Designer.

To set up an Ethernet communication between controller and HMI, following configurations are mandatory:
- Ethernet configuration of the controller
- Ethernet configuration of the HMI
- Controller equipment address (node name) in the HMI application

All configuration of the HMI can be configured in the HMI application. The Ethernet settings of the LMC078 must be stored directly in the controller. Therefore, a USB connection to the LMC078 has to be established, using one of the following cables:
- TCSXCNAMUM3P
- BMXXCAUSBH045

To configure the communication settings of the devices, proceed as follows. Precondition for this workflow is a working USB connection between PC and controller.

| Step | Action | Comment |
|---|---|---|
| 1 | In the **Devices tree** of the , double-click the controller. | The controller device editor opens. |
| 2 | Select the **Controller selection** tab in the device editor. | The controllers detected by the gateway on the PC are listed. |

| Step | Action | Comment |
|---|---|---|
| 3 | Right-click the desired controller and select **Process communication settings**. | The **Process communication settings** dialog box opens with the current settings of the controller. |
| 4 | Perform the Ethernet configuration in the **Process communication settings** dialog box. | The **Process communication settings** dialog box allows the configuration of the Ethernet settings directly on the controller.<br>The Ethernet configuration is required to set up a connection between controller and HMI. The two devices have to be in the same sub network. |
| 5 | Activate the check box **Save settings permanently** and click **OK** to apply the settings. | To save the communication settings in the controller even if it is restarted, activate the option **Save settings permanently**. The settings are applied immediately. A restart of the controller is not required. |
| 6 | Note down or copy the **Node Name** of the controller. | In the **Controller selection** tab, you can obtain or modify the **Node Name** of the controller. The **Node Name** is required for the **SoMachine Network Equipment** configuration in the Vijeo-Designer application. |
| 7 | Select **Vijeo Designer** from the **Quick Toolswitch** list of the overlay bar *(see SoMachine Central, User Guide)*. | The Vijeo-Designer software opens in a new window. |
| 8 | In Vijeo-Designer, select the target node in the **Navigators Project** tab. | The target property editor opens. |
| 9 | Select **Network** in the target property editor. | The network property editor opens. |
| 10 | Click the **...** button for network configuration. | The **Network Configuration** dialog box opens. |
| 11 | Perform the Ethernet configuration in the **Network Configuration** dialog box. | The **Network Configuration** dialog box allows the Ethernet configuration for the HMI.<br>The Ethernet configuration is required to set up a connection between controller and HMI. The two devices have to be in the same sub network. |
| 12 | Click **OK** to apply the settings. | The Ethernet configuration becomes effective after a download of the application to the HMI. |
| 13 | In Vijeo-Designer, double-click **SoM_MyController** under the **I/O Manager** → **SoMachineNetwork01** node in the **Navigators Project** tab. | The **SoMachine - Network Equipment Configuration** dialog box opens. |
| 14 | Set the address of the associated controller in the field **Equipment Address or Node Name**. | The required information is provided in the **Controller selection** tab of the device editor of the controller in . Refer to step 6. |
| 15 | Click **OK** to apply the settings. | The settings made in the **SoMachine - Network Equipment Configuration** become effective after a download of the application to the HMI. |

## Download Procedure

For the download procedure described in this section, an Ethernet connection between the PC, the LMC078 controller and the HMI is used.

Precondition for this download procedure is a working Ethernet connection between PC, controller, and HMI.

Using the established Ethernet connection between all the devices, proceed as follows to download the  and HMI application.

| Step | Action | Comment |
|---|---|---|
| 1 | In the **Devices tree** of the , double-click the controller. | The device editor of the controller opens. |
| 2 | Select the **Controller selection** tab of the device editor. | The devices detected by the gateway on the PC are listed. |
| 3 | Double-click the desired controller. | The selected controller is displayed in bold and the address is displayed at the bottom of the device editor. |
| 4 | In the **Devices tree** of the , double-click the HMI device. | The device editor of the HMI opens. |
| 5 | Select the **Controller selection** tab of the device editor. | The devices detected by the gateway on the PC are listed. |
| 6 | Double-click the desired HMI. | The selected HMI is displayed in bold and the address is displayed at the bottom of the device editor. |
| 7 | Select the command **Multiple Download...** from the **Online** menu. | The **Multiple Download** dialog box opens. |
| 8 | Select the applications for download in the **Multiple Download** dialog box. | Additional settings for the multiple download can be performed in the dialog. |
| 9 | Click **OK** to start the multiple download. | The selected applications are downloaded to the associated devices. |

**NOTE:** The firmware version of the controller has to correspond with the firmware version of the controller in the SoMachine project. If the versions of the devices mismatch, you have to upgrade the version of the controller. The procedure to update the firmware of the controller is described in the SoMachine online help and in the product manual of the controller.
For the initial download, the HMI requires the latest version of the runtime kernel. This is accomplished by using Vijeo-Designer for the initial download. Alternatively you can use the **Runtime Installer** to download the runtime on the HMI.
The **Runtime Installer** is accessible via the tool access bar *(see SoMachine Central, User Guide)* in (**Tool Access Bar → Maintenance → Download Firmware HMI**).

# Section 7.2
## Setup Other Devices

### What Is in This Section?

This section contains the following topics:

# Network and Device Parameter Settings

## Overview

This section describes the steps required to initialize and configure the different devices required to attain the described system function.

The following devices are configured by using the local control panel on the device itself:

- Lexium 32S
- Altivar 32
- PM3250 Power Meter

**NOTE:** If a device has already been configured for some other use, re-establish the factory settings. Instructions on how to do this can be found in the respective documentation.

**NOTE:** Be sure that the controller is in STOP state before parameterizing the drives.

**⚠ WARNING**

**UNINTENDED EQUIPMENT OPERATION**

- Never assume that your controller is in a certain controller state before commanding a change of state, configuring your controller options, uploading a program, or modifying the physical configuration of the controller and its connected equipment.
- Before performing any of these operations, consider the effect on all connected equipment.
- Before acting on a controller, always positively confirm the controller state by viewing its LEDs, confirming the condition of the Run/Stop input (if so configured) and/or the Run/Stop switch (if so equipped), verifying the presence of output forcing, and reviewing the controller status information via SoMachine (1).

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

(1) The controller states can be read in the `DiagCode`, `DiagMsg`, and `DiagExtMsg` system variables of the LMC078 Motion Controller - Programming Guide *(see Modicon LMC078, Motion Controller, Programming Guide)*.

For setting the communication parameters of the following devices, refer to the respective sections in the *Communication* chapter *(see page 157)*:

- Modicon TM5NS31 Sercos Interface Module - Sercos Wiring

# Preventa Safety Controller XPS MP - Setup

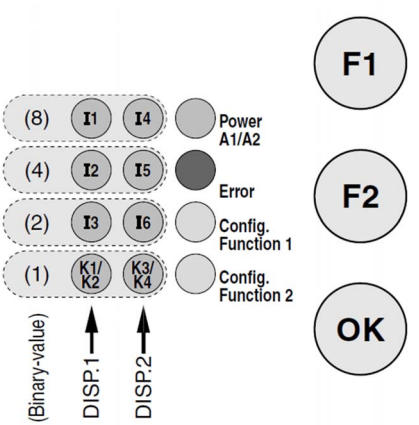
## Overview

The Preventa safety controller XPS MP supports two safety functions that are independent of each other. The two safety functions, F1 and F2, are configured using the touch-sensitive keypad on the device cover.

The default setting is **Configuration 0 (no function)** for **F1** and **F2**, and the device remains inactive to start with. To start operation, select and activate a configuration for each function.

## Operation

Operating panel of the XPS MP:




The operating panel consists of 12 LEDs arranged in three columns, and a touch-sensitive keypad with three buttons:

| Button | Description |
|---|---|
| **F1** | To configure function 1. |
| **F2** | To configure function 2. |
| **OK** | To confirm the configuration. |

During normal operation, four green LEDs in each of the two left columns **DISP.1** and **DISP.2** show the status of the inputs and outputs for each function separately. The two yellow LEDs **Config. Function 1** and **Config. Function 2** are not illuminated.

If one of the yellow LEDs is illuminated or flashes, then **DISP.1** or **DISP.2** will show the configuration in binary code. The lowest LEDs each show the LSB (Lowest Significant Bit) with the value **(1)**.

## Display the Current Configuration

To determine the current configuration of function 1, press the button **F1**. The yellow LED **Config. Function 1** is illuminated and the four LEDs in column **DISP.2** show the configuration of function 1 in binary code until the button is released. The same applies for pushing the **F2** button. The four LEDs in column **DISP.2** show the configuration of function 2.

## Select a Configuration

To enter configuration mode, the two safety outputs of the XPS MP must be switched off. Then press the required function key **F1** or **F2** together with the **OK** button for at least one second. The yellow LED **Config. Function 1** or **Config. Function 2** starts to flash, depending on whether **F1** or **F2** has been selected and configuration mode is activated.

The LEDs in columns **DISP.1** and **DISP.2** both show the currently saved configuration for the selected function in binary code. Each time the function key is pressed again, the LEDs in column **DISP.2** change to the next possible binary code, and thus to the next possible configuration. The LEDs in column **DISP.1** continue to display the saved configuration.

Once **DISP.2** shows the desired configuration code, press the button **OK** to save the new configuration. The LEDs in columns **DISP.1** and **DISP.2** then both display the new configuration. The yellow LED for the selected function is illuminated and stays on.

The outputs of the XPS MP, however, remain locked until the new configuration is confirmed and activated by turning off the power supply and then back on again. The eight green LEDs in columns **DISP.1** and **DISP.2** then again display the operating status of the inputs and outputs in accordance with their labeling.

The table shows the different applications which can be assigned to function 1 and function 2 as required:

| Configuration | | Description | Parameter | | | | Comment |
|---|---|---|---|---|---|---|---|
| # | Binary code | | Sync time(1) | Start-up lock(2) | Automat. start(3) | Monitored start(4) | |
| 0 | 0000 | No function. | – | – | – | – | Default setting |
| 1 | 0001 | Emergency stop monitoring, single channel. | – | – | X | – | – |
| 2 | 0010 | | – | – | – | X | |
| 3 | 0011 | Emergency stop or protective guard monitoring, two channel. | ∞ | X | X | – | – |
| 4 | 0100 | | ∞ | X | – | X | |
| 5 | 0101 | | 1.5 s | X | X | – | |
| 6 | 0110 | | 1.5 s | X | – | X | |
| 7 | 0111 | | ∞ | – | X | – | |
| 8 | 1000 | | ∞ | – | – | X | |

***NOTE**: Configuration #9, always occupies function 1 and function 2. It can only be activated if it is saved for function 1. In this case, when button F2 is pressed, the code 0000 is displayed, and function 2 can no longer be configured.

| Configuration | | Description | Parameter | | | | Comment |
|---|---|---|---|---|---|---|---|
| # | Binary code | | Sync time(1) | Start-up lock(2) | Automat. start(3) | Monitored start(4) | |
| 9* | 1001 | Protective guard monitoring for injection molding and blow molding machines. | 1.5 s | X | – | X | Both safety outputs are controlled by F1. F2 is automatically locked. |
| 10 | 1010 | Enabling device (3 position switch). | – | X | X | – | The start button acts as the start preparation. |
| 11 | 1011 | Monitoring of a safety mat. | – | – | X | – | Short-circuit forming safety mat. |
| 12 | 1100 | | – | – | – | X | |
| 13 | 1101 | Monitoring of a light curtain with relay outputs | 0.5 s | X | – | X | – |
| 14 | 1110 | Magnetic switch monitoring | 1.5 s | – | X | – | Magnetic switch one NO and one NC |
| 15 | 1111 | | 1.5 s | – | – | X | |
| ***NOTE**: Configuration #9, always occupies function 1 and function 2. It can only be activated if it is saved for function 1. In this case, when button F2 is pressed, the code 0000 is displayed, and function 2 can no longer be configured. | | | | | | | |

Definition of terminology used in the table:

**(1) Synchronous time**: Within this time, two (or more) input signals must be generated at the same time; so that the system can start.

**(2) Start-up lock:** After the power supply has been switched on, the start-up lock helps to prevent start-up until existing input signals have been switched off and turned on again (for example, open and close protective guard).

**(3) Automatic start or non-monitored start:**

**Automatic start**: There is no start button or it has been replaced by a wire jumper. Start-up is automatic as soon as the relevant conditions have been met.

**Non-monitored start**: The start input is not monitored. Start-up is triggered after activation by closing the start circuit. If the start circuit remains closed, automatic start is executed.

**(4) Monitored start:** The start input is monitored. Start-up is triggered after activation by releasing the start button if it has not been closed for longer than 10 s.

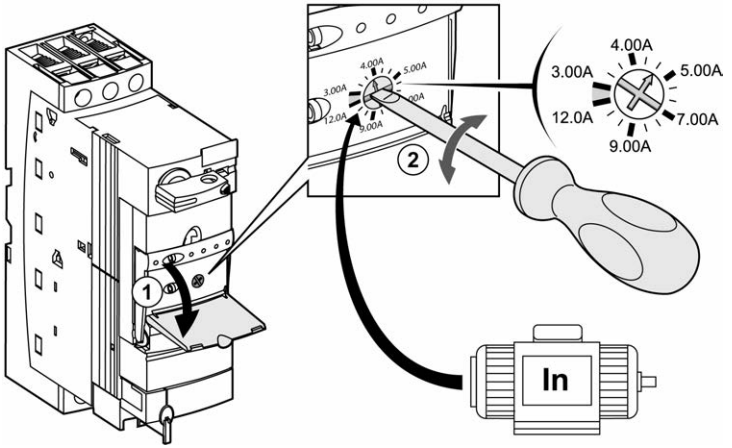
For more information, refer to XPS-MP Instruction Sheet, S1A2876601.

# TeSys U Motor Starter - CANopen Setup

## Overview

The setup of the TeSys U motor starter includes 2 steps.

- The communication settings will be done by the dip switches located on the communication module LULC08 and is described in the communication chapter *(see page 145)*.
- The thermal protection of the motor is set by the rotary switch on the front of the control unit LUCA05BL. The set value has to be appropriate for the connected motor.



# Altivar 32 Variable Speed Drive - CANopen Setup

## Overview

To operate the Altivar 32 via CANopen fieldbus, the communication parameters have to be set for the device. In addition to this, it is mandatory to set the parameter of the connected motor in the drive. Further configuration settings are dependent on your application and on the installation.

There are several options to configure the drive:

- by the local HMI on the front of the drive
- by a graphic display terminal*
- by a remote display terminal*
- by the configuration software SoMove installed on a PC*
- by the FDT/DTM integrated in SoMachine installed on a PC*
- by the software SoMove Mobile installed on a mobile phone linked via Bluetooth

(* linked to the integrated communication port on the front of the drive)

**⚠ WARNING**

**UNINTENDED EQUIPMENT OPERATION**

- Verify that both wiring and mounting are correct before you start to configure the drive.
- Verify that an unintentional start of the connected motor will not endanger personnel or equipment in any way.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

If necessary, disconnect the motor from the drive to prevent an unintentional motor start.

## Configuration

**NOTE:** The parameter or menu items which are mentioned within the table could be located under unmentioned menu items. This is dependent to the method of configuration.

| Step | Action | Comment |
|---|---|---|
| 1 | Switch on the power supply. | Do not give a run command to the drive. |
| 2 | Configure the motor parameters under the menu **[Motor Control]** (`drc-`):<br>● **[Standard mot. freq]** (`bFr`)<br>● **[Max frequency]** (`tFr`)<br>● **[Motor control type]** (`Ctt`) | Refer to the motor rating plate. Values have to be adjusted if the factory settings differ with your application.<br>If the drive shall apply the brake control logic, the parameter **[Motor control type]** (`Ctt`) has to be set either to `[SVC V] (UUC)` or `[Energy sav.] (nLd)`. |

| Step | Action | Comment |
|---|---|---|
| 3 | Configure the motor parameters under the menu **[ASYNC. Motor]** (ASY-):<br>• **[Rated motor power]** (nPr)<br>• **[Motor 1 Cosinus Phi]** (COS)<br>• **[Rated motor volt.]** (UnS)<br>• **[Rated motor current]** (nCr)<br>• **[Rated motor freq.]** (FrS)<br>• **[Rated motor speed]** (nSP) | Refer to the motor rating plate. Values have to be adjusted if the factory settings differ with your application. |
| 4 | Configure the parameters under the menu **[SETTINGS]** (Set-):<br>• **[Acceleration]** (ACC)<br>• **[Deceleration]** (dEC)<br>• **[Low Speed]** (LSP)<br>• **[High Speed]** (HSP)<br>• **[Mot. Therm. current]** (ItH) | In most cases, the factory settings can be maintained for a quick start. But nevertheless, you have to verify the values. |
| 5 | Configure the I/O assignment under the menu **[INPUTS/OUTPUTS CFG]** (I_O-). | The I/O configuration depends on your architecture and the activated application functions of the drive. In most cases, the factory settings can be maintained for a quick start. But nevertheless, you have to verify the values. |
| 6 | Configure the command channel under the menu **[COMMAND]** (Ctl-):<br>• **[Ref. 1 channel]**] (Fr1) | If the drive is operated via CANopen fieldbus, the parameter **[Ref. 1 channel]** (Fr1) has to be set either to **[CANopen]** (CAn) or **[Com.card]** (net). This depends on the used communication port. |
| 7 | Configure the communication parameter under the menu **[COMMUNICATION]** (COM-):<br>• **[CANopen]** (CnO-)<br>❍ **[CANopen address]** (AdCO)<br>❍ **[CANopen bit rate]** (bdCO) | The communication parameter for the CANopen network is dependent on your architecture and the settings of the CANopen master which is usually the controller. |
| 8 | Set the access level to enable further application functions under the menu **[ACCESS LEVEL]** (LAC) | To enable the settings for the brake control logic, the parameter **[ACCESS LEVEL]** (LAC) has to be set to **[Expert]** (EPr). |
| 9 | Configure the parameter for the brake control under the menu **[BRAKE LOGIC CONTROL]** (bLC-):<br>• **[Brake assignment]** (bLC) | By the parameter **[Brake assignment]** (bLC) you select the logic output or control relay to control the contactor to release the electro magnetic brake on the motor. Further parameter can be set dependent to your application. |
| 10 | Power cycle the drive. | If the configuration is finished, do a power cycle of the drive, because some parameters only become effective after a power cycle. |

## ⚠ WARNING

**UNINTENDED EQUIPMENT OPERATION**

After any configuration changes or adjustments, power cycle the drive (power removal followed by power reapplied).

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

# Lexium 32S Servo Drive - Sercos Setup

## Overview

To operate the Lexium 32S via Sercos, the communication parameters have to be set for the device. Further configuration settings are dependent on your application and on the installation.

There are several options to configure the drive:

- by the local HMI on the front of the drive
- by an external graphic display terminal*
- by the configuration software SoMove lite installed on a PC*
- by the FDT/DTM integrated in SoMachine installed on a PC*

* linked to the integrated communication port (CN7) on the front of the drive

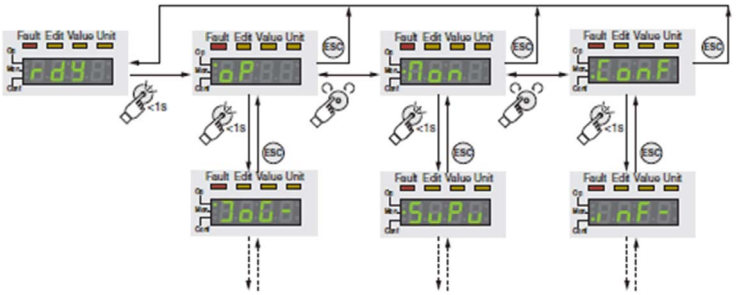
**NOTE:** If a device has already been configured for some other use, re-establish the factory settings. Instructions on how to do this can be found in the respective documentation.

If necessary, disconnect the motor from the drive to prevent an unintentional motor start.

## Basic Configuration

If the drive is being started for the first time, the FSu (first setup) menu is invoked.

If the FSu menu is not displayed, the following menu structure is accessible.




Only the Sercos address (Addr) is initially needed. In the described application, additional configuration for the homing method and the input functions are performed.

To adjust the parameters, use the following path and values

| Step | Action | Comment |
|---|---|---|
| 1 | Switch on the power supply of the controller. | – |
| 2 | Set the Sercos address:<br>• [FSu-] → [Addr]<br>or<br>• [ConF] → [CoM] → [Addr] | Every device in the Sercos network has a unique address in the format of an IP address. The last digit of the address is set by the parameter Addr. It has a range from 1...255. |

| Step | Action | Comment |
|---|---|---|
| 3 | Set the preferred homing method:<br>● [oP] → [hoM] → [Meth] | The HMprefmethod parameter is used to save the preferred method to the EEPROM (persistent).<br>Whenever the drive is power cycled, the actual homing method is updated with this parameter. There are various homing methods which can be selected via this parameter.<br>In this application, the value 33 is set. This means that the axis is homed on the index pulse reached in negative direction. |
| 4 | Disable the input functions for the limit switches:<br>● [ConF] → [i-o-] → [di2]<br>or<br>● [ConF] → [i-o-] → [di3] | By default, the input functions of the digital inputs DI2 and DI3 are set to positive [LiMP] and negative [LiMn] limit switch.<br>In this application, the axis is operated in modulo mode. Therefore, the digital inputs DI2 and DI3 are set to freely available [nonE]. |
| 5 | Restart the controller. | In the FSu- menu, the display shows boot in case a restart of the drive is required. Confirm by pressing the navigation button.<br>In the standard menu, the display shows nrdy in case a restart of the drive is required. In this case, power-cycle the drive. |

**⚠ WARNING**

**UNINTENDED EQUIPMENT OPERATION**

After any configuration changes or adjustments, power cycle the drive (power removal followed by power reapplied).

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

**NOTE:** The limit switches were disabled because the drive is applied in modulo motion mode (endless movements). If your application requires the end of travel limits, keep the default configuration or configure the desired inputs for the limit switches.

When the device is switched on and if the motor encoder is connected to the drive, the device automatically reads technical information on the motor (nominal torque and peak torque, nominal current, nominal velocity and number of pole pairs). Without this information, the device is not ready for operation.

You can perform further configurations, such as tuning, limit values, and I/O configuration based on the application. In this architecture, an auto tuning has been performed and for all other values the default settings were retained.

For more information, refer to LXM32S, AC servo drive, Product manual, 0198441114060 (ENG).

# Lexium 32i Servo Drive - CANopen Setup

## Overview

To operate the Lexium 32i via CANopen fieldbus, the communication parameters have to be set for the device. Further configuration settings depend on your application.

There are several options to configure the communication parameter of the drive:

- by the switches on the drive
- by the configuration software SoMove installed on a PC*

(* linked to the integrated communication port CN10) below the cover of the commissioning interface of the drive *(see page 149)*.

**NOTE:** If a device has already been configured for some other use, re-establish the factory settings. Instructions on how to do this can be found in the respective documentation.

**⚠ WARNING**

**UNINTENDED EQUIPMENT OPERATION**

- Verify that both wiring and mounting are correct before you start to configure the drive.
- Verify that an unintentional start of the connected motor will not endanger personnel or equipment in any way.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

If necessary, disconnect the motor from the drive to prevent an unintentional motor start.

## Communication Settings

### Address

The device address can be set directly with the DIP switches *(see page 150)*. If all DIP switches are set to 0 (default), the address has to be set via the parameter `CANaddress` using the commissioning software.

Refer to Commissioning Interface and Address Setting *(see page 150)*.

### Baud rate

The baud rate can be set directly with the DIP switches *(see page 150)*. If the DIP switches are set in a specific combination (default), the baud rate has to be set via the parameter `CANbaud` using the commissioning software.

Refer to Commissioning Interface and Baud Rate *(see page 150)*.

Also refer to LXM32iCAN BMi, Lexium 32 Integrated, Product manual, 0198441113950 (ENG).

# PM3250 Power Meter - Modbus SL Setup

## Overview

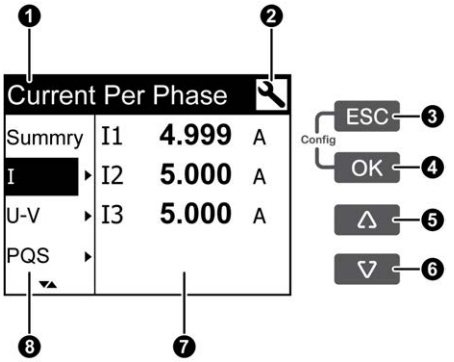
In addition to this system user guide the product manual for the PM3250 power meter has to be read carefully.

For more information, refer to PM3200 series, Power Meters, User Manual, DOCA0006EN.

The power meter features a sophisticated and intuitive Human Machine Interface (HMI) with signaling LEDs, a graphic display, and contextual menu buttons for accessing the information required to operate the power meter and modify parameter settings.

The navigation menu allows displaying, configuring, and resetting parameters.

## General Display




1 Main title
2 Configuration mode
3 Cancel
4 Confirm
5 Up
6 Down
7 Values/parameters
8 Sub menu

## Basic Configuration

Before starting the configuration of the power meter, you have to check the correct installation.

| Step | Action | Comment |
|---|---|---|
| 1 | Switch on the power supply. | The control voltage is sufficient to configure the device. |

| Step | Action | Comment |
|---|---|---|
| 2 | Keep **ESC** + **OK** pressed for at least 2 seconds. | The display switches to configuration mode. |
| 3 | Select the **Setup** menu. | The password (high) has to be entered. By default the password is `0010`. |
| 4 | Select the submenu **Wire** and set the parameters for:<br>• **Power System**: `3PH4W`<br>• **VTs**: `direct connection`<br>• **CTs**: `3 CTs` | This parameter describes the power system and the wiring of the power meter. |
| 5 | Select the submenu **CT Ratio** and set the parameter for:<br>• **Primary**: `5 A`<br>• **Secondary**: `100 A` | This parameter describes ratio of the connected current transformers. |
| 6 | Select the submenu **Nominal Frequency** and set the parameter to `50 Hz`. | - |
| 7 | Select the submenu **Communication** and set the parameter for:<br>• **Baud Rate**: `19200`<br>• **Parity**: `EVEN`<br>• **Address**: `1` | To operate the power meter via Modbus SL the communication parameters have to be set based on the settings on the master, usually the controller. |
| 8 | Press ESC to leave the **Setup** menu. | Basic configuration is finished. The power meter should display now the expected values and is ready for communication via Modbus SL. |

Further configurations can be done depending on your application needs.

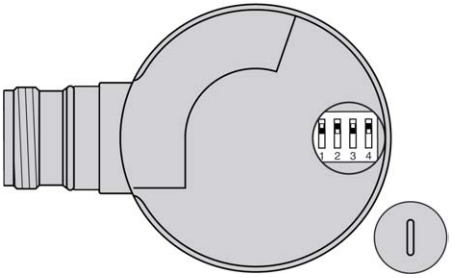
# OsiSense XCC Encoder - Setup

## Overview

The OsiSense XCC Encoder is an incremental encoder with a configurable resolution range of 500...8,000 points. The resolution is to adjust via DIP switches on the encoder.

## Basic Configuration

The figure shows the DIP switches on the OsiSense XCC Encoder.




The table shows the dependency between the position of the DIP switches and the basic resolution of the encoder. In this architecture, the encoder is configured with a resolution of 5,000 points per revolution.

| Interpolation factor | | Basic resolution | | | | | DIP switches | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Speed | Counting | | | | | | ON | | | |
| | | | | | | | 1 | 2 | 3 | 4 |
| x1 | x1 | 256 | 360 | 500 | 1024 | 5000 | | | | |
| x2 | x2 | 512 | 720 | 1000 | 2048 | 10,000 | | | | |
| x3 | x3 | 768 | 1080 | 1500 | 3072 | 15,000 | | | | |
| x4 | x4 | 1024 | 1440 | 2000 | 4096 | 20,000 | | | | |

| Interpolation factor | | Basic resolution | | | | | DIP switches | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Speed | Counting | | | | | | ON | | | |
| | | | | | | | 1 | 2 | 3 | 4 |
| – | x5 | 1280 | 1800 | 2500 | 5120 | 25,000 | | | | |
| | x8 | 2048 | 2880 | 4000 | 8192 | 40,000 | | | | |
| | x10 | 2563 | 3600 | **5000** | 10,240 | 50,000 | | | | |
| | x12 | 3072 | 4320 | 6000 | 12,288 | 60,000 | | | | |
| | x16 | 4096 | 5760 | 8000 | 16,384 | 80,000 | | | | |

For more information, refer to XCC1•••P/T Incremental Encoder, Instruction Sheet, W916900170111-A02.

# Chapter 8
# Adapt TVDA Template

## What Is in This Chapter?

This chapter contains the following sections:

# Section 8.1
# Adapt SoMachine Project Template

## What Is in This Section?

This section contains the following topics:

# Introduction

## Overview

The structure of a TVDA project template has a modular design which is based on Device Module *(see page 226)*.

This allows you to create your customized project in an easy and flexible way by adapting the TVDA project template.

- Add Device Modules *(see page 228)*
- Remove Device Modules *(see page 230)*

# Device Modules in General

## Overview

The Device Modules out of the **TVDA Device Module Library** are represented by Function Templates *(see SoMachine, Programming Guide)* within SoMachine. They are especially created for the TVDA project template.

Device Modules are available for all functional units implemented in the different TVD architectures.

By definition functional units in the extent of Device Modules are all sorts of field devices controlled (connected) in various ways by the controller.

All required SoMachine application content, beginning with integrating the device to the hardware configuration up to integration of all needed program code is provided.

Each Device Module comes with its own global variable definition and helps to ensure consistency within the application.

During the device module insertion process, the software prompts you to assign the required configuration such as addresses, names, variable assignment to I/Os, and parameter assignment. (Refer to Add Device Module *(see page 228)*.)

Each Device Module provides a ready to use interface within the application program to control the device and to monitor its status.

# Device Modules Used in This Project Template

## Used Device Modules

The following Device Modules of the **TVDA Device Module Library** are used in this project template.

| Device Module |
|---|
| ATV32_CANopen |
| Lexium_32i_CANopen |
| Lexium_32S_Sercos |
| MED_PM3250_ModbusSL |
| TeSysU_CANopen_Standard |

Refer to TVDA Device Module Library *(see TVDA Device Module Library, Function Template Library Guide)*.

# Add Device Modules

## Procedure

To add a Device Module, proceed as follows:

| Step | Action |
|---|---|
| 1 | Right-click the **Application** node in the **Tools tree** and select **Add Function From Template** from the context menu.<br>The **Add Function From Template** dialog box is displayed. |
| 2 | Enter a **Function Name** that is used for the new folder of the Device Module and for the naming of the elements it contains (GVL, POU, POU call, device, and so on). |
| 3 | Click the **...** button and select a Device Module (Function Template) from the **TVDA Device Module Library**. Confirm with **OK**. |
| 4 | Now you can edit the different properties. Which properties can be edited depends on the selected Device Module. |
| 5 | For some Device Modules, it is possible to configure the device addresses.<br>In **Address** column of the **I/O Devices** field, click the **...** button to open the **Select Device Address** dialog box and select a free address.<br>(Free addresses are displayed in black and can be selected. Already applied addresses are grayed/disabled). |
| 6 | In **Master** column of the **I/O Devices** field, click the **...** button to open the **Select Fieldbus Master** dialog box and select the fieldbus master for your Device Module. Confirm with **OK**.<br>If an appropriate fieldbus master is available, it is preselected in the dialog box. |
| 7 | The **I/O Mapping** field is an optional feature and not mandatory. For some Device Modules, it is possible to map variables directly to I/Os of the configuration.<br>In **Mapping** column of the **I/O Mapping** field, click the **...** button to open the **Select I/O Mapping** dialog box and map the variable to a **Channel** of your I/O configuration. Confirm with **OK**. |
| 8 | In **New Value** column of the **Parameters** field, you can enter an initial value for the displayed variables (for example constants).<br>If you do not enter a value, the **Default** value is used in your project. |

**NOTE:** For Device Modules associated with a fieldbus, the appropriate fieldbus master has to be available in your project. For example, the Device Module ATV32_CANopen requires a CANopen manager in the project configuration.

## Objects Added

If you add a Device Module, all associated objects are added to the project at the appropriate position. Information on what was done during adding the Device Module, is displayed in the **Messages** window.

Potential objects and actions are listed in the table.

| Object | Description |
|---|---|
| root folder | A new folder is added under the **Application** node in the **Tools tree** that is named as defined in the **Function Name** text box in the **Add Function From Template** dialog box. |
| GVL (global variable list) | The global variable list that is included in the Device Module is added below the root folder using the **Function Name**.<br>For example `GVL_ATV32_CANopen`. |
| POU (program organization unit) | The POU that is included in the Device Module is added below the root folder using the **Function Name**.<br>For example `Prg_ATV32_CANopen (PRG)`. |
| POU call | The call of the POU that is included in the Device Module is added below **Task Configuration → MAST** using the **Function Name**.<br>For example `Prg_ATV32_CANopen`. |
| device | A device (if included in the Device Module) is added below the respective fieldbus (for example **CAN0 → CANopen_Performance (CANopen Performance)**) as selected in the **Select Fieldbus Master** dialog box.<br>For example `ATV32_CANopen (Altivar 32)`. |
| I/O mapping | Variables mapped in the **Add Function From Template** dialog box (**I/O Mapping** field), appear in the device editor of the respective device. |
| libraries | Libraries referenced by the Device Module are automatically added to the **Library Manager** of your project. |

# Remove Device Module

## Procedure

By adding *(see page 228)* a Device Module, various objects are added to your project.

To remove a functional unit (based on a Device Module) from your project, you have to remove the following objects manually from your project.

## Objects to be Removed

| Object | Description |
|---|---|
| root folder | Remove the folder of the Device Module under the **Application** node in the **Tools tree**. |
| GVL (global variable list) | As the GVL is part of the root folder, it is removed with the root folder. |
| variables | Remove the variables coming from your Device Module and being used in the project. For example in the **Symbol configuration** or in the I/O mapping. |
| POU (program organization unit) | As the POU is part of the root folder, it is removed with the root folder. |
| POU call | Remove the POU call of the Device Module from **Task Configuration**. |
| device | Remove the device (if included in the Device Module) from the respective fieldbus (for example **CAN0 → CANopen_Performance (CANopen Performance)**). |
| libraries | Remove the libraries referenced by the Device Module from the **Library Manager** of your project (if not referenced by other objects in your project). |

# Section 8.2
# Adapt HMI Application

## Introduction

### Overview

The provided HMI application is a general solution.

Since every machine needs its own specific interface, the provided HMI application will in all likelihood not match exactly your requirements. Therefore, you will need to modify the provided HMI application using the Vijeo-Designer configuration software.

Vijeo-Designer is an efficient and flexible tool. It provides numerous functions to facilitate the creation or adaptation of the HMI application.

Especially for an easy adaptation, the following features are highlighted:
- Objects can be saved as templates in tool chest.
- Placeholder in variable expressions can be used.
- Resources for object design can be used.
- Export/import function is available.
- Master panels can be used.

If desired, the provided HMI application can be used as pattern for your solution.

# Chapter 9
# Bill of Material (BOM)

## Bill of Material (BOM)

### Overview

In this chapter, a Bill of Materials (BOM) for the main components of the architecture is provided.

Components and component combinations of the protection system of this architecture are marked with additional information about the conformity to standards IEC and UL. Those which are marked as UL can be considered as a multistandard solution. Nonetheless, you must consider and respect the local standards and codes, as well as the electrical and environmental conditions, where the system is installed and operated. For more information on this topic, refer to the associated product manuals and on the Schneider Electric webpage.

Regardless of the industrial application of a control panel, its protection systems and devices must comply with applicable international standards:

- IEC 60-204 safety of machinery
- UL 508A industrial control panel

Components and component combinations that meet multiple standards are equally important to design and size for ensuring that control panels meet legal requirements across international markets.

**⚠ WARNING**

**REGULATORY INCOMPATIBILITY**

Ensure that all equipment applied and systems designed comply with all applicable local, regional, and national regulations and standards.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

Schneider Electric offers UL 508A support on the website at *www.Schneider-Electric.us*. A number of educational and product search tools are available on the website, including overview information, a UL 508A SCCR (Short Circuit Current Rating) determination flow chart, and information on Schneider Electric individual or product combination SCCRs. Underwriters Laboratories also publish SCCR tested combination ratings on its website. Updated tested combination ratings of Schneider Electric can be found on both websites and are free to download.

The UL 508A support website of Schneider Electric is located at:

*http://www.schneider-electric.us/sites/us/en/support/product-support-resources/ul-508a-support/ul-508a-support.page*

The UL 508A combination motor controller website of UL is located at:

*http://www.ul.com/global/eng/pages/offerings/industries/powerandcontrols/industrialcontrolequipment*

## Main Switch

| Quantity | Description | Reference | IEC | UL |
|---|---|---|---|---|
| 1 | PowerPact H-Frame multistandard circuit breaker, main switch, 3pin, 35 kA | NHGF36015TW | x | x |
| 1 | Lug kit 15...150 A | AL150HDS | x | x |
| 1 | Short lug shield | S37446 | x | x |
| 1 | Extended rotary handle | LV429502 | x | x |
| 1 | Red rotary handle on yellow bezel | LV429340 | x | x |

## Powermeter

| Quantity | Description | Reference | IEC | UL |
|---|---|---|---|---|
| 4 | Circuit breaker Multi9 UL1077 1P, C, 1A (~230 V) | 24425 | x | x |
| 1 | Power meter PM3250 | METSEPM3250 | x | x |
| 3 | Current transformer 100/5 A | 16453 (only IEC) | x | * |
| * For applications on the North American market, use approbated current transformers. | | | | |

## Emergency Stop

| Quantity | Description | Reference |
|---|---|---|
| 1 | Preventa safety controller with two independent configurable safety functions | XPSMP |
| 1 | E-Stop push-button, 2 NC, 22 mm (0.87 in), complete unit | XB5AS8444 |
| 1 | E-Stop push-button, complete plastic control station, yellow / red, 2 NC | XALK178F |
| 1 | Illuminated push-button, blue, 1 NO + 1 NC, integral LED, complete unit | XB5AW36B5 |
| 1 | Legend holder and blank label (white or yellow) 18x27 mm (0.7x1.06 in) | ZBY6102 |
| 1 | Circular yellow legend for E-stop push-button "EMERGENCY STOP" | ZBY8330 |
| 2 | TeSys D contactor, AC-3 400 V / 7.5 kW | LC1D18BD |

## Door Guard

| Quantity | Description | Reference |
|---|---|---|
| 0* | Preventa safety controller with two independent configurable safety functions | XPSMP |
| 1 | Preventa safety module used to extend the number of safety output contacts of the base module XPSMP | XPSECPE |
| 1 | Preventa door guard switch | XCSPA792 |
| 1 | Actuator for door guard switch | XCSZ12 |
| 1 | Illuminated push-button, blue, 1 NO + 1 NC, integral LED, complete unit | XB5AW36B5 |
| 1 | Legend holder and blank label (white or yellow) 18x27 mm (0.7x1.06 in) | ZBY6102 |
| * One Preventa safety controller is used for both safety functions. | | |

## Display and Indicators

| Quantity | Description | Reference |
|---|---|---|
| 1 | Pilot light with integral LED, 24 Vac/dc, white, complete unit | XB5AVB1 |
| 1 | Plastic control station, empty, 3 cut-outs, IP66 | XALD03 |
| 2 | Push-button, green, 1 NO, complete unit | XB5AA31 |
| 1 | Push-button, red, 1 NC, complete unit | XB5AA42 |
| 4 | Legend holder and blank label (white or yellow) 18x27 mm (0.7x1.06 in) | ZBY6102 |
| 1 | Mounting plate for use on vertical support of tower light | XVBC12 |
| 1 | Mounting base with support tube 80 mm (3.1 in) black | XVBZ02 |
| 1 | Base unit for tower light | XVBC21 |
| 1 | Set of 6 colored markers for the position | XVBC22 |
| 1 | Signal element for tower light, green | XVBC2B3 |
| 1 | Signal element for tower light, red | XVBC2B4 |
| 1 | Signal element for tower light, blue | XVBC2B6 |
| 1 | Signal element for tower light, clear | XVBC2B7 |

## Automation Components

| Quantity | Description | Reference |
|---|---|---|
| 1 | Modicon LMC078 Motion Controller | LMC078CECS20T |
| 1 | TM5 Sercos III interface module | TM5SNS31 |

| Quantity | Description | Reference |
|---|---|---|
| 1 | TM5 interface power distribution module | TM5SPS3 |
| 2 | TM5 expansion module 12 digital inputs | TM5SDI12 |
| 1 | TM5 expansion module 4 AI, 16 bits, Pt100/Pt1000 | TM5SAI4PH |
| 1 | TM5 power distribution module | TM5SPS2 |
| 2 | TM5 expansion module, 12 digital transistor outputs | TM5SDO12T |
| 1 | TM5 expansion module 4 AI, 12 bits, ±10 V/0...20 mA | TM5SAO4L |
| 1 | TM5 transmitter module for TM7 bus | TM5SBET7 |
| 1 | TM5 bus base for interface module | TM5ACBN1 |
| 7 | TM5 bus base 24 Vdc, I/O segment pass through | TM5ACBM11 |
| 1 | TM5 bus base 24 Vdc, I/O segment left isolated | TM5ACBM01R |
| 2 | TM5 12 pin terminal block for IPDM, PDM | TM5ACTB12PS |
| 7 | TM5 12 pin terminal block | TM5ACTB12 |
| 1 | TM7 I/O block, 16 configurable I/O channels with 8 M12 connectors | TM7BDM16A |
| 1 | TM7 power cable 10 m (32.8 ft), M8 4 pin female angled connector, 1 open end | TCSXCNEFNX10V |
| 1 | TM7 expansion bus cable 10 m (32.8 ft), M12 B-coded 4 pin female angled connector, 1 open end | TCSXCN2FNX10E |

## Magelis HMI

| Quantity | Description | Reference |
|---|---|---|
| 1 | Magelis HMIGTO 10.4 color touch-panel VGA-TFT | HMIGTO5310 |

## Control Voltage Power Supply and Distribution

| Quantity | Description | Reference | IEC | UL |
|---|---|---|---|---|
| 1 | Circuit breaker Multi9 UL1077 2P, C, 3A (~230V) | 24444 | x | x |
| 1 | Power supply 230 Vac / 24 Vdc, 10 A | ABL8RPS24100 | x | x |
| 5 | Circuit breaker Multi9 UL1077 1P, C, 1A (24 Vdc) | 24425 | x | x |
| 14 | Circuit breaker Multi9 UL1077 1P, C, 2A (24 Vdc) | 24426 | x | x |
| 2 | Circuit breaker Multi9 UL1077 1P, C, 4A (24 Vdc) | 24428 | x | x |
| 9 | Auxiliary contact circuit breaker C60 Multi 9 UL 489/1077 | 26925 | – | – |
| 1 | Disconnect terminal (9760U/8TKE48) | 5711016550 (Wieland) | x | x |

## Heating

| Quantity | Description | Reference | IEC | UL |
|---|---|---|---|---|
| 4 | Solid-state relays for heating | SSRPCDS10A1 | x | x |
| 4 | Circuit breaker Multi9 UL489 1P, C, 10A (~230V) | 60110 | x | x |

## Drives and Power

| Quantity | Description | Reference | IEC | UL |
|---|---|---|---|---|
| Altivar 32 | | | | |
| 2 | Altivar 32 variable speed drive, 0.37 kW | ATV32H037N4 | x | x |
| 2 | Magnetic circuit breaker, 2.5 A (3~400 V) | GV2L07 | x | – |
| 2 | Auxiliary contacts for circuit breaker, 1 NO, 1 NC | GVAE11 | x | – |
| 2 | Thermal-magnetic circuit breaker, 1.6...2.5 A (3~480 V) | GV2P07 | – | x |
| 2 | Insulating barrier for motor circuit breaker | GV2GH7 | – | x |
| 2 | Auxiliary contacts for circuit breaker, 1 NO, 1 NC | GVAN11 | – | x |
| 2 | CANopen communication card for daisy chain | VW3A3608 | x | x |
| Lexium 32 | | | | |
| 2 | Lexium 32S servo drive 1~230 V/1 kW | LXM32SD18M2 | x | x |
| 2 | Magnetic circuit breaker, 10 A (1~230 V) | GV2L14 | x | – |
| 2 | Auxiliary contacts for circuit breaker, 1 NO, 1 NC | GVAE11 | x | – |
| 2 | TeSys DFCC fuse holders + class CC fuses 10 A (fuses to be ordered separately - no Schneider Electric product) | DFCC2 | – | x |
| 2 | Servo motor 0.6 kW 2500U/min, multi, brake | BMH0702T02F2A | x | x |
| 2 | Power cable for Lexium 32, 5 m (16.4 ft) | VW3M5101R50 | x | x |
| 2 | Encoder cable for Lexium 32, 5 m (16.4 ft) | VW3M8102R50 | x | x |
| Lexium 32i | | | | |
| 1 | BMi servomotor with integrated power stage, single-phase, smooth shaft, multiturn encoder high resolution, without brake | BMI702T02A | x | x |
| 1 | Magnetic circuit breaker, 10 A (1~230 V) | GV2L14 | x | – |
| 1 | TeSys DFCC fuse holders + class J fuses 8 A (fuses to be ordered separately - no Schneider Electric product) | DFCC2 | – | x |
| 1 | LXM32i control unit for CAN fieldbus | LXM32ICAN | x | x |
| 1 | Connection module supply voltage | VW3M9002 | x | x |

| Quantity | Description | Reference | IEC | UL |
|---|---|---|---|---|
| 1 | Connection module, 4 logic inputs with M8 connectors, STO function | VW3M9101 | x | x |
| 1 | Cable STO with one 4-way female M8 industrial connector at one end and flying leads at the other | VW3M9405 | x | x |
| TeSys U | | | | |
| 1 | TeSys U base module reversing; 12 A (without terminals) | LU2BA0BL | x | x |
| 1 | TeSys U control unit, standard 0.15...0.6 A | LUCAX6BL | x | x |
| 1 | TeSys U wiring kit coil (reversible) | LU9MRC | x | x |
| 1 | TeSys U communication module CANopen | LULC08 | x | x |
| 1 | Insulating barrier for TeSys U | LU9SPO | – | x |

## Encoder

The encoders are designed for compatibility with the UL standard, but they are not certified.

| Quantity | Description | Reference |
|---|---|---|
| 1 | Incremental encoder 500...8000 points<br>Out: 5 Vdc, RS422<br>Supply: 4.75...30 Vdc | XCC1510PSM05X |
| 1 | Cable for incremental encoder, UL, 5 m (16.4 ft), RJ45/M23 | VWE2097R050 |
| 1 | Encoder mounting bracket | XCCRE5SN |

## Ethernet Wiring

| Quantity | Description | | Reference |
|---|---|---|---|
| 1 | Ethernet TCP/IP unmanaged switch,10BASET/100BASE-TX, 5x RJ45 ports copper cable | | TCSESU053FN0 |
| 3 | Ethernet ConneXium cable, shielded twisted-pair straight cord, one RJ45 connector at each end | 2.0 m (6.56 ft) | 490NTW00002 |
| 1 | Connexium M12 to RJ45 Ethernet adapter. | | TCSEAAF11F13F00 |

## Sercos III Wiring

| Quantity | Description | | Reference |
|---|---|---|---|
| 3 | Sercos III patch cable, 2xRJ45 | 2.0 m (6.56 ft) | VW3E5001R020 |
| 5 | Sercos III patch cable, 2xRJ45 | 0.18 m (0.59 ft) | VW3E5001S018 |

## CANopen Wiring

| Quantity | Description | | Reference |
|---|---|---|---|
| 1 | IP20 CANopen tap junction,<br>4 SUB-D ports, screw terminal block for connecting the trunk cables, line termination | | TSX CAN TDM4 |
| 1 | CANopen cable, dedicated to the American market, UL and CSA certified, fire retarding | 50 m (164 ft) | TSXCANCB50 |
| 2 | Preformed cordset.<br>One 9-way SUB-D connector<br>One RJ 45 connector | 1.0 m (3.28 ft) | TCS CCN 4F3M1T |
| 1 | Preformed cordset,<br>One RJ 45 connector at each end | 0.3 m (0.98 ft) | VW3 CAN CARR03 |
| 1 | IP20 line terminator, RJ 45 termination resistor (for end of bus) | | TCS CAR 013M120 |
| 2 | Preformed cordset,<br>One 9-way SUB-D female connector at each end,<br>UL certification | 1.0 m (3.28 ft) | TSXCANCBDD1 |
| 1 | IP67 M12 connector, 5-way M12 A-coded connectors female | | FTX CN 12F5 |
| 1 | IP67 line terminator, equipped with one M12 connector (for end of bus) | | TM7ACTLA |

## Software Tools

| Quantity | Description | Reference |
|---|---|---|
| 1 | SoMachine (includes Vijeo-Designer) on DVD | SOMNACS41* |
| 1 | Single user license for SoMachine | SOMNACCZXSPA41 |
| 1 | Programming cable | TCSXCNAMUM3P |
| 1 | Ethernet cable M12 - RJ45 | TCSECL1M3M3S2 |
| * The latest Add-On including the Modicon LMC078 Motion Controller must be installed in addition to the SoMachine DVD separately. | | |

**NOTE:** The SoMachine Add-Ons can be downloaded from the Schneider Electric webpage or via the Schneider Electric Software Update (SESU) tool.

# Glossary

## A

**application**

A program including configuration data, symbols, and documentation.

**A coded**

Connectors that have 1 raised key on the male connector and 1 mating slot on the female connector. This is the standard coding used for sensors and distribution box applications.

## B

**BOOTP**

(*bootstrap protocol*) A UDP network protocol that can be used by a network client to automatically obtain an IP address (and possibly other data) from a server. The client identifies itself to the server using the client MAC address. The server, which maintains a pre-configured table of client device MAC addresses and associated IP addresses, sends the client its pre-configured IP address. BOOTP was originally used as a method that enabled diskless hosts to be remotely booted over a network. The BOOTP process assigns an infinite lease of an IP address. The BOOTP service utilizes UDP ports 67 and 68.

**bps**

(*bit per second*) A definition of transmission rate, also given in conjunction with multiplicator kilo (kbps) and mega (mbps).

**BSH**

A Lexium servo motor from Schneider Electric.

**bus base**

A mounting device that is designed to seat an electronic module on a DIN rail and connect it to the TM5 bus for M258 and LMC058 logic controllers. Each base bus extends the integrated TM5 data and electronic power buses as well as the 24 Vdc I/O power segment. The electronic modules are added to the TM5 system through their insertion on the base bus.

## C

**CANmotion**

A CANopen-based motion bus with an additional mechanism that provides synchronization between the motion controller and the drives.

**CANopen**

An open industry-standard communication protocol and device profile specification (EN 50325-4).

**CiA**

(*CAN in automation*) A non-profit group of manufacturers and users dedicated to developing and supporting CAN-based higher layer protocols.

**configuration**

The arrangement and interconnection of hardware components within a system and the hardware and software parameters that determine the operating characteristics of the system.

**control network**

A network containing logic controllers, SCADA systems, PCs, HMI, switches, ...

Two kinds of topologies are supported:

- flat: all modules and devices in this network belong to same subnet.
- 2 levels: the network is split into an operation network and an inter-controller network.

These two networks can be physically independent, but are generally linked by a routing device.

**controller**

Automates industrial processes (also known as programmable logic controller or programmable controller).

**CSA**

(*Canadian standards association*) The Canadian standard for industrial electronic equipment in hazardous environments.

## D

**DHCP**

(*dynamic host configuration protocol*) An advanced extension of BOOTP. DHCP is more advanced, but both DHCP and BOOTP are common. (DHCP can handle BOOTP client requests.)

**DTM**

(*device type manager*) Classified into 2 categories:

- Device DTMs connect to the field device configuration components.
- CommDTMs connect to the software communication components.

The DTM provides a unified structure for accessing device parameters and configuring, operating, and diagnosing the devices. DTMs can range from a simple graphical user interface for setting device parameters to a highly sophisticated application capable of performing complex real-time calculations for diagnosis and maintenance purposes.

## E

**encoder**

A device for length or angular measurement (linear or rotary encoders).

**Ethernet**

A physical and data link layer technology for LANs, also known as IEEE 802.3.

**EtherNet/IP**

(*Ethernet industrial protocol*) An open communications protocol for manufacturing automation solutions in industrial systems. EtherNet/IP is in a family of networks that implement the common industrial protocol at its upper layers. The supporting organization (ODVA) specifies EtherNet/IP to accomplish global adaptability and media independence.

**expansion bus**

An electronic communication bus between expansion I/O modules and a controller.

## F

**FBD**

(*function block diagram*) One of 5 languages for logic or control supported by the standard IEC 61131-3 for control systems. Function block diagram is a graphically oriented programming language. It works with a list of networks, where each network contains a graphical structure of boxes and connection lines, which represents either a logical or arithmetic expression, the call of a function block, a jump, or a return instruction.

**FDT**

(*field device tool*) The specification describing the standardized data exchange between the devices and control system or engineering or asset management tools.

**FTP**

(*file transfer protocol*) A standard network protocol built on a client-server architecture to exchange and manipulate files over TCP/IP based networks regardless of their size.

## H

**HMI**

(*human machine interface*) An operator interface (usually graphical) for human control over industrial equipment.

## I

**I/O**

(*input/output*)

**IEEE 802.3**

A collection of IEEE standards defining the physical layer, and the media access control sublayer of the data link layer, of wired Ethernet.

**IL**

(*instruction list*) A program written in the language that is composed of a series of text-based instructions executed sequentially by the controller. Each instruction includes a line number, an instruction code, and an operand (refer to IEC 61131-3).

**IP 20**

(*ingress protection*) The protection classification according to IEC 60529 offered by an enclosure, shown by the letter IP and 2 digits. The first digit indicates 2 factors: helping protect persons and for equipment. The second digit indicates helping protect against water. IP 20 devices help protect against electric contact of objects larger than 12.5 mm, but not against water.

**IP 67**

(*ingress protection*) The protection classification according to IEC 60529. IP 67 modules are protected against ingress of dust, contact, and water up to an immersion depth of 1 m.

## L

**LD**

(*ladder diagram*) A graphical representation of the instructions of a controller program with symbols for contacts, coils, and blocks in a series of rungs executed sequentially by a controller (refer to IEC 61131-3).

## M

**Magelis**

The commercial name for Schneider Electric's range of HMI terminals.

**Modbus SL**

(*Modbus serial line* The implementation of the protocol over a RS-232 or RS-485 serial connection.

## P

**Profibus DP**

(*Profibus decentralized peripheral*) An open bus system uses an electrical network based on a shielded 2-wire line or an optical network based on a fiber-optic cable. DP transmission allows for high-speed, cyclic exchange of data between the controller CPU and the distributed I/O devices.

**program**

The component of an application that consists of compiled source code capable of being installed in the memory of a logic controller.

**PTO**

(*pulse train outputs*) a fast output that oscillates between off and on in a fixed 50-50 duty cycle, producing a square wave form. The PTO is especially well suited for applications such as stepper motors, frequency converters, and servo motor control, among others.

## R

**RJ45**

A standard type of 8-pin connector for network cables defined for Ethernet.

**RS-232**

A standard type of serial communication bus, based on 3 wires (also known as EIA RS-232C or V.24).

**RS-485**

A standard type of serial communication bus, based on 2 wires (also known as EIA RS-485).

## S

**SFC**

(*sequential function chart*) A language that is composed of steps with associated actions, transitions with associated logic condition, and directed links between steps and transitions. (The SFC standard is defined in IEC 848. It is IEC 61131-3 compliant.)

**SL**

(*serial line*)

**SNMP**

(*simple network management protocol*) A protocol that can control a network remotely by polling the devices for their status and viewing information related to data transmission. You can also use it to manage software and databases remotely. The protocol also permits active management tasks, such as modifying and applying a new configuration.

**SoMachine**

A comprehensive controller development system software tool for configuring and programming the Modicon logic controller and devices compliant with IEC 61131-3.

**ST**

(*structured text*) A language that includes complex statements and nested instructions (such as iteration loops, conditional executions, or functions). ST is compliant with IEC 61131-3.

## T

**TCP**

(*transmission control protocol*) A connection-based transport layer protocol that provides a simultaneous bi-directional transmission of data. TCP is part of the TCP/IP protocol suite.

**terminal block**

(*terminal block*) The component that mounts in an electronic module and provides electrical connections between the controller and the field devices.

**TVDA**

(*tested validated documented architectures*) Control system proposals based on Schneider Electric components.TVDAs cover a wide range of machine types and consider machine performance requirements, installation constraints, and target costs. To optimize the implementation effort, each TVDA comes with a detailed component list, wiring diagrams, and commissioning guide, as well as controller and HMI applications to control components of the system.

# V

**VSD**

(*variable speed drive*) An equipment that makes a variable and regulates the speed and rotational force, or torque output, of an electric motor.

# Index