TeSys™ island

System Guide

Instruction Bulletin

TeSys™ offers innovative and connected solutions for motor starters. This instruction bulletin introduces and describes the main functions of **TeSys** island.

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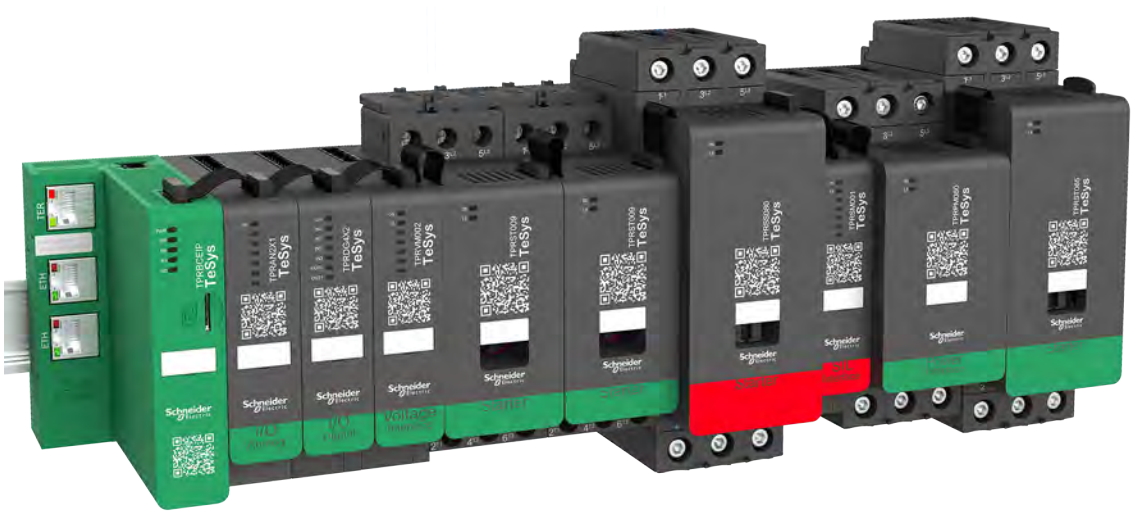

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Legal Information

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Hazard Categories and Special Symbols

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

The addition of either 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 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.

NOTE: Provides additional information to clarify or simplify a procedure.

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, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved.

About the Book

Master Range: TeSys

TeSys™ is an innovative motor control and management solution from the global market leader. TeSys offers connected, efficient products and solutions for switching and protection of motors and electrical loads in compliance with all major global electrical standards.

Document Scope

This instruction bulletin introduces and describes:

- TeSys™ island
- The physical modules that comprise TeSys island
- Digital tools
- TeSys avatars and their functions
- Avatar hardware and wiring

⚠DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Read and understand this instruction bulletin and all related documents before installing, operating, or maintaining your TeSys island. Installation, adjustment, repair, and maintenance must be performed by qualified personnel.

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

Validity Note

This instruction bulletin is valid for all TeSys™ island configurations. The availability of some functions described in this bulletin depends on the communication protocol used and the physical modules installed on the island.

For product compliance with environmental directives such as RoHS, REACH, PEP, and EOLI, go to *www.se.com/green-premium*.

For technical characteristics of the physical modules described in this bulletin, go to *www.se.com*.

The technical characteristics presented in this bulletin should be the same as those that appear online. We may revise content over time to improve clarity and accuracy. If you see a difference between the information contained in this bulletin and online information, use the online information.

Related Documentation

Table 1 - Related Documentation

Document Title	Description	Document Number
TeSys™ island System Guide	Introduces and describes the main functions of TeSys island	*8536IB1901*
TeSys™ island Installation Guide	Describes the mechanical installation, wiring, and commissioning of TeSys island	*8536IB1902*
TeSys™ island Operating Guide	Describes how to operate and maintain TeSys island	*8536IB1903*
TeSys™ island Functional Safety Guide	Describes the Functional Safety features of TeSys island	*8536IB1904*
TeSys™ island Third Party Function Block Guide	Contains the information needed to create function blocks for third party hardware	*8536IB1905*
TeSys™ island EtherNet/IP™ Function Block Library Guide	Describes the TeSys island library used in the Rockwell Software® Studio 5000® EtherNet/IP™ environment	*8536IB1914*
TeSys™ island EtherNet/IP™ Quick Start Guide	Describes how to quickly integrate TeSys island into the Rockwell Software Studio 5000 EtherNet/IP environment	*8536IB1906*
TeSys™ island DTM Online Help Guide	Describes how to install and use various functions of TeSys island configuration software and how to configure the parameters of TeSys island	*8536IB1907*
TeSys™ island PROFINET and PROFIBUS Function Block Library Guide	Describes the TeSys island library used in the Siemens™ TIA Portal environment	*8536IB1917*
TeSys™ island Quick Start Guide for PROFINET and PROFIBUS Applications	Describes how to quickly integrate TeSys island into the Siemens™ TIA Portal environment	*8536IB1916*
TeSys™ island Product Environmental Profile	Describes constituent materials, recyclability potential, and environmental impact information for the TeSys island	*ENVPEP1904009*
TeSys™ island Product End of Life Instructions	Contains end of life instructions for the TeSys island	*ENVEOLI1904009*
TeSys™ island Instruction Sheet, Bus Coupler, TPRBCEIP	Describes how to install the TeSys island Ethernet/IP bus coupler	*MFR44097*
TeSys™ island Instruction Sheet, Bus Coupler, TPRBCPFN	Describes how to install the TeSys island PROFINET bus coupler	*MFR44098*
TeSys™ island Instruction Sheet, Bus Coupler, TPRBCPFB	Describes how to install the TeSys island PROFIBUS DP bus coupler	*GDE55148*
TeSys™ island Instruction Sheet, Starters and Power Interface Modules, Size 1 and 2	Describes how to install size 1 and 2 TeSys island starters and power interface modules	*MFR77070*
TeSys™ island Instruction Sheet, Starters and Power Interface Modules, Size 3	Describes how to install size 3 TeSys island starters and power interface modules	*MFR77085*
TeSys™ island Instruction Sheet: Input/Output Modules	Describes how to install the TeSys island analog and digital I/O modules	*MFR44099*
TeSys™ island Instruction Sheet: SIL Interface and Voltage Interface Modules	Describes how to install the TeSys island voltage interface modules and SIL[1] interface modules	*MFR44100*

1. Safety Integrity Level according to standard IEC 61508.

Precautions

Read and understand the following precautions before performing any procedures in this guide.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- This equipment must only be installed and serviced by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside this equipment.
- Use only the specified voltage when operating this equipment and any associated products.
- Always use a properly rated voltage sensing device to confirm power is off.
- Use appropriate interlocks where personnel and/or equipment hazards exist.
- Power line circuits must be wired and protected in compliance with local and national regulatory requirements.
- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices per NFPA 70E, NOM-029-STPS, or CSA Z462 or local equivalent.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- For complete instructions about functional safety, refer to the *TeSys™ island Functional Safety Guide*, 8536IB1904.
- Do not disassemble, repair, or modify this equipment. There are no user serviceable parts.
- Install and operate this equipment in an enclosure appropriately rated for its intended application environment.
- 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.

⚠ **WARNING:** This product can expose you to chemicals including Antimony oxide (Antimony trioxide), which is known to the State of California to cause cancer. For more information go to *www.P65Warnings.ca.gov*.

Qualified Personnel

Only appropriately trained persons who are familiar with and understand the content of this guide and all other related product documentation are authorized to work on and with this product.

The qualified person must be able to detect possible hazards that may arise from modifying parameter values and generally from mechanical, electrical, or electronic equipment. The qualified person must be familiar with the standards, provisions, and regulations for the prevention of industrial accidents, which they must observe when designing and implementing the system.

The use and application of the information contained in this guide requires expertise in the design and programming of automated control systems. Only you,

the user, machine builder, or integrator, can be aware of all the conditions and factors present during installation, setup, operation, and maintenance of the machine or process, and can therefore determine the automation and associated equipment and the related safeties and interlocks which can be effectively and properly used when selecting automation and control equipment, and any other related equipment or software, for a particular application. You must also consider applicable local, regional, or national standards and/or regulations.

Pay particular attention to conformance with any safety information, electrical requirements, and normative standards that apply to your machine or process in the use of this equipment.

Intended Use

The products described in this guide, together with software, accessories, and options, are starters for low-voltage electrical loads, intended for industrial use according to the instructions, directions, examples, and safety information contained in the present document and other supporting documentation.

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

Before using the product, you must perform a risk assessment of the planned application. Based on the results, appropriate safety-related measures must be implemented.

Since the product is used as a component of a machine or process, you must ensure the safety of persons by means of the overall system design.

Operate the product only with the specified cables and accessories. Use only genuine accessories and spare parts.

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

Cybersecurity

NOTE: Schneider Electric adheres to industry best practices in the development and implementation of control systems. This includes a “Defense-in-Depth” approach to secure an industrial Control System. This approach places the controllers behind one or more firewalls to restrict access to authorized personnel and protocols only.

⚠ WARNING

UNAUTHENTICATED ACCESS AND SUBSEQUENT UNAUTHORIZED MACHINE OPERATION

- Evaluate whether your environment or your machines are connected to your critical infrastructure and, if so, take appropriate steps in terms of prevention, based on Defense-in-Depth, before connecting the automation system to any network.
- Limit the number of devices connected to a network inside your company.
- Isolate your industrial network from other networks inside your company.
- Protect any network against unintended access by using firewalls, VPN, or other, proven security measures.
- Monitor activities within your systems.
- Prevent subject devices from direct access or direct link by unauthorized parties or unauthenticated actions.
- Prepare a recovery plan including backup of your system and process information.

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

Introduction to TeSys™ island

Island Concept

TeSys™ island is a modular, multifunctional system providing integrated functions inside an automation architecture, primarily for the direct control and management of low-voltage loads. TeSys island can switch, help protect, and manage motors and other electrical loads up to 80 A (AC1) installed in an electrical control panel.

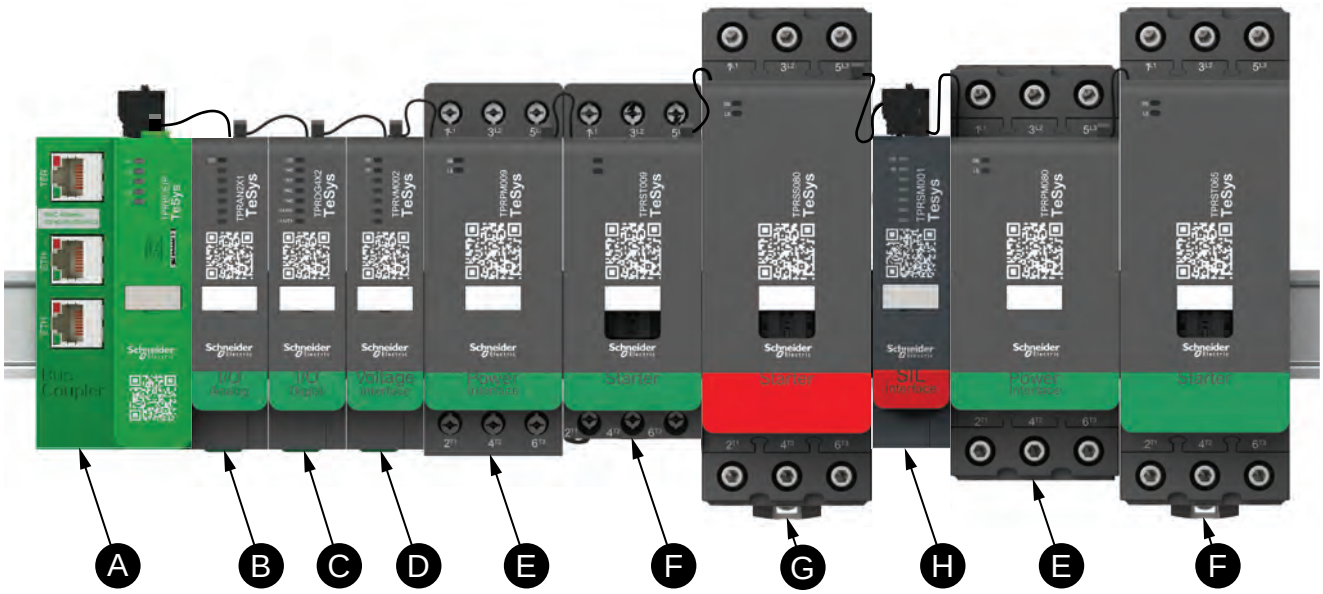
This system is designed around the concept of TeSys avatars. These avatars

- Represent both the logical and physical aspects of the automation functions
- Determine the configuration of the island

The logical aspects of the island are managed with software tools, covering all phases of product and application lifecycle: design, engineering, commissioning, operation, and maintenance.

The physical island consists of a set of devices installed on a single DIN rail and connected together with flat cables providing the internal communication between modules. The external communication with the automation environment is made through a single bus coupler module, and the island is seen as a single node on the network. The other modules include starters, power interface modules, analog and digital I/O modules, voltage interface modules, and SIL (Safety Integrity Level according to standard IEC 61508) interface modules, covering a wide range of operational functions.

Figure 1 - TeSys island Overview



A	Bus Coupler	E	Power Interface Module
B	Analog I/O Module	F	Standard Starter
C	Digital I/O Module	G	SIL Starter
D	Voltage Interface Module	H	SIL Interface Module

Industrial Communication Protocols

TeSys™ island supports the EtherNet/IP™, Modbus™ TCP, PROFINET™, and PROFIBUS-DP™ industrial communication protocols.

TeSys™ Island Specifications

Technical Specifications

Table 2 - TeSys™ island Specifications

Width	up to 112.5 cm (3.83 ft)
Modules	up to 20 modules, excluding the bus coupler and the voltage interface modules
PROFIBUS fieldbus only: Cyclic data size limit	Maximum size of 240 bytes possible
Control power consumption per system	3 A / 72 W maximum
Maximum load current per starter	80 A, 37 kW (50 hp), maximum
Internal data refresh time	10 ms
Mounting	Metallic DIN rail, horizontal or vertical

Operating Conditions

TeSys™ island is designed to durably sustain the following conditions. Other conditions may apply to specific modules as described in their data sheet document, available on *www.se.com/tesys-island*.

- 40 °C (104 °F) ambient temperature
- 400/480 V motor
- 50% humidity
- 80% load
- Horizontal mounting orientation
- All inputs activated
- All outputs activated
- 24 hours/day, 365 days/year run time

Derating Guidelines

TeSys™ island standard starters, SIL[2] starters, and power interface modules are designed for operation **without derating** under the following conditions:

- Horizontal mounting position
- Ambient temperature up to 50 °C (122 °F)

For vertical mounting or ambient temperatures above 50 °C (122 °F), apply the derating values in the following table to the load rating requirements. If both derating conditions apply, then you must apply both derating factors. Derating is calculated by the digital tools.

2. Safety Integrity Level according to standard IEC 61508.

Table 3 - Derating Guidelines for Mounting Position and Ambient Operating Temperature

Derating Condition	Derating Factor
Mounting position	20% derating required in the vertical mounting position
Ambient operating temperature	2% derating per °C of temperature rise above 50 °C (122 °F), with a maximum of 60 °C (140 °F)

The derating conditions apply to all standard starters, SIL starters, and power interface modules. The derating conditions do not affect short-circuit protection devices.

Derating Examples

Table 4 - Example 1—Derating Required

Load rating	8 A
Derating factor: Temperature inside the enclosure is 60 °C (140 °F)	1.20
Maximum load rating of starter TPRST009	9 A

8 A * 1.20 = 9.60 A

Since 9.60 A is greater than the maximum load rating of 9 A, derating is required. Upgrade from the TPRST009 reference number to the TPRST025 reference number with a maximum load rating of 25 A.

Table 5 - Example 2—Derating Not Required

Load Rating	6 A
Derating Factor: Temperature inside the enclosure is 60 °C (140 °F) + Vertical Mounting	1.2 + (1.2 x 20%) = 1.44
Maximum Load Rating of TPRST009	9 A

6 A * 1.44 = 8.64 A

Since 8.64 A is less than the maximum load rating of 9 A, derating is not required. The TPRST009 reference number is appropriate.

Electromagnetic Interference

The protection and energy monitoring features of TeSys™ island devices are based on current sensors. To reduce the risk of electromagnetic interference between two adjacent devices, we recommend that you implement one of the following installation rules if the ratio between the FLA settings of two adjacent devices is >100:1.

- Option 1: Using the engineering tool, reorganize the order of the avatars on the island so there are no adjacent devices with FLA ratios >100:1
- Option 2: Leave a spacing of 30 mm (1.18 in.) between the two adjacent devices.

The figure below illustrates Option 2.

Figure 2 - Avoiding Electromagnetic Interference: Option 2

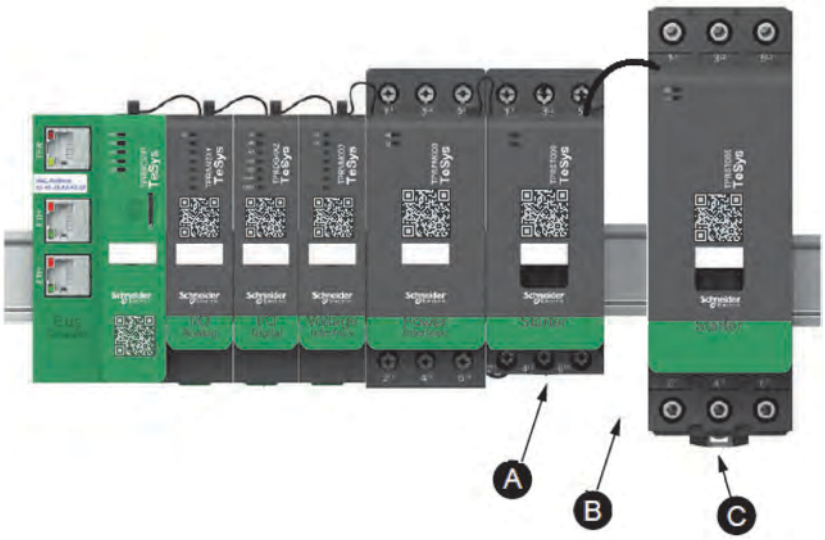


Table 6 - Legend

A	A TeSys island device with an FLA setting of 0.6 A
C	An adjacent TeSys island device with an FLA of 65 A (>0.6 A ×100)
B	The recommended 30 mm (1.18 in.) spacing between the two adjacent devices with an FLA ratio >100:1

Additionally:

1. Maintain a minimum distance of 30 cm (11.8 in.) between the island and sources of extremely high 50/60 Hz magnetic fields, such as three-phase bus systems.
2. TeSys island modules have integrated electrostatic discharge (ESD) protection. Discharge potential body charge to the equipment ground before handling or installing a module to reduce the risk of ESD damage.
3. Keep mobile communication devices at least 20 cm (7.87 in.) away from the island to reduce the likelihood of interference with the island.
4. Integrating radio communication devices in the same panel or in a near-by panel requires specific precautions related to transmit power and antenna location. Contact a Schneider Electric representative for more information.
5. TeSys island is a Class A device designed for use in environment A (according to *FCC Rules & Regulations*, Title 47, Part 15, Subpart B). Using TeSys island in environment B may cause radio interference necessitating additional mitigation methods.
6. For additional information on EMC installation practices, refer to Schneider Electric's *Electrical Installation Guide*, EIGED306001, or contact a Schneider Electric representative.

Heat Dissipation

To allow adequate heat dissipation, always leave a spacing of 10 cm (3.94 in.) between the short-circuit protection devices and the TeSys™ island starters.

Additional installation recommendations pertain under the following conditions:

- Three or more starters are mounted on the island side-by-side.
- The starters have ratings (Ie) greater than or equal to 25 A.
- The starters are used with a motor having a nominal current In > 85% x Ie.

Under these conditions, we recommend that you implement one of the following installation rules:

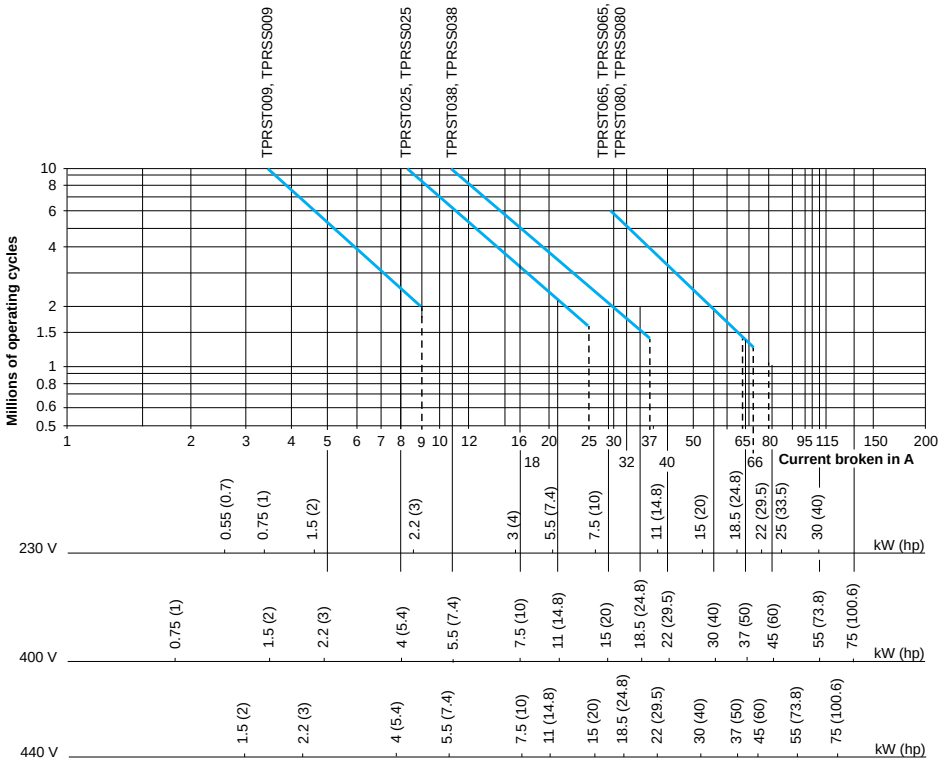
- Option 1: Using the engineering tool, reorganize the avatars on the island to avoid these conditions.
- Option 2: Use 50 cm (1.64 ft) cables to wire the short-circuit protection devices with the affected middle starters. In a group of three starters, which all meet the conditions itemized above, the extra length is only recommended for the starter in the middle. In a group of four starters, the extra length is only recommended for the two starters in the middle.

Durability Curves

For utilisation category AC-3

Table 7 - Selection according to required electrical durability, in category AC-3 (Ue ≤ 440 V)

- Control of three-phase asynchronous squirrel-cage motors with breaking while running.
- The current broken (Ic) in category AC-3 is equal to the rated operational current (Ie) of the motor.



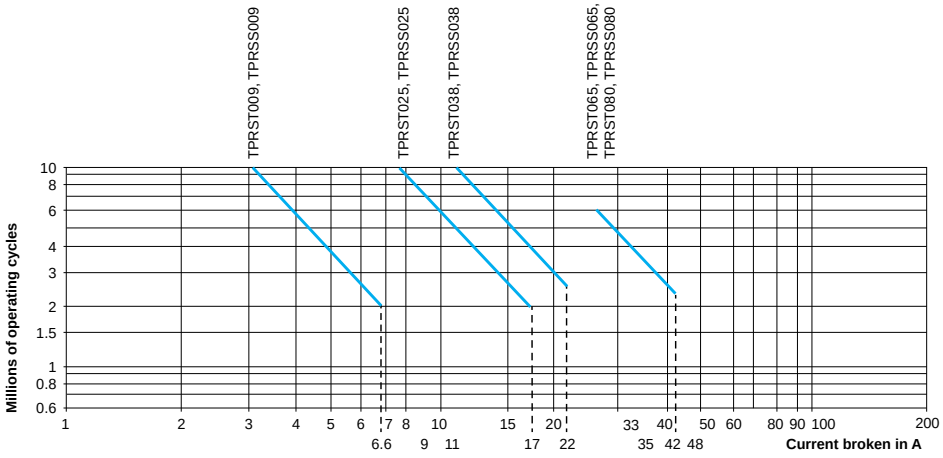
Operational power in kW (hp)—50 Hz.

Example:

- Asynchronous motor with
  - P = 5.5 kW (7.4 hp) − Ue = 400 V − Ie = 11 A − Ic = Ie = 11 A, or
  - P = 5.5 kW (7.4 hp) − Ue = 415 V − Ie = 11 A − Ic = Ie = 11 A
- 5 million operating cycles required.
- The above selection curves show the starter rating needed: TPRS•025.

Table 8 - Selection according to required electrical durability, in category AC-3 (Ue = 660/690 V)

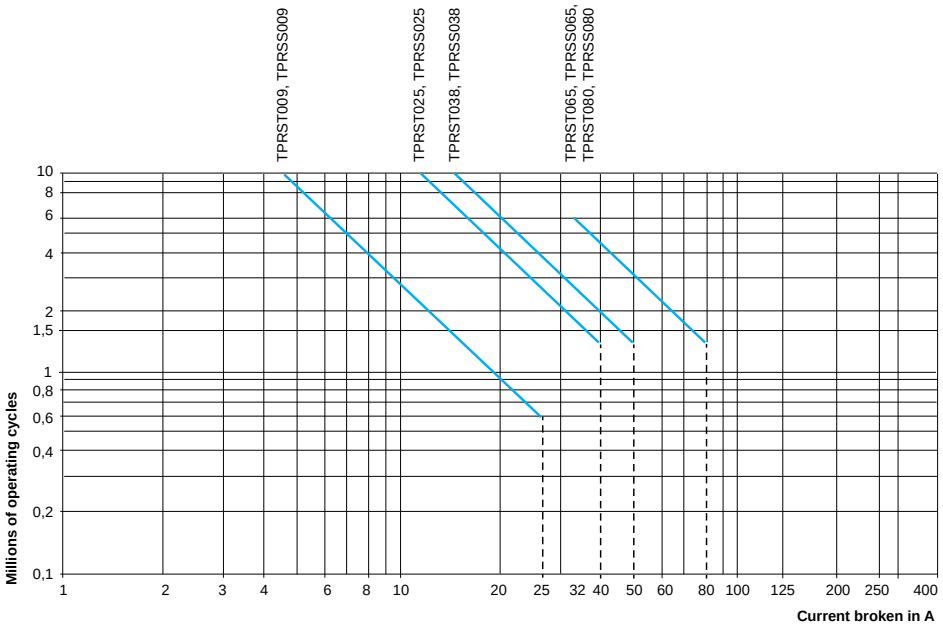
- Control of three-phase asynchronous squirrel-cage motors with breaking while running.
- The current broken (Ic) in category AC-3 is equal to the rated operational current (Ie) of the motor.



For utilisation category AC-1

Table 9 - Selection according to required electrical durability, in category AC-1 (Ue ≤ 690 V)

- Control of resistive circuits (cos ϕ ≥0.95).
- The current broken (Ic) in category AC-1 is equal to the current (Ie) normally drawn by the load.



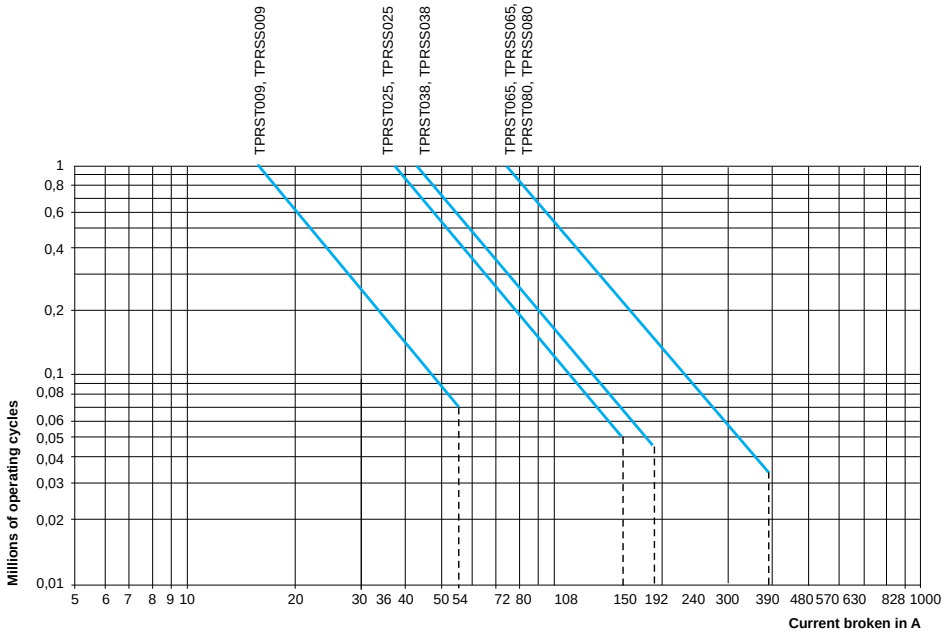
Example:

- Ue = 220 V − Ie = 50 A − θ ≤ 40 °C − Ic= Ie = 50 A
- 2 million operating cycles required
- The above selection curves show the starter rating needed: TPRS•065 or TPRS•080.

For utilisation categories AC-2 or AC-4

Table 10 - Selection according to required electrical durability, in categories AC-2 or AC-4 (Ue ≤ 440 V)

- Control of 3-phase asynchronous squirrel cage motors (AC-4) or slip ring motors (AC-2) with breaking while the motor is stalled.
- The current broken (Ic) in AC-2 is equal to 2.5 × Ie.
- The current broken (Ic) in AC-4 is equal to 6 × Ie (Ie = rated operational current of the motor).

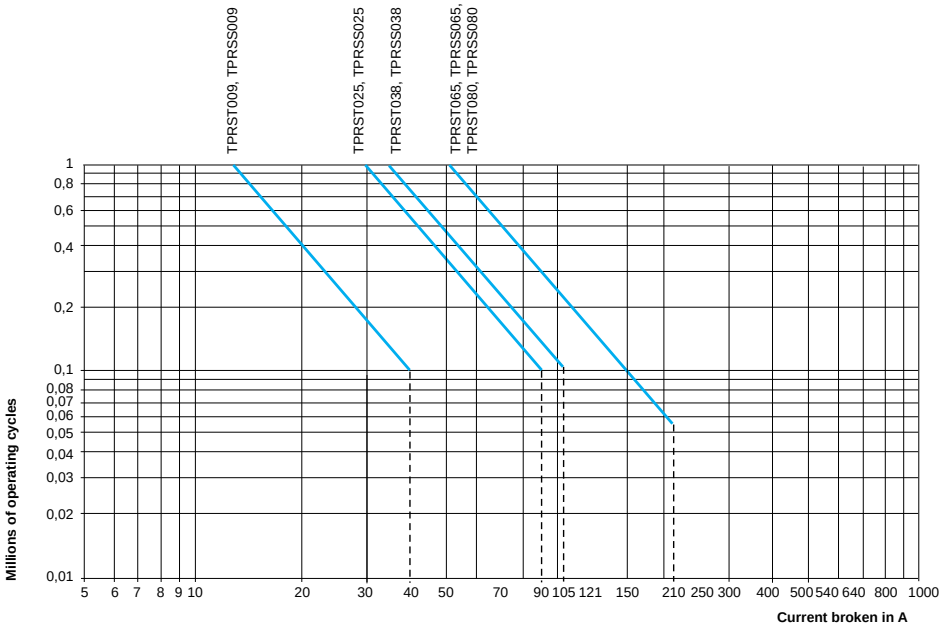


Example:

- asynchronous motor with
  - P = 5.5 kW (7.4 hp) − Ue = 400 V − Ie = 11 A. Ic = 6 ×Ie = 66 A, or
  - P = 5.5 kW (7.4 hp) − Ue = 415 V − Ie = 11 A. Ic = 6 ×Ie = 66 A
- 200,000 operating cycles required
- The above selection curves show the starter rating needed: TPRS•025

Table 11 - Selection according to required electrical durability, use in category AC-4 (440 V < Ue ≤ 690 V)

- Control of 3-phase asynchronous squirrel cage motors with breaking while the motor is stalled.
- The current broken (Ic) in AC-2 is equal to 2.5 × Ie.
- The current broken (Ic) in AC-4 is equal to 6 × Ie (Ie = rated operational current of the motor).



Hardware Descriptions

Bus Coupler

A single bus coupler is always present in the island as the fieldbus communication interface, and to control all other modules of the island. The bus coupler reference number is selected based on the required fieldbus protocol shown in the following table:

Table 12 - Bus Couplers

Fieldbus Protocol	Reference
EtherNet/IP™	TPRBCEIP
Modbus™ TCP	TPRBCEIP
PROFINET™	TPRBCPFN
PROFIBUS-DP™	TPRBCPFB

The following are the main functions of the bus coupler:

- Communicating with the PLC
- Managing the TeSys™ avatars and their associated modules
- Collecting operational status and diagnostic data from the island's modules
- Communicating with configuration, operation and maintenance digital tools
- Supplying the modules with control power

The bus coupler is connected:

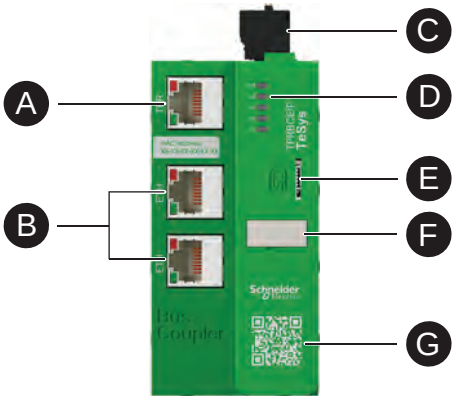
- Upstream to the fieldbus
- Downstream to the island devices with the daisy-chain flat cable
- Upstream to the control power supply
- Optionally, upstream through its service port, to a software tool (EcoStruxure™ Machine Expert programming tool or SoMove™ software)

The bus coupler service port and dual port Ethernet switch on the TPRBCEIP and TPRBCPFN are located on the same network on the TPRBCEIP and TPRBCFN. On the TPRBCPFN bus coupler, the service port is for temporary use during commissioning and troubleshooting only.

The bus coupler is equipped with a micro SD card slot, to allow upload and backup functions on a micro SD card.

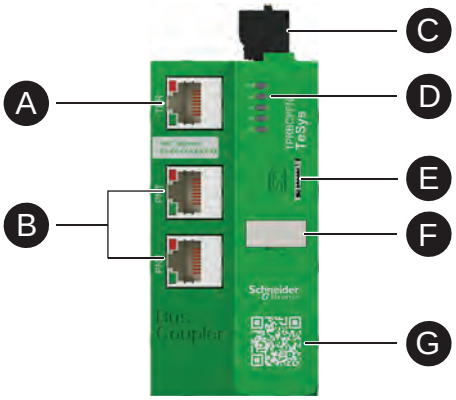
For the position of the bus coupler on the island, refer to *TeSys™ island Overview, page 12*.

Figure 3 - Bus Coupler Features—TPRBCEIP



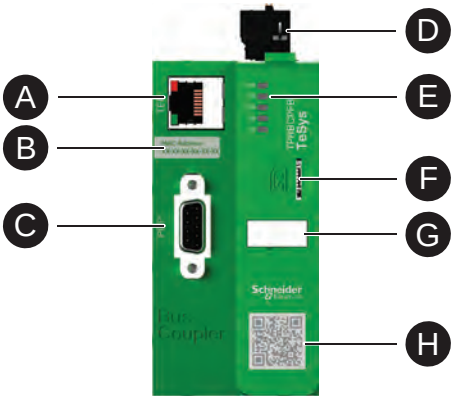
A	Terminal/Service port: 1 x RJ45	E	Slot for micro SD card
B	Dual port Ethernet switch: 2 x RJ45	F	Name tag
C	24 Vdc control power supply connector with spring terminals	G	QR code
D	LED status indicators		

Figure 4 - Bus Coupler Features—TPRBCPFN



A	Terminal/Service port: 1 x RJ45	E	Slot for micro SD card
B	Dual port Ethernet switch: 2 x RJ45	F	Name tag
C	24 Vdc control power supply connector with spring terminals	G	QR code
D	LED status indicators		

Figure 5 - Bus Coupler Features—TPRBCPFB



A	Terminal/Service port: 1 x RJ45	E	LED status indicators
B	MAC Address	F	Slot for micro SD card
C	PROFIBUS-DP fieldbus port	G	Name tag
D	24 Vdc control power supply connector with spring terminals	H	QR code

Power Devices

TeSys™ island offers two types of power devices:

- Standard and SIL[3] starters that include a contactor and provide the following functionality as part of a TeSys avatar:
  - load control management
  - electrical protection functions
  - digital asset management
- Power interface modules that monitor current but do not provide load control. Load control must be provided by a downstream external power device like a solid-state relay or a soft starter.

Avatars that include power devices can provide load level energy monitoring when a voltage interface module (VIM) is installed in the island.

SIL starters in combination with a SIL interface module (SIM) can achieve certified Stop Category 0 and Stop Category 1 functions. [4]

Power Interface Module

Power interface modules (PIMs) provide the following:

- Electrical and thermal protection functions
- Digital asset management

TeSys™ avatars that include power devices can provide full-load energy monitoring when a voltage interface module is installed on the island.

A PIM can be associated with an analog I/O module to measure temperature through an external sensor. A PIM can also control and monitor the current supplied to an external device.

3. Safety Integrity Level according to standard IEC 61508.
4. Stop categories according to EN/IEC 60204-1.

The main functions of the PIMs are as follows:

- Measure electrical downstream data related to the load
- Provide energy monitoring data when a voltage interface module is installed on the island

The PIMs are connected:

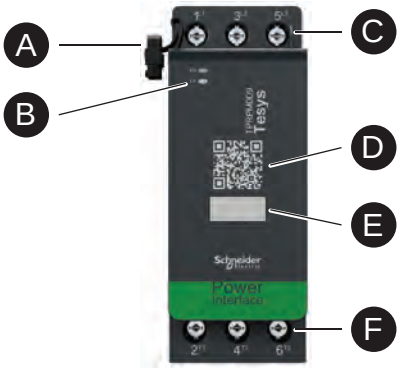
- Upstream to a circuit breaker
- Downstream to an external power device like a contactor, soft starter, or variable speed drive

The PIMs communicate with the bus coupler, sending operational data and receiving commands.

Table 13 - Power Interface Module Ratings

Power Ratings		Amperage	Reference
kW	hp		
4	5	0.18–9	TPRPM009
18.5	20	0.76–38	TPRPM038
37	40	4–80	TPRPM080

Figure 6 - Power Interface Module Features



A	Flat cable (for connection with the module to the left)	D	QR code
B	LED status indicators	E	Name tag
C	Upstream power connections	F	Downstream power connections

Standard Starters

Standard starters provide load control, electrical and thermal protection functions, and digital asset management.

Starters provide the following main functions:

- On/Off power control for loads (three phase or single phase)
- Electrical data measurement related to the load
- Energy monitoring when a voltage interface module is installed on the island
- Functional testing and simulation
- Event logging and counters

Multiple starters might be needed for a single TeSys™ avatar function. For example, a motor two-direction avatar includes two standard starters.

The standard starters are connected:

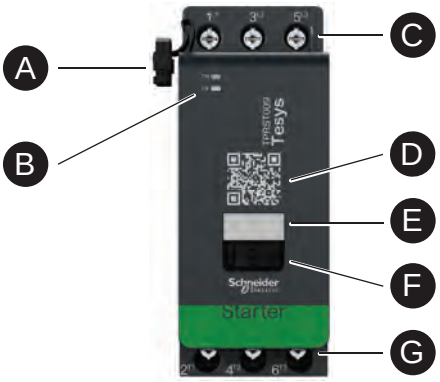
- Upstream to a circuit breaker
- Downstream to the load (three phase or single phase)

The starters communicate with the bus coupler, sending operational data and receiving commands.

Table 14 - Standard Starter Ratings

Power Ratings		Amperage	Reference
kW	hp		
4	5	0.18–9	TPRST009
11	15	0.5–25	TPRST025
18.5	20	0.76–38	TPRST038
30	40	3.25–65	TPRST065
37	40	4–80	TPRST080

Figure 7 - Standard Starter Features



A	Flat cable (for connection with the module to the left)	E	Name tag
B	LED status indicators	F	Mobile bridge
C	Upstream power connections	G	Downstream power connections
D	QR code		

SIL Starters

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

For complete instructions about functional safety, refer to the *TeSys™ island Functional Safety Guide*, 8536IB1904.

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

SIL[5] starters provide similar functions to standard starters but are associated with a SIL interface module.

5. Safety Integrity Level according to standard IEC 61508.

The main functions of the SIL starters are as follows:

- Provide Stop Category 0 and Stop Category 1[6] functionality
- Provide operational control for loads
- Measure electrical data related to the load
- Provide energy monitoring data when a voltage interface module is installed in the island

Multiple SIL starters might be needed for a single TeSys avatar function. For example, the avatar Motor Two Directions - SIL Stop, W. Cat 1/2[7] includes two SIL starters. In addition, avatars using SIL starters always include a SIL interface module.

The SIL starters are connected:

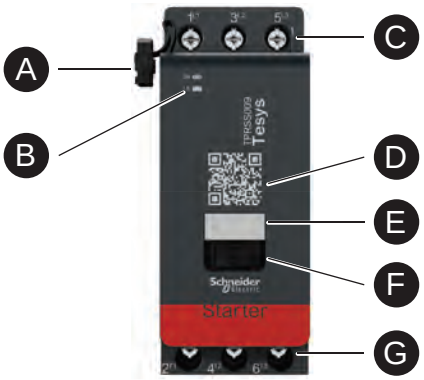
- Upstream to a circuit breaker
- Downstream to the load

The SIL starters communicate with the bus coupler, sending operational data and receiving commands.

Table 15 - SIL Starter Ratings

Power Ratings		Amperage	Reference
kW	hp		
4	5	0.18–9	TPRSS009
11	15	0.5–25	TPRSS025
18.5	20	0.76–38	TPRSS038
30	40	3.25–65	TPRSS065
37	40	4–80	TPRSS080

Figure 8 - SIL Starter Features



A	Flat cable (for connection with the module to the left)	E	Name tag
B	LED status indicators	F	Mobile bridge
C	Upstream power connections	G	Downstream power connections
D	QR code		

6. Stop Category 0 and Stop Category 1 according to EN/IEC 60204-1.
7. Wiring Category 1 and Category 2 according to ISO 13849.

SIL Interface Module

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

For complete instructions about functional safety, refer to the *TeSys island Functional Safety Guide*, 8536IB1904.

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

A SIL[8] interface module (SIM), associated with one or several SIL starters, allows the design of Stop functions according to EN/IEC 60204-1:

- Stop Category 0: immediate machine power disconnection
- Stop Category 1: electrical power is maintained on the machine actuators until the stop process fully ends (absence of motion)

The reference number is TPRSM001.

The following are the main functions of the SIM:

- Interface with an external interlocking device
- Command the stop function of its SIL group of SIL starters

Several SIL groups of SIL starters can be set up on the island. Each SIL group is delimited by a SIM on the right side (or the top side if vertically mounted).

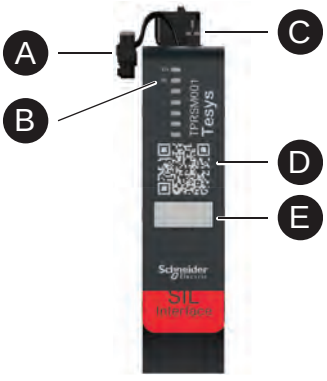
The SIM is connected upstream:

- To the 24 Vdc source
- To an interlock (for example, a Preventa™ XPS-AC module)

The SIM communicates with the bus coupler, sending operational data.

The Stop function is achieved by electromechanical means without any digital communication or bus coupler involvement.

Figure 9 - SIL Interface Module Features



A	Flat cable (for connection with the module to the left)	D	QR code
B	LED status indicators	E	Name tag
C	Connector with spring terminals		

8. Safety Integrity Level according to standard IEC 61508

I/O Modules

Analog and digital I/O modules are typically used to get data from sensors and control actuators.

Digital I/O Module

The main functions of the digital I/O module are as follows:

- To monitor binary sensors and switches via four 24 Vdc sink/source inputs
- To control devices like relays, signaling lights, or controller binary inputs via two 0.5 A, 24 Vdc transistor-type outputs
- To capture statistical operational data of the I/O module:
  - Number of power cycles
  - Number of detected events
  - Time the module is on
- To perform I/O Channel testing and simulation

The reference number is TPRDG4X2.

The digital I/O module is connected:

- Upstream to the 24 Vdc source needed to power the downstream actuators
- Input channel: downstream to a binary sensor or switch
- Output channel: downstream to the 24 Vdc input of the actuator

Refer to *Avatar Wiring Schematics, page 75* for module wiring.

Devices connected to the digital I/O module must be protected against short-circuits by external means like fuses. Use one 0.5 A Type T fuse per output. Recommended are Littlefuse 215, 218, FLQ, or FLSR series or equivalent.

The digital I/O module communicates with the bus coupler, sending operational data and receiving commands.

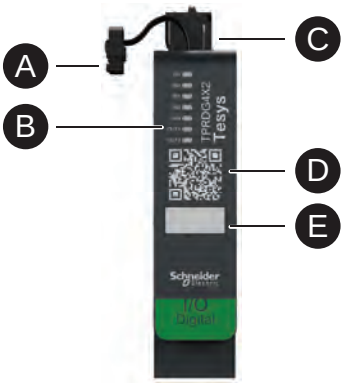
Table 16 - Input Specifications

Channel	Inputs
Rated power supply	24 Vdc
Input type	Type 1 (IEC/EN 61131-2)
Number of discrete inputs	4 isolated with common point
Discrete input current	7 mA at 24 V
Discrete input voltage	24 Vdc (voltage limits: 19.2–28.8 V)
Cable type	Refer to instruction sheet MFR44099, *Analog I/O and Digital I/O Modules*, and instruction bulletin 8536IB1902, *Installation Guide*.
Cable length, maximum	30 m (98 ft)

Table 17 - Output Specifications

Channel	Inputs
Number of discrete outputs	2 isolated with common point
Discrete output voltage	24 Vdc (voltage limits: 19.2–28.8 V)
Rated output current	0.5 A, resistive
Cable type	Refer to instruction sheet MFR44099, *Analog I/O and Digital I/O Modules*, and instruction bulletin 8536IB1902, *Installation Guide*.
Cable length, maximum	30 m (98 ft)

Figure 10 - Digital I/O Module Features



A	Flat cable (for connection with the module to the left)	D	QR code
B	LED status indicators	E	Name tag
C	Connector with spring terminals		

Analog I/O Module

The main functions of the analog I/O module are as follows:

- Monitor voltage or current from analog sensors (such as thermocouple, PT100, PT1000, NI100, NI1000, PTC Binary) via two −10 to +10 V / 0 to 20 mA capable inputs
- Control voltage–driven actuators (such as variable speed drives or a current loop to the controller's analog input) via one −10 to +10 V / 0 to 20 mA capable output
- Capture statistical operational data:
  - Number of power cycles
  - Number of device events
  - Time the module is on

The reference number is TPRAN2X1.

The analog I/O module is connected:

- Upstream to the 24 Vdc source needed to power the downstream actuators
- Input channel: downstream to an analog sensor or sensor transmitter
- Output channel: downstream to the control input of a voltage-driven actuator, such as a variable speed drive

Refer to *Avatar Wiring Schematics, page 75* for module wiring.

Devices connected to the analog I/O module must be protected against short circuits by external means like fuses.

The analog I/O module communicates with the bus coupler, sending operational data and receiving commands.

NOTE: No per-channel LEDs are provided.

Table 18 - Input/Output Specifications

Channel	Inputs	Output
Number of analog inputs and outputs	2 isolated with common point	1 isolated
Rated power supply	24 Vdc	

Table 18 - Input/Output Specifications (Continued)

Channel	Inputs	Output
Resolution, maximum	16 bits, or 15 bits + sign	12 bits (4096 points)
Cable type	Twisted pair shielded	
Cable length, maximum	30 m (98 ft)	

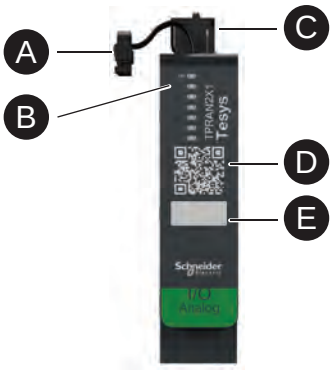
Table 19 - Signal Type: Inputs

Channel	Inputs			
Signal type	**Voltage (Vdc)**	**Current (mA)**	**Thermocouple**	**3–wire RTD (Resistance Temperature Detector)**
Range	• 0 to 10 • −10 to +10	• 0–20 • 4–20	• Type K, J, R, S, B, E, T, N, C • PTC Binary	PT100, PT1000, NI100, NI1000

Table 20 - Signal Type: Outputs

Channel	Output	
Signal type	**Voltage**	**Current**
Range	• 0 to 10 Vdc • −10 to +10 Vdc	• 0–20 mA • 4–20 mA

Figure 11 - Analog I/O Module Features



A	Flat cable (for connection with the module to the left)	D	QR code
B	LED status indicators	E	Name tag
C	Connector with spring terminals		

Voltage Interface Module

The voltage interface module (VIM) enables voltage, power, and energy monitoring for the island.

The reference number is TPRVM001.

The main functions of the VIM are as follows:

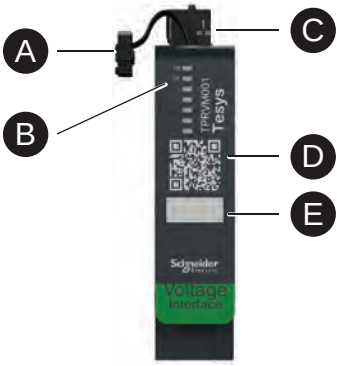
- Measure single-phase and three-phase line voltages (47–63 Hz) at one connection point of the island
- Monitor the energy-related data at the island level
- Monitor the voltages in single-phase systems L-N or L-L
- Monitor the voltages in three-phase systems without neutral N connection
- Calculate the RMS phase voltages and the voltage phase sequence
- Monitor for fundamental frequency
- Identify the level and duration of dip and swell events

Refer to *Avatar Wiring Schematics, page 75* for module wiring.

The VIM is connected upstream to the island common power supply.

The VIM communicates with the bus coupler, sending operational data.

The connection specifications for measuring input are as follows: removable spring terminal block with three rigid cables sized 0.2–2.5 mm² (AWG 24–14).



A	Flat cable (for connection with the module to the left)	D	QR code
B	LED status indicators	E	Name tag
C	Connector with spring terminals		

Digital Tools

The TeSys™ island digital tools are online and offline software interfaces used to manage the island through all offer life-cycle phases—from component selection, to operational monitoring, to maintenance.

Three tools are available:

- TeSys island Configurator: an online tool for the initial design of the island: *www.se.com/en/work/products/industrial-automation-control/tools/motor-control-configurator.jsp*
- Engineering tools: personal computer software for configuring, monitoring, and controlling the island (TeSys island DTM within EcoStruxure™ Machine Expert or SoMove™ software)
- Operation and Maintenance Tool (OMT): an online tool embedded in the bus coupler for operation, maintenance, and troubleshooting

These powerful tools offer a wide range of functions. In many cases, the functionalities overlap—different tools can be used to achieve the same result.

Table 21 - Digital Tools

Functions	TeSys island Configurator	Engineering (EcoStruxure Machine Expert or SoMove software)	Operation and Maintenance Tool
Build	X	X	
Configure		X	
Adjust Settings		X	X
Document	X	X	
Test		X	X
Command		X	X
Monitor		X	X
Diagnostics		X	X

TeSys™ island Configurator

The TeSys island Configurator is an online tool accessible from the Schneider Electric website. The configurator is an intelligent catalog, computing and providing the island's configuration based on the requirements entered for the specific application.

The TeSys island Configurator's main purpose is as follows:

- Capture the functional requirements of the application, and the electrical characteristics of the island
- Compute the list of required TeSys island devices automatically
- Generate the physical topology of the island
- Generate the associated bill of materials
- Generate the configuration files, which can be downloaded for re-use by EcoStruxure™ Machine Expert and SoMove™ software.
- Provide access to technical documentation related to electrical panel engineering and automation control programming

The TeSys island Configurator can be found at *www.se.com/en/work/products/industrial-automation-control/tools/motor-control-configurator.jsp*.

Engineering Tools

The engineering tools include EcoStruxure™ Machine Expert, SoMove™ software, and the TeSys™ island DTM.

These tools allow you to configure, monitor, control, and customize TeSys island. The engineering tools assist with the design, engineering, and commissioning phases of the island, as well as with PLC programming. The TeSys island engineering tools are built using open FDT/DTM technology.

Design Functions

- Design the island topology.
- Generate a bill of material.

Engineering Functions

- Adjust the settings of TeSys avatars to customize the electrical and load protection parameters.
- Communicate with the PLC (Machine Expert and SoMove software).

Commissioning Functions

- Check the electrical wiring and test the electrical lines in Test mode without loading a configuration.
- Simulate commands from the PLC and set the status of the avatars in Force mode.
- Check the island's status and monitor the avatars with diagnostic features.
- Compare the loaded configuration and topology against the project file.
- Operate the island directly from a control panel.

Programming Functions

- Generate exchange files for third-party PLC programming environments (SoMove software).
- Access a library of function blocks (Machine Expert) for control, diagnostics, energy monitoring, and asset management.

The engineering tool can be downloaded from *www.se.com* by entering *TeSys island DTM* in the Search field. SoMove software can also be downloaded directly from the Schneider Electric website.

Full Integration into SoMove Software

Aided design to determine

- The bill of materials of the island
- The topology of the island

Aided engineering

- Generation of exchange files with a third party programming environment (EDS files, AML files)
- Fast programming using function blocks
- Customized functions for Electrical protections, Motor protections, and Energy monitoring
- Contextual setting of parameters for communication with the controller and avatars

Aided commissioning

- Test mode: Check the electrical wiring and test the electrical lines without loading a configuration.
- Force mode: Force the commands and avatar status to ease commissioning.
- Diagnostic tab: Check the status, monitor the avatars and their associated modules, and compare the loaded configuration and topology with the project file.
- Control panel: Operate the island directly.

Operation and Maintenance Tool

The Operation and Maintenance tool (OMT) is web-based and optimized for use with a tablet so a technician can troubleshoot and diagnose the island without opening the electrical panel. The operation and maintenance tool offers the following features to aid in operation, maintenance, and troubleshooting:

- Customizable user interface
- User access and rights management for secure login
- Monitoring of device behavior, load behavior, and energy consumption
- Test mode and Force mode available for ease of maintenance
- Diagnostics to check the island's status and monitor the TeSys™ avatars
- Control panel to operate the island directly
- Maintenance alarms to help avoid machine down time
- Access to product data for asset management
- Accessibility from the engineering tools with a QR scan

Fieldbus Communication

Industrial Communication Protocols

TeSys™ island supports the EtherNet/IP™, Modbus™ TCP, PROFINET™, and PROFIBUS-DP™ industrial communication protocols.

Degraded Mode

When fieldbus communication with the controller is lost, TeSys™ island remains in the operational state but enters Degraded mode. A communication loss is defined as follows:

- **EtherNet/IP™ fieldbus:** A communication loss is detected when an established exclusive owner connection times out.
- **Modbus™/TCP fieldbus:** A communication loss is detected after receiving no write requests to the cyclic I/O scanning data for the duration specified by the Communication Loss Timeout setting in the DTM.
- **PROFINET™ fieldbus:** a communication loss is detected when an established application relation (AR) with an I/O controller is closed or disconnected on either end of the AR. TeSys island supports one AR per I/O controller.
- **PROFIBUS-DP™ fieldbus:** a communication loss is detected when the watchdog timer for the connection expires.

NOTE: Loss of communication with the DTM or OMT does not trigger the transition to Degraded mode.

During Degraded mode:

- The Fieldbus ports remain active.
- The Service port remains active.
- The TeSys avatars enter Degraded mode. During Degraded mode, avatars with local control are driven by local inputs. All other avatars enter Fallback state. For the definition of Fallback state, see “System States” in the *TeSys island Operating Guide,* 8536IB1903.

Recovering from Degraded Mode

You can enable the Degraded mode auto-reset option in the DTM. If *Enable Degraded Mode Auto-Reset* is set to Yes, then TeSys™ island exits Degraded mode when communication is restored. Refer to the *TeSys™ island Operating Guide* for more information.

If the option *Enable Degraded Mode Auto-Reset* is set to No, then a System Restart command or power cycle is required to exit Degraded mode.

Ethernet Network Topologies

TeSys™ island can be used in a star or ring topology. TeSys™ island supports Rapid Spanning Tree Protocol (RSTP), a network protocol that builds a loop-free logical topology for Ethernet networks. RSTP is enabled by default in the system avatar.

TeSys™ Avatar Introduction

Avatar Definition

TeSys™ avatars bring ready-to-use functions through their predefined logic and associated physical devices. The avatar logic is executed in the bus coupler. The bus coupler manages data exchanges internally within the island, and also externally with the PLC.

There are four types of TeSys avatars:

System avatar

Represents the whole island as a system. The System avatar allows setting the network configuration and computes island level data.

Device avatars

Represent functions performed by switches and I/O modules.

Load avatars

Represent functions related to specific loads, such as a forward-reverse motor. Load avatars include the appropriate modules and operating characteristics to serve the load type. For example, a Motor Two Directions avatar includes two starter modules, accessories, pre-programmed control logic, and a pre-configuration of the available protection functions.

Standard (non-SIL[9]) Load avatars provide the following:

- Local control
- Bypass (to allow an operator to use a local command to temporarily bypass a trip condition and continue the operation of the avatar)
- Process variable monitoring

Application avatars

Represent functions related to specific user applications, such as a pump or conveyor. Application avatars provide the following:

- Local control
- Bypass (to allow an operator to use a local command to temporarily bypass a trip condition and continue the operation of the avatar)
- Manual mode override (to allow an operator to use a local input to override the configured control mode and control the avatar from a local command source)

  NOTE: Manual mode override only applies to the Pump avatar.
- Process variable monitoring

For example, a Pump avatar includes the following:

- one starter module
- one or more digital I/O modules for local control and Process Variable (PV) switches
- one or more analog I/O modules for PV inputs
- configurable control logic
- pre-configuration of the load and electrical functions

PV inputs receive analog values from sensors such as a pressure meter, a flow meter, or a vibration meter. PV switches receive discrete signals from switches such as a flow switch or a pressure switch.

Operational control (Run and Stop command) of the avatar in autonomous mode is configurable for up to two PV inputs or PV switches. It includes settings for the

9. Safety Integrity Level according to standard IEC 61508.

threshold and hysteresis for analog inputs, and positive or negative logic for both analog and digital inputs for the Pump avatar.

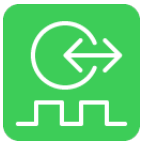
The avatars installed on the TeSys island are controlled by the island's bus coupler. Each avatar includes predefined logic for managing its physical modules, while also providing easy data exchange with PLCs through function blocks. Avatars include pre-configuration of the available protection functions.

Information accessible through the avatar includes the following:

- Control data
- Advanced diagnostics data
- Asset management data
- Energy data

List of TeSys™ Avatars

Table 22 - TeSys Avatars

Name	Icon	Description
System avatar		A required avatar that enables a single point of communication to the island.
Device		
Switch		To make or break a power line in an electrical circuit
Switch - SIL Stop, W. Cat 1/2[10]		To make or break a power line in an electrical circuit with Stop Category 0 or Stop Category 1[11] function compliance for Wiring Category 1 and Category 2.
Switch - SIL Stop, W. Cat 3/4[12]		To make or break a power line in an electrical circuit with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 3 and Category 4.
Digital I/O		To provide control of 2 digital outputs and status of 4 digital inputs
Analog I/O		To provide control of 1 analog output and status of 2 analog inputs

10. Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.
11. Stop category according to EN/IEC 60204-1.
12. Safety Integrity Level according to standard IEC 61508. Wiring Category 3 and Category 4 according to ISO 13849.

Table 22 - TeSys Avatars (Continued)

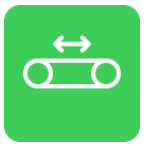
Name	Icon	Description
Load		
Power Interface without I/O (measure)		To monitor current supplied to an external device, such as a solid-state relay, soft starter, or variable speed drive
Power Interface with I/O (control)		To monitor current supplied to and to control an external device, such as a solid-state relay, soft starter, or variable speed drive
Motor One Direction		To manage[13] a motor in one direction
Motor One Direction - SIL Stop, W. Cat 1/2		To manage a motor in one direction, with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 1 and Category 2.
Motor One Direction - SIL Stop, W. Cat 3/4		To manage a motor in one direction, with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 3 and Category 4.
Motor Two Directions		To manage a motor in two directions (forward and reverse)
Motor Two Directions - SIL Stop, W. Cat 1/2		To manage a motor in two directions (forward and reverse), with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 1 and Category 2
Motor Two Directions - SIL Stop, W. Cat 3/4		To manage a motor in two directions (forward and reverse), with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 3 and Category 4
Motor Y/D One Direction		To manage a wye-delta (star-delta) motor in one direction

13. “Manage” in this context encompasses energizing, controlling, monitoring, diagnosing, and protecting the load.

Table 22 - TeSys Avatars (Continued)

Name	Icon	Description
Motor Y/D Two Directions		To manage a wye-delta (star-delta) motor in two directions (forward and reverse)
Motor Two Speeds		To manage a two-speed motor
Motor Two Speeds - SIL Stop, W. Cat 1/2		To manage a two-speed motor, with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 1 and Category 2
Motor Two Speeds - SIL Stop, W. Cat 3/4		To manage a two-speed motor, with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 3 and Category 4
Motor Two Speeds Two Directions		To manage a two-speed motor in two directions (forward and reverse)
Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2		To manage a two-speed motor in two directions (forward and reverse), with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 1 and Category 2
Motor Two Speeds Two Directions - SIL Stop, W. Cat 3/4		To manage a two-speed motor in two directions (forward and reverse), with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 3 and Category 4
Resistor		To manage a resistive load
Power Supply		To manage a power supply
Transformer		To manage a transformer

Table 22 - TeSys Avatars (Continued)

Name	Icon	Description
Application		
Pump		To manage a pump
Conveyor One Direction		To manage a conveyor in one direction
Conveyor One Direction - SIL Stop, W. Cat 1/2		To manage a conveyor in one direction, with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 1 and Category 2
Conveyor Two Directions		To manage a conveyor in two directions (forward and reverse)
Conveyor Two Directions - SIL Stop, W. Cat 1/2		To manage a conveyor in two directions (forward and reverse), with Stop Category 0 or Stop Category 1 function compliance for Wiring Category 1 and Category 2

Avatar Logic and Functionality

This section describes the avatar logic and functionality for the application and load avatars equipped with configurable control logic.

Process Variables

Application and load avatars introduce Process Variable (PV) inputs and switches:

- PV inputs receive analog values from sensors such as pressure meters, flow meters, or vibration meters. PV inputs connect to analog I/O modules (AIOMs) that are included as part of the avatar. The number of AIOMs required for the avatar is determined based on the number of configured PV inputs.
- PV switches receive discrete signals from switches such as float switches or proximity switches. PV switches connect to digital I/O modules (DIOMs) that are included as part of the avatar. The number of DIOMs required for the avatar is determined based on the number of configured PV switches.

Bypass Functionality

Bypass functionality is included with certain load and application avatars. This functionality allows the user to manually bypass detected avatar trips and continue operation. The Bypass switch is connected to a port on a digital I/O module that is included as part of the avatar. When the Bypass switch is set to the On position, the Bypass function bypasses any detected trips until the user returns the switch to the Off position.

Manual Mode Override

The operational control comes from a digital I/O module on the avatar that overrides the configuration selection of Remote Control mode or Autonomous Control mode. It enables the avatar to take operational control from the local command, as if it were configured for the Local Control mode. When Manual Mode Override is activated, the PV Control input conditions need to be satisfied.

Pump Avatars

The Pump avatars include one starter module, digital I/O module(s) for PV switches, analog I/O module(s) for PV inputs, configurable control logic, and optional or configurable motor temperature monitoring.

Pump Avatars Control Modes

The Pump avatar has three types of control modes, described below. The type of Control mode for the avatar can be selected during the configuration of the avatar.

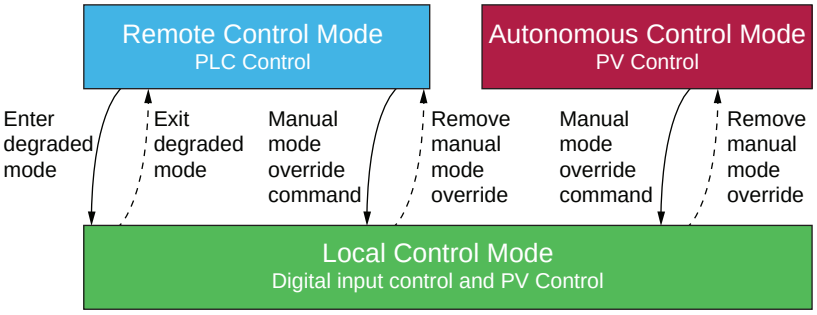
- **Remote Control mode**—The operational control is managed by the PLC.
- **Autonomous Control mode** (available on pump avatar only)—The operational control of the avatar in autonomous mode comes from configurable PV Control inputs. PV Control inputs are one or two PV inputs or PV switches. They have the following settings:
  - Analog PV Control inputs: PV control level, PV control logic, and PV control hysteresis.
  - Digital PV Control inputs: PV control logic.

  Degraded mode does not impact the Autonomous Control mode.
- **Local Control mode**—The operational control is managed by local control inputs (digital I/O). When the avatar is in Local Control mode, the configured PV Control input conditions need to be satisfied.

The operational control of the avatar can transition out of the configured control mode based on the following two conditions:

- The system degraded mode status
- The manual mode override status

Figure 12 - Pump Avatar Control Modes



Configured Control Mode:

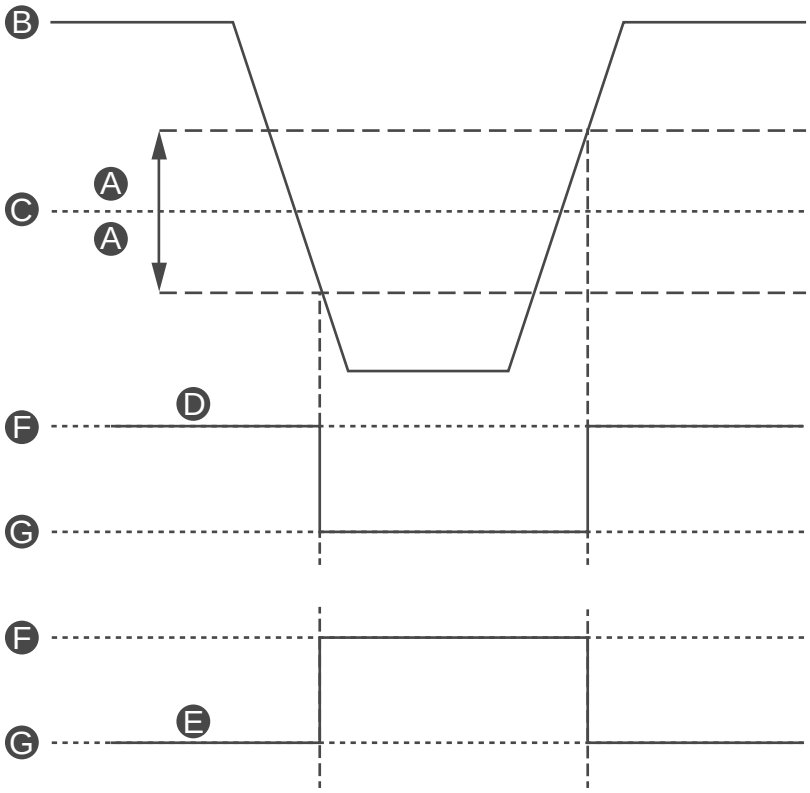
- Remote Control mode—The avatar transitions into Local Control mode if the system enters degraded mode or if the avatar's Manual Mode Override command is issued. The avatar transitions from Local Control mode back to the configured Remote Control mode when the system is not in degraded mode and the avatar's Manual Mode Override is not issued.
- Autonomous Control mode—The avatar transitions into Local Control mode if this avatar's Manual Mode Override command is issued. The system degraded mode status does not impact the Autonomous Control mode. The avatar transitions from Local Control mode back to the configured Autonomous Control mode when the avatar's Manual Mode Override command is not issued.

Configurable PV Control Inputs

PV Control inputs allow you to select the following:

- a PV Control Input Source (PV Input, PV Switch) from the configured PV inputs and switches for the avatar
- the PV Control Logic (Positive, Negative) of each input source that determines how the pump will operate

Figure 13 - PV Control Input Settings



A	PV Control Hysteresis	E	PV Control Status (Negative Logic)
B	PV Input Value	F	ON
C	PV Control Level	G	OFF
D	PV Control Status (Positive Logic)		

PV Control inputs configured with an analog PV Input source also have a configurable PV Control Hysteresis percentage that can be set.

NOTE: Hysteresis is a window to avoid spurious state changes with small signal variations on analog sensors.

For example, if the control input level is set at 10 °C with a PV Control Hysteresis of 10%, this would trigger a change in the pump command:

- when crossing 9 °C in the decreasing temperature direction
- when crossing 11 °C in the increasing temperature direction

If the PV Control Hysteresis setting for a PV Control input is updated while the system is operational, to avoid unexpected behavior, the PV Control input state does not immediately change. The PV Control input changes state when the input value crosses the updated threshold in the appropriate direction.

The configurable PV Control Logic setting for positive and negative logic for the PV Control inputs are as follows:

- **Positive Logic**—The PV Control input provides a Run command to the avatar when the associated PV input is above the PV control level (with hysteresis) or the associated PV switch is a logical high (that is, 11 °C). The PV Control input provides a Stop command to the avatar when the associated PV input is below the PV control level (with hysteresis) or the associated PV switch is a logical low (that is, 9 °C).
- **Negative Logic**—The logic is inverted compared to the Positive Logic configuration. The PV Control input provides a Run command to the avatar when the associated PV input is below the PV control level (with hysteresis) or the associated PV switch is a logical low (that is, 11 °C). The PV Control input provides a Stop command to the avatar when the associated PV input is above the PV control level (with hysteresis) or the associated PV switch is a logical high (that is, 9 °C).

The PV Control mode setting determines if the Pump operates based on separate or combined PV control.

- **Separate Control**—If either one of the PV Control inputs' status is On, PV Control input provides a Run command to the avatar.
- **Combined**—Both PV Control inputs based on the PV Control Logic, PV Control Hysteresis, and the PV Control Level settings must provide a Run command to the avatar.

Conveyor Avatars

There are four conveyor application avatars, which include the following:

- Standard or SIL[14] starter modules
- One or more digital I/O modules for PV switches and local control inputs
- One or more analog I/O modules for PV inputs and motor temperature monitoring, if enabled
- Configurable control logic

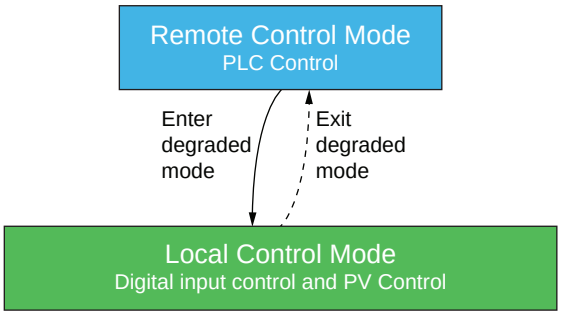
Conveyor Avatars Control Modes

The conveyor avatars have two types of Control modes, described below. You can select the type of Control mode for the avatar during the configuration of the avatar.

- **Remote Control mode**—The operational control is managed by the PLC.
- **Local Control mode**—The operational control is managed by local control inputs (digital I/O).

The operational control of the avatar can transition out of the configured Control mode based on the system degraded mode status condition.

Figure 14 - Conveyor Avatar Control Modes



14. Safety Integrity Level according to standard IEC 61508.

Configured Control Mode:

- Remote Control mode—The avatar transitions into Local Control mode if the system enters degraded mode. The avatar transitions from Local Control mode back to the configured Remote Control mode when the system is not in degraded mode.

Conveyor One Direction avatars include a local control input on a digital I/O module. You can connect the input port to a selector switch on the operator control panel, which sends a Run command to the avatar.

Conveyor Two Direction avatars include multiple local control inputs on one or more digital I/O modules. You can connect the input ports to a selector switch on the operator control panel, which sends a command to the avatar to run in the forward or reverse direction.

Load Avatars

Standard (non-SIL[15]) load avatars include the following:

- Standard starter modules
- One or more digital I/O modules for PV switches and local control inputs
- One or more analog I/O modules for PV inputs and motor temperature monitoring, if enabled
- Configurable control logic—Is enabled for the avatar when the Local Control Enabled Avatar Parameter is set to Yes during the build phase.

The load avatars that include configurable control logic are as follows:

- Motor One Direction
- Motor Two Directions
- Motor Y/D One Direction
- Motor Y/D Two Directions
- Motor Two Speeds
- Motor Two Speeds Two Directions

Load Avatars Control Modes

The load avatars have two types of control modes, described below. You can select the type of Control mode for the avatar during the configuration of the avatar.

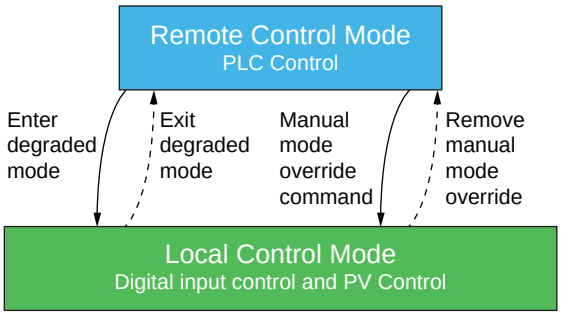
- **Remote Control mode**—The operational control is managed by the PLC.
- **Local Control mode**—The operational control is managed by local control inputs (digital I/O).

The operational control of the avatar can transition out of the configured control mode based on the following two conditions:

- The system degraded mode status
- The manual mode override status

15. Safety Integrity Level according to standard IEC 61508.

Figure 15 - Load Avatar Control Modes



Configured Control Mode:

- Remote Control mode—The avatar transitions into Local Control mode if the system enters degraded mode or if the avatar's Manual Mode Override command is issued. The avatar transitions from Local Control mode back to the configured Remote Control mode when the system is not in degraded mode and the avatar's Manual Mode Override is not issued.

Load avatars can include multiple local control inputs on one or more digital I/O modules. You can connect the input ports to a selector switch on the operator control panel, which sends a command to the avatar to run in the forward or reverse direction, as well as in low or high speed, depending on the avatar.

Avatar Predictive Alarms

Predictive Alarms (PA) alert you of possible events regarding the applications being monitored. Predictive Alarms are triggered by a combination of configured protection functions and PV Input conditions. This section describes the configuration and requirements for the Predictive Alarms function.

The following is the list of avatars with configurable predictive alarms:

- Motor One Direction
- Motor Two Directions
- Motor Y/D One Direction
- Motor Y/D Two Directions
- Motor Two Speeds
- Motor Two Speeds Two Directions
- Pump
- Conveyor One Direction
- Conveyor One Direction - SIL Stop, W. Cat 1/2[16]
- Conveyor Two Directions
- Conveyor Two Directions - SIL Stop, W. Cat 1/2

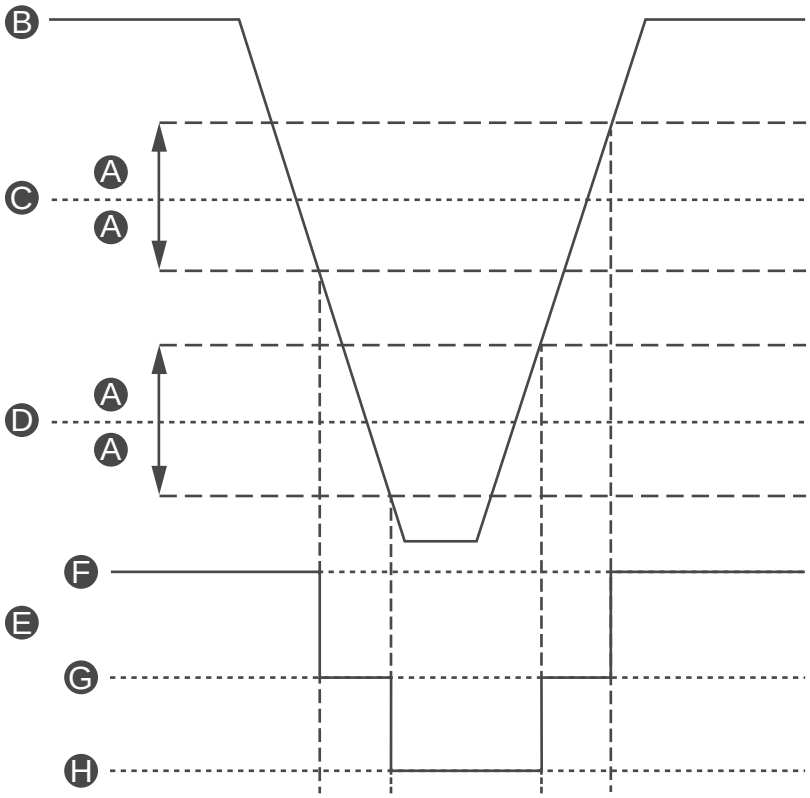
You can set up Predictive Alarms to send a specific message for a protection function without assigning a PV Input condition. PV Input conditions that trigger Predictive Alarms occur when the configured PV Inputs for the avatar are within a selected region of operation based on configurable thresholds. When either the protection function alarm resets or the PV Inputs exit the selected region of operation, the Predictive Alarm resets. Avatars support up to ten Predictive Alarms.

Avatars with Predictive Alarms support the following behavior for the PV Input PA Status output, applying a hysteresis of 5% (rounding down, from the range of valid values).

> **NOTE:** Hysteresis is a window to avoid spurious state changes with small signal variations on analog sensors.

16. Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.

Figure 16 - Predictive Alarm Hysteresis



A	Hysteresis	E	PV Input PA Status
B	PV Input value	F	High
C	PV Input PA High Threshold	G	Nominal
D	PV Input PA Low Threshold	H	Low

The following settings are needed to configure Predictive Alarms on avatars with Predictive Alarms support:

- Alarm Input
- Alarm Definition

Alarm Input

There are two Alarm Inputs that can be set up for the avatar: Alarm Input 1 and Alarm Input 2. You can set up a unique type of input for each of these alarm inputs. The following inputs are available:

- Temperature
- Pressure
- Flow
- Vibration
- Proximity
- Generic

Each Predictive Alarm Input has the following two alarm threshold values that you can set:

- Alarm High Threshold Value—Specifies the threshold between the low and nominal region of operation
- Alarm Low Threshold Value—Specifies the threshold between the high and nominal regions of operation

Nominal is the region between the high and low threshold values. For example, if the high threshold value is set at 10 °C and the low threshold value is set at 2 °C, anything greater than 10 °C is considered high threshold values. Low threshold values are 0–2 °C. The nominal range is from 2–10 °C.

Alarm Definition

Up to ten Predictive Alarms can be set up for the avatar. Each Predictive Alarm Definition includes the following settings and outputs:

Type of Protection

This is the protection function alarm assigned to the Predictive Alarm. The following protection functions are available for the Predictive Alarms:

- None—This setting disables the Predictive Alarm.
- Thermal Overload
- Motor Overheat
- Jam
- Undercurrent
- Overcurrent
- Ground Current
- Current Phase Unbalance

PV Input Trigger

You can assign up to three PV Input Triggers to the Predictive Alarm. The following regions of operation are available for each PV Input Trigger:

- None
- PVInput1—Low
- PVInput1—Nominal
- PVInput1—High
- PVInput2—Low
- PVInput2—Nominal
- PVInput2—High

Predictive Alarm Message

Up to 150 characters of application-specific text can be associated with the Predictive Alarm.

Predictive Alarms are triggered when the result of the logical AND of the following configured PA settings is True. The Predictive Alarms are reset when the result of the logical AND of these PA settings is False.

- PA Protection Function Trigger
- PA PV Input Condition Trigger 1
- PA PV Input Condition Trigger 2
- PA PV Input Condition Trigger 3

Predictive Alarms consider any PA Protection Function Trigger configured with a value of None to be False. This provides a mechanism to disable the Predictive Alarm. Predictive Alarms consider any PA PV Input Condition Trigger configured with a value of None to be True.

Predictive Alarms Examples—Pump Avatar

The following are working examples of how to set up Predictive Alarms for the Pump avatar. Combining the protection functions and PV Input conditions allows you to set up example Predictive Alarms for the Pump avatar as shown below. Remember, these are only examples. Predictive Alarms can be customized to provide more accurate alarms for an avatar's specific application.

Table 23 - Examples of Predictive Alarm Messages—Pump Avatar

Protection Type	Alarm Input Sensor Type					
	Temperature	Pressure	Flow	Vibration		Generic Alarms
	PV Input Trigger					
	PVInput < Low Temperature	PVInput < Low Pressure	PVInput < Low Flow	PVInput1 < Low Flow Value, and PVInput2 > High Vibration	PVInput > High Vibration	All PVInput Triggers = None (not configured)
Thermal Overload	High Viscosity	X	Friction Force Increase	Impeller Jam	Check alignment or bearings	Mechanical seal or bent shaft, or impeller jam
Motor Overheat	X	Dry run or seals worn out	Material in impeller or heavy sludge (sand/silt)	Dry run or inspect line for blockage or closed valve	Check alignment or bearings	No cooling or high ambient temp or tight seal alarm, or multiple starts without cool-time
Jam	X	Cut-out fused, hose blocked, clogged, or frozen, or has come off one end	Impeller jam	Valve stuck, or blocked impeller. Suction intake or leakage.	Inspect impeller	Impeller jam or broken, or check transducers or air-locked
Undercurrent	X	Dry run	Clogged inlet, or inspect line for closed valve	Cavitation or dry run	Inspect impeller	Check coupling, inspect line for blockage, or check inlet
Overcurrent	High Viscosity	Pump run-out or broken pipe	Closed discharge valve or discharge cavitation	X	Check alignment or bearings	Binding shaft or bad bearings, or check impeller
None	Low PV Temperature	Low PV pressure	Low PV flow	No flow and high PV vibration	High PV vibration	X

Avatar Functional Description

Avatar Function Allocation

In the following table, a check mark ✓ indicates the function groups that are possible with each TeSys™ avatar.

Table 24 - Avatar Function Allocation—Protection and Monitoring

Name	Current Monitoring	Upstream Voltage Presence	Electrical Protection	Load Protection	Motor Overheat Protection[17]	Energy Monitoring[18]
System avatar	—	—	—	—	—	✓
Switch	✓	✓	✓	—	—	—
Switch - SIL Stop, W. Cat 1/2[19]	✓	✓	✓	—	—	—
Switch - SIL Stop, W. Cat 3/4[20]	✓	✓	✓	—	—	—
Digital I/O	—	—	—	—	—	—
Analog I/O	—	—	—	—	—	—
Power Interface without IO (measure)	✓	✓	✓	✓	✓	✓
Power Interface with IO (control)	✓	✓	✓	✓	✓	✓
Motor One Direction	✓	✓	✓	✓	✓	✓
Motor One Direction - SIL Stop, W. Cat 1/2	✓	✓	✓	✓	✓	✓
Motor One Direction - SIL Stop, W. Cat 3/4	✓	✓	✓	✓	✓	✓
Motor Two Directions	✓	✓	✓	✓	✓	✓
Motor Two Directions - SIL Stop, W. Cat 1/2	✓	✓	✓	✓	✓	✓
Motor Two Directions - SIL Stop, W. Cat 3/4	✓	✓	✓	✓	✓	✓
Motor Y/D One Direction	✓	✓	✓	✓	✓	✓
Motor Y/D Two Directions	✓	✓	✓	✓	✓	✓
Motor Two Speeds	✓	✓	✓	✓	✓	✓
Motor Two Speeds - SIL Stop, W. Cat 1/2	✓	✓	✓	✓	✓	✓
Motor Two Speeds - SIL Stop, W. Cat 3/4	✓	✓	✓	✓	✓	✓
Motor Two Speeds Two Directions	✓	✓	✓	✓	✓	✓
Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2	✓	✓	✓	✓	✓	✓
Motor Two Speeds Two Directions - SIL Stop, W. Cat 3/4	✓	✓	✓	✓	✓	✓
Resistor	✓	✓	✓	✓	—	✓
Power Supply	✓	✓	✓	✓	—	✓
Transformer	✓	✓	✓	✓	—	✓

17. With analog I/O module.
18. With voltage interface module.
19. Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.
20. Safety Integrity Level according to standard IEC 61508. Wiring Category 3 and Category 4 according to ISO 13849.

Table 24 - Avatar Function Allocation—Protection and Monitoring (Continued)

Name	Current Monitoring	Upstream Voltage Presence	Electrical Protection	Load Protection	Motor Overheat Protection[21]	Energy Monitoring[22]
Pump	✓	✓	✓	✓	✓	✓
Conveyor One Direction	✓	✓	✓	✓	✓	✓
Conveyor One Direction - SIL Stop, W. Cat 1/2	✓	✓	✓	✓	✓	✓
Conveyor Two Directions	✓	✓	✓	✓	✓	✓
Conveyor Two Directions - SIL Stop, W. Cat 1/2	✓	✓	✓	✓	✓	✓

In the following table, a check mark ✓ indicates the function groups that are possible with each TeSys™ avatar.

Table 25 - Avatar Function Allocation—Predictive Alarms, PV, and Control Modes

Name	Predictive Alarms	Process Variable Monitoring	Configurable Control Modes
System avatar	—	—	—
Switch	—	—	—
Switch - SIL Stop, W. Cat 1/2[23]	—	—	—
Switch - SIL Stop, W. Cat 3/4[24]	—	—	—
Digital I/O	—	—	—
Analog I/O	—	—	—
Power Interface without IO (measure)	—	—	—
Power Interface with IO (control)	—	—	—
Motor One Direction	✓	✓	✓
Motor One Direction - SIL Stop, W. Cat 1/2	—	—	—
Motor One Direction - SIL Stop, W. Cat 3/4	—	—	—
Motor Two Directions	✓	✓	✓
Motor Two Directions - SIL Stop, W. Cat 1/2	—	—	—
Motor Two Directions - SIL Stop, W. Cat 3/4	—	—	—
Motor Y/D One Direction	✓	✓	✓
Motor Y/D Two Directions	✓	✓	✓
Motor Two Speeds	✓	✓	✓
Motor Two Speeds - SIL Stop, W. Cat 1/2	—	—	—
Motor Two Speeds - SIL Stop, W. Cat 3/4	—	—	—
Motor Two Speeds Two Directions	✓	✓	✓
Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2	—	—	—
Motor Two Speeds Two Directions - SIL Stop, W. Cat 3/4	—	—	—
Resistor	—	—	—
Power Supply	—	—	—
Transformer	—	—	—
Pump	✓	✓	✓

21. With analog I/O module.
22. With voltage interface module.
23. Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.
24. Safety Integrity Level according to standard IEC 61508. Wiring Category 3 and Category 4 according to ISO 13849.

Table 25 - Avatar Function Allocation—Predictive Alarms, PV, and Control Modes (Continued)

Name	Predictive Alarms	Process Variable Monitoring	Configurable Control Modes
Conveyor One Direction	✓	✓	✓
Conveyor One Direction - SIL Stop, W. Cat 1/2	✓	✓	✓
Conveyor Two Directions	✓	✓	✓
Conveyor Two Directions - SIL Stop, W. Cat 1/2	✓	✓	✓

Protection Functions

TeSys™ island offers a wide range of load protection functions (including thermal protection) and electrical protection functions. These functions can be enabled for each applicable TeSys avatar, and configured to react to given operational conditions, by signaling alarm messages and triggering load trips.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Make sure to set the protection functions' parameters according to the required protection level of the controlled motors and loads.

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

The following table lists the protection functions available for all avatars. The functions can be enabled and configured individually.

Table 26 - Protection Functions

Load Protection Functions	Thermal Protection Functions
• Jam • Long Start • Stall • Undercurrent • Overcurrent • Rapid Cycle Lockout • Rapid Restart Lockout	• Thermal Overload • Motor Overheat
	Electrical Protection Functions
	• Phase Configuration • Current Phase Unbalance • Current Phase Loss • Ground Current Detection • Current Phase Reversal

The following table defines parameters that are associated with multiple protection functions. They are referred to throughout the protection function sections in this instruction bulletin.

Table 27 - Common Protection Function Parameters

Parameter	Definition
<*function name*> Trip Enable	Enables the trip function
<*function name*> Trip Delay	A time setting specifying the duration that a trip condition must exist to trigger a trip
<*function name*> Trip Level	A setting to define the level of an input that triggers a trip
<*function name*> Alarm Enable	Enables the alarm function
<*function name*> Alarm Level	A setting to define the level of an input that triggers an alarm

About Motor Start and Run States

Based on the electrical consumption of the driven motor, TeSys™ island identifies whether the motor is in the Off, Start, or Run state. These states, along with the enable setting, determine which protection functions apply. For instance, the Undercurrent protection function does not apply to a motor in the Off state.

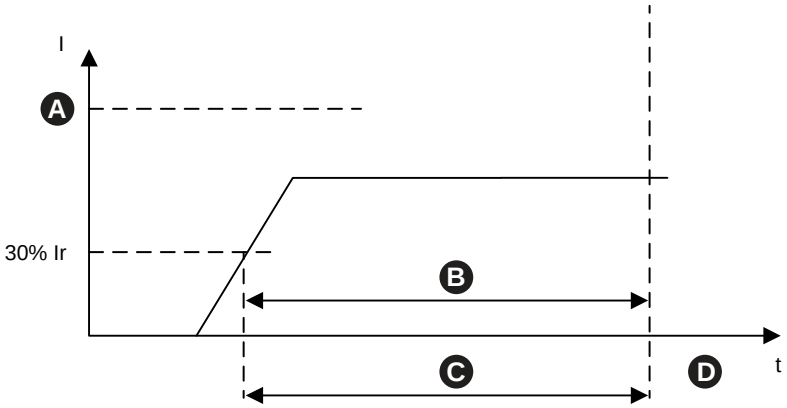
The motor states are defined by the following:

- Off state: the measured current is less than or equal to 30% Ir.
- Start state: this state begins after the Off state, with the detection of a measured current greater than 30% Ir. It continues until a transition occurs to Run state (or Off).
- Run State (condition 1): The Long Start Trip protection function is disabled. The detected current stays between 30% Ir and the Long Start Trip Level for the time defined by the Long Start Trip Delay. (The timer starts at the beginning of the Start state.)
- Run State (condition 2): The Long Start Trip protection function is disabled. The detected current rises above the Long Start Trip Level, and does not fall below the Long Start Trip Level within the time defined by Long Start Trip Delay. (The timer starts at the beginning of the Start state.)
- Run State (condition 3): The detected current rises above Long Start Trip Level and then falls below the Long Start Trip Level.

Run State

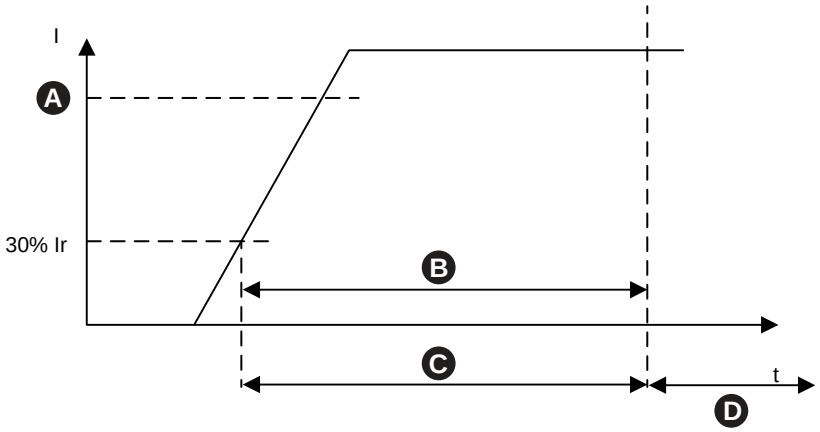
The following figures illustrate the different transitions from the Start State to Run State.

Figure 17 - Run State (Condition 1)



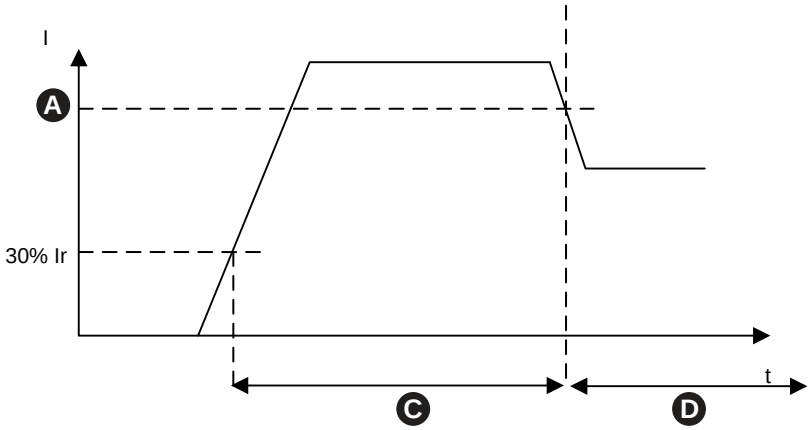
I	Current	**Ir**	Rated Current
A	Long Start Trip Level	**B**	Long Start Trip Delay
C	Start State	**D**	Run State
t	Time		

Figure 18 - Run State (Condition 2)



I	Current	**Ir**	Rated Current
A	Long Start Trip Level	**B**	Long Start Trip Delay
C	Start State	**D**	Run State
t	Time		

Figure 19 - Run State (Condition 3)



I	Current	**Ir**	Rated Current
A	Long Start Trip Level	**C**	Start State
D	Run State	**t**	Time

Protection Settings

The following tables provide the range settings for the protection **setting** values.

Electrical Protection

Table 28 - Electrical Protection Settings Values

Setting Name	Value Range	Default Value	Increment
Ground Current Trip Delay	0.1–1.0 s	1 s	0.1
Ground Current Trip Level	20–100%[25] FLA	50%	1
Ground Current Alarm Level	20–100%[25] FLA	50%	1
Current Phase Unbalance Trip Delay - Start	2–20 s	2 s	0.1

25. 50–100% for FLA<1A

Table 28 - Electrical Protection Settings Values (Continued)

Current Phase Unbalance Trip Delay - Run	2–20 s	5 s	0.1
Current Phase Unbalance Trip Level	10–70%	20%	1
Current Phase Unbalance Alarm Level	10–70%	10%	1
Current Phase Loss Trip Delay	0.1–30 s	3 s	0.1
Current Phase Loss Trip Level	80%	80%	–
Current Phase Sequence	ABC ACB	ABC	–

Thermal Protection

Table 29 - Thermal protection settings values

Setting Name	Value Range	Default Value	Incre-ment
Ir (FLA)	0.18–9 A (TPR••009) 0.50–25 A (TPR••025) 0.76–38 A (TPR••038) 3.25–65 A (TPR••065) 4–80 A (TPR••080)	0.18 A 0.50 A 0.76 A 3.25 A 4 A	0.01
Ir (FLA) 2	0.18–9 A (TPR••009) 0.50–25 A (TPR••025) 0.76–38 A (TPR••038) 3.25–65 A (TPR••065) 4–80 A (TPR••080)	0.18 A 0.50 A 0.76 A 3.25 A 4 A	0.01
Thermal Overload Trip Class	5–30	10	—
Thermal Overload Reset Threshold	10–95%	85%	1
Thermal Overload Alarm Level	10–100%	85%	1
Motor Overheat Trip Delay	0–10 s	5 s	0.1
Motor Overheat Trip Level	0–200 °C	0 °C	1
Motor Overheat Reset Threshold	0–200 °C	0 °C	1
Motor Overheat Alarm Threshold	0–200 °C	0 °C	1
Motor Overheat Temperature Sensor	PT 100 PT 1000 NI 100 NI 1000 PTC Binary	PT 100	—

Load Protection

Table 30 - Load protection settings values

Setting Name	Value Range	Default Value	Increment
Jam Trip Delay	1–30 s	5 s	1
Jam Trip Level	100–800%	200%	1
Jam Alarm Level	100–800%	200%	1
Undercurrent Trip Level	30–100%	50%	1

Table 30 - Load protection settings values (Continued)

Undercurrent Trip Delay	1–200 s	1 s	1
Undercurrent Alarm Level	30–100%	70%	1
Long Start Trip Delay	1–200 s	10 s	1
Long Start Trip Level	100–800%	100%	1
Rapid Cycle Lockout Timeout	1–9999 s	300 s	1
Rapid Restart Lockout Timeout	1–9999 s	300 s	1
Overcurrent Trip Level	30–800%	200%	1
Overcurrent Trip Delay	1–250 s	10 s	1
Overcurrent Alarm Level	100–1000%	180%	1
Stall Trip Delay	1–30 s	5 s	1
Stall Trip Level	50–1000%	250%	1

Load Protection Functions

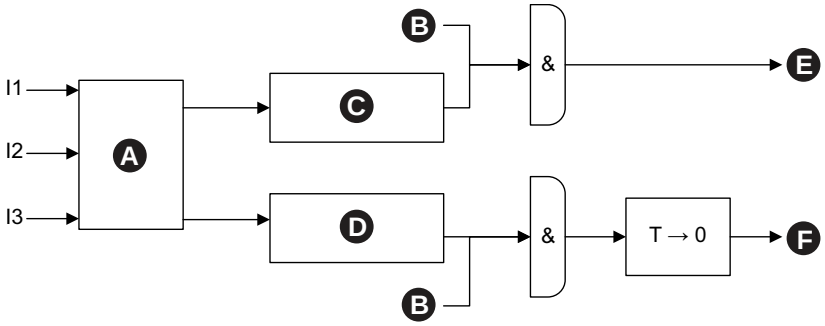
Jam

The Jam function detects when a motor is jammed during the Run state. The motor either stops or is suddenly overloaded and draws excessive current.

If enabled, this protection function performs the following when the motor is in the Run state:

- Signals a Jam Alarm when the maximum phase current (Imax) exceeds the specified Jam Alarm Level
- Triggers a Jam Trip when the maximum phase current (Imax) exceeds the specified Jam Trip Level for a time longer than the specified Jam Trip Delay

Figure 20 - Jam Trip and Alarm



I1	Phase 1 Current	**I2**	Phase 2 Current
I3	Phase 3 Current	**T**	Jam Trip Delay
A	Imax	**B**	Run State
C	Imax ≥ Jam Alarm Level	**D**	Imax ≥ Jam Trip Level
E	Jam Alarm	**F**	Jam Trip

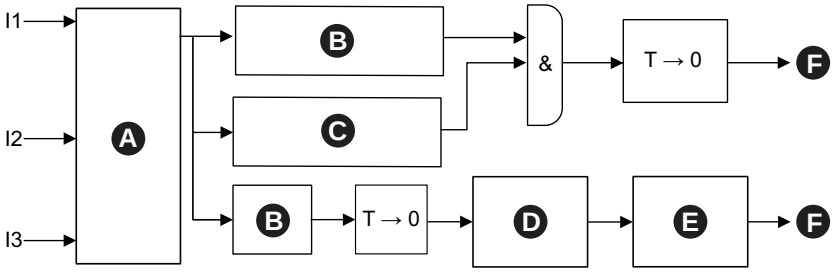
Long Start

The Long Start function detects when a motor remains in the Start state for an excessive period of time.

If enabled, this protection function triggers a Long Start trip when the motor is in the Start state, and one of the following conditions occur during the specified Long Start Trip Delay:

- Average current too low: the average current remains below the specified Long Start Trip Level
- Average current too high: the average current rises above the specified Long Start Trip Level but does not fall below it again.

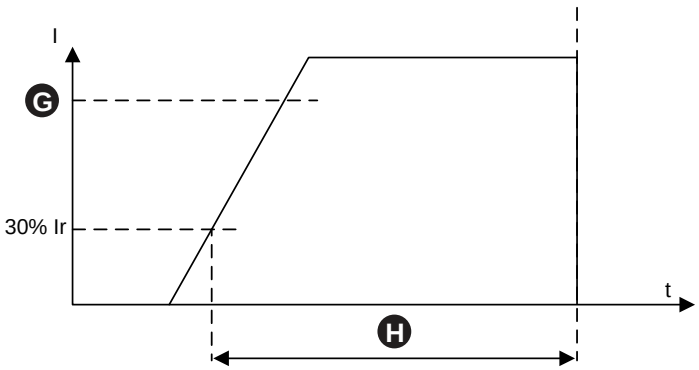
Figure 21 - Long Start Trip



I1	Phase 1 Current	**I2**	Phase 2 Current
I3	Phase 3 Current	**T**	Long Start Trip Delay
A	Iavg	**B**	Iavg ≥ 30%
C	Iavg ≤ Long Start Trip Level	**D**	Iavg ≥ Long Start Trip Level
E	# of Crossings = 1	**F**	Long Start Trip

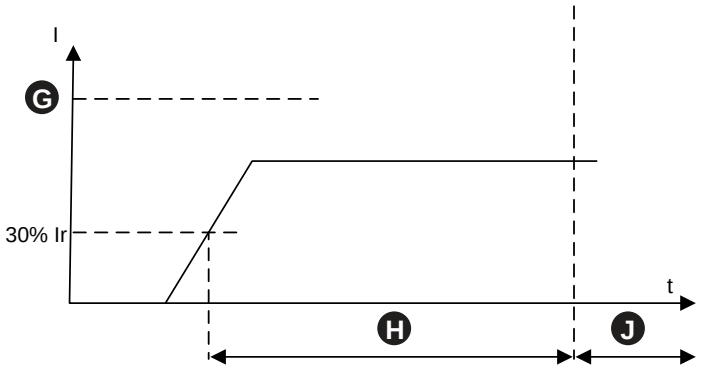
NOTE: Number of Crossings = the number of times the value of current crossed (from above to below, or below to above) the Long Start Trip Level.

Figure 22 - Average Current Continuously Exceeds the Long Start Trip Level (1 Crossing)



G	Long Start Trip Level	**H**	Long Start Trip Delay (in Start State)
I	Current	**Ir**	Rated Current
t	Time		

Figure 23 - Average Current Does Not Reach the Long Start Trip Level



G	Long Start Trip Level	**H**	Long Start Trip Delay (in Start State)
I	Current	**Ir**	Rated Current
J	Run State	**t**	Time

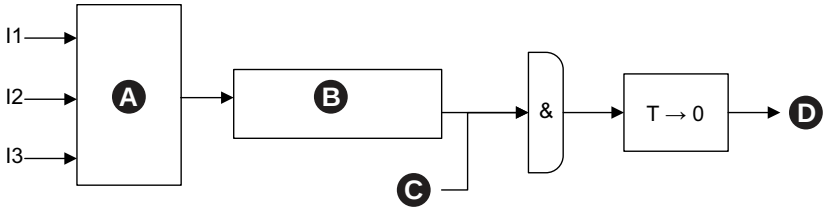
Stall

The Stall function detects high current intensity, typically associated with a locked or stalled motor, while in the Start state.

If enabled, this protection function triggers a Stall trip when the motor is in the Start state, and the maximum phase current exceeds the specified Stall Trip Level for a time longer than the specified Stall Trip Delay.

NOTE: No Stall detection alarm is associated with this function.

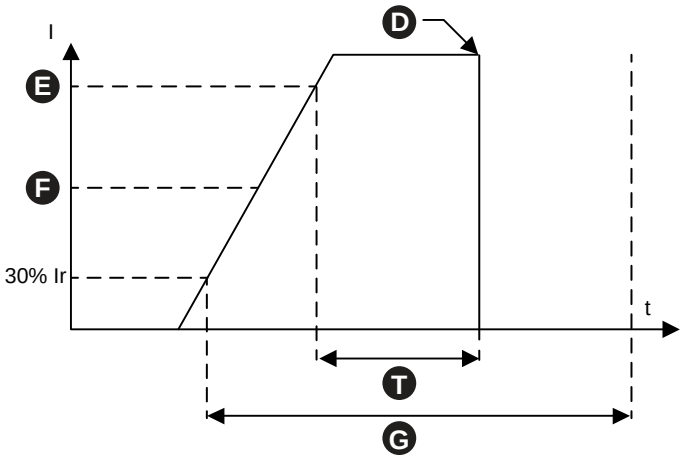
Figure 24 - Stall and Trip



I1	Phase 1 Current	**I2**	Phase 2 Current
I3	Phase 3 Current	**A**	Imax
B	Imax ≥ Stall Trip Level	**C**	Start State
D	Stall Trip	**T**	Stall Trip Delay

This function is typically enabled in addition to the Long Start protection function, setting a higher acceptable current intensity level and a shorter trip delay.

Figure 25 - Stall Trip Versus Long Start Trip



D	Stall Trip	**E**	Stall Level
F	Long Start Trip Level	**G**	Long Start Trip Delay
I	Current	**Ir**	Rated Current
t	Time	**T**	Stall Trip Delay

NOTE: In this illustration, the Stall protection function triggers a trip—while the Long Start protection function does not (because the Long Start Trip Delay has not elapsed yet).

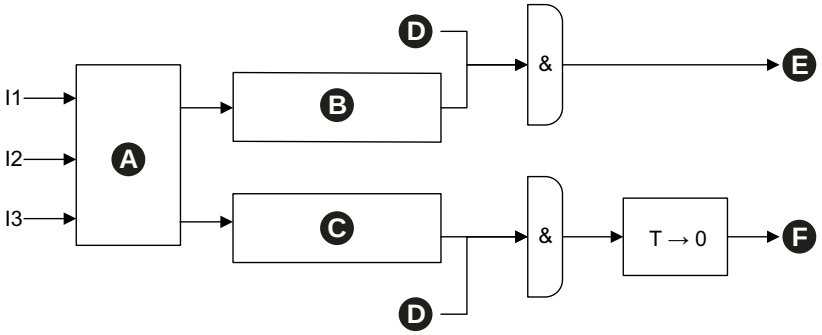
Undercurrent

The Undercurrent function detects unexpected low current consumption during the Run state. This condition is typically associated with motors running free, without a load—for instance, if a drive belt or shaft has broken.

If enabled, this protection function performs the following:

- Signals an Undercurrent Alarm when the average phase current remains below the specified Undercurrent Alarm Level
- If the motor is in the Run state, triggers an Undercurrent Trip when the average phase current remains below the specified Undercurrent Trip Level, for a time longer than the specified Undercurrent Trip Delay

Figure 26 - Undercurrent Trip and Alarm



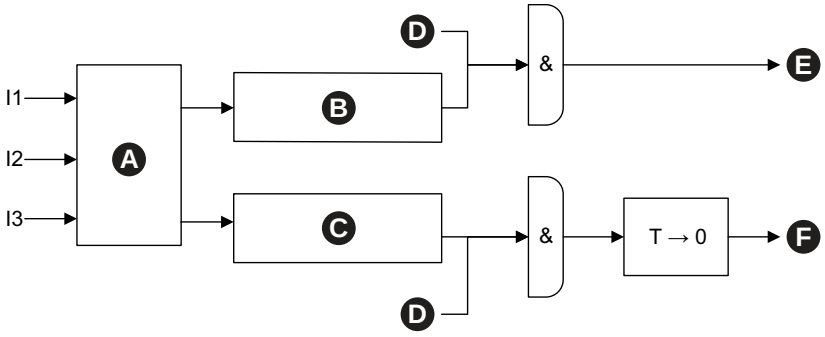
I1	Phase 1 Current	**I2**	Phase 2 Current
I3	Phase 3 Current	**A**	Iavg
B	Iavg ≤ Undercurrent Alarm Level	**C**	Iavg ≤ Undercurrent Trip Level
D	Run State	**E**	Undercurrent Alarm
F	Undercurrent Trip	**T**	Undercurrent Trip Delay

Overcurrent

TeSys™ avatars with Overcurrent Alarm enabled signal an Overcurrent Alarm if the maximum phase current exceeds the Overcurrent Alarm Level in the motor Run state.

Avatars with Overcurrent Trip enabled signal an Overcurrent Trip if the maximum phase current exceeds the Overcurrent Trip Level in the motor Run state for a time longer than the Overcurrent Trip Delay.

Figure 27 - Overcurrent Trip and Alarm



I1	Phase 1 Current	**I2**	Phase 2 Current
I3	Phase 3 Current	**A**	Imax
B	Imax ≥ Overcurrent Alarm Level	**C**	Imax ≥ Overcurrent Trip Level
D	Run State	**E**	Overcurrent Alarm
F	Overcurrent Trip	**T**	Overcurrent Trip Delay

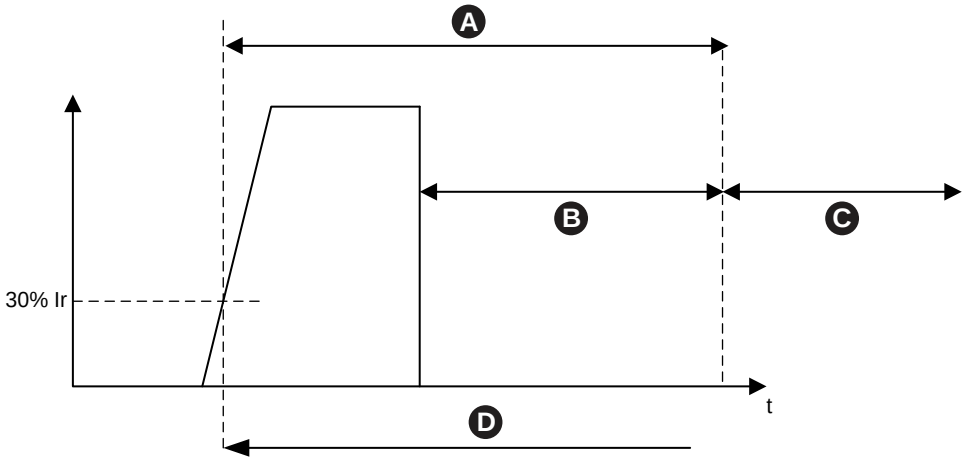
Rapid Cycle Lockout

The Rapid Cycle Lockout function helps prevent potential harm to the motor caused by repetitive, successive inrush currents resulting from too little time between starts.

If this protection function is enabled, the TeSys™ avatar ignores Run commands for the duration specified by the Rapid Cycle Lockout Timeout, starting from the last transition to the motor Start state.

No alarm or trip is associated with this function.

Figure 28 - Rapid Cycle Lockout Timeout



Ir	Rated Current	**A**	Rapid Cycle Lockout Timeout
B	New Run Commands Ignored	**C**	New Run Commands Not Ignored
D	Transition into Motor Start State	**t**	Time

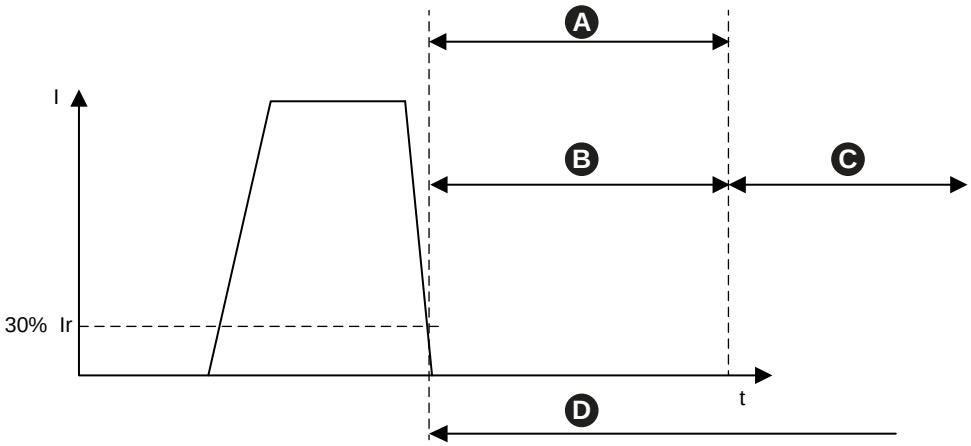
Rapid Restart Lockout

The Rapid Restart Lockout function helps prevent potential harm to the motor caused by repetitive, successive stop and start events.

If this protection function is enabled, the TeSys™ avatar ignores Run commands for the duration specified by the Rapid Restart Lockout Timeout, starting from the last transition to the motor Off state .

No alarm or trip is associated with this function.

Figure 29 - Rapid Restart Lockout



Ir	Rated Current	**I**	Current
A	Rapid Restart Lockout Timeout	**B**	New Run Commands Ignored
C	New Run Commands Not Ignored	**D**	Transition to Motor Off State
t	Time		

Thermal Protection Functions

Thermal Overload

The Thermal Overload protection function is based on a thermal model which calculates the used thermal capacity of the motor.

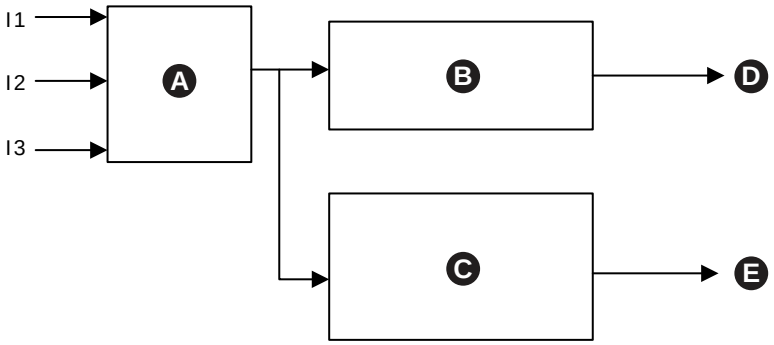
If enabled, this function performs the following:

- Signals a Thermal Overload Alarm when the motor thermal capacity used exceeds the Overload Alarm Level
- Triggers a Thermal Overload Trip when the motor thermal capacity used exceeds 100%

The Thermal Reset Threshold parameter sets the percentage below which the motor thermal capacity used must fall, before a thermal overload trip reset is allowed.

NOTE: For single phase, thermal overload protection uses only I1 and I3.

Figure 30 - Thermal Overload Protection Trip and Alarm



I1	Phase 1 Current	**I2**	Phase 2 Current
I3	Phase 3 Current	**A**	Motor Thermal Model
B	Motor Thermal Capacity Used ≥ 100%	**C**	Motor Thermal Capacity Used ≥ Thermal Overload Alarm Level
D	Thermal Overload Trip	**E**	Thermal Overload Alarm

Motor Overheat

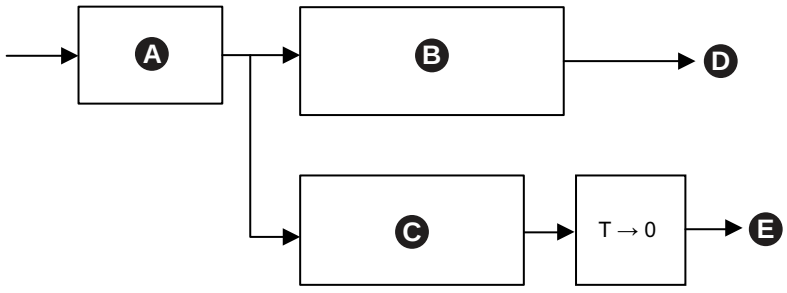
The Motor Overheat function is only available for TeSys™ avatars whose Temperature Sensor Available parameter is activated. These avatars include an analog I/O module, which is wired to the temperature input from the temperature sensor associated with the protected motor.

If enabled, this protection function performs the following:

- Signals a Motor Overheat Alarm when the motor temperature exceeds the Motor Overheat Alarm Level
- Triggers a Motor Overheat Trip when the motor temperature exceeds the Motor Overheat Trip Level, for a time longer than the Motor Overheat Trip Delay

The Motor Overheat Trip Reset Threshold parameter sets the percentage below which the temperature must fall, before a trip reset is allowed.

Figure 31 - Motor Overheat Trip and Alarm



A	Motor Temperature	**B**	Motor Temperature ≥ Motor Overheat Alarm Level
C	Motor Temperature ≥ Motor Overheat Trip Level	**D**	Alarm
E	Trip	**T**	Motor Overheat Trip Delay

Electrical Protection Functions

Electrical protection functions detect electrical problems.

- Phase Configuration
- Current Phase Unbalance
- Current Phase Loss
- Ground Current Detection
- Current Phase Reversal

Phase Configuration

The Phase Configuration function applies only to single-phase TeSys™ avatars. In a single-phase system, this feature is automatically enabled. It triggers a Phase Configuration trip if the current in phase two is greater than 50% Ir FLA for more than 1 s.

NOTE: Phase Configuration protection does not apply to three-phase operation.

Current Phase Unbalance

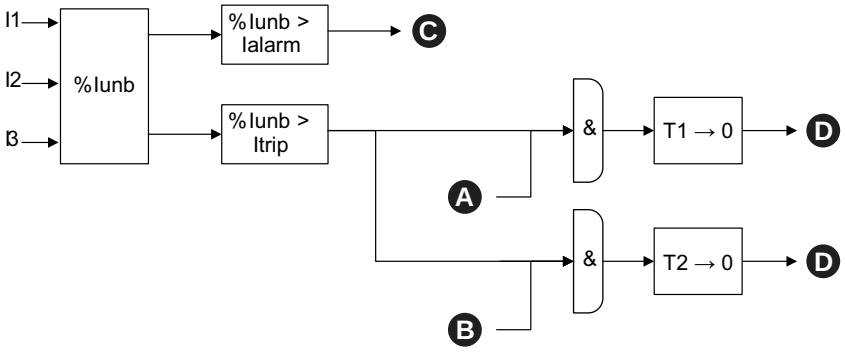
The Current Phase Unbalance function only applies to three-phase TeSys™ avatars.

If enabled, this protection function performs the following:

- Signals a Current Phase Unbalance Alarm when the current phase unbalance exceeds the specified Current Phase Unbalance Alarm Level
- Triggers a Current Phase Unbalance Trip when the current phase unbalance exceeds the specified Current Phase Unbalance Trip Level for a time longer than the specified Current Phase Unbalance Trip Delay

NOTE: Separate trip delays are configurable for Run State and Start State.

Figure 32 - Current Phase Unbalance Trip and Alarm



I1	Phase 1 Current	**I2**	Phase 2 Current
I3	Phase 3 Current	**%Iunb**	%Current Phase Unbalance
Ialarm	Current Phase Unbalance Alarm Level	**Itrip**	Current Phase Unbalance Trip Level
T1	Current Phase Unbalance Trip Delay —Start	**T2**	Current Phase Unbalance Trip Delay —Run
A	Motor Start State	**B**	Motor Run State
C	Current Phase Unbalance Alarm	**D**	Current Phase Unbalance Trip

NOTE: The %Current Phase Unbalance value is

- The maximum difference between any individual phase RMS current (in absolute value) and the average of the three-phase RMS currents
- Divided by the average of the three-phase RMS currents

Current Phase Loss

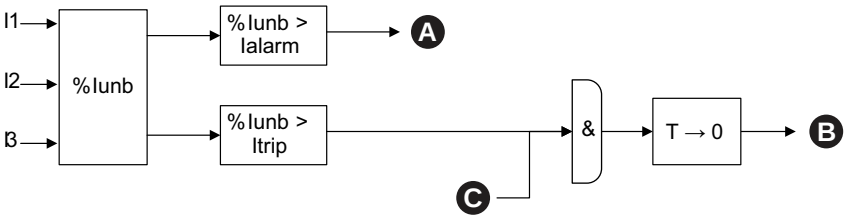
The Current Phase Loss function only applies to three-phase TeSys™ avatars.

If enabled, then in the motor Start or Run state, this protection function triggers a Current Phase Loss Trip when the current phase unbalance exceeds the Current Phase Loss Trip Level, for a time longer than the Current Phase Loss Trip Delay.

NOTE: The Current Phase Unbalance value is the ratio of the following:

- The maximum difference between any individual phase RMS current (in absolute value) and the average of the three-phase RMS currents
- Divided by the average of the three-phase RMS currents

Figure 33 - Current Phase Loss Trip



I1	Phase 1 Current	**I2**	Phase 2 Current
I3	Phase 3 Current	**%Iunb**	%Current Phase Unbalance
Ialarm	Current Phase Loss Alarm Level	**Itrip**	Current Phase Loss Trip Level
A	Current Phase Loss Alarm	**B**	Current Phase Loss Trip
C	Motor Start or Run State	**T**	Current Phase Loss Trip Delay

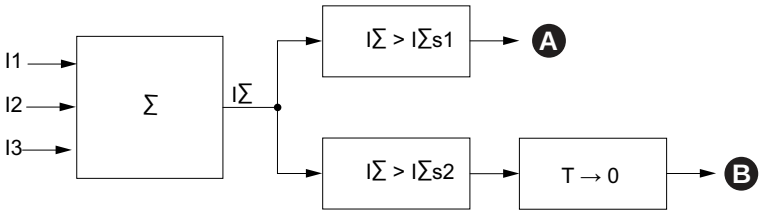
Ground Current Detection

The Ground Current Detection function detects ground currents.

If enabled, this protection function performs the following:

- Signals a Ground Current Detection Alarm when the ground current exceeds the specified Ground Current Alarm Level
- Triggers a Ground Current Detection Trip when the ground current exceeds the specified Ground Current Trip Level, for a time longer than the specified Ground Current Trip Delay

Figure 34 - Ground Current Trip and Alarm



I1	Phase 1 Current	**I2**	Phase 2 Current
I3	Phase 3 Current	**IΣ**	Summation of the Current
IΣs1	Ground Current Alarm Level	**IΣs2**	Ground Current Trip Level
A	Ground Current Alarm	**B**	Ground Current Trip
T	Ground Current Trip Delay		

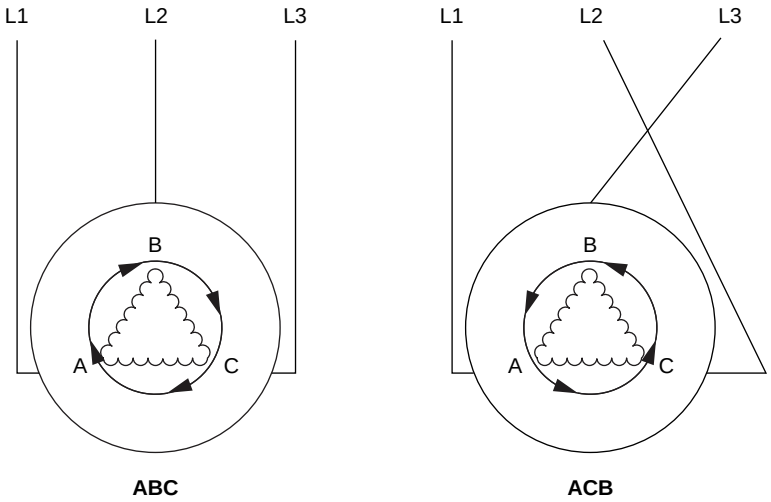
Phase Reversal

The Phase Reversal function detects incorrect phase sequence in a three-phase system, causing a connected three-phase motor or other rotating equipment to run in the opposite direction than expected.

If enabled, this protection function triggers a Phase Reversal trip if the detected current phase sequence does not match the Current Phase Sequence setting over a time period of 100 ms.

No alarm is associated with this function. The 100 ms time period is not adjustable.

Figure 35 - Phase Reversal for Setting ABC



ABC	No Trip	**ACB**	Trip

Alarm and Trip Counters

Protection functions increment alarm and trip event counters, both at the TeSys™ avatar level and overall at the island level. Counters can be reset to zero on demand.

The following tables describe counter behavior.

Table 31 - Counter Inputs

Inputs	Description
Alarm Counter Reset	Resets all alarm counters (see the following table) to zero.
Trip Counter Reset	Resets all trip counters (see the following table) to zero. All avatars store the last five trip records, each containing the timestamp and cause of the trip.

Table 32 - List of Alarm Counters

Outputs	Description
Thermal Overload Alarm Count	Increments when an individual alarm is triggered. Reset by Alarm Counter Reset
Jam Alarm Count	
Undercurrent Alarm Count	
Overcurrent Alarm Count	
Current Phase Unbalance Alarm Count	
Ground Current Alarm Count	
All Alarms Count	Increments when any type of protection alarm is triggered. Reset by Alarm Counter Reset.

Table 33 - List of Trip Counters

Outputs	Description
Thermal Overload Trip Count	Increments when an individual trip is triggered. Reset by Trip Counter Reset
Jam Trip Count	
Undercurrent Trip Count	
Long Start Trip Count	
Overcurrent Trip Count	
Stall Trip Count	
Current Phase Unbalance Trip Count	
Phase Configuration Trip Count	
Ground Current Detection Trip Count	
Current Phase Reversal Trip Count	
Current Phase Loss Trip Count	
All Trips Count	Increments when any type of protection trip is triggered. Reset by Trip Counter Reset.

Table 34 - Records of the Last Five Trips

Outputs	Description
Trip Record Register 1 (most recent)	First In First Out registers without reset
Trip Record Register 2	
Trip Record Register 3	
Trip Record Register 4	
Trip Record Register 5 (least recent)	

Table 35 - List of Auto-Reset Counters

Outputs	Description
Thermal Protection Auto-Reset Retry Count	Provides the number of auto-reset retry attempts for Thermal Protection functions. If there is no trip within one minute after a retry attempt, the start is considered successful and Auto Reset Retry Count is reset to 0.
Electrical Protection Auto-Reset Retry Count	Provides the number of auto-reset retry attempts for Electrical Protection functions. If there is no trip within one minute after a retry attempt, the start is considered successful and Auto Reset Retry Count is reset to 0.
Load Protection Auto-Reset Retry Count	Provides the number of auto-reset retry attempts for Load Protection functions. If there is no trip within one minute after a retry attempt, the start is considered successful and Auto Reset Retry Count is reset to 0.

Trip Reset Command

NOTE: The Reset function may lead to immediate energizing of the load, with an active command from the PLC or the Force mode function.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Before resetting the protection functions, verify that this function does not result in unsafe conditions.

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

A tripped TeSys™ avatar can only reset protection trips after receiving a Trip Reset command and if all the trip reset conditions are met for all its protection functions. This mechanism helps ensure that, after a trip, normal operation can only resume when all the defined normal operational conditions are met again.

When a protection function has caused an avatar to trip, the avatar remains in the tripped state until both of the following occur:

- The operational conditions again match the trip reset conditions of the protection function
- The avatar receives a Trip Reset command

The Trip Reset command applies to all the protection functions enabled for a given avatar. However:

- The Tripped state output is set to false only for those protection functions whose trip reset conditions are met.
- The Tripped status output remains set to true for those protection functions whose trip reset conditions are still not met.

A tripped avatar has at least one tripped protection function (with a Tripped status set to true).

According to the same logic, an avatar that is not tripped has no tripped protection functions (no protection with a Tripped status set to true).

Tripped protection functions can be reset by the Auto-Reset function, via the controller or by using one of the digital tools.

Note that the Tripped status of all protection functions is maintained through a power cycle of the system—with the exception of the Current Phase Reversal and Phase Configuration functions. For these functions, a power cycle resets the Tripped status (to not tripped).

The following table describes the Trip Reset Conditions, including hysteresis, for all avatars.

Table 36 - Trip Reset Conditions

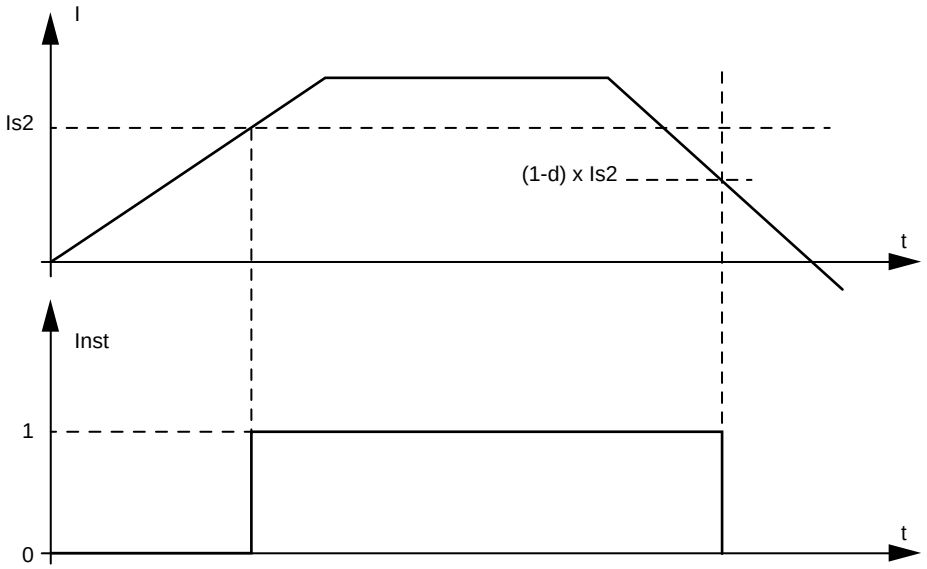
Protection Function	Trip Reset Conditions
Thermal Overload	Thermal capacity has decreased below Thermal Reset Threshold (no hysteresis).
Motor Overheat	Motor temperature has decreased below Motor Overheat Reset Threshold (no hysteresis).
Current Phase Unbalance	Current unbalance has decreased below Current Phase Unbalance Trip Level.
Current Phase Loss	Current unbalance has decreased below Current Phase Loss Trip Level.
Jam	Maximum phase current has decreased below Jam Trip Level.
Undercurrent	Average current has increased above Undercurrent Trip Level.
Long Start	Average current has decreased below 30% Ir (no hysteresis).
Overcurrent	Maximum phase current has decreased below Overcurrent Trip Level.
Stall	Maximum phase current has decreased below Stall Trip Level.
Ground Current	Ground current has decreased below Ground Current Trip Level.
Current Phase Reversal	Average current has decreased below 30% Ir (no hysteresis).
Phase Configuration	Average current has decreased below 30% Ir (no hysteresis).

Where indicated, protection functions apply a 5% hysteresis value to the trip reset conditions. This increases the stability of the protection functions' behavior. The trip reset is only authorized when normal conditions and this extra 5% margin are recovered.

For instance, the Jam protection function triggers a trip when the maximum phase current exceeds the defined Jam trip level. The trip reset conditions are met when the maximum phase current decreases below the Jam trip level minus 5%.

Additionally, setting the Trip Enable parameter for a protection function to Disable meets the Trip reset condition for that protection function.

Figure 36 - Hysteresis



NOTE: d = Hysteresis percentage

Trip Auto-Reset Function

NOTE: The Auto-Reset function may lead to immediate energizing of the load, with an active command from the PLC or the Force mode function.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Configure this function in a such a way that it does not result in unsafe conditions.

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

The Automatic Reset function triggers trip reset commands automatically, without the intervention of a human operator. This function can be configured separately for each Thermal group, Electrical group, and Load group of protection functions of a TeSys™ avatar.

The following table defines the Auto-Reset groups.

Table 37 - Auto-Reset Groups

Auto-Reset Group	Protection Trip Cause
Load Protection	Jam
	Long Start
	Stall
	Undercurrent
	Overcurrent
Thermal Protection	Thermal Overload
	Motor Overheat
Electrical Protection	Phase Configuration
	Current Phase Unbalance
	Current Phase Loss
	Ground Current Detection
	Current Phase Reversal

For each group, you can configure the following:

- A delay before a reset attempt
- Functionality to repeat reset attempts

The Auto-Reset function ultimately works as the Trip Reset command: the tripped protection functions are reset only if their trip reset conditions are met.

Two parameters can be configured for each group of protection functions.

- The Auto-Reset Timer is a delay between the moment a protection function detects the presence of trip conditions (and triggers a trip), and the first auto-reset attempt. The actual reset can occur only after the delay elapses and the trip reset conditions are met. For instance, if the delay is set to 60 s and it takes 70 s for the system to meet the trip reset conditions, then the reset occurs after 70 s (that is, the shortest duration that satisfies both rules). If it only takes 50 s to meet the trip reset conditions, then the delay still applies and the reset occurs after 60 s.
- The Auto-Reset Retry Attempt Maximum specifies the number of reset attempts made if the previous ones are unsuccessful (for instance, if the external conditions causing the trip to occur still exist.). If the Auto-Reset Retry Attempt Maximum parameter is set to A, the reset attempts are repeated indefinitely until the reset is successful. Otherwise, only the specified number of resets is attempted.

These parameters apply to each protection function within the group. If multiple protection functions are tripped within a given group, then the delay, the criteria of the trip reset conditions, and the retry attempt maximum setting apply to all the tripped functions of that group. For example, if both the Stall and Long Start protection functions are tripped, the Auto-Reset triggers a trip reset only after the delay set for the Load Protection group elapses, and the trip reset conditions are met for both protection functions.

The Group Auto-Reset Retry counter increments for each retry attempt. It is reset to zero one minute after a successful trip reset (in the absence of further trips).

The following table describes Auto-Reset parameters.

Table 38 - Auto-Reset Parameters

Setting Name		Description	Value Range	Units	Default Value	Increment
Load Protection	Auto-Reset Retry Attempt Maximum	Parameter to limit Auto-Reset operations	0–10 (A)	—	0	1
	Auto-Reset Timer	Timer to trigger Auto-Reset	0–65,535	s	60	1
Thermal Protection	Auto-Reset Retry Attempt Maximum	Parameter to limit Auto-Reset operations	0–10 (A)	—	A	1
	Auto-Reset Timer	Timer to trigger Auto-Reset	0–65,535	s	480	1
Electrical Protection	Auto-Reset Retry Attempt Maximum	Parameter to limit Auto-Reset operations	0–10 (A)	—	0	1
	Auto-Reset Timer	Timer to trigger Auto-Reset	0–65,535	s	1,200	1

Monitoring Data

Upstream Voltage Presence

The Upstream Voltage Presence function detects the presence of voltage in the upstream power connections of the devices. This information typically indicates the open/closed state of upstream protection devices (like circuit breakers).

Current Monitoring

The Current Monitoring function provides average and per-phase current information at the TeSys™ avatar level. It can also detect the maximum current seen since last reset, along with an associated timestamp. Average current is available in the Control function block for each avatar, with additional information in the Diagnostics function block.

Energy Monitoring

The Energy Monitoring functions provide several voltage, power, and energy measurements, both at the TeSys™ avatar level and for the full island.

These functions can be activated through the avatars' Load Energy Monitoring setting, and require one voltage interface module to be installed in the island.

Energy is measured within a 10% accuracy for loads running under nominal conditions (50–125% FLA, power factor 0.7, 47–63 Hz).

System Monitoring

The monitoring functions described in the following tables apply to the TeSys™ island as a whole.

Table 39 - Voltage Monitoring

- Phase RMS Voltage
- Average RMS Voltage
- Maximum RMS Voltage and Timestamp
- Voltage Fluctuation Status (Dip and Swell)
- Percentage of Unbalance Voltage
- Maximum Unbalance Voltage and Timestamp
- Voltage Frequency (Hz)
- Voltage Phase Sequence

Table 40 - Power Monitoring

- Instantaneous Total Active Power (kW)
- Maximum Total Active Power (kW) and Timestamp
- Instantaneous Total Reactive Power (kVAR)
- Maximum Total Reactive Power (kVAR) and Timestamp
- True Power Factor
- Minimum True Power Factor and Timestamp
- Maximum True Power Factor and Timestamp

Table 41 - Energy Monitoring

- Total Active Energy (kWh)
- Total Reactive Energy (kVARh)

Avatar Monitoring

The monitoring functions described in the following tables apply to the TeSys™ avatars individually.

Table 42 - Power Monitoring

- Instantaneous Total Active Power (kW)
- Maximum Total Active Power (kW) and Timestamp
- Instantaneous Total Reactive Power (kVAR)
- Maximum Total Reactive Power (kVAR) and Timestamp
- True Power Factor
- Minimum True Power Factor and Timestamp
- Maximum True Power Factor and Timestamp

Table 43 - Energy Monitoring

- Total Active Energy (kWh)
- Total Reactive Energy (kVARh)

Avatar Composition

Standard Starter (ST)

Power Interface Module (PM)

SIL[26] Starter (SS)

SIL Interface Module (SM)

Digital I/O Module (DG)

Analog I/O Module (AN)

Table 44 - Avatar Modules

TeSys™ Avatar	Module 1	Module 2	Module 3	Module 4	Module 5	Optional
Switch	ST					
Switch - SIL Stop, W. Cat 1/2 [27]	SS	SM				
Switch - SIL Stop, W. Cat 3/4 [28]	SS	SS	SM			
Digital I/O	DG					
Analog I/O	AN					
Power Interface without I/O (Measure)	PM					AN
Power Interface with I/O (Control)	DG	PM				AN
Motor One Direction	ST					AN/DG
Motor One Direction - SIL Stop, W. Cat 1/2	SS	SM				AN
Motor One Direction - SIL Stop, W. Cat 3/4	SS	SS	SM			AN
Motor Two Directions	ST	ST				AN/DG
Motor Two Directions - SIL Stop, W. Cat 1/2	SS	SS	SM			AN
Motor Two Directions - SIL Stop, W. Cat 3/4	SS	SS	SS	SM		AN
Motor Y/D One Direction	ST	ST	ST			AN/DG
Motor Y/D Two Directions	ST	ST	ST	ST		AN/DG
Motor Two Speeds	ST	ST				AN/DG
Motor Two Speeds - SIL Stop, W. Cat 1/2	SS	SS	SM			AN
Motor Two Speeds - SIL Stop, W. Cat 3/4	SS	SS	SS	SM		AN
Motor Two Speeds Two Directions	ST	ST	ST	ST		AN/DG
Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2	ST	ST	SS	SS	SM	AN
Motor Two Speeds Two Directions - SIL Stop, W. Cat 3/4	SS	SS	SS	SS	SM	AN
Resistor	ST					

26. Safety Integrity Level according to standard IEC 61508.
27. Wiring Category 1 and Category 2 according to ISO 13849.
28. Wiring Category 3 and Category 4 according to ISO 13849.

Table 44 - Avatar Modules (Continued)

TeSys™ Avatar	Module 1	Module 2	Module 3	Module 4	Module 5	Optional
Power Supply	ST					
Transformer	ST					
Pump	DG	ST				AN/DG
Conveyor One Direction	DG	ST				AN/DG
Conveyor One Direction - SIL Stop, W. Cat 1/2	DG	SS	SM			AN/DG
Conveyor Two Directions	DG	ST	ST			AN/DG
Conveyor Two Directions - SIL Stop, W. Cat 1/2	DG	SS	SS	SM		AN/DG

Table 45 - LAD9R1 Assembly Kit for 9–38 A (Size 1 and 2) Starters

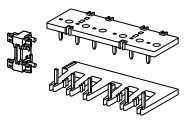
LAD9R1 Assembly Kit	For Use with Avatars:	Kit Components	Description
	Motor Two Directions	LAD9V5	Parallel link between two starters
	Motor Two Directions - SIL Stop, W. Cat 1/2	LAD9V6	Reversing link between two starters
	Motor Two Directions - SIL Stop, W. Cat 3/4 Motor Y/D One Direction Motor Two Speeds Two Directions Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2 Motor Two Speeds Two Directions - SIL Stop, W. Cat 3/4 Conveyor Two Directions Conveyor Two Directions - SIL Stop, W. Cat 1/2	LAD9V2	Mechanical interlock with assembly staple

Table 46 - LAD9R3 Assembly Kit for 40–65 A (Size 3) Starters

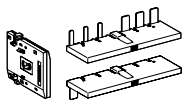
LAD9R3 Assembly Kit	For Use with Avatars:	Kit Components	Description
	Motor Two Directions	LA9D65A6	Parallel link between two starters
	Motor Two Directions - SIL Stop, W. Cat 1/2	LA9D65A9	Reversing link between two starters
	Motor Two Directions - SIL Stop, W. Cat 3/4 Motor Y/D One Direction Motor Two Speeds Two Directions Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2 Motor Two Speeds Two Directions - SIL Stop, W. Cat 3/4 Conveyor Two Directions Conveyor Two Directions - SIL Stop, W. Cat 1/2	LAD4CM	Mechanical interlock

Table 47 - Shorting Blocks for Y/D Avatars

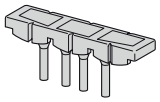
Shorting Blocks	For Use with Avatars:	Reference Number	Description
	Motor Y/D One Direction Motor Y/D Two Directions	LAD9P3	Shorting block / 3P parallel link for 9–38 A (size 1 and 2) starters Used for linking 3 poles of a contactor in a wye-delta (Y/D) starter
	Motor Y/D One Direction Motor Y/D Two Directions	LAD9SD3S	Shorting block / 3P parallel link for 40–65 A (size 3) starters and warning label Used for linking 3 poles of a contactor in a wye-delta (Y/D) starter

Table 48 - Mechanical Interlocks

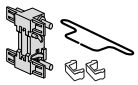
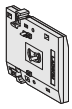
Mechanical Interlocks	For Use with Avatars:	Reference Number	Description
	Motor Y/D One Direction Motor Y/D Two Directions Motor Two Speeds Motor Two Speeds - SIL Stop, W. Cat 1/2 Motor Two Speeds - SIL Stop, W. Cat 3/4 Motor Two Speeds Two Directions Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2 Motor Two Speeds - SIL Stop, W. Cat 3/4	LAD9V2	Mechanical interlock for 9–38 A (size 1 and 2) starters
	Motor Y/D One Direction Motor Y/D Two Directions Motor Two Speeds Motor Two Speeds - SIL Stop, W. Cat 1/2 Motor Two Speeds - SIL Stop, W. Cat 3/4 Motor Two Speeds Two Directions Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2 Motor Two Speeds Two Directions - SIL Stop, W. Cat 3/4	LAD4CM	Mechanical interlock for 40–65 A (size 3) starters

Table 49 - Reversing Links

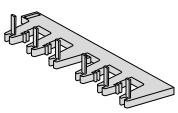
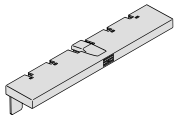
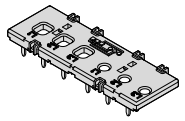
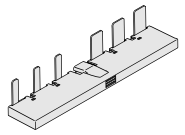
Reversing Links	For Use with Avatars:	Reference Number	Description
	Motor Y/D One Direction Motor Y/D Two Directions	LAD9V6	Reversing link for 9–38 A (size 1 and 2) starters
	Motor Y/D One Direction Motor Y/D Two Directions	LA9D65A9	Reversing link for 40–65 A (size 3) starters

Table 50 - Parallel Links

Parallel Links	For Use with Avatars:	Reference Number	Description
	Motor Two Speeds Motor Two Speeds - SIL Stop, W. Cat 1/2 Motor Two Speeds - SIL Stop, W. Cat 3/4 Motor Two Speeds Two Directions Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2 Motor Two Speeds - SIL Stop, W. Cat 3/4	LAD9V5	Parallel link for 9–38 A (size 1 and 2) starters
	Motor Two Speeds Motor Two Speeds - SIL Stop, W. Cat 1/2 Motor Two Speeds - SIL Stop, W. Cat 3/4 Motor Two Speeds Two Directions Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2 Motor Two Speeds Two Directions - SIL Stop, W. Cat 3/4	LA9D65A6	Parallel link for 40–65 A (size 3) starters

Avatar Wiring Schematics and Accessory Diagrams

Bus Coupler with I/O Modules and Voltage Interface Modules

NOTE: The TPRBCEIP and TPRBCPFN bus couplers each have three RJ45 ports. The TPRBCPFB bus coupler has only one RJ45 port.

Figure 37 - Wiring

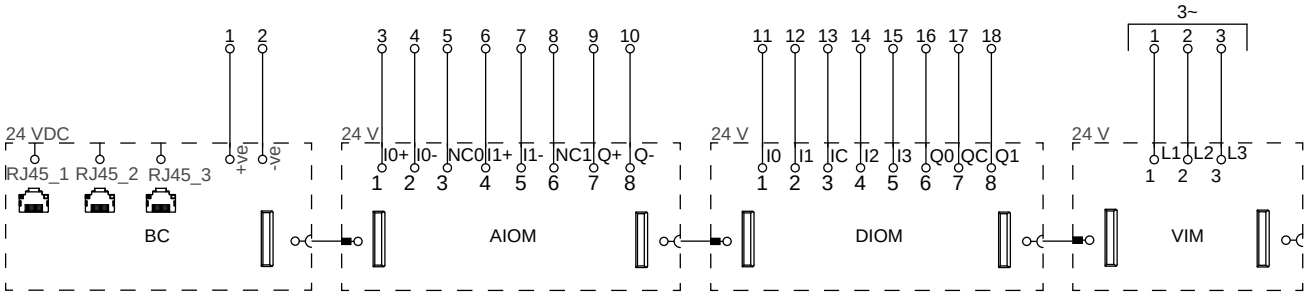


Table 51 - Legend

BC	Bus Coupler (TPRBCEIP)
AIOM	Analog I/O Module
DIOM	Digital I/O Module
VIM	Voltage Interface Module

Switch

Figure 38 - Wiring

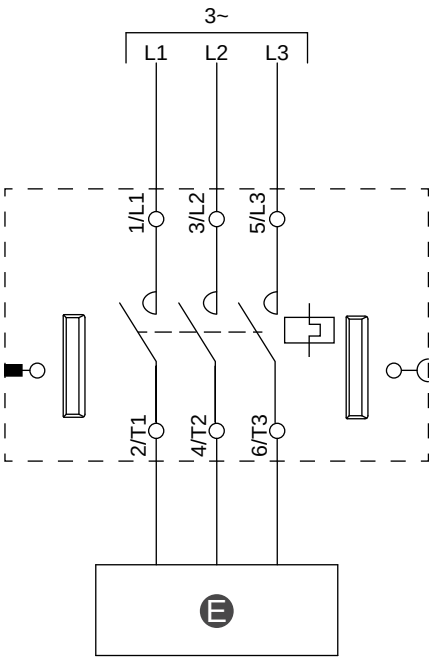


Table 52 - Legend

E	Electrical circuit

Switch - SIL Stop, W. Cat 1/2

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.

Figure 39 - Wiring

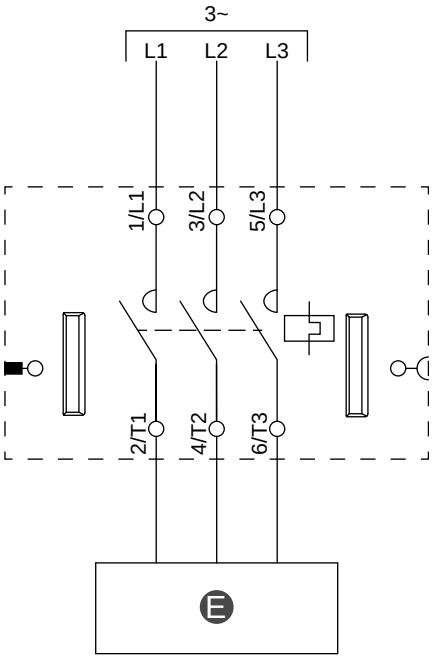


Table 53 - Legend

E	Electrical circuit

Switch - SIL Stop, W. Cat 3/4

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 3 and Category 4 according to ISO 13849.

Figure 40 - Wiring (See Legend Table below)

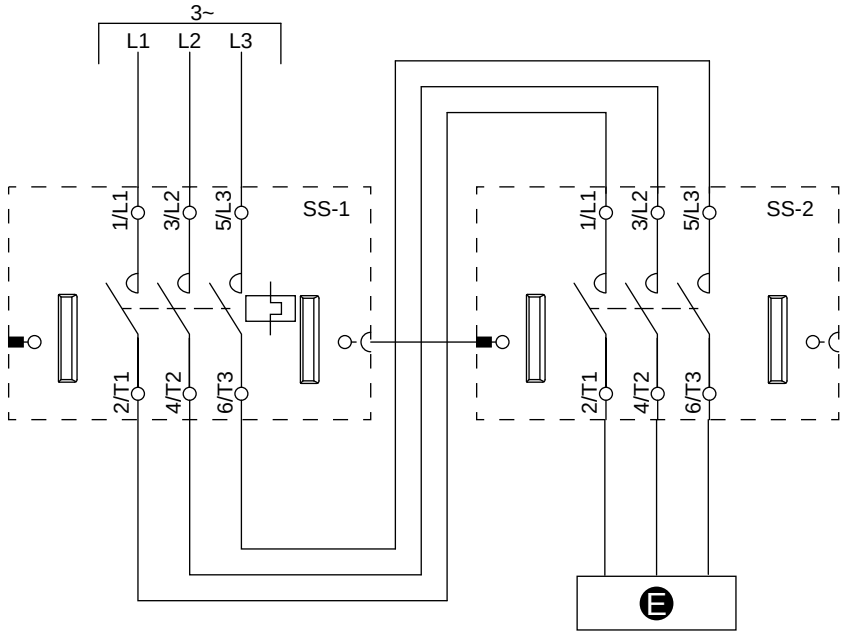
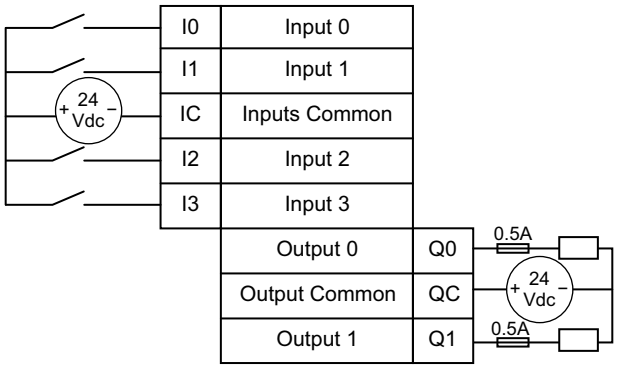


Table 54 - Legend

E	Electrical Circuit
SS–1	SIL starter 1
SS-2	SIL starter 2

Digital I/O

Figure 41 - Wiring



Analog I/O

Figure 42 - Current/Voltage Analog Device Input

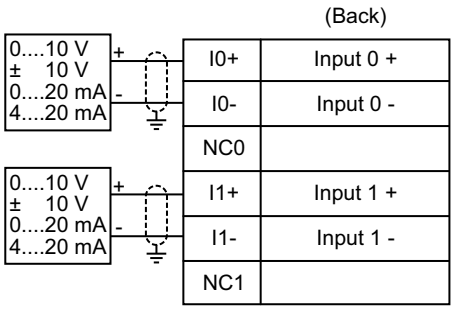


Figure 43 - Thermocouples and Positive Temperature Coefficient (PTC) Binary

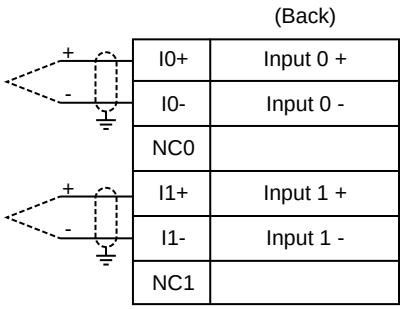


Figure 44 - Resistance Temperature Detector

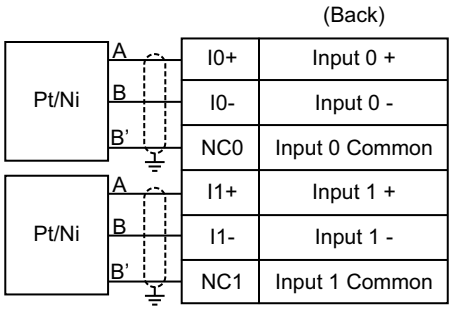
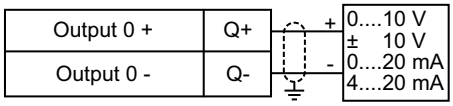


Figure 45 - Current/Voltage Analog Device Output



Power Interface without I/O (Measure)

Figure 46 - Wiring

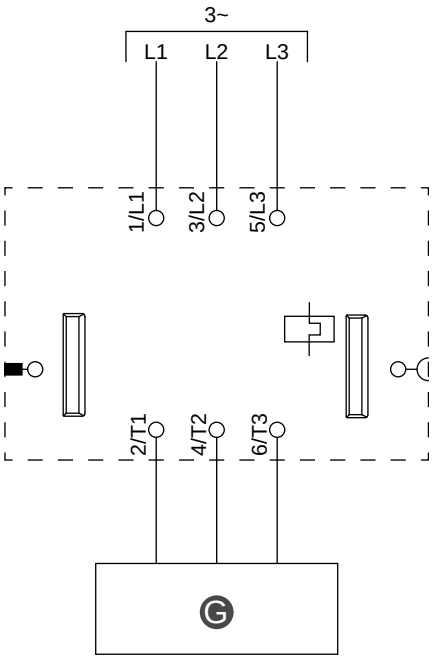


Table 55 - Legend

G	Relay, soft starter, or variable speed drive

Power Interface with I/O (Control)

Figure 47 - Wiring

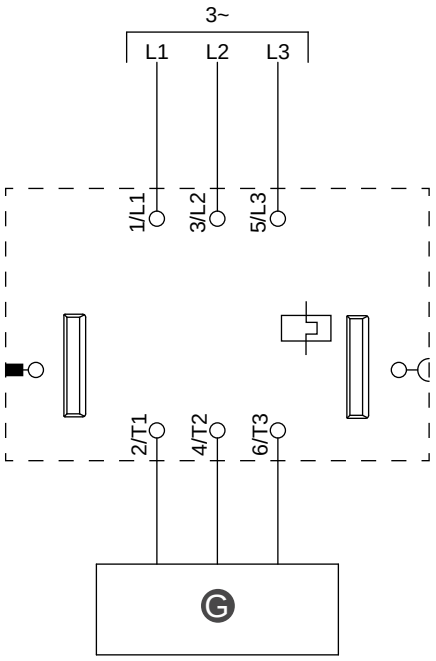
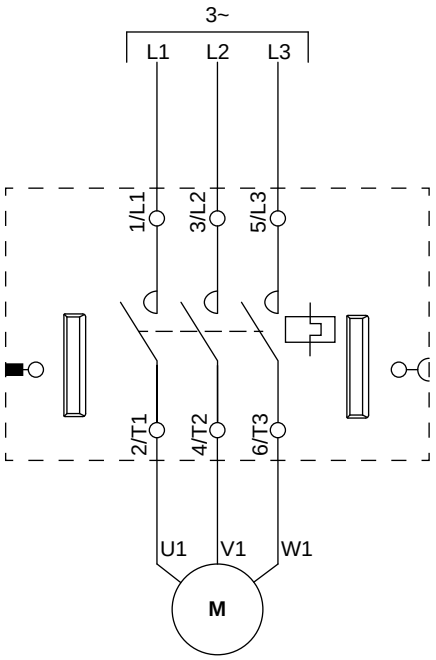


Table 56 - Legend

G	Relay, soft starter, or variable speed drive

Motor One Direction

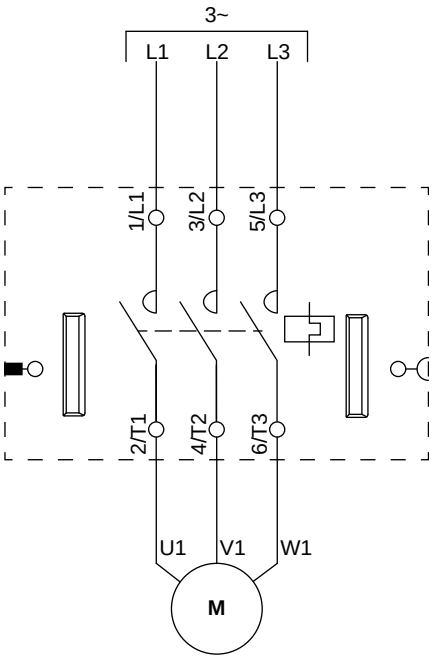
Figure 48 - Wiring



Motor One Direction - SIL Stop, W. Cat 1/2

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.

Figure 49 - Wiring



Motor One Direction - SIL Stop, W. Cat 3/4

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 3 and Category 4 according to ISO 13849.

Figure 50 - Wiring (See Legend Table below)

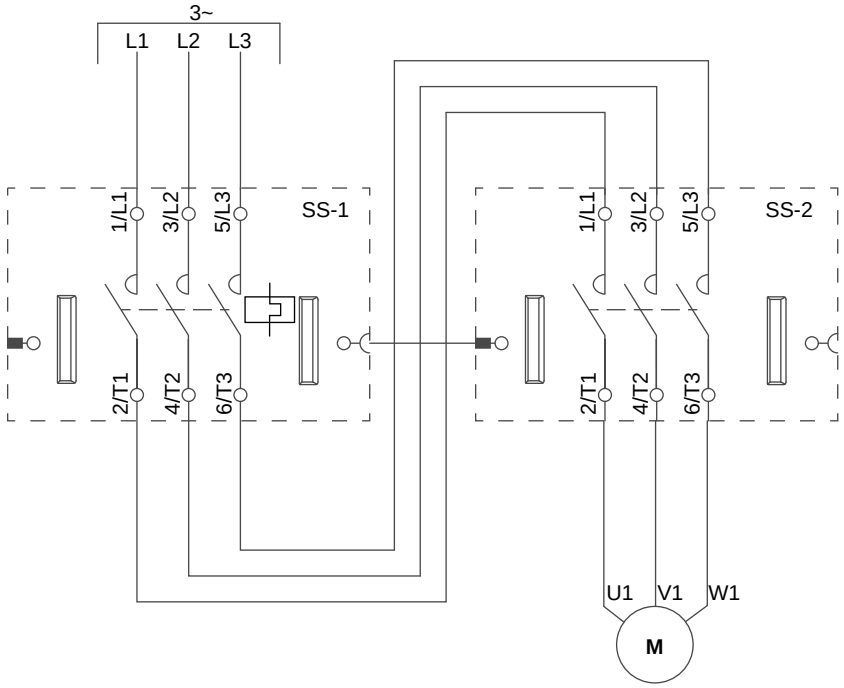


Table 57 - Legend

SS-1	SIL starter 1
SS-2	SIL starter 2

Motor Two Directions

Figure 51 - Wiring (See Legend Table below.)

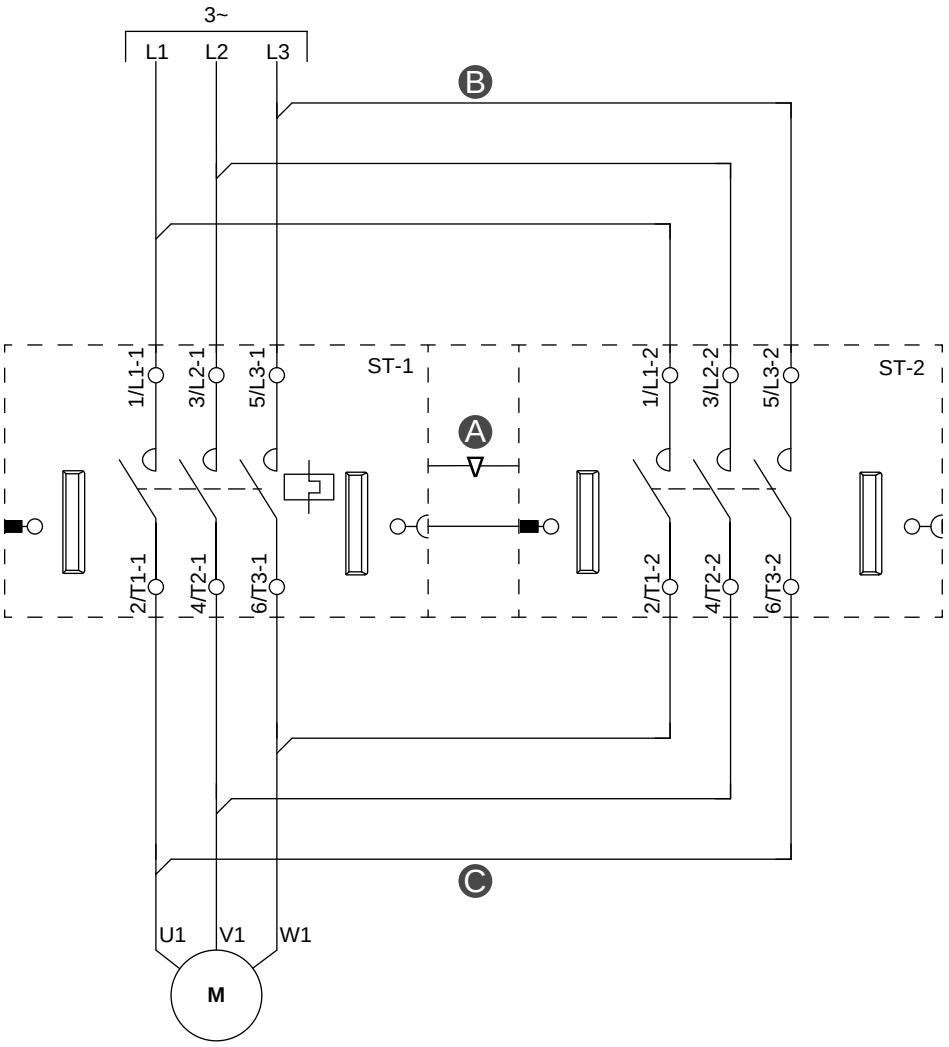


Figure 52 - Accessories

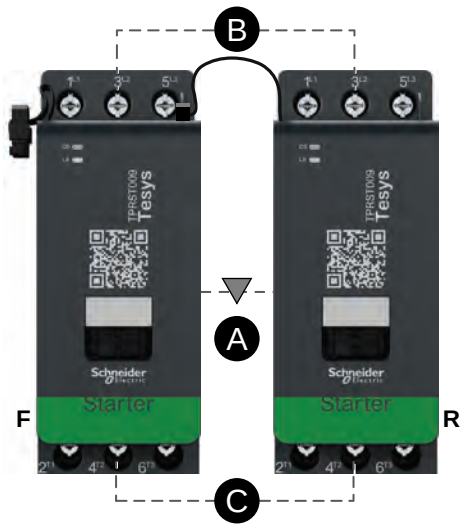


Table 58 - Legend

A	Mechanical interlock
B	Parallel link
C	Reversing link
F	Forward starter
R	Reverse starter
ST-1	Starter 1
ST-2	Starter 2

Motor Two Directions - SIL Stop, W. Cat 1/2

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.

Figure 53 - Wiring (See Legend Table below.)

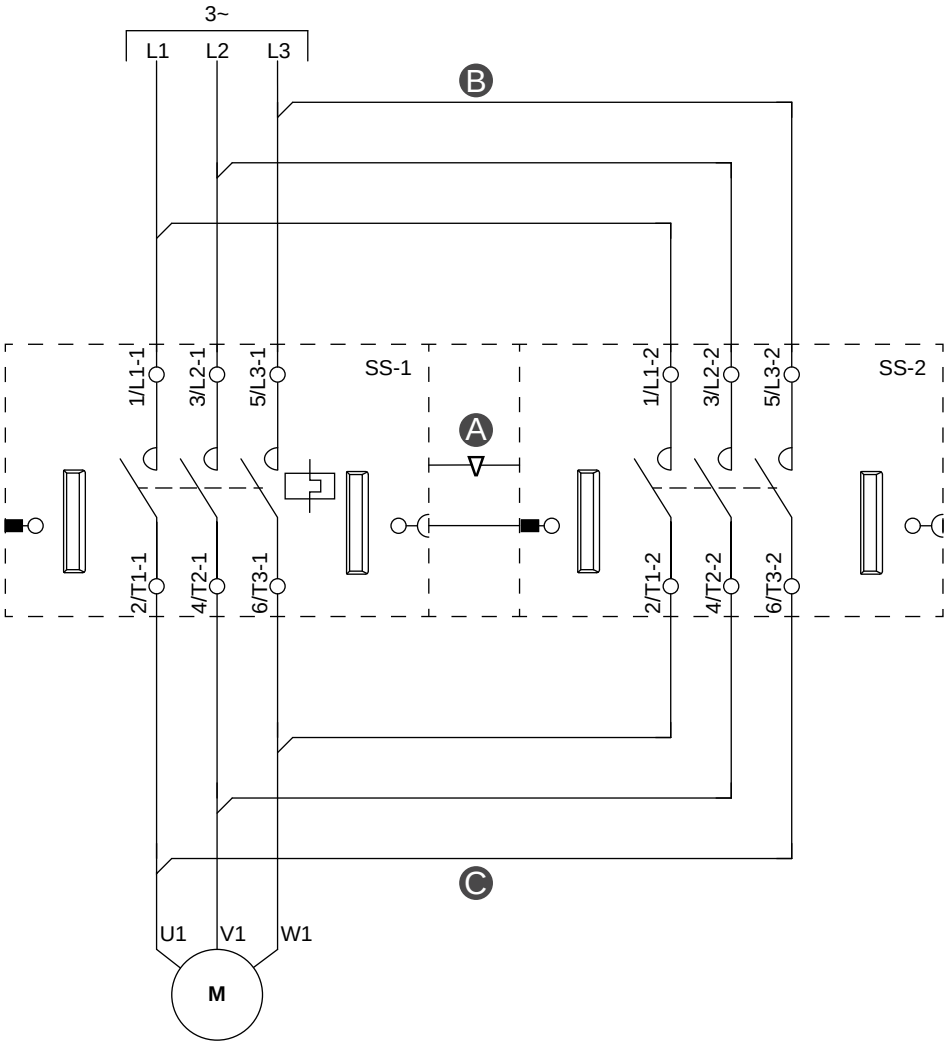


Figure 54 - Accessories

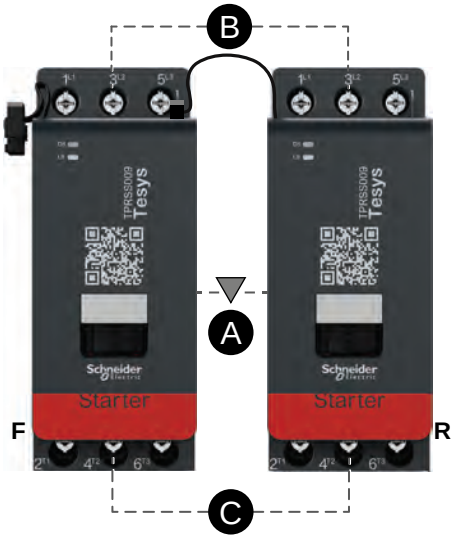


Table 59 - Legend

A	Mechanical interlock
B	Parallel link
C	Reversing link
F	Forward
R	Reverse
SS-1	SIL starter 1
SS-2	SIL starter 2

Motor Two Directions - SIL Stop, W. Cat 3/4

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 3 and Category 4 according to ISO 13849.

Figure 55 - Wiring (See Legend Table below)

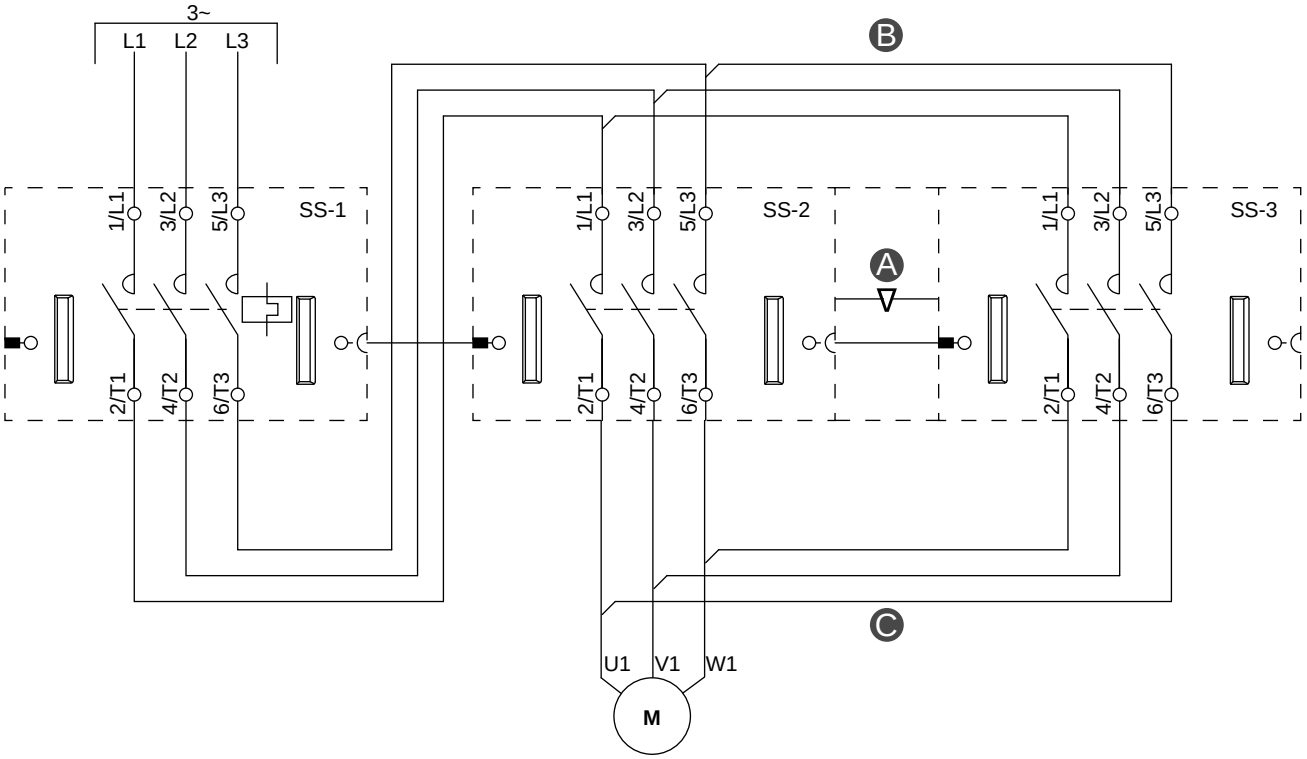


Figure 56 - Accessories

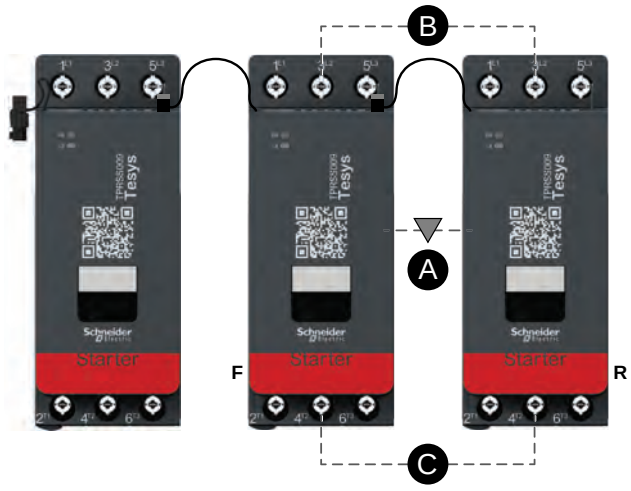


Table 60 - Legend

A	Mechanical interlock
B	Parallel link
C	Reversing link
F	Forward
R	Reverse
SS-1	SIL starter 1
SS-2	SIL starter 2
SS-3	SIL starter 3

Motor Y/D One Direction

Figure 57 - Wiring (See Legend Table below.)

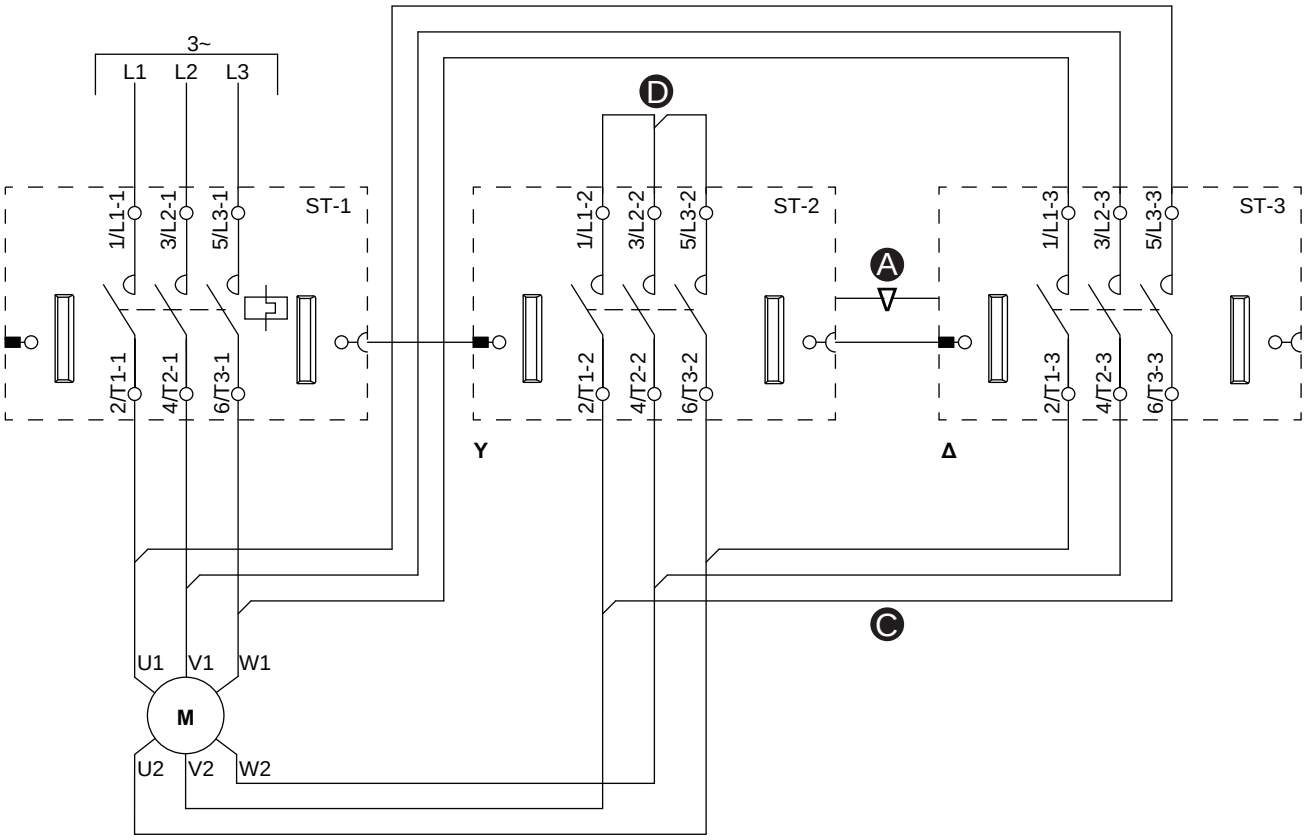


Figure 58 - Accessories

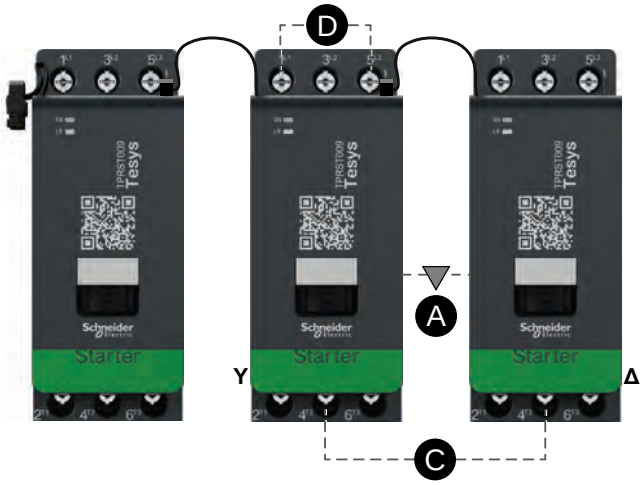


Table 61 - Legend

A	Mechanical interlock
C	Reversing link
D	Shorting block
Y	Wye
Δ	Delta
ST-1	Starter 1
ST-2	Starter 2
ST-3	Starter 3

Motor Y/D Two Directions

Figure 59 - Wiring (See Legend Table below.)

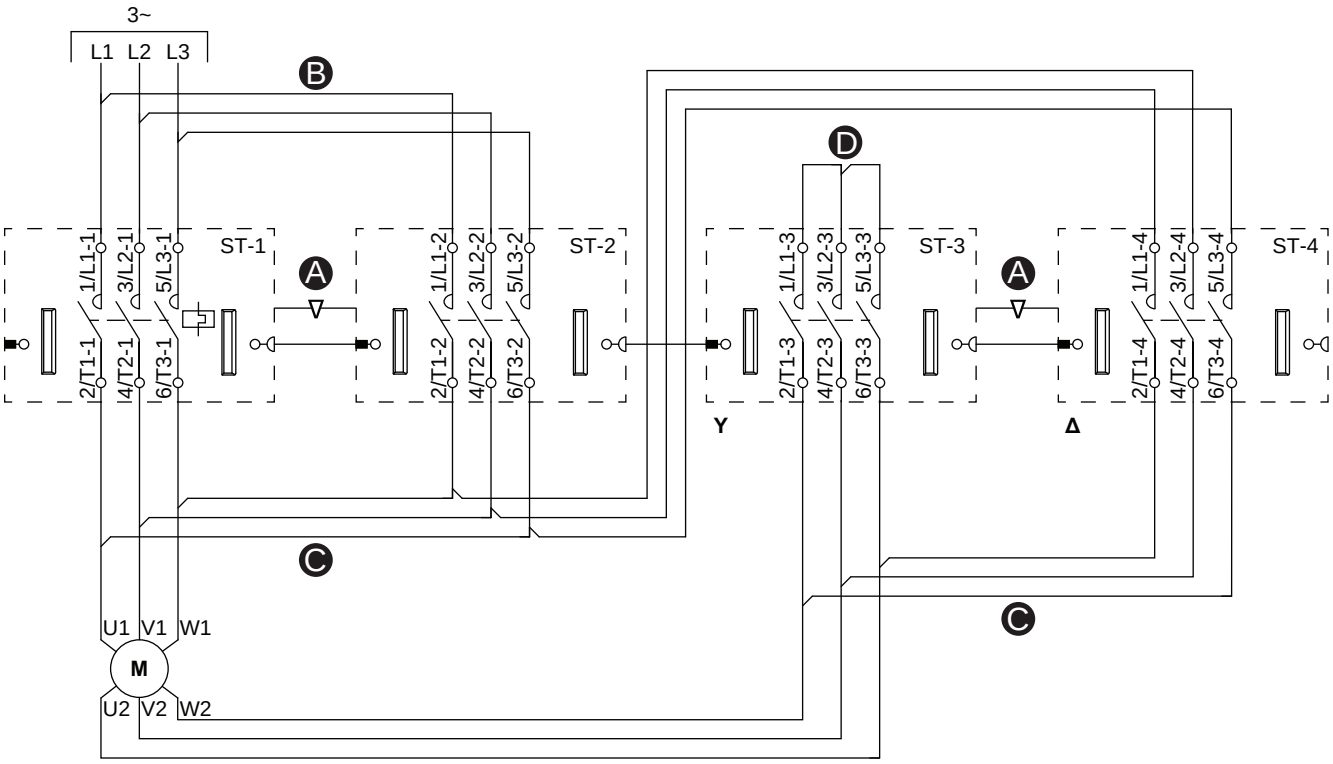


Figure 60 - Accessories

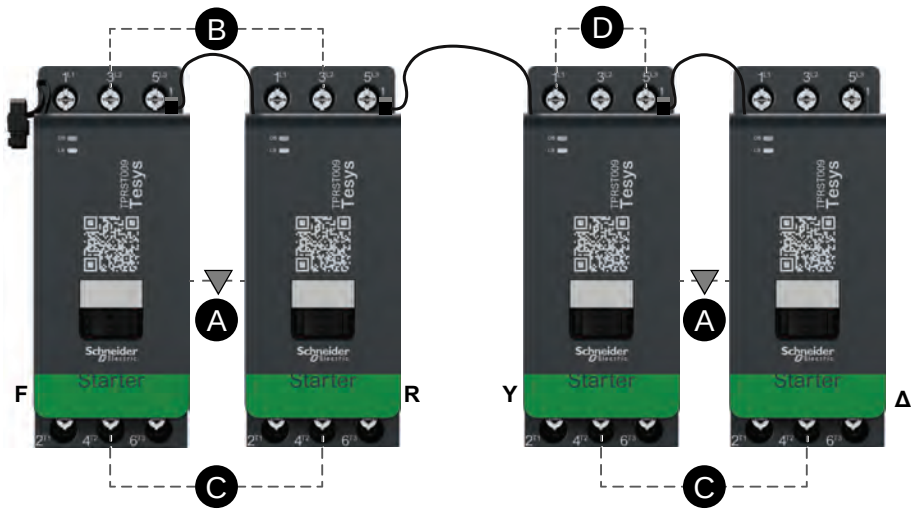


Table 62 - Legend

A	Mechanical interlock
B	Parallel link
C	Reversing link
D	Shorting block
F	Forward
R	Reverse
Y	Wye
Δ	Delta
ST-1	Starter 1
ST-2	Starter 2
ST-3	Starter 3
ST-4	Starter 4

Motor Two Speeds

Figure 61 - Wiring (See Legend Table below.)

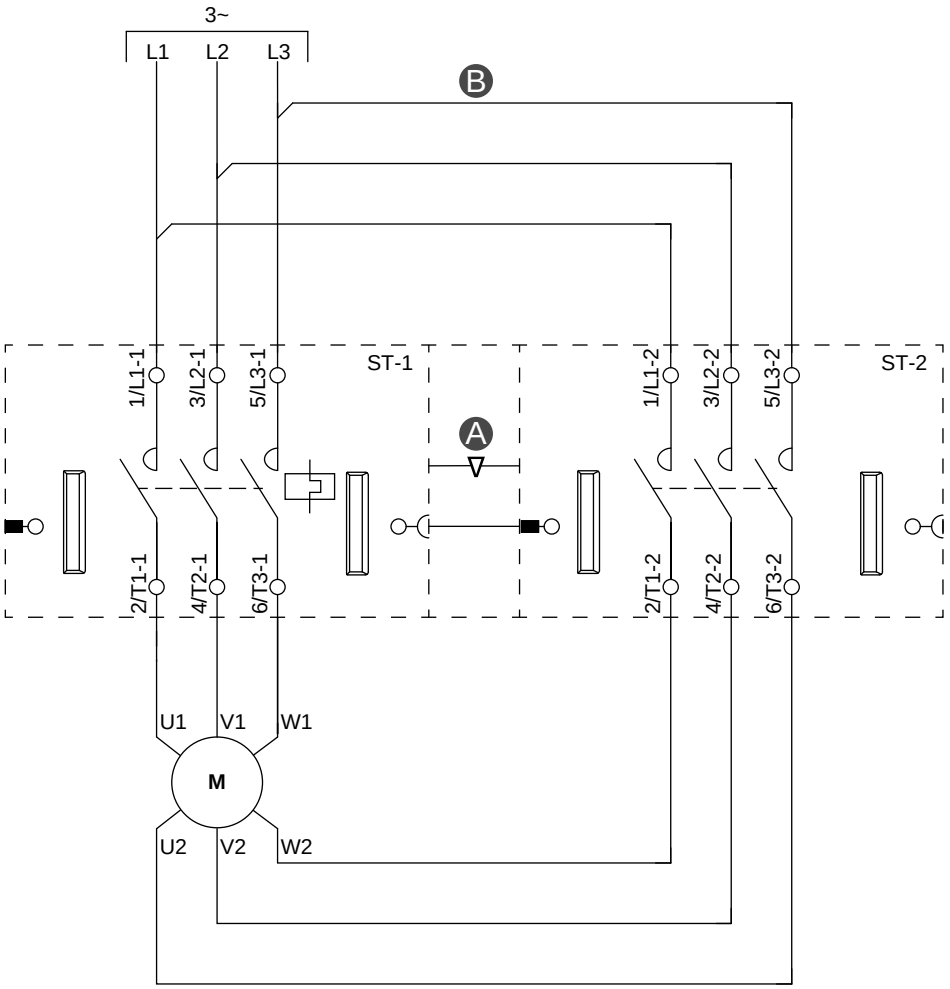


Figure 62 - Accessories

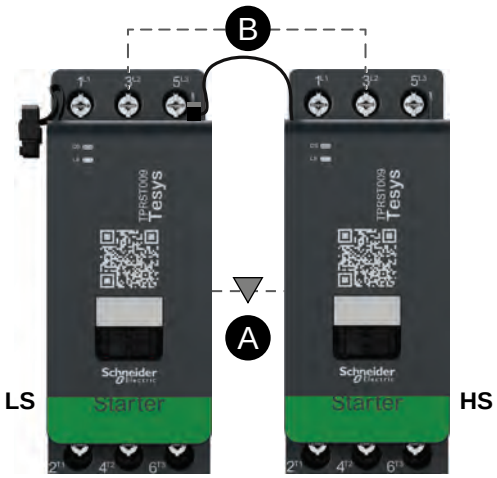


Table 63 - Legend

A	Mechanical interlock
B	Parallel link
LS	Low speed
HS	High speed
ST-1	Starter 1
ST-2	Starter 2

Motor Two Speeds - SIL Stop, W. Cat 1/2

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.

Figure 63 - Wiring (See Legend Table below.)

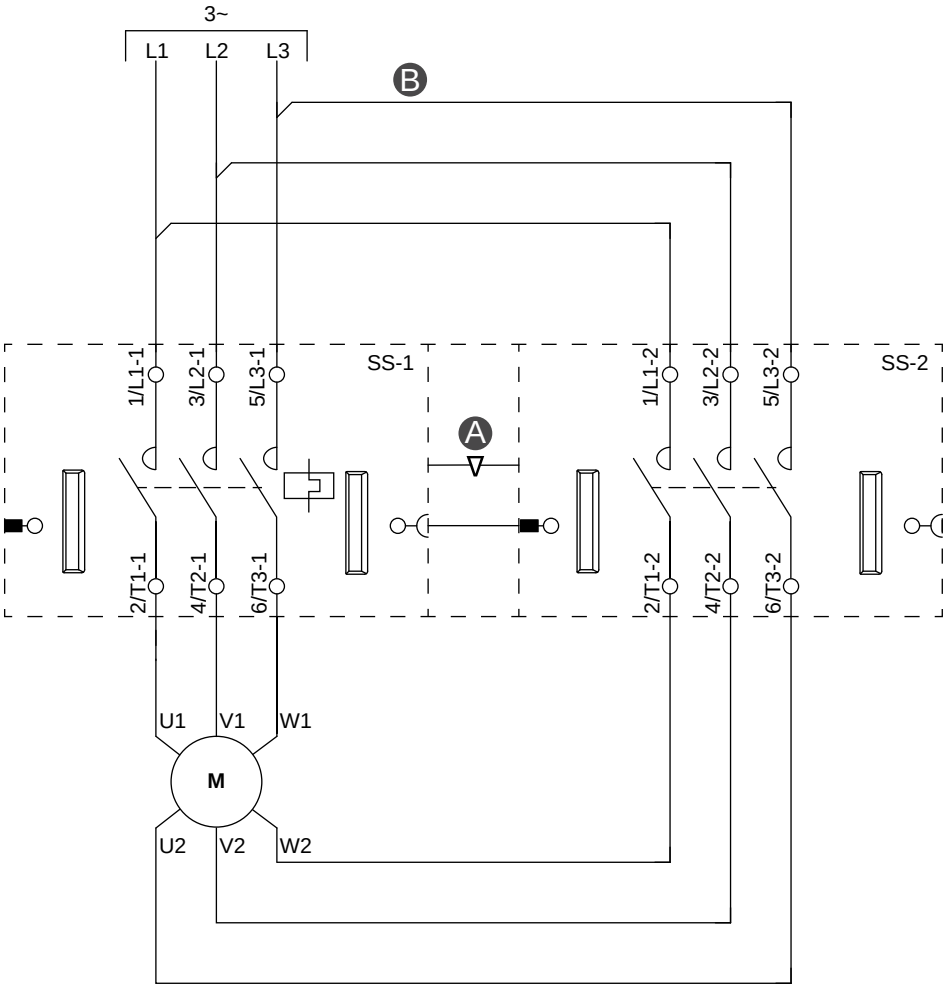


Figure 64 - Accessories

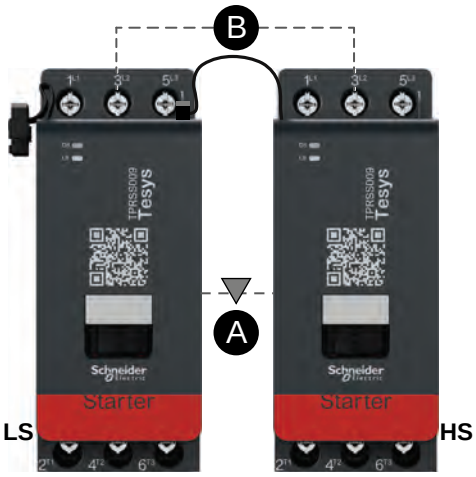


Table 64 - Legend

A	Mechanical interlock
B	Parallel link
LS	Low speed
HS	High speed
SS-1	SIL starter 1
SS-2	SIL starter 2

Motor Two Speeds - SIL Stop, W. Cat 3/4

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 3 and Category 4 according to ISO 13849.

Figure 65 - Wiring (See the table below.)

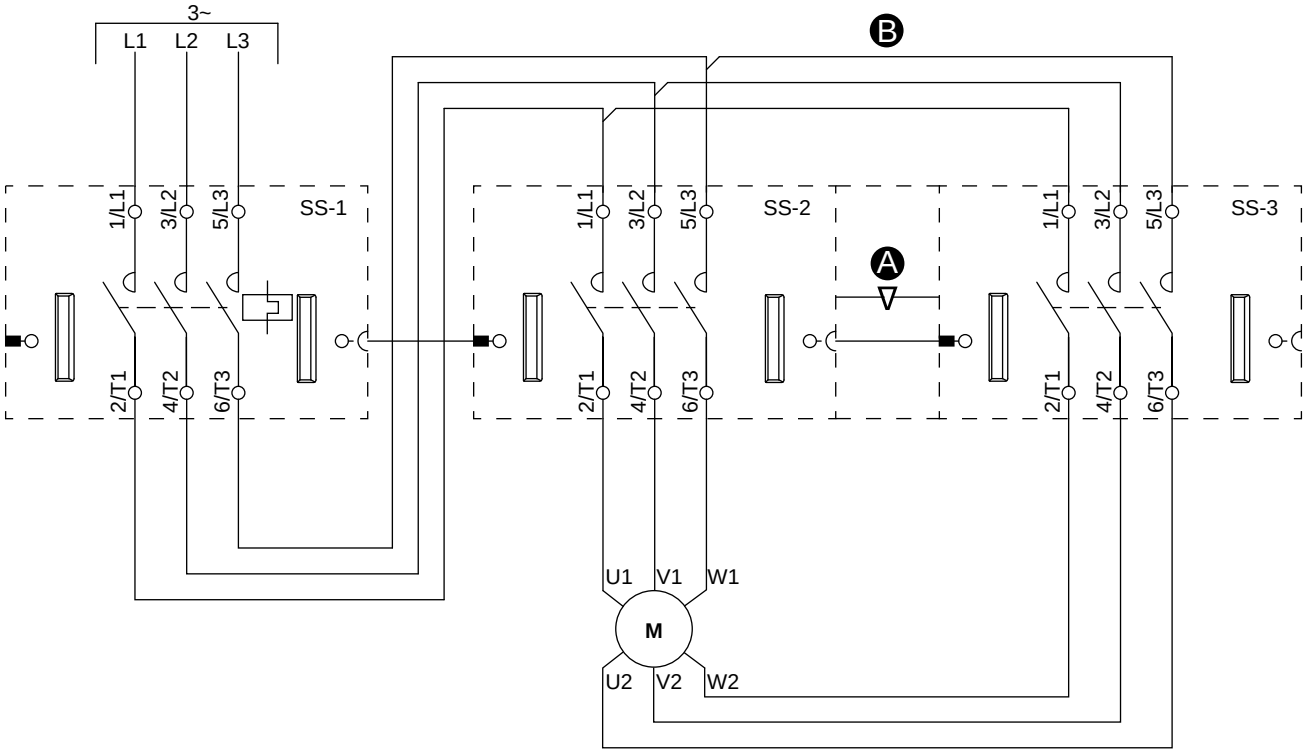


Figure 66 - Accessories

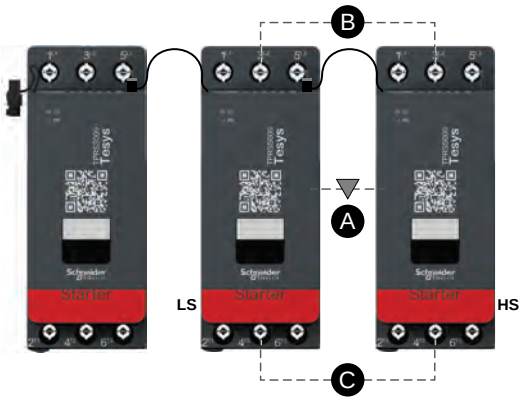


Table 65 - Legend

A	Mechanical interlock
B	Parallel link
LS	Low speed
HS	High speed
SS-1	SIL starter 1
SS-2	SIL starter 2
SS-3	SIL starter 3

Motor Two Speeds Two Directions

Figure 67 - Wiring (See Legend Table below.)

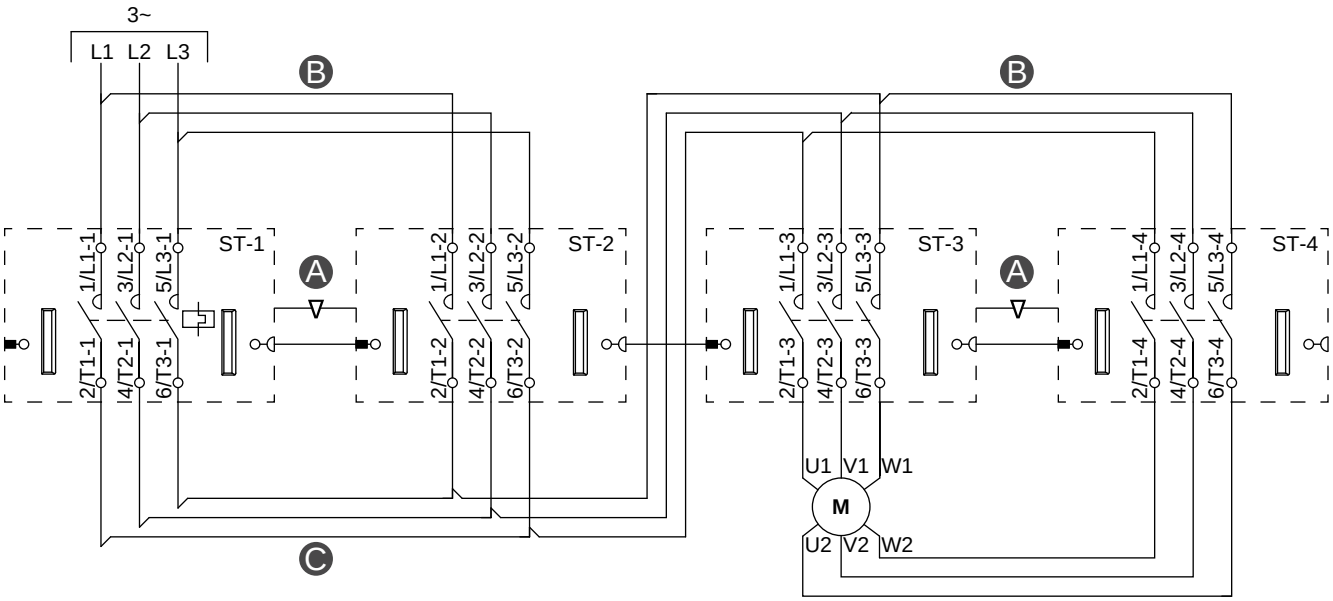


Figure 68 - Accessories

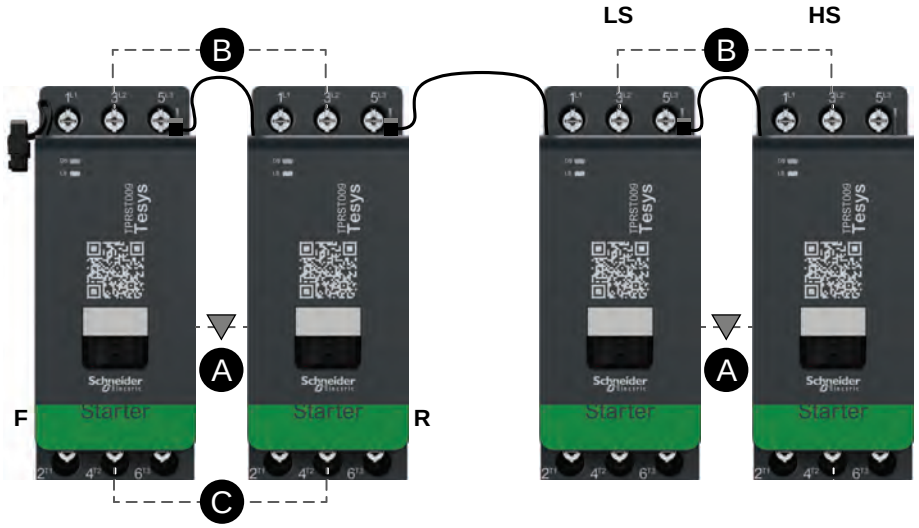


Table 66 - Legend

A	Mechanical interlock
B	Parallel link
C	Reversing link
F	Forward
R	Reverse
LS	Low speed
HS	High speed
ST-1	Starter 1
ST-2	Starter 2
ST-3	Starter 3
ST-4	Starter 4

Motor Two Speeds Two Directions - SIL Stop, W. Cat 1/2

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.

Figure 69 - Wiring (See Legend Table below.)

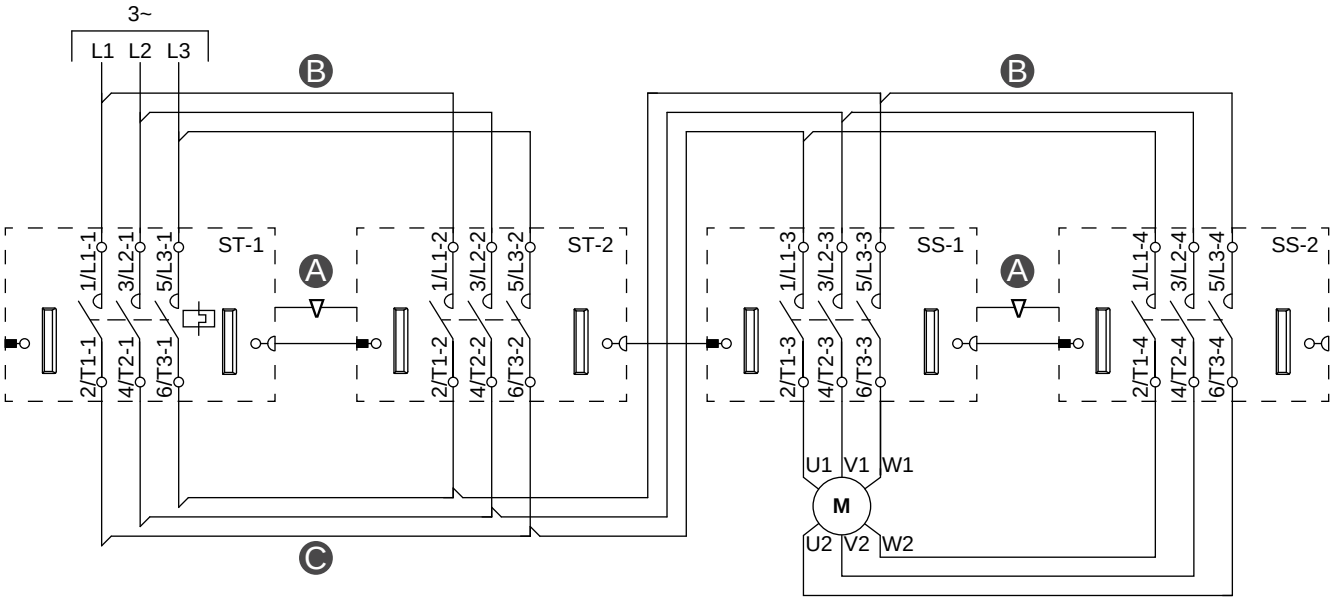


Figure 70 - Accessories

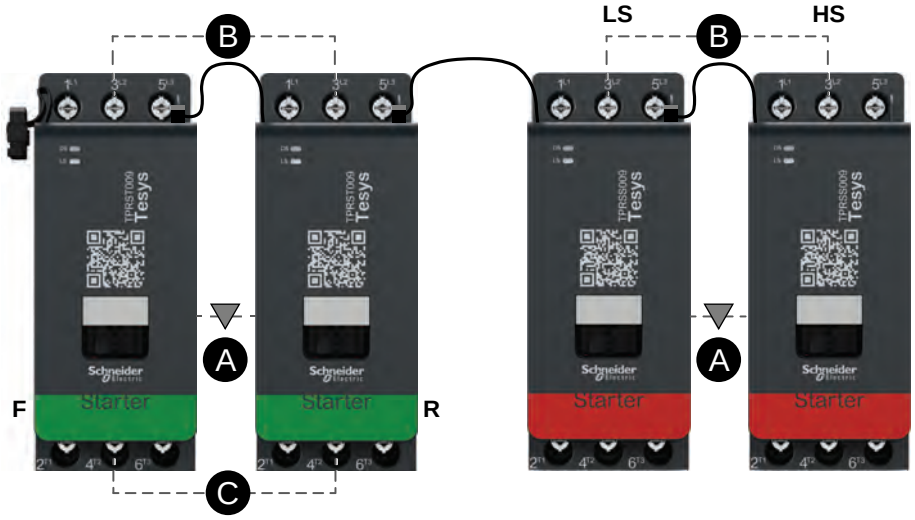


Table 67 - Legend

A	Mechanical interlock
B	Parallel link
C	Reversing link
F	Forward starter
R	Reverse starter
LS	Low speed
HS	High speed
ST-1	Starter 1
ST-2	Starter 2
SS-1	SIL starter 1
SS-2	SIL starter 2

Motor Two Speeds Two Directions - SIL Stop, W. Cat 3/4

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 3 and Category 4 according to ISO 13849.

Figure 71 - Wiring (See Legend Table below)

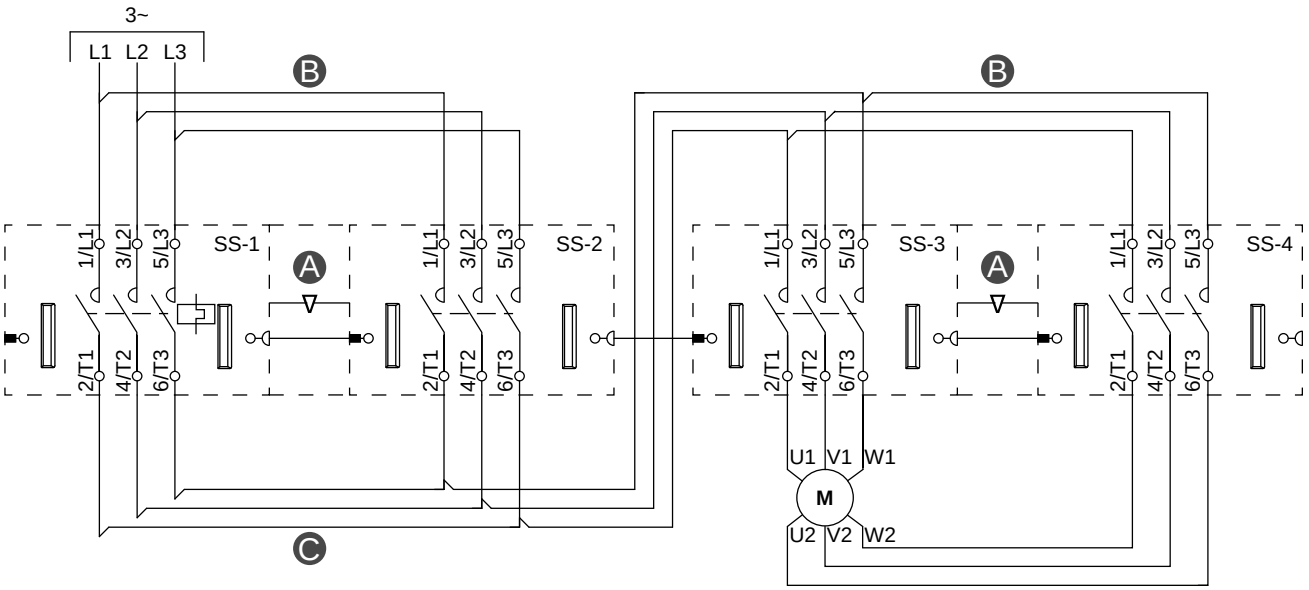


Figure 72 - Accessories

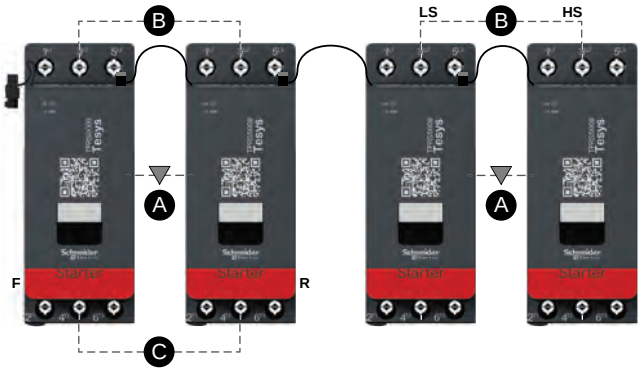
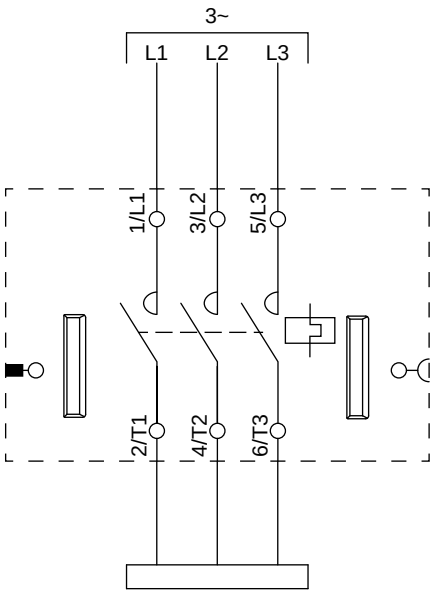


Table 68 - Legend

A	Mechanical interlock
B	Parallel link
C	Reversing link
F	Forward starter
R	Reverse starter
LS	Low speed
HS	High Speed
SS-1	SIL starter 1
SS-2	SIL starter 2
SS-3	SIL starter 3
SS-4	SIL starter 4

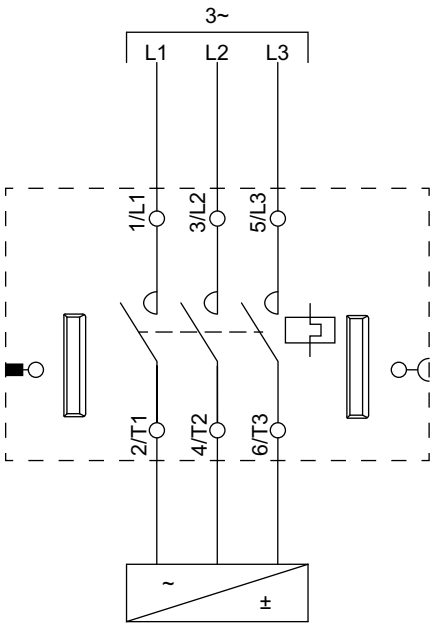
Resistor

Figure 73 - Wiring



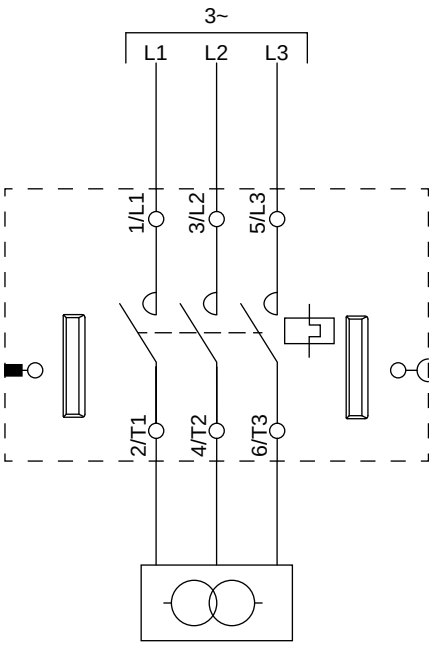
Power Supply

Figure 74 - Wiring



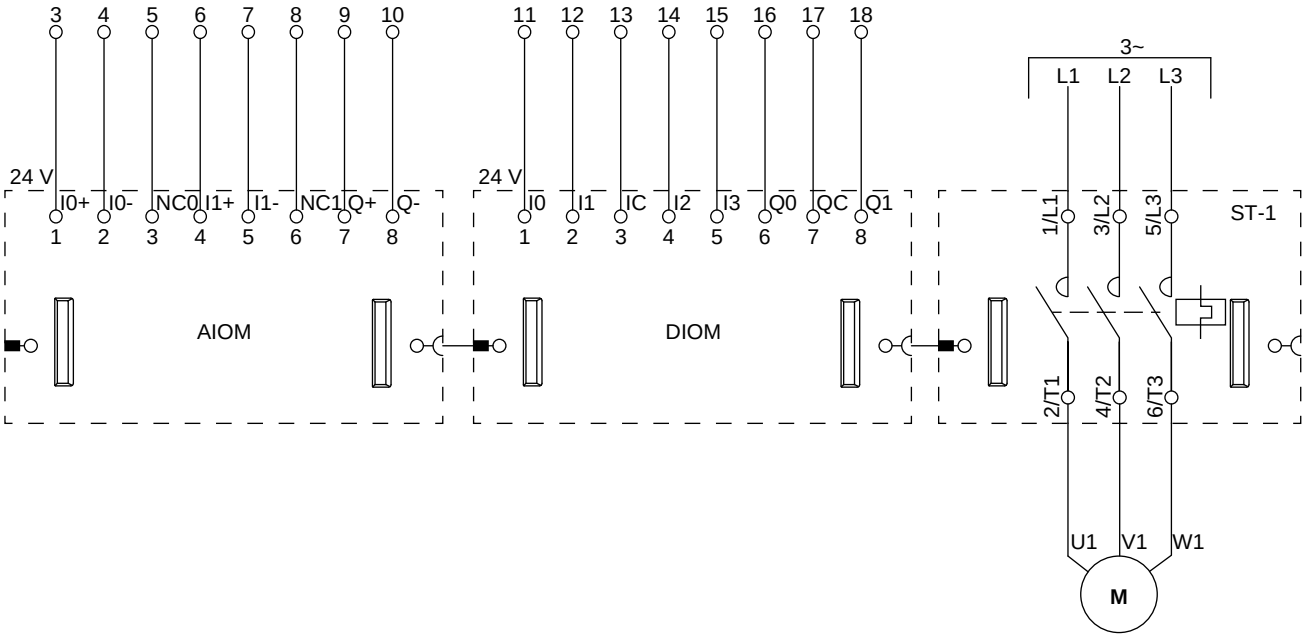
Transformer

Figure 75 - Wiring



Pump

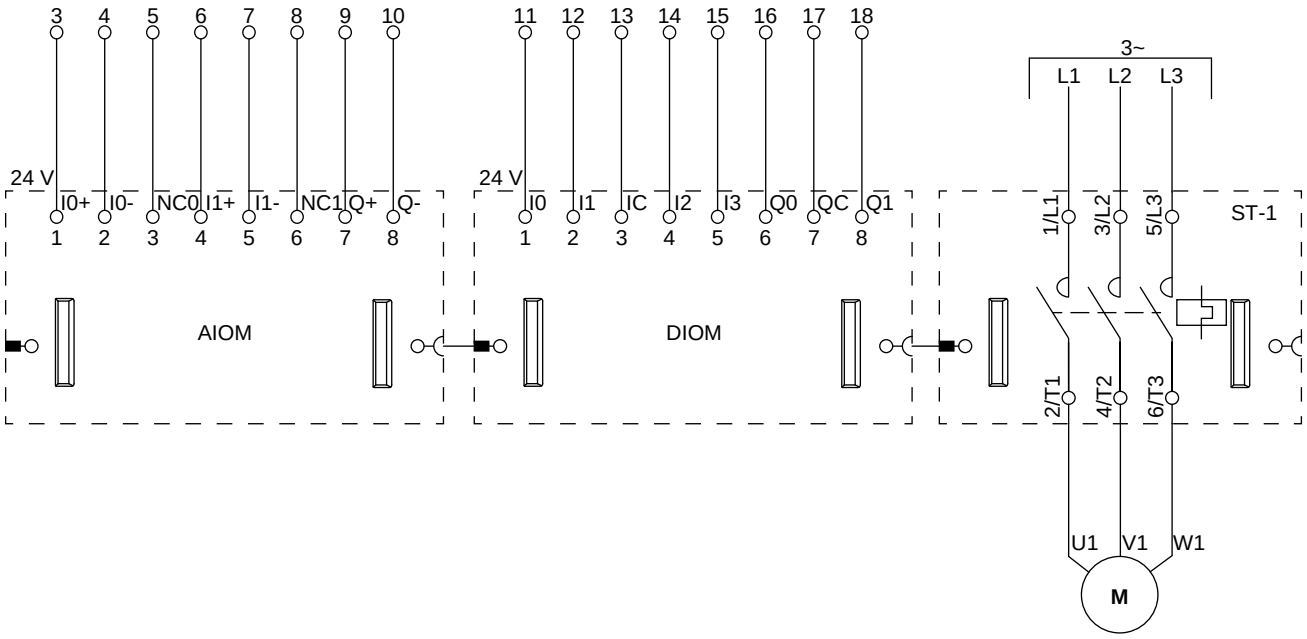
Figure 76 - Wiring



Note: Analog I/O modules (AIOMs) and digital I/O modules (DIOMs) are configurable.

Conveyor One Direction

Figure 77 - Wiring

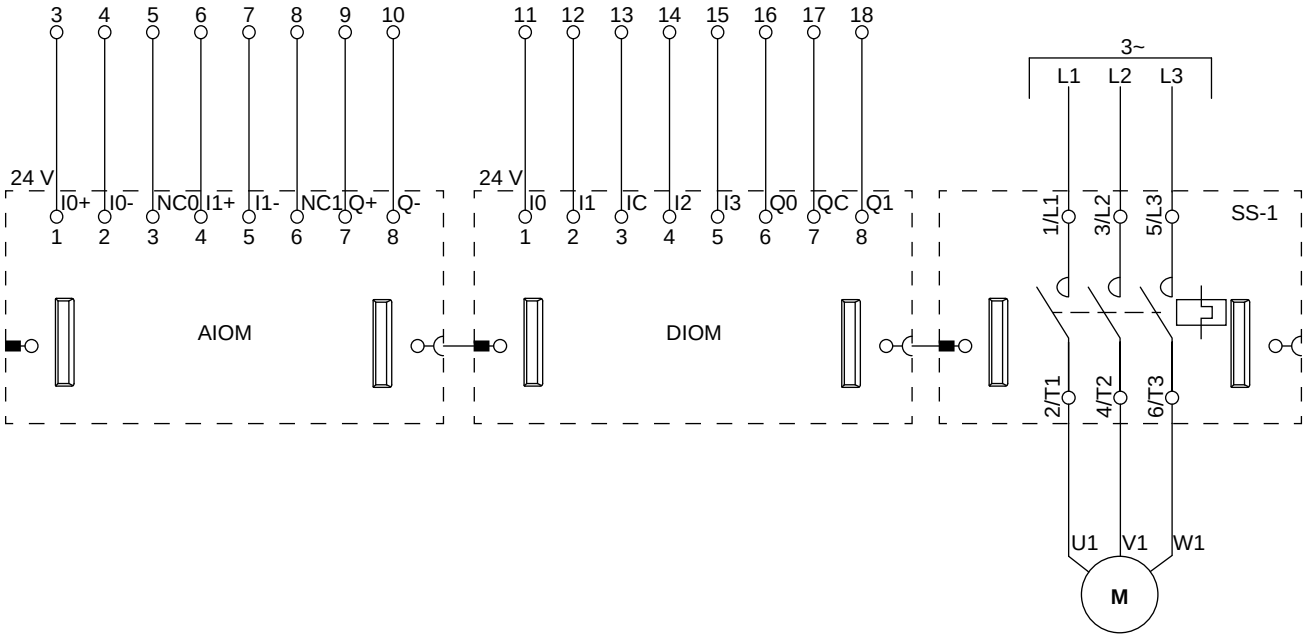


Note: Analog I/O modules (AIOMs) and digital I/O modules (DIOMs) are configurable.

Conveyor One Direction - SIL Stop, W. Cat 1/2

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.

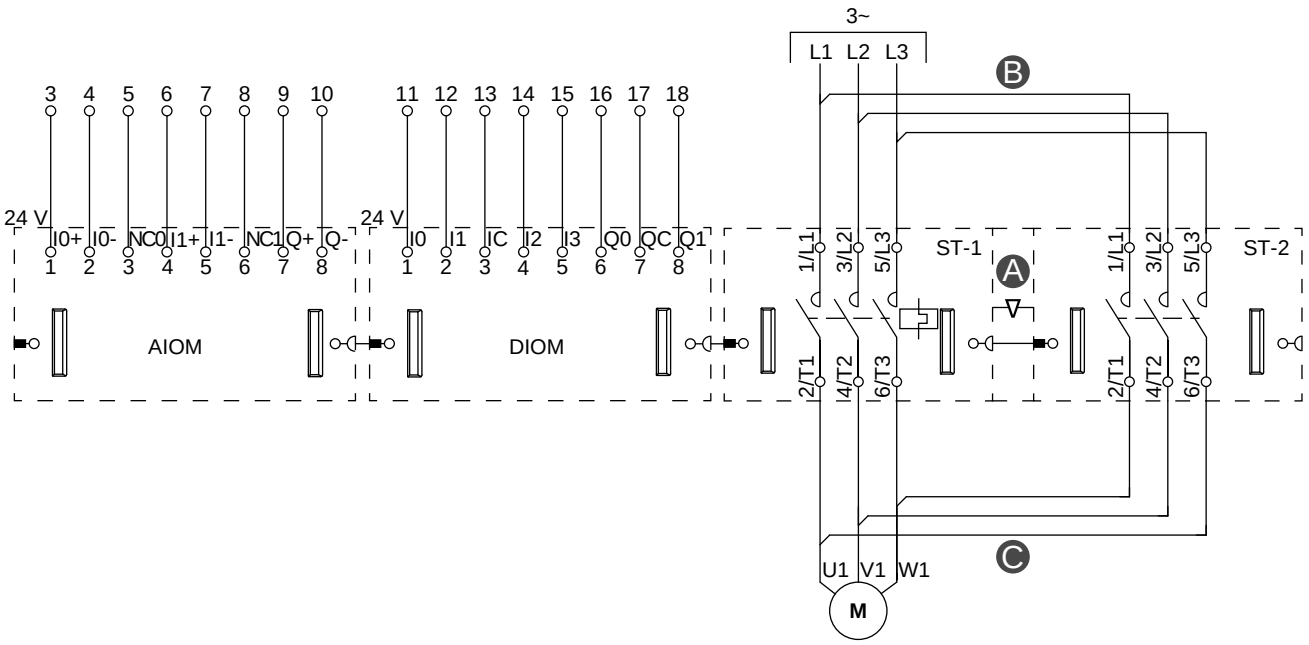
Figure 78 - Wiring



Note: Analog I/O modules (AIOMs) and digital I/O modules (DIOMs) are configurable.

Conveyor Two Directions

Figure 79 - Wiring (See Legend Table below)



Note: Analog I/O modules (AIOMs) and digital I/O modules (DIOMs) are configurable.

Figure 80 - Accessories

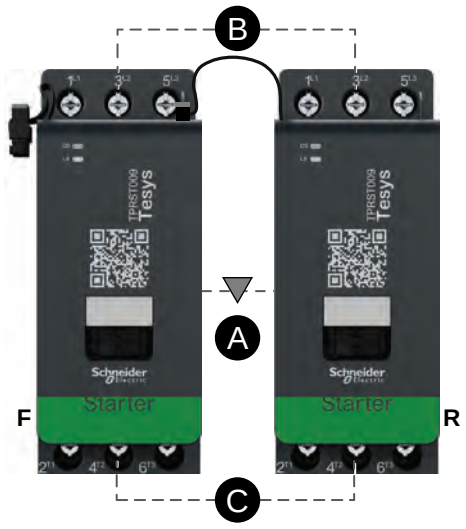


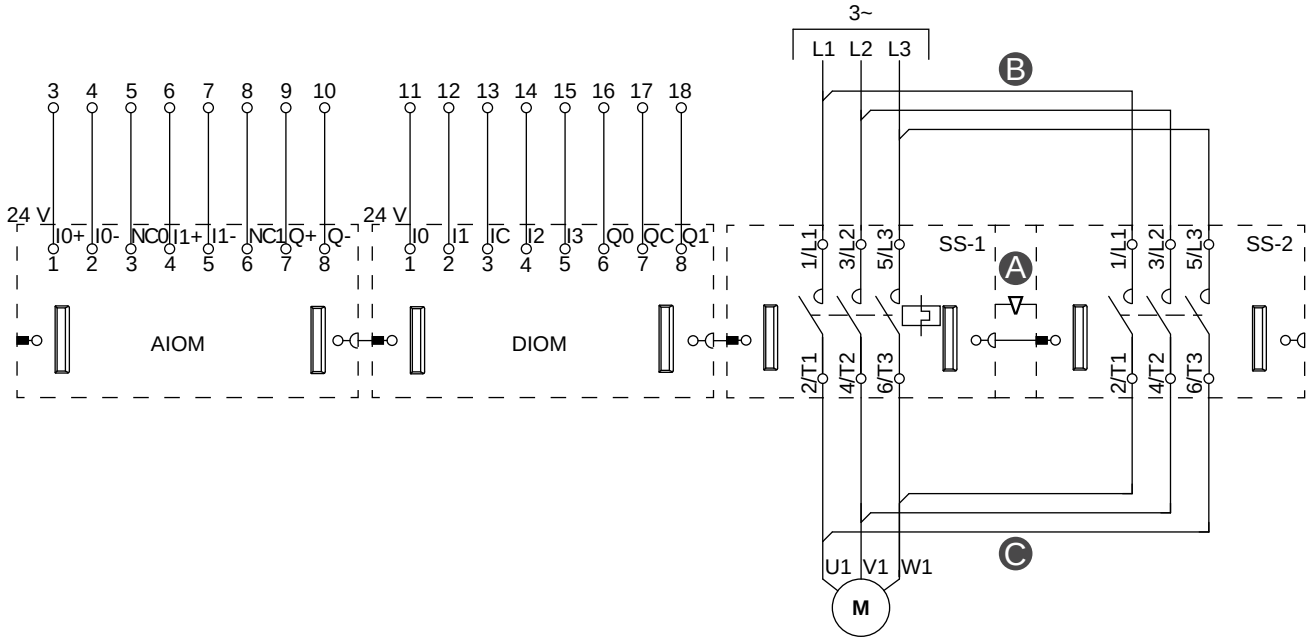
Table 69 - Legend

A	Mechanical interlock
B	Parallel link
C	Reversing link
F	Forward starter
R	Reverse starter
ST-1	Starter 1
ST-2	Starter 2

Conveyor Two Directions - SIL Stop, W. Cat 1/2

NOTE: Safety Integrity Level according to standard IEC 61508. Wiring Category 1 and Category 2 according to ISO 13849.

Figure 81 - Wiring (See Legend Table below)



Note: Analog I/O modules (AIOMs) and digital I/O modules (DIOMs) are configurable.

Figure 82 - Accessories

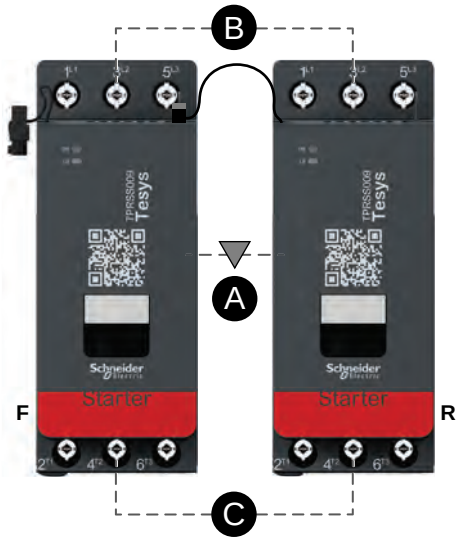


Table 70 - Legend

A	Mechanical interlock
B	Parallel link
C	Reversing link
F	Forward
R	Reverse
SS-1	SIL starter 1
SS-2	SIL starter 2

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As standards, specifications, and design change from time to time, please ask for confirmation of the information given in this publication.

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