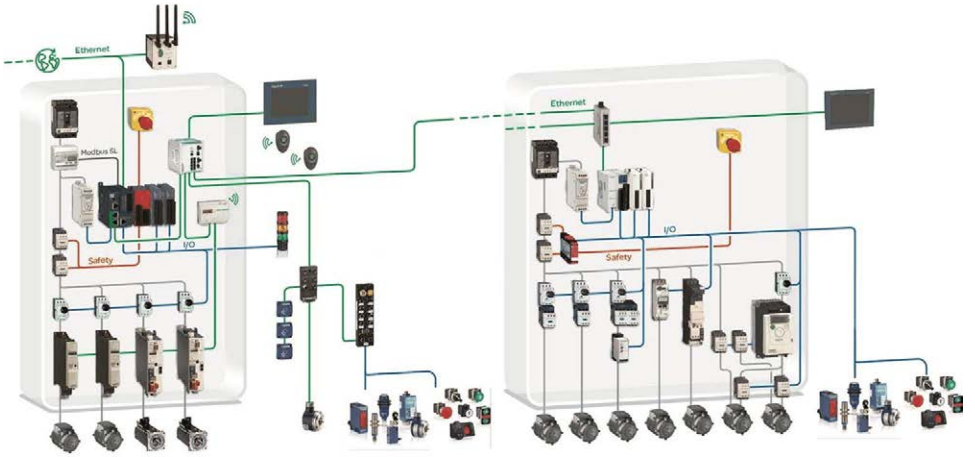
Distributed Modbus TCP Logic Controller M251

System User Guide

11/2015



EIO0000001680.02

www.schneider-electric.com

Schneider Electric

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, 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.

⚠ CAUTION

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 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 M251 Logic 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 for the release of SoMachine V4.1 SP2.

Related Documents

Title of Documentation	Reference Number
PowerPact Multistandard, Catalogue	LVPED212023EN
The essential guide for power supplies and transformers	DIA3ED2070412EN
C60 Multi-Standard Range, Catalog	CM909003E
Phaseo power supplies and transformers, Catalogue Pages	14082-EN
iEM3100 series / iEM3200 series, Energy Meters, User Manual	DOCA0005EN
Control and protection components	MKTED210011EN
Control and signaling components	MKTED208031EN
LAD5C Instruction Sheet	HRB8873800
Preventa solutions for efficient machine safety - catalogue	MKTED2140201EN
Magelis GTO, User Manual	EIO0000001133 (ENG)
Magelis XBT GC/XBT GK/XBTGT, SoMachine - Combo and Network Drivers	EIO00000000219 (ENG)
Harmony XB5R, ZBRN1/ZBRN2, User Manual	EIO0000001177 (EN)
Harmony XB5R, Expert Instruction Sheet	EIO0000000812 (EN)
Modicon M251 Logic Controller, Hardware Guide	EIO0000001486
Modicon M251 Logic Controller, Programming Guide	EIO0000001462
Modicon TM3, Digital I/O Modules, Hardware Guide	EIO0000001408
Modicon TM2, Analog I/O Modules, Hardware Guide	EIO0000000034
Modicon TM2, Digital I/O Modules, Hardware Guide	EIO0000000028
Modicon TM2, High Speed Counter Modules, Hardware Guide	EIO0000000022
Modicon TM3, Expert I/O Modules, Hardware Guide	EIO0000001420
Modicon TM3, Expansion Modules Configuration, Programming Guide	EIO0000001402
Advantys ETB, IP67 Ethernet Block I/O Modules for Modbus TCP/IP, User Guide	EIO0000000158
Advantys OTB Ethernet, Remote Inputs/Outputs, User Manual	1606385
ConneXium Ethernet Cabling System TCSESM, TCSESM-E Managed Switch Basic Configuration, User Manual	31007122
ConneXium TCSESM, TCSESM-E Managed Switch Redundancy Configuration, User Manual	31007126
ConneXium TCSESM, TCSESM-E, Managed Switch, Web-based Interface, Reference Manual	EIO0000000482
ConneXium TCSESM Managed Switch, Installation Manual	31007118

Title of Documentation	Reference Number
ConneXium Industrial Ethernet Cabling System, 5TX IP67 Switch, TCSESU051F0	31006691
ConneXium Ethernet Switches, TCSESU0••F•N0, Quick Reference Guide	31007950
Advantys ETB, IP67 Ethernet Block I/O Modules for Modbus TCP/IP, User Guide	EIO0000000158
TeSys U, Starter-controllers, Catalogue	DIA1ED2081003EN
The essential guide, TeSys for power control & protection	DIA1ED2040401EN
ATV32 - Safety integrated functions manual	S1A45606
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)
Altivar 32 Variable speed drives for synchronous and asynchronous motors, Modbus TCP - EtherNet/IP, Communication Manual	S1A28701
Altistart 01, Soft Starts for Single-Phase and Three-Phase Asynchronous Motors	45A01SS
Characteristics, Soft starters for asynchronous motors Altistart 01	60541-EN
Reduce mechanical stress on your machines	DIA2ED1121204EN
Instruction Sheet ATS01N1...FT	1624685
LXM32M AC servo drive, Product manual	0198441113767
LXM32M, Modbus-TCP module, Fieldbus manual	0198441113843
BMH, Servo motor, Motor manual	0198441113749 (ENG)
BSH, Servo motor, Motor manual	0198441113837 (ENG)
Detection for automation solutions OsiSense	MKTED210041EN
RFID OsiSense XG, Ethernet Smart Antenna, User Manual	EIO0000001601
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.
EN 61496-1:2013	Safety of machinery: Electro-sensitive protective equipment. 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 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.

Standard	Description
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
2004/108/EC	Electromagnetic Compatibility Directive
2006/95/EC	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 *EC Machinery Directive* (*EC/2006/42*) 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 optimized performance class and is distinguished by the following characteristics:

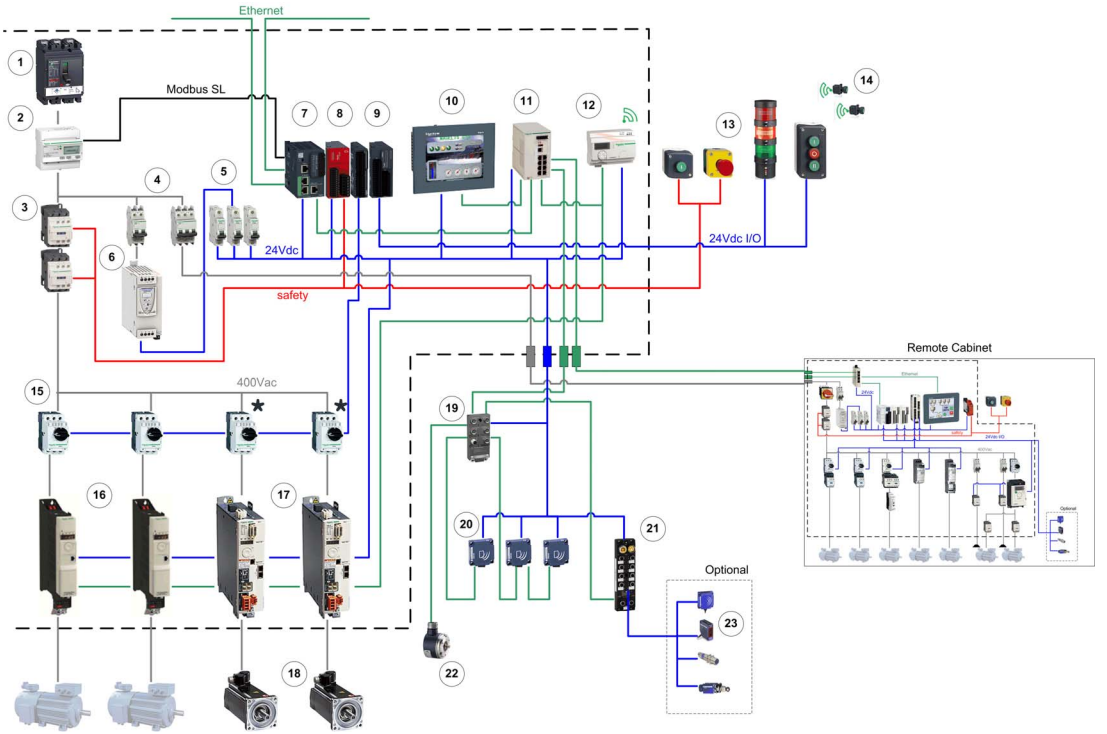
- Modicon M251 Logic Controller
- 2 optimized Magelis touch panels HMIGTO4310 and HMIGTO5315
- Energy metering
- Industrial Ethernet (Modbus TCP)
- Modbus serial line communication
- Ethernet connectivity
- Application of machine safety
- Wireless and batteryless operator push-buttons
- 82 digital inputs (16 local and 66 distributed)
- 56 digital outputs (16 local and 40 distributed)

The following devices are linked to the Industrial Ethernet (Modbus TCP) and are controlled and monitored by the controller as Modbus TCP slave:

- 2 Altivar 32 variable speed drives
- 2 Lexium 32M servo drives
- 1 Harmony wireless push-button access point
- 1 Absolute multiturn encoder
- 3 OsiSense XG RFID smart antennas
- 1 Modicon ETB IP 67 distributed I/O block
- 1 Modicon OTB equipped with TM2 expansion modules

Layout

Main cabinet

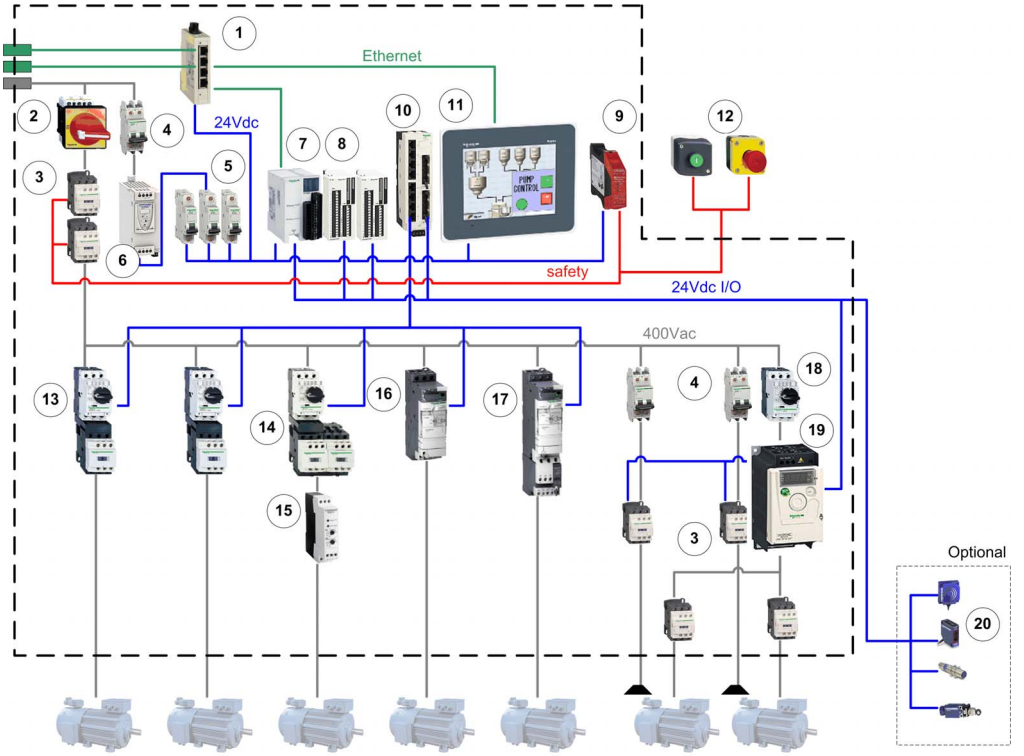


* Conformance to UL standards requires that fuses are used for the branch circuit protection in place of the motor circuit breakers depicted above in front of the Lexium servo drives. For more information, refer to LXM32M AC servo drive, Product manual, 0198441113767.

1	PowerPact circuit breaker	13	Harmony signaling/control devices
2	iEM3150 energy meter	14	Harmony wireless push-buttons
3	TeSys D LC1D contactor	15	TeSys GV2P motor circuit-breaker
4	Multi-9 C60 (UL 489) circuit breaker	16	Altivar 32 variable speed drive + Ethernet communication module
5	Multi-9 C60 (UL 1077) circuit breaker	17	Lexium 32M servo drive + Ethernet communication module
6	Phaseo power supply	18	Lexium BSH servo motor
7	Modicon M251 Logic Controller	19	Ethernet switch IP 67 (unmanaged)
8	Modicon TM3 embedded safety module	20	OsiSense XG RFID smart antenna (Modbus TCP)

9	TM3 digital I/O expansion module	21	Advantys ETB 16 I/O module (Modbus TCP)
10	Magelis HMIGTO touch panel	22	Absolute multiturn encoder (Modbus TCP)
11	ConneXium Ethernet switch (managed)	23	OsiSense sensors and switches
12	Harmony wireless receiver (Modbus TCP)	-	-

Remote cabinet



1	ConneXium Ethernet switch (unmanaged)	11	Magelis HMIGTO touch panel (stainless steel)
2	Vario disconnector switch	12	Harmony signaling/control devices
3	TeSys D LC1D contactor	13	TeSys D motor starter and wiring adapter
4	Multi-9 C60 (UL 489) circuit breaker	14	TeSys D motor starter (reversible) and wiring adapter
5	Multi-9 C60 (UL 1077) circuit breaker	15	Altistart ATS01N1 soft starter
6	Phaseo power supply	16	TeSys U motor starter controller

7	Modicon OTB I/O module (Modbus TCP)	17	TeSys U motor starter controller (reversible)
8	TM2 digital I/O expansion module	18	TeSys GV2P motor circuit-breaker
9	Preventa safety module XPSAF	19	Altivar 12 variable speed drive
10	TeSys splitter box, parallel wiring	20	OsiSense sensors + switches

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

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

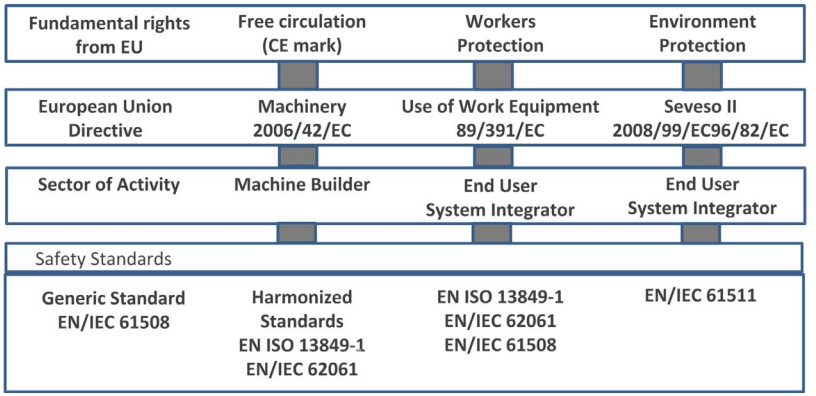
A standard becomes harmonized when published throughout the member states.

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.

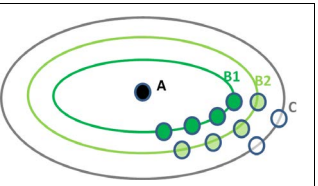
European standards for the machinery safety form the following structure:

Type A standards
Basic safety standards giving basic concepts, principles for design, and general aspects that can be applied to all machinery.

Type B standards
Generic safety standards dealing with one safety aspect or one type of safeguard that can be used across a wide range of machinery:

- Type B1 standards on particular safety aspects (for example, safety distances, surface temperature, noise)
- Type B2 standards on safeguards (for example, two-hand controls, interlocking devices, pressure sensitive devices, guards)

Type C standards
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.

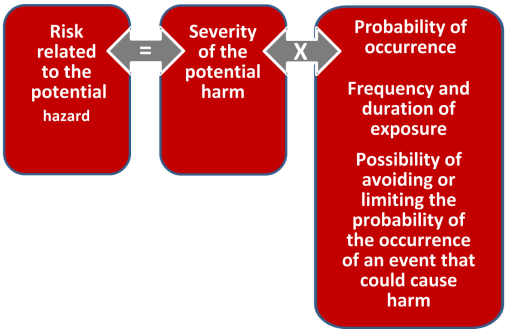
Risk Assessment

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

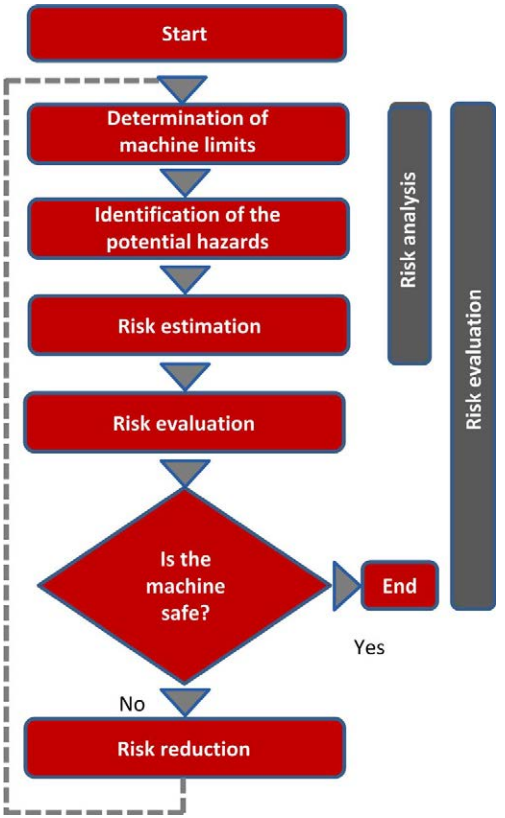
Risk assessment starts by determining the limits of the machine at all stages of its life cycle:

- 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.

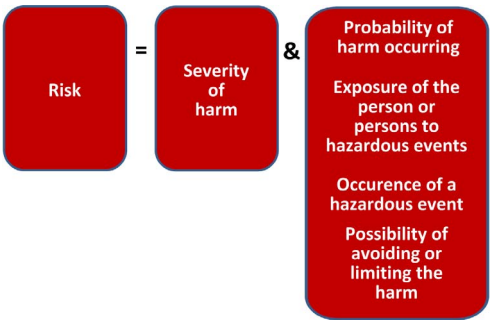
The risk is a function of the severity of the harm and the probability that this harm will occur. The severity of the harm takes into account:

- 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.

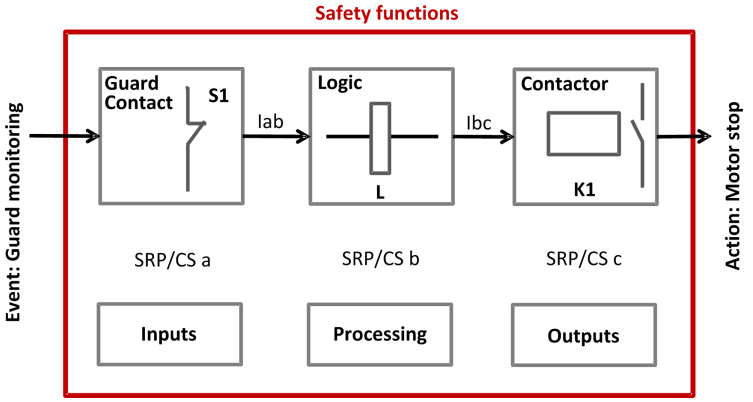
The above 6 stages will be illustrated taking as an example a safety function where a severe injury can be caused by a horizontal movement on a machine not stopping where an operator maybe exposed to this dangerous situation. The machine is sometimes accessed by production workers and monitored during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

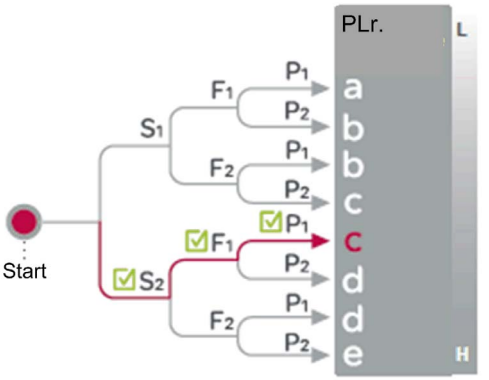
Considering the example of the person coming into area where the machine is operating, the risk is estimated using the risk graph.

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

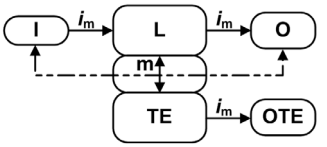
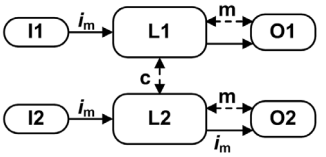
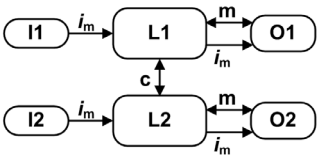
There is a need to describe the PL (performance level) calculation method.

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.	
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)

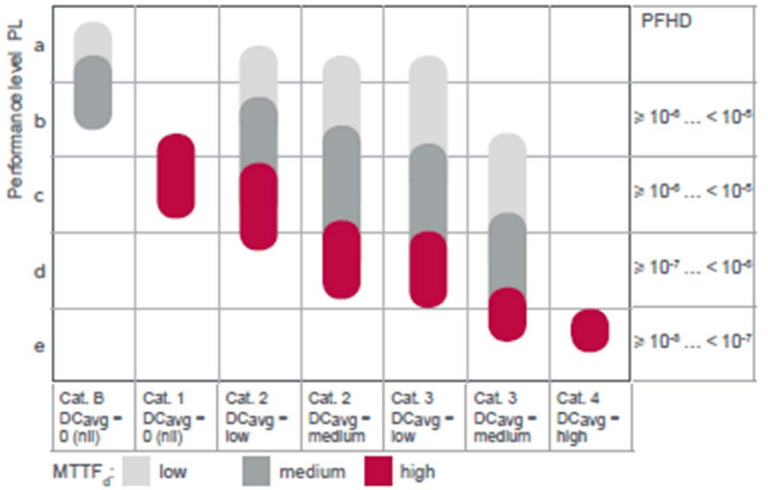
This term is expressed as a percentage and quantifies the ability to diagnose a dangerous failure.

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.

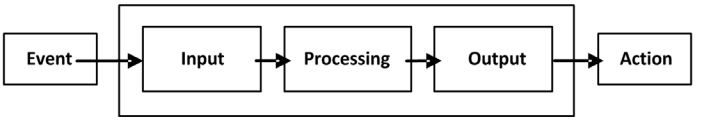


Using the above chart you can now select the most appropriate architecture, the required diagnostic coverage as well as ensure the products selected have the right $MTTF_d$ values.

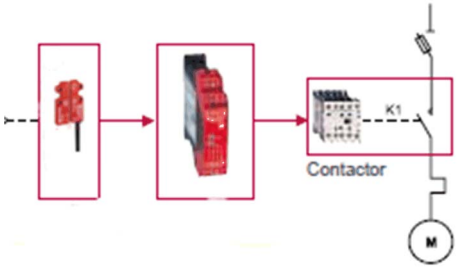
As the example requires PL=c the chart states as a minimum a category 1 architecture with a diagnostic coverage of 0 (Nil) and a $MTTF_d$ of high is required.

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:

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

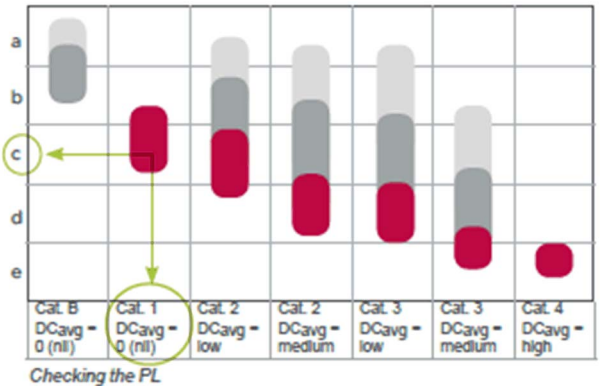
The DC in the example is < 60%, for example nil.

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.

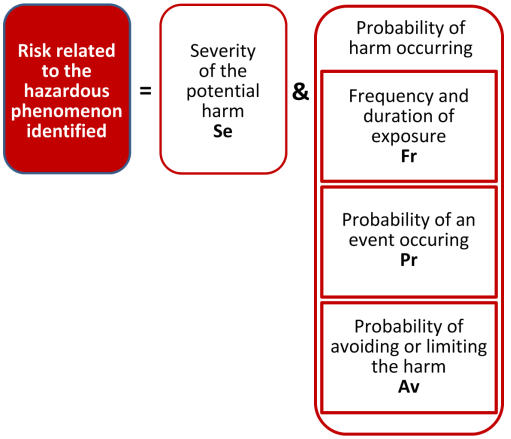
The method consists of assigning a SIL to each function, taking into account the following parameters:

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

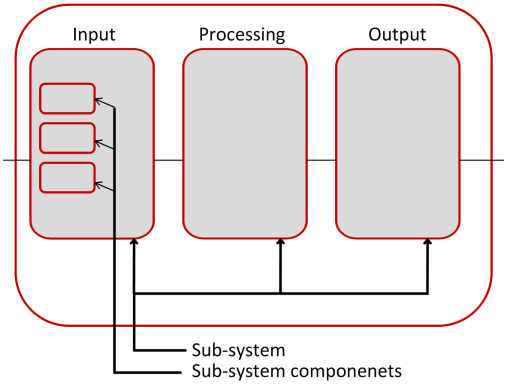
Designing a system is split into 5 stages after having drawn up the functional safety plan:

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
> 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 Cl = 5 + 2 + 3 = 10

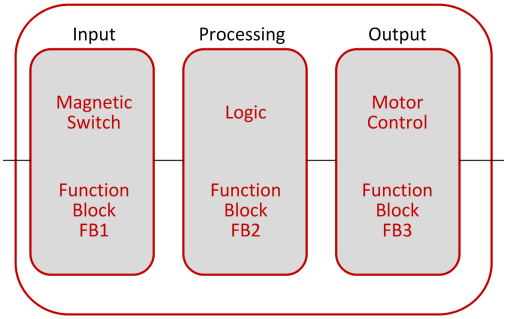
A level of SIL 2 must be achieved by the safety-related electrical control systems (SRECS) on the machine.

Se	Class Cl				
	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.

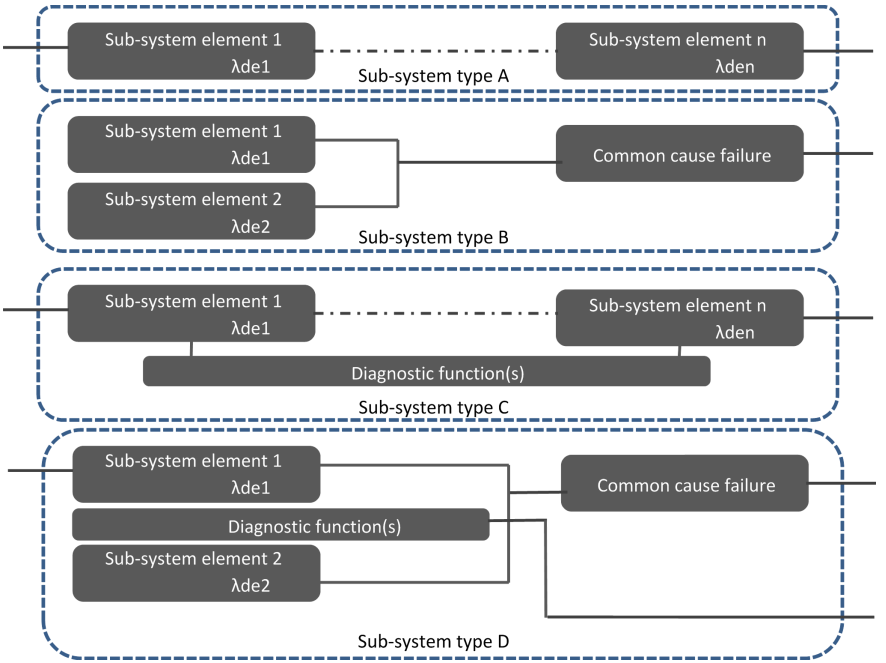
Stage 3 - List the Safety Requirements for Each Function Block and Assign the Function Blocks to the Subsystems

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

Step	Action	Comment
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.
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 are 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

Ensure that a risk assessment is conducted and respected according to EN/ISO 12100 during the design of your machine.

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

Emergency Stop - Main Cabinet

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

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
Input	2 channel emergency stop button Harmony XAL K
Logic	Modicon TM3 embedded safety module TM3 SAF5R
Output	2 redundant contactors with feedback loop LC1D

Emergency Stop - Remote Cabinet

In this TVDA, a separate safety function emergency stop is applied to disconnect the main power supply of all drives which are located in the remote cabinet.

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
Input	2 channel emergency stop button Harmony XAL K
Logic	Preventa safety module XPSAF
Output	2 redundant contactors with feedback loop LC1D

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 ● Breaking capacity from 18...65 kA at 480 Vac ● 3-pole versions ● 3 frame sizes: PowerPact H (15...150 A), PowerPact J (150...250 A), and PowerPact L (250...600 A) ● Thermal-magnetic and electronic protection available for the entire range ● Common accessories and auxiliaries with Compact NSX range ● Suitable for isolation ● Switch-disconnector versions available ● Compliance with IEC 60947-2 and UL 489 ● Certifications: UL, CSA, CCC
Benefits	● Multistandard compliant: IEC, UL, CSA, CCC ● Worldwide available with unique global part numbers ● Flexible and simple offer, with proven performance ● 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. ● International & global multi-site OEMs applications ● 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 System C60 Multi-Standard Range - Hardware

Front View

Description

The Multi 9 system is designed for OEMs to provide an electric protection of their products or the specific circuits inside the equipment.

This range allows OEMs to offer equipment in compliance with the leading international standards:

- UL 489, UL 1077
- CSA C22.2 No. 5-02, CSA C22.2 No. 235-04
- IEC 60947-2
- GB 14048-2

It saves space in the switchboard thanks to its small size.

Easy installation on symmetrical DIN rail (35 mm).

It includes ratings that also make it possible to protect low-power circuits.

The setup of circuit protective devices depends on the electrical installation standard. Multi 9 devices (designed for machinery and equipment manufacturers, integrators, panelbuilders, and so on) are tested in accordance with the UL (Underwriter Laboratories) product standard in order to meet the requirements of the NEC (National Electric Code) installation standard, in force in the United States. Multi 9 "UL" products are also tested to ensure compliance with IEC and CSA standards.

For more information, refer to C60 Multi-Standard Range, Catalog, CM909003E.

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

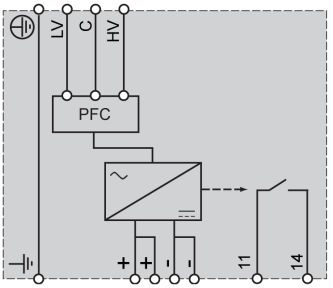
Standards and certifications	UL, CSA, TÜV, C-Tick
Power range	72…960 W
Voltage range	Input: 100…500 Vac Output: 24 Vdc
Degree of protection	IP 20 conforming to IEC 60529
Dimensions	6 different types (W x H x D): 44…165 x 143 x 120…155 mm (1.73…6.5 x 5.63 x 4.72…6.1 in.)

For more information, refer to :

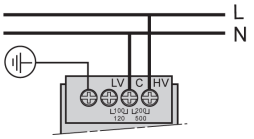
- The essential guide for power supplies and transformers, DIA3ED2070412EN
- Phaseo power supplies and transformers, Catalogue Pages, 14082-EN

Wiring

Connection overview ABL8RPS24100



Wiring example: 200…500 V single phase



iEM31xx Energy Meter Series - Hardware

Front View

The graphic shows the front view of the energy meter iEM3110:

Description

The Acti 9 iEM3100 Energy Meter series offers a cost-attractive, competitive range of DIN rail-mounted energy meters ideal for subbilling and cost allocation applications. Combined with communication systems such as Smart Link, the Acti 9 iEM3100 series makes it easy to integrate electrical distribution measurements into your facility management systems. The Acti 9 iEM3100 series contains 8 versions of energy meter (for example, iEM3110 and iEM3150) to satisfy basic to advanced applications for buildings and industry, data centers, and networks, infrastructure, and so on.

- Graphical display for easy viewing
- Self-powered meters
- Direct measurement up to 63 A
- Onboard Modbus, LON, M-Bus or BACnet communication
- Commissioning safely with ease
- Compact size

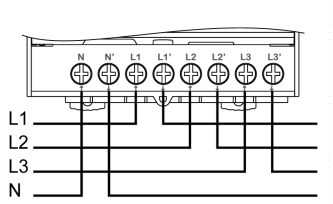
Standards and certifications	IEC 61557-12, IEC 61036, IEC 61010, IEC 62053-21/22 class 1 and 0.5S, IEC 62053-23, EN50470-3
Current (max)	63 A
Models	iEM3100, iEM3110, iEM3115, iEM3135, iEM3150, iEM3155, iEM3165, iEM3175

Functions (depending on the model	• Active energy measurement • Electrical measurements such as I, V, P, and so on. • Alarm • Digital output for pulse • MID (legal metrology certification)
Degree of protection	• front panel: IP40 • casing: IP20
Dimensions	W x H x D: 90 x 95 x 69 mm (3.54 x 3.74 x 2.72 in.)

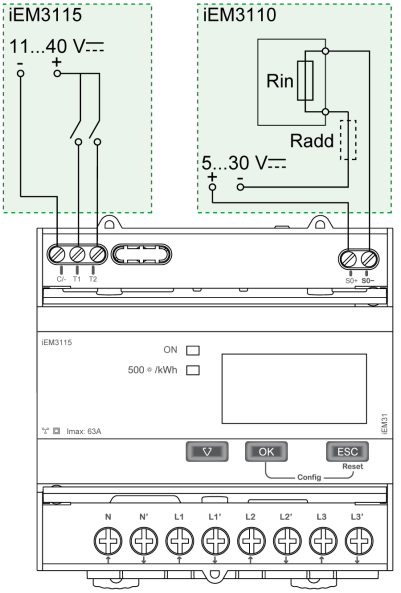
For more information, refer to iEM3100 series / iEM3200 series, Energy Meters, User Manual, DOCA0005EN.

Wiring

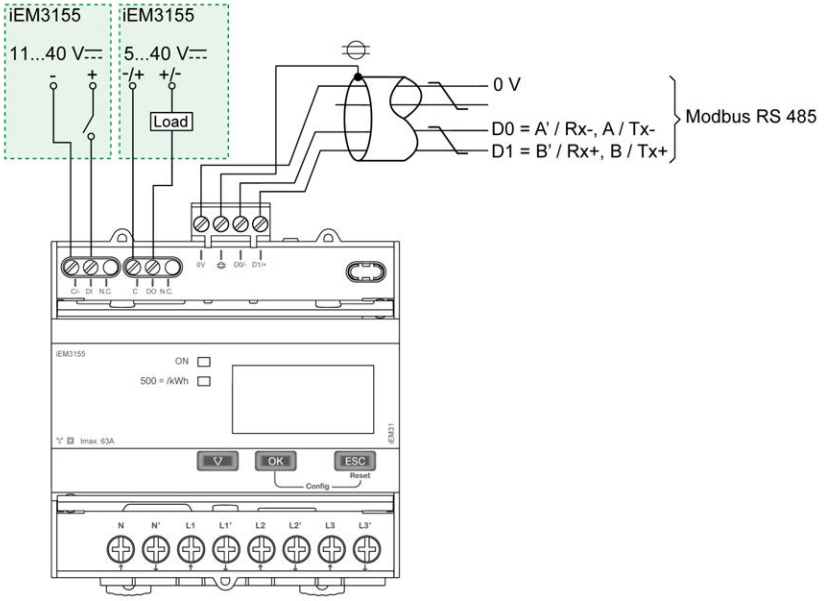
The graphic shows the wiring on three-phase systems for direct measurement of iEM31••



The graphic shows the connection diagram of iEM3100 / iEM3110 / iEM3115:



The figure shows the connection diagram of iEM3150 / iEM3155:



Section 4.2
Safety Modules

What Is in This Section?

This section contains the following topics:

Preventa XPSAF Safety Module - Hardware

Front View

Preventa XPSAF safety module

Description

Safety module XPSAF is used for monitoring emergency stop circuits conforming to standards EN/ISO 13850 and EN 60204-1 and also meets the safety requirements for the electrical monitoring of switches on protection devices conforming to standard EN1088/ISO 14119.

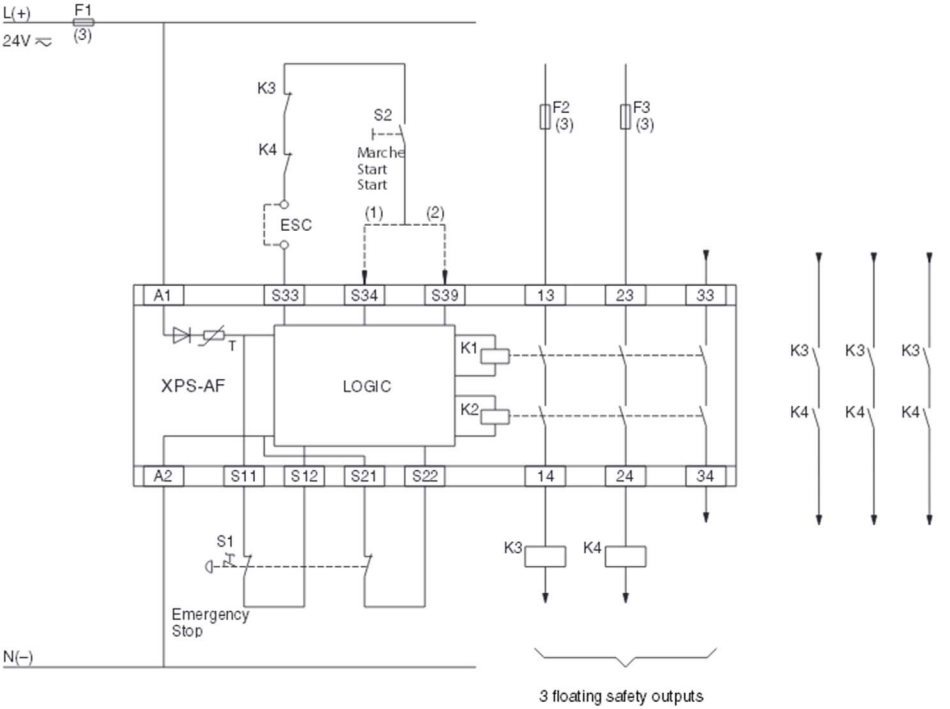
- 3 LEDs which provide information on the monitoring circuit status
- Manual or automatic start
- 3 enabling paths, 1 signaling path
- Feedback loop to monitor external contactors

Maximum achievable safety integrity level	SILCL3 conforming to EN/IEC 62061, PL e/Category 4 conforming to EN/ISO 13849-1
Standards and certifications	EN 60204-1, Cat 4 EN954-1 ISO 13849-1, EN /ISO 14119, EN/ISO 13850, EN50082-2, EN/IEC 60947-5-1, UL, CSA, BG
Power supply	24 Vdc 24 Vac
Outputs	Relay immediate opening 3 NO, volt-free
Response time on input opening	< 40 ms
Degree of protection	Terminals: IP 20 Enclosure: IP 40
Dimensions	W x H x D: 22.5 x 99 x 114 mm (0.88 x 3.9 x 4.49 in.)
Options	Safety relay modules XPSECME and XPSECPE (for increasing the number of safety contacts)

For more information, refer to
- Preventa, Machine Safety Products, MKTED208051EN
- The essential guide: Preventa machine safety, DIA4ED2041204EN

Wiring

Wiring diagram for module XPSAF



(1) With monitoring of the start button
(2) Without monitoring of the start button
(3) See technical data for maximum fuse size
ESC External start conditions

Modicon TM3 Safety Module - Hardware

Front View

Modicon TM3 safety module

Description

The Modicon TM3 modular I/O system provides flexible and scalable configuration of expansions by direct connection with M221, M241, and M251 controllers. Characterized by easy wiring and maintenance, this modular I/O system offers a wide variety of modules that enables you to meet your desired configuration for reduced costs and simplification.

The Modicon TM3 modular I/O system contains a range of TM3 safety modules. These Modicon TM3 safety modules contain inputs and relay outputs to manage one safety function at a time. The safety function is realized in the module itself and the monitor and control functions are processed by the controller via the TM3 I/O bus.

There are several types of Modicon TM3 safety modules supporting multiple functions. The achievable Performance Level (PL) according to EN/ISO 13849-1:2008 reaches from PL **d** up to PL **e** and is dependent on the selected module type and the application.

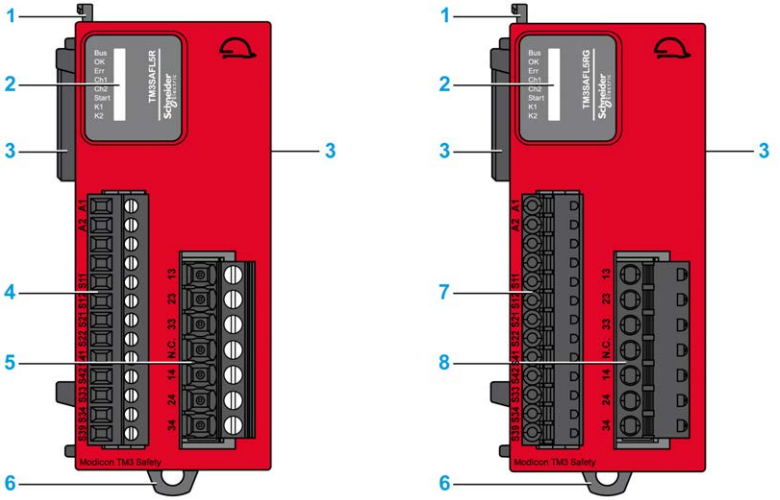
The module used in the described architecture is the TM3SAF5R. The main characteristics are described in the table below.

Max. Performance Level (PL) / Safety Integrity Level (SIL)	Category 4, PL "e" according to EN/ISO 13849-1: 2008, SIL 3 according to IEC/EN 61508-1:2010
Safety function	2 channel operation with cross circuit detection either with monitored or non-monitored start
Standards and certifications	CE For more information on the standards and certifications, refer to the Modicon TM3 Safety Modules, Hardware Guide.
Power supply	24 Vdc (-15...+20 %)
Power consumption	3.6 W (power supply), 0.2 W (TM3 I/O bus)

Input channels	2 safety inputs and 1 start input (monitored or non-monitored)
Output channels	3 relay outputs normally open controlled together, AC-15: 230 V, 5 A per output DC-13: 24 V, 4 A per output
Degree of protection	IP 20

Components

Modicon TM3 safety module with removable screw or spring terminal block

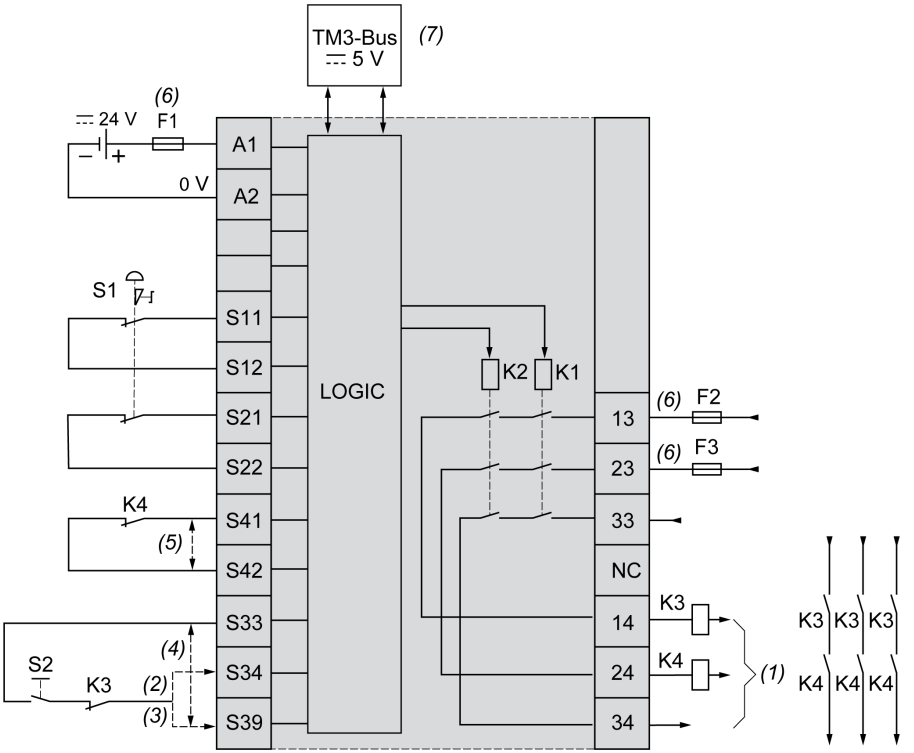


1	Locking device for attachment to the previous module
2	Status LEDs
3	Expansion connector for I/O bus (one on each side)
4	Power supply and input removable screw terminal block with a 3.81 mm (0.15 in) pitch
5	Relay output removable screw terminal block with a 5.08 mm (0.20 in) pitch
6	Clip-on lock for 35 mm (1.38 in.) DIN-rail
7	Power supply and input removable spring terminal block with a 3.81 mm (0.15 in) pitch
8	Relay output removable spring terminal block with a 5.08 mm (0.20 in) pitch

For more information, refer to Modicon TM3 Safety Modules, Hardware Guide, EIO0000001831.

Wiring

Wiring example of emergency stop connection to a TM3SAF5R• module



S1	Emergency stop switch
S2	Start switch
(1)	Safety outputs
(2)	Monitored start
(3)	Non-monitored start
(4)	For automatic start, directly connect **[S33]** and **[S39]** terminals
(5)	Second external device monitoring channel. Connect **[S41]** and **[S42]** terminals if not used.
(6)	Fuses: Power supply max. 4 A (gG), output max. 4 A (gG) or 6 A (F)
(7)	Non-safety related I/O bus communication with logic controller

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

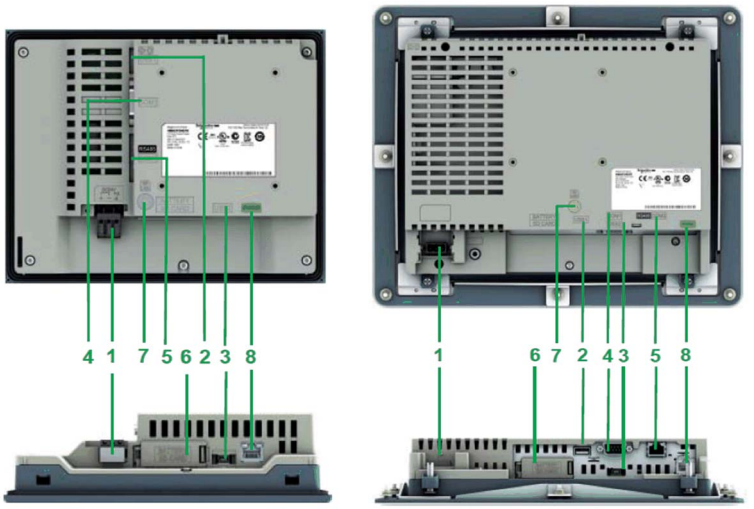
Standards and certifications	EN 61000-6-4, EN 61000-6-2, UL508, CSA C22.2 n°142
Power supply	24 ± 4.4 Vdc
Degree of protection	Depends on the type: ● IP 65 (IP 67 with addition of a cover) ● IP 66 K (front panel with stainless steel frame)
Dimensions	8 different types (W x H x D) ● Min.: 132 x 106 x 42 mm (5.2 x 4.2 x 1.65 in.) ● 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) • 7.0" (wide): 800 x 480 pixels (WVGA) • 7.5" and 10.4": 640 x 480 pixels (VGA) • 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 ZBRN1/ZBRN2 Access Point - Hardware

Front View

Harmony ZBRN1 access point

Description

Harmony XB5R wireless and batteryless push buttons are used for remote control with an access point. This allows more flexibility and simplicity in the installation.

The control is realized via radio transmission. Each transmitter is equipped with a "dynamo" generator that converts the mechanical energy produced by pressing the push button into electrical energy.

A radio-coded message with a unique ID code will be sent in a single pulse to one or more receiver(s). These receivers can be located several tens of meters away.

The access points process the received radio frequency inputs and provide these via various communication protocols. They operate as intermediate equipment between a transmitter and a controller. Based on the model the receiver is linked to the controller via RS-485 2 wire serial line (Modbus RTU) or Ethernet (Modbus/TCP).

Wireless and batteryless push-button technology reduces the wiring and hence the cost of installation. They have a wide range of industrial and building applications such as:

- packing lines
- automatic doors in logistic centers
- automobile industries
- bag filling in cement industries
- office lighting for efficient usage of the power

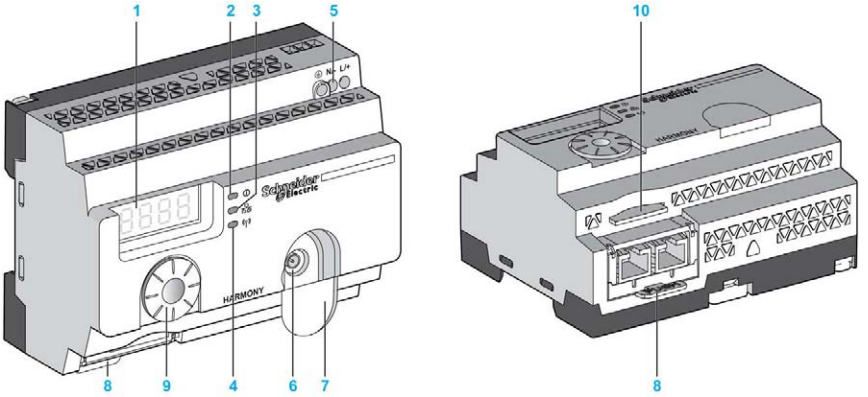
Standards and certifications	R&TTE 1995/EC, LVD2006/95/EC, EMC 2004/108/EC EN/IEC 60947-1, EN/IEC 60947-5-1, EN/IEC 60950-1, IEC 61131-2, EN 300440-2, EN 300489-3, EN 300328, EN 62311 UL 508 (USA), CSA C22-2 n°14 (Canada), CCC (China), GOST (Russia)

Radio certifications	FCC (USA), CSA, RSS (Canada), C-Tick (Australia), ANATEL (Brazil), SRRC (China), MIC (Japan)
Agencies	UL508, 17th edition, CSA C22.2 No. 142-M2000
Rated voltage	24...240 Vac/Vdc
Degree of protection	IP 20
Dimensions	W x H x D: 122 x 89 x 63 mm (4.8 x 3.5 x 2.48 in.)
Options	Wide range of wireless and batteryless push buttons, external antennas (active or passive)

For more information, refer to :
- Harmony XB5R, ZBRN1/ZBRN2, User Manual, EIO0000001177 (EN)
- Harmony XB5R, Expert Instruction Sheet, EIO0000000812 (EN)

Components

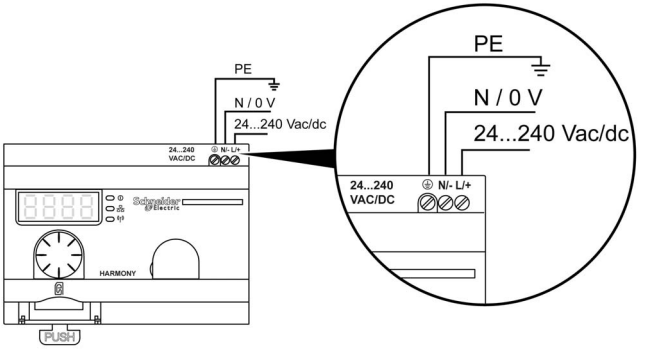
Harmony ZBRN1



1	Four 7-segment displays with 5 LEDs	6	External antenna (optional) connector
2	Power LED	7	External antenna (optional) connector protective plug
3	Communication LED	8	• ZBRN1: Communication module inserted with 2 RJ45 Ethernet connectors • ZBRN2: 2 RJ45 Modbus RS 485 2 wire serial line connectors
4	Radio signal strength LED	9	Jog dial
5	Power input terminal block	10	SD memory card slot

Wiring

The power supply voltage allows any common supply connection from 24...240 Vac/Vdc.



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 M251 Logic Controller - Hardware

Front View

Modicon M251 Logic Controller

Description

The Modicon M251 Logic Controller has various powerful features and can service a wide range of applications. Software configuration, programming, and commissioning are accomplished with the SoMachine software.

Thanks to the SoMachine software platform it offers optimized solutions for speed control, counting, axis control and communication functions.

The SoMachine software, used to configure and program the Modicon M251 Logic Controller, supports the following IEC61131-3 programming languages for use with these controllers:

- IL: Instruction List
- ST: Structured Text
- FBD: Function Block Diagram
- SFC: Sequential Function Chart
- LD: Ladder Diagram

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

The Modicon M251 Logic Controller native communication ports include (depending on the controller reference):

- Ethernet
- USB programming
- Serial line
- CANopen Master

All controllers support up to 13 application program tasks with the following limits:
- 3 cyclic tasks: one is configured by default (MAST)
- 1 freewheeling task
- 8 event tasks
- 1 external event task

Standards and certifications	IEC/EN 61131-2, UL 508
Rated voltage	24 Vdc
Degree of protection	IP 20
Memory	RAM: 64 Mbytes, of which 8 Mbytes available for the application - to execute the application Flash: 128 Mbytes - to save the program and data in case of power interruption
Dimensions	Device-dependent (W x H x D): 54 x 90 x 90 mm (2.12 x 3.54 x 3.54 in.)]
Options	• SD card • TM2 I/O modules • TM3 I/O modules • TM4 communication modules

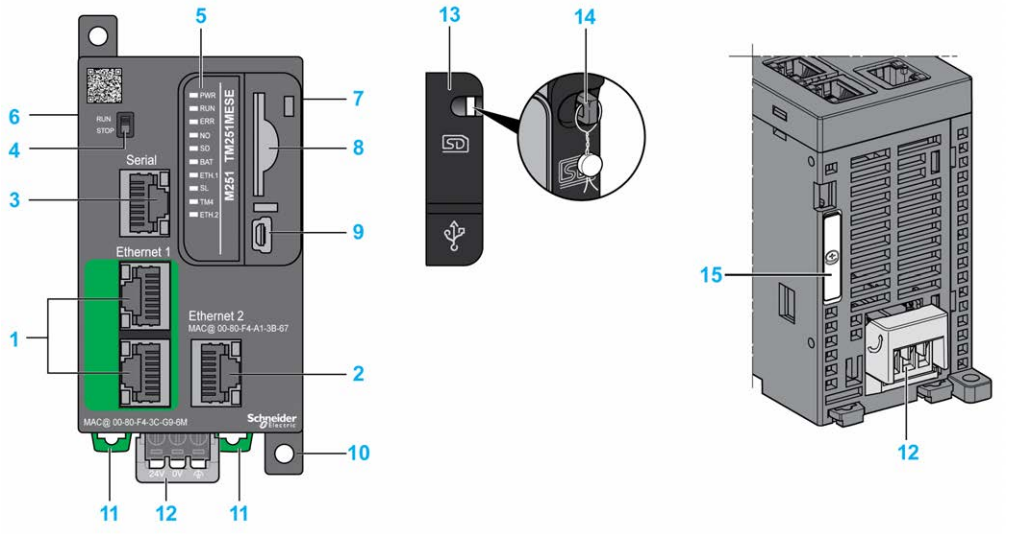
For more information, refer to :
- Modicon M251 Logic Controller, Hardware Guide, EIO0000001486
- Modicon M251 Logic Controller, Programming Guide, EIO0000001462

Modicon M251 Logic Controllers

Device	Digital inputs	Digital outputs	Communication ports
TM251MESC	0	0	1 serial line port 1 USB mini-B programming port 2 Ethernet switched ports 1 CANopen port
TM251MESE	0	0	1 serial line port 1 USB mini-B programming port 2 Ethernet switched ports 1 Ethernet port for fieldbus

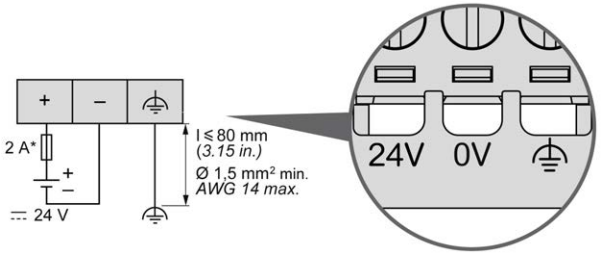
Physical Overview

Modicon TM251MESE logic controller



1	2 Ethernet switched ports	9	USB mini-B programming port
2	Ethernet port 2	10	Screwing plate
3	Serial line port	11	Clip-on lock for 35 mm (1.38 in) top hat section rail (DIN-rail)
4	Run/Stop switch	12	24 Vdc power supply
5	Status LEDs	13	Protective cover
6	TM4 bus connector	14	Locking hook
7	TM3/TM2 bus connector	15	Battery holder
8	SD card slot	-	-

Wiring Power Supply



***** Type T fuse

Modicon TM3 Modules - Hardware

Front View

Modicon TM3 Modules

Description

The Modicon TM3 modular I/O system provides flexible and scalable configuration of expansions by direct connection with M221, M241, and M251 controllers. Characterized by easy wiring and maintenance, this modular I/O system offers a wide variety of modules that enables you to meet your desired configuration for reduced costs and simplification.

Flexible and scalable I/O configuration:

- Local or remote expansion via the local TM3 expansion bus on M221, M241, and M251 controllers.
- Wide range of I/O expansion modules:
  - Digital I/O modules
  - Analog I/O modules
  - Expert I/O modules
  - Safety I/O modules
  - Transmitter and receiver modules

Simplified maintenance installation:

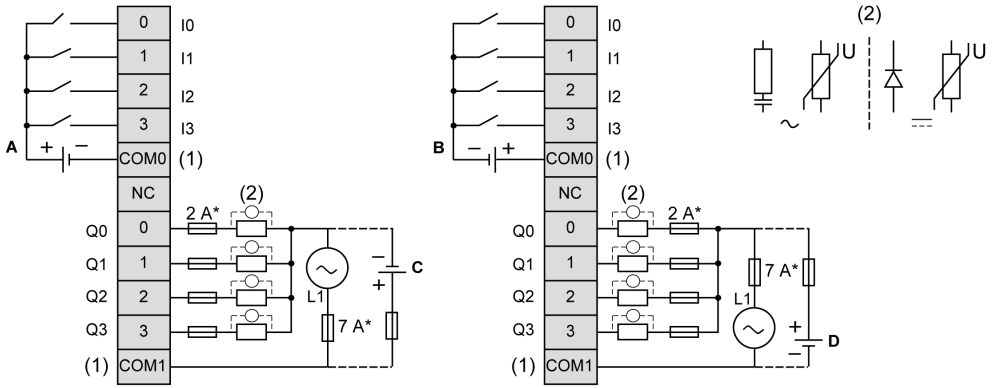
- Embedded diagnostics for local and distant supervision
- Wiring simplicity: spring terminals, removable terminal blocks

Standards and certifications	IEC/EN 61131-2 ed. 3 2007, UL 508, CSA 22.2 No. 142, CE
Power supply	24 Vdc or 120 Vac* * only TM3DI8A
Degree of protection	IP 20
Dimensions	One assembled integral module (W x H x D): 21.4…42.9 x 94.5…95 x 81.3…88.1 mm (0.84…1.69 x 3.72…3.74 x 3.2…3.47 in.)

For more information, refer to Modicon TM3, Expansion Modules Configuration, Programming Guide, EIO0000001402.

Wiring

Wiring example TM3DM8R



***** Type T fuse

(1) The COM0 and COM1 terminals are **not** connected internally.

(2) To improve the life time of the contacts, and to protect from potential inductive load damage, you must connect a free wheeling diode in parallel to each inductive DC load or an RC snubber in parallel of each inductive AC load.

A Sink wiring (positive logic)

B Source wiring (negative logic)

C Source wiring (positive logic)

D Sink wiring (negative logic)

TM3XTYS4 TeSys Module - Hardware

Front View

Description

The TM3XTYS4 I/O expansion module connects the controller to the parallel wiring system of TeSys. This I/O expansion module provides the status and command information for each TeSys motor starter via an RJ45 connector. One TM3XTYS4 module can manage up to 4 TeSys motor starters, reverse or forward, whatever they are TeSys D or TeSys U or mix.

The TM3XTYS4 module is compatible with:

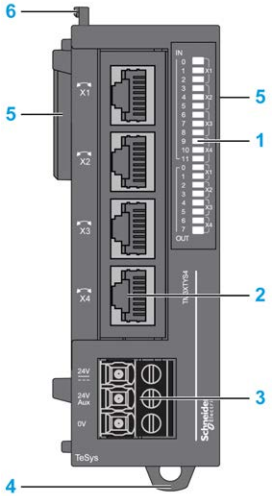
- TeSys U system equipped with the LUFC00 parallel wiring module
- GV and TeSys D system equipped with the LAD5C•• wiring adapter

The TM3XTYS4 module provides:

- 4 channels each with an RJ45 connector
- Each channel provides:
  - 3 sink transistor inputs (24 Vdc type 1 (IEC/EN 61131-2))
  - 2 source transistor outputs (24 Vdc / 0.3 A)
- Removable 24 Vdc power supply terminal block

For more information, refer to Modicon TM3, Expert I/O Modules, Hardware Guide, EIO0000001420

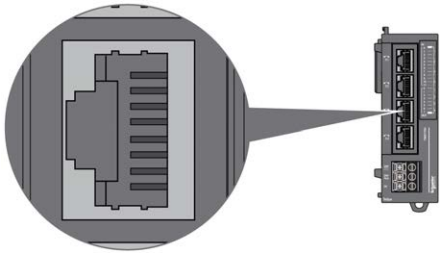
Physical Overview



1	LEDs for displaying the state of the I/O channels
2	TeSys RJ45 connectors
3	Removable power supply screw terminal block
4	Clip-on lock for 35 m (1.38 in) top hat section rail (DIN-rail)
5	Expansion connector for I/O bus.
6	Locking device for attachment to the previous module

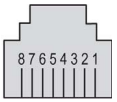
I/O Channel RJ45 Connector

The TM3XTYS4 module is equipped with 4 channel RJ45 connectors.



Pin Assignment

RJ45 connector



Pin	Type	Signal	Description
1	Output 1	Direction 1 control	Drives to direct (forward) command of the motor
2	Output 2	Direction 2 control	Drives to direct (backward) command of the motor
3	0 V	-	-
4	Input 1	Ready	Active if the selector of the TeSys is in the ON position
5	Input 2	Run	Input active if the power contacts of TeSys are closed.
6	N.C.	-	Reserved. Do not connect.
7	Input 3	Trip	Input active if the selector of TeSys is in the TRIP position (only for TeSys U).
8	24 Vdc input common	Common for sensors	Power supply for inputs 1, 2 and 3 (pins 4, 5 and 7).

⚠ 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.

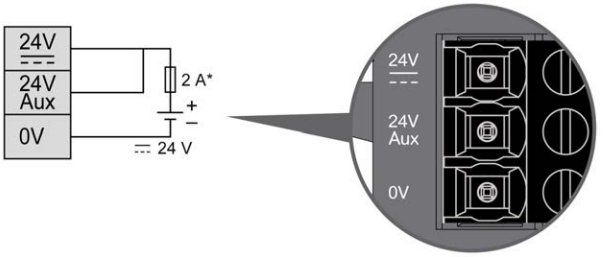
⚠ CAUTION

INCOMPATIBLE EQUIPMENT

Use the RJ45 connector only for the link with devices which are compatible with the TeSys RJ45 connection system.

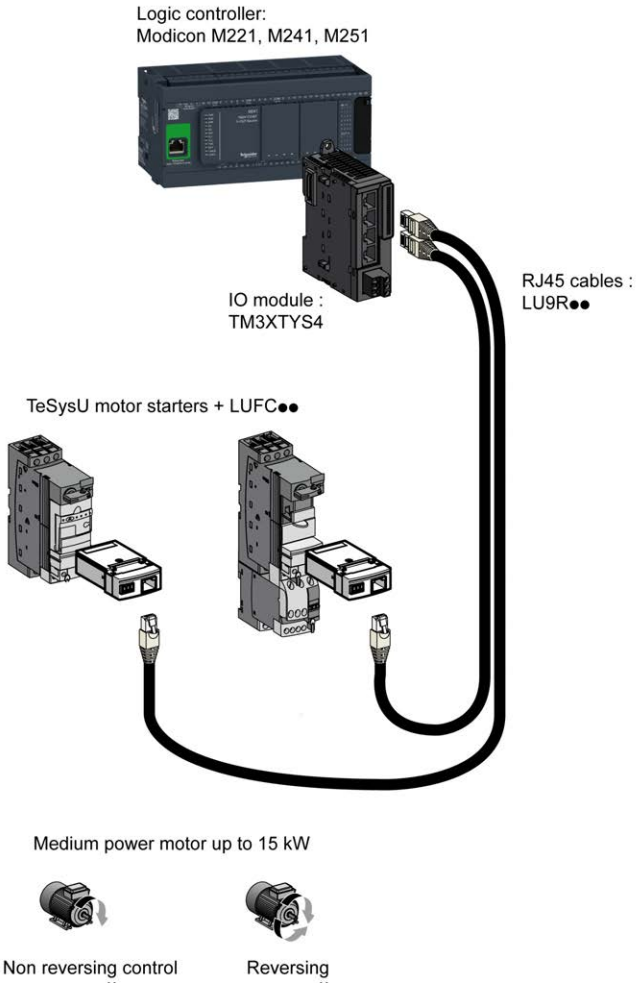
Failure to follow these instructions can result in injury or equipment damage.

DC Power Supply Wiring Diagram

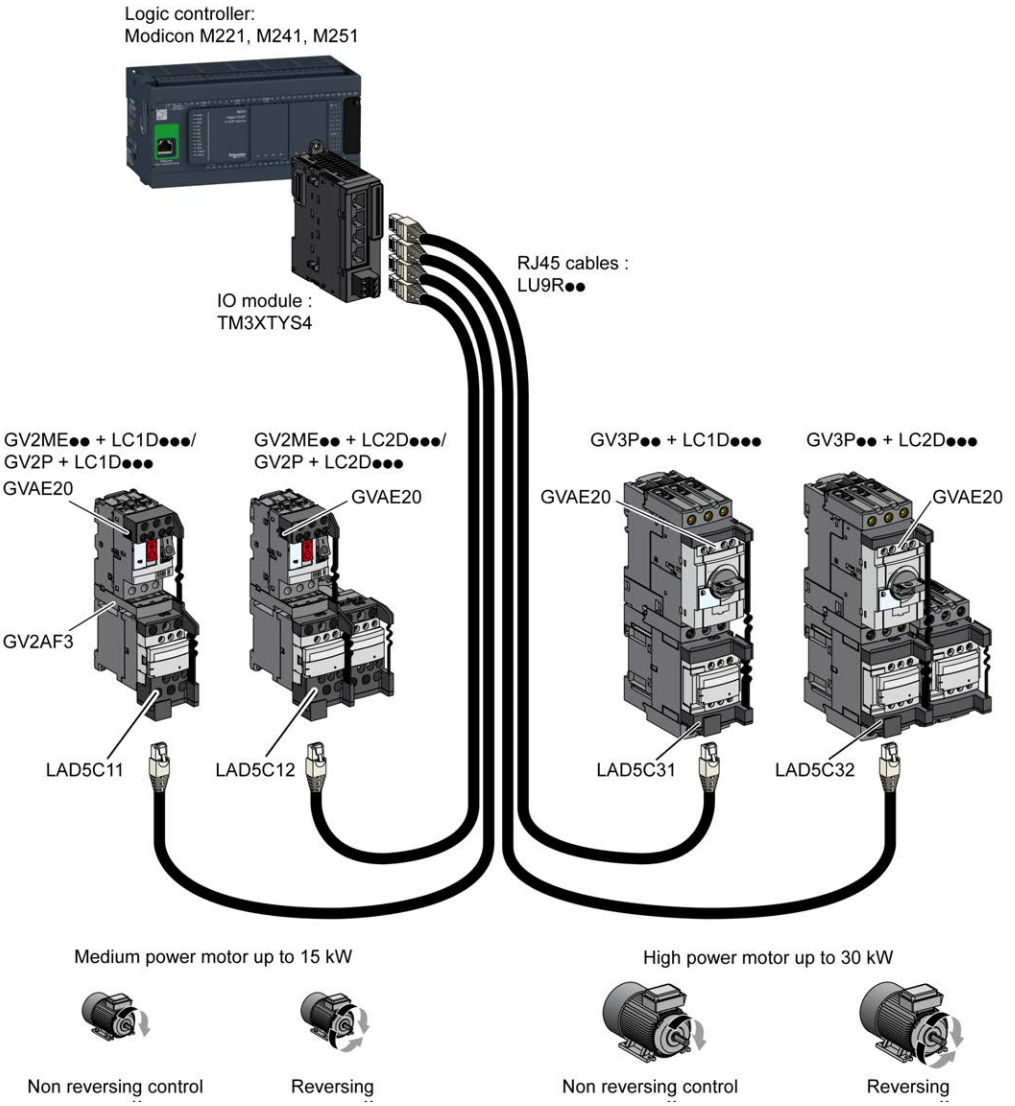


***** Type T fuse
24 Vdc Is dedicated to outputs power supply
24 Vdc Aux Is dedicated to inputs power supply

Application Example with TeSys U



Application Example with TeSys D



Modicon OTB - Hardware

Front View

Modicon OTB series

Description

Modicon OTB optimized distributed I/O allows the creation of I/O islands managed by a master controller via a fieldbus or communication network. With its expandable block type architecture, the Modicon OTB is ideally suited for small and medium size islands of distributed I/O that can be placed closer to the sensors and actuators they control, reducing wiring time and costs. The Modicon OTB solution includes 3 communication bases (interface modules) for the various types of fieldbus, CANopen, Modbus TCP/IP, or Modbus RS 485 serial line.

- Expandable with up to 7 TM2 expansion modules
- A wide range of I/O expansion modules
- Sensor/actuator connection using removable screw terminals
- Direct mounting on DIN rail
- Ideal compactness: 20 I/Os within a width of 55 mm (2.17 in.), including bus connection
- Reduces installation time and wiring costs

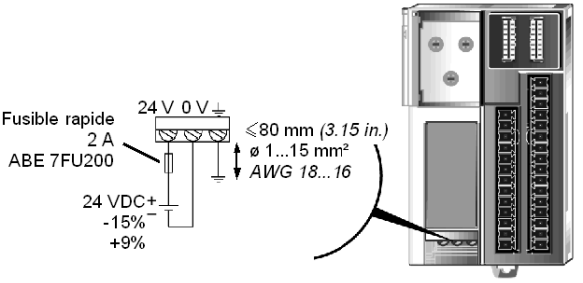
Standards and certifications	CSA, CSA C22.2 No. 213 (Class 1 division 2 groups A), CSA C22.2 No. 213 (Class 1 division 2 groups B), CSA C22.2 No. 213 (Class 1 division 2 groups C), CSA C22.2 No. 213 (Class 1 division 2 groups D), EN 61131-2, IEC 41131-2, UL508
power supply	24 Vdc
Degree of protection	IP20
Embedded I/Os	• 12 digital inputs • 8 digital outputs
Dimensions	W x H x D: 55 x 99 x 70 mm (2.17 x 3.9 x 2.76 in.)

For more information, refer to :

- Advantys OTB CANopen, Remote Inputs and Outputs, User Manual, 1606384
- Advantys OTB Ethernet, Remote Inputs/Outputs, User Manual, 1606385
- Modbus Advantys OTB, Remote Inputs/Outputs, User Manual, 1606383

Electrical Installation

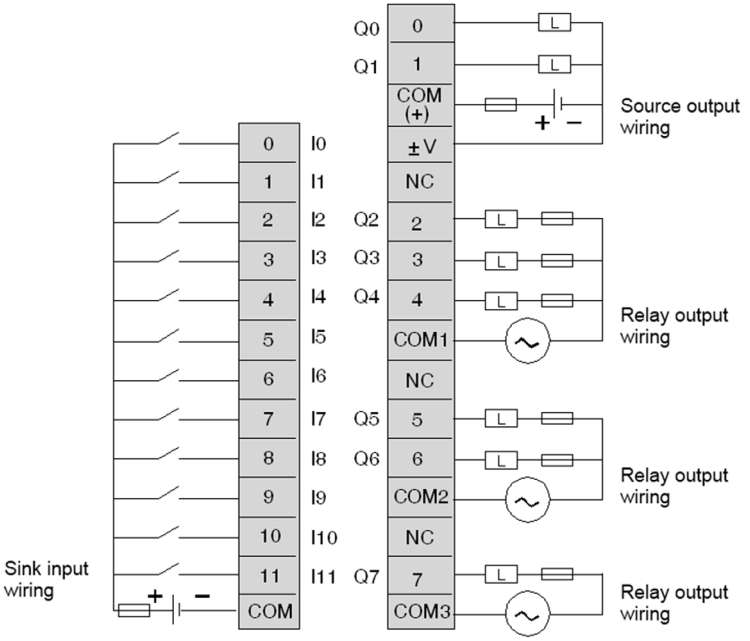
Wiring example: power supply



Grounding wire length should not exceed 80 mm (3.15 in.)

The sensor/actuator cables must be shorter than 30 m (98.4 ft.)

Wiring example: OTB 1•0DM9LP modules



- Output points 0 and 1 are source transistor outputs, all other output points are relay.
- The COM terminals are **not** connected together internally.
- Connect an appropriate fuse for the load.

Modicon TM2 Modules - Hardware

Front View

Modicon TM2 expansion modules

Description

The range of Modicon TM2 expansion modules includes analog I/O modules, digital I/O modules, expert expansion modules, and communication expansion modules. Characterized by easy wiring and maintenance, these expansion modules offer a wide choice of modularity and so a large variety of automation configurations. The modules can be used in combination with 4 platforms: M238 bases, Modicon OTB, HMI controllers, and Twido bases.

The analog I/O expansion modules are compatible with sensors and suitable for economic and easy to use measurement. The digital I/O expansion modules are available in 3 wiring modes: screw terminals, high-density connectors, and spring terminals. The expert expansion modules are used for high speed counting in repetitive processes with advanced features like reflex outputs for enhanced accuracy.

- Fits customer application in the targeted market segments
- High level of quality and performance
- High EMC immunity for all modules
- Inputs and DC transistor outputs protected against short-circuits and polarity inversions
- All TM2 modules are RoHS compliant
- Low standard cost

Standards and certifications	Depends on the module: CE UL CSA UL/CSA class I, Div. 2, TÜV IEC EN 61131-2 edition 2 2003, cULus, Nemko - GL - LR - DNV
Power supply	Depends on the module: 24 Vdc or 120 Vac
Degree of protection	IP20

Dimensions	Depends on the module: (W x H x D): 21.2...42.9 x 90 x 95.6...117.2 mm (0.84...1.69 x 3.54 x 3.76...4.61 in.)

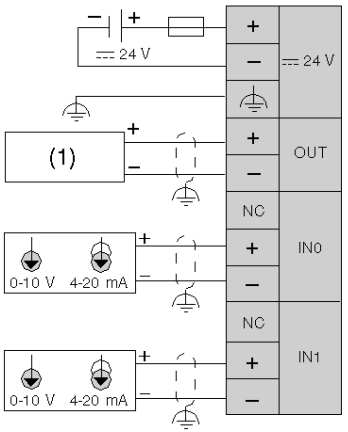
For more information, refer to

- Modicon TM2, Analog I/O Modules, Hardware Guide, EIO0000000034
- Modicon TM2, Digital I/O Modules, Hardware Guide, EIO0000000028
- Modicon TM2, High Speed Counter Modules, Hardware Guide, EIO0000000022

Wiring

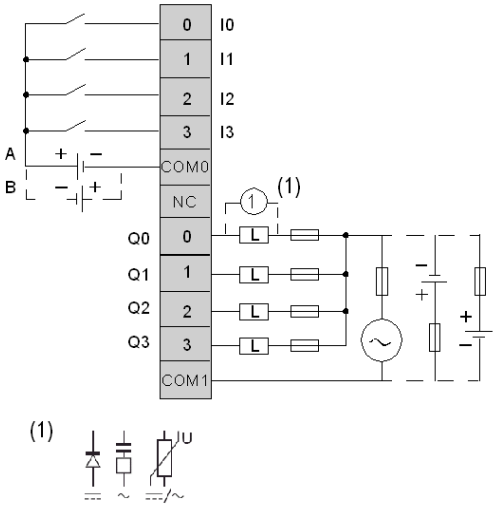
For a brief overview, refer to the 2 wiring examples below.

Wiring example TM2AMM3HT analog mixed I/O module



(1) Voltage/current preactuator

Wiring example: TM2DMM8DRT digital mixed I/O module



(1) Protection for inductive load
A Sink wiring (positive logic)
B Source wiring (negative logic)

Advantys ETB I/O Module - Hardware

Front View

Advantys ETB IP 67 Ethernet block I/O module

Description

The Advantys ETB family of I/O modules includes modules designed for use with either the Modbus TCP/IP or the Ethernet IP protocols. This architecture includes a module designed for the Modbus TCP/IP protocol.

Advantys ETB I/O modules combine the functionality of a block I/O with an embedded 2-port Ethernet switch. These modules can be used in applications where I/O is mounted directly on equipment without an enclosure. They can be exposed to water or oil spray.

Each Advantys ETB I/O module is housed in an IP 67 rated enclosure that when properly installed (according to IEC 60529) provides protection against the ingress of:

- Dust
- Water (when temporarily immersed (for up to 30 minutes) to a depth of 1 meter)

Module data is accessible via Modbus messaging and embedded webpages, and includes:

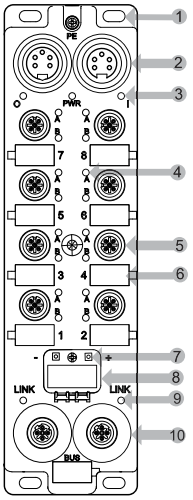
- Input and output data
- Input and output status
- I/O configuration settings
- Module Ethernet (Modbus TCP/IP) communication configuration settings
- Module firmware data

Standards and certifications	UL, CUL, CE mark
Power supply	24 Vdc
Temperature	● Operation: -25...+70 °C (-13...+158 °F) ● Storage: -40...+85 °C (-13...+158 °F)
Inputs/outputs	● ETB1EM16EPPO: 16/0 ● ETB1EM08E08SPP0: 8/8 ● ETB1EM12E04SPPO: 12/4 ● ETB1EM16CP00: 16 configurable input and output points
Output current	2.0 A / point sum = 8 A
Short circuit current (typical)	6.5 A
Output switching frequency	200 Hz
Dimensions	W x H x D: 60 x 270 x 37 mm (2.4 x 8.7 x 1.5 in)
Degree of protection	IP 67 according to IEC 60529

For more information, refer to Advantys ETB, IP67 Ethernet Block I/O Modules for Modbus TCP/IP, User Guide, EIO0000000158

Components

The front face of the module includes the mounting holes, connectors, port connector labels, LEDs, push buttons, and the HMI display. The details and locations of these features are shown below.

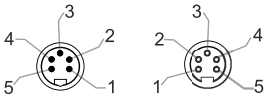


1	Five mounting holes, including the center one
2	Two 5-pin power connectors including input (left) and output (right) to connect the next module in the system (7/8 mini-change cables)
3	Three power LEDs: **[O]** = output; **[PWR]** = not used; **[I]** = both input and module
4	Sixteen I/O point LEDs
5	Eight 5-pin I/O port connectors numbered from bottom to top (M12 or ultra-Lock M12 cables)
6	Eight white port labels
7	Two buttons for selecting the method of IP address assignment
8	Four-character scrolling display
9	Two link LEDs
10	Two 4-pin Ethernet network connectors (M12 D coded cables)

Pin Assignment of the Connectors

Power connectors

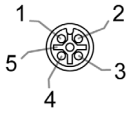
The pin assignments for the power connectors are outlined in the following figure, with the male on the left and the female on the right.



1	Output power 0 Vdc
2	Module/input power 0 Vdc
3	Protective earth ground (PE)
4	Module/input power 24 Vdc
5	Output power 24 Vdc

I/O Port Connectors

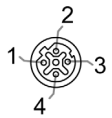
The following figure displays an ETB I/O port connector on the left of the module and its corresponding point assignments. The port connectors on the right side of the module are rotated 90 ° counter-clockwise from the ones on the left.



1	+24 Vdc
2	Point B input or output
3	GND
4	Point A input or output
5	Protective earth ground (PE)

Ethernet Network Connectors

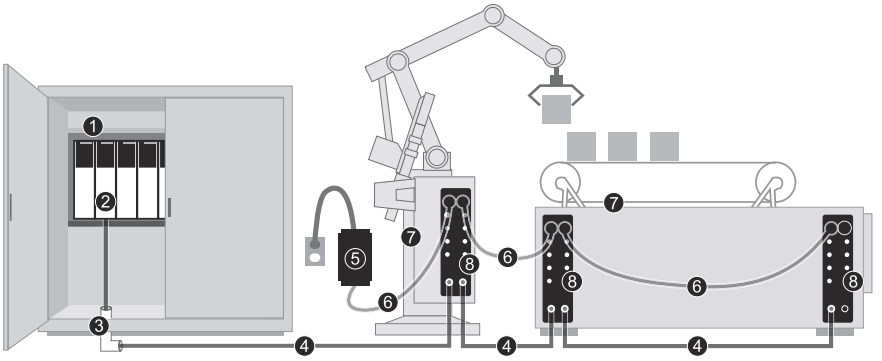
The following figure shows the pin assignments of the two Ethernet network connectors on the module.



1	TX+ (Ethernet transmit line +)
2	RX+ (Ethernet receive line +)
3	TX- (Ethernet transmit line -)
4	RX- (Ethernet receive line -)

Installation Example

This diagram shows you an example of how to arrange your Advantys ETB I/O modules in a daisy-chain topology.



1	Cabinet-mounted PLC
2	Ethernet interface module on PLC system
3	Ethernet adapter
4	Ethernet connector cable
5	24 Vdc power supply **NOTE:** Alternatively, the power supply could be mounted in the cabinet.
6	Power supply cable
7	Machine
8	Advantys ETB I/O modules mounted on machine

Section 4.5
Communication

What Is in This Section?

This section contains the following topics:

ConneXium Ethernet Switch (Managed) - Hardware

Front View

8-port TCSESM083F23F0 switch

Description

The ConneXium managed switch range is comprised of products required to build the infrastructure of an industrial Ethernet network.

Managed devices are those which there is possibility to configure or control the parameters of the device (manage them) and to access to its internal information. They provide features that improve performance, network, and diagnostics efficiency.

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.

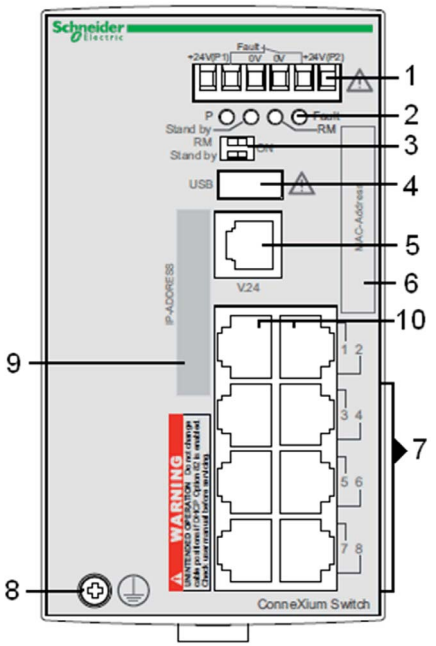
- Managed Ethernet switch with user configurated services and features
- Web based configuration
- Network configurations include line, star, mesh, or ring structures
- Automatic negotiation of 10/100 Mbit/s and duplex mode
- Redundancy protocols that include HIPER-ring, MRP and RSTP
- Quality of service traffic class prioritization
- Remote monitoring of operation

Standards and certifications	EN/IEC 61131-2, UL508 & 1604, CSA C22.2 No. 14 & No. 213, C-Tick, GL
Power supply	24 Vdc
Operating voltage range	9.6...60 Vdc or 18...30 Vdc
Ports	4,8,10,16, 24
Degree of protection	IP 20
Dimensions	W x H x D: 47/74/111 x 131 x 111 mm (1.85/2.91/4.37 x 5.13 x 4.37 in.)

For more information, refer to ConneXium TCSESM Managed Switch, Installation Manual, 31007118.

Physical Overview

Connector overview of the TCSESM083F23F0



1	Plug-in terminal block for power supply	6	MAC address field
2	LED display elements	7	Ports in compliance with 10/100BASE-T(X) (RJ45)
3	2-pin DIP switch	8	Protective earth ground (PE)
4	USB interface	9	IP address field
5	V.24 connection for external management	10	Port 1 + port 2: Twisted-Pair T(X), RJ45, 10/100 Mbit/s Multi-mode FX, DSC, 100 Mbit/s Single-mode FX, DSC, 100 Mbit/s

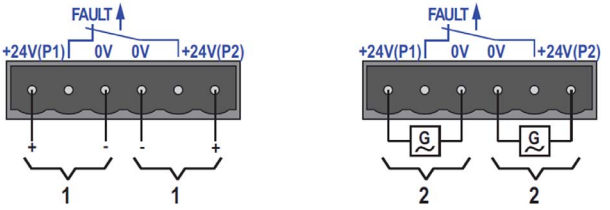
Wiring Supply Voltage and Signal Contact

Redundant power supplies can be used. Both inputs are uncoupled. There is no distributed load.

With redundant supply, the power supply unit supplies the device only with the higher output voltage.

The supply voltage is electrically isolated from the housing.

You can choose between DC or AC voltage when connecting the supply voltage.



1 DC voltage, voltage range: 9.6 Vdc...60 Vdc
2 AC voltage, voltage range: 18 Vac...30 Vac

The signal contact "FAULT" monitors the functioning of the device, thus enabling remote diagnostics. You can specify the type of function monitoring in the management.

A break in contact is used to report the following conditions via the potential-free signal contact (relay contact, closed circuit):

- The detected inoperability of at least one of the 2 voltage supplies (voltage supply 1 or 2 is below the threshold value).
- The loss of connection for at least one port. The report of the link status can be masked by the management for each port. In the delivery state, link status monitoring is deactivated.
- The loss of ring redundancy reserve.
- A detected error during the self-test.

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.

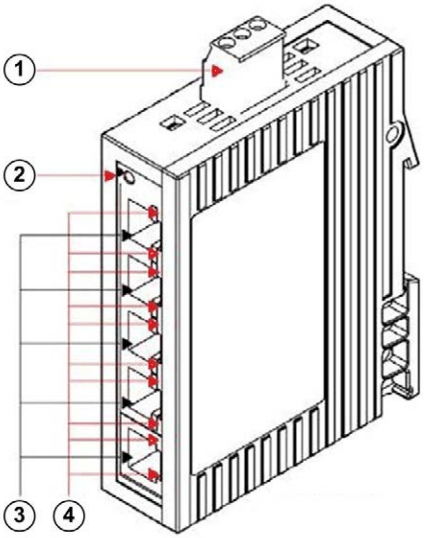
- Multi-address capability
- Storage and rerouting of received data
- Data packets with VLAN tags are transmitted unchanged (IEEE 802.1 Q)
- Automatic negotiation of 10/100 Mbit/s and duplex mode
- Automatic change of polarity
- Low-cost wiring solution

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

ConneXium Ethernet Switch (Unmanaged) IP 67 - Hardware

Front View

ConneXium Ethernet 5TCSESU051F0 switch

Description

The ConneXium 5TCSESU051F0 switch has been especially designed for use in industrial environments.

According to EN 620529 the Ethernet switch has a degree of protection of IP 67.

It supports Ethernet 10 Mbit/s and Fast Ethernet 100 Mbit/s.

The switch module supports switched Ethernet networks in accordance with IEEE standard 802.3 (10BASE-T) or 802.3u (100BASE-TX) using copper technology.

The ConneXium 5TCSESU051F0 switch has five 10/100 Mbit/s twisted-pair ports (10BASET/100BASE-TX, shielded M12 connectors).

It is mounted at the installation site using screws.

- 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
- Protected against shock and foreign particles
- Dust proof
- Water protected (temporary immersion)

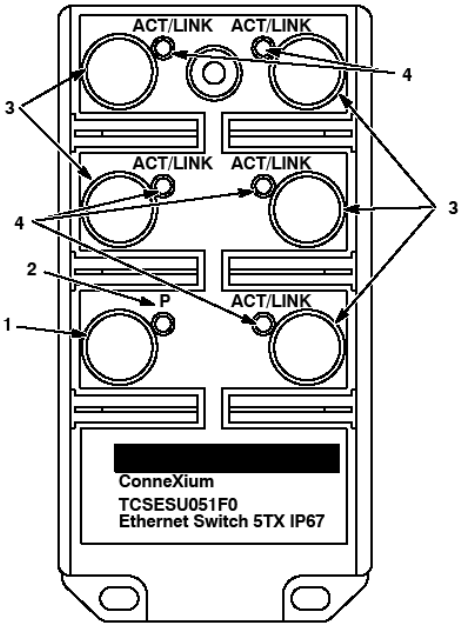
Standards and certifications	UL508, CSA 22.2 No.14 (cUL mark), CE
Power supply	24 Vdc
Ports	5
Degree of protection	IP 67
Dimensions	W x H x D: 60 x 126 x 31 mm (2.36 x 4.96 x 1.22 in.)

For more information, refer to :

- ConneXium Industrial Ethernet Cabling System, 5TX IP67 Switch, TCSESU051F0, 31006691
- ConneXium Ethernet Switches, TCSESU0••F•N0, Quick Reference Guide, 31007950

Physical Overview

Connector overview of the TCSESU051F0



1 Power supply connector
2 Power LED
3 Ethernet connector
4 Port status LED

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)

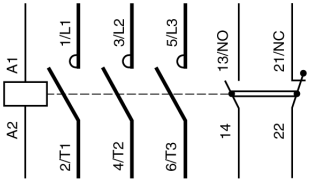
Standards and certifications	IEC/EN 60947-4-1, IEC/EN 60947-5-1, UL 508, CSA C22.2 n°14, UL, CSA, CCC, GOST, GL, DNV, RINA, VB, LROS
Rated operational current (Ie)I in AC-3 (Ue max. 440 V)	9…150 A
Rated control circuit voltage (Uc)	12(24*)…690(500*) Vac 12(24*)…440 Vdc *D115 and D150
Degree of protection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

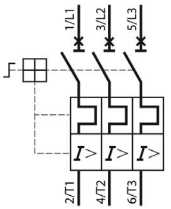
Standards and certifications	IEC 60947-1, 60947-2, 60947-4-1, EN 60204, UL508, CSA C 22.2 n° 14-05, NF C 63-650, 63-120, 79-130, VDE 0113, 0660, UL*, CSA, PTB, EZU, GOST, TSE, DNV, LROS, GL, BV, RINA, CCC, ATEX *UL508 type E for GV2 P••H7 (line spacer included)
Operational voltage	690 V

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 • Sets of 3-pole busbars • Protective end cover • Terminal blocks • Padlock able external operator • Contact blocks: Error signaling contact and immediate auxiliary contacts • Undervoltage/Shunt trips • Padlocking devices

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

Wiring

TeSys GV2 P 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

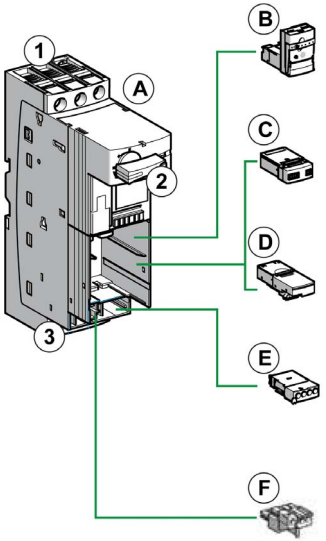
Standards and certifications	IEC/EN 60947-6-2, CSA C22-2 N°14, Type E, UL508 type E: with phase barrier LU9SP0, UL, CSA, CCC, Gost, ASEFA, ABS, BV, DNV, GL, LROS, ATEX
Power range	0…15 kW at 400 V
Rated insulation voltage	● Conforming to IEC/EN 60947-1, overvoltage category III: 690 V ● Conforming to UL508, CSA C22-2 n°14: 600 V
Degree of protection	● Front panel outside connection zone: IP 40 ● 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.) *LU2B (reversible)
Options	● Four different control units ● Error signaling modules ● Communication modules ● Auxiliary contact modules ● Load level modules ● Reverser block ● Plug-in terminal blocks ● Control circuit pre-wiring system

For more information, refer to :

- Control and protection components, MKTED210011EN
- TeSys U, Starter-controllers, Catalogue, DIA1ED2081003EN

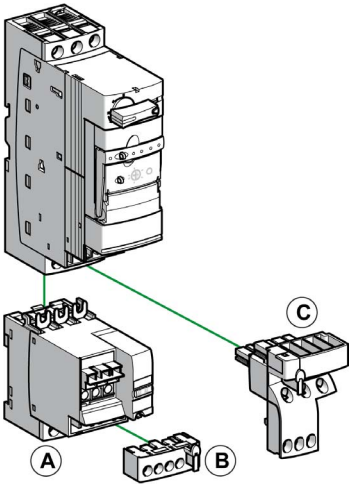
Components

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

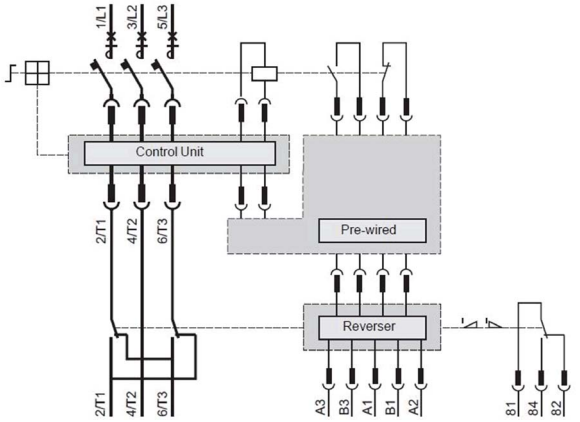


A Reverser block
B Plug-in terminal blocks
C Control circuit pre-wiring system

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

Wiring

TeSys U - reversing



TeSys GV2DP - Hardware

Front View

TeSys GV2DP

Description

The Schneider Electric TeSys product range offers a wide range of pre-assembled automatic motor starter combinations with a power rate of up to 15 kW at 400/415 Vac. Motor starter combinations with higher power ratings are available for customer assembly.

The product range of the TeSys GV2D•••••• motor starter combinations offers you a quick and simple selection and product compatibility. The TeSys D contactor, when combined with the TeSys GV2 motor circuit-breaker, provides a compact motor starter solution.

Range description

- Direct On Line (D.O.L.) or reversing starters, 45 mm (1.77 in), and 90 mm (3.54 in) wide respectively
- Motor circuit-breaker with control via push-buttons (GV2ME) or selector switch (GV2P)
- Circuit-breaker with built-in overload protection
- Type 1 or type 2 coordination
- Breaking capacity up to 130 kA
- Enclosure for thermal-magnetic circuit breakers TeSys GV2ME

Each pre-assembled combination comprises:

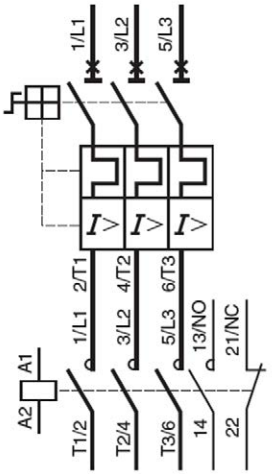
- 1 motor circuit breaker GV2ME or GV2P
- 1 3-pole contactor LC1D or LC2D
- 1 combination block GV2AF3

For more information, refer to :

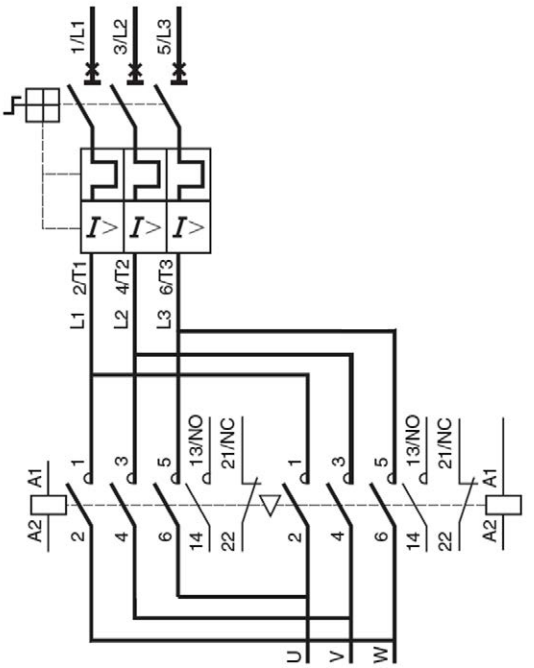
- The essential guide, TeSys for power control & protection, DIA1ED2040401EN
- Control and protection components, MKTED210011EN

Wiring

GV2DP1••••

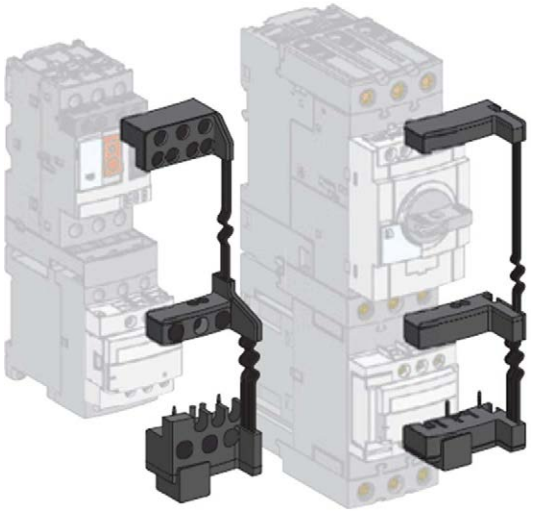


GV2DP2••••



TeSys LAD5Cxx Wiring Adapter - Hardware

Front View



Description

The TeSys LAD5C•• wiring adapter makes the TeSys motor starter combinations with screw-clamp terminals compatible to the RJ45 connection system.

The RJ45 connection system offers a quick and easy connection to the TM3 I/O expansion module TM3XTYS4.

All the control and command terminals of the motor starter combination are individually connected to the adapter with pre-shaped pins. The upstream liaison with the TM3XYS4 module is carried out with a simple RJ45 preformed cable.

4 types of the wiring adapter are available:

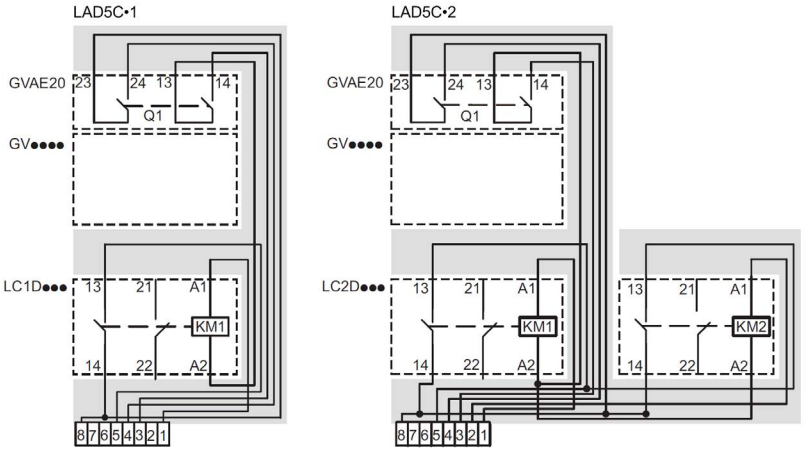
Reference	Motor control	Motor starter combination
LAD5C11	Non-reversing	GV2ME/GV2P with LC1D09BL to LC1D32BL
LAD5C12	Reversing	GV2ME/GV2P with LC2D09BL to LC2D32BL
LAD5C31	Non-reversing	GV3P with LC1D40ABD to LC1D65ABD
LAD5C32	Reversing	GV3P with LC2D40ABD to LC2D65ABD

Notes:

- GV2AF3 combination block is required for GV2 circuit breaker/contactor assembling.
- GVAE20 auxiliary contact block must be assembled on GV2 and GV3 circuit breaker before LAD5C••
- Depth of the motor starter assemblies is increased by 15 mm (0.59 in), height is increased by 22 mm (0.87 in).

For more information, refer to LAD5C Instruction Sheet, HRB8873800

Electrical Schematics



Altistart 01 Soft Starter - Hardware

Front View

Altistart 01

Description

The Altistart 01 soft starter enhances starting performance by providing a smooth and controlled start for asynchronous motors, while providing torque surge suppression during both the starting and stopping operation. This highly functional mini soft starter can help to decrease your maintenance work and production downtime by helping to prevent the mechanical shocks that create wear and tear on your motor and machinery.

- Reduce mechanical stress on drive-train components
- Ensure smooth acceleration of conveyors
- Suppress water hammer on pumping applications
- Eliminate belt slippage on fan loads
- Minimize voltage sags on the distribution system

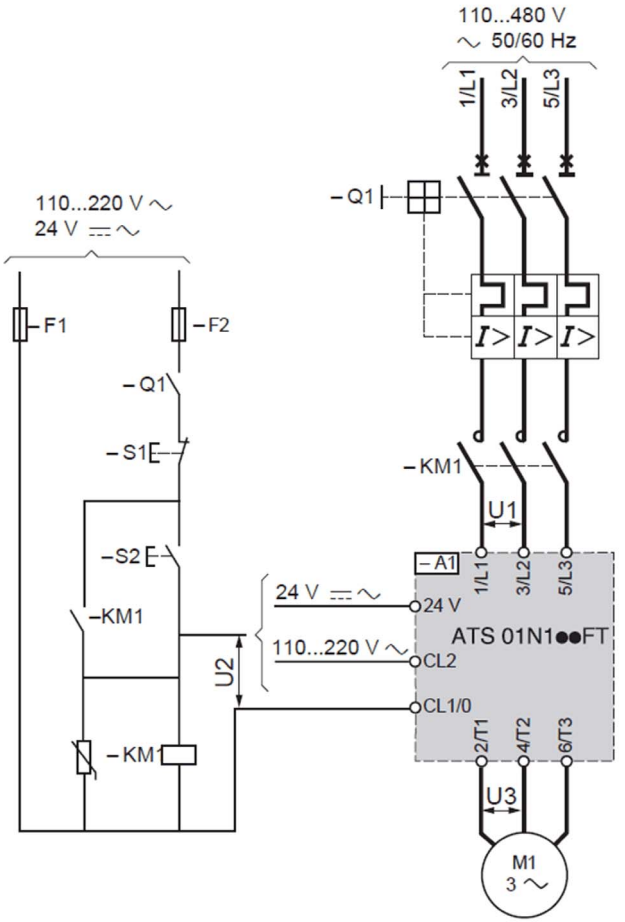
Standards and certifications	UL, CSA, C-Tick, CCC, B44.1-96/ASME A14.5 for starter wired to the motor delta terminal
Power range	• ATS 01N1••: 0,37...11 KW • ATS 01N2••: 0.75...75 kW
Voltage range	• ATS 01N1••: 110...480 V • ATS 01N2••: 230, 400, 480 V and 690 V
Functions	• 2-wire control • Adjustable starting time • Signaling completion of starting
Degree of protection	IP 20
Dimensions	W x H x D (depends on the model): 22.5...180 x 100...242 x 100.4...126 mm (0.89...7.1 x 3.94...9.5 x 3.95...4.96 in)

For more information, refer to :

- Characteristics, Soft starters for asynchronous motors Altistart 01, 60541-EN
- Reduce mechanical stress on your machines, DIA2ED1121204EN
- Instruction Sheet ATS01N1...FT, 1624685

Wiring

Wiring example power supply and motor



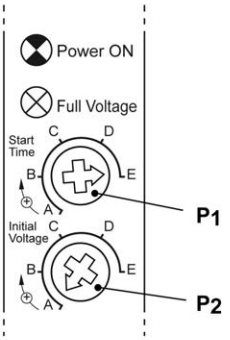
Directly applying line voltage to the Altistart soft starter will result in passing one of the three phases of power to the motor, even in the case where there is no control power to the soft starter.

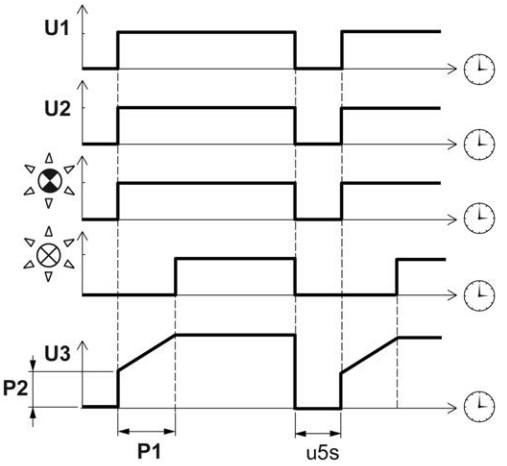
⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

Always use a contactor (-KM1) to remove all power from the motor when using the soft starter of type ATS01N1••••.

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





Altivar 12 Variable Speed Drive - Hardware

Front View

Altivar 12 variable speed drive

Description

The Altivar 12 drive is a frequency inverter for 200…240 V three-phase asynchronous motors rated from 0.18 kW to 4 kW.

The Altivar 12 drive is robust, compact, and easy to install. Its integrated functions are suitable for the requirements of applications involving simple industrial machines for example, packaging machines, pumps, compressors, fans.

- Small: easily integrated in any machine
- Easy communication with all other machine components via integrated universal Modbus serial link.
- Low noise level
- Product factory set for most applications
- Numerous application-specific functions

Standards and certifications	IEC 61800-5-1; IEC 61800-3 (environments 1 and 2, categories C1 to C3, cat. C1 with option for ATV 212); UL, CSA, C-Tick, NOM, GOST
Power range	0.18…4 kW
Voltage range	• Single-phase 100…120 V (0.18 to 0.75 kW) • Single-phase 200…240 V (0.18 to 2.2 kW) • Three-phase 200…240 V (0.18 to 4 kW)
Output frequency	0.1…400 Hz

Transient overtorque	150…170 % of the nominal motor torque
Communication	Integrated: Modbus
Functions	• Switching between local control and control via the terminals • Motor control profiles: standard, performance, and pump/fan • Frequency skips • Preset speeds • PID regulator • S ramp, U ramp, ramp switching • Freewheel stop, fast stop • Jog operation • Configuring the logic and analog I/O • Underload and overload detection • Viewing the state of the logic inputs on the drive display • Configuring how the parameters are displayed • Error log
I/Os	• 1 analog input • 4 logic inputs • 1 analog output • 1 logic output • 1 relay output
Degree of protection	IP 20
EMC filter	• Integrated: ATV12•••M2 and ATV312H••N4 • Optional: ATV12•••F1; ATV12•••M3
Dimensions	ATV12H018M2 (W x H x D): 72 x 142 x 102.2 mm (2.84 x 5.6 x 4.02 in)
Options	• SoMove and SoMove Mobile setup software • Simple-loader and multi-loader configuration tool • Remote display terminals • EMC plate

For more information, refer to Altivar 12, Variable speed drives for asynchronous motors, User manual, BBV28581.

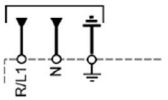
Wiring

Altivar 12 connector overview

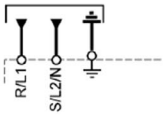
1 Power terminals
2 Control terminals
3 RJ45 communication port

Wiring examples: power supply and motor

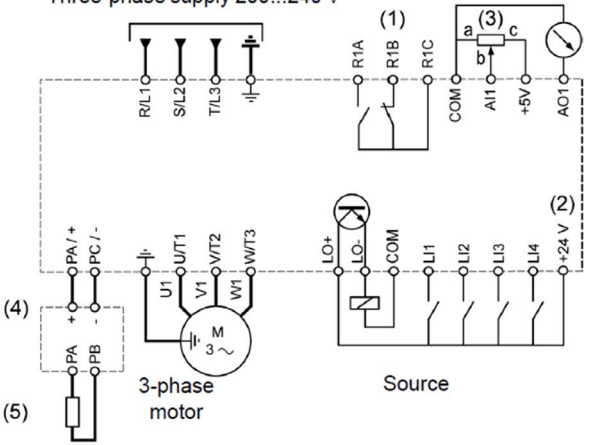
ATV12●●●●F1 Single-phase supply 100...120 V



ATV12●●●●M2 Single-phase supply 200...240 V



ATV12●●●●M3 Three-phase supply 200...240 V



Item	Description
1	R1 relay contacts, for remote indication of the drive status.
2	Internal +24 Vdc. If an external source is used (+30 Vdc maximum), connect the 0 V of the source to the COM terminal, and do not use the +24 Vdc terminal on the drive.
3	Reference potentiometer SZ1RV1202 (2.2 kΩ) or similar (10 kΩ maximum).
4	Optional braking module VW3A7005.
5	Optional braking resistor VW3A7••• or other acceptable resistor. See the possible resistor values in the catalog.

NOTE:

- Use transient voltage surge suppressors for all inductive circuits near the drive or coupled to the same circuit (relays, contactors, solenoid valves, and so on).
- The ground terminal (green screw) is located on the opposite side in comparison with its position on the ATV 12 (see wiring trap label).

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

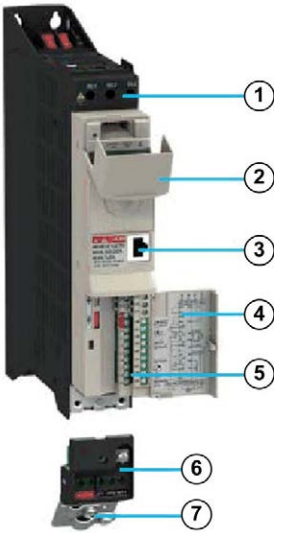
Standards and certifications	IEC 61800-5-1, IEC 61800-3 (environments 1 and 2, category C2), ISO/EN13849-1/-2 (category 3, PL d), IEC 61508 (parts 1 & 2), IEC 60721-3-3 (environments 3C3 and 3S3, classes 3C3 and 3S2), UL508c, CSA, NOM, GOST, C-Tick
Power range	0.18…15 kW
Voltage range	● single-phase 200…240 V (0.18 to 2.2 kW) ● 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 ● optional: DeviceNet, PROFIBUS DP V1, Modbus SL RS-485 2-wire, EtherNet/IP, Modbus TCP, EtherCAT
Functions	● standard or customizable configurations ● factory or OEM settings ● application-specific functions ● adjustable switching frequency ● HMI and dialog or configuration tools ● uploads and downloads with drive on or off
Protections	● STO: Safe Torque Off ● SLS: Safely Limited Speed ● SS1: Safe Stop 1
I/Os	● 3 analog inputs - response time: 3 ms, resolution 10 bits ● 6 logic inputs - response time: 8 ms, configurable in PTC and IN PWM ● 1 analog input - updating time: 2 ms ● 1 logic output - sampling time: 2 ms, configurable as voltage or current ● 2 relay outputs
Degree of protection	IP 20
EMC filter	● integrated: C2 EMC ● optional: C1 EMC
Dimensions	4 types (WxHxD) ● 45 x 317 x 245 mm (1.77 x 12.48 x 9.65 in.) ● 60 x 317 x 245 mm (2.36 x 12.48 x 9.65 in.) ● 150 x 308 (232*) x 232 mm (5.9 x 12.13 (9.13*) x 9.13 in.) ● 180 x 404 (330*) x 232 mm (7.1 x 15.9 (13*) x 9.13 in.) * = EMC plate not installed
Options	● SoMove and SoMove Mobile setup software ● simple and multi-loader configuration tool ● remote display terminals ● communication cards in cassette format ● optimized offer for connection to the CANopen bus ● 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).

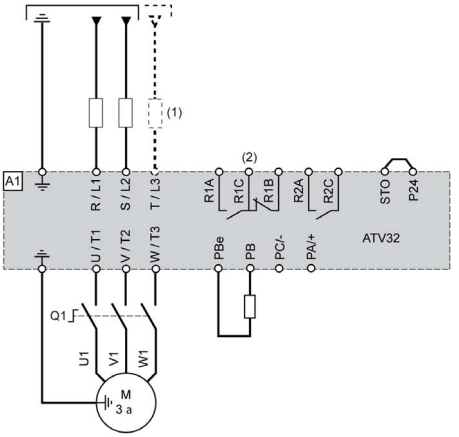
Wiring

Altivar 32 connector overview



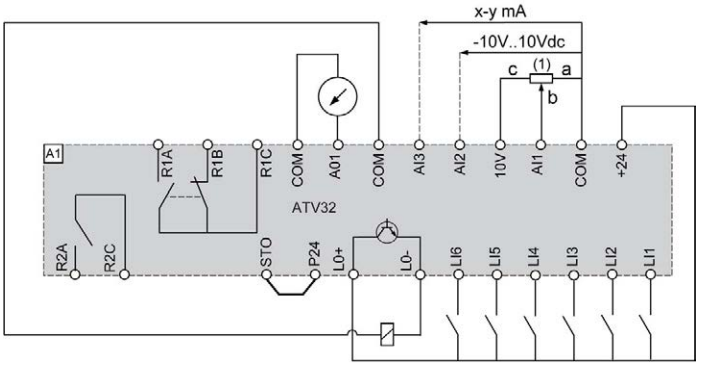
1 Power terminals
2 Protective cover
3 RJ45 Modbus SL RS-485 2-wire
4 Protective cover
5 Control terminals
6 Removable motor power terminal block
7 EMC mounting plate

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 32M Servo Drive - Hardware

Front View

Lexium 32M servo drive

Description

The Lexium 32 is a drive system for applications involving high-precision and/or dynamic positioning.

The Lexium 32 servo range consists of 3 high-performance book-size servo drive models - Lexium 32 (C, A, M) and 2 motor families - the versatile medium inertia Lexium BMH and the dynamic low inertia Lexium BSH.

Preferred machines for the integration of the Lexium 32 are: packaging machines, material handling machines, material working machines, and assembling machines.

Simplicity throughout the entire lifecycle 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-to-market
- Simplified installation with easy access to removable, color-coded connectors, memory cards, and multi-loader

- Memory card and standardized "Faulty Device Replacement" (FDR) function with EtherNet/IP for fast device replacement
- "Safe Torque Off" function on board

Openness and modularity:
- Intelligent, modular product concept responds to most requirements
- Large selection of fieldbus modules for fast integration into your architecture
- 3 encoder modules for machine encoder/second motor encoder
- eSM module for additional safety-related functions

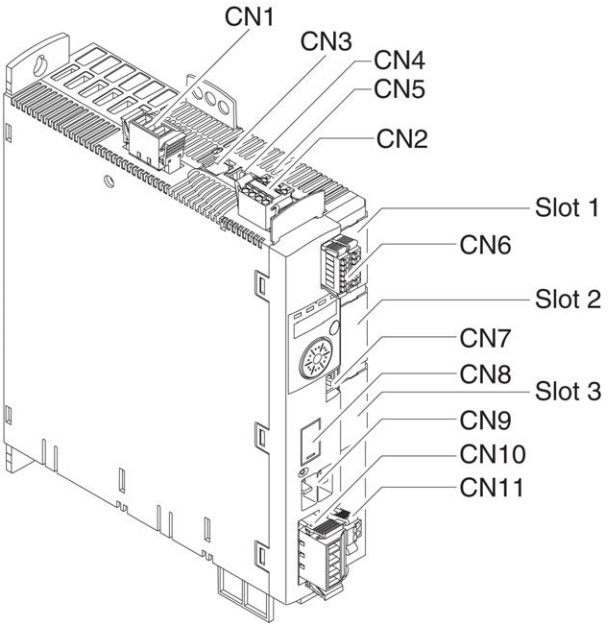
Power and performance:
- Easy auto-tuning for different levels of expertise
- Superior motor control
- Intelligent vibration and jerk suppression for long machine life
- 2 powerful motor ranges: the versatile medium-inertia Lexium BMH and the dynamic low-inertia Lexium BSH

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…240 Vac, 400…480 Vac
Speed	up to 8000 rpm
Torque	up to 84 Nm
Communication	● Integrated: Modbus serial link, Pulse train ● As an option: CANopen, CANmotion machine bus, DeviceNet, EtherNet/IP, PROFIBUS DP, EtherCAT, I/O module
Operating modes	● homing ● manual mode (JOG) ● motion sequence ● electronic gearbox ● speed control ● current control ● position control
Functions	● auto-tuning, monitoring, stopping, conversion ● stop window ● rapid entry of position values ● rotary axis ● position register
I/Os	● 4 logic inputs (24 Vdc) ● 2 capture input (24 Vdc) ● 3 logic outputs (24 Vdc)
Pulse control input	1 configurable as: ● RS 422 link ● 5 V or 24 V push-pull ● 5 V or 24 V open collector

ESIM PTO output	RS 422 link
Safety-related functions	• Integrated: "Safe Torque Off" STO • As an option: Safe Stop 1 (SS1) and Safe Stop 2 (SS2), Safe Operating Stop (SOS), Safe Limited Speed (SLS)
Sensor	• Integrated: SinCos Hiperface sensor • As an option: Resolver encoder, analog encoder, digital encoder
Degree of protection	IP 20
Dimensions	2 types (W x H x D) • 68 x 270 x 225 mm (2.68 x 10.63 x 8.86 in.) • 108 x 274 x 225 mm (4.25 x 10.79 x 8.86 in.)
Options	• SoMove setup software • Multi-Loader configuration tool • IP 54 remote graphic display terminal • filters, braking resistors, line chokes

For more information, refer to LXM32M AC servo drive, Product manual, 0198441113767.

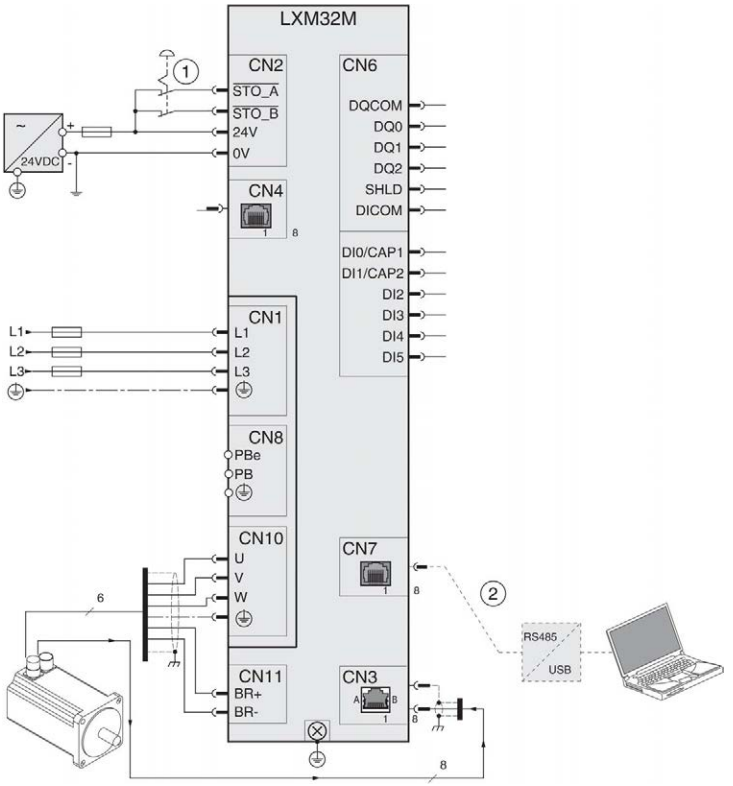
Physical Overview



Connector	Description
CN1	Power stage supply
CN2	24 controller power supply and safety-related function STO
CN3	Motor encoder (encoder 1)
CN4	PTO (encoder simulation ESIM)
CN5	PTI (A/B signals, P/D-signale, 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
Slot 1	Safety module or I/O module
Slot 2	Encoder module (encoder 2)
Slot 3	Fieldbus module

Wiring

The wiring example shows the basic wiring of the Lexium 32M servo drive. Thanks to the flexibility of the Lexium 32M servo drive the device can be adapted to a wide variety of tasks with numerous modules. See the product manuals of the modules for details on wiring.



1 Emergency stop
2 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 3K3 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 3K3, 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.

Section 4.7
Detection

What Is in This Section?

This section contains the following topics:

OsiSense XGCS850 RFID - Hardware

Front View

OsiSense XGC850

Description

The OsiSense XG Ethernet smart antenna combines a compact design and remarkable features to provide elevated performances in read/write operations on 13.56 MHz RFID tags, and flexibility in network connectivity supporting both Ethernet IP and Modbus TCP/IP networks.

The smart antenna is a compact RFID station offering the following advantages:

- 2 Ethernet ports
- An embedded Web server allowing:
  - Setup
  - Diagnostic
  - Monitoring
- Daisy chaining up to 32 smart antennas
- Compatible with most 13.56 MHz tags on the market

Embedded functions are activated by standard requests to read/write words, sent by the PLC:

- Reset: The RFID part of the smart antenna is reinitialized and assumes its factory default configuration.
- Init: The smart antenna is reinitialized and operates as it would after being switched back on (address unchanged, RFID parameters deleted).
- Sleep mode: Transmission of the electromagnetic field of the smart antenna is only activated upon receipt of a read or write instruction. This mode reduces the power consumption of the smart antenna and prevents interference when the smart antennas are in close proximity to each other.
- Auto read/write: This mode enables the smart antenna to execute up to 10 read or write instructions on a tag automatically (without PLC command) as soon as the RFID tag enters the dialogue zone.

For more information, refer to RFID OsiSense XG, Ethernet Smart Antenna, User Manual, EIO0000001601.

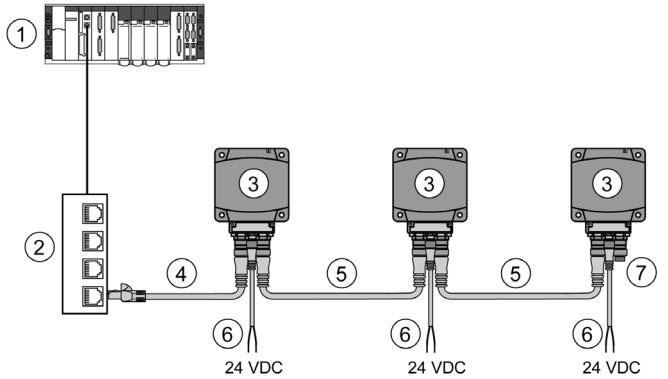
Standards and certifications	UL508, CE, EN 300330, EN 301489-01/03
Power supply	24 Vdc PELV, connection on M8 4 pins male socket
Power consumption	< 150 mA
Nominal range	20...100 mm (0.78...3.94 in) depending on associated tag
Type of associated tag	Standardized ISO 15693 and ISO 14443 tags, automatic detection of the tag type
RFID frequency	13.56 MHz
Communication	Interface: Ethernet dual port 10 BASE-T/100 BASE-TX Connection: 2x M12 D coded female sockets for chaining
Temperature	Operation: -25...+70 °C (-13...+158 °F) Storage: -40...+85 °C (-13...+158 °F)
Degree of protection	IP 65 according to IEC 60529
Dimensions	W x H x D: 80 x 93 x 40 mm (3.15 x 3.66 x 1.57 in.)

Physical Overview

1	TAG: Tag LED	6	M8 socket, 24 Vdc power supply
2	COM: Communication LED	7	M12 socket, Ethernet port 2
3	NS: Network status LED	8	LK/SP: Ethernet communication port 2 LED
4	LK/SP: Ethernet communication port 1 LED	9	MS: Ethernet module status LED
5	M12 socket, Ethernet port 1	-	-

Installation Example

Example of an Ethernet TCP/IP network setup with smart antennas



1	PLC	5	Ethernet cable XGSZ12E12••
2	Ethernet switch	6	Power supply cable XZCP0941L•
3	Smart antenna	7	M12 connector cap ASI67FACC1 (2 caps are supplied with the smart antenna)
4	Ethernet cable XGSZ12E45••	-	-

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 three different communication networks.

- Ethernet 1
  The Ethernet 1 interface of the M251 controller is equipped with an embedded 2-port Ethernet switch and is used to connect the controller to a LAN (Local Area Network).

- Ethernet 2
  The Ethernet 2 interface of the M251 controller is used to connect the controller to the device network of the architecture. The device network links the devices with Ethernet connectivity in the architecture. The network structure combines star and daisy-chain topology.

  The Ethernet network is the physical layer for the communication protocols used in this architecture.

  The SoMachine network protocol is used for the communication between the controller and the 2 Magelis touch panels HMI GTO.

  The Modbus TCP protocol is used as fieldbus in the architecture and the Modicon M251 Logic Controller is defined as Modbus TCP master. The Altivar 32 drives, Lexium 32 drives, Harmony wireless access point, Advantys ETB, encoder, OsiSense XG, and the Modicon OTB are Modbus TCP slaves.

- Modbus SL
  The Modbus SL RS-485 2-wire network is used for the communication between the Modicon M251 Logic Controller (master) and the energy meter iEM3150 (slave).

Section 5.2
Ethernet Network

What Is in This Section?

This section contains the following topics:

Network Planning and Installation

Overview

The controller TM251MESE is equipped with two independent Ethernet interfaces. This allows you to link the controller to two different networks. Usually, the Ethernet 1 interface is used to link the controller to the control network, such as a manufacturing execution system. The Ethernet 2 interface of the controller is dedicated for the device network of the architecture.

In contrast to Ethernet 1 interface, the Ethernet 2 interface supports additional features like **Modbus TCP IOScanner**, **EtherNet/IP IOScanner**, and **DHCP Server**, which are tools for the realization of an industrial Ethernet network at the machine level; that is, as a fieldbus network. These features are contained within the **Industrial Ethernet Manager** in the **Devices tree** in SoMachine.

For more information, refer to :

- Modicon M251 Logic Controller, Programming Guide, EIO0000001462.
- SoMachine Industrial EtherNet, User Guide, EIO0000002215

Transparency

The controller TM251MESE supports IP Forwarding between the Ethernet 1 network and the Ethernet 2 network. Therefore a PC connected to the Ethernet 1 network is able to access to the devices linked to the Ethernet 2 network.

A precondition for IP Forwarding is that the PC has the correct IP routes defined. For example, you can set the gateway in the Ethernet settings of the PC to those defined for the Ethernet 1 interface. In addition, the devices on the Ethernet 2 network must use the IP address of the Ethernet 2 interface of the target controller as gateway address.

Security Parameters

The controller TM251MESE supports numerous features related to the cyber security. The different protocols supported by the controller can be enabled or disabled in the Ethernet configuration.

In addition, a configurable firewall can be activated for the controller. The firewall helps to protect the controller on the network by blocking unauthorized access while permitting authorized access. The firewall is configured via a script file. The script file can be stored on the controller or on the SD card of the controller.

Network Planning

Define Ethernet 1 network

In this architecture, the Ethernet 1 interface is used to link the controller to the control network. The Ethernet setting for the Ethernet 1 interface of the controller are defined by the administrator of the control network.

Define Ethernet 2 network

The Ethernet 2 network is an independent, local network and has only few nodes.

Essential steps for the planning of the device network:

- Define the IP address of the controller.
- Decide whether to use static or served IP addresses for the devices.
- Define the IP addresses of the devices.
- Define the number and type of switches to be used, taking into account the capability of daisy chaining on some devices.
- Define for each device the repetition rate (Modbus TCP) and the RPI (CIP connection) according to your needs and in order to optimize the band width of the network.

NOTE: Each daisy chain link introduces 20 µs delay of the frames.

Test Installation and IP Address Assignment

After installation and configuration, verify your installation:

- Verify the correct installation of the network.
- Verify the Ethernet state LEDs on all network devices.
- Connect a PC with a compatible IP address to the network and verify the IP addresses for each device using a ping service. (Remote ping service is available on the Web server of the M251 controller).

Carefully manage the IP addresses because each device on the network requires a unique address. Having multiple devices with the same IP address can cause unintended operation of your network and associated equipment.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

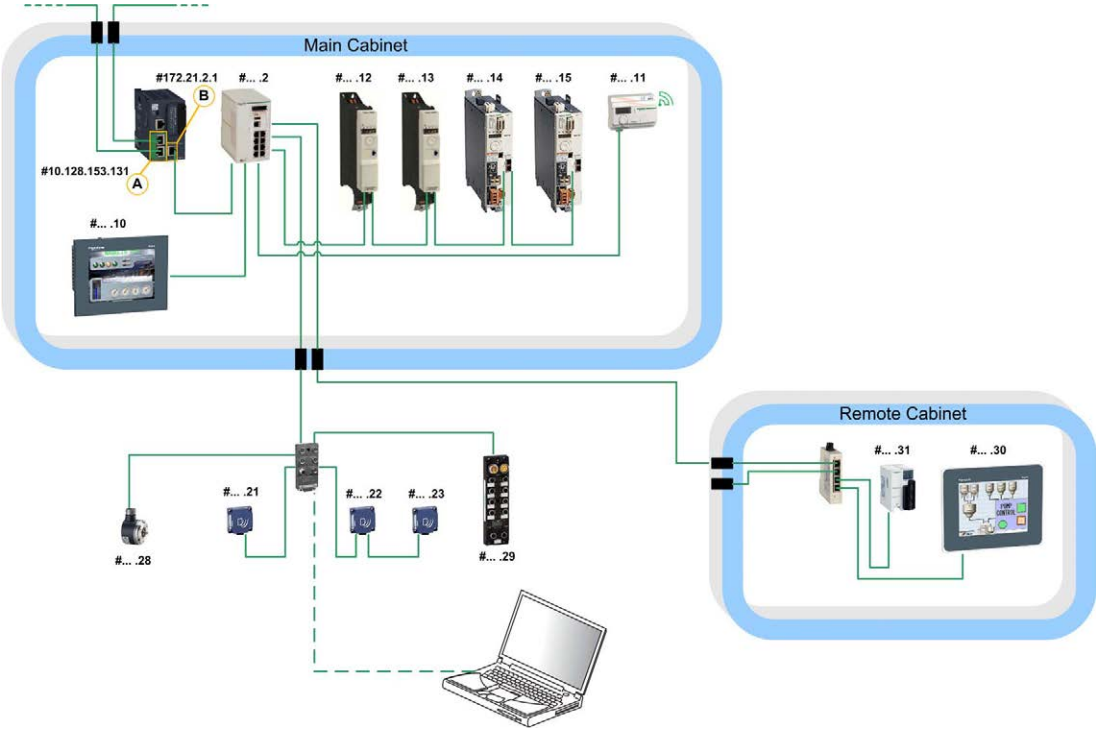
- Verify that there is only one master controller configured on the network or remote link.
- Verify that all devices have unique addresses.
- Obtain your IP address from your system administrator.
- Confirm that the IP address of the device is unique before placing the system into service.
- Do not assign the same IP address to any other equipment on the network.
- Update the IP address after cloning any application that includes Ethernet communications to a unique address.

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

NOTE: Verify that your system administrator maintains a record of all assigned IP addresses on the network and subnetwork, and inform the system administrator of all configuration changes performed.

Ethernet Network Topology

Ethernet Topology



#... IP address starts with 172.21.2.
A Ethernet 1 interface - linked to the control network
B Ethernet 2 interface - fieldbus architecture and HMI communication

The subnet mask for Ethernet 1 is 255.255.255.0.

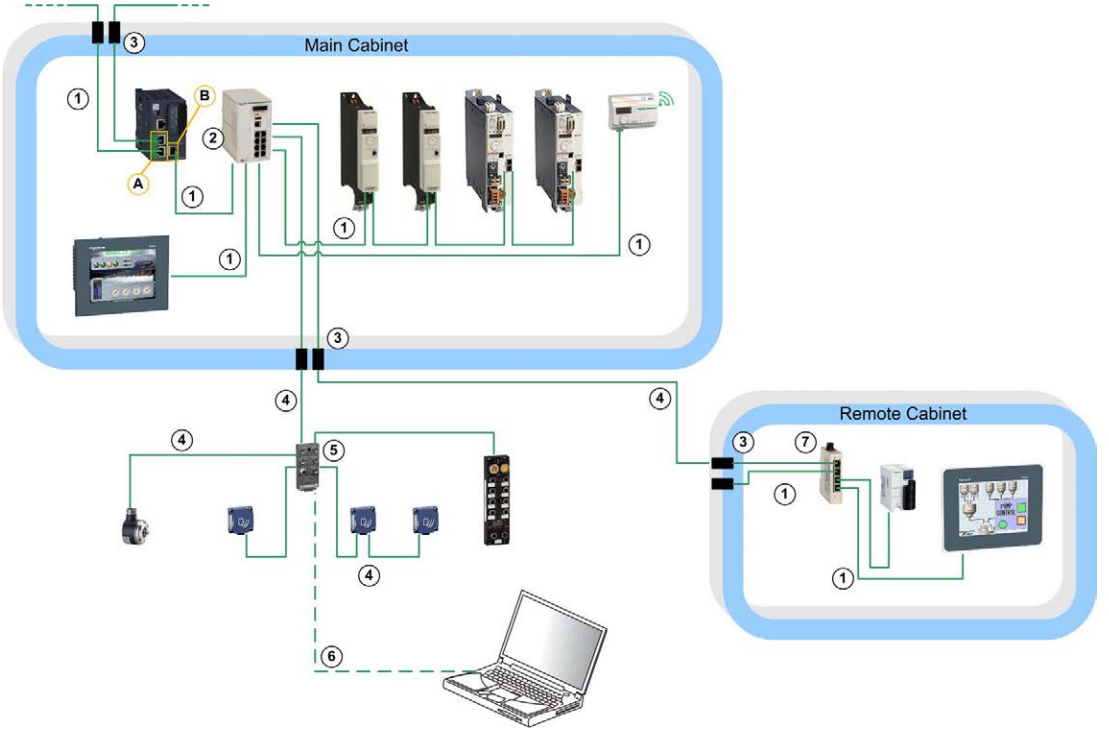
The subnet mask for Ethernet 2 is 255.255.255.0.

Optionally a PC with compatible Ethernet settings can be linked to the Ethernet 2 network for commissioning and monitoring.

Thanks to the capability of the IP Forwarding on the M251 controller, you also have access to Ethernet 2 network from a PC which is linked to Ethernet 1 network (refer to *Transparency* *(see page 160)*).

Ethernet Wiring

Overview Ethernet



A Ethernet 1 interface - linked to the control network
B Ethernet 2 interface - fieldbus architecture and HMI communication

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

Wiring Accessories

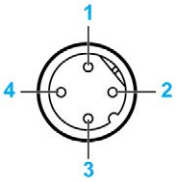
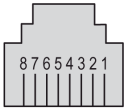
Position	Reference	Designation	Description	Cable length
1	VW3E3001R005	Ethernet patch cable - shielded twisted-pair straight cord	One RJ45 connector at each end	0.5 m (1.64 ft)
	VW3E3001R010			1.0 m (3.28 ft)
	VW3E3001R020			2.0 m (6.56 ft)
	VW3E3001R030			3.0 m (9.84 ft)
3	TCSEAAF11F13F00	ConneXium M12 to RJ45 Ethernet adapter	Adapter for panel mounting	-
4	TCSECL1M1M1S2	Ethernet patch cable - shielded twisted-pair straight cord	One IP 67, M12, 4-pin (D-coded) connector at each end	1.0 m (3.28 ft)
	TCSECL1M1M3S2			3.0 m (9.84 ft)
	TCSECL1M1M10S2			10.0 m (32.8 ft)
	TCSECL1M1M25S2			25.0 m (82 ft)
	TCSECL1M1M40S2			40.0 m (131.2 ft)
6	TCSECL1M3M3S2	Ethernet patch cable - shielded twisted-pair straight cord	One IP 67, M12, 4-pin (D-coded) connector and one RJ45 connector	3.0 m (9.84 ft)

Switches

Position	Reference	Designation	Description
2	TCSESM083F23F0	ConneXium Ethernet TCP/IP managed switch	8 x 10/100BASE-TX ports (copper cable), RJ45 shielded connectors
5	TCSESU051F0	ConneXium Ethernet TCP/IP unmanaged switch	5 x 10BASE-T/100BASE-TX ports (copper cable), shielded M12 type D connectors, IP 67
7	TCSESU053FN0	ConneXium Ethernet TCP/IP unmanaged switch	5x 10BASE-T/100BASE-TX ports (copper cable), RJ45 shielded connectors

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	

ConneXium Ethernet Cable

TCSECL1M1MxxS2

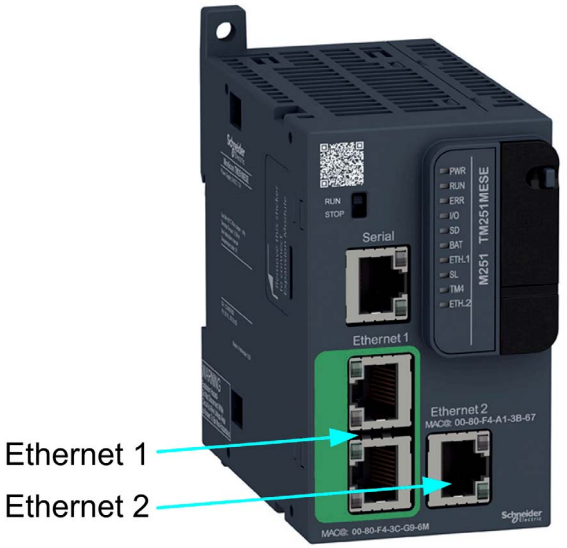
M12	Signal		Signal	M12
1	TD +		TD +	1
3	TD –		TD –	3
2	RD +		RD +	2
4	RD –		RD –	4

TCSECL1M3MxxS2

M12	Signal		Signal	RJ45
1	TD +		TD +	1
3	TD –		TD –	2
2	RD +		RD +	3
4	RD –		RD –	6

Modicon M251 Logic Controller - Ethernet Wiring

Ethernet Interfaces TM251MESE



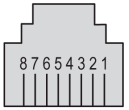
Characteristic	Description
Standard	Ethernet
Connector type	● Ethernet 1: Embedded dual port RJ45 Ethernet switch ● Ethernet 2: RJ45
Bit rate	Supports Ethernet "10BaseT" and "100BaseTX" with auto-negotiation
Automatic cross-over	MDI / MDIX
Services supported	Ethernet 1 and Ethernet 2: ● Modbus TCP client/server ● EtherNet/IP device ● FTP server ● Web server ● SNMP ● Modbus TCP slave device ● IEC VAR ACCESS For Ethernet 2 only: ● Modbus TCP IOScanner ● EtherNet/IP originator ● DHCP server ● Fast Device Replacement (FDR) server

Characteristic	Description
IP address negotiation type supported	• DHCP • BOOTP • Fixed IP
Power over Ethernet	No

For more information, refer to Modicon M251 Logic Controller, Hardware Guide, EIO0000001486.

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).

Altivar 32 Variable Speed Drive - Ethernet Wiring

Overview

For the operation via Modbus TCP or EtherNet/IP, the Altivar 32 has been equipped with the dual port Ethernet communication module VW3 A3616.

In addition to the communication services provided by each protocol, the VW3 A3616 provides a set of common services at the Ethernet and TCP/IP level.

The VW3 A3616 also provides an embedded web server which offers monitoring and commissioning functions directly from a web browser.

Altivar 32 with dual port Ethernet communication module (VW3 A3616)

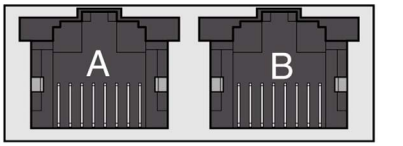
VW3 A3616 option cards, with 1.2IE01 or greater version of firmware, are compliant with Altivar 32.

NOTE: Verify the firmware version on the packaging label (on the right part of the label).

For more information, refer to Altivar 32 Variable speed drives for synchronous and asynchronous motors, Modbus TCP - EtherNet/IP, Communication Manual, S1A28701.

Pin Assignment

The VW3 A3616 option card is equipped with 2 RJ45 female sockets for the Ethernet connection.



The table describes the pin out of each RJ45 female socket.

Pin	Signal	Description
1	TX+	Ethernet transmit line +
2	TX-	Ethernet transmit line -
3	RX+	Ethernet receive line +
4	No connection	Not connected
5	No connection	Not connected
6	RX-	Ethernet receive line -
7	No connection	Not connected
8	No connection	Not connected

Communication Settings

The configuration of the devices used in this architecture is described in the *System Setup* chapter.

Lexium 32M Servo Drive - Ethernet Wiring

Overview

For the operation via Modbus TCP or EtherNet/IP, the Lexium 32M has been equipped with the dual port Ethernet communication module VW3 A3616.

In addition to the communication services provided by each protocol, the VW3 A3616 provides a set of common services at the Ethernet and TCP/IP level.

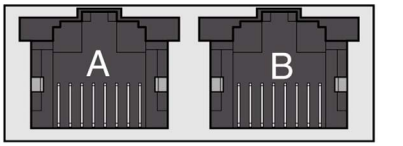
The VW3 A3616 also provides an embedded web server which offers monitoring and commissioning functions directly from a web browser.

Lexium 32M with dual port Ethernet communication module (VW3 A3616)

For more information, refer to LXM32M, Modbus-TCP module, Fieldbus manual, 0198441113843.

Pin Assignment

The VW3 A3616 option card is equipped with 2 RJ45 female sockets for the Ethernet connection.



The table describes the pin out of each RJ45 female socket.

Pin	Signal	Description
1	TX+	Ethernet transmit line +
2	TX-	Ethernet transmit line -
3	RX+	Ethernet receive line +
4	No connection	Not connected
5	No connection	Not connected
6	RX-	Ethernet receive line -
7	No connection	Not connected
8	No connection	Not connected

Communication Settings

The configuration of the devices used in this architecture is described in the *System Setup* chapter.

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

OsiSense XGCS850 RFID - Ethernet Wiring

Overview

The OsiSense XG smart antenna is equipped with a built-in unmanaged 2-port Ethernet switch comprising two female 4-pin D-coded M12 connectors. This allows you to use the network topology that meets your application needs.

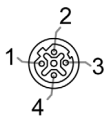
These topologies include the following:

- Star
- Daisy-chain
- Ring (daisy-chain with loopback)
- Combination of star and daisy-chain

For more information, refer to RFID OsiSense XG, Ethernet Smart Antenna, User Manual, EIO0000001601.

Pin Assignment

The figure shows the pin assignments of the two Ethernet network connectors on the module.



Pin	Signal	Description
1	TX+	Ethernet transmit line +
2	RX+	Ethernet receive line +
3	TX-	Ethernet transmit line -
4	RX-	Ethernet receive line -

Address Settings

In this architecture, the module is configured with a static IP address.

The configuration of the IP address is done by setting parameters in the web server embedded in the smart antenna.

The configuration of the device used in this architecture is described in the *System Setup* chapter.

Advantys ETB - Ethernet Wiring

Overview

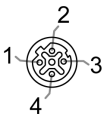
Advantys ETB I/O modules combine the functionality of a block I/O with an embedded 2-port Ethernet switch.

1 Four-character scrolling display
2 Two 4-pin Ethernet network connectors

For more information, refer to Advantys ETB, IP67 Ethernet Block I/O Modules for Modbus TCP/IP, User Guide, EIO0000000158.

Pin Assignment

The figure shows the pin assignments of the two Ethernet network connectors on the module.



Pin	Signal	Description
1	TX+	Ethernet transmit line +
2	RX+	Ethernet receive line +
3	TX-	Ethernet transmit line -
4	RX-	Ethernet receive line -

Address Settings

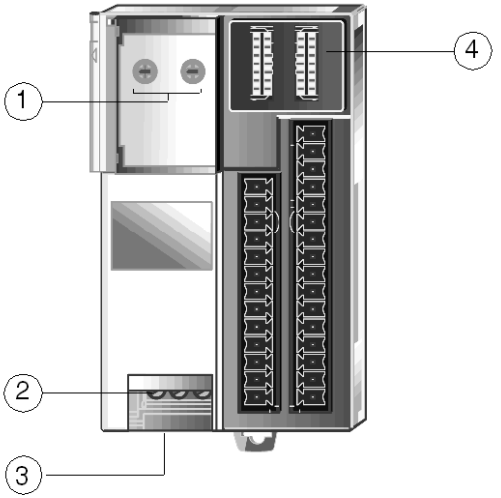
In this architecture, the module is configured with a static IP address.

The configuration of the IP address is done by setting parameters in the Web server embedded in the smart antenna.

The configuration of the device used in this architecture is described in the *System Setup* chapter *(see page 237)*.

Modicon OTB - Ethernet Wiring

Overview

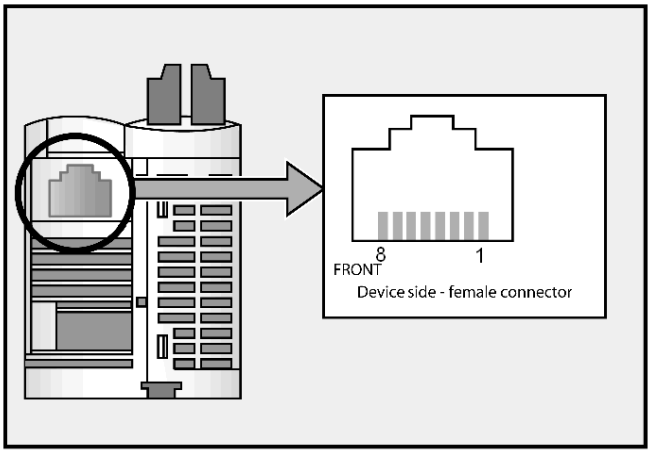


1	Two encoder wheels are used to define the IP address assignment mode.
2	Terminal for the 24 Vdc supply of the network interface module.
3	An RJ45 connector is used to connect the Modicon OTB module to an Ethernet network.
4	Visual information on the operational state of the network interface module.

For more information, refer to Advantys OTB Ethernet, Remote Inputs/Outputs, User Manual, 1606385.

Pin Assignment

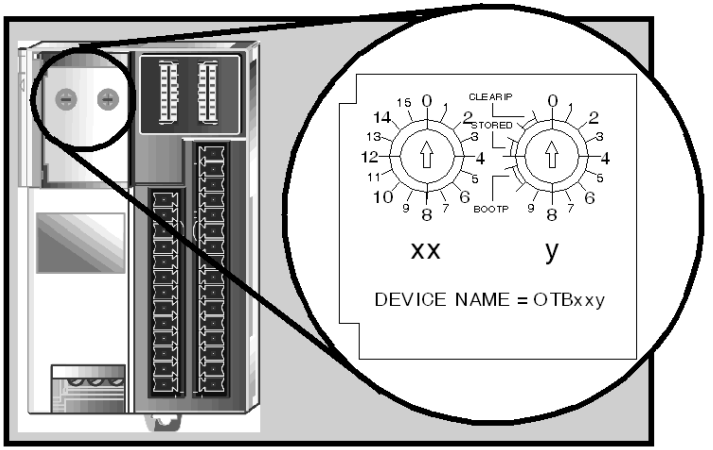
The Ethernet connector is located on the bottom side of the network interface module.



Pin	Signal	Description
1	TX+	Ethernet transmit line +
2	TX-	Ethernet transmit line +
3	RX+	Ethernet receive line +
4	-	-
5	-	-
6	RX-	Ethernet receive line -
7	-	-
8	-	-

Address Settings

Two encoder wheels on the OTB 1E0DM9LP Modicon OTB are used to define the IP address assignment mode.



There are 3 different ways to assign the Modicon OTB island IP address:

- Address assignment by a DHCP (Dynamic Host Control Protocol) server
- Address assignment by a BOOTP (Bootstrap Protocol) server (BOOTP zone on right encoder wheel)
- IP address stored in the flash memory (stored zone on right encoder wheel)

NOTE: If the above addressing modes are unsuccessful, the OTB starts on a default IP address derived from the MAC address.

NOTE: The Modicon OTB module detects if a duplicate address is present. It will not start up until it has been rectified.

In this architecture, the address assignment by a DHCP server is selected. The DHCP server is configured on the Modicon M251 Logic Controller. The Modicon OTB is identified by the device name **OTB105**. The device name is set using the two encoder wheels on the front of the OTB.

Step	Action	Comment
1	Set the encoder wheels to the value 10 and 5: ● Left thumbwheel = 10 (tens) ● Right thumbwheel = 5 (ones)	This action defines the name of the Modicon OTB module **OTBXXY** which is used by the DHCP server. **XXY** corresponds to the value coded on the encoder wheels.
2	Wait for 10 s.	When the position has been stable for 10 s, the OTB module triggers a request for an IP address.

Absolute Encoder - Ethernet Wiring

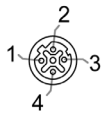
Overview

The encoder of type MHM5-EM00B-1213-C100-PRM from BEISensors is equipped with one 4-pin D-coded M12 connector for the Ethernet connection.

For more information, refer to the associated user manual for absolute rotary encoders with Modbus TCP interface provided by BEISensors.

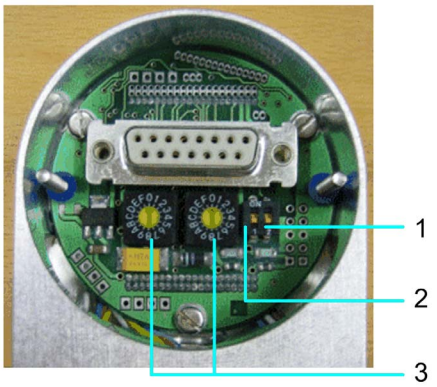
Pin Assignment

The figure shows the pin assignments of the Ethernet network connectors on the encoder.



Pin	Signal	Description
1	TX+	Ethernet transmit line +
2	RX+	Ethernet receive line +
3	TX-	Ethernet transmit line -
4	RX-	Ethernet receive line -

Address Settings



1	Switch 2 - selection for source of the IP address
2	Switch 1 - not in use
3	Two hex rotary switches - not in use

The rotary encoder can be used either with the wired IP 10.10.10.10 or the software IP address which can be programmed.

A switch to choose either option is located in the connection cap. If the switch 2 is in position "off", the programmable IP has been chosen. Both hex rotary switches and switch 1 are not in use for this encoder.

In this architecture, the encoder is configured with a static IP address.

The configuration of the device used in this architecture is described in the *System Setup* chapter *(see page 245)*.

Harmony ZBRN1 Access Point - Ethernet Wiring

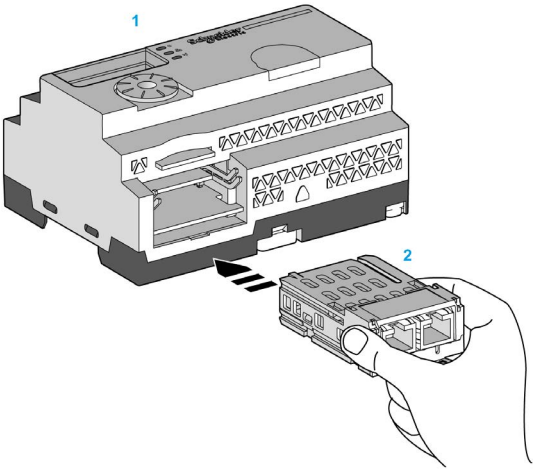
Ethernet Port

The Ethernet connection is used to exchange data between several devices connected together on a network.

The ZBRN1 access point is equipped with a plugged-in ZBRCETH communication module which provides 2 RJ45 plugs.

The communication module supports the Ethernet Modbus/TCP protocol.

It enables daisy chain wiring between devices without using a switch.



1 ZBRN1 access point
2 ZBRCETH communication module with 2 RJ45 plugs

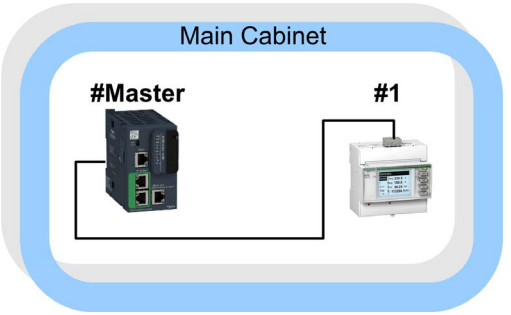
Section 5.3
Modbus Serial Line Network

What Is in This Section?

This section contains the following topics:

Modbus SL Network Topology

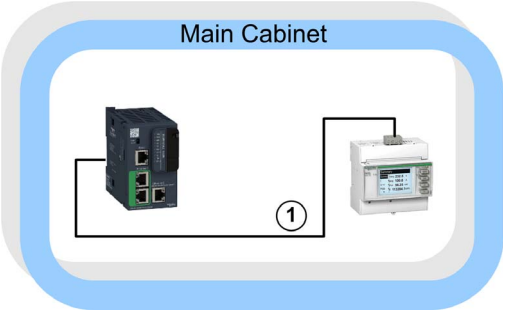
Modbus SL Topology



#... Slave address

Modbus SL Wiring

Modbus SL Overview



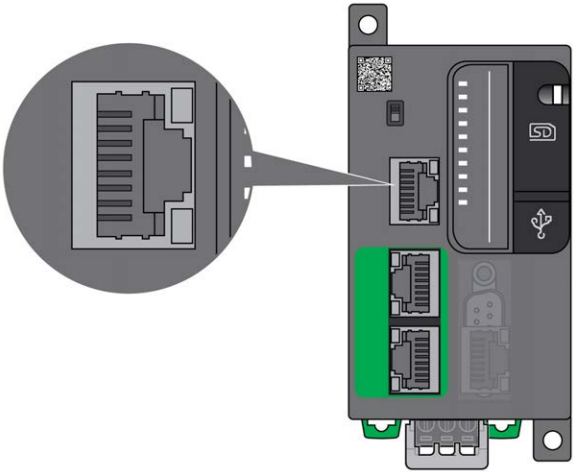
For more information, refer to Modbus Serial Line, Planning and Installation Guide, 33003925.

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 M251 Logic Controller - Modbus SL Wiring

Modbus SL Port (Serial Line)



The serial line

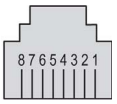
- is used to communicate with devices supporting the Modbus protocol as either master or slave, ASCII protocol (printer, modem...), and SoMachine protocol (HMI,...)
- provides a 5 Vdc power distribution

For more information, refer to Modicon M251 Logic Controller, Hardware Guide, EIO0000001486.

Pin Assignment

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

Pins for RS-485 and RS-232



Pin	Signal RS-485	Signal RS-232	Description
1	-	RxD	RS-232: Receive data line
2	-	TxD	RS-232: Transmit data line
3	-	-	-
4	D1	-	Modbus SL: D1 (+/B) RS-485 2-wire
5	D0	-	Modbus SL: D0 (-/A) RS-485 2-wire
6	-	-	-
7	VP5S	-	Power over Modbus SL: 5 V / max. 200 mA supply
8	SNG	Common	Modbus SL signal ground / reference to VP5S

⚠ 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.

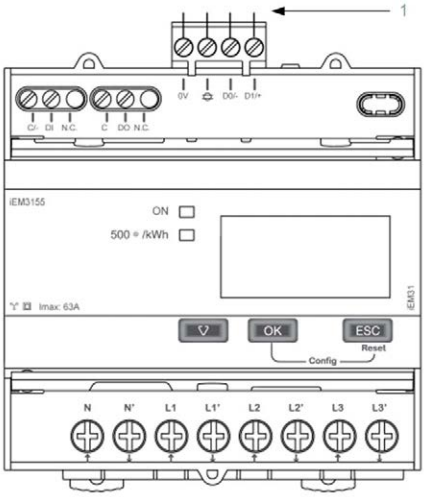
- Baud rate: 19.2 kbps
- Parity: even
- Stop bit: 1
- Physical medium: Modbus SL RS-485 2-wire

Line Polarization

Line polarization is provided by the controller.

iEM31xx Energy Meter - Modbus SL Wiring

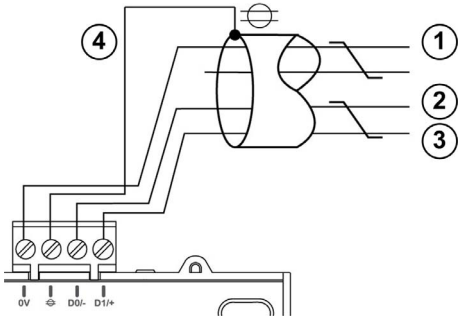
Modbus SL Port



1 Modbus SL RS-485 2-wire port

For more information, refer to iEM3100 series / iEM3200 series, Energy Meters, User Manual, DOCA0005EN.

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 energy meter has to be configured via the local HMI on the front.

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 4.1 SP2 or later.

NOTE: The SoMachine 4.1 SP2 software is an update package and requires a previously installed SoMachine 4.1 SP1 on your PC.

The following components must be installed together with SoMachine:

- SoMachine components
  - SoMachine Logic Builder
  - Vijeo-Designer
  - Gateway
- Auxiliary tools
  - Controller assistant
- Controllers
  - M251 MESE EIP
- Devices
  - Advantys (DTM)
  - Altivar (DTM)
  - Harmony (DTM)
  - Lexium (DTM)
- Repository
  - Optimized repository
- Documentation
  - Tested, Validated and Documented Architecture

The SoMachine Configuration Manager, which is part of the SoMachine installation, allows you to verify the installation on your PC. 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. The **Get started** dialog box of SoMachine Central is displayed.
2	Click **New**. The **New Project** dialog box is displayed.
3	Click **Templates**. 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. A new project based on the selected template is opened in SoMachine Logic Builder.
7	Now you can adapt *(see page 252)* 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 TM251MESE. The mandatory settings for the controller are described below. The parameter values depicted in this document relate to the template project and the test equipment used during development.

For more information about the Ethernet settings, refer to the document Modicon M251 Logic Controller, Programming Guide, EIO0000001462.

Ethernet 1

The Ethernet 1 network in this architecture is used to connect the controller to a LAN (Local Area Network), for example the control network.

The Ethernet settings for the Ethernet 1 interface in this architecture are:

- Fixed IP address
  - IP address: 10.128.153.131
  - Subnet mask: 255.255.255.0

The default settings for the network security parameters have been retained (all services and protocols enabled). You need to decide, according to your network security needs, which services and protocols must be disabled.

Ethernet 2

The Ethernet 2 network on the M251 controller is defined for the device network. The Ethernet devices of this architecture like HMIs, drives, sensors, and I/O devices are linked to the Ethernet 2 network.

The Ethernet settings for the Ethernet 2 interface in this architecture are:

- Fixed IP address
  - IP address: 172.21.2.1
  - Subnet mask: 255.255.255.0

The default settings for the network security parameters have been retained (all services and protocols enabled). You need to decide, according to your network security needs, which services and protocols must be disabled.

The Ethernet 2 interface supports a DHCP server. By the corresponding check box in the device editor of the Ethernet 2 interface, the DHCP server can be disabled. In this application, the DHCP server is enabled because some of the slave devices are configured in this mode. If the DHCP server is enabled, the use of fixed IP addresses is not suppressed, but if so, each device that is added under the Ethernet **Network Manager** in the **Devices tree** has the DHCP mode enabled by default.

Industrial Ethernet manager

The **DHCP server** and the fieldbus communication with the slave devices in the device network is managed through the **Industrial Ethernet manager**. Therefore it is added under the Ethernet 2 interface of the controller in the **Devices tree**.

Scanner Settings

On the tab **Scanner Settings**, various parameters can be adjusted.

The preferred protocol in this architecture is Modbus TCP. The preferred protocol parameter determines the type of protocol used for a device when added to the fieldbus using the drag-and-drop function from the catalog.

The timeout for the explicit messaging is set to 3 s for connected messages and 10 s for unconnected messages.

Network Manager

On the tab **Network Manager**, the network devices configured in the device network are listed. This is a central place to manage the IP configuration of the devices. Although this is the central place to manage IP configuration, you can also modify IP configuration information in the **Device Editor** of the device. The settings on the devices are updated with the settings which were modified in the **Network Manager** and conversely with the **Device Editor**.

Scanner Resources

On the tab **Scanner Resources**, the resources used by the configuration are summarized. Based on the resources used, the total load for the **Industrial Ethernet manager** can be calculated. The values for this application are listed below:

- EtherNet/IP scanner resources
  - Number of connections configured: 0/16
  - Input words: 0/1024
  - Output words: 0/1024
- Modbus TCP scanner resources
  - Number of channels configured: 12/64
  - Input words: 119/2048
  - Output words: 44/2048
  - Industrial Ethernet scanner load: 33%

Serial Line

The serial line in this architecture is used for the communication between the controller and the energy meter. Therefore, a Modbus manager has been added, via the template you used to create the application, under the serial line interface 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

HMI

Overview

In this architecture, there are two different HMIs (HMI GTO 5310 and HMI GTO 4310). The mandatory settings for the HMI devices are described below. The parameter values depicted in this document relate to the template project and the test equipment used during development.

Ethernet

The communication between the HMIs and the controller is realized via an Ethernet connection using the SoMachine network protocol. Therefore, the HMIs are also linked to the device network of the system but, in contrast to the other slave devices, the HMIs are not configured on the controller.

The Ethernet settings for the panel HMI GTO 4310 are:

- Fixed IP address
  - IP address: 172.21.2.10
  - Subnet mask: 255.255.255.0
  - Gateway address: 172.21.2.1

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

The Ethernet settings for the panel HMI GTO 5310 are:

- Fixed IP address
  - IP address: 172.21.2.30
  - Subnet mask: 255.255.255.0
  - Gateway address: 172.21.2.1

For the 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 defined 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, you can change it to a user-defined name (for example: *machine 1*).

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

Usually the node name of the controller is added automatically to configuration in Vijeo-Designer once the controller has been selected in the **Controller Selection** tab in SoMachine. If not, or if the node name has been modified, the node name can be obtained in the **Controller Selection** tab in SoMachine and must be added manually in Vijeo-Designer.

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, the devices configured within the SoMachine project are described.

TM3 Safety Modules

The TM3 safety modules are configured as I/O expansion modules and must be connected to the TM3 bus of the controller. Diagnostic and administrative control functions are provided over the TM3 bus while the safety-related function is managed in the module. The diagnostic and control signals are treated as I/O in the controller configuration, and can be processed in the application program as such. To add a TM3 safety module to the configuration, select the command **Add Device** from the context menu of the **IO_Bus** node in the **Devices tree**. In the **Add Device** dialog box, double-click the desired device.

In this architecture, the following module was added to the TM3 **IO_Bus**.

Module name	Module type	Comment
Module_2	TM3SAF5R	Safety module emergency stop Cat. 4

For more information, refer to Modicon TM3 Safety Modules, Hardware Guide, EIO0000001831.

TM3 I/O Expansion Modules

The controller provides the possibility to expand the embedded I/Os by adding TM3 expansion modules to the controller.

To add a TM3 module to the configuration, select the command **Add Device** from the context menu of the **IO_Bus** node in the **Devices tree**. In the **Add Device** dialog box, double-click the desired device. Each expansion module provides an individual configuration. Double-clicking the module in the **Devices tree** opens the associated device editor. In the device editor, you can modify the module-specific parameter in accordance with your application as you have adapted it from the template you had chosen..

In this architecture, the following modules were added to the TM3 **IO_Bus**.

Module name	Module type	Comment	Configuration
Module_0	TM3DI16	16-channel, 24 Vdc digital inputs expansion module, with 1 common line	Default
Module_1	TM3DQ16T	16-channel, 0.5 A/24 Vdc source transistor outputs expansion module, with 1 common line	Default

For more information, refer to Modicon TM3, Expansion Modules Configuration, Programming Guide, EIO0000001402.

Modicon OTB

The architecture implements a Modicon OTB distributed I/O island which is linked to the Ethernet network. The communication between the controller and the OTB I/O island is realized using the Modbus TCP protocol.

This I/O island must be configured within the SoMachine project.

There are 2 steps to create the island under the **Modbus TCP IOScanner**:

1. Add the Ethernet interface module OTB1E0DM9LP under the **Modbus TCP IOScanner**.
2. Add the desired TM2 expansion modules under the Ethernet interface module OTB1E0DM9LP.

Each device provides the possibility for an individual configuration if the default settings do not meet the requirements of your application.

In this architecture, the default settings are sufficient and the following devices were added under the **Industrial Ethernet manager** of the Ethernet 2 interface:

Module name	Module type	Comment	Configuration
OTB1E0DM9LP	OTB1E0DM9LP	Network interface module with 12 digital inputs and 8 digital outputs	IP address*: 172.21.2.31 I/O configuration: Default
Module_3	TM2DMM24DRF	TM2 expansion I/O module with 16 digital inputs and 8 digital outputs 24 Vdc	I/O configuration: Default
Module_4	TM2DMM24DRF	TM2 expansion I/O module with 16 digital inputs and 8 digital outputs 24 Vdc	I/O configuration: Default
Module_5	TM2DDI16DT	TM2 expansion I/O module with 16 digital inputs 24 Vdc	I/O configuration: Default
Module_6	TM2DDO8TT	TM2 expansion I/O module with 8 digital outputs 24 Vdc	I/O configuration: Default
* The OTB device obtains its IP address from the DHCP server of the M251 controller. Therefore, the **DHCP Device Name** must be selected in the **Network Manager** tab in the device editor of the **Industrial Ethernet manager** *(see page 196)*. The **DHCP Device Name** of the OTB is configured via the rotary switches on the front of the OTB, refer to Modicon OTB - Ethernet Wiring, Address Settings *(see page 179)*.			

NOTE: The changes in the I/O configuration of the OTB or the TM2 modules become valid after a successful execution of the function block `CONFIGURE_OTB`. For more information, refer to **Modbus TCP IOScanner** *(see Modicon M251 Logic Controller, Programming Guide)*.

Energy Meter iEM3150

The architecture implements one energy meter of type iEM3150 for energy measurement. The energy data are read from the device 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 energy meter was created in the application by adding the Device Module MED_iEM3150_ModbusSL which is represented as a function template within the **TVDA Device Module Library - Modbus SL**.

The Modbus slave address and the network ID must be assigned by an initial value to the associated variables (`CONSTANT`). The assignment of the values can be done directly within the **Add Function From Template** dialog box. It can also be done later in the declaration part of the associated program (**POU**) after the template was added to the application.

Harmony ZBRN1

The architecture implements one Harmony wireless access point of type ZBRN1. The ZBRN1 receives the signals from the wireless and batteryless push-buttons and provides these in four 16-bit registers. The registers are read from the device via Modbus TCP.

The Harmony ZBRN1 must be configured within the SoMachine project. Therefore, the device ZBRN1 was added under the **Industrial Ethernet manager**.

The device was added using the Device Module Harmony_Wireless_ModbusTCP_2, which is represented as a function template within the **TVDA Device Module Library - Modbus TCP**.

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 IP address what can be done directly within the **Add Function From Template** dialog box. Further settings for the IP parameter dependent to the selected IP mode must be done within the **Network Manager** tab of the **Industrial Ethernet manager**.

The following device was added under the **Industrial Ethernet manager** of the Ethernet 2 interface:

Device name	Configuration
HarmonyWireless_ZBRN1	Fixed IP address: 172.21.2.11

Altivar 32

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

These devices must be configured within the SoMachine project. Therefore, the devices were added under the **Industrial Ethernet manager**.

Each device was added with the use of the Device Module ATV32_ModbusTCP, which is represented as a function template within the **TVDA Device Module Library - Modbus TCP**.

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 IP address within the **Add Function From Template** dialog box. Further settings for the IP parameter dependent to the selected IP mode must be done within the **Network Manager** tab of the **Industrial Ethernet manager**.

The following devices were added under the **Industrial Ethernet manager** of the Ethernet 2 interface:

Device name	Configuration
ATV32_Motor01	Fixed IP address: 172.21.2.12
ATV32_Motor02	Fixed IP address: 172.21.2.13

Lexium 32M

The architecture implements two servo drives of type Lexium 32M which are controlled via Modbus TCP.

These devices must be configured within the SoMachine project. Therefore the devices were added under the **Industrial Ethernet manager**.

Each device was added with the use of the Device Module Lexium_32M_ModbusTCP, which is represented as a function template within the **TVDA Device Module Library**.

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 IP address within the **Add Function From Template** dialog box. Further settings for the IP parameter dependent to the selected IP mode must be done within the **Network Manager** tab of the **Industrial Ethernet manager**.

The following devices were added under the **Industrial Ethernet manager** of the Ethernet 2 interface:

Device name	Configuration
Lexium32_Motor01	Fixed IP address: 172.21.2.14
Lexium32_Motor02	Fixed IP address: 172.21.2.15

OsiSense RFID Antenna

The architecture implements three OsiSense XGCS smart antennas which are controlled via Modbus TCP.

These devices must be configured within the SoMachine project. Therefore the devices were added under the **Industrial Ethernet manager**.

Each device was added with the use of the Device Module OsiSense_RFID_ModbusTCP, which is represented as a function template within the **TVDA Device Module Library - Modbus TCP**.

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 IP address within the **Add Function From Template** dialog box. Further settings for the IP parameter dependent to the selected IP mode must be done within the **Network Manager** tab of the **Industrial Ethernet manager**.

The following devices were added under the **Industrial Ethernet manager** of the Ethernet 2 interface:

Device name	Configuration
RFID_1	Fixed IP address: 172.21.2.21
RFID_2	Fixed IP address: 172.21.2.22
RFID_3	Fixed IP address: 172.21.2.23

Encoder

The architecture implements one absolute multiturn encoder which is monitored via Modbus TCP.

This device must be configured within the SoMachine project. Therefore the device was added under the **Industrial Ethernet manager**.

The device was added with the use of the Device Module Encoder_AbsMlt_ModbusTCP, which is represented as a function template within the **TVDA Device Module Library - Modbus TCP**.

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 IP address within the **Add Function From Template** dialog box. Further settings for the IP parameter dependent to the selected IP mode must be done within the **Network Manager** tab of the **Industrial Ethernet manager**.

The following device was added under the **Industrial Ethernet manager** of the Ethernet 2 interface:

Device name	Configuration
Encoder	IP address: 172.21.2.28

ETB

The architecture implements one Advantys ETB I/O block which is monitored and controlled via Modbus TCP.

This device must be configured within the SoMachine project. Therefore the devices were added under the **Industrial Ethernet manager**.

The device was added with the use of the Device Module IO_ETB_ModbusTCP, which is represented as a function template within the **TVDA Device Module Library - Modbus TCP**.

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 IP address within the **Add Function From Template** dialog box. Further settings for the IP parameter dependent to the selected IP mode must be done within the **Network Manager** tab of the **Industrial Ethernet manager**.

The following device was added under the **Industrial Ethernet manager** of the Ethernet 2 interface:

Device name	Configuration
IO_ETB	IP address: 172.21.2.29

TeSys U

The architecture implements two motor starter controllers of type TeSys U which are controlled via hardwired signals.

The devices themselves are not configured in the application. Only the variables to control and to monitor each motor starter are assigned to physical I/Os of the configuration.

The program code in relation with the needed variables to control and to monitor one motor starter, was created in the application through adding the Device Modules TeSysU_HW_1D (non-reversing) and TeSysU_HW_2D (reversing). The Device Modules are represented as function templates within the **TVDA Device Module Library - Hardwired**.

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

In the table, the variables are listed which were assigned to physical I/Os of the configuration within the **Add Function From Template** dialog box for each Device Module.

Variable name	Assigned to	Comment
`GVL_TeSysU_Motor04.xTeSysU_Rdy`	Digital input	Signal linked to the TeSys U contact indicating that the device is turned ON.
`GVL_TeSysU_Motor04.xTeSysU_Trip`	Digital input	Signal linked to the TeSys U contact indicating that the device is tripped (detected error).

Variable name	Assigned to	Comment
GVL_TeSysU_Motor04.xTeSysU_Actv	Digital input	Signal linked to the TeSys U contact indicating that the contactor is activated.
GVL_TeSysU_Motor04.xTeSysU_MotFwd	Digital output	Command to activate the contactor for forward direction.

Variable name	Assigned to	Comment
GVL_TeSysU_Motor05.xTeSysU_Rdy	Digital input	Signal linked to the TeSys U contact indicating that the device is turned ON.
GVL_TeSysU_Motor05.xTeSysU_Trip	Digital input	Signal linked to the TeSys U contact indicating that the device is tripped (detected error).
GVL_TeSysU_Motor05.xTeSysU_Actv	Digital input	Signal linked to the TeSys U contact indicating that the contactor is activated.
GVL_TeSysU_Motor05.xTeSysU_MotFwd	Digital output	Command to activate the contactor for forward direction.
GVL_TeSysU_Motor05.xTeSysU_MotRev	Digital output	Command to activate the contactor for reverse direction.

TeSys GV2DP

The architecture implements three motor starter combinations of type TeSys GV2DP which are controlled via hardwired signals.

The devices themselves are not configured in the application. Only the variables to control and to monitor each motor starter are assigned to physical I/Os of the configuration.

The program code in relation with the needed variables to control and to monitor one motor starter, was created in the application through adding the Device Modules Motor_Ctrl_1D1S (non-reversing) and Motor_Ctrl_2D1S (reversing). The Device Modules are represented as function templates within the **TVDA Device Module Library - Hardwired**.

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

In the table, the variables are listed which were assigned to physical I/Os of the configuration within the **Add Function From Template** dialog box for each Device Module.

Variable name	Assigned to	Comment
GVL_TeSysD_Motor01.xMcbRdy	Digital input	Signal linked to the TeSys GV2DP contact indicating that the device is turned ON.
GVL_TeSysD_Motor01.xFwdFdbck	Digital input	Signal linked to the TeSys GV2DP contact indicating that the contactor is activated.
GVL_TeSysD_Motor01.xDriveMotFwd	Digital input	Command to activate the contactor for forward direction.

Variable name	Assigned to	Comment
GVL_TeSysD_Motor02.xMcbRdy	Digital input	Signal linked to the TeSys GV2DP contact indicating that the device is turned ON.
GVL_TeSysD_Motor02.xFwdFdbck	Digital input	Signal linked to the TeSys GV2DP contact indicating that the contactor is activated.
GVL_TeSysD_Motor02.xDriveMotFwd	Digital input	Command to activate the contactor for forward direction.

Variable name	Assigned to	Comment
GVL_TeSysD_Motor03.xMcbRdy	Digital input	Signal linked to the TeSys GV2DP contact indicating that the device is turned ON.
GVL_TeSysD_Motor03.xFwdFdbck	Digital input	Signal linked to the TeSys GV2DP contact indicating that the contactor is activated.
GVL_TeSysD_Motor03.xDriveMotFwd	Digital input	Command to activate the contactor for forward direction.
GVL_TeSysD_Motor03.xDriveMotRev	Digital input	Command to activate the contactor for reverse direction.

Altivar 12

The architecture implements one motor control function comprising of 2 motors and 1 Altivar 12. The motor control function is realized via hardwired I/O signals. Each motor can be controlled by the Altivar in forward or reverse direction with 2 switchable preset speeds.

The devices themselves are not configured in the application. Only the variables to control, and to monitor the Altivar and the switching between the motors are assigned to physical I/Os of the configuration.

The program code in relation with all needed variables for the motor control function, was created in the application through adding the Device Module VSD_HW_2Motors_2D2S.

The name of each added application object corresponds with the name which was assigned within the **Add Function From Template** dialog box, which is represented as function template within the **TVDA Device Module Library - Hardwired**.

In the table, the variables are listed which were assigned to physical I/Os of the configuration within the **Add Function From Template** dialog box for each Device Module.

Variable name	Assigned to	Comment
VSD_ATV12_Motor06_07.xMcbRdy	Digital input	Signal linked to the motor circuit breaker contact what indicates that the device is turned ON.
VSD_ATV12_Motor06_07.xDriveNoFlt	Digital input	Signal linked to the drive contact what indicates that the drive is operational (no error detected).
VSD_ATV12_Motor06_07.xDriveRun	Digital input	Signal linked to the drive contact what indicates that the drive is running.
VSD_ATV12_Motor06_07.xDrive1StatSel	Digital output	Signal linked to the contactor indicating motor 1 is linked to the drive.
VSD_ATV12_Motor06_07.xDrive2StatSel	Digital output	Signal linked to the contactor indicating motor 2 is linked to the drive.
VSD_ATV12_Motor06_07.xDriveCmdMotFwd	Digital input	Command to operate the drive in forward direction. Linked to an input of the drive.
VSD_ATV12_Motor06_07.xDriveCmdMotRev	Digital input	Command to operate the drive in reverse direction. Linked to an input of the drive.
VSD_ATV12_Motor06_07.xDriveCmdFast	Digital input	Command to select the second preset speed for the drive. Linked to an input of the drive.
VSD_ATV12_Motor06_07.xDriveRst	Digital output	Command to reset the drive in case of drive error detected. Linked to an input of the drive.
VSD_ATV12_Motor06_07.xDriveCmdSel1	Digital output	Command to activate the contactor which links the motor 1 to the drive.
VSD_ATV12_Motor06_07.xDriveCmdSel2	Digital output	Command to activate the contactor which links the motor 2 to the drive.

Application

Library Manager

The library manager is a standard object of the application. Most of the libraries referenced by the library manager are loaded automatically when adding devices or objects to the application.

Furthermore, SoMachine provides libraries with utility functions for the access to extended features of the controller and/or to assist the user during the realization of the application.

In this example project, the libraries listed in the following table have been added manually to the library manager:

Library name	Comment
SysTimeRtc	Library provides access to the target real-time clock.
Toolbox	Set of utility functions and function blocks complementary to the Standard library and Util library.

Symbol Configuration

The symbol configuration functionality allows you to create symbol names for objects, so that those objects can be accessed from external devices, for example when exchanging variables with an HMI application created with Vijeo-Designer or via the OPC server.

The variables for control and monitor functions on the Magelis HMI were published within the symbol configuration editor. By publishing the variables in SoMachine, they are automatically 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)*

Task Configuration

The **Task Configuration** defines one or several tasks for controlling the processing of an application program. It is a core resource object for an application that is automatically added to the application node.

In this example application, one task is configured:

Task	Type	Comment
MAST	Cyclic: 10 ms	This task includes the program calls related to the Ethernet devices, Modbus SL communication, and general application code.

For more information, refer to Task Configuration Editor *(see SoMachine, Programming Guide)*.

Program Code

The program code, part of the project template you had selected, is divided into several POUs (Program Organization Units) of type program and GVLs (Global Variable Lists).

Each POU is called separately within the associated task.

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

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

- **Main Cabinet Modules**
  - ATV32_Motor01
  - ATV32_Motor02
  - iEM3150_MDBSL
  - LXM32_Motor03
  - LXM32_Motor04
  - ZBRN1
- **Field Modules**
  - OsiSense_XGCS_1
  - OsiSense_XGCS_2
  - OsiSense_XGCS_3
  - Encoder
  - IO_ETB
- **Remote Cabinet Modules**
  - TeSysD_Motor01
  - TeSysD_Motor02
  - TeSysD_Motor03
  - TeSysU_Motor04
  - TeSysU_Motor05
  - ATV12_Motor0607

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-related functions is realized in relation to the different functional units of the application.

The following POUs are available:

- **Prg_PreProcessing**: This POU is called at the beginning of the task and mainly contains the input mapping.
- **Prg_Alarms**: Processing of alarm management of the system.
- **Prg_Main**: Processing of command signals for the devices (for example, operator push buttons, HMI commands, and so on) and processing of summary information about device and communication state.
- **Prg_PostProcessing**: This POU is called at the end of the task and mainly contains the 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 two Magelis HMI panels. One of type HMI GTO 4310 and the other one of type HMI GTO 5315.

Both identical applications are executed on these panels and provide 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
- State of the safety-related functions

Alarm Page

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

Ethernet Network Page

The Ethernet network page provides the network topology and the communication state of the Ethernet slave devices.

Date and Time Page

The date and time page provides the 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 differentiated in the several architecture areas and grouped by products:

- Devices main cabinet:
  - Altivar 32
  - Lexium 32
  - Harmony
- Devices remote cabinet:
  - TeSys D motor control
  - TeSys U motor control
  - Altivar 12
- Field devices:
  - RFID
  - Encoder
  - I/O ETB

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

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 an USB cable (linked to the integrated mini USB port on the devices).
- With an USB key (linked to the integrated USB port on the HMI).
- Via an SD card (inserted in the SD card slot on the front of the controller).
- 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 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 in both applications (controller and HMI) 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

To configure these settings, proceed as follows:

Step	Action	Comment
1	In the **Devices tree** of the SoMachine Logic Builder, double-click the **Ethernet** node of the controller.	The **Ethernet** device editor opens.
2	Configure the Ethernet settings of the controller.	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.
3	Select **Vijeo-Designer** from the **Quick Toolswitch** list of the SoMachine Central overlay bar (refer to SoMachine Central, User Guide *(see SoMachine Central, User Guide)*).	The Vijeo-Designer opens in a new window.

Step	Action	Comment
4	In Vijeo-Designer, select the target node in the **Navigators Project** tab.	The target property editor opens.
5	Select **Network** in the target property editor.	The network property editor opens.
6	Click the **...** button for network configuration.	The **Network Configuration** dialog box opens.
7	Perform the Ethernet configuration in the **Network Configuration** dialog box.	The **Network Configuration** dialog box allows the Ethernet configuration for the HMI. 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.
8	Click **OK** to apply the settings.	The Ethernet configuration becomes effective after a download of the application to the HMI.
9	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.
10	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 SoMachine Logic Builder if the PC is connected to the controller.

Download Procedure

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

To set up a communication between a controller and a PC via USB, use one of the following cables:

- TCSXCNAMUM3P
- BMXXCAUSBH045

If HMI and controller are successfully connected via the Ethernet network, the HMI application can be transferred to the HMI using the USB connection between PC and controller.

The controller is routing between the mini USB and the Ethernet interface.

Using the established USB connection between PC and controller and the Ethernet connection between controller and HMI, proceed as follows to download the SoMachine Logic Builder and HMI application.

Precondition for this workflow is a working Ethernet connection between controller and HMI.

Step	Action	Comment
1	In the SoMachine Logic Builder double-click the controller node in the **Devices tree**.	The controller device editor opens.
2	Select the **Controller selection** tab.	The compatible controllers detected by the gateway on the PC are listed.
3	Double-click a list entry to select a controller.	The selected controller is displayed in bold and the address is displayed at the bottom of the device editor.
4	In the SoMachine Logic Builder double-click the HMI device node in the **Devices tree**.	The HMI device editor opens.
5	Select the **Controller selection** tab.	The compatible HMIs detected by the gateway on the PC are listed.
6	Double-click a list entry to select an HMI.	The selected HMI is displayed in bold and the address is displayed at the bottom of the device editor.
7	Click **Online** → **Multiple Download...** to download the applications.	The **Multiple Download** dialog box opens. You can choose which application should be downloaded. Using the **Additional operations** a start of all applications after download can be performed.

NOTE: The firmware version of the controller must correspond with the firmware version of the controller in the SoMachine project. If the versions of the devices mismatch, 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 appropriate product guide of your 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, 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 SoMachine Central (**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.

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 a 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.

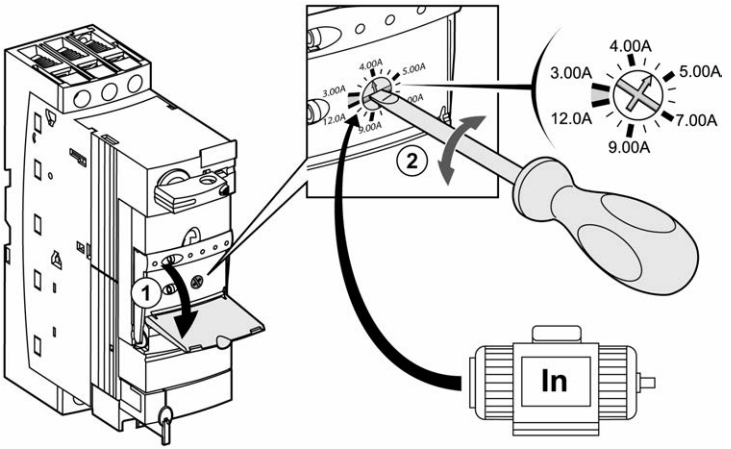
(1) The controller states can be read in the `SEC.PLC_GVL.PLC_R.i_wStatus` system variable of the M251 PLCSystem Library *(see Modicon M251 Logic Controller, System Functions and Variables, PLCSystem Library Guide)*.

For setting the communication parameters of the Modicon OTB, refer to the *Communication* chapter *(see page 177)*.

TeSys U Motor Starter - Setup

Overview

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.



Altistart 01 Soft Starter - Setup

Soft Start Functions

Starting time

The ATS01N1 soft starter controls the starting time of the motor by ramping up the voltage applied to one phase of the motor.

The starting voltage ramp time can be adjusted 1...5 seconds with the potentiometer on the front of the soft starter. Since the actual motor starting time is dependent on the level of the applied load, the scale on the front of the soft starter is calibrated from A to E rather than 1...5 seconds, with A being the shortest time and E being the longest time.

The starting voltage ramp begins at the AC line voltage level set by the initial voltage adjustment. See the diagram below for more detail.

The ATS01 soft starter is internally bypassed at the end of the time set by the start time adjustment. If the motor is not up to speed by that time (due to a heavy load), the internal contactor can be damaged, requiring replacement of the soft starter.

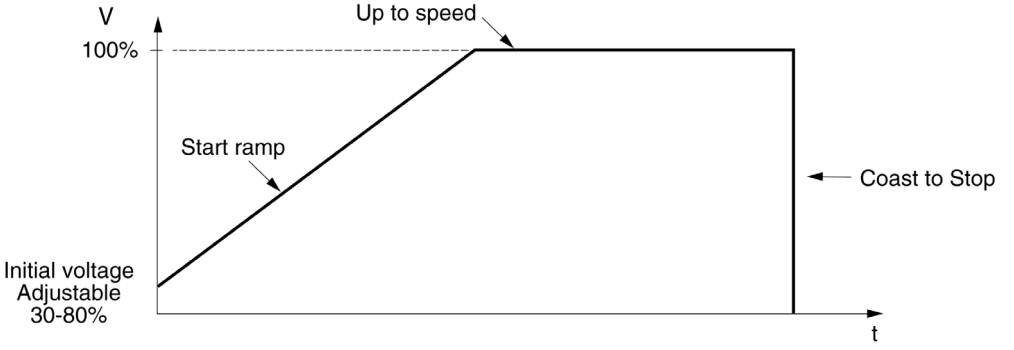
⚠ CAUTION

INOPERABLE EQUIPMENT

Set the start time to a level that can be reached even if the motor is operating with maximum load conditions.

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

Voltage start ramp, initial voltage, and up to speed



Initial voltage

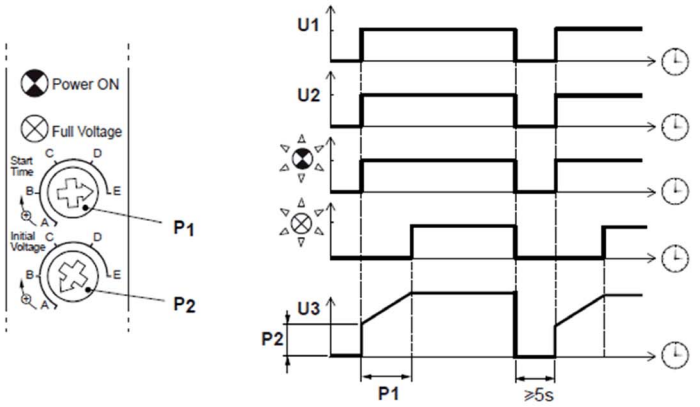
The initial voltage applied to the motor (the level at which the voltage ramp begins) can be adjusted by a potentiometer on the front of the ATS01N1 soft starter.

The initial voltage level can be adjusted from approximately 30 to 80% of the AC line voltage level. See the diagram above for more details.

Since the resultant motor torque varies in proportion to the square of the applied voltage, the scale on the front of the soft start is calibrated from A to E rather than from 30 to 80%, with A being the lowest level and E being the highest level. A lower setting reduces motor torque during starting.

Set this level to the minimum required that will result in motor rotation immediately after a start command.

Settings



U1 Level of input voltage
U2 Level of voltage on control terminals
U3 Level of output voltage (motor)
P1 Potentiometer for starting voltage ramp time adjustment, A (min.) to E (max.)
P2 Potentiometer for initial voltage adjustment, A (min.) to E (max.)

For more information, refer to Altistart 01, Soft Starts for Single-Phase and Three-Phase Asynchronous Motors, 45A01SS.

Altivar 12 Variable Speed Drive - Setup

Overview

To operate the Altivar 12 via hardwired signals as it is defined in this example, the I/O configuration has to be set for the drive. 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 remote display terminal*
- By the software SoMove lite installed on a PC*

(* linked to the integrated communication port 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.

⚠ 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.

For more information, refer to Altivar 12, Variable speed drives for asynchronous motors, User manual, BBV28581.

Settings

The signals to control the Altivar 12 are defined in the table below.

Signal	Control terminal Altivar 12	Description
Run forward	LI1	Command to start the drive in forward direction.
Run reverse	LI2	Command to start the drive in reverse direction.
Fault reset	LI3	Command to reset the drive in case of error state.
Fast speed	LI4	Switching between slow and fast speed. ● High: Fast speed, preset speed determined by the parameter (SP2). ● Low: Slow speed, preset speed determined by the parameter (LSP).
Control brake contactor	R1A (relay output)	R1 is active if the drive is in run state - brake contactor becomes activated.
Drive no fault	LO-	Indicates that the drive has no error detected.

The following steps to set up the drive are based on the configuration by the local HMI on the front of the drive.

Step	Action	Comment
1	Switch on the power supply.	Do not give a run command to the drive.
2	Configure the I/O parameters under the menu `(FULL) -> (I_O-)`: ● `[Type of control] (tCC)` ● `[2 wire type control] (tCt)` ● `[Logic inputs type] (nPL)` ● `[R1 assignment] (r1)`	In this example, the drive is controlled in 2 wire control with transient detection. The inputs are of type positive logic. The output R1 controls the brake contactor. ● `tCC` = 2C (2 wire) ● `tCt` = trn (transient detection) ● `nPL` = POS (positive logic) ● `r1` = rUn (active in RUN state)
3	Configure the logical output LO1 under the menu `(FULL) -> (I_O-) -> (LO1-)`: ● `[LO1 assignment] (LO1)` ● `[LO1 output active level] (LO1S)`	In this example, the logic output indicates if the drive is in no error state. ● `LO1` = Flt (active in no error state) ● `LO1S` = POS (active high)
4	Configure the motor parameters under the menu `(FULL) -> (drc-)`: ● `[Standard mot. freq.] (bfr)` ● `[Rated mot. power] (nPr)` ● `[Rated mot. volt.] (UnS)` ● `[Rated mot. current] (nCr)` ● `[Rated mot. freq.] (FrS)` ● `[Rated motor speed] (nSP)`	Refer to the motor rating plate. Values have to be adjusted if the factory settings differ with your application.

Step	Action	Comment
5	Configure the ramp parameters under the menu (FULL) -> (FUn-) -> (rPt-): ● [Acceleration] (ACC) ● [Deceleration] (dEC)	In most cases, the factory settings can be maintained for a quick start. Nevertheless, you have to verify the values.
6	Configure the parameter [Reverse direction] under the menu (FULL) -> (FUn-) -> (rrS)	The reverse direction is disabled per default and is activated by the assignment of a logic input. rrS = L2H (LI2 - start reverse)
7	Configure the preset speed control under the menu (FULL) -> (FUn-) -> (PSS-): ● [2 Preset speeds] (PS2) ● [Preset speed 2] (SP2)	In this example, the drive is controlled with 2 preset speeds. Speed 2 is defined as fast speed and is activated by logic input LI4. ● PS2 = L4H (LI4 activates preset speed 2) ● SP2 = 50 Hz (preset speed 2)
8	Configure the speed limit parameters under the menu (FULL) -> (FUn-) -> (SPL-): ● [Low Speed] (LSP) ● [High Speed] (HSP)	In this example, the preset speed 1 is determined by the low speed limit because the analog input is not connected. ● LSP = 20 Hz (low speed limit) ● HSP = 50 Hz (high-speed limit)
9	Configure the [Fault reset assignment] under the menu (FULL) -> (Flt-) -> (rSF).	In this example, the logic input LI3 is used for the reset of a drive error. rSF = L3H (LI3 - reset fault)
10	Configure the parameter [Motor thermal current] under the menu (FULL) -> (Flt-) -> (tHt-) -> (itH).	Refer to the motor rating plate. Values have to be adjusted if the factory settings differ from your application.

⚠ 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.

Altivar 32 Variable Speed Drive - Modbus TCP Setup

Overview

To operate the Altivar 32 via Modbus TCP, 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 embedded web server of the Ethernet communication module VW3A3616

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

(** various connection options)

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.

All configurations described in this section are done using the local HMI on the front of the drive.

Basic Configuration

All submenus and parameters listed in the table are accessible via **[CONFIGURATION]** (COnF) -> **[FULL]** (FULL) menu.

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-): • **[Standard mot. freq]** (bFr) • **[Max frequency]** (tFr) • **[Motor control type]** (Ctt)	Refer to the motor rating plate. Values have to be adjusted if the factory settings differ with your application. 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).
3	Configure the motor parameters under the menu **[ASYNC. Motor]** (ASY-): • **[Rated motor power]** (nPr) • **[Motor 1 Cosinus Phi]** (COS) • **[Rated motor volt.]** (UnS) • **[Rated motor current]** (nCr) • **[Rated motor freq.]** (FrS) • **[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-): • **[Acceleration]** (ACC) • **[Deceleration]** (dEC) • **[Low Speed]** (LSP) • **[High Speed]** (HSP) • **[Mot. Therm. current]** (ItH)	In most cases, the factory settings can be maintained for a quick start. 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. Nevertheless, you have to verify the values.
6	Configure the command channel under the menu **[COMMAND]** (Ctl-): • **[Ref. 1 channel]**] (Fr1)	If the drive is operated via Modbus TCP, the parameter **[Ref. 1 channel]** (Fr1) has to be set to **[Com. card]** (nEt).
7	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).
8	Configure the parameter for the brake control under the menu **[BRAKE LOGIC CONTROL]** (bLC-): • **[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.
9	Power cycle the drive.	If the configuration is finished, perform a power cycle of the drive because some parameter changes 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.

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

Modbus TCP Configuration

The parameters are accessible via **[CONFIGURATION]** (COnF) -> **[FULL]** (FULL) -> **[COMMUNICATION]** (COM-) menu and **[COMMUNICATION CARD]** (Cbd-) submenu.

These settings are only visible when the parameter **[Ethernet protocol]** (EtHM) is defined on **[ModbusTCP]** (MbtP).

Step	Action	Comment
1	Set the parameter for the **[Ethernet protocol]** (EtHM).	The Ethernet protocol is Modbus TCP. EThM = MbtP
2	Set the parameter for the **[IP Mode]** (IPM).	Use this parameter to select the address assignment method. In this architecture, a fixed IP address is selected. IPM = ManU
3	Set the IP address for the communication card. **[IP card]** (IPC-): • (IPC1) • (IPC2) • (IPC3) • (IPC4)	These parameters are editable when parameter **[IP Mode]** is set to fixed IP (ManU). Value: 0...255 for each of the four parameters
4	Set the subnet mask for the communication card. **[IP Mask]** (IPM-): • (IPM1) • (IPM2) • (IPM3) • (IPM4)	These parameters are editable when parameter **[IP Mode]** is set to fixed IP (ManU). Value: 0...255 for each of the four parameters
5	Set the gateway address for the communication card. **[IP card]** (IPG-): • (IPG1) • (IPG2) • (IPG3) • (IPG4)	These parameters are editable when parameter **[IP Mode]** is set to fixed IP (ManU). Value: 0...255 for each of the four parameters In this example, the gateway address is equal to the IP address (Ethernet 2) of the controller.

Step	Action	Comment
6	Set the parameter for the **[Eth IO scan act]** (IOSA).	This parameter enables the I/O scanner of the communication card. IOSA = On
7	Set the parameter for the **[Services]** (E E-).	This parameter enables the web server of the communication card. E E- = Eb''
8	Set the parameter for the **[Ethernet Timeout]** (tOUt).	This parameter enables the timeout monitoring for the Ethernet communication. tOUt = 2.0 seconds (default)

For more information about the Ethernet communication, refer to Altivar 32 Variable speed drives for synchronous and asynchronous motors, Modbus TCP - EtherNet/IP, Communication Manual, S1A28701.

Lexium 32M Servo Drive - Modbus TCP Setup

Overview

To operate the Lexium 32M via Modbus TCP, the communication parameters have to be set for the drive.

There are several options to configure the drive:

- By the local HMI on the front of the drive
- By a graphic display terminal*
- By the configuration software SoMove installed on a PC**
- By the FDT/DTM integrated in SoMachine installed on a PC**
- By the embedded web server of the Ethernet communication module VW3A3616

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

(** various connection options)

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

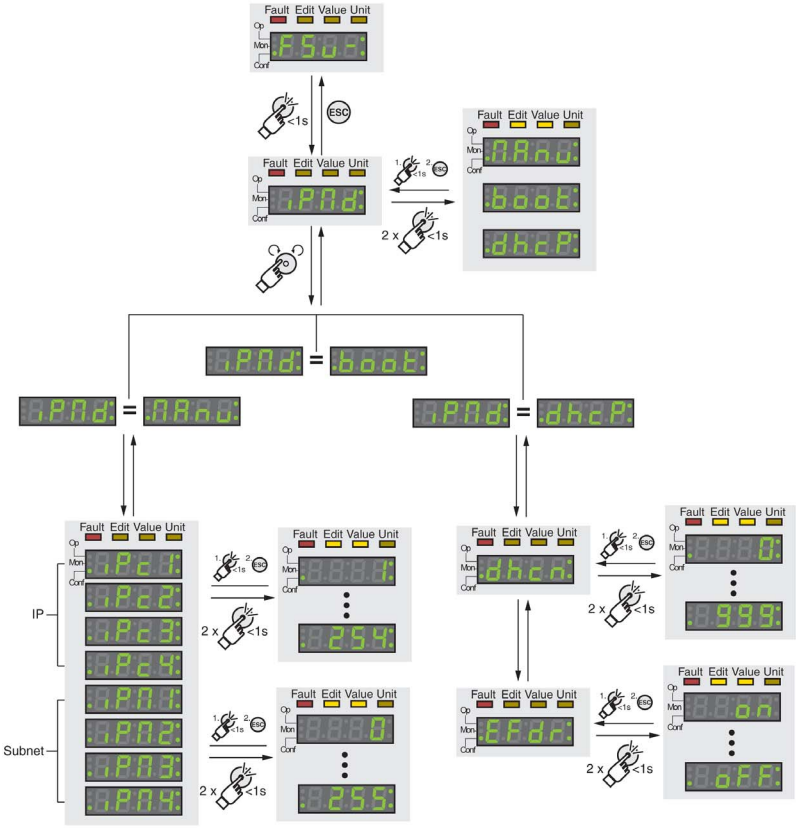
- Verify that both wiring and mounting are correct before you start to configure the drive.
- Verify that an unintentional start of the connected motor will not endanger personnel or equipment in any way.

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

All configurations described in this section are done using the local HMI on the front of the drive.

Basic Configuration

A first setup is required when the power supply of the drive is switched on for the first time or after the factory settings have been restored. In this case follow the depicted menu structure below. After the initialization, the fieldbus interface must be configured. The product is configured via the integrated HMI.



Step	Action	Comment
1	Switch on the drive.	● The power stage supply is switched off. ● Disconnect the drive from the fieldbus during commissioning in order to avoid conflicts by simultaneous access. ● Switch on the power supply of the controller.
2	Set the parameter **[EthIpMode]**: `ConF -> CoM -> iPMd`	Select the type of network address assignment. In this architecture, a fixed IP address is used for the drive: `iPMd = MAnu`
3	Set the parameters **[EthIPmodule1]**… **[EthIPmodule4]**: `ConF -> CoM -> iPc1 ... iPc4`	Set the IP address of the interface module. Value: 0...255 for each of the 4 parameters
4	Set the parameters **[EthIPmask1]**… **[EthIPmask4]**: `ConF -> CoM -> iPM ... iPM4`	Set the subnet mask of the interface module. Value: 0...255 for each of the 4 parameters
5	Set the parameters **[EthIPgate1]**… **[EthIPgate4]**: `ConF -> CoM -> iPG1... iPG4`	Set the IP address of the gateway of the interface module. Value: 0...255 for each of the four parameters In this example, the gateway address is equal to the IP address (Ethernet 2) of the controller.
6	Set the parameter **[EthMode]**: `ConF -> CoM -> EtMd`	Set the protocol for the Ethernet communication. In this architecture, the Modbus TCP protocol is used. `EtMd = MtCP` **NOTE:** In addition to the **[EthMode]** the parameter **[EthMbScanner]** must stay enabled (default).

For more information, refer to LXM32M, Modbus-TCP module, Fieldbus manual, 0198441113843.

When the drive is switched on and if the motor encoder is connected to the drive, the device automatically reads technical information on the motor such as nominal torque and peak torque, nominal current, nominal velocity and number of pole pairs. Without this information, the device is not ready for operation.

Further configurations like tuning, limit values and I/O configuration can be done on basis of the application. In this architecture, an auto tuning has been performed and for all other values the default settings were retained.

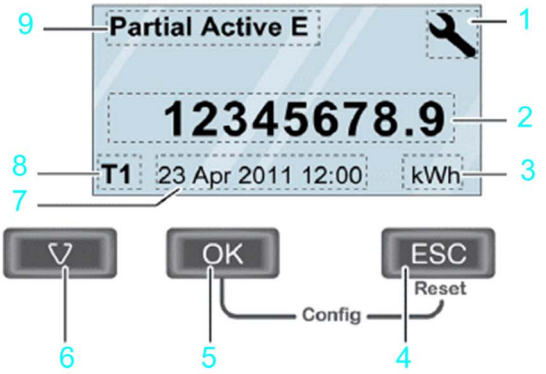
For more information, refer to LXM32M AC servo drive, Product manual, 0198441113767.

iEM3150 Energy Meter - Modbus SL Setup

Overview

The energy 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 energy meter and modify parameter settings. The navigation menu allows displaying, configuring, and resetting parameters.

The graphic shows the general display:



1 configuration mode
2 values / parameters
3 unit
4 cancellation
5 confirmation
6 selection
7 date and time (except for iEM3100 / iEM3200)
8 Active tariff (iEM3115 / iEM3155 / iEM3215 / iEM3255)
9 functions / measurements

In addition to this system user guide the product manual for the iEM3150 energy meter has to be read carefully.

For more information, refer to iEM3100 series / iEM3200 series, Energy Meters, User Manual, DOCA0005EN.

Configuration

Before starting the configuration of the energy meter, verify and ensure that your equipment is properly installed and the application functions correctly:

Step	Action	Comment
1	Set date and time.	When the power is interrupted, the iEM3150 automatically resets the date and time. The start screen after power-on prompts you to set the date and time.
2	Enter the configuration mode. Press and hold **ESC** + **OK** for at least 2 seconds.	The display switches to configuration mode.
3	Select the submenu **Wiring** and set the parameter for it.	The default wiring parameter is set to 3PH4W.
4	Select the submenu **Frequency** and set the parameter for it.	The default frequency parameter is set to 50 Hz.
5	Select the submenu **Communication** and set the slave address, baud rate, and parity for it.	The default values of the parameters are set to: ● slave address = 1 ● baud rate = 19200 ● parity = even
6	Leave the setup menu by pressing **ESC** .	–

NOTE: Further configuration can be done depending on your application needs. For more information, refer to iEM3100 series / iEM3200 series, Energy Meters, User Manual, DOCA0005EN.

Harmony ZBRN1 Access Point - Modbus TCP Setup

Overview

To operate the Harmony wireless receiver via Ethernet, the communication parameters have to be set for the device.

There are several options to configure the drive:

- by the local HMI on the front of the drive
- by web pages via PC*
- by the FDT/DTM integrated in SoMachine installed on a PC*

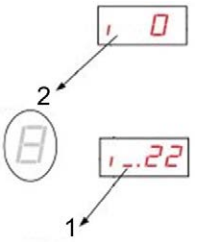
(* linked to the communication port on the bottom of the device)

Basic Configuration

After configuring the communication parameters, you have the opportunity to teach up to 60 wireless push-buttons. To configure the wireless receiver, use the jog dial on front of the device.

Before configuring the devices, connect the receiver module to the power supply and place the wireless push button within reach of the receiver module.

Steps to configure the ZBRN1

Step	Action	Comments
1	Configure the communication parameters under menu: **Configuration [Conf]** ● **Ethernet [Et.••]** ❍ **DHCP [d•••]** ❍ **BootP [bP]** ❍ **Static IP [St]** - **IP address [IP]** - **Subnet mask [SnN]** - **Gateway [gate]** - **Save [Save]** Save your settings.	Depending on your network select **DHCP**, **BootP** or **Static IP**. By selecting **Static IP** you have to set the 4 bytes of the **IP address**, **Subnet mask** and **Gateway**.
2	Set the input to teaching mode: **Configuration [Conf]** ● **Inputs [in.••]** ❍ **Unteached input •• [i ••]** - **Teach[t]** --- **Teach [t]** (blinking)	How to recognize whether an input is already taught:  **1** taught **2** not taught
3	Teach the wireless push button by pushing it 3 times while it is blinking.	
4	Unteach a battery less push button: **Configuration [Conf]** ● in.•• ❍ **i._••** - **Clr**	
5	Configure the holding time: **Configuration [Conf]** ● **Hd.••**	The input holding time can be set to: ● **Hd. 1** = 100 ms ● **Hd. 2** = 200 ms ● **Hd. 3** = 300 ms ● **Hd. 4** = 400 ms ● **Hd.5** = 500 ms ● **Hd.10** = 1 s

For more information, refer to Harmony XB5R, ZBRN1/ZBRN2, User Manual, EIO0000001177 (EN).

Advantys ETB - Modbus TCP Setup

Overview

To operate the Advantys ETB via Modbus TCP, the communication parameters have to be set for the device. In addition, the I/O configuration of the device must be done in accordance to your application.

The Advantys ETB module provides an embedded web server for the configuration. The web server can be accessed from a standard browser on PC using the IP address of the device.

NOTE: Stop I/O communication with the module before you attempt to change the IP parameters, as no such changes are possible during I/O communication.

NOTE: Assign a unique IP address to each Advantys ETB I/O module before connecting it to your network. Do not concurrently connect multiple unconfigured Advantys ETB I/O modules to your network because each unconfigured module is set to the same factory IP address of 192.168.1.1.

NOTE: Your IP address changes take effect and are displayed on the 4-character scrolling HMI panel of the module when they are made. You do not need to power cycle the module.

Ethernet Configuration

The following procedure describes how to access the embedded web server and change the network settings.

Step	Action	Comment
1	Stop all other communications with the module.	Using either a straight or crossed Ethernet cable, connect the module to a PC running a standard web browser.
2	Connect the Advantys ETB module with your PC via Ethernet.	-
3	Enter the IP address of the module in the address field of your browser.	The PC and the ETB module must be in the same subnetwork. The Ethernet settings of the module are displayed on the scrolling LED display on the module.
4	A dialog box opens and prompts you for a user name and password.	The default login parameters are: **User name**: admin **Password**: admin
5	On the left side of the webpage, under **IP Address**, select **IP Configuration**.	The **IP Configuration** page is open.
6	Configure the source of IP parameters for the module.	In the **IP Configuration** page, select **Static IP**.
7	Configure user-defined static IP parameters.	Enter the following IP parameters: ● **IP Address**: 172.21.2.29 ● **Subnet Mask**: 255.255.255.0 ● **Gateway Address**: 172.21.2.1 (M251 controller)

Step	Action	Comment
8	Click **Apply** to save your static IP parameters.	A dialog opens where you need to confirm the applying of the changes.
9	Click **OK** to accept your IP parameter changes.	The changes are taking effect immediately. Depending on your changes, probably you lose the connection to the module.
10	Look at the scrolling 4-character HMI of the module to verify that the intended IP address is displayed.	-

I/O and Watchdog Configuration

You can configure the I/O and watchdog settings of the Advantys ETB I/O module using either the controller or webpages.

Configuring I/O settings and watchdog via the controller simplifies module replacement because the configuration is stored on the controller and does not have to be reconfigured in the webpages when a module is replaced.

The embedded webpages offer a method for configuring the I/O and watchdog settings of the module. However, configuration settings made to a module via its webpages cannot be transferred to a replacement module.

The ETB1EM16CP00 module contains configurable I/O points that can be configured for IN, OUT, or IN/OUT. This topic shows you how to configure the I/O points of the ETB1EM16CP00 module and only applies to this specific module.

NOTE: By default, each point is pre-configured as an auto-configurable (IN/OUT) I/O point.

Step	Action	Comment
1	Connect and logon to the module using a web browser.	See the described procedure under Ethernet configuration above.
2	On the left side of the webpage, under **I/O Configuration**, select **IN/OUT Configuration**.	The **IN/OUT Configuration** page is open.
3	Select an **I/O Type** for each point.	● **IN**: the selected point is configured as an input ● **OUT**: the selected point is configured as an output ● **IN/OUT**: the selected point auto-configures as an: ❍ Input, if it detects that it is connected to a sensor, or ❍ Output, if it detects that it is connected to an actuator
4	Select the **Input Type** for all points acting as inputs.	You can select one type which is applied for all inputs: ● **PNP** ● **NPN**

Step	Action	Comment
5	Click **Apply** to save your I/O configuration changes.	The changes become effective.
6	Select an **Input Filter** value.	Valid values include: ● 0 ms ● 0.5 ms ● 1 ms ● 1.5 ms ● 2 ms ● 2.5 ms ● 5 ms

During normal operations, each Advantys ETB I/O module remains in continuous communication with the Modbus master (usually a controller). If communication with the Modbus master is lost, the behavior of the outputs of the Advantys ETB I/O module is governed by its watchdog settings.

The following settings are configurable:

Setting	Description
Watchdog Timeout	The time period, in milliseconds, that the module waits after the communication with the Modbus master is lost and before adopting the pre-configured **Watchdog Behavior**.
Watchdog Behavior	The behavior that the output points of the module adopt if communication with the Modbus master is lost for a continuous period greater than the **Watchdog Timeout**. Choices are: ● **Apply Output Fallback Value**: places each output into a pre-configured on or off state, or ● **Hold Output Value**: maintains the state of each output at the time communication with the Modbus master is lost.
Fallback Value (for each output point)	The pre-determined state, on or off, each output point adopts if communication with the Modbus master is lost for a time period longer than the **Watchdog Timeout**.

For more information, refer to Advantys ETB, IP67 Ethernet Block I/O Modules for Modbus TCP/IP, User Guide, EIO0000000158.

Diagnostics

The scrolling LED of the module displays messages for you to verify the status of the module.

During normal operation, only the source of the IP address, the address itself, and the state of the I/O scanning is displayed. The HMI shows the following specific data when available.

Source information displayed on the HMI:

Message	Description
DHCP	The module is waiting for a response from a DHCP server.
BOOT	The module is waiting for a response from a BootP server.
FACT	The module is applying the factory IP address of 192.168.1.1.

IP address information displayed on the HMI:

Message	Description
DHCP:192.168.1.1	The IP address of 192.168.1.1 was acquired by a DHCP server.
BOOTP:192.168.1.1	The IP address of 192.168.1.1 was acquired by a BootP server.
FACTORY:192.168.1.1	The IP address is set to the factory IP address of 192.168.1.1.
STATIC:192.168.1.21	The IP address of 192.168.1.21 was manually set by the user, either through the embedded webpages or push buttons.
DEFx	The module detects an IP conflict and defends its own IP address. **NOTE:** x: number of times the module defends its IP address
IP CONFLICT on 192.168.1.1	The module detects an IP address conflict on 192.168.1.1.

Module status information displayed on the HMI:

Message	Description
WLNK	There is no Ethernet link on any ports of the switch.
PING	The module is receiving PING requests on the network.
IO:ERR	A detected I/O error exists on one or more points.
WD:ACTIV	The watchdog was triggered and is now active.

ConneXium TCSESM Ethernet Switch - Setup

Overview

The Ethernet switch has been developed for practical application in a harsh industrial environment. So, the installation process has been kept simple.

Thanks to the selected default settings, you only have to enter a few settings before starting to operate the device. The IP parameters must be entered when the device is installed for the first time.

There are several options to configure the Ethernet switch:

- By the Command Line Interface (CLI)
- By the Ethernet switch configurator software protocol
- By the Memory Backup Adaptor (EAM)
- By BOOTP
- By DHCP
- By DHCP option 82
- By web-based interface

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.

Basic Configuration

The following procedure describes how to change the network settings using the Ethernet switch configurator software protocol.

Step	Action	Comment
1	Install the **Ethernet Switch Configurator Software** on your PC.	-
2	Connect the ConneXium Ethernet switch with your PC via Ethernet.	The Ethernet settings of the PC and the switch are not mandatory for the connection using the configurator software.
3	Start the **Ethernet Switch Configurator Software** program.	When the software is started, a scan is automatically executed for the selected Ethernet adapter.
4	Identify the devices displayed: Select a device line.	The software displays a line for each device which responds to the Ethernet switch configurator software protocol.
5	Click the signal symbol in the toolbar to set the LEDs for the selected device flashing.	To switch off the flashing, click the symbol again.
6	Double-click a line to open a dialog box where you can enter the device name and the IP parameters.	● **IP address** = **172.21.2.2** ● **Subnet mask**= **255.255.255.0** ● **Default Gateway** = **172.21.2.1** (M251 controller)
7	Click **OK**.	The selected IP parameters are immediately applied and stored on the device.

After entering the IP address, the web-based interface can be used to configure the managed Ethernet switch. The ConneXium TCSESM can be addressed by any web browser (for example, Internet Explorer, Firefox and so on).

NOTE: Before you begin, verify that both your PC and the ConneXium Ethernet switch are configured with IP addresses that are located in the same subnet (or, alternatively, are connected via a routing mechanism).
The ConneXium manged Ethernet switch provide you with a range of functions to manage your network. These are, among others,:

- Redundancy
- Network security
- Synchronized system time in the network
- Network load control
- Operation diagnostics

The following procedure describes how to:

- Access the embedded web server
- Configure the Port Mirroring
- Disable the Ethernet Switch Configurator Software function

Step	Action	Comment
1	Start your web browser.	-
2	Connect the ConneXium Ethernet switch with your PC via Ethernet.	The PC and the switch must be in the same subnetwork.
3	Enter the configured IP address using the following form: **http://xxx.xxx.xxx.xxx**	A dialog box opens and prompts you for a user name and password.
4	Enter the factory default settings for user name and password.	User name: **admin** Password: **private** **NOTE:** If you previously changed the password, you must enter the new password in this dialog box. See important safety-related information below.
5	Click **OK**.	The website of the device is displayed.
6	In the **Diagnostics** menu, select **Port Mirroring**.	-
7	Activate the check mark **Operation On**.	-
8	Select the destination port.	All network traffic from the selected source port(s) is forwarded to the selected destination port.
9	Select one or more source ports.	
10	Click the **Set** button.	The port mirroring configuration is applied immediately.
11	In the **Basics** menu, select **Network**.	-

Step	Action	Comment
12	Disable the **Ethernet Switch Configurator Software** function in the **Ethernet Switch Configurator Software Protocol** frame or limit the access to read-only.	This helps to prevent unwanted or unauthenticated access to the IP configuration of the device. **NOTE:** See important safety-related information below.
13	In the **Basics** menu, select **Load/Save**.	**NOTE:** To save all changes made, so that they will be retained after a power cycle or restart of the device, use the save option in the **Load/Save** dialog.
14	Select **Save to Device** and click the **Save** button.	-

Change the default password upon first use. In addition, consider carefully the implications for giving any access to other people.

⚠ WARNING

UNAUTHORIZED DATA ACCESS

- Immediately change any and all default passwords to new, secure passwords.
- Do not distribute passwords to unauthorized or otherwise unqualified personnel.

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

NOTE: A secure password is one that has not been shared or distributed to any unauthorized personnel and does not contain any personal or otherwise obvious information. Further, a mix of upper and lower case letters and numbers offer greater security. You should choose a password length of at least seven characters.

⚠ WARNING

UNAUTHENTICATED ACCESS

Disable the **Ethernet Switch Configurator Software** function to prevent any unwanted or unauthenticated access to the IP configuration of the device.

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

For more information about the other security settings for the ConneXium TCSESM managed Ethernet switch refer to:

- ConneXium Ethernet Cabling System TCSESM, TCSESM-E Managed Switch Basic Configuration, User Manual, 31007122
- ConneXium TCSESM, TCSESM-E, Managed Switch, Web-based Interface, Reference Manual, EIO0000000482

Absolute Encoder - Modbus TCP Setup

Overview

To operate the absolute rotary encoder via Modbus TCP, the communication parameters have to be set for the device.

The absolute rotary encoder can be addressed by a web browser (for example, Internet Explorer, Firefox, and so on.)

NOTE: Before you begin, verify that both your PC and the encoder are configured with IP addresses that are located in the same subnet (or, alternatively, are connected via a routing mechanism).

Basic Configuration

The following procedure describes how to access the embedded web server and change the network settings.

Step	Action	Comment
1	Connect the encoder to a PC via Ethernet.	-
2	Open a web browser.	-
3	Enter the IP address of the encoder in the address line of the browser and press **Enter** on your keyboard.	The factory default address is http://10.10.10.10.
4	Open the **E-Mail and Network Configuration** page.	-
5	Set the parameters of the encoder.	• **IP address** = **172.21.2.28** • **Subnet mask**= **255.255.255.0** • **Default Gateway** = **172.21.2.1** (M251 controller)
6	Click the **Set** button to apply the settings.	-
7	Power-cycle the encoder (power off and on) to apply the new settings.	-

For more information, refer to the associated user manual for absolute rotary encoders with Modbus TCP interface provided by BEI Sensors.

OsiSense XGCS850 RFID - Ethernet Setup

Overview

To operate the RFID smart antenna via Modbus TCP or EtherNet/IP, the communication parameters have to be set for the device. The parameters have to be set by the integrated web server.

To access the smart antenna web server, you need:
- Microsoft Windows 7 or later
- Microsoft Internet Explorer version 8 and later
- Java runtime environment version later than 7

NOTE: Before you begin, verify that both your PC and the smart antenna are configured with IP addresses that are located in the same subnet (or, alternatively, are connected via a routing mechanism).

Basic Configuration

The following procedure describes how to access the embedded Web server and change the network settings.

Step	Action	Comment
1	Connect the smart antenna to a PC via Ethernet.	-
2	Open a web browser.	-
3	Enter the IP address of the smart antenna in the address line of the browser and press **Enter** on your keyboard.	The factory default address is http://192.168.0.10.
4	A dialog box opens and prompts you for a user name and password.	-
5	Enter the factory default settings for user name and password.	User name: **USER** Password: **USER** **NOTE:** If you previously changed the password, you must enter the new password in this dialog box. See important safety-related information below.
6	Click **OK**.	The Web server home page is displayed.
7	Click the **Setup** tab on the **Home** page.	-
8	Click the **IP & FDR CONFIGURATION** link on the **Setup** page.	-
9	Select the type of IP addressing: Select: **Local**.	You can choose between: ● **DHCP Client** ● **Automatic** (BootP) ● **Local** (Stored IP)

Step	Action	Comment
10	Set the parameters of the smart antenna.	Depending on the selected IP mode set the parameters: ● **DHCP**: Enter a device name ● **Local**: Enter the IP address, the subnet mask, and the gateway IP address (Ethernet 2 of the M251 controller)
11	Click **Apply** to validate the settings.	-
12	Power-cycle the smart antenna (power off and on) to apply the new settings.	-

Change the default password upon first use. In addition, consider carefully the implications for giving any access to other people.

⚠ WARNING

UNAUTHORIZED DATA ACCESS

- Immediately change any and all default passwords to new, secure passwords.
- Do not distribute passwords to unauthorized or otherwise unqualified personnel.

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

NOTE: A secure password is one that has not been shared or distributed to any unauthorized personnel and does not contain any personal or otherwise obvious information. Further, a mix of upper and lower case letters and numbers offer greater security. You should choose a password length of at least seven characters.

For more information, refer to RFID OsiSense XG, Ethernet Smart Antenna, User Manual, EIO0000001601.

Diagnostics

The 6 two-tone LEDs display the operating states of the OsiSense XG smart antenna.

LED	Name	LED state	Description	Smart antenna state
1	TAG	Solid green	Tag presence	A tag is detected, communication ok
		1 flash	No tag detected	Waiting for a tag
		Red flashes	RFID detected error	Errors detected in the communication with the tag
2	COM	Green flashes	Requests received from a client	Ok
		Red flashes	Detected error in requests received from a client	Detected error code returned to the client (no tag / incorrect parameters, etc.)
3	NS (Network status)	Steady off	Not powered or no IP address	Waiting for IP address setting (fixed or DHCP).
		Flashing green	No connections	No CIP connection established, and an exclusive owner connection with a client has not timed out.
		Solid green	Connected	At least one CIP connection is established, and an exclusive owner connection with client has not timed out.
		Flashing red	Connection timeout	An exclusive owner connection with client has timed out.
		Solid red	Duplicate IP	The smart antenna has detected that its IP address is already in use.
		Flashing green/red	Self-test	The smart antenna is performing its power-on self-test.

LED	Name	LED state	Description	Smart antenna state
4	Link activity (port 1 and 2)	Solid green	Ethernet link present at 100 Mbit/s	Ok
5		Flashing green	Traffic at 100 Mbit/s	Ok
		Solid yellow	Ethernet link present at 10 Mbit/s	Ok
		Flashing yellow	Traffic at 100 Mbit/s	Ok
6	MS (Ethernet module status)	Solid green	The Ethernet module of the smart antenna is operational	Ok
		Flashing green	Standby	The smart antenna is waiting for network configuration.
		Flashing red	Recoverable error	The smart antenna has detected a recoverable error. **NOTE:** An incorrect or inconsistent configuration is considered as a recoverable error.
		Steady red	Non-recoverable error	The smart antenna has detected a non-recoverable error on its Ethernet module.
		Flashing green/red	Self-test	The smart antenna is performing its power-on self-test.

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 thanks to the use of Device Modules.

This allows you to create your customized project in an easy and flexible way by adapting the TVDA project template.

Device Modules in General

Overview

The Device Modules out of the **TVDA Device Module Library** are represented by Function Templates within SoMachine. They are especially created for the TVDA project template.

Device Modules are available for the functional units implemented in the different TVD architectures.

By definition functional units in the extent of Device Modules are different sorts of field devices controlled (connected) in various ways by the controller.

The required SoMachine application content, beginning with integrating the device to the hardware configuration up to integration of the 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 256)*.)

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

Device Modules Used

The following Device Modules of the **TVDA Device Module Library** are used in this project template.

Device Module
MED_iEM3150_ModbusSL
Harmony_Wireless_ModbusTCP_2
ATV32_EtherNetIP
ATV71_EtherNetIP
Lexium_32M_EtherNetIP
Lexium_ILA2K_EtherNetIP
Lexium_ILE2K_EtherNetIP
Lexium_ILS2K_EtherNetIP
Preventa_XPSMCM_EtherNetIP
OsiSense_XUW_EtherNetIP
OsiSense_RFID_EtherNetIP

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 **Application tree** and select **Add Function From Template** from the context menu. 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 Device Modules which include a field device, the appropriated fieldbus master is preselected in the **Master** column of the **I/O Devices** field. If your configuration includes more than one fieldbus masters for the selected **I/O Device**, you can select the desired fieldbus master from the **Select Fieldbus Master** dialog box. This dialog box is open when you click the **...** button.
6	For Device Modules which include a field device, the device address must be selected. In **Address** column of the **I/O Devices** field the address must be entered respectively it can be selected from the **Select Device Address** dialog box. This dialog box is open when you click the **...** button.
7	The **I/O Mapping** field is an optional feature. For some Device Modules, it is possible to map variables directly to I/Os of current I/O configuration. 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). If you do not enter a value, the **Default** value is used in your project.
9	Click the **OK** button to add the Device Module to 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_ModbusTCP requires a **Industrial Ethernet manager** in the project configuration.

Objects Added

If you add a Device Module, the associated objects are added to the project at the appropriate position. Information on what was done when 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**. For example `GVL_ATV32_ModbusTCP`.
POU (program organization unit)	The POU that is included in the Device Module is added below the root folder using the **Function Name**. For example `Prg_ ATV32_ModbusTCP (PRG)`.
POU call	The call of the POU that is included in the Device Module is added below **Task Configuration** → **MAST**.
Device	A device (if part of the Device Module) is added below the respective fieldbus master (for example **Ethernet_2** → **Industrial Ethernet manager**) as selected in the **Select Fieldbus Master** dialog box. For example `ATV32_ModbusTCP`.
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 256)* 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.
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 part of the Device Module) from the respective fieldbus (for example **Ethernet_2** → **Industrial Ethernet manager**).
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.
Libraries	Remove the libraries referenced by the Device Module from the **Library Manager** of your project (if they are 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 multi-standard 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.

For more information about the multi-standard offer of Schneider Electric, refer to the website *http://www2.schneider-electric.com/sites/corporate/en/products-services/product-launch/multistandard-offer/multistandard-offer.page*

⚠ 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
Main cabinet				
1	PowerPact H-Frame multistandard circuit breaker, main switch, 3pin, 35 kA, with factory sealed trip unit current rating 15 A	NHGF36015TW	x	x
1	Lug kit 15...150 A	AL150HDS	x	x
1	Short lug shield	S37446	x	x
1	Red rotary handle on yellow bezel	LV429340	x	x
Remote cabinet				
1	Vario main switch for panel mounting, 25 A	VCD0	x	x
1	Protective cover for terminals	VZ8	x	x

Energy meter

Quantity	Description	Reference	IEC	UL
1	Energy meter iEM3150, direct measurement up to 63 A, Modbus communication	A9MEM3150	x	x

Emergency Stop

Quantity	Description	Reference
Main cabinet		
1	Safety module emergency stop Cat. 4	TM3SAF5R
1	Emergency stop push-button, 2 NC, 22 mm, complete unit	XB5AS8444
1	Emergency 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	Circular yellow legend for emergency stop push-button "emergency stop"	ZBY8330
2	TeSys D contactor, AC-3 400 V / 7.5 kW	LC1D18BD
Remote cabinet		
1	Preventa safety module, emergency stop cat. 4	XPSAF5130P
1	Emergency stop push-button, 2 NC, 22 mm, complete unit	XB5AS8444
1	Emergency 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	Circular yellow legend for emergency stop push-button "emergency stop"	ZBY8330
2	TeSys D contactor, AC-3 400 V / 7.5 kW	LC1D18BD

Display and Indicators

Quantity	Description	Reference
Main cabinet		
1	Pilot light with integral LED 24 Vac/dc, white, complete unit	XB5AVB1
1	Harmony Wireless access point	ZBRN1
1	Communication module (Modbus TCP) for ZBRN1	ZBRCETH
1	Plastic control station, empty, 2 cut-outs, IP 66	XALD02
1	Wireless push-button green	ZB5RTA3
1	Wireless push-button red	ZB5RTA4
1	Empty plastic box for mobile transmitter, 1 cut-out	ZBRM01
1	Wireless push-button blue	ZB5RTA6
1	Plastic control station, empty, 3 cut-outs, IP 66	XALD03
2	Push-button, green, 1 NO, complete unit	XB5AA31
1	Push-button, red, 1 NC, complete unit	XB5AA42
5	Legend holder and blank label (white or yellow) 18x27 mm	ZBY6102
1	Fixing plate for use on vertical support of tower light	XVBC12

Quantity	Description	Reference
1	Fixing base with support tube 80 mm, 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
Remote cabinet		
1	Pilot light with integral LED 24 Vac/dc, white, complete unit	XB5AVB1

Automation Components

Quantity	Description	Reference
Main cabinet		
1	Modicon M251 Logic Controller 24 Vdc, 2x Ethernet	TM251MESE
1	TM3 expansion module 16 DI	TM3DI16
1	TM3 expansion module 16 DO	TM3DQ16T
Remote cabinet		
1	Distributed I/O module, Ethernet (Modbus TCP), 12 DI, 8 DO	OTB1E0DM9LP
2	TM2 expansion module 16 DI, 8 DO	TM2DMM24DRF
1	TM2 expansion module 16 DI	TM2DDI16DT
1	TM2 expansion module 8 DO	TM2DDO8TT
1	TeSys splitterbox to connect motor starters with parallel wiring module, 8x RJ45 connectors	LU9G02
2	Prewired cable with HE10 connector at one end and flying leads at the other end, 3 m (9.84 ft)	TSXCDP301
Field		
1	Advantys ETB I/O module Modbus TCP, IP 67, 16 DIO	ETB1EM16CP00
1	Power cable for Advantys ETB I/O module (7/8 elbowed, single ended), 2 m (6.57 ft)	ETXPC511M400020

Magelis HMI

Quantity	Description	Reference
Main cabinet		
1	Magelis HMI optimum advanced panel, touch screen 7.5",	HMI GTO4310
Remote cabinet		
1	Magelis HMI optimum advanced panel, touch screen 10.4", "stainless steel" version for food and beverage environment	HMI GTO5315

Control Voltage Power Supply and Distribution

Quantity	Description	Reference	IEC	UL
Main cabinet				
1	Circuit breaker Multi9 UL1077 2P, C, 3 A (~230 V)	24444	x	x
1	Power supply 230 Vac / 24 Vdc, 10 A	ABL8RPS24100	x	x
10	Circuit breaker Multi9 UL1077 1P, C, 1 A (24 Vdc)	24425	x	x
9	Circuit breaker Multi9 UL1077 1P, C, 2 A (24 Vdc)	24426	x	x
1	Ground disconnect terminal 9760 U/8 TKE 48	57.110.1655.0 (Wieland)	x	x
Remote cabinet				
1	Circuit breaker Multi9 UL1077 2P, C, 3 A (~230 V)	24444	x	x
1	Power supply 230 Vac / 24 Vdc, 10 A	ABL8RPS24100	x	x
3	Circuit breaker Multi9 UL1077 1P, C, 1 A (24 Vdc)	24425	x	x
7	Circuit breaker Multi9 UL1077 1P, C, 2 A (24 Vdc)	24426	x	x
4	Auxiliary contacts for Multi9 circuit breaker, 1 N/C	26925	x	x
1	Ground disconnect terminal 9760 U/8 TKE 48	57.110.1655.0 (Wieland)	x	x

Drives and Power

Quantity	Description	Reference	IEC	UL
Main cabinet				
Altivar 32				
2	Altivar 32 variable speed drive, 0.37 kW	ATV32H037N4	x	x
2	Magnetic circuit breaker, 2.5 A (3-phase, ~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-phase, ~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	Communication module Modbus TCP	VW3A3616	x	x
Lexium 32				
2	Lexium 32M servo drive 1-phase, ~230 V/1 kW	LXM32MD18M2	x	x
2	Magnetic circuit breaker, 10 A (1-phase, ~230 V)	GV2L14	x	-
2	Auxiliary contact for circuit breaker, 1 NO, 1 NC	GVAE11	x	-
2	TeSys DFCC fuse holders + class CC fuses 10 (fuses to be ordered separately - no Schneider Electric product)	DFCC2	-	x
2	Communication module Modbus TCP	VW3A3616	x	x
2	Servo motor 0.6 kW 2500 U/min, multi, brake	BMH0702T02F2A	x	x
2	Motor cable, 5 m (16.4 ft)	VW3M5101R50	x	x
2	Encoder cable, 5 m (16.4 ft)	VW3M8102R50	x	x
Remote cabinet				
TeSys D				
2	TeSys D motor starter combination, 24 Vdc, 3-phase, ~400 V/ 0.18 kW	GV2DP104BD	x	x
1	TeSys D motor starter combination reversing, 24 Vdc, 3-phase, ~400 V/ 0.18 kW	GV2DP204BD	x	x
2	SoLink wiring kit TeSys D motor starter combination	LAD5C11	x	x
1	SoLink wiring kit TeSys D motor starter combination reversing	LAD5C12	x	x
3	TeSys connection cable (SoLink), 2x RJ45, 1 m (3.28 ft)	LU9R10	x	x
2	Auxiliary contact block TeSys D contactor, 1 NO + 1 NC	LADN11	x	x
3	Auxiliary contact for circuit breaker, 2 NO	GVAE20	x	x
3	Auxiliary contact for circuit breaker, 1 NO, 1 NC	GVAN11	x	x
1	Set of 3-pole 63 A busbar 5 tap-offs, 54 mm (2.13 in)	GV2G554	x	x

Quantity	Description	Reference	IEC	UL
1	Terminal block for supply busbar sets	GV1G09	x	x
1	Cover for unused busbar connection points	GV1G10	x	x
1	Altistart softstarter 3-phase, ~400 V/ 1.1 kW (3 A)	ATS01N103FT	x	x
TeSys U				
1	TeSys U base module, 12 A (without terminals)	LUB120	x	x
1	TeSys U base module reversing, 12 A (without terminals)	LU2BA0BL	x	x
2	TeSys U control unit, standard 0.15…0.6 A	LUCAX6BL	x	x
1	TeSys U wiring kit coil	LU9BN11C	x	x
1	TeSys U wiring kit coil (reversing)	LU9MRC	x	x
2	TeSys U function module parallel wiring	LUFC00	x	x
1	Set of 3-pole 63 A busbar 2 tap-offs, 54 mm (2.13 in)	GV2G254	x	x
2	TeSys connection cable (SoLink), 2x RJ45, 1 m (3.28 ft)	LU9R10	x	x
Altivar 12 - 2 motors				
1	Altivar 12 variable speed drive, 0.37 kW	ATV12H037M2	x	x
1	Magnetic circuit breaker, 6.3 A (1-phase, ~230 V)	GV2L10	x	-
1	Auxiliary contact for circuit breaker, 1 NO, 1 NC	GVAE11	x	-
1	Thermal-magnetic circuit breaker, 4.0...6.3 A (1-phase, ~240 V)	GV2P10	-	x
1	Insulating barrier for motor circuit breaker	GV2GH7	-	x
1	Auxiliary contact for circuit breaker, 1 NO, 1 NC	GVAN11	-	x
4	TeSys D contactor, AC-3 400 V / 4 kW	LC1D09BD	x	x
2	Auxiliary contact block TeSys D contactor, 1 NO, 1 NC	LADN11	x	x
2	Auxiliary contact for Multi9 circuit breaker	60137	x	x
2	Circuit breaker Multi9 UL489 2P, C, 2 A (~230 V)	26925	x	x

Encoder

The encoders are designed for compatibility with the UL standard, but they are not certified.

Quantity	Description	Reference
1	Absolute multi-turn optical rotary encoder (4096 inc. x 8192 turns), Modbus TCP	MHM5-EM00B-1213-C100-PRM (BEI sensors)
1	Power cable encoder with 5-pin M12 connector at one end and flying leads at the other end, 2.0 m (6.56 ft)	XZCP1164L2
1	Encoder mounting bracket	XCCRE5SN

Sensors

Quantity	Description	Reference
3	RFID smart antenna, Modbus TCP, IP 67	XGCS850C201
1	RFID electronic tag - 13.56 MHz - ISO badge 54 x 85.5 x 1 mm - 256 Kb (10 pc.)	XGHB90E340
3	Power cable smart antenna with M8 connector at one end and flying leads at the other end, 2.0 m (6.56 ft)	XZCP0941L2

Ethernet Wiring

Quantity	Description		Reference
Main cabinet			
1	Ethernet TCP/IP managed switch, 10BASET/100BASE-TX, 8x RJ45 ports copper cable		TCSESM083F23F0
1	Memory backup adapter for managed Ethernet switch		TCSEAM0100
4	Ethernet patch cable, 2x RJ45, cat. 7, green	0.5 m (1.64 ft)	VW3E3001R005
1		1 m (3.28 ft)	VW3E3001R010
5		2 m (6.56 ft)	VW3E3001R020
1		3 m (9.8 ft)	VW3E3001R030
4	ConneXium M12 to RJ45 Ethernet adapter		TCSEAAF11F13F00
Remote cabinet			
1	Ethernet TCP/IP unmanaged switch, 10BASET/100BASE-TX, 5x RJ45 ports copper cable		TCSESU053FN0
1	Ethernet patch cable, 2x RJ45, cat. 7, green	0.5 m (1.64 ft)	VW3E3001R005
2		2 m (6.56 ft)	VW3E3001R020
1		3 m (9.8 ft)	VW3E3001R030
2	ConneXium M12 to RJ45 Ethernet adapter		TCSEAAF11F13F00
Field			
1	ConneXium Ethernet switch, unmanaged, IP 65, 5 ports M12		TCSESU051F0
1	Power cable Ethernet switch IP 67 with 5-pin M12 connector at one end and flying leads at the other end	2.0 m (6.56 ft)	XZCP1164L2
4	Ethernet cable, 2 x M12 straight	1.0 m (3.28 ft)	TCSECL1M1M1S2
4	Ethernet cable, 2 x M12 straight	3.0 m (9.8 ft)	TCSECL1M1M3S2

Modbus SL Wiring

Quantity	Description		Reference
1	Modbus SL drop cable, 1 RJ45, connector, and 1 end stripped	3.0 m (9.8 ft)	VW3A8306D30

Software Tools

Quantity	Description	Reference
1	SoMachine (includes Vijeo-Designer) on DVD, trial version - SoMachine 4.1 SP2 update	SOMNACS41
1	Single user license for SoMachine	SOMNACCZXSPA41
1	Programming cable (USB)	TCSXCNAMUM3P
1	Ethernet cable M12 - RJ45	TCSECL1M3M3S2
1	SD card, 2 GB	TMASD1

Glossary

B

BSH

A Lexium servo motor from Schneider Electric.

C

CANopen

An open industry-standard communication protocol and device profile specification (EN 50325-4).

CFC

(*continuous function chart*) A graphical programming language (an extension of the IEC 61131-3 standard) based on the function block diagram language that works like a flowchart. However, no networks are used and free positioning of graphic elements is possible, which allows feedback loops. For each block, the inputs are on the left and the outputs on the right. You can link the block outputs to the inputs of other blocks to create complex expressions.

CIP

(*common industrial protocol*) When a CIP is implemented in a network application layer, it can communicate seamlessly with other CIP-based networks without regard to the protocol. For example, the implementation of CIP in the application layer of an Ethernet TCP/IP network creates an EtherNet/IP environment. Similarly, CIP in the application layer of a CAN network creates a DeviceNet environment. In that case, devices on the EtherNet/IP network can communicate with devices on the DeviceNet network through CIP bridges or routers.

CSA

(*Canadian standards association*) The Canadian standard for industrial electronic equipment in hazardous environments.

D

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.

G

GVL
(*global variable list*) Manages global variables that can be passed between controllers on an Ethernet TCP/IP Modbus network.

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

MAC address

(*media access control address*) A unique 48-bit number associated with a specific piece of hardware. The MAC address is programmed into each network card or device when it is manufactured.

Magelis

The commercial name for Schneider Electric's range of HMI terminals.

Modbus

The protocol that allows communications between many devices connected to the same network.

Modbus SL

(*Modbus serial line* The implementation of the protocol over a RS-232 or RS-485 serial connection.

P

POU

(*program organization unit*) A variable declaration in source code and a corresponding instruction set. POUs facilitate the modular re-use of software programs, functions, and function blocks. Once declared, POUs are available to one another.

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.

R

RJ45

A standard type of 8-pin connector for network cables defined for Ethernet.

RPI

(*requested packet interval)* The time period between cyclic data exchanges requested by the scanner. EtherNet/IP devices publish data at the rate specified by the RPI assigned to them by the scanner, and they receive message requests from the scanner with a period equal to RPI.

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*)

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.

Index