ACTILINK-S Integro Operations Manual

For machine builders and system integrators

1. Notices

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1.1. Copyrights and Trademarks

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1.2. Intended Use

Synapticon documentation contains information to ensure the safe and proper use of its products. As such, all Synapticon products should be handled, installed, and maintained by trained automation and control specialists who have knowledge of electrical systems and/or drive technology. These individuals should also be familiar with the applicable standards and requirements.

It is recommended to understand all components, safety information, and precautions for correct operation prior to use. Refer to, and retain, this documentation for reference.

ATTENTION
Synapticon products must be used in accordance with all specified safety requirements, i.e., all standards and regulations, applicable laws.

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3. Documentation Overview

3.1. Original Instructions

This document includes original instructions for using *ACTILINK-S Integro*. All product components described in this documentation are delivered in a specific hardware/software configuration. Any changes made to the hardware or software configuration that differ from the documented options, void any Synapticon liability in this regard.

3.2. Warnings

Boxes are used to indicate potentially dangerous situations as follows:

> **NOTE**
> Background information that is not necessarily required for basic operation but for optimal performance.

> **IMPORTANT**
> Required for correct functionality. Ignoring these facts may result in erratic behavior or lack of function.

> **ATTENTION**
> Indicates a situation that could possibly lead to serious accidents and/or destruction of the servo drive.

> **DANGER**
> If these warnings are ignored, hazardous and potentially fatal situations may arise from improper or careless use.

3.3. Reporting Errors

It is in our best interest to provide detailed, user-oriented and error-free documentation. If something is missing, incomprehensible or incorrect, go to Suggest Documentation Improvement and complete the form displayed there. In the “Link to documentation page” field, enter **ACTILINK-S Integro Operations Manual v1.46**.

3.4. Versioning

This documentation will be constantly updated and improved. The version in the footer reflects the current documentation release.

4. Overview

ACTILINK-S Integro is an integrated servo motor developed by Synapticon for applications in factory automation, robotics and mechanical engineering. It consolidates multiple components of a traditional servo system into a single unit, reducing installation space and wiring complexity. The extra-low voltage motor is available in 60 mm and 80 mm sizes, with power ratings ranging from 200 to 1000 watts and more. Its thermal management system enhances efficiency and improves dynamic performance compared to conventional approaches of integrating a servo motor with a servo drive.

4.1. Introduction

This manual is intended for machine builders and system integrators who will use *ACTILINK-S Integro* to build a machine.

Figure 4.1 - Sample 600W ACTILINK-S Integro Motor

4.2. ACTILINK-S Integro Essential Motor Specifications

The specifications for the *Compact line* are listed below.

4.2.1. ACTILINK-SC Line without Brake

Model Number (MPN)	Flange [mm]	Rated Power	Torque Rated	Torque Peak	Rated Speed	L (mm)
ASC1-061A-0K	60	204 W	0,6 Nm	2.5 Nm	3000 rpm	104
ASC1-062A-0K	60	408 W	1,3 Nm	5 Nm	3000 rpm	121
ASC1-063A-0K	60	597 W	1,9 Nm	8 Nm	3000 rpm	141
ASC1-081A-0K	80	754 W	2,4 Nm	9.5 Nm	3000 rpm	124
ASC1-082A-0K	80	1005 W	3,2 Nm	13 Nm	3000 rpm	137

4.2.2. ACTILINK-SC Line with Brake

Model Number (MPN)	Flange [mm]	Rated Power	Torque Rated	Torque Peak	Brake Holding Torque	Rated Speed	L (mm)
ASC1-061A-BK	60	204 W	0,6 Nm	2.5 Nm	2.0 Nm	3000 rpm	133
ASC1-062A-BK	60	408 W	1,3 Nm	5 Nm	2.0 Nm	3000 rpm	150
ASC1-063A-BK	60	597 W	1,9 Nm	8 Nm	2.0 Nm	3000 rpm	170
ASC1-081A-BK	80	754 W	2,4 Nm	9.5 Nm	3.2 Nm	3000 rpm	157
ASC1-082A-BK	80	1005 W	3,2 Nm	13 Nm	3.2 Nm	3000 rpm	170

NOTE
Data is for 48 V supply. For performance at other voltages, refer to the Application Note 24 V - 60 V Operating ACTILINK-S Integro Outside Nominal Voltage.

NOTE
To view more detailed data or representative CAD drawings for each ACTILINK-SC variant, go to Downloads / Datasheets and Catalog and select the Datasheet desired.

4.3. Essential Drive Specifications (SOMANET Integro)

All ACTILINK-S Integros include the Integrated Motion Device (IMD, servo drive, electronics) SOMANET Integro. Several configurations are available and can be combined with different motors specified in the ACTILINK-S Integro Essential Motor Specifications.

Either one of the following SOMANET Integro connector configurations can be used:

- M8/M12
- Hybrid Variant

4.3.1. M8/M12

This configuration uses metric connectors. The connectors used are standardized M8 and M12 circular connectors according to IEC 61076-2-101 and IEC 61076-2-104 respectively.

Figure 4.2 - Metric (M8/M12) option

4.3.2. Hybrid Variant

With this configuration, the connector is located at the top and has an integrated power and data signal. The hybrid connector is not standardized. Mating cables can be sourced through Synapticon.

Figure 4.3 - Hybrid (Y-Tec or I-Tec) option

All signals except for the general purpose I/Os are combined in a single cable.

- For SOMANET Integro 6, a "Y-Tec" connector creates daisy-chaining with the I/Y-Tec Single Cable Technology variant, an input and an output for such hybrid cable (to allow daisy-chaining). In alternative product configurations, an “I-Tec” connector creates only an input.
- For SOMANET Integro 8, an "I-Tec" connector creates only an input, as daisy-chaining is not considered useful for the high currents that are typical for this variant.

Both the I-Tec and Y-Tec connector can be rotated by 300 degrees.

Figure 4.4 - Daisychaining with the I/Y-Tec single cable technology variant

4.3.3. Product Specifications

Core specifications of the servo drive include the following:

Specifications	SOMANET Integro 6	SOMANET Integro 8
Supported motors	3-phase PMSM	
DC bus voltage***	24-60 V	
Rated current***	20 A RMS	40 A RMS
Peak current***	60 A RMS	120 A RMS
DC current max continuous***	16 A	I-Tec / Y-Tec connector variant: 25 A Metric connector variant: 32 A****
Motor flange sizes (typical)***	60 mm	80 mm
Operating temperature	0-40℃ ambient air	
Maximum installation altitude	2000 m Derating applies above 1000 m	
Protection classes	IP65*	
Environmental requirement	PD 2	
Shock	25 g @ 6 ms shock	
Vibration	5 - 10 Hz ±10mm displacement 10 - 57 Hz at 4 g 57 - 500 Hz at 5 g	
Operation and storage humidity	5% to 95% relative humidity, no condensation	
Storage/Transport temperature	-35 to 85℃	
Minimum transport air pressure	70 kPa**	
Motor temperature sensor support***	PT-1000	
Thermal management and protection	Internal temperature sensors, motor temperature sensor input, I2t	

Specifications	SOMANET Integro 6	SOMANET Integro 8
Safety functions	STO, SBC	
Safety integrity level	SIL3, PLe-Cat.3	
I-Tec and Y-Tec connector rotation range	320°	
Bus interface	Options: EtherCAT, EtherNet/IP, PROFINET	
GPIO	Optional, up to: ● DIO: 2x DIO + 1x DI + 1x +24V ● Analog*: 2x AI ● External encoder*: 1x ABI or SSI or BiSS ** External encoder input and Analog Inputs can be available in the same devices; however, their usage is mutually exclusive (either AI or ext. Enc., configurable in firmware).*	
Touch Probe	1 channel, accuracy 15 µs	
Commissioning	OBLAC Drives, native apps available for Windows, Linux or OBLAC Box	
Control system architectures	With PLC / master controller via field bus, standalone via micro PLC***** or combined	
Integrated encoders	Default: 18 bit multiturn (battery-free) - 262,144 increments per revolution Options (singleturn): 12 bit, 14 bit, 18 bit Options (multiturn, battery-free): 14 bit	
Approvals and certificates	CE, IEC-61800, among others. See: Standards and Compliance for details.	

** Except for A-side motor shaft seals*
To keep the IP rating, SOMANET Integro should not be unmounted.

*** The electronic assemblies manufactured by Synapticon are suitable for transportation at ambient pressures of up to 700 hPa (corresponding to approximately 3000 m / 9842.52 ft above sea level), provided that no additional external stresses such as severe temperature changes or mechanical shocks occur. Transportation should be carried out in suitable packaging. Pressure sensitive components or hermetically sealed housings must be tested or specified separately.*

After transportation under conditions with strongly fluctuating temperatures or humidity, an acclimatization period of at least 24 hours at room temperature must be provided before commissioning. This ensures that any condensation that may have formed evaporates completely. Premature switch-on can lead to damage to the module.

**** Specification values related to plain servo drive do not override ACTILINK-S system level specifications. In particular, see, for example, ACTILINK-S DC current consumption in section* *[DC Current Consumption](#)**.*

***** Currents > 32 A feasible with dual connector wiring scheme and application-specific approval.*

****** Available on request.*

4.3.4. Functional Safety Specifications

Safety parameters	
Safety Integrity Level (SIL) according to IEC 61508:2010	SIL 3
Performance Level (PL) according to ISO 13849-1:2023	PL e
Reaction time Input signal LOW to open phases and brake output	6 ms

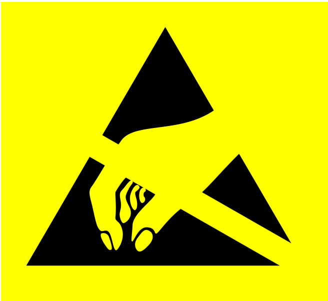
Safety parameters IEC 61508:2010	
Probability of dangerous failure per hour (PFH_d)	$1.07 \cdot 10^{-9}$ / h < 1.1 FIT
Probability of dangerous failure on demand (PFD_{avg})	$8.56 \cdot 10^{-5}$
Hardware Fault Tolerance (HFT)	1
HW-type	Type A
Mission time T_M	20 a
Supported demand modes	High;Low

Safety parameters ISO 13849-1:2015	
Category	Cat. 3
Meantime to dangerous Failure (MTTF $_{d}$)	430 years (capped to 100 years)
Diagnostic coverage (DC $_{avg}$)	90%
Common cause failure factor score	> 65

STO-SBC input	
Number of digital inputs	2 (1 dual-channel safety input for activating STO-SBC function)
Digital input type according to IEC 61131-2:2007	Type 1
Voltage range	0-30 VDC
Allowed maximum Voltage range in fault conditions	-60 V to +60 V VDC
Input voltage, logic 1	15-30 V
Input voltage, logic 0	0-5 V
Input current per channel	Max. 2.3 mA (@24 VDC)
Test pulse toleration (OSSD pulses)	Max. 1 ms
Reverse voltage protected	Yes
Allowed time discrepancy between digital input channel states	100 ms
De-activation time	10 ms

5. Safety and Product Information

5.1. Handling Instructions



All Synapticon products are sensitive electronic devices; use the following guidelines when handling them.

- Protective devices - Check all protective devices and do not remove or bypass them. Also ensure that all emergency switches are operational.
- Grounding electrical components - Make sure to ground all conductive components to avoid any electric shocks.
- Shutting the machine down - Make sure that the machine is secured by a lock-out mechanism or other method so that it cannot be restarted by mistake.
- Monitoring tightening torques - Check all components and connections to comply with the recommended tightening torques.

> NOTE:
> This product cannot be used independently; a machine builder must install it into a machine.

5.1.1. Safety During Operation

Follow these safety rules when operating this product:

- Do not work on the motor or motor cable - or loosen any electrical connections - when they are live. Additionally, only work on the motor when the voltage has dropped to < 50 V. Additionally, make sure that the protective conductor is properly connected.

- Operate the servo drive according to its technical specifications. Make sure that sufficient cooling exists and once switched off, allow all components to cool down.
- Do not touch any components during operation, or immediately after operation, and make sure that all components are safely secured.

ATTENTION
If the temperature is too high, immediately turn-off the servo drive.

5.1.2. Safety After Operation

It is important to check that all safety-related devices are functioning properly. Additionally, make sure to de-energize and turn-off any components before using them.

5.2. Magnetic Sensitive Devices

The SOMANET Integro and ACTILINK-S products contain magnetic sensitive electronic components: an absolute magnetic single-turn encoder and a battery-free magnetic multi-turn counter.

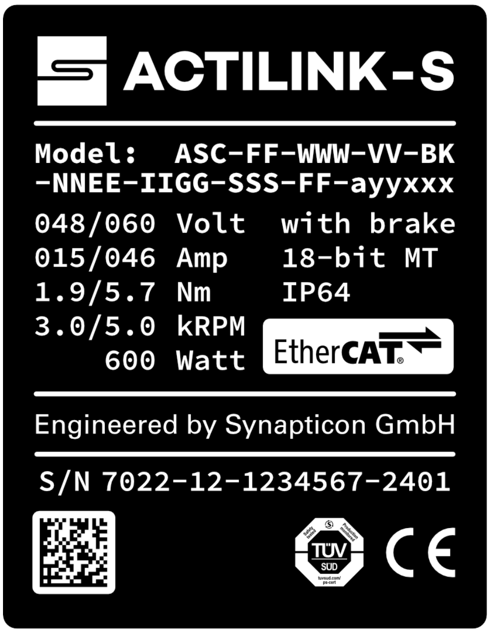
External magnetic fields can disrupt the operation of the integrated encoder and the battery-free magnetic multi-turn counter. If possible, the device should be isolated from all external magnetic fields. Please contact support for additional information.

Special precautions must be taken during assembly, handling, and storage of ACTILINK-S Integro:

- Note the maximum external magnetic field density not in operation: 5 mT.
- Keep magnets away from the device, specifically from its back end (“B-side”).
- Ensure that no contact can occur between the device and permanent magnets or electromagnets.
- Remove all bags or garments with magnetic closures when working with the ACTILINK-S Integro.
- Do not attempt to attach any components or tools, e.g., torches, to the ACTILINK-S using permanent magnets. The device contains minimal ferromagnetic material - resulting in poor holding force - and exposure to magnetic fields may impair or damage the ACTILINK-S.
- Avoid possible inductances caused by high current power lines near ACTILINK-S Integro.

5.3. Name Plate

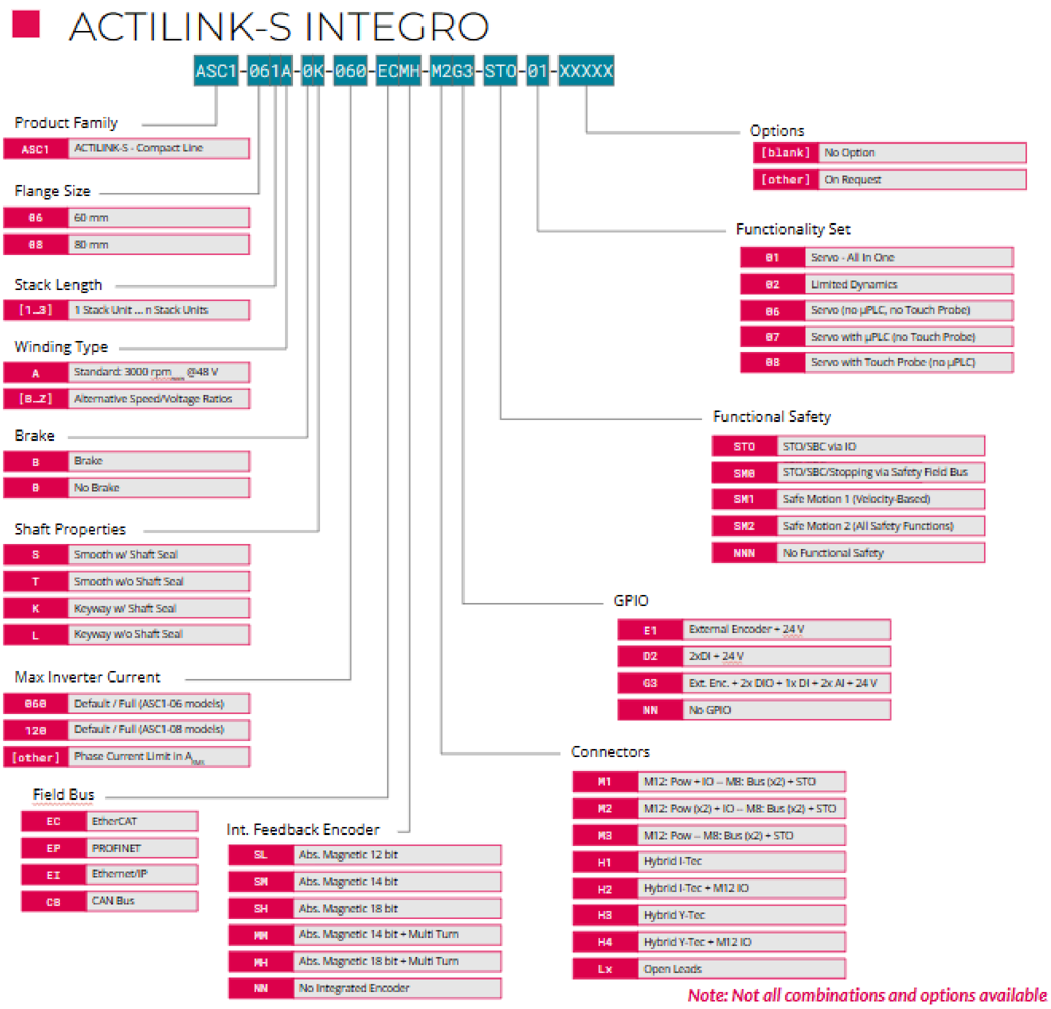
The following is a sample ACTILINK-S Integro name plate.



5.4. Manufacturer Part Number (MPN)

Below is an image of the schema used to describe the Synapticon-assigned, unique part number that is used to identify ACTILINK-S Integro.

> **NOTE**
> Due to current mechanical configurations, not all MPN combinations are available.

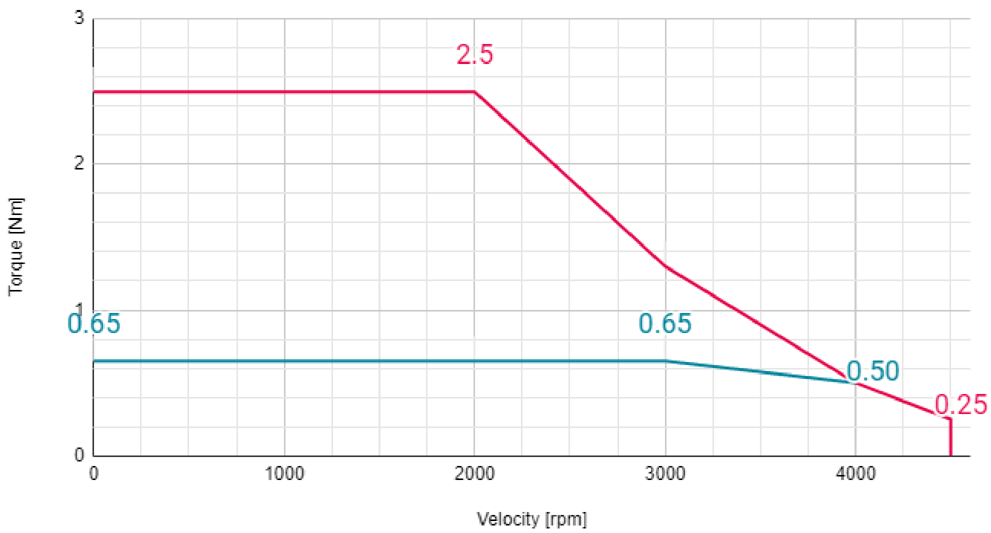


> **NOTE**
> Under *Field Bus*, CAN Bus is a custom variant.

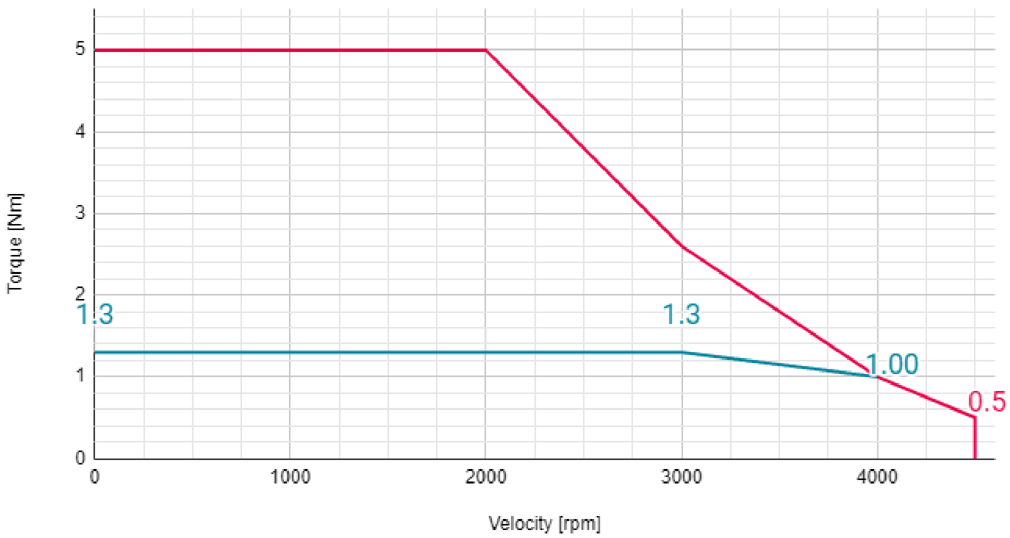
5.5. Characteristic Torque and Speed Curves

See below for characteristic torque and speed curves.

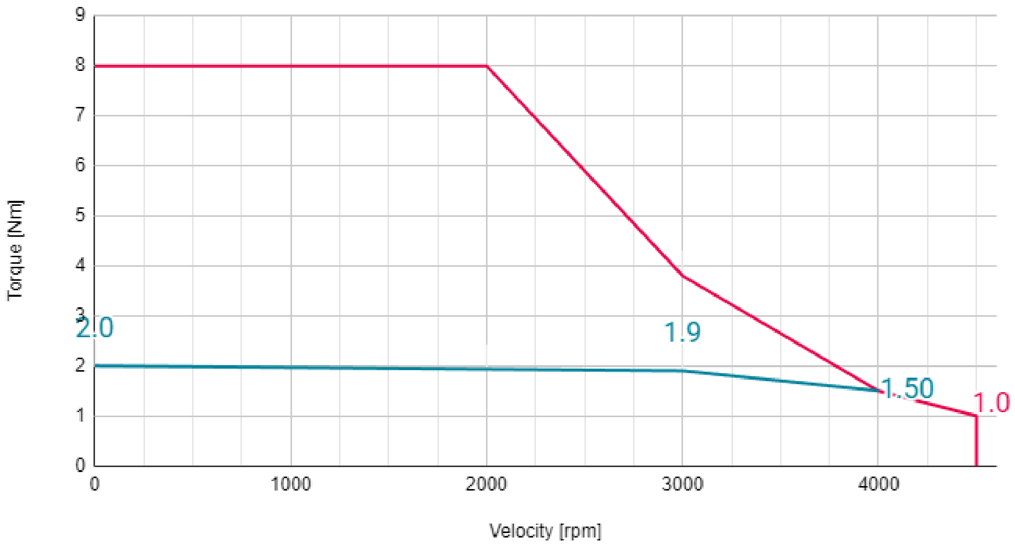
5.5.1. ACTLINK-S Integro Motor Curve ASC1-061A



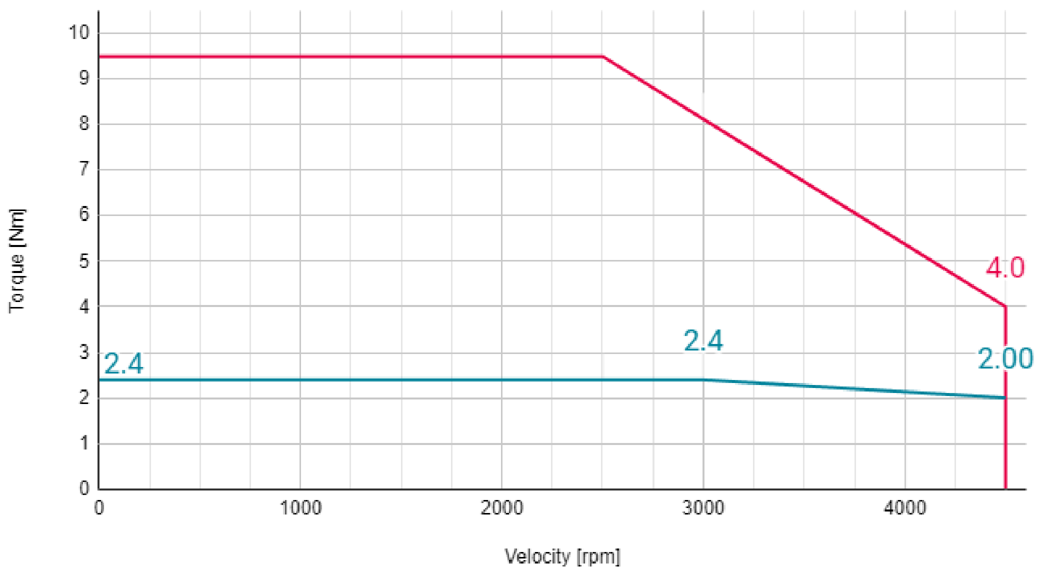
5.5.2. ACTILINK-S Integro Motor Curve ASC1-062A



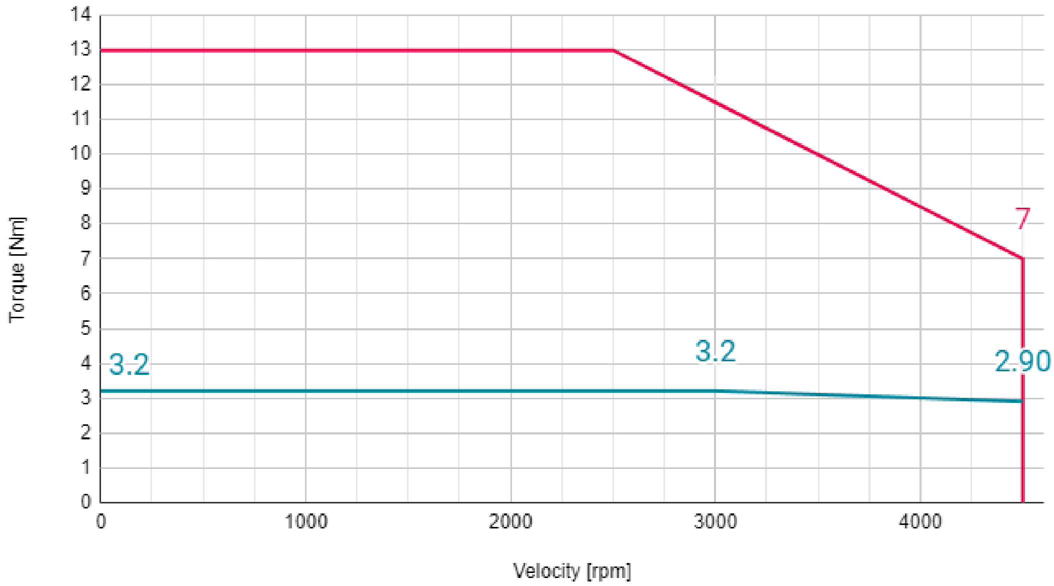
5.5.3. ACTILINK-S Integro Motor Curve ASC1-063A



5.5.4. ACTILINK-S Integro Motor Curve ASC1-081A



5.5.5. ACTILINK-S Integro Motor Curve ASC1-082A



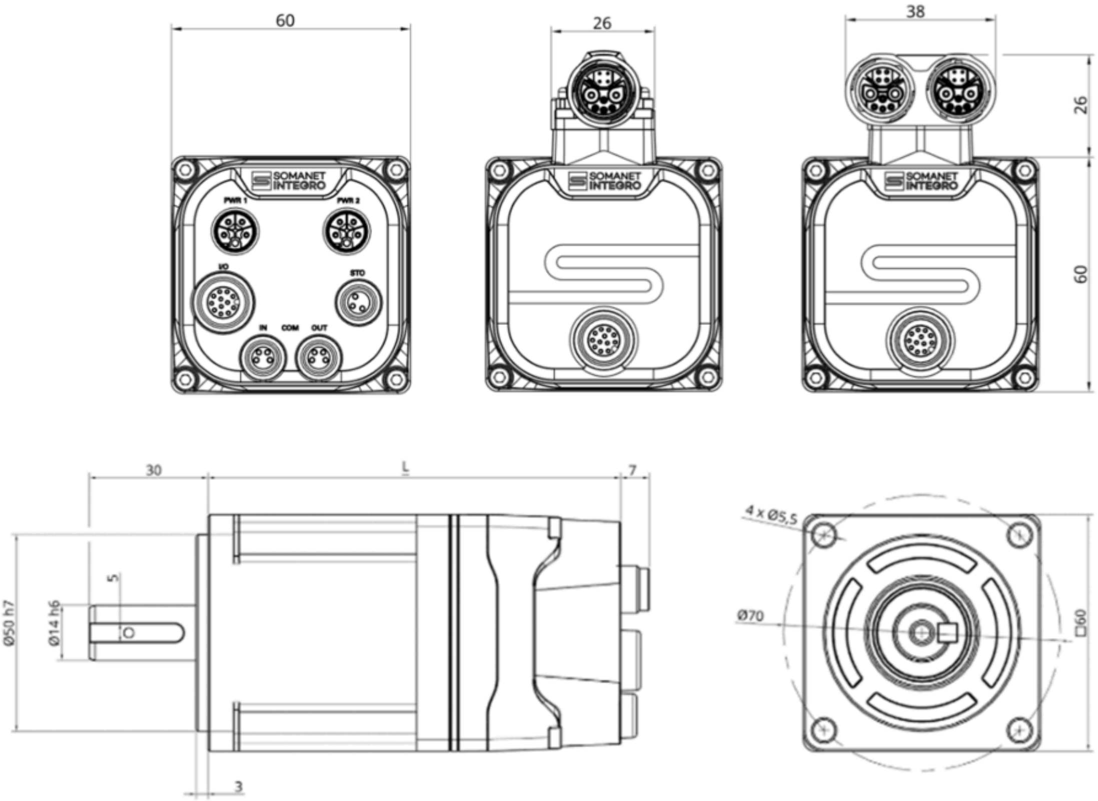
NOTE

Data is for 48 V supply. For performance at other voltages, refer to the Application Note 24 V - 60 V Operating ACTILINK-S Integro Outside Nominal Voltage.

6. Mechanical Installation

6.1. Motor Integration Guidelines

6.1.1. Housing Shape



	L
No Brake	104
Brake	133

Figure 6.1 - Representative drawings for an ACTILINK-SC 6-1

Model Number (MPN)	Flange [mm]	L [mm]
ASC1-061A-0K	60	104
ASC1-062A-0K	60	121
ASC1-063A-0K	60	141
ASC1-061A-BK	60	133
ASC1-062A-BK	60	150
ASC1-063A-BK	60	170

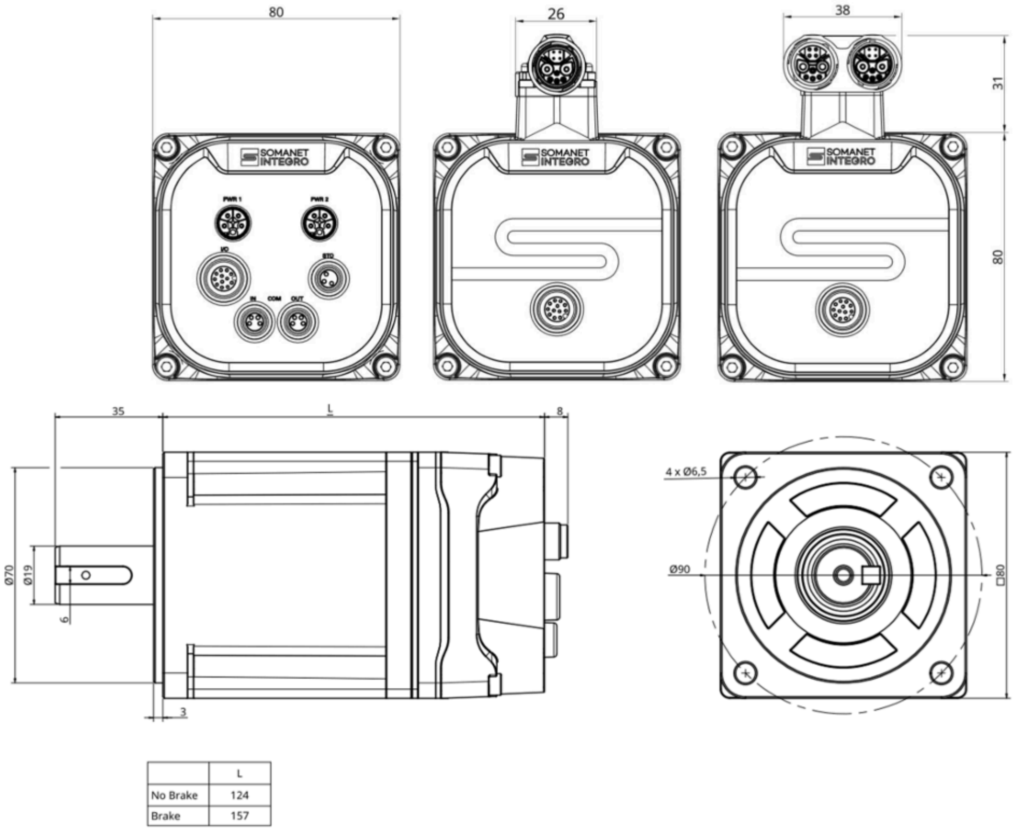


Figure 6.2 - Representative drawings for an ACTILINK-SC 8-1

Model Number (MPN)	Flange [mm]	L [mm]
ASC1-081A-0K	80	124
ASC1-082A-0K	80	137
ASC1-081A-BK	80	157
ASC1-082A-BK	80	170

6.1.2. Device Options

6.1.2.1. Brake ACTILINK-S 6

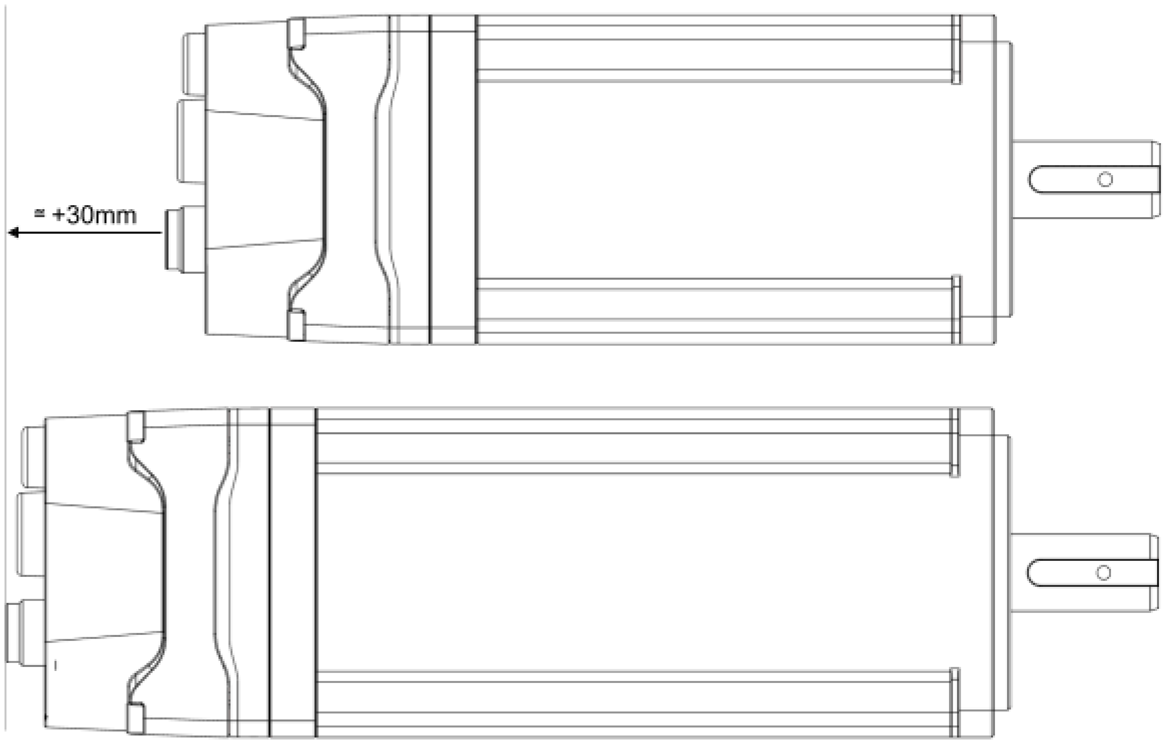


Figure 6.3 - Size comparison of ACTILINK-S 6 with and without brake

Brake parameters	
Rated power [W]	8.1
Pull voltage [V]	24
Pull time [ms]	100
Brake torque [Nm]	2

6.1.2.2. Brake ACTILINK-S 8

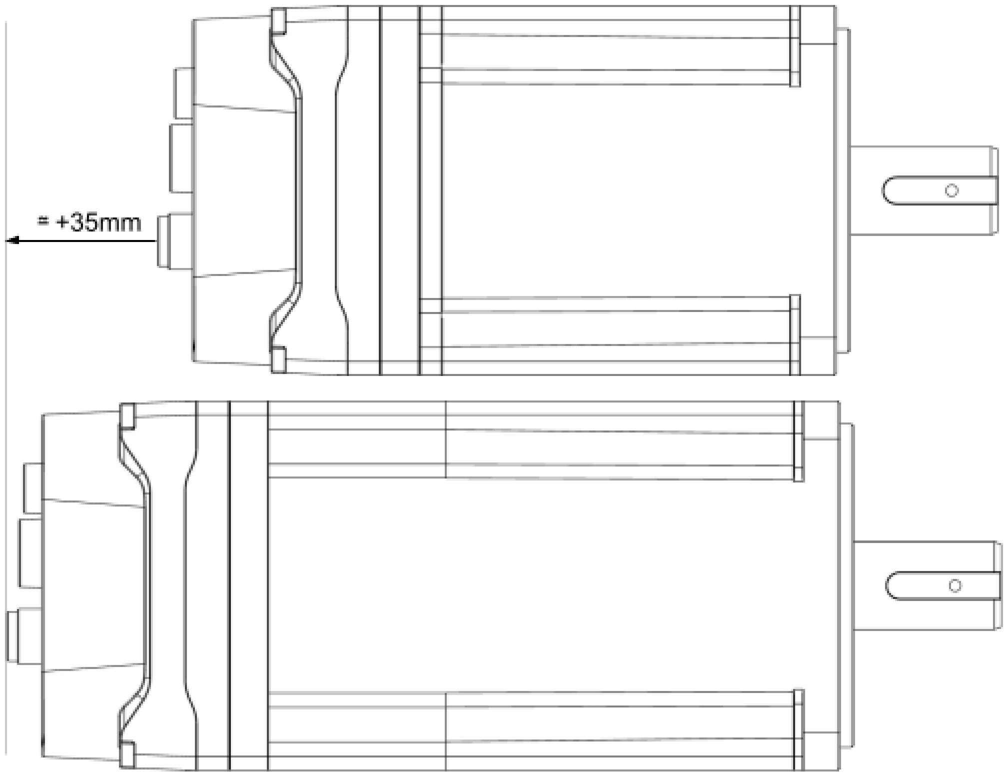


Figure 6.4 - Size comparison of ACTILINK-S 8 with and without brake

Brake parameters	
Rated power [W]	11
Pull voltage [V]	24
Pull time [ms]	100
Brake torque [Nm]	3,2

6.1.3. Mounting Interfaces

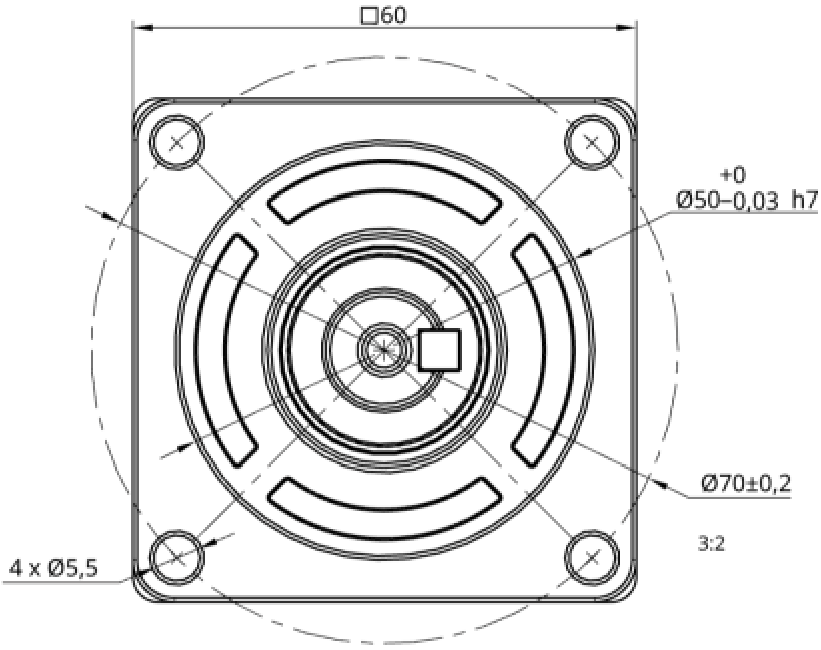


Figure 6.5 - ACTILINK-S 6 mounting interface

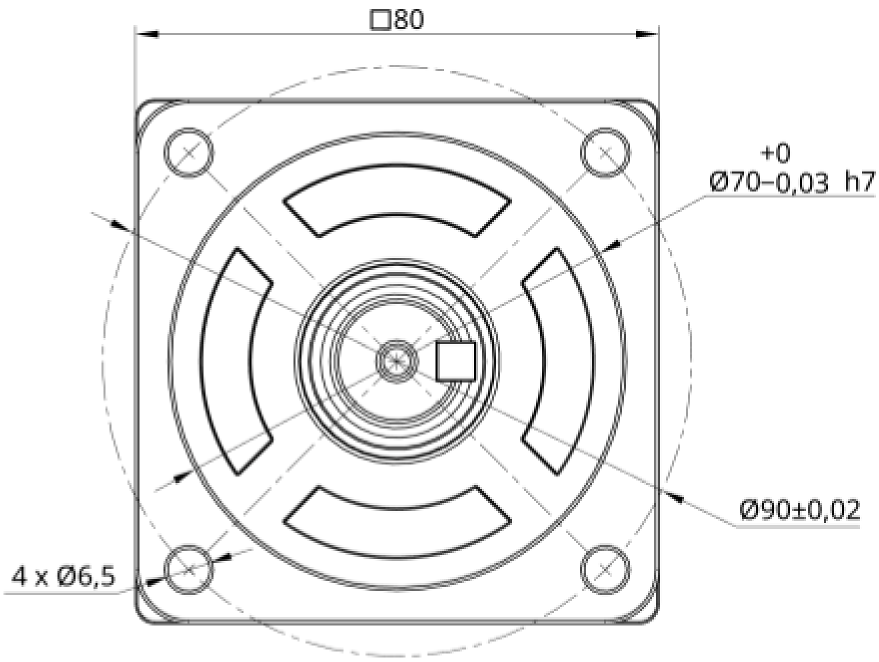


Figure 6.6 - ACTILINK-S 8 mounting interface

6.1.4. Mounting Instructions

6.1.4.1. Permissible forces on the motor shaft

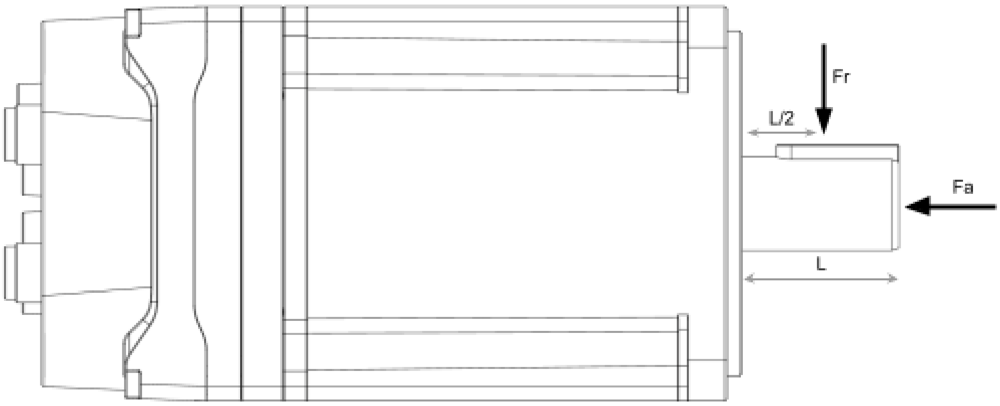


Figure 6.7 - ACTILINK-S 8 mounting interface

Force	ACTILINK-S 6	ACTILINK-S 8
F_a	74N	147N
F_r	245N	392N

6.1.5. Shaft Dimensions

The ACTILINK-S C-line is - by default - delivered with a standard shaft dimension with keyway. Other shaft ends are available on request.

For specific details on the ACTILINK-S 6 and ACTILINK-S 6 Hybrid as well as on the ACTILINK-S 8 and ACTILINK-S 8 Hybrid, refer to the Synapticon CAD Portal.

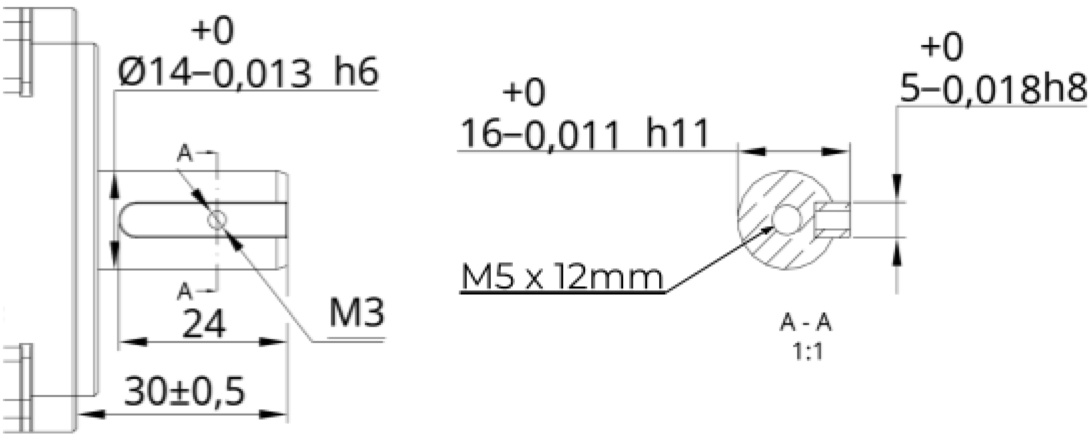


Figure 6.8 - ACTILINK-S 6: 14 mm shaft with keyway

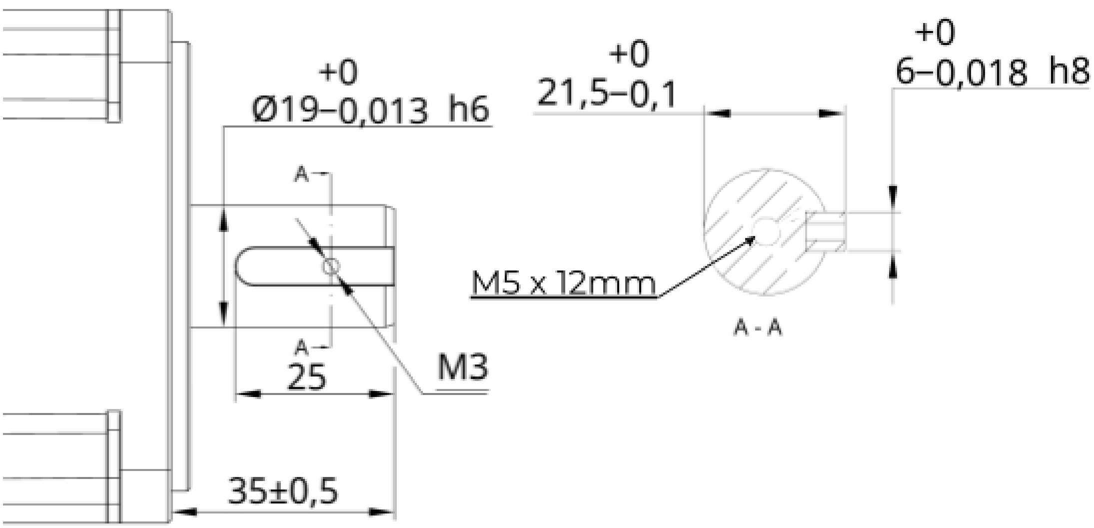


Figure 6.9 - ACTILINK-S 8: 19 mm shaft with keyway

6.2. CAD Data

Use this link to access CAD data including 3D models of all variants as well as integrated servo motor design drawings.

7. Electrical Installation

7.1. Cabling Lengths

Please observe the maximum allowed cable lengths:

Connection	Maximum wire length
Power supply cable	30 m*
STO-SBC	30 m
Field bus	30 m
GPIO: Digital Inputs and Outputs	30 m
GPIO: External Encoder / Analog Inputs	3 m / 30 m**

* *For large currents, consider the voltage drop along the cable.*
*** Wiring locally at the axis, max 3 m recommended. Up to 30 m possible with shielded cables and depending on signal quality.*

With a daisy-chain topology, the cable lengths mentioned above apply to the length of the entire daisy-chain - from the power supply / battery / distribution box / network switch to the last motor of the chain.

7.2. Power Supply

Use a Protected Extra-Low Voltage (PELV) or Safety Extra Low Voltage (SELV) power supply to ensure that the DC supply voltage is isolated from the grid.

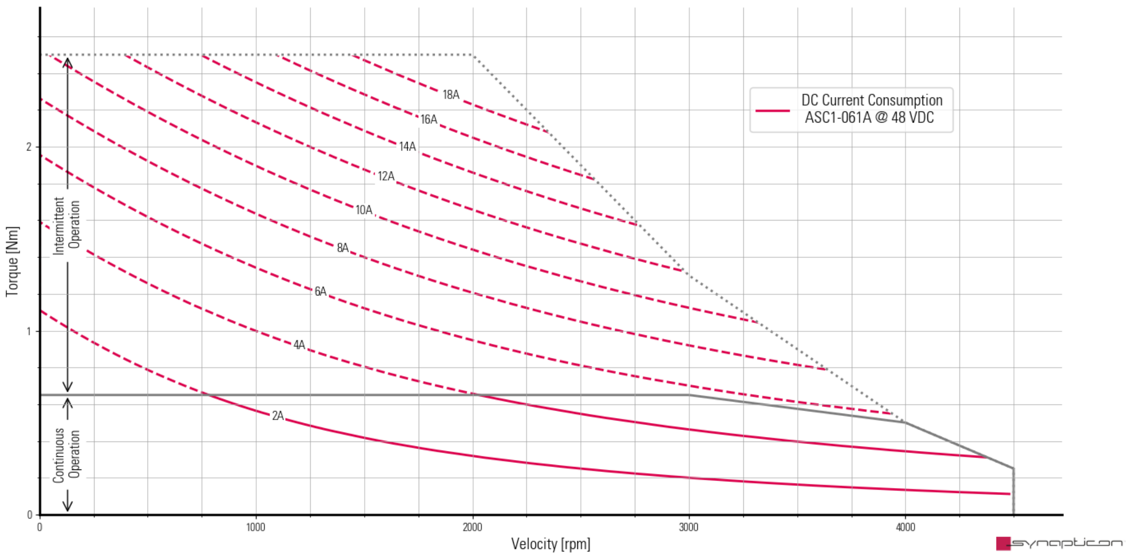
Synapticon recommends the use of a power supply optimized for motion applications, such as the Synapticon ACTILINK MPSU 1500-48-IB, with integrated braking chopper.

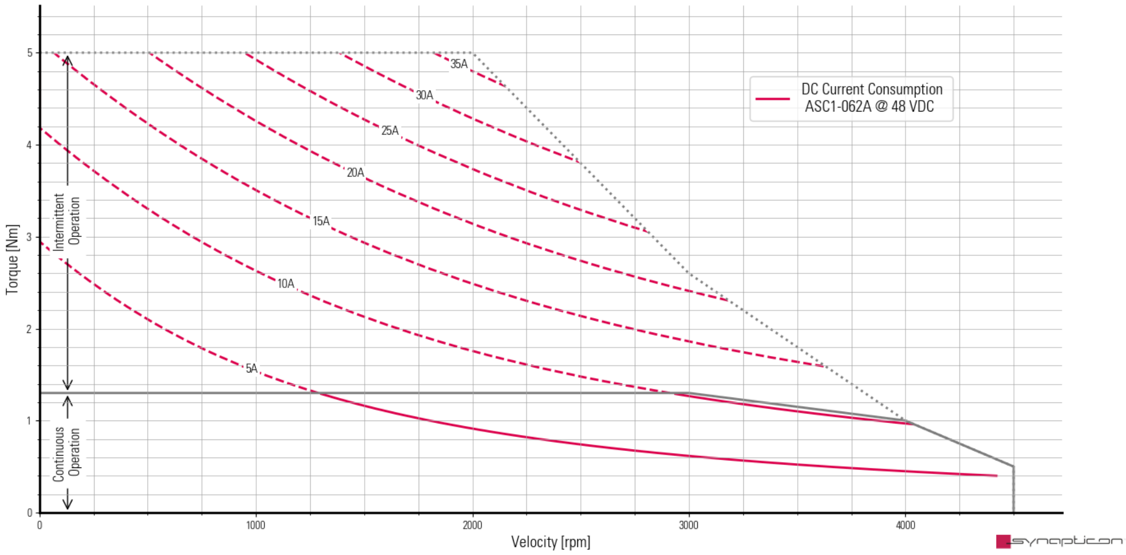
For battery powered applications, it is important that while charging the battery, the charger fulfills the requirements of a SELV/PELV power supply, or the drive is switched off from the battery during charging. To prevent damage to the battery in the event of a short circuit, it is crucial to implement short circuit protection mechanisms. These protections can include devices such as fuses and PPTC devices, among others.

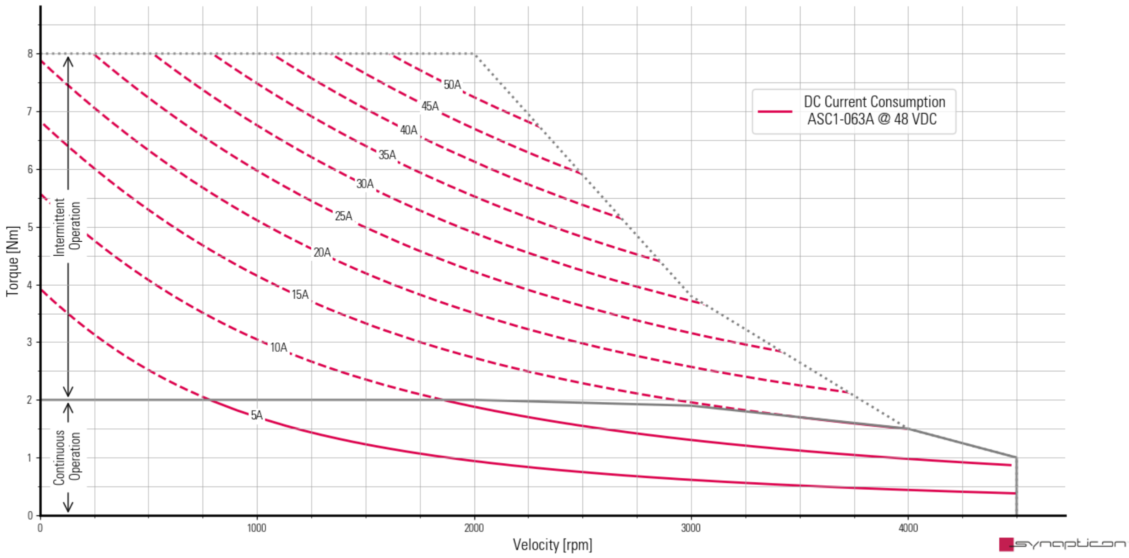
IMPORTANT
For the electrical safety concept of the drive, the mean DC voltage is not allowed to exceed 60V during operation, including regenerative conditions.

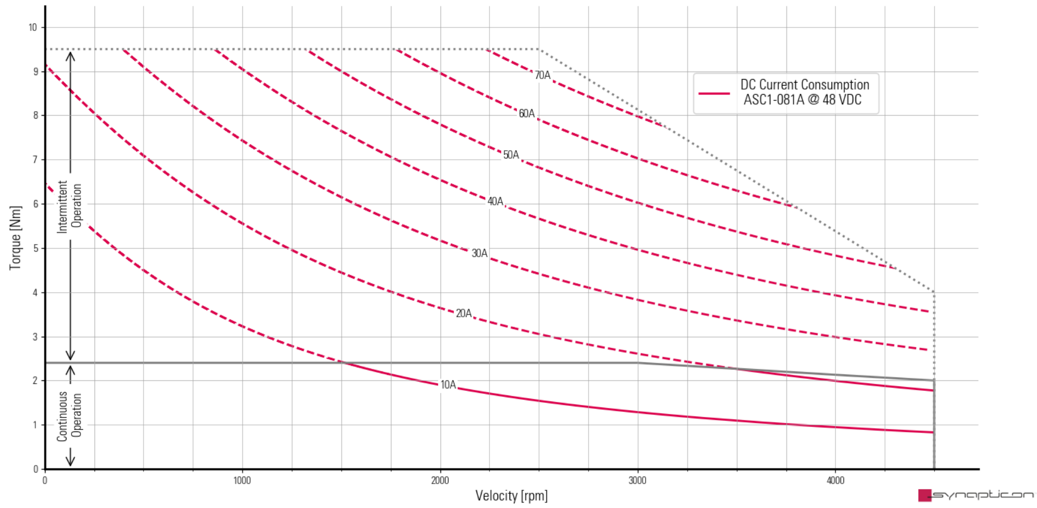
By satisfying these requirements, the equipment can be seen as fulfilling protective class III (3), hence no provision for basic protection is required.

7.2.1. DC Current Consumption




DC Current Consumption
ASC1-062A @ 48 VDC
Torque [Nm]
Velocity [rpm]
Intermittent Operation
Continuous Operation
35A
30A
25A
20A
15A
10A
5A


DC Current Consumption
ASC1-063A @ 48 VDC
Torque [Nm]
Velocity [rpm]
Intermittent Operation
Continuous Operation
50A
45A
40A
35A
30A
25A
20A
15A
10A
5A



NOTE

Data is for 48 V supply. For performance at other voltages, refer to the Application Note 24 V - 60 V Operating ACTILINK-S Integro Outside Nominal Voltage.

7.3. Connection Guide

This section explains the connection pinouts and their associated functions.

WARNING
For R1.5 (“Early Samples”, 2023) users, the pinout power connector has changed!
Do not use your R1.5 / Early Samples power supply cable; instead, configure the cables as described in this document..

7.3.1. Connection Schemes

ACTILINK-S and its variants allow for different general connection schemes - daisy chain or star - depending on the variant and the required electrical load.

Both connection schemes are available in conjunction with the metric and hybrid connector variants.

Additionally, the option to select the connection scheme applies to the power cables, STO cables, field bus cables, or to the hybrid cable. It is possible to combine daisy and star topology for the different signal types.

7.3.1.1. Daisy Chain Wiring

In a daisy chain configuration, multiple servo drives are connected in a series, where the communication or power line runs from the controller (or power source) to the first drive, then from the first to the second, and so on. This setup reduces cabling complexity and is suitable for systems where devices are installed in a linear or sequential arrangement.

- **Advantages:**
  - Requires less cabling and fewer connectors.
  - Simple and cost-effective installation.

- **Considerations:**
  - Failure at one node or segment can disrupt communication or power to subsequent drives.
  - A voltage drop may occur over long chains or with high current demands.

This method is ideal for low- to medium-load systems with well-managed cable lengths.

7.3.1.2 Star Wiring

In a star wiring configuration, each servo drive connects individually back to a central node, such as a controller, power supply, or switch. Each drive has a dedicated path, forming a topology that resembles a star.

- **Advantages:**
    - High reliability: failure in one branch does not affect others.
    - Easier troubleshooting and maintenance.

- **Considerations:**
    - Requires more cabling and potentially larger enclosures or cable trays.
    - The central node (controller or power supply) must be capable of supporting multiple connections simultaneously.

This method is recommended for high-performance applications requiring higher current loads, or when redundancy and isolation between drives are critical.

7.3.2. Earthing

All live parts of the drive are isolated from the earth potential by basic isolation. The earth potential does not serve a protective purpose since the system is considered to be safe to touch. A proper functional earth (FE) connection could still be recommended to improve the EMC behavior of the system.

- Earthing via motor chassis / flange is recommended
- Earthing via the connector’s earth pin as an alternative

> **NOTE**
> It is not recommended to use both.

7.3.3. Conventions Used in this Document

The diagrams in this document use the following conventions but are also explicitly labeled where feasible to avoid confusion:

- Female pin slots are drawn as open (white) areas
- Male pins are drawn as closed (black) areas

> **NOTE**
> All metric connectors conform to IEC 61076-2-101 (M12) and IEC 61076-2-104 (M8).

7.4. Metric (M8/M12) Variant

The power, fieldbus, and STO/SBC input connectors are shown below.

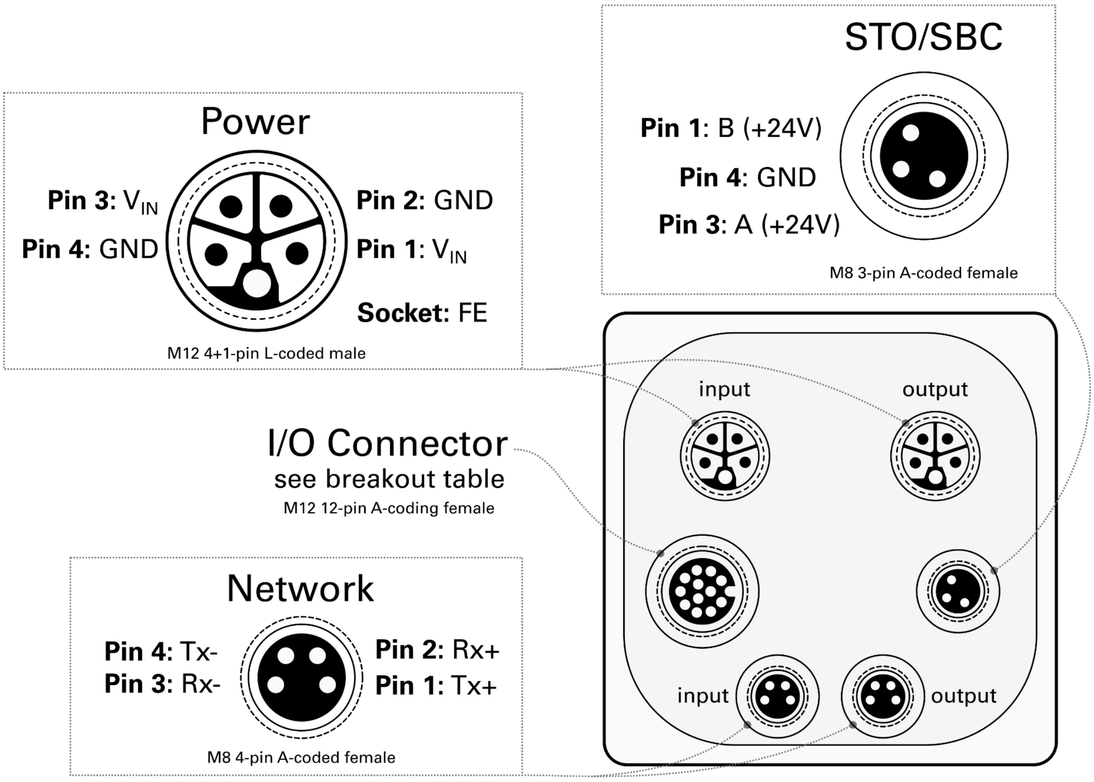


Figure 7.1 - Overview of the SOMANET Integro metric option connections - view from the cable side towards the device side

NOTE

GND refers to Ground (-).

V_{IN} refers to Voltage In (+).

With the network connector, the pinout applies to all variants except the CAN variants.

7.4.1. Power Connector Pinouts

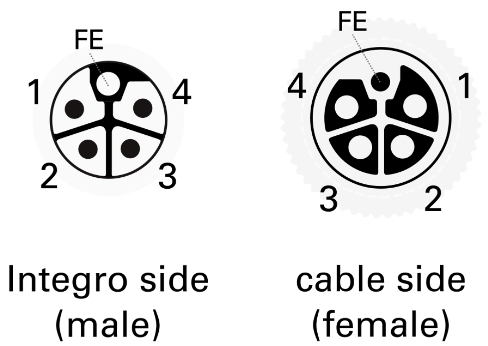


Figure 7.2 - Power Connector from both SOMANET Integro and cable perspectives (This is an M12 4+1-pin L-coded connector.)

Pin #	Color	Function
1	Brown	VIN
2	White	GND
3	Blue	VIN
4	Black	GND
FE	Grey	PE

7.4.2. STO/SBC Input Connector Pinouts

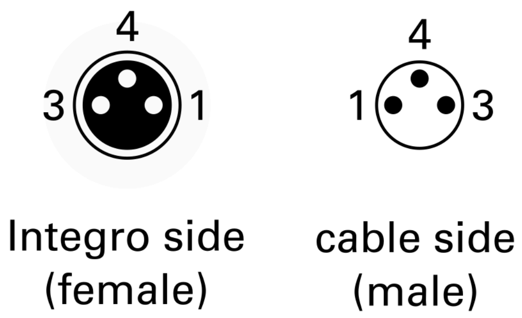


Figure 7.3 - STO/SBC input connector from both SOMANET Integro and cable perspectives
(This is an M8 3-pin A-coded connector.)

Pin #	Color	Function
1	Blue	STO-SBC B (+24 V)
3	Brown	STO-SBC A (+24 V)
4	Black	STO-SBC GND

7.4.3. Fieldbus Connector Pinouts

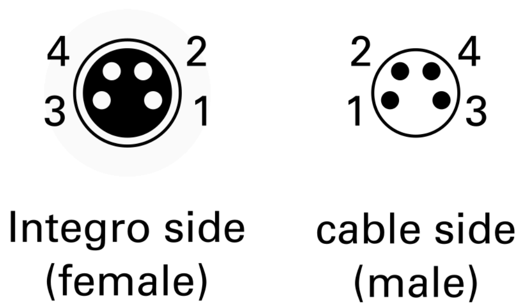


Figure 7.4 - Fieldbus connector from both SOMANET Integro and cable perspectives
(This is an M8 4-pin A-coded connector.)

The devices with Ethernet/IP, EtherCAT, and PROFINET interface use the standard M8 4-pin Ethernet pinout. The CAN variant* uses the same connector for the respective CAN signals. All pinouts are the same for input and output.

Pin #	Color	Function for Ethernet, EtherCAT, Ethernet/IP and PROFINET	Function for CAN*
1	Yellow	TX+	CANL
2	White	RX+	CAN_0V
3	Orange	RX-	CANH
4	Blue	TX-	CAN_+V

7.5. ACTILINK SINGLE CABLE TECHNOLOGY Variant

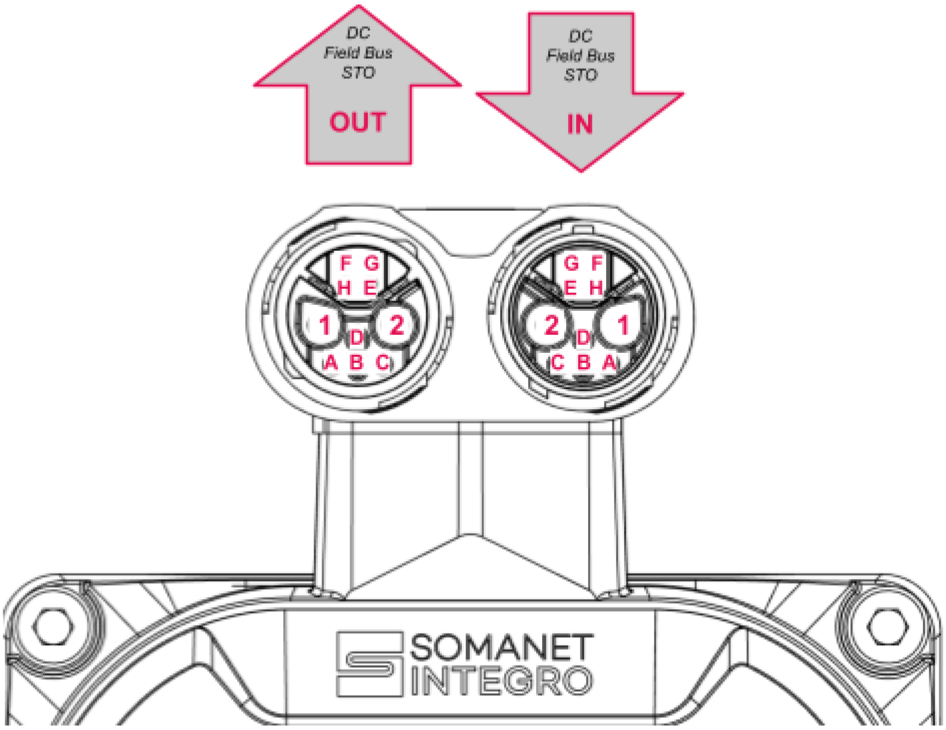
The ACTILINK SINGLE CABLE TECHNOLOGY combines power, field bus and STO signal in one cable and one connector - the hybrid cable and hybrid connector.

The devices come either as:

- I-Tech devices - with a male hybrid connector for input power and signals
- Y-Tech devices - with a male hybrid connector for input power and signals and a female hybrid connector for output power and signals

7.5.1. Pinout

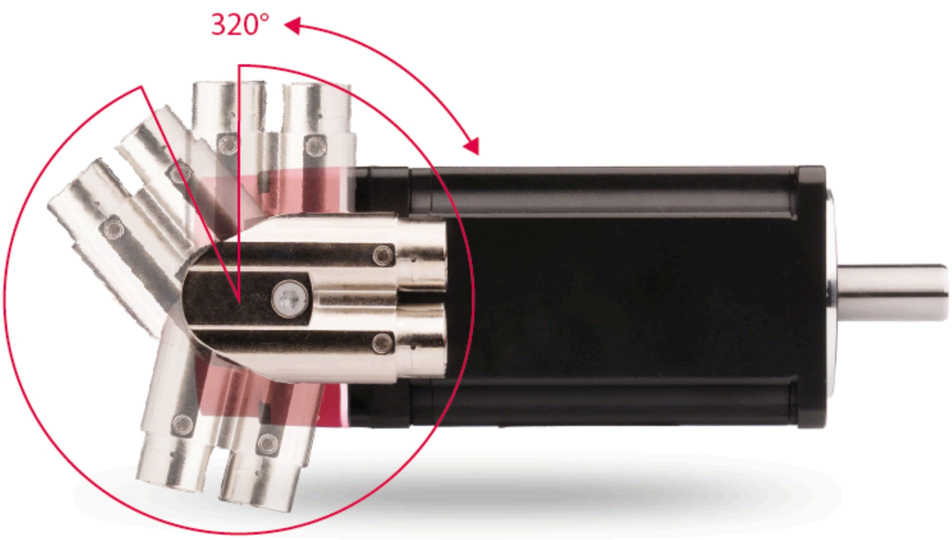
The pinout for a Y-Tec connector is as follows:



Pin	Dedication	Cable Color
1	GND	Black
2	VCC	Red
A	STO B	Yellow/Gray
B	STO GND	Black
C	STO A	Yellow/White
D	FE	Pink
E	TD+	Yellow
F	RD-	Blue
G	TD-	Orange
H	RD+	White

The pinout for the I-Tec connector is the same.

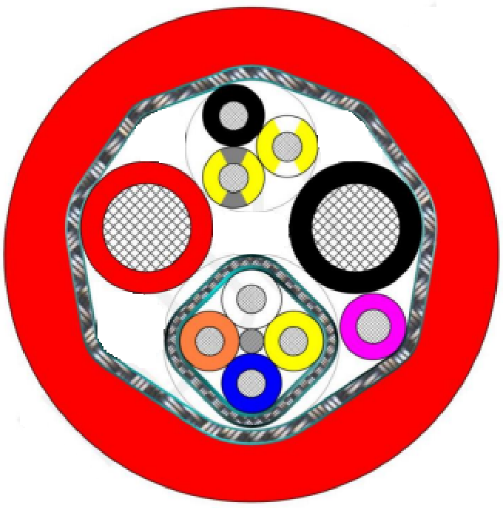
Both the I-Tec and the Y-Tec connector can be rotated freely by 320°. This rotation requires significant force and is intended to occur only during installation, not during operation. Refer to the image below for possible rotation positions.



Hybrid devices are available with GPIO functionality as well. The respective GPIO connector is separate from the hybrid connector and the pinout is the same as in I/O Connector Pinouts.

7.5.2. Cable Properties

ACTILINK HYBRID CABLE TECHNOLOGY cables use the following internal design:



Each cable consists of 10 wires:

Functionality Group	Functionality	Color	Cross Section
DC	VIN	red	2.5 mm2
	GND	black	2.5 mm2
STO	STO A	yellow/white	0.25 mm2
	STO B	yellow/grey	0.25 mm2
	STO GND	black	0.25 mm2
Bus	TD+	yellow	0.25 mm2
	RD-	blue	0.25 mm2
	TD-	orange	0.25 mm2
	RD+	white	0.25 mm2
Earth	FE	pink	0.34 mm2

7.6. Variants with GPIO

7.6.1. I/O Connector Pinouts

In regard to I/O, both the M8/M12 connector configuration and the Hybrid variation use the following pinout on the M12 12-pin connector.

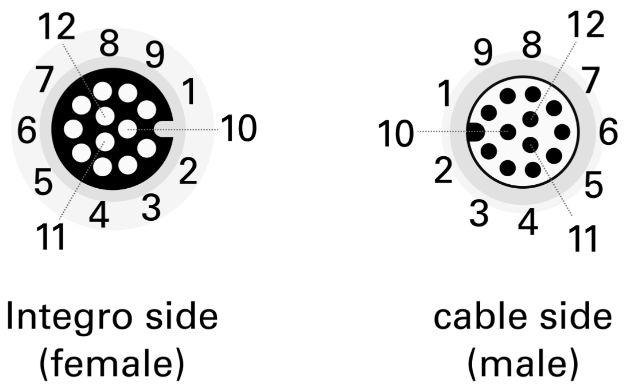


Figure 7.5 - I/O Connector from both SOMANET Integro and cable perspectives (This is an M12 12-pin A-coded connector.)

The I/O Connector pinout options depend on the variant. Refer to the table below for additional information.

Part Number	Input Options
Ixxx-xxx-xxx-xxxx-xxG3-xxx-xx	Two AIN or BiSS/SSI/ABI encoder + One DI + Two DIOs + 24Vout
Ixxx-xxx-xxx-xxxx-xxD2-xxx-xx	Two DIs + 24Vout

IMPORTANT
If a single-channel control source, e.g., an analog input or digital input, is used to control the motor, errors in the signal or hardware can cause unexpected motion. The user must ensure that the application is suitable and remains safe!

Pin	Color	Ixxx-xxx-xxx-xxxx-xxG3-xxx-xx	Ixxx-xxx-xxx-xxxx-xxD2-xxx-xx
1	White	AI_2_n/Clock-/B-	NC
2	Brown	I-	DI_4*
3	Green	DI_1/DO_1*	NC
4	Yellow	DI_2/DO_2*	NC
5	Gray	DI_3** (Fast DI)	DI_3* (Fast DI)
6	Pink	DI_COM	GND
7	Blue	AI_1_p/Data1+/A+	NC
8	Red	AI_1_n/Data1-/A-	NC
9	Black	AI_2_p/Clock+/B+	NC
10	Violet	GND	GND
11	Gray/Pink	I+	NC
12	Red/Blue	+24V_out*	+24V_out*

** Referenced to GND.*
*** Referenced to DI_COM. This is functionally isolated from GND.*

7.6.2. Detailed Specification of Inputs and Outputs

7.6.2.1. Analog Inputs (AI)

SOMANET servo drives use differential and single-ended analog inputs to measure various sensors. These inputs support analog sensors for temperature, pressure, torque measurements, etc.

The analog inputs of SOMANET Integro can also be used for sensors that output resistance as a measured value. The measured analog values can be converted into a corresponding temperature, pressure, etc, by the drive itself.

For information on installing analog sensors to SOMANET Integro, refer to Analog In.

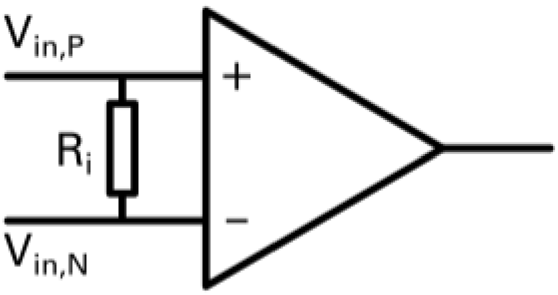
SOMANET servo drives have different ports for measuring analog voltage. They are connected to an integrated ADC (Analog-to Digital converter) with 16-bit resolution (0-65,520 ticks).

ADCs scale the measured voltage of a sensor to digital ticks.

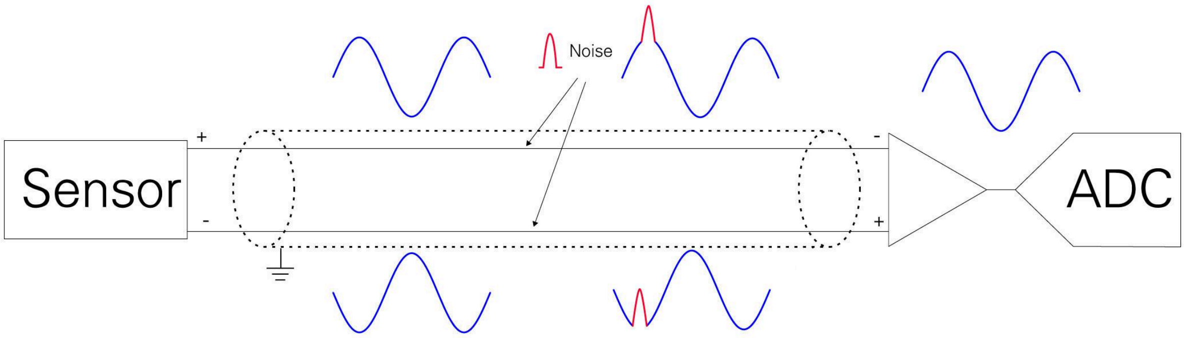
The analog input specification for differential and single-ended inputs is listed below.

7.6.2.1.1. Differential Mode

Differential inputs measure the voltage between two distinct input signals.



A differential input resists electromagnetic noise better than a single-ended input. Most of the noise induced in one line is also induced in the other. The differential input measures only the difference between the two lines, and the noise common to both is ignored. The advantages of a differential input are: its wider input range, the possibility to measure negative voltage, and the robustness against common mode noise.


Noise
+
-
Sensor
-
+
ADC

Symbol	Min.	Typical	Max.	Description	Impact
V_{diff}	-10.2V	-	+10.2V	The input voltage between the positive and negative input pins	Any voltage out of this range causes saturation to the min/max ADC value.
$V_{diff, max}$	-12V	-	+14V	The tolerable input voltage	Any voltage out of this range damages the analog input's circuitry.
V_{cm}	-1	+5 V	+6V	The common mode voltage applied to the inputs	Any voltage out of this range causes excessive DC bias to the input pins.
$V_{cm, max}$	-10V	-	+12V	Absolute maximum common mode voltage	Any voltages out of this range may cause permanent damage to the input circuit.
$R_{in, diff}$	19.9K	20.3K	20.7K	Internal input impedance	-
f_c	-	9.5KHz	-	Cut-off frequency of the input circuit low pass filter	-
Error	-1%	-	+1%	-	-

ADC Ticks Calculation in Differential Mode

The conversion between deferential voltage and ADC ticks is given by:

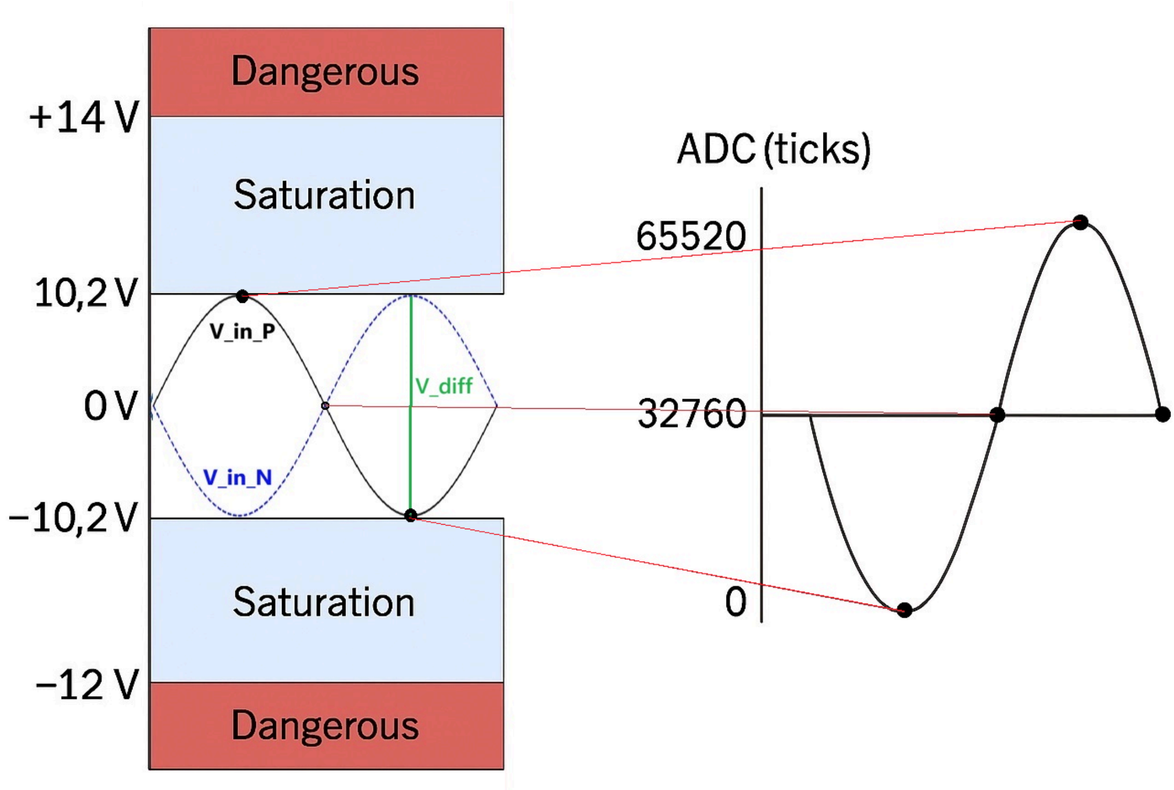
- $ADC_{Total,Ticks} = 65520\, Ticks$
- $V_{diff,\, max} = 10.2V;\ V_{diff,\, min} = -10.2V$

$$ADC_{(ticks)} = \begin{cases} \left(\dfrac{V_{diff}}{V_{diff,max}} \cdot \dfrac{65{,}520}{2}\right) + \dfrac{65{,}520}{2}, & if\ V_{diff,min} \le V_{diff} \le V_{diff,max} \\ 0, & if\ V_{diff} < V_{diff,min} \\ 65{,}520, & if\ V_{diff} > V_{diff,max} \end{cases}$$

To calculate the differential input voltage, use the following formula:

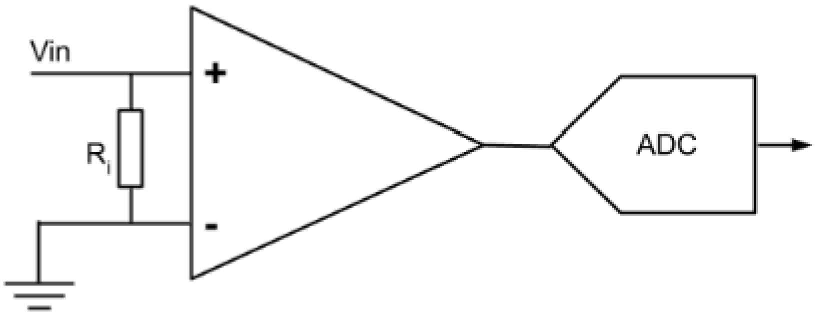
$$V_{\text{diff}} = V_{\text{in,P}} - V_{\text{in,N}}$$

$$V_{\text{diff}}(V) = \begin{cases} \left(\dfrac{\text{ADC}_{\text{ticks}} - \frac{65520}{2}}{\frac{65520}{2}}\right) \times 10.2, & \text{if } 0 < \text{ADC}_{\text{ticks}} < 65520 \\ \le -10.2\,, & \text{if ADC}_{\text{ticks}} = 0 \\ \ge +10.2\,, & \text{if ADC}_{\text{ticks}} = 65520 \end{cases}$$



7.6.2.1.2. Single-ended Mode

The accuracy of the single-ended measurement will be affected by the source impedance. To keep the accuracy in the acceptable range, use an analog source with output impedance below 200R.



Symbol	Min.	Typical	Max	Description	Impact
V_{in}	-10.2V	-	+10.2V	The input voltage between the input and GND	Any voltage out of this range causes saturation to min/max of the input circuitry.
$V_{in,\ max}$	-12V	-	+14V	The tolerable input voltage between the Vp input and GND	Any voltage out of this range damages the analog input's circuitry.
$R_{in,\ single}$	11K	12.5K	14K	Internal input resistance	-
f_c	-	9.5KHz	-	Cut-off frequency of the input circuit low pass filter	-
Error	-1%	-	+1%	-	-

ADC Ticks Calculation in Single-ended Mode

The conversion between measured voltage in volts to digital ticks for single-ended mode is given by:

- $ADC_{Total,Ticks} = 65520\ Ticks$
- $V_{in,\ max} = 10.2V;\ V_{in,\ min} = -\ 10.2V$

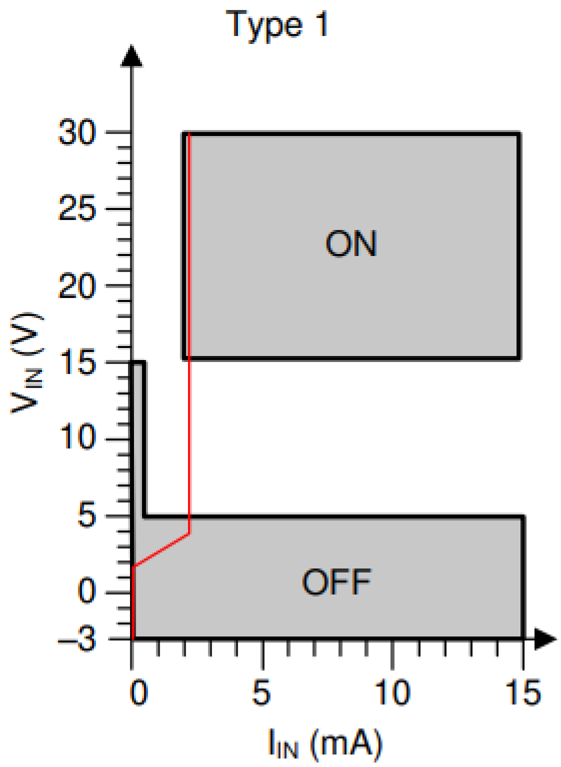
$$ADC_{(ticks)} = \begin{cases} \left(\frac{V_{in}}{V_{in,max}} . \frac{65{,}520}{2}\right) + \frac{65{,}520}{2}, & if\ V_{in,min} \le V_{in} \le V_{in,max} \\ 0, & if\ V_{in} < V_{in,min} \\ 65{,}520, & if\ V_{in} > V_{in,max} \end{cases}$$

To calculate the single-ended input voltage, use the following formula:

$$V_{\text{in}}(V) = \begin{cases} \left(\frac{\text{ADC}_{\text{ticks}} - \frac{65520}{2}}{\frac{65520}{2}}\right) \times 10.2, & \text{if } 0 < \text{ADC}_{\text{ticks}} < 65520 \\ \le -10.2\,, & \text{if ADC}_{\text{ticks}} = 0 \\ \ge +10.2\,, & \text{if ADC}_{\text{ticks}} = 65520 \end{cases}$$

7.6.2.2. Digital Inputs (DI)

- Digital inputs can be used to read digital signals “into” the ACTILINK device. For example:
    - Home switches or limit switches can be connected to digital inputs so that the status (open/closed) of the end switch becomes available in the drive’s object dictionary.
    - The 24V supply line can be used to supply such switches.
- Compliant thresholds according to IEC 61131-2:2017 Type 1
- Input voltage/Current curve displaying ON/OFF thresholds:



- Input logic: Current Sinking (NPN)
- Max input current: 2.5 mA
- Protections:
    - ESD
    - Overvoltage up to 60V
    - Reverse polarity connection
- Signal propagation time:
    - Standard mode: <1 communication cycle (<250 µs)
    - Touch probe mode: contact Support for details.
- Minimum pulse duration: 13 µs
- Object 0x2210 determines specific functionalities assigned to the input.

7.6.2.3. Configuring Digital Inputs/Outputs (DIO)

Via object 0x2210, the DIOs can be configured to serve as either input or output.

7.6.2.3.1. Configured as Inputs

See Digital Inputs (DI)

7.6.2.3.2. Configured as Outputs

- Digital outputs can be used to “switch” external devices connected to ACTILINK-S. For example, a valve, a relay, or an external status LED can be connected to a digital output and be controlled through the motor’s object dictionary; thus, by signals coming from the PLC or an internal control logic.
- Voltage and current: The digital outputs are internally supplied from the 24V Out. Refer to the V Out section for specifics. The claimed current capacity is shared between the 24V output and all digital outputs in use.
- Output logic: Sourcing (PNP)
- Max. switching frequency: 2.5 kHz
- Isolation: Functional isolated
- Load capabilities: Resistive, inductor,
    - Capacitive load < 100 nF
    - Resistive load > 100 Ω
- Protected against:
    - ESD
    - Reverse polarity
    - Short-circuit and overload

7.6.2.4. For additional information, refer to Digital IO.

7.6.2.5. Digital IO Hardware Specification

7.6.2.5.1. Digital IO Timing Characteristics (Propagation Delay)

The following propagation delays were measured on SOMANET Integro / ACTILINK-S Integro Digital IO lines.

DIOs	Mode	Low → Hight Delay	Hight → Low Delay
DIO1	Input	15 µs	18 µs
	Output	21 µs	22 µs
DIO2	Input	15 µs	21 µs
	Output	21 µs	22 µs
DIO3	Input	850 ns	1100 ns

7.6.2.5.2. Default Input State (nothing connected)

With the pin configured as Input and no external connection:

DIO1, DIO2, DIO3: **LOW**

7.6.2.6. External Encoder Interface (ExtEnc)

7.6.2.6.1. Incremental

- Digital incremental encoders with differential lines for $A/\overline{A}$ and $B/\overline{B}$
- Index pulses ($I/\overline{I}$) optional
- Signal level: RS-422 with maximum 3.3V voltage level
- Max frequency: on request
- Receiver input impedance: 1 kΩ. Proper termination is imperative to minimize reflections. In point-to-point networks, the main cable should be terminated in its characteristic impedance (typically 120 Ω) at the end that is farthest from the driver.
- Cable length: <= 3 m recommended, longer possible

7.6.2.6.2. BiSS / SSI

- Interface type: BiSS-C or SSI
- Signal level: RS-422 compliant differential signals
- Supported Encoder types: Absolute, Single-turn, Multi-turn
- Cable length: <= 3 m recommended, longer possible
- Max clock frequency: On request
- Data word: Configurable, 32 bit

7.6.2.6.3. EnDat

This is available on request.

7.6.3. V Out

- Voltage
  - 24V +/-1V if the device’s DC supply voltage is >= 26V.
  - [DC supply voltage] +0/-2V if the DC supply voltage is < 26V.
  - If using the 24V output, it is recommended to use a continuous DC supply voltage of 30V or more to ensure that the above condition is fulfilled even in transient conditions.
- Current:
  - Max. 250 mA for the sum of all digital outputs and the 24V out
- Protections
  - Protected against short-circuit/over-current.

7.6.4. Isolation and Grounding on the I/O Connector (Digital Inputs)

The inputs and outputs are designed according to **IEC 61131-2**.

Some connections on the I/O connector are not galvanically isolated. When external sensors/PLCs are connected, ensure that return currents do not flow back to the power supply via unintended paths through the I/O connector.

Reference domains on the I/O connector are as follows:

- DI1 / DI2 are referenced to GND.
- DI3 is referenced to DI_COM. DI_COM is functionally isolated from GND.
- 24V_out is referenced to GND.

IMPORTANT
If DI_COM is connected (directly or indirectly) to GND, the DI3 / DI_COM circuit is no longer isolated from the drive GND.

7.6.4.1. Wiring Scenarios

For wiring scenarios, refer to the figures that follow.

- *Figure 7.6*
  Sensor supplied by ACTILINK-S Integro. There is no return path to an external power supply.

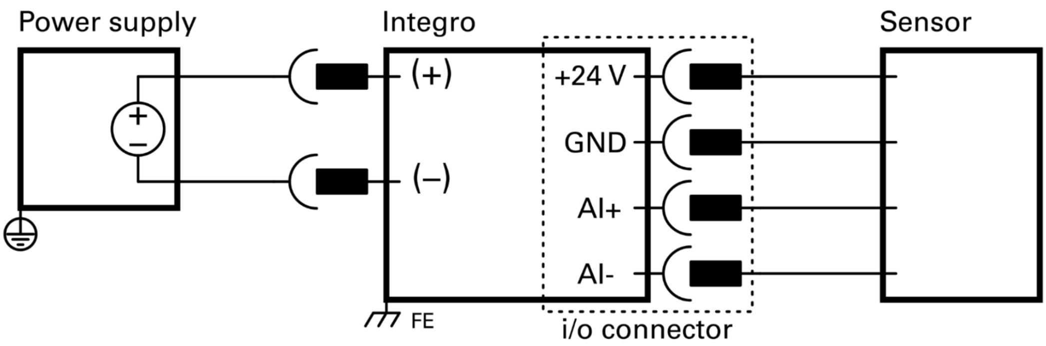


Figure 7.6

- *Figure 7.7*
  If galvanic isolation[1] is required, it must be provided either by the I/O interface (often inside the PLC I/O module), or by isolating the sensor/PLC supply from the drive supply, e.g., using an isolated DC/DC converter.

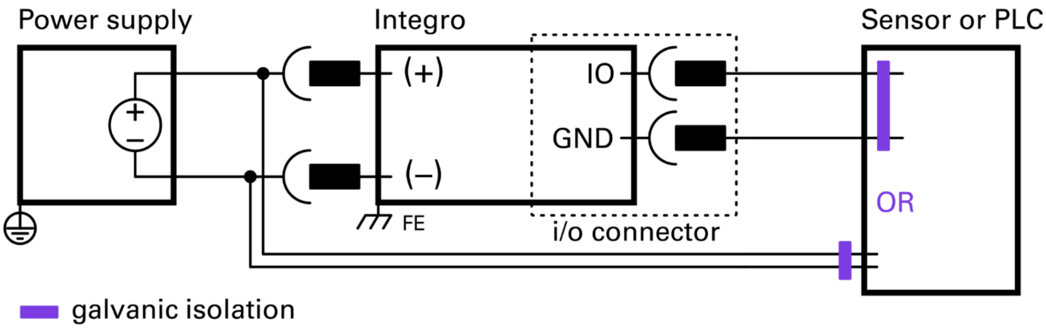


Figure 7.7

- *Figure 7.8*
  When using DI3, additional measures are not required for functional isolation[2]. DI3 and DI_COM are functionally isolated from the drive GND inside ACTILINK-S Integro. To benefit from this isolation, keep DI_COM separated from GND in the external wiring.

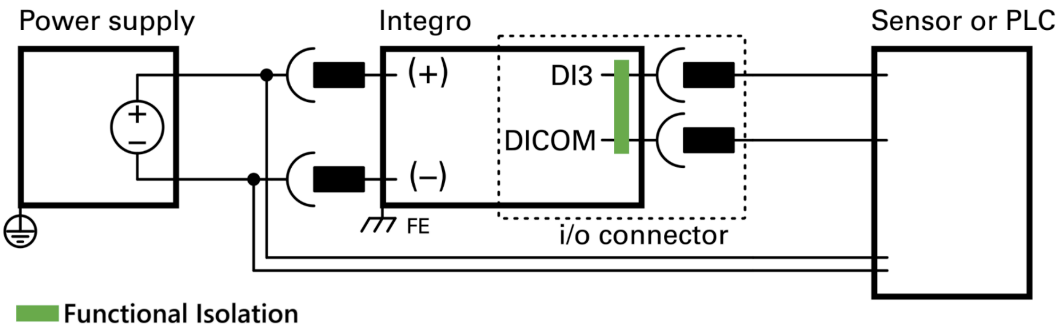


Figure 7.8

1 Galvanic isolation: There is no conductive (DC) path between two circuits. It breaks ground loops and can provide safety separation (if rated).

2 Functional isolation: Circuits are separated for function/noise reasons; however, it is not a safety barrier by itself. In Integro, DI3/DI_COM are functionally isolated from GND.

7.6.5. Connecting Sensor / PLC Outputs to Digital Inputs

This section provides wiring examples for connecting common industrial outputs, e.g., home switch, limit switch, PLC output, to the digital inputs of ACTILINK-S Integro. It focuses on **PNP (sourcing)** and **NPN (sinking)** transistor outputs.

7.6.5.1. Definitions

Output Active / Output Inactive

- *Output Active* indicates that the sensor output transistor is ON.
- *Output Inactive* indicates that the sensor output transistor is OFF (high-impedance / open).
  - PNP sensor output (sourcing): When the sensor output is activated, OUT pulls high.
  - When the sensor output is deactivated, the output is high-impedance (open).

NPN sensor output (sinking)

- When the sensor output is activated, OUT pulls low.
- When the sensor output is deactivated, the output is high-impedance (open).

> **NOTE**
> Real output levels: Sensor outputs are transistor switches and are not ideal. In the Active state, the output voltage is typically close to +24 V (PNP) or close to 0 V (NPN), but not exactly equal due to internal voltage drops.

7.6.5.2. Connecting a PNP Output to Integro Input

Connecting a PNP Output Sensor to DI1 and DI2

DI1 and DI2 are referenced to GND. A PNP sensor can be connected directly. Depending on how the sensor is powered, refer to the corresponding wiring diagram.

> **NOTE**
> If the sensor is supplied by INTEGRO 24V_out, GND must also be connected.

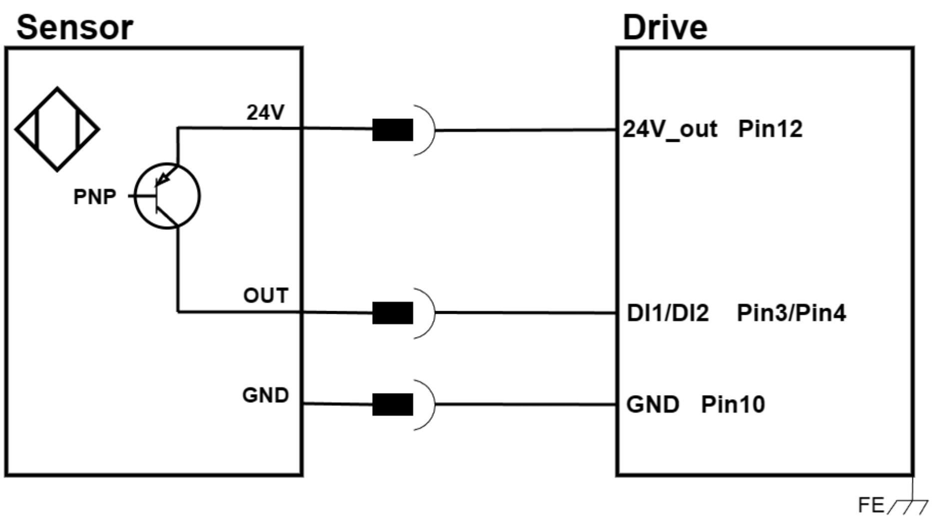


Figure 7.9 - Sensor powered from the Integro drive

> **NOTE**
> DI1/DI2 are referenced to GND. If the sensor is powered from the Integro drive, the sensor 0V/GND must be connected to the drive GND to provide the return path.

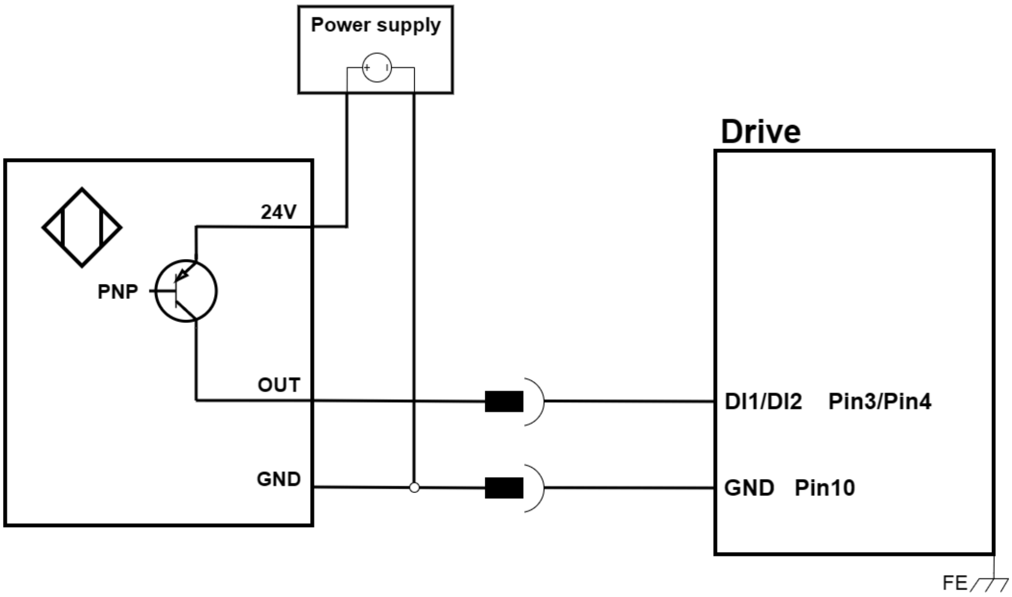


Figure 7.10 - Sensor powered from an external power supply

Expected behavior:

- Not Active → input reads LOW
- Active → input reads HIGH

Connecting a PNP Sensor Output to DI3

DI3 is referenced to DI_COM (not to GND). DI_COM is the return path for the DI3 input current. Use one of the following options depending on whether DI3/DI_COM must be functionally isolated from the drive GND.

- **Functional isolation not required**

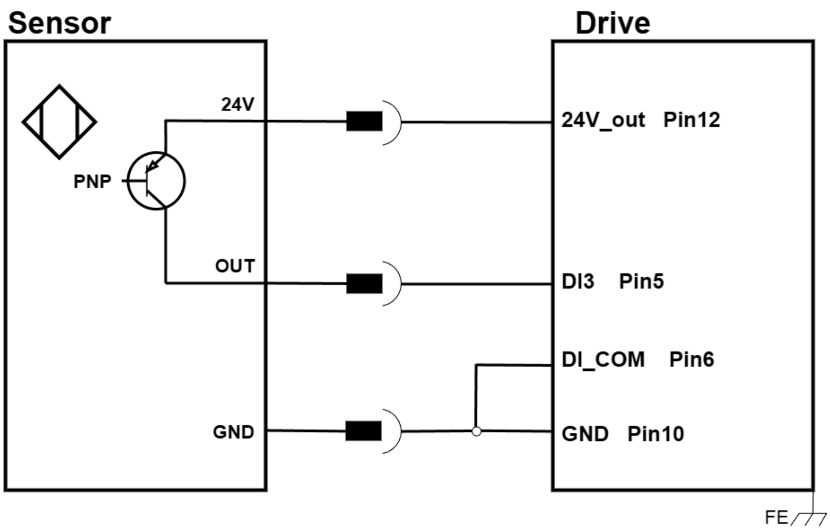


Figure 7.11 - Sensor powered from the Integro drive

Use this option when functional isolation is not required. The sensor may be powered from the drive supply.

> **NOTE**
> This wiring references the DI3 loop to the drive supply and does not maintain DI3/DI_COM functional isolation from drive GND.

- **Keep DI3/DI_COM functionally isolated from drive GND**

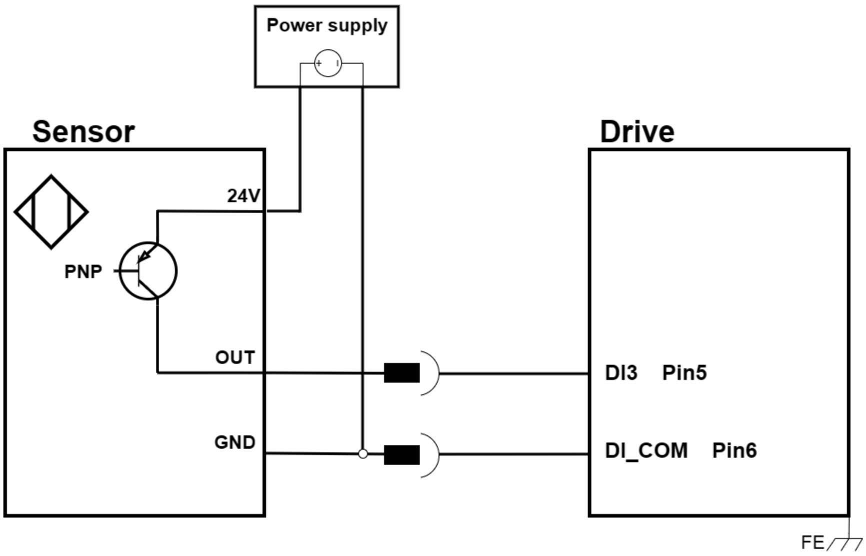


Figure 7.12 - Sensor powered from an external power supply

Use this option when DI3/DI_COM must remain functionally isolated from drive GND. In this case, power the sensor from an external (preferably isolated) 24 V supply and connect the supply 0V/GND to DI_COM only (do not connect DI_COM to drive GND).

Expected behavior:

- Not Active→ DI3 reads LOW
- Active → DI3 reads HIGH

7.6.5.3. Connecting an NPN Output to Integro Input

An NPN sensor output does not directly produce a “high” level. For Integro, the recommended and validated method is to use DI3 together with DI_COM.

> **NOTE**
> DI3 is referenced to DI_COM (not to GND).

- **Functional isolation not required**

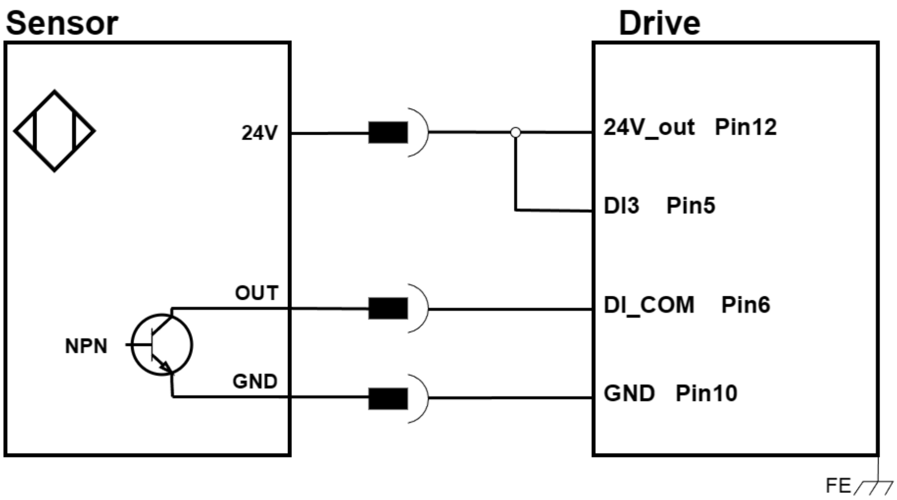


Figure 7.13 - Sensor powered from the Integro drive

Use this option when functional isolation is <u>not</u> required. The sensor may be powered from the drive supply.

> **NOTE**
> This wiring references the DI3 loop to the drive supply and does not maintain DI3/DI_COM functional isolation from drive GND.

- **Keep DI3/DI_COM functionally isolated from drive GND**

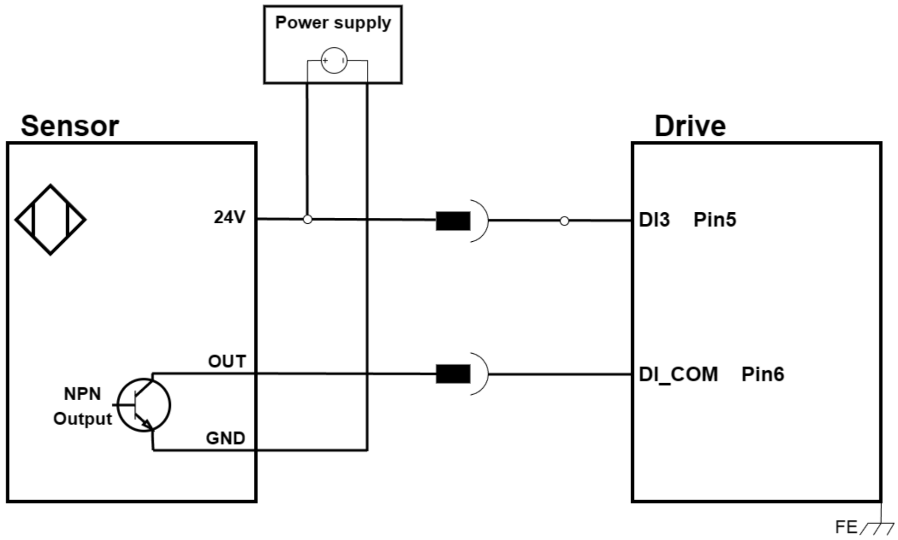


Figure 7.14 - Sensor powered from an external power supply

Use this option when DI3/DI_COM must remain functionally isolated from drive GND. Power the sensor from an external (preferably isolated) 24 V supply and connect the supply 0V/GND only to DI_COM.

Expected behavior:

- Not Active → DI3 reads LOW
- Active → DI3 reads HIGH

Notes / Limitations:

- This method is supported for DI3 only.
- Ensure the sensor output can sink the required input current.

7.7. Compatible Cables

For information on cabling, refer to the Accessories section / Compatible Cables.

8. Using the Product

8.1. ACTILINK-S Integro Quick Start Guide

The *ACTILINK-S Integro Quick Start Guide* explains the essential steps to safely install, connect, and commission an ACTILINK-S Integro integrated servo motor by using the SOMANET Integro *metric* connector configuration as an example.

To access the manual, see ACTILINK-S Integro Quick Start Guide.

8.2. Commissioning Guide

> **NOTE**
> Because of its integrated nature, SOMANET Integro reduces the required commissioning efforts for end users. Encoder, temperature sensor, motor, current controller, brake and protection features all come pre-configured. To reduce complexity, all unnecessary parameters are hidden to end users.

All application-dependent features, including fine-tuning of the motion control loops, setting IO functionality etc., must be tuned by the machine builder.

Tuning can occur using one of the following methods::

1. With Synapticon's OBLAC Drives, you can easily set up and test your motor, encoder and fieldbus systems. Additionally, you can optimize and test your performance, supported by automated tuning functions. Once set up, the expert interface provides quick and direct access to all parameters. OBLAC Drives is available as a Windows and Linux program as well as a virtual machine
2. All parameters are accessible via the motor's field bus interface as well. Therefore, all changes can also be performed from the machine's master or PLC.
3. For series processes, there are multiple ways of batch commissioning. Refer to OBLAC Drives to deploy *config* files or parts of them in batch mode, or refer to a script API to automate these processes within a given production environment.

In addition to the actual commissioning, OBLAC Drives offers functionalities for testing the setup in different modes of operation, i.e.,"Playground".

8.3. Firmware Functionality

A description of the firmware functionality can be found in the
Software Reference 5.x section online, e.g., see Software Reference 5.6.

> **NOTE**
> There will be additions to this documentation as new firmware updates are released.

To download applicable files, refer to Downloads.

8.4. SOMANET Integro LED Ring Specification

This document outlines the behavior of the status LED ring on SOMANET Integro.The LED ring provides a visual indication of the device's operational state through different colors and flashing patterns.

8.4.1. LED State Overview

The operational status of the Integro device is indicated by the LED ring's color and behavior. A key factor in determining the color for non-fault states is the Safe Torque Off (STO) function.

- If STO is active, the LED color will be yellow.
- If STO is not active, the LED color will be green.

Device Status	LED Behavior	LED Color
Initialization (Init Mode)	Circular (1500ms)	Synapticon Pink
Not ready to switch on or Switch on disabled	Solid	Green / Yellow*
Ready to switch on or Switched on	Slow Blinking (1000 ms)	Green / Yellow*
Operation enabled or Quick stop active	Two Plane Pulses (1500 ms)	Green / Yellow*
Fault reaction active	Two Plane Pulses (1500 ms)	Red
Fault	Solid	Red
Bootloader	Circular (1500ms)	Blue
Locating the device (used in SPoE)	Slow Blinking (1000 ms)	Synapticon Pink
Variant mismatch/failure	Slow Blinking (1000 ms)	Red

** The color is yellow if STO is active; otherwise, it is green.*

8.4.1.1. Pattern Definitions

The specific patterns for the LED behaviors are defined below.

8.4.1.1.1. Slow Blinking (1000 ms)

A single, smooth pulse of light that gradually brightens and dims over a total period of 1000 milliseconds. This cycle then repeats.

8.4.1.1.2. Two Plane Pulses (1500 ms)

This is a repeating 1500 millisecond cycle characterized by a quick double-pulse:

1. Pulse 1: 60 ms ON
2. Gap: 120 ms OFF
3. Pulse 2: 60 ms ON
4. Interval: 1260 ms OFF

The entire 1500 ms cycle then repeats.

8.4.1.1.3. Circular (1500ms)

This is an animation pattern whereby the LED brightness moves around the drive followed by fading.

8.5. Digital I/O

8.5.1. Overview

SOMANET Integro supports Digital I/O as follows:

Specification	SOMANET Integro 6	SOMANET Integro 8
GPIO	Optional, up to: • DIO: 2x DIO + 1x DI + 1x +24V • Analog*: 2x AI • External encoder*: 1x ABI or SSI or BiSS	

** External encoder input and Analog Inputs can be available in the same devices; however, their usage is mutually exclusive (either AI or ext. Enc., configurable in firmware).*

8.5.2. Using Digital I/Os

It is possible to use the Digital Inputs of the Drive to command actions and to configure the Digital Outputs to trigger when certain events happen. This can be used to control some aspects of the Drive with an external signal, or to control an external device with the Drive. For additional information, refer to Digital IO.

9. Functional Safety

9.1. Safety Functions (STO-SBC)

ACTILINK-S Integro provides two drive integrated safety functions according to EN 61800-5-2:2017 as a pure hardware solution:

- STO (Safe Torque Off) prevents the creation of torque in the motor and enables an uncontrolled stop in accordance with stop category 0 of IEC 60204-1:2016.
- SBC (Safe Brake Control) prevents an electrical current from being supplied to the brake output and thus safely closes the external brake.

ATTENTION
The safety circuit safely inhibits currents to the motor and to a brake when the STO-SBC command has been given, e.g., from an emergency stop device. When the command has been released, e.g., manually resetting the emergency stop device, the currents are allowed to be carried to the motor and to the brake. The safety system must be designed to meet the requirement “restarting the machinery after a stoppage must be possible only by an intended actuation of a control device provided for the purpose”.

9.2. Wiring the Safety Inputs

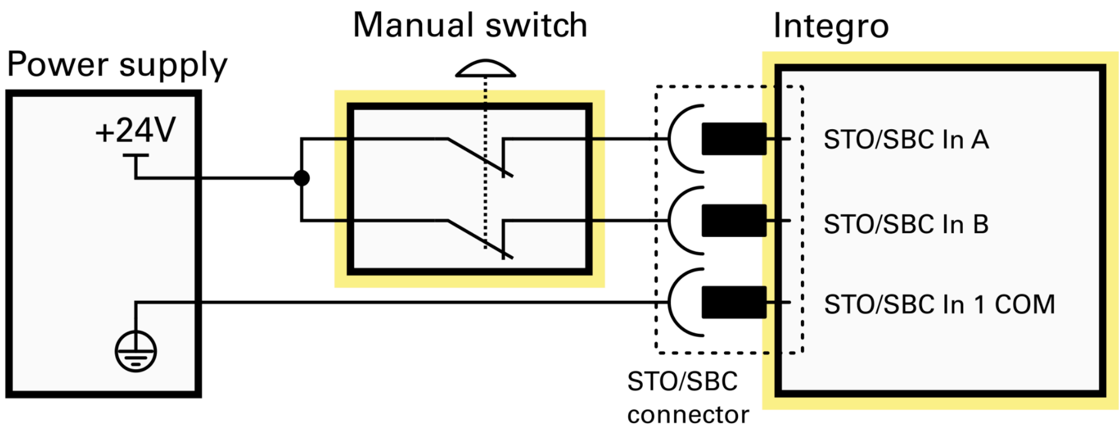
ATTENTION
For SIL 3, PL e, cat.3 it is required to detect or prevent cabling faults. This can be achieved by:
- sending test pulses from the PLC **OR**
- ensure fault exclusion for wiring “Short circuit between any two conductors” according to ISO 13849- 2:2012 between signals STO-SBC A and STO-SBC B.
The fault exclusion can be claimed by:
- permanently connected (fixed) and protected against external damage, e.g. by cable ducting, armouring, **OR**
- separate multicore cables, **OR**
- installation within an electrical enclosure, **OR**
- individually shielded with earth connection.

9.2.1. Connection Diagrams for the STO-SBC Inputs

IMPORTANT
Safety GND is an isolated signal from drive GND.

9.2.1.1. Dual Manual Switch

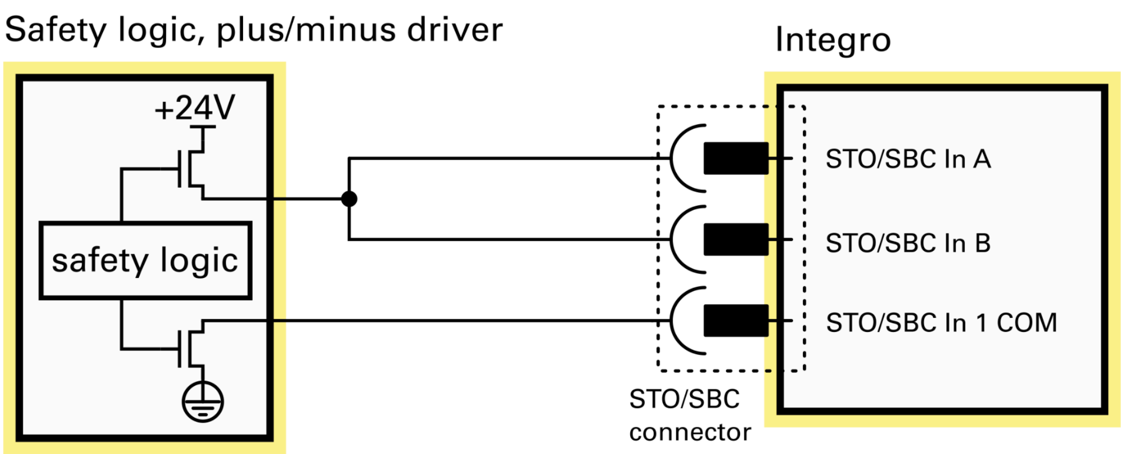
This allows safety functions up to **SIL 3**, **PL e**, **cat.3**.



9.2.1.2. Safety PLC PM (Plus-Minus output)

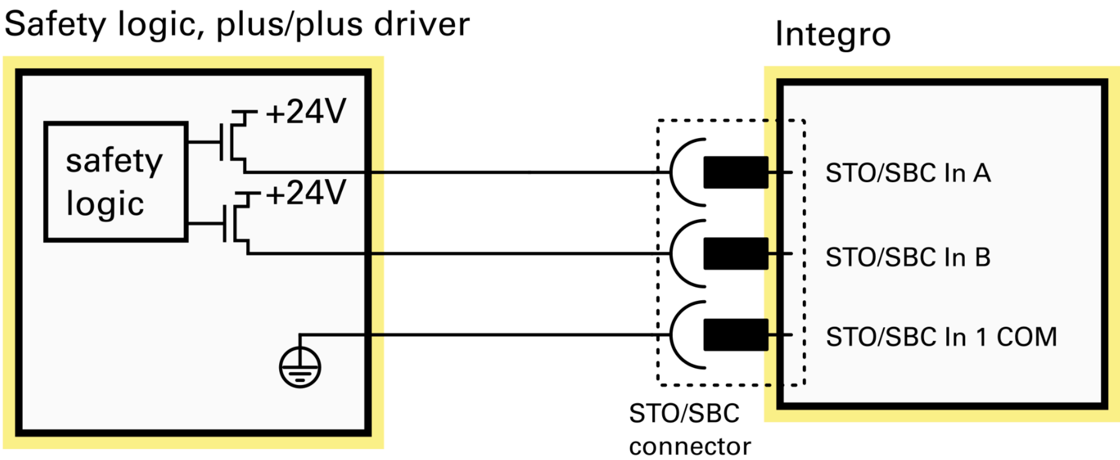
This allows safety functions up to **SIL 3**, **PL e**, **cat.3**.

> **NOTE**
> Safety GND functions as a secondary line when a PLC with Plus-Minus output is used.



9.2.1.3. Safety PLC PP (Plus-Plus output)

This allows safety functions up to **SIL 3**, **PL e**, **cat.3**.



9.2.2. Covering of Unused Plugs

Unused - and therefore open - plugs must be covered by a protective cap if the ACTILINK-S Integro is used in an environment other than PD 2.

9.3. Using the Safety Functions

DANGER
The usage of handheld radio transmitters within 20 cm of the drive might cause disturbances on the drive affecting safety and functionality.

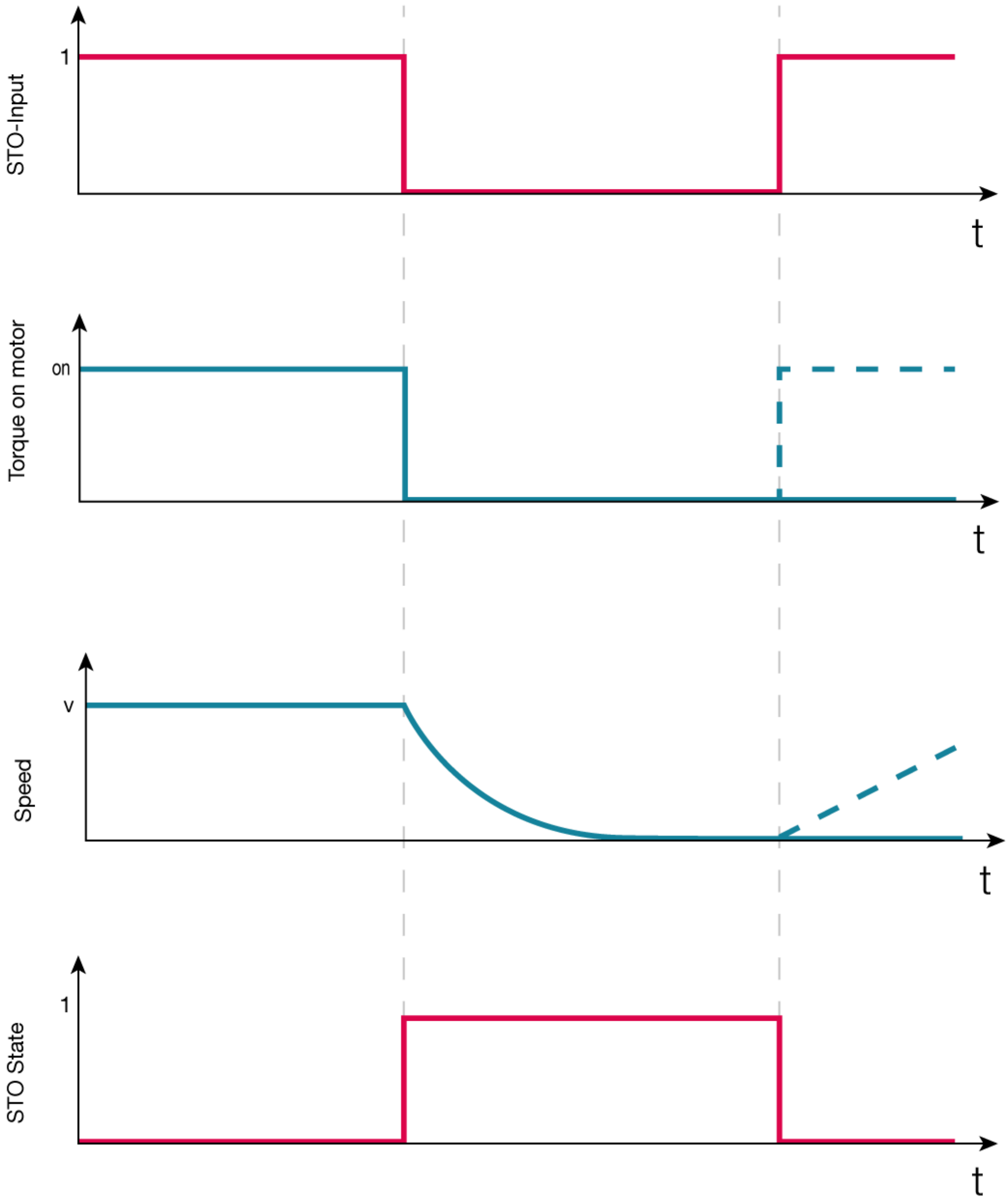
DANGER
A SfeFault triggered on activation of STO/SBC is indicating an internal hardware fault. After each power cycle to clear that fault STO/SBC must be triggered at least once. If the fault occurs again, or is permanent, replace the drive! Safe operation of the drive is not ensured anymore!

.

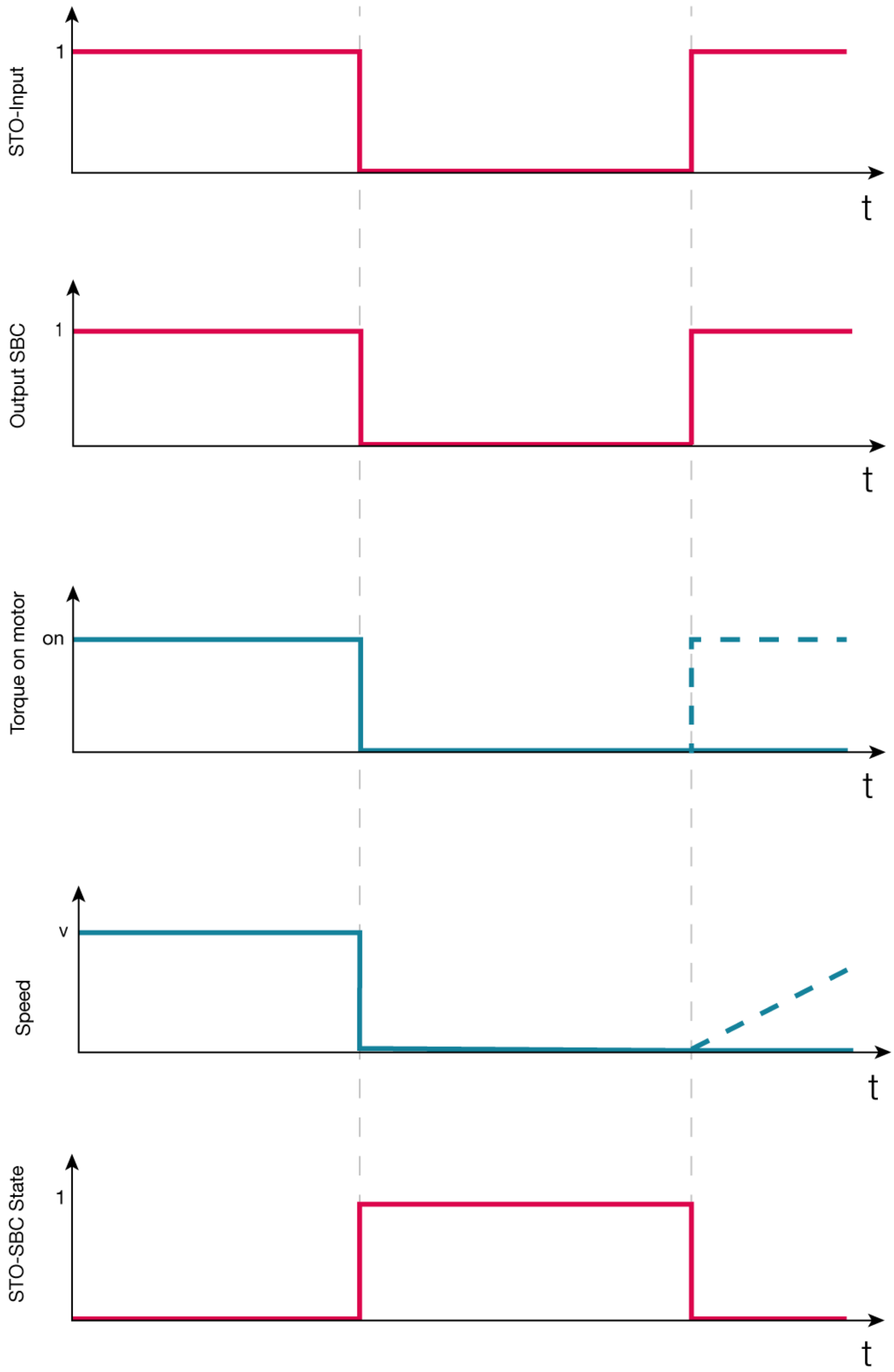
ATTENTION
Activating SBC independently of - or with a delay to - STO is not possible. When STO is active, SBC will also be activated; if a brake is connected it will be engaged.

9.3.1. Timing Diagrams

9.3.1.1. Timing diagram for STO-function without connected brake



9.3.1.2. Timing diagram for STO-function with SBC-function



9.3.2. Diagnostic Functions

9.3.2.1. Software Diagnostics

The safety circuit has two integrated diagnostic functions:

- Comparing safety digital input statuses. The fault is activated after a 100 ms discrepancy of the STO-SBC inputs. In case a fault is detected, the servo drive will stop the motor and indicate a fault “SfeDilvd” in the Error Report object.
- During the activation of the STO-SBC function, the servo drive verifies that the two channels of the module are operating correctly internally. In case an internal fault is detected, the servo drive will stop the motor and indicate a fault “SfeFault” in the Error Report object .

9.3.2.2. Truth Table for Diagnostics

STO-SBC In A	STO-SBC In B	Internal Fault	Safe State STO-SBC	Safety Status Word	Error Entry
0	0	no	yes	1	
0	1	no	yes	1	“SfeDilvd”
1	0	no	yes	1	“SfeDilvd”
1	1	no	no	0	
0	0	yes	yes	1	“SfeFault”

9.3.3. STO-SBC Status Register

Safety Statusword indicates the current state of safety functions and *Safety Digital Input Diagnostics* shows the state of the safety inputs.

Index	Name	Descriptions
0x2611	Safety Digital Input Diagnostics	Subindex: 1 - Input A: 2 - Input B: Input A/B: 0: Input is LOW 1: Input is HIGH
0x6621	Safety Statusword	Subindex: 1 - Bit 1: STO status is the first bit of byte 2 - Bit 2: SBC status is the first bit of byte STO/SBC status: 0: is not active 1: is active

NOTE

Using the SBC function while running the motor may damage the brake due to mechanical stress. During normal operation it is recommended to activate STO-SBC after the motor has come to a halt.

ATTENTION

The STO-function does not provide electrical isolation from the mains supply. If electrical changes must be made on the system, the servo drive must be completely isolated from mains supply, e.g., with a mechanical switch.

9.4. Examples for Realizing Safety Functions

The following examples can be used as a guide for implementing some of the most common safety functions. A risk and hazard analysis is required for each application to determine necessary safety functionalities and requirements for the safety functions.

- Emergency stop
- Prevention of unexpected start-up

9.4.1. Emergency Stop

The STO and SBC functions can be used for implementing the category 0 emergency stop function according to IEC 60204-1:2016.
The Emergency stop function can be realized:

- with an emergency stop switch connected directly to control the STO-SBC input signals,
- with an emergency stop relay + an emergency stop switch, or
- with a safety PLC + an emergency stop switch.

All cases above require correct behavior from the controlling PLC. After releasing the emergency stop device, a separate and deliberate action must be used to restart the system.

Depending on the risk assessment for the overall system, in many cases restarting can be performed, e.g., with a non-safety PLC by only re-enabling the drive via a specific manual action.

ATTENTION
IEC 60204-1:2016 requires “reset shall not initiate a restart” regarding an emergency stop.

9.4.2. Prevention of an Unexpected Start-up

The STO and SBC function can be used when power removal is required to prevent an unexpected start-up according to ISO 14118.

The function “Prevention of unexpected start-up” can be used for system maintenance activities, e.g., repairing/cleaning activities inside hazardous areas.

A lockable safety switch for activating the STO-SBC function might be required in cases where an unexpected reenabling of the drive will lead to hazardous situations - it depends on the individual risk assessment.

9.5. Commissioning and Maintenance

9.5.1. Commissioning

Before the system is used, the safety functions must be tested/validated.
The STO-SBC function shall be activated/deactivated and the reactions shall be monitored (the reaction depends if used as an emergency stop or prevention of unexpected start-up, or something else).

- Safety wiring diagrams and the commissioning test shall be documented and stored (who,what,when)
- Define maintenance routines according to the need

9.5.2. Maintenance

IEC 61800-5-2:2017 requires that maintenance testing exists for the STO-SBC function. The frequency of testing depends on the required safety level:

- one test per year for SIL 2 , PL d / category 3
- one test per three months for SIL 3 , PL e / category 3.

Maintenance test procedure:

- Activating the STO/SBC function through the STO-SBC safe digital input by driving the dual channel STO-SBC input to logic LOW.
- Wait for at least 20 seconds after activating STO/SBC.
- Observe the reaction of the drive:
    - If the drive is disabled, the brake engages (if a brake is connected) and the drive does not report any error.
      => Test successfully passed
    - If a **SfeFault** is triggered (error code 0x5300), the brake does not engage or the drive is not disabled.

      => Test failed

DANGER
If the test fails, the drive must be put out of service immediately!

9.6. Changelog of the Safety-related Documentation

Version	Reason	Details	Date Released
1.2	Safety Functions (STO-SBC) Initial Release	Original Functional Safety Module Documentation	2024-11-07
1.3	Technical specifications adapted Minor textual and formal fixes	IP rating and environmental recommendations adapted Section wire length modified	2024-11-22
1.5	Safety parameters and technical specifications	Fixed IP rating nameplate and MTTF values.	2024-11-26

10. Downloads

10.1. OBLAC Drives

OBLAC Drives

This is commissioning and tuning software that includes setup files for Windows and Linux.

10.2. Firmware

To download the latest firmware - or any earlier firmware version - click the link below.

Firmware

10.3. CAD Data

ACTILINK-S CAD Data Portal

This portal includes 3D models of all variants as well as integrated servo motor design drawings.

10.4. Device Descriptions

Device Descriptions for EtherCAT (ESI), PROFINET (GSDML) and Ethernet/IP (EDS) are available via the link below.

ESI / GSMDL / EDS Device Descriptions

10.5. Certifications

EC-Type Examination Certificate

Original EU.Declaration of conformity CE for ACTILINK-S Integro

Regulation (EC) No 1907/2006 - Registration, Evaluation, and Authorisation of Chemicals (REACH) certificate

RoHS (Directive 2011/65/EU and amendment 2015/863/EU) Statement

STO-SBC safety functions certificate issued by TÜV SÜD

10.6. PDFs

For a full copy of the Object Dictionary or Operations Manual, the following PDFs are available to download:

ACTILINK-S Integro Operations Manual

Object Dictionary (firmware version 5.6)

NOTE
Where possible, Synapticon recommends using the online versions to ensure the most up-to-date content.

10.7. Datasheets and Catalog

Product Information (ACTILINK-SC Brochure)

Datasheet ACTILINK-SC 6-1

Datasheet ACTILINK-SC 6-2

Datasheet ACTILINK-SC 6-3

Datasheet ACTILINK-SC 8-1

Datasheet ACTILINK-SC 8-2

10.8. Application Notes and Supporting Files per Fieldbus Version

10.8.1. EtherCAT / TwinCAT

Using EtherCAT with TwinCAT

Controlling Synapticon Devices Using TwinCAT3 - a Quick Start Guide

TwinCAT3 Motion Control Library for Synapticon Drives

Using Synapticon TwinCAT3 Library - Demo Documentation

Drive Operations through File Access over EtherCAT (FOE)

10.8.2. PROFINET / Tia Portal

Using ACTILINK-S with PROFINET - Quick Start Guide

Connecting a PROFINET Device to OBLAC Drives

Synapticon Library

TIA Portal Motion Control Library for Synapticon Drives

PROFINET Parameter Records List

Synapticon Library TIA Portal Example

Using Synapticon PROFINET Library - TIA Portal Example

10.8.3. Ethernet IP / Rockwell

Controlling Synapticon Devices Using Rockwell Studio 5000 Logix Designer - a Quick Start Guide

CIP Parameters List

10.8.4. Operating ACTILINK-S Integro Outside Nominal Voltage

24 V - 60 V Operating ACTILINK-S Integro Outside Nominal Voltage

10.8.5. Mitigating Transient Torque Spikes

Mitigating Transient Torque Spikes (while using the Cycle Synchronous Position mode)

10.9. Changelog

Software Reference Version 5.6 Changelog
As Synapticon releases new v5.6 firmware, information will automatically be updated. Go here, to see these latest changes.

Documentation Changelog for all products

11. Maintenance Procedures

11.1. Cleaning

Because dust and/or other particles can adversely affect electronic and mechanical parts and/or cause failure, it is recommended to clean all components regularly. Before doing so, however, make sure that the unit has been turned-off and is not energized.

DANGER
Operating a unit while performing any cleaning activity can lead to severe injuries!

In general, a damp cloth is all that is required to clean parts. Additionally, a non-aggressive cleaning substance, such as *isopropanol*, can be used with the cloth to help remove any accumulated dirt or grease.

ATTENTION
Clean your parts carefully. Never immerse ACTILINK-S Integro into any liquid solution, or use a spray solution on it, as doing so can cause substantial damage to the servo drive.

11.2. Service Intervals

The operating hours for motor components vary. Below is a list of actions required for a particular component when service on that component is recommended.

Component	Action	Interval
Ball bearing	Replace bearing	20000 hours
Shaft sealing ring	Replace sealing	5000 hours
Cables	Visual inspection. Replace if perceivable damage.	On demand, or scheduled device inspection*
Connector sockets	In case of damage, contact service/vendor.	500 mating cycles
Integrated motor	Visual inspection, Check for any wear, mechanical damage, or scrapings.	On demand, or scheduled device inspection*
Connections	Inspect all electrical connections for signs of corrosion, looseness, or damage. Tighten any loose connections.	On demand, or scheduled device inspection*
Configuration	Back-up configuration settings.	After initial configuration and after every configuration change
Thermal health check	Read out motor and drive temperature via software and compare to similar situations in other devices or at earlier points in time. Changes of more than 10°C without known cause should be investigated.	On demand, or scheduled device inspection*
Diagnostic test STO	Test STO functionality by activating STO once - passed if STO is activated without any failure appearing.	3 months / 1 year**

** Devices are generally maintenance free. For heavy duty or rough environment applications, Synapticon recommends to execute the specified checks based on a regular interval, with typical intervals between 6 and 12 months.*

*** The testing frequency depends on the required safety level:*
- one test per year for SIL 2, PL d / category 3
- one test per three months for SIL 3, PL e / category 3

12. Quality and Compliance

Synapticon develops with a focus on cybersecurity and systematic failure avoidance to deliver a highly performant and reliable product.

NOTE
For customers who require access to detailed FMEA reports due to regulatory compliance and/or other reasons, the reports can be provided on request. Please contact support for additional information.

12.1. Standards and Compliance*

Synapticon will adhere to the following standards and compliance requirements:

Category	Standards
General Product Safety Directive	2001/95/EC
EMC	IEC 61800-3 Emissions: C2 Immunity: second environment
Electrical Safety	IEC 61800-5-1
Functional Safety	IEC 61800-5-2, IEC 61508 parts 1-7, ISO 13849-1, ISO 13849-2
UL	UL 61800-5-1, 2nd edition
Shock	IEC 60068-2-6
Vibration	IEC 60068-2-27

** Pending certification.*

12.1.1. CE

SOMANET Integro complies with the requirements of the respective European directives (CE), ensuring that it meets the highest standards set by the European Union. The CE mark is a symbol of quality and safety, providing assurance that the product complies with the essential requirements of relevant European health, safety, and environmental protection legislation. A declaration of conformity (DoC) can be issued on request.

12.1.2. REACH Compliance

SOMANET Integro is fully compliant with the REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals) regulation, ensuring the safety and environmental responsibility of the product..REACH is a European Union regulation that addresses the production and use of chemical substances. SOMANET Integro complies with REACH by adhering to the strict restrictions set on the use of hazardous substances, as outlined in the regulation.

12.1.3. RoHS Compliance

RoHS (Restriction of Hazardous Substances) is an EU directive that restricts the use of certain hazardous substances in electrical and electronic equipment. SOMANET Integro is RoHS-compliant, ensuring that it does not contain any restricted substances - such as lead, mercury, cadmium, and others - above the specified limits.

12.1.4. Cybersecurity

Synapticon designs and develops according to widely held practices to avoid systematic failures, and performs threat modeling to act proactively against external threats. The attack surface on SOMANET Integro is quite small, as only the fieldbus and basic I/O functionality is available at the connectors. However, reliability of the fieldbus is dependent on ensuring that no physical access to the network is allowed by an attacker.

> **ATTENTION**
> With physical network access, an attacker could attach a device that disrupts network traffic, either intermittently or on demand.

Internally, the device is protected from tampering with standard encryption and signing practices.

13. Accessories

The following is a list of recommended accessories.

13.1. Power Supplies

ACTILINK Power Supply MPSU-1500-48-IB

ACTILINK Power Supply MPSU-0960-48-MB

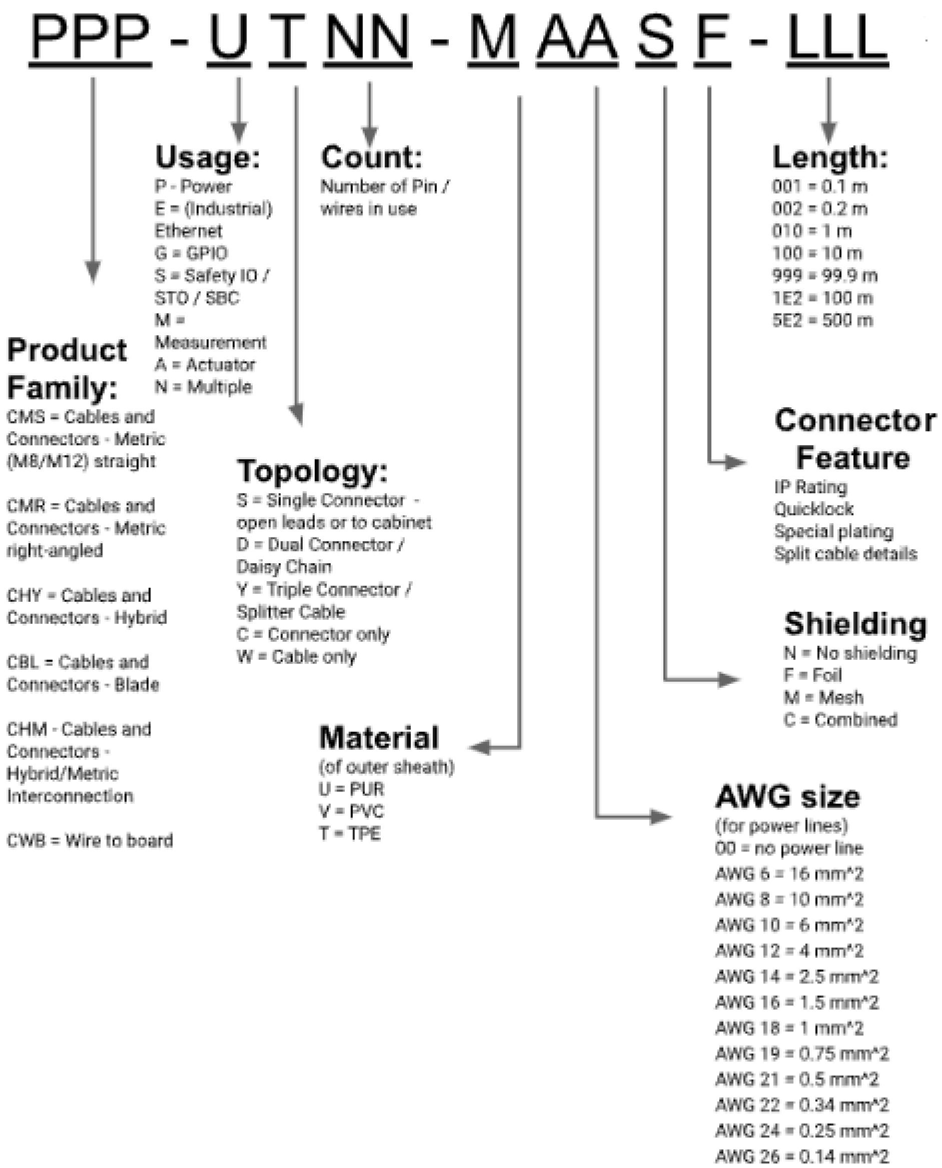
13.2. Braking Chopper

SOMANET Braking Chopper 48V 500W

13.3. Compatible Cables

13.3.1. Cables Ordering Scheme

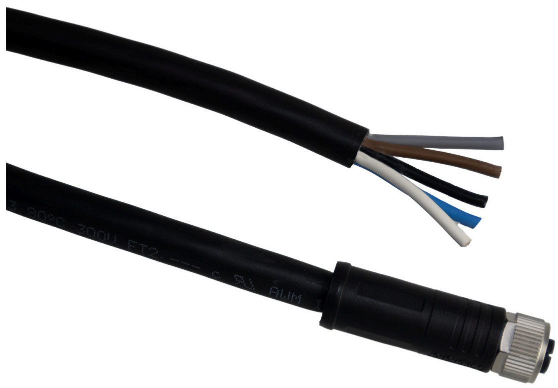
Most of the cable options depicted in the image below are available on request.



The following subsections represent standard cables that are available off the shelf and in both small and large quantities.

13.3.2. Cables for Metric Variants

Metric Power to Open Leads



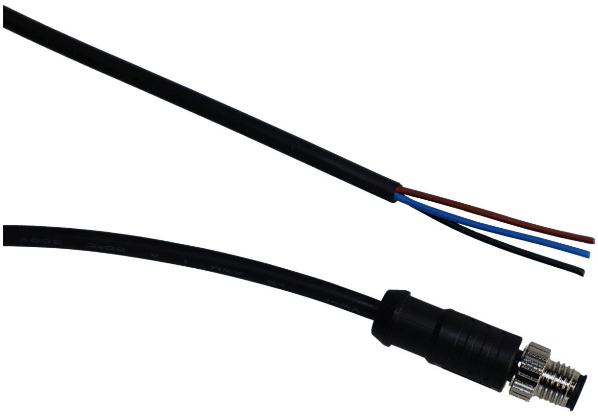
MPN:	CMS-PS05-U14N0-020
Product Identifier	Cables and Connectors: M12 straight
Usage	Power
Topology	Single Connector (Open Leads / to Cabinet)
Count	Pin / wire count 5
Material	PUR
Cross Section	AWG 14 = 2.5 mm^2
Shielding	No Shielding
Max. Current	32 A continuous (16 A cont. per pin)
Drag Chain Spec	4 million cycles, 1 m, 40x/min, radius 100 mm
Length [m]	2 m

MPN:	CMS-PS05-U14M0-050
Product Identifier	Cables and Connectors: M12 straight
Usage	Power
Topology	Single Connector (Open Leads / to Cabinet)
Count	Pin / wire count 5
Material	PUR
Cross Section	AWG 14 = 2.5 mm^2
Shielding	Mesh
Max. Current	32 A continuous (16 A cont. per pin)
Drag Chain Spec	2 million cycles, 1 m, 120x/min, radius 100 mm
Length [m]	5 m

Metric Ethernet to RJ45

MPN:	CMS-ES04-U00F0-020 CMS-ES04-U00F0-050
Product Identifier	Cables and Connectors: M8 straight
Usage	(Industrial) Ethernet
Topology	Single Connector (Open Leads / to Cabinet)
Count	Pin / wire count 4
Material	PUR
Shielding	Foil
Drag Chain Spec	1 million cycles, 1 m, 2 m/s, radius 100 mm
Length [m]	2 m, 5 m

Metric Safety to Open Leads



MPN:	CMS-SS03-U00N0-020 CMS-SS03-U00N0-050
Product Identifier	Cables and Connectors: M8 straight
Usage	Safety IO / STO/SBC
Topology	Single Connector (Open Leads / to Cabinet)
Count	Pin / wire count 3
Material	PUR
Shielding	No Shielding
Drag Chain Spec	3 million cycles, 1 m, 30x/min, radius 100 mm
Length [m]	2 m, 5 m

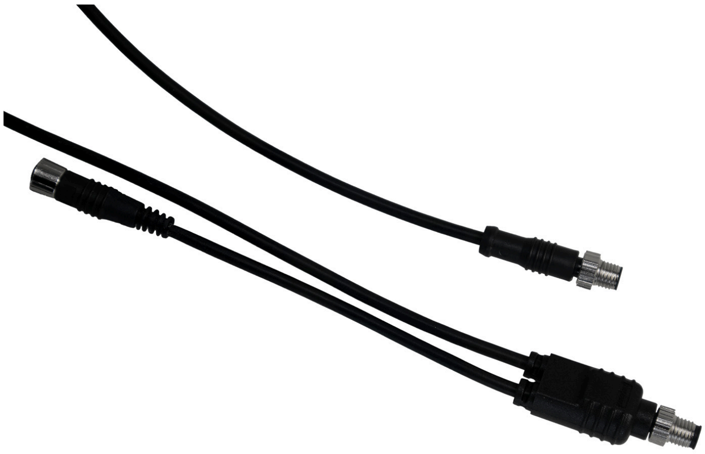
Metric Power Daisy Chain

MPN:	CMS-PD05-U14M0-010 CMS-PD05-U14M0-030
Product Identifier	Cables and Connectors: M12 straight
Usage	Power
Topology	Dual Connector / Daisy Chain
Count	Pin / wire count 5
Material	PUR
Cross Section	AWG 14 = 2.5 mm^2
Shielding	Mesh
Max. Current	32 A continuous (16 A cont. per pin)
Drag Chain Spec	2 million cycles, 1 m, 120x/min, radius 100 mm
Length [m]	1 m, 3 m

Metric Ethernet Daisy Chain

MPN:	CMS-ED04-U00F0-010 CMS-ED04-U00F0-030
Product Identifier	Cables and Connectors: M8 straight
Usage	(Industrial) Ethernet
Topology	Dual Connector / Daisy Chain
Count	Pin / wire count 4
Material	PUR
Shielding	Foil
Drag Chain Spec	1 million cycles, 1 m, 2 m/s, radius 100 mm
Length [m]	1 m, 3 m

Metric Safety Daisy Chain



MPN:	CMS-SY03-U00N1-010 CMS-SY03-U00N1-030
Product Identifier	Cables and Connectors: M8 straight
Usage	Safety IO / STO/SBC
Topology	Triple Connector / Splitter Cable
Count	Pin / wire count 3
Material	PUR
Shielding	No Shielding
Connector Features	Split cable length 0.1 m
Drag Chain Spec	3 million cycles, 1 m, 30x/min, radius 100 mm
Length [m]	1 m, 3 m

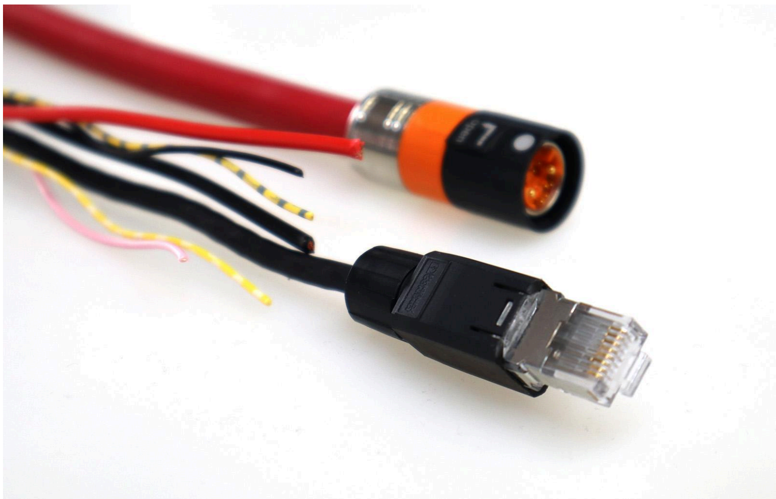
A wide range of cable assemblies compliant to IEC 61076-2-101 (M12 connectors) and IEC 61076-2-104 (M8 connectors) is available on the market. They vary, among others, in length, secondary side termination, manufacturers, cross sections, materials, etc.

IMPORTANT

Such cables can be used at your own risk. Make sure that anything from mechanical properties to sealing compatibility is considered when deciding on a certain model from a third-party vendor.

13.3.3. Cables for Hybrid Variants

Hybrid Source to Female

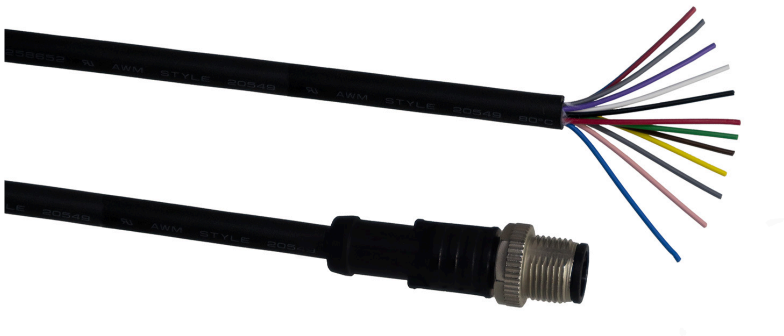


MPN:	CHY-NS10-U14CQ-020 CHY-NS10-U14CQ-050 CHY-NS10-U14CQ-100 CHY-NS10-U14CQ-150 CHY-NS10-U14CQ-200
Product Identifier	Cables and Connectors: Hybrid
Usage	Multiple
Topology	Single Connector (Open Leads / to Cabinet)
Count	Pin / wire count 10
Material	PUR
Shielding	Combined
Drag Chain Spec	3 million cycles, 5 m, 5 m/s, radius 90 mm (60 mm for fixed installation)
Length [m]	2 m, 5 m, 10 m, 15 m, 20 m

Hybrid Daisy Chain

MPN:	CHY-ND10-U14CQ-004 CHY-ND10-U14CQ-010 CHY-ND10-U14CQ-030 CHY-ND10-U14CQ-050 CHY-ND10-U14CQ-100 CHY-ND10-U14CQ-150 CHY-ND10-U14CQ-200
Product Identifier	Cables and Connectors: Hybrid
Usage	Multiple
Topology	Dual Connector / Daisy Chain
Count	Pin / wire count 10
Material	PUR
Shielding	Combined
Drag Chain Spec	3 million cycles, 5 m, 5 m/s, radius 90 mm (60 mm for fixed installation)
Length [m]	0.4 m, 1 m, 3 m, 5 m, 10 m, 15 m, 20 m

13.3.4. Cables for Variants with GPIO Connector



Both Metric and Hybrid Variants are optionally available with an M12 GPIO connector. Cables offered for this connector are:

MPN:	CMS-GS12-U00N0-030
Product Identifier	Cables and Connectors: M12 straight
Usage	GPIO
Topology	Single Connector (Open Leads / to Cabinet)
Count	Pin / wire count 12
Material	PUR
Shielding	No Shielding
Drag Chain Spec	3 million cycles, 1 m, 30x/min, radius 100 mm
Length [m]	3 m

14. Appendix A - Application Notes

14.1. Using EtherCAT Devices with TwinCAT

This section serves as a comprehensive guide for integrating and controlling Synapticon devices using the EtherCAT protocol in conjunction with TwinCAT.

Designed to empower users with the knowledge and tools necessary for seamless operation, this section provides a structured approach to understanding and leveraging the full capabilities of Synapticon hardware within a TwinCAT environment.

The section is organized into five subsections, each one addressing a critical aspect of the integration process:

- Quick Start
- TwinCAT Library
- EtherCAT Slave Information (ESI) File
- Object Dictionary
- Using the Library

By following the information in this EtherCAT section, users will gain the expertise required to efficiently integrate, configure, and operate Synapticon devices within their EtherCAT-based automation systems.

14.1.1. Quick Start

Quick Start provides a practical foundation and offers a downloadable example TwinCAT program that demonstrates drive movement across all supported operational modes.

Controlling Synapticon Devices Using TwinCAT3 - a Quick Start Guide includes detailed, step-by-step instructions to guide users through its usage, ensuring a smooth initiation into controlling Synapticon devices.

14.1.2. TwinCAT Library

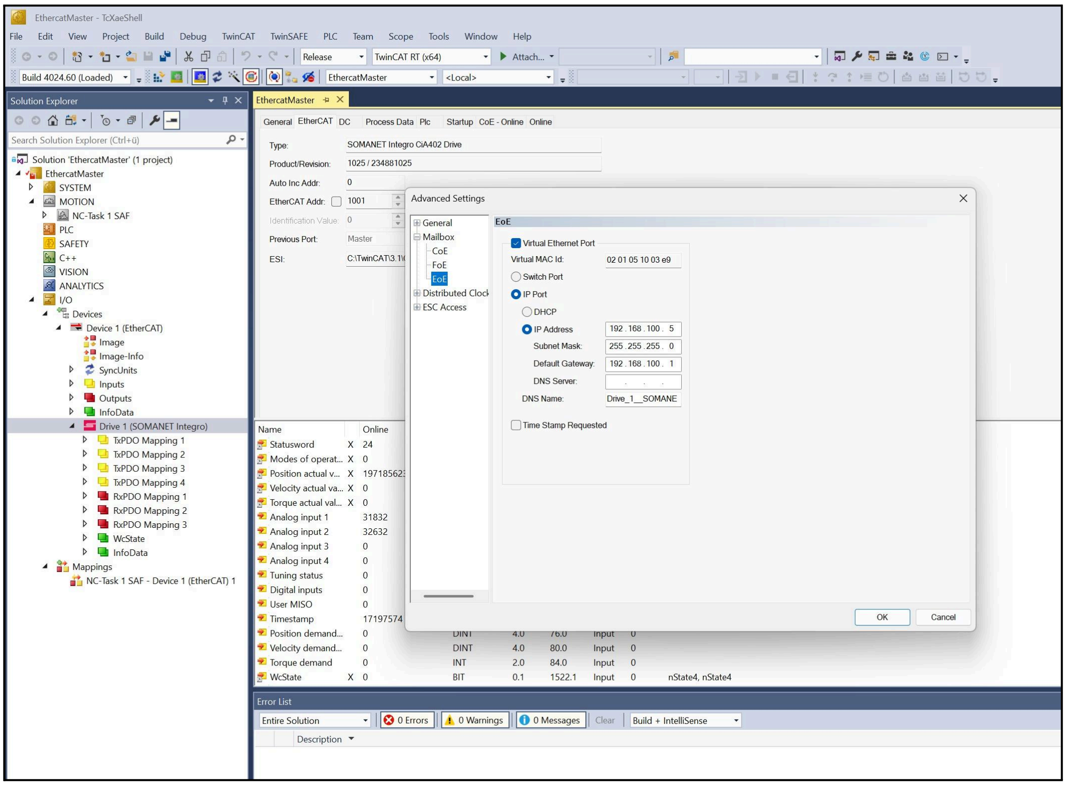
The TwinCAT Library introduces Synapticon's specially developed TwinCAT library, designed to simplify complex control tasks.

Download the Library files [here](), accompanied by the [TwinCAT3 Motion Control Library for Synapticon Drives]() documentation, which details the inputs, outputs, and functionalities of each function block.

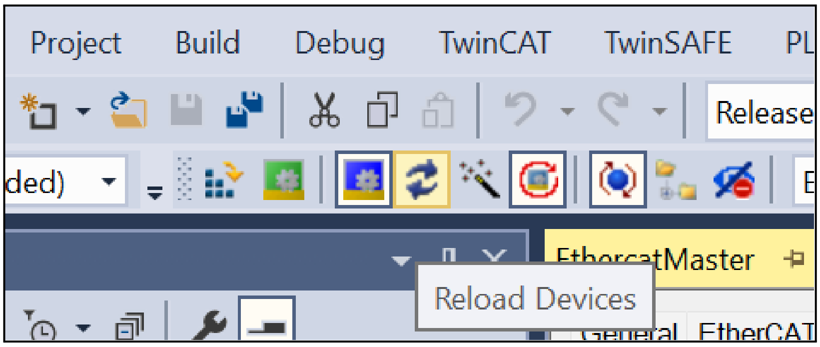
14.1.3. Using EoE (Ethernet over EtherCAT) with TwinCAT

Synapticon ACTILINK-S and SOMANET Integro devices support EoE through the SPOE protocol. The following information illustrates how to configure this feature.

1. Once the device is successfully found in TwinCAT, assign its IP address:

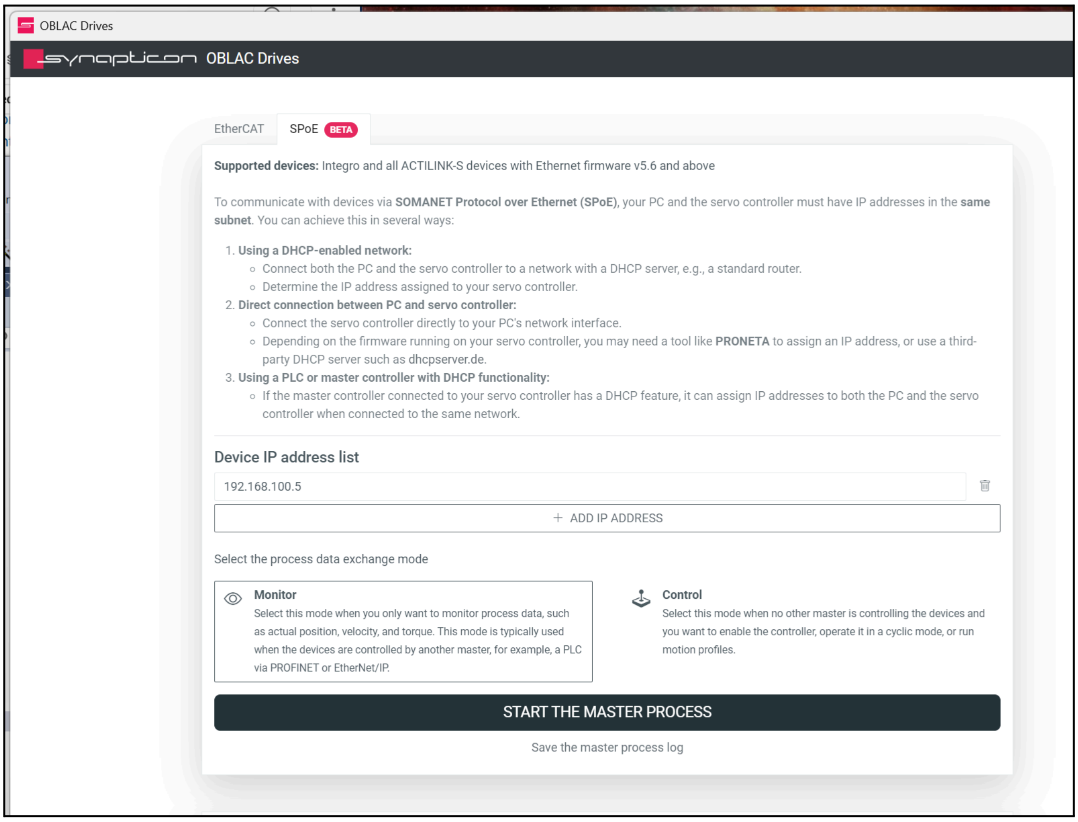


2. Reload the devices.

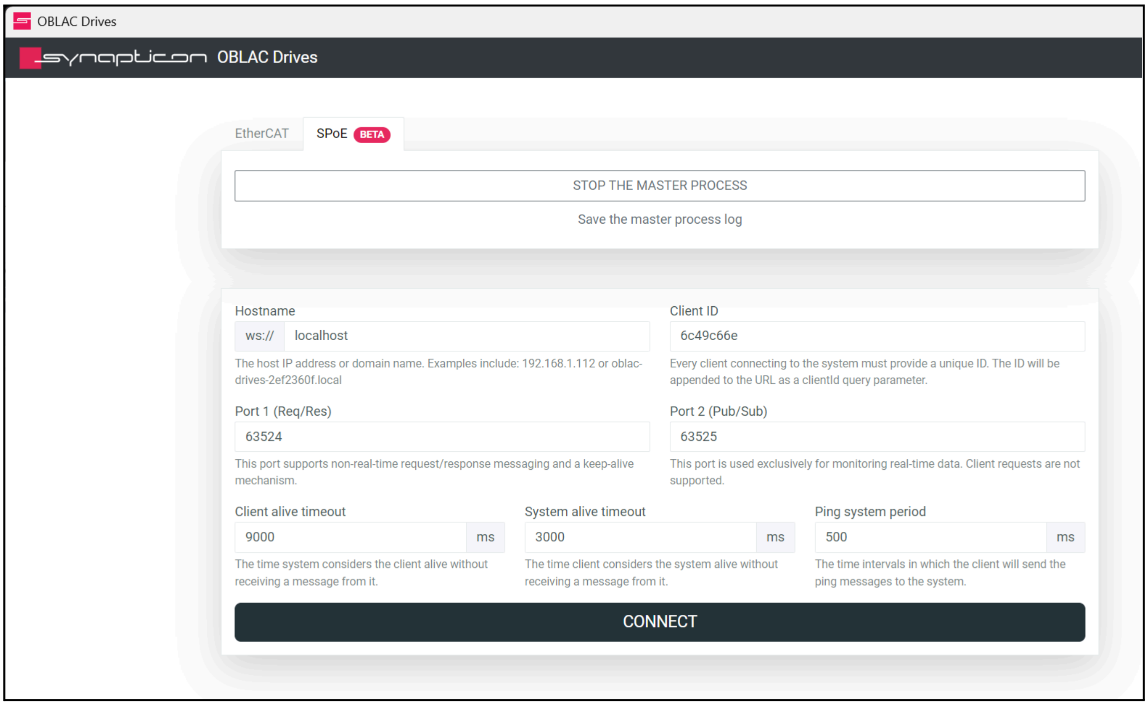


3. In OBLAC Drives:
    a. Select **SPoE**.
    b. Enter the assigned IP address.
    c. Select **Monitor** mode.

When **Monitor** mode is selected, OBLAC Drives will be able to receive all PDOs and read/write SDO objects. PDOs cannot be sent to the drive while in **Monitor** mode. Sending PDOs is handled by the master (TwinCAT).



4. Press the **Connect** button.



14.1.4. EtherCAT Slave Information (ESI) File

The EtherCAT Slave Information (ESI) File offers a concise description of the ESI file's role in EtherCAT communication. This subsection also provides a direct link to the Synapticon Web site, where users can download the latest ESI files specific to their devices, which is crucial for proper device identification and configuration for any EtherCAT based master.

An EtherCAT Slave Information (ESI) file is an essential XML-based document that acts as a comprehensive instruction manual for an EtherCAT slave device. Its primary purpose is to provide an EtherCAT master controller, e.g., a PLC or industrial PC, with all the necessary details to correctly identify, configure, and communicate with a specific slave device within an EtherCAT network.

Key information typically contained in an ESI file includes:

- **Device identification:** Vendor ID, product code, and revision number to uniquely identify the slave device.
- **Supported features and capabilities:** Information about the device's functionality, such as supported mailbox protocols, e.g., CoE - CANopen over EtherCAT, synchronization settings, and distributed clock configurations.
- **Process Data Object (PDO) mapping:** Descriptions of the input and output data structures that define how process data (real-time I/O) is exchanged between the master and slave.
- **Service Data Object (SDO) initialization sequences:** Instructions for configuring the device's parameters and behavior during network startup.
- **Physical port details:** Information about the device's physical connections.

ESI files are crucial for simplifying EtherCAT network setup, enabling automated configuration, ensuring compatibility across different manufacturers and device versions, and facilitating efficient integration of new devices into an existing EtherCAT system.

ESI files can be obtained for Synapticon devices as follows:

1. The easiest method is to connect your device to OBLAC Drives and select the **SAVE ETHERCAT SLAVE INFO. ESI (.xml)** option. This will download the correct ESI file directly from your connected device.
2. Alternatively, download the ESI files from the Synapticon Web site at: bundles.synapticon.com/latest/latest/deviceDescriptions. If this option is selected, it is crucial to **select the proper firmware version** that matches your device.

IMPORTANT
It is vital to use the correct ESI file version that matches the device's firmware version.

14.1.5. Object Dictionary

The Object Dictionary provides a complete object dictionary of Synapticon's firmware. This essential resource provides an in-depth understanding of the device's internal parameters and their respective functionalities, enabling advanced configuration and diagnostics.

14.1.6. Using the Library

Using the Library includes downloadable Using the Synapticon TwinCAT3 Library Demo files that illustrate the practical application of Synapticon's TwinCAT library. These demos are complemented by the Using Synapticon TwinCAT3 Library - Demo Documentation, which provides step-by-step instructions, allowing users to quickly implement and customize solutions for their specific control needs.

14.2. Drive Operations through File Access over EtherCAT (FoE)

Synapticon SOMANET servo drives support *File Access over EtherCAT (FoE)* operations, which allows a number of operations for accessing files in the drive memory including:

- Updating the firmware
- Uploading a drive configuration

Additionally, files can be stored on the drive's file system using FoE; however, do not store files that exceed 400 KBs (in total). Although the total available memory is larger, the 400 KB limit must be adhered to so that the drive is compatible with future firmware versions.

> Note:
> The operation instructions provided here are based on a TwinCAT 3 environment. The steps are similar in other master applications.

14.2.1. Updating the Firmware

> Attention:
> Installing firmware to a drive is a critical operation. Using a third-party tool, e.g., a Master, cannot provide protection mechanisms, such as version or hardware validation.

- Always use OBLAC Drives for drive configurations unless it is unavoidable to use a third-party tool.
- Some critical items - such as version compatibility . must be thoroughly checked to avoid unexpected results such as drive failure.

14.2.1.1. Setup Information

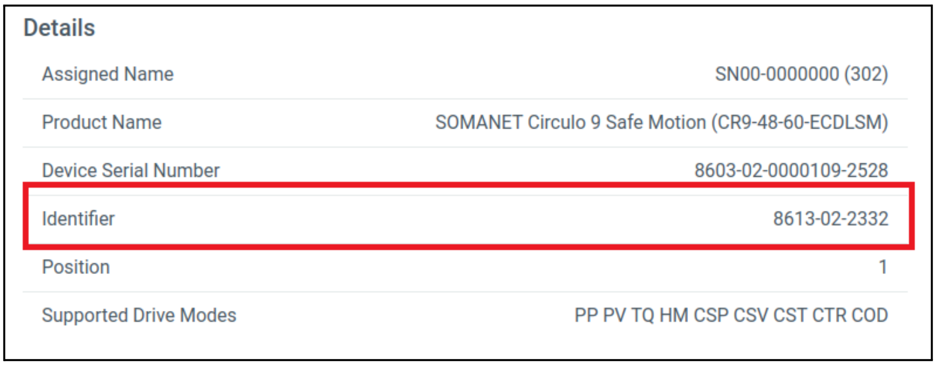
- The master environment used for the example is TwinCAT v3.1.4024.4
- The firmware used for the example is version 5.4.2.

> **NOTE**
> The servo drive in the example had firmware installed; however, the procedure is the same if the firmware were not installed.

14.2.1.2. Preparation

The appropriate firmware package can be downloaded as displayed in the images that follow.

1. Check the Identifier of your drive in the OBLAC Drives - Configuration tab of the device for which the firmware is to be downloaded.



Details

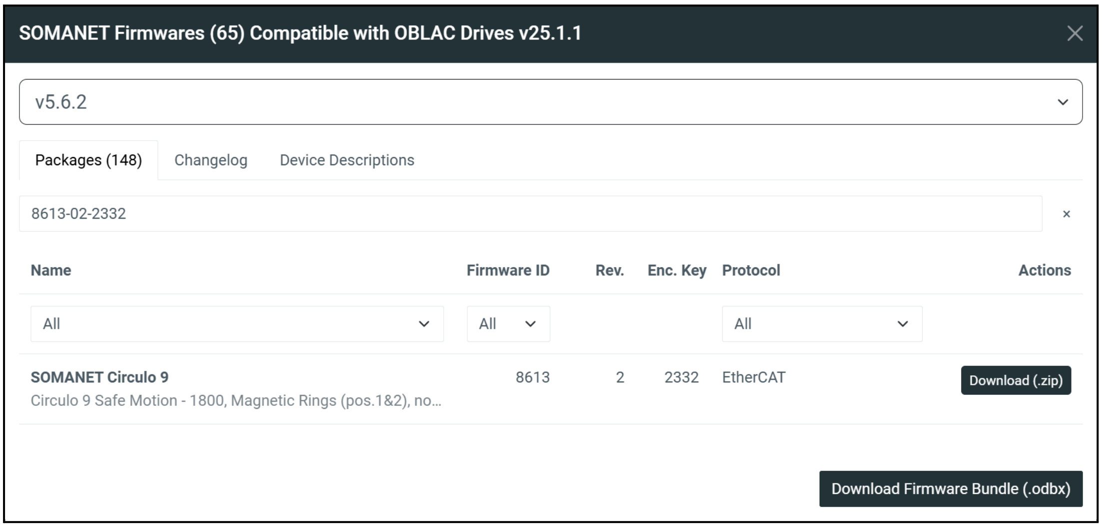
Assigned Name	SN00-0000000 (302)
Product Name	SOMANET Circulo 9 Safe Motion (CR9-48-60-ECDLSM)
Device Serial Number	8603-02-0000109-2528
Identifier	8613-02-2332
Position	1
Supported Drive Modes	PP PV TQ HM CSP CSV CST CTR COD

Go to https://bundles.synapticon.com/latest/latest/packages?name=ACTILINK.

Click on **Browse SOMANET Firmwares**.

2. Select the firmware version to be downloaded, enter the Identifier of your device in the search bar, and download the package.

   To download the firmware package, click the **Download (.zip)** button in the *Actions* column.



For any questions on which version to use, contact support.

> **NOTE**
> The tool/master to be used should support File Access over EtherCAT (FoE) access and, if necessary, SII/EEPROM access.

14.2.1.3. Operational Steps

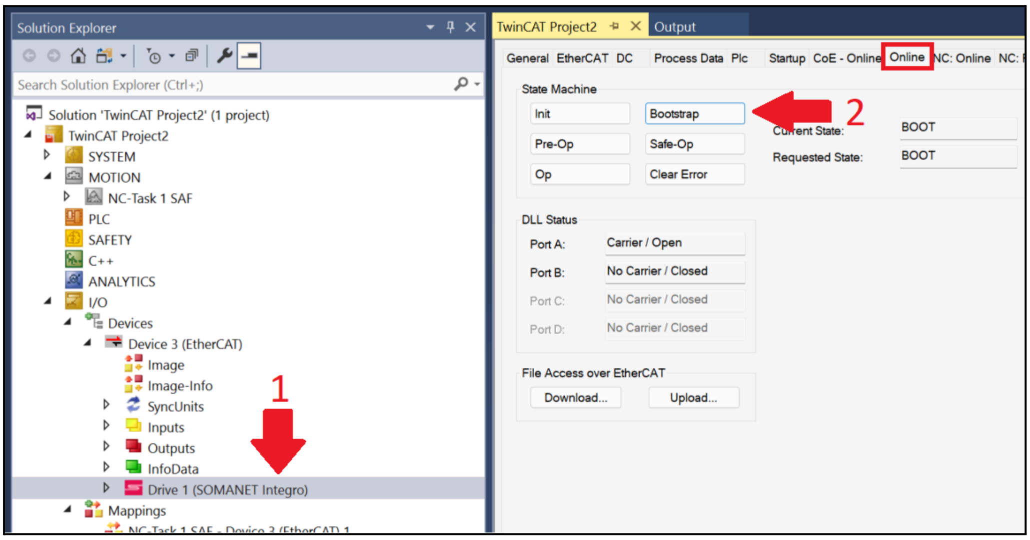
> **Attention:**
> The following steps assume that the firmware has been checked for compatibility. In this example, the drive has firmware installed and it is being updated. The procedure is the same as when a device without firmware installed, i.e., never used or factory reset. The only difference is that the icon and the name of the drive in TwinCAT will be displayed differently.

To proceed:

1. Unzip the firmware package to the expected location. After the operation, it should appear as displayed below.

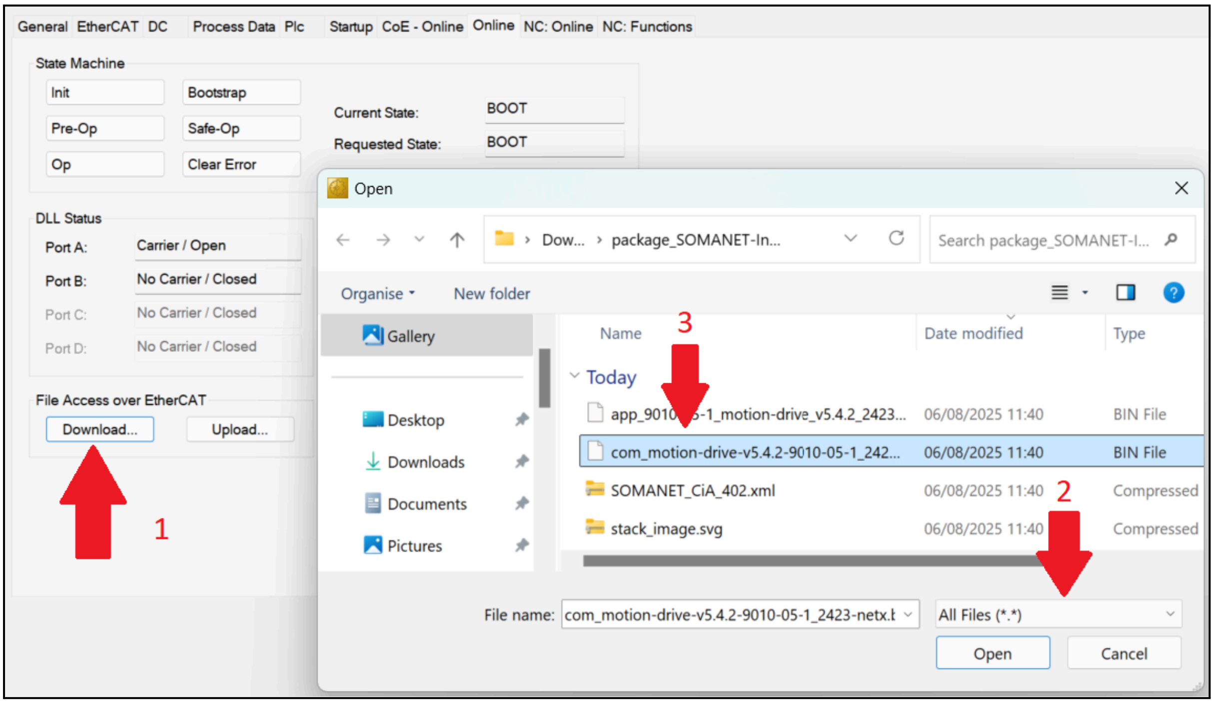
app_9010-05-1_motion-drive_v5.4.2_2423.bin	Firmware Binary
com_motion-drive-v5.4.2-9010-05-1_2423-netx.bin	Communication Binary
SOMANET_CiA_402.xml	EtherCAT Slave Information (ESI) File
stack_image.svg	Stack Image File

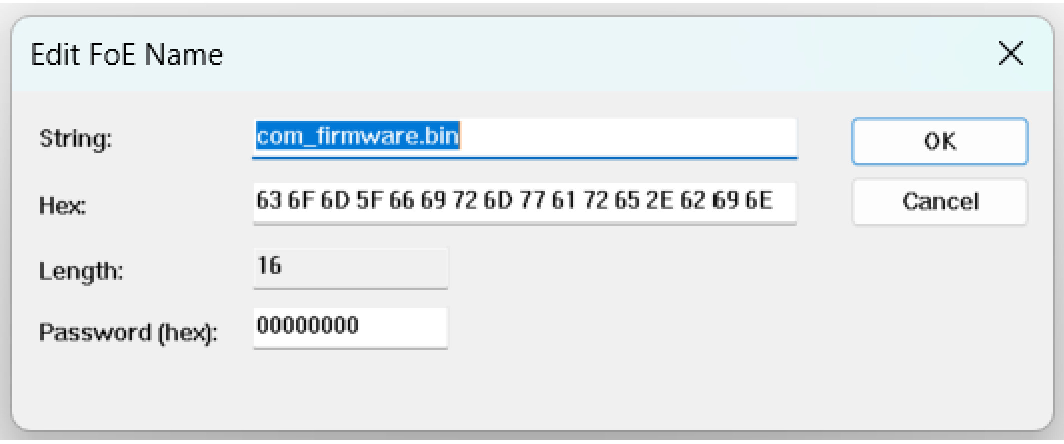
2. Switch the drive EtherCAT state to BOOT. In TwinCAT 3, the access (clicking "Bootstrap") can be found - as displayed below - together with the FOE access.



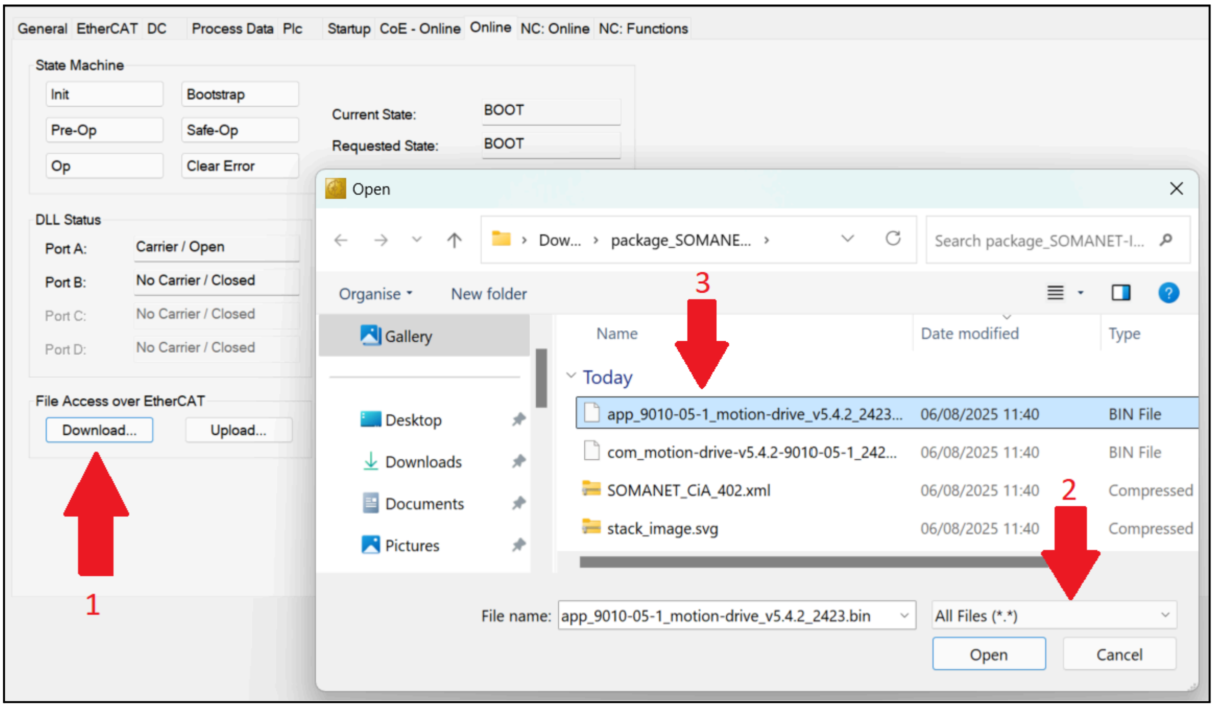
3. In BOOT state, upload the communication binary file to the drive memory through FOE, with the FOE name edited as *com_firmware.bin*. In TwinCAT 3, the operations are displayed in the images below.

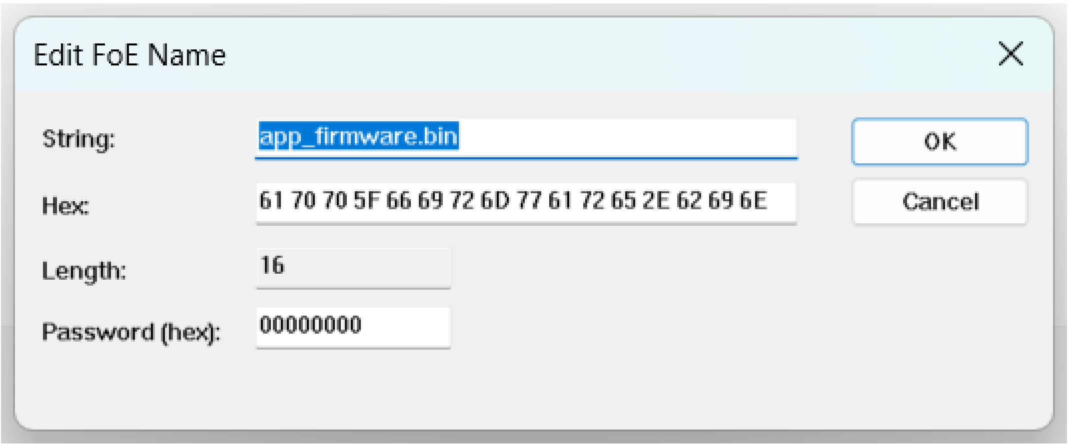
   This prompts the bootloader to flash the communication firmware.





4. The firmware binary is flashed similarly. Note that the drive must remain in the boot state and upload the communication binary file to the drive memory through FOE, with the FOE name edited as *app_firmware.bin*. In TwinCAT 3, the operations are displayed in the images that follow.





14.2.2. Uploading a Drive Configuration

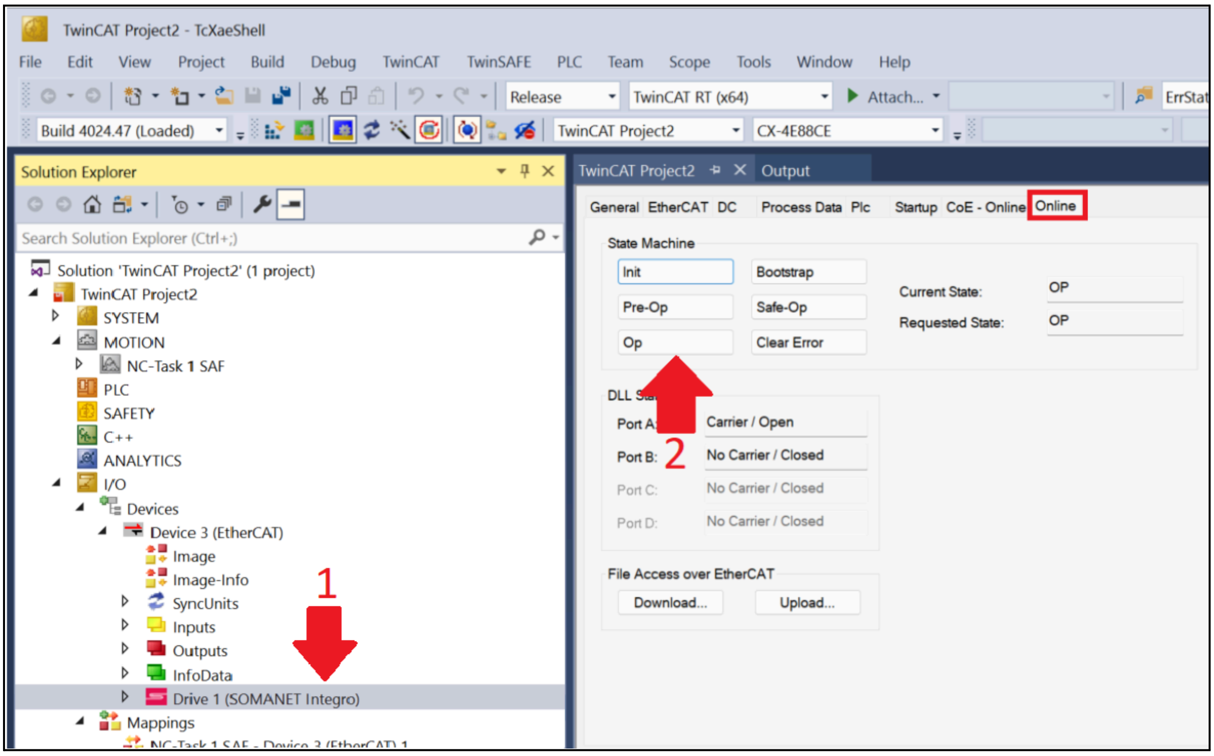
14.2.2.1. Setup Information

- The master environment used for the example is TwinCAT v3.1.4024.4
- The firmware used for the example is version 5.4.2

> Note:
> Make sure that the configuration file used is compatible with the firmware version installed.

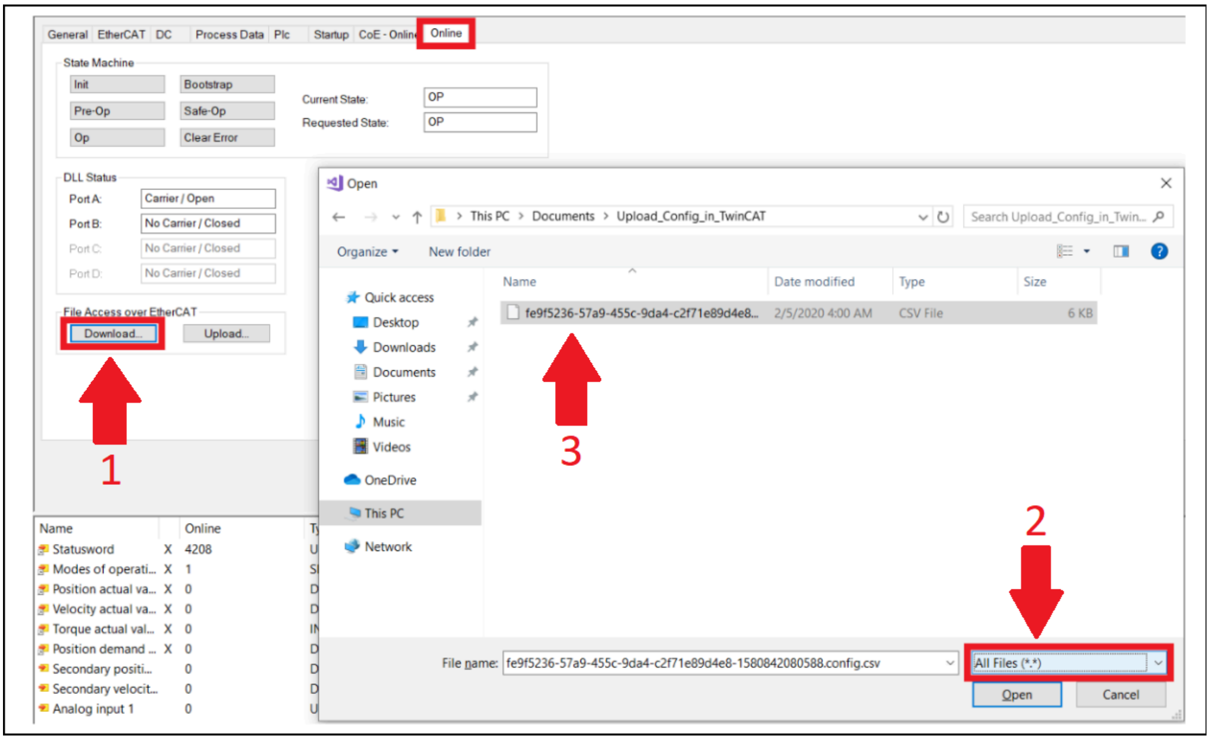
14.2.2.2. Operational Steps

1. In TwinCAT 3, double-click the servo drive under “I/O” - “Devices”, as indicated in the image below, to access the slave operations. Select the tab “Online” for state machine operations and FOE access.

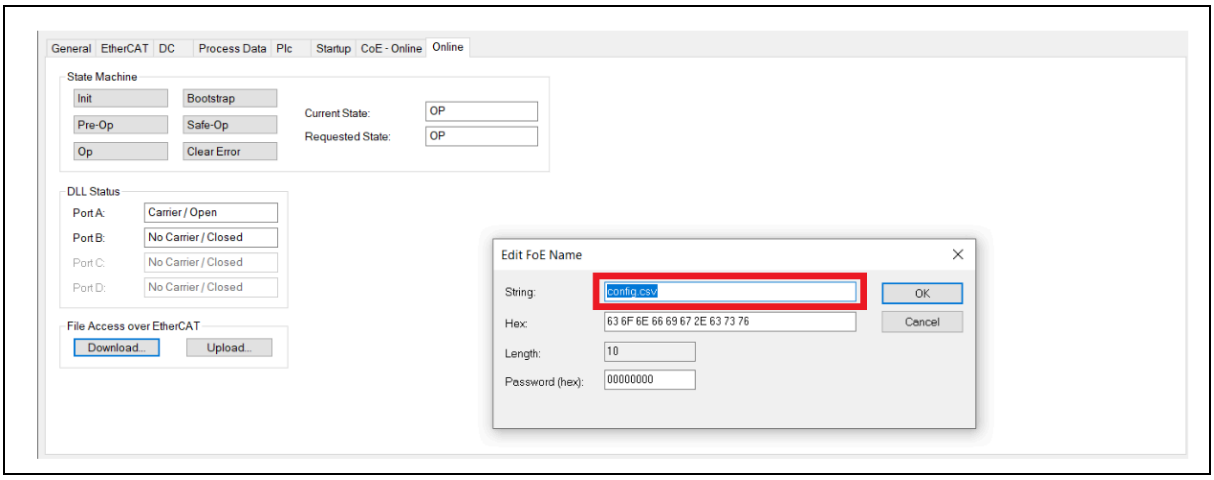


2. Switch the EtherCAT state of the drive to BOOT by clicking **Bootstrap**, this allows the following operations.

3. Click **Download** under “File Access over EtherCAT”, switch to browse “All Files”, and select the configuration file to be uploaded, as displayed in the image below.



4. Change the name to *config.csv* and click **OK**, as displayed in the image below.



5. A progress bar is displayed at the bottom of the page in TwinCAT 3 after the FOE operation; see image below.

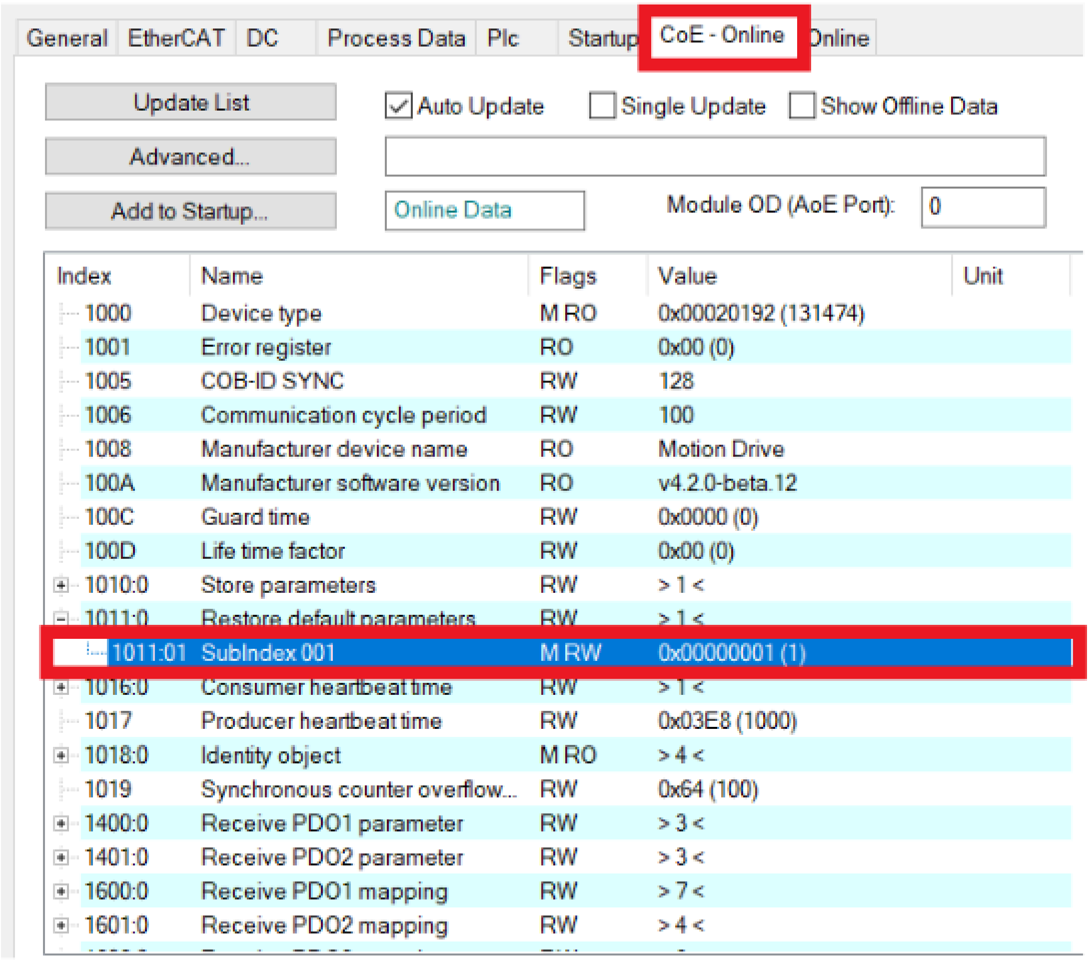
6. The configuration file is successfully uploaded and stored in the permanent storage of the servo drive. It will be used once the drive is reinitialized at the transition from BOOT to INIT (or when the drive is power-cycled).

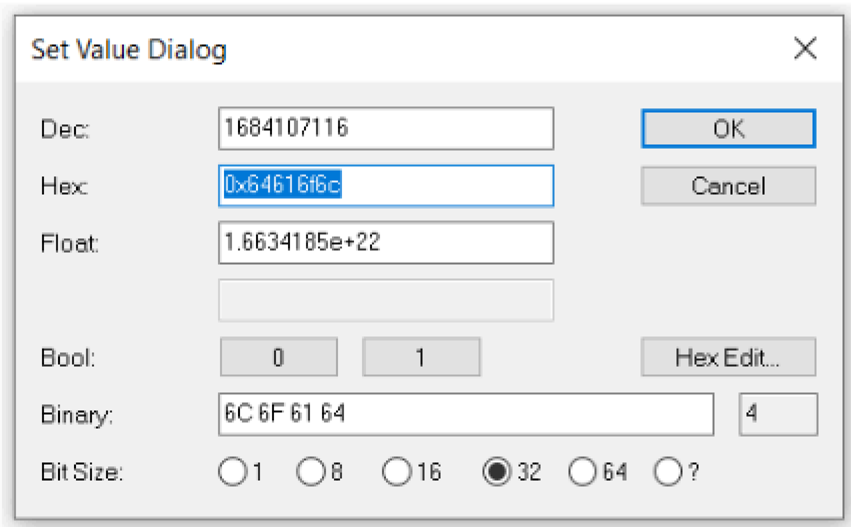
7. In case resetting or power-cycling the drive is not desired, object 0x1011 **("Restore default parameters")** allows loading from the permanent storage through CANopen over EtherCAT (CoE).

   Through the SDO operation, read the current value of 0x1011:01 **("Restore all default parameters")**. Reading a value of "1" indicates that the procedure is ready. Write value 0x64616f6c ("daol", "load" spelled backwards in ASCII) to 0x1011:01 to start the restore procedure.

   In TwinCAT 3, this can be done in the "CoE - Online" tab.

Double-click on the object to write it, as displayed in the images below.





14.3. Using ACTILINK-S Integro with Ethernet IP

IMPORTANT
The profile in Ethernet IP is similar to - but not exactly the same in details as - the original CiA402 profile.

This section explains how to set up an Ethernet IP ACTILINK-S drive.
It provides:

- a simple example that uses a similar profile as the CiA402 profile to drive an EthernetIP ACTILINK-S, and
- a complete library for, and description of, the Rockwell Studio 5000 PLC programming environment. This library enables the user to use most of the features of the ACTILINK-S drives.

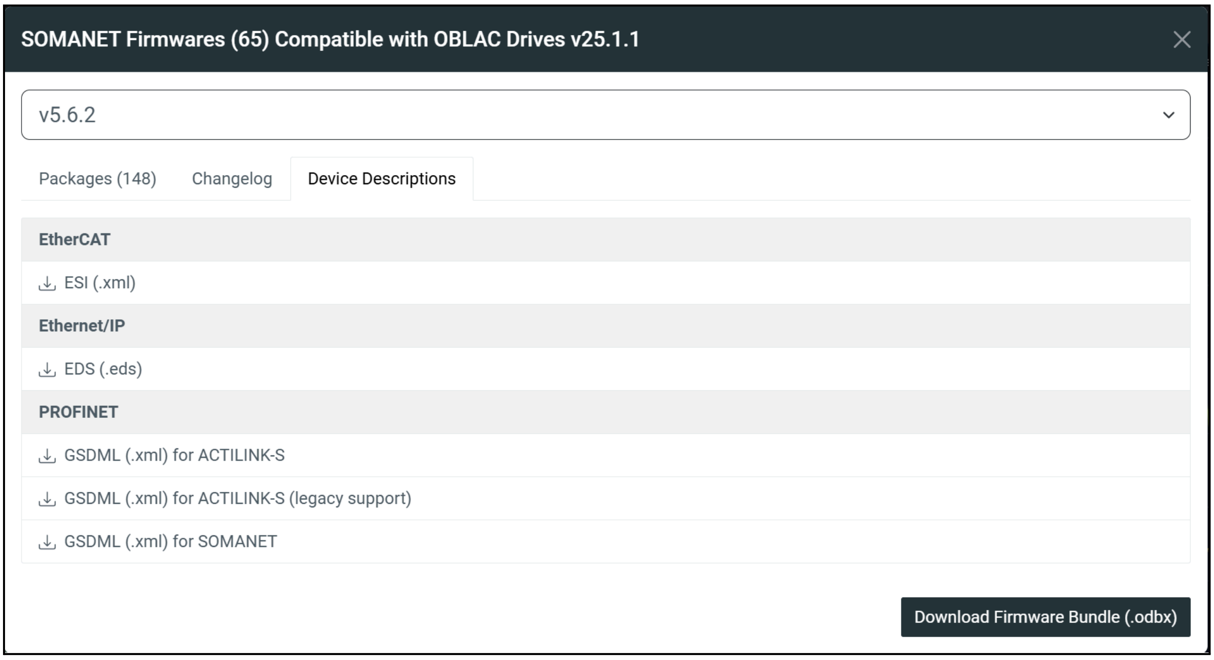
14.3.1. EDS File for ACTILINK-S

The EDS file contains - in machine readable format - all of the information a master PLC requires to effectively communicate with the ACTILINK-S drives. Without this file, it is not possible to integrate the drive into any machine.

The EDS file is:

- distributed with the package,
- downloaded from https://bundles.synapticon.com/latest/latest/deviceDescriptions, or
- read directly with the Synapticon configuration tool.

IMPORTANT
Use the correct EDS file that corresponds to the firmware version installed on your device. On the download page, find the correct firmware version and navigate to the *Device Descriptions* tab to select and download the EDS File (.eds).



14.3.2. Controlling Synapticon Devices using Rockwell Studio 5000

The Controlling Synapticon Devices Using Rockwell Studio 5000 Logix Designer - a Quick Start Guide provides an example on how to use SOMANET drives with Rockwell Studio 5000 Logix Designer. This example has been created to help users better understand how ACTILINK-S communicates over EthernetIP.

It can be used:

- if more low-level access to the profile and the drive functionality is desired, or
- when the Rockwell Studio 5000 Logix Designer libraries cannot be used.

> **NOTE**
> Because it is an example, the content may not match with the latest version of Rockwell Studio 5000 Logix Designer or with the SOMANET firmware.

14.3.3. Using the Rockwell Studio 5000 Logix Designer

Rockwell Studio 5000 Logix Designer is a software package available from Rockwell Automation. It allows the user to program all of the available Rockwell PLCs.The software can be obtained directly from the official Rockwell Automation Web site here.

14.3.4. Using Synapticon Libraries for Rockwell Studio 5000

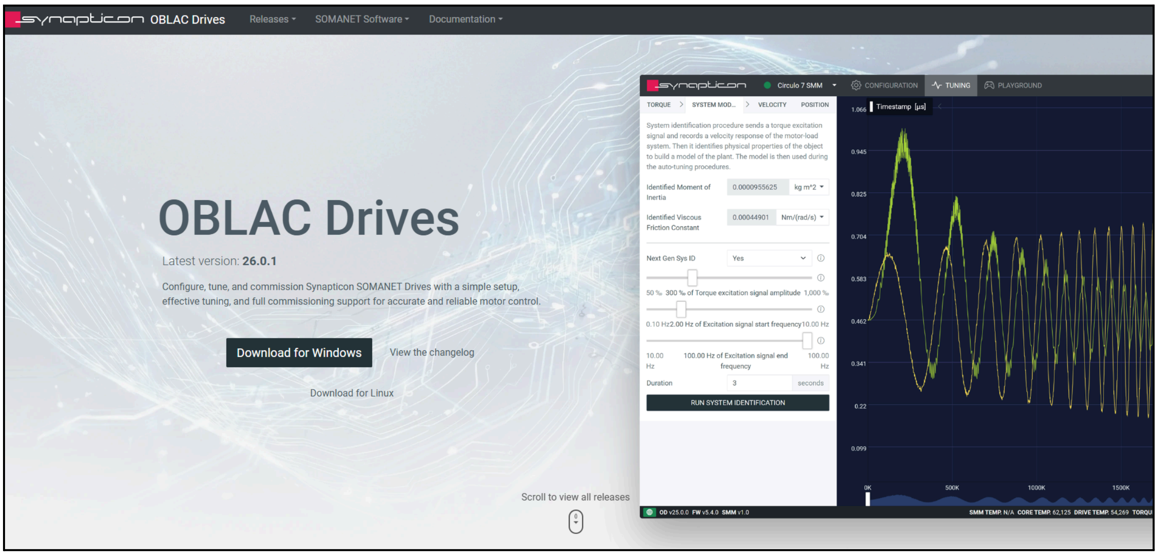
With the Synapticon libraries for Rockwell Studio 5000 Logix Designer, using ACTLINK-S with Ethernet IP is simple. The library provides an intuitive API to access the drive functions.

For additional information, refer to the [Controlling Synapticon Devices Using Rockwell Studio 5000 Logix Designer - a Quick Start Guide]().

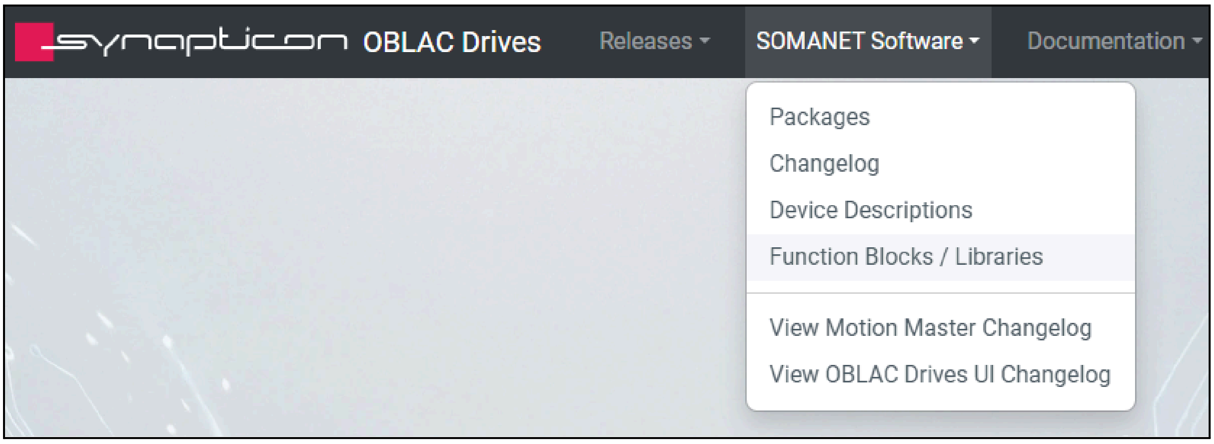
To download the Add-On Instructions (AOIs) library, which is also available in the *Add-On Instructions (AOIs)* section in the above manual, follow the procedure below.

> NOTE:
> The *Rockwell_AOI_Demo-v1.0.zip* file is only available for firmware equal to, or greater than, v5.6.5.

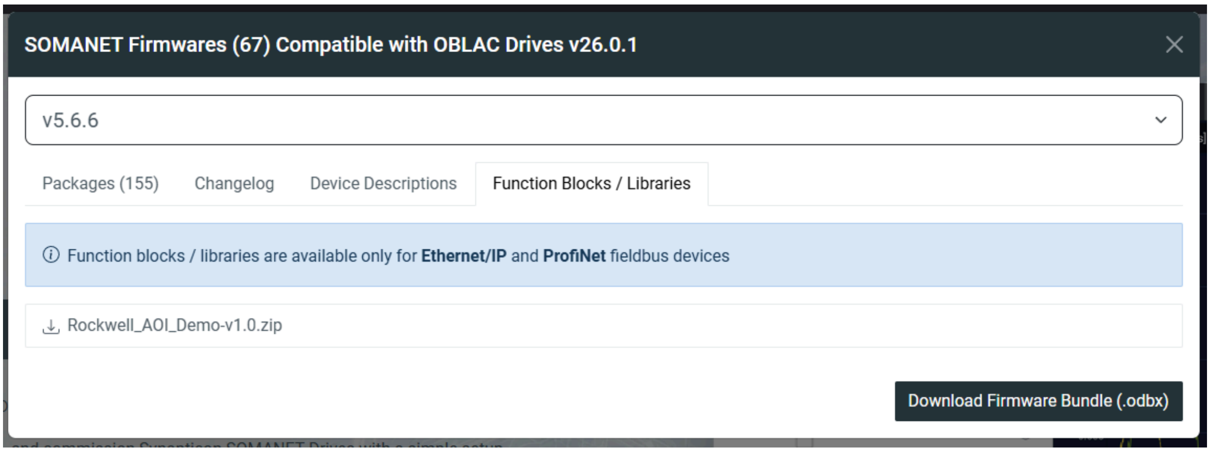
1. Go to [OBLAC Drives](). The following screen appears.



2. From the main OBLAC Drives screen, go to the Navigation bar at the top. From the *SOMANET Software* pulldown menu, select **Function Blocks / Libraries**.



The following screen appears:



3. Use the drop-down menu at the top to select the firmware version desired then click **Rockwell_AOI_Demo-v1.0.zip**. The package is downloaded.

14.3.5. Parameter List

The ACTILINK-S with Ethernet IP protocol provides the same configuration parameters as the EtherCAT version.

Refer to the CIP Parameters List, for a comprehensive list of parameters.:

> **NOTE**
> The available parameters can change between releases.

14.4. Using ACTILINK-S Integro with PROFINET

This section serves as a comprehensive guide for integrating and controlling Synapticon Integro and ACTILINK-S devices using the PROFINET protocol in conjunction with Siemens TIA Portal.

Designed to empower users with the knowledge and tools necessary for their operation, the information provides a structured approach to understanding and leveraging the full capabilities of Synapticon hardware within a TIA Portal environment.

The section is organized into five subsections, each addressing a critical aspect of the integration process:

- Quick Start
- Connecting Device to OBLAC Drives
- TIA Portal Library
- GSDML File
- Parameter List
- Using the Library

By following the information provided, users will gain the expertise required to efficiently integrate, configure, and operate Synapticon Integro and ACTILINK-S devices within their PROFINET-based automation systems.

14.4.1. Quick Start

The *Quick Start Guide* provides a practical foundation for integrating the drive with a PLC. It consists of a downloadable PDF document that serves as a manual for the TIA Portal integration process.

This guide discusses the following essential topics:

- a breakdown of the available PROFINET telegrams,
- instructions for reading and writing parameters using acyclic communication (RDREC/WRREC), and
- a step-by-step walkthrough on how to add and configure the drive within the TIA Portal hardware environment.

It is the primary reference for setting up communication between your Siemens PLC and the ACTILINK-S drive.

For additional information, see: Using ACTILINK-S with PROFINET - Quick Start Guide.

14.4.2. Connecting Device to the OBLAC Drives Commissioning Tool

Before a drive can be integrated into a PLC project, it requires initial commissioning. This crucial setup process is performed before any PLC programming starts and ensures that the drive is discoverable on the network and properly configured for your specific motor.

This section guides you through the two essential steps of this process:

- Network Setup: Users will use a PROFINET commissioning tool, such as Siemens PRONETA, to find the drive on the network and assign it a unique IP address and Device Name. Details on the required steps are provided in Connecting a PROFINET Device to OBLAC Drives.
- Drive Configuration: Once the drive has a network address, users will connect to it via Synapticon's OBLAC Drives software. This tool is used to load motor parameters, tune the control loops, and verify its basic functionality. Instructions for commissioning the device using the OBLAC Drives software are available here.

14.4.3. TIA Portal Library

This subsection introduces Synapticon's specially developed library, designed to simplify complex control tasks and streamline development within the TIA Portal environment.

The library can be downloaded from Synapticon Library. Additionally, the documentation on the implemented function blocks can be found here: TIA Portal Motion Control Library for Synapticon Drives. A code example for using the library is provided in one of the following sections.

14.4.4. GSDML File

This subsection explains the role of the GSDML file in PROFINET communication and provides a direct link to download the necessary files for your Synapticon device.

A *General Station Description Markup Language (GSDML)* file is an essential XML-based document required for any PROFINET IO device. Its primary purpose is to provide a PROFINET IO controller, such as a Siemens PLC, with all the necessary details to correctly identify, configure, and communicate with the device.

GSDML files for Synapticon devices can be downloaded at:

https://bundles.synapticon.com/latest/latest/deviceDescriptions

> **IMPORTANT**
> Use the correct GSDML file that corresponds to the firmware version installed on your device. On the download page, find the correct firmware version and navigate
>
> to the *Device Descriptions* tab to select and download the GSD File (.xml).

14.4.5. Parameter Records List

The PROFINET Parameter Records List is an essential resource that provides a complete list of the device's internal objects and parameters. This allows for an in-depth understanding of the drive's functionalities, enabling advanced configuration and diagnostics.

14.4.5. Using the Library

This section provides a practical demonstration of how to implement the function blocks from the Synapticon TIA Portal library. It includes downloadable example project files (see: Synapticon Library TIA Portal Example), and complementary documentation with step-by-step instructions (see: Using Synapticon PROFINET Library - TIA Portal Example).

14.5. Position Reference Systems, Homing and Limits

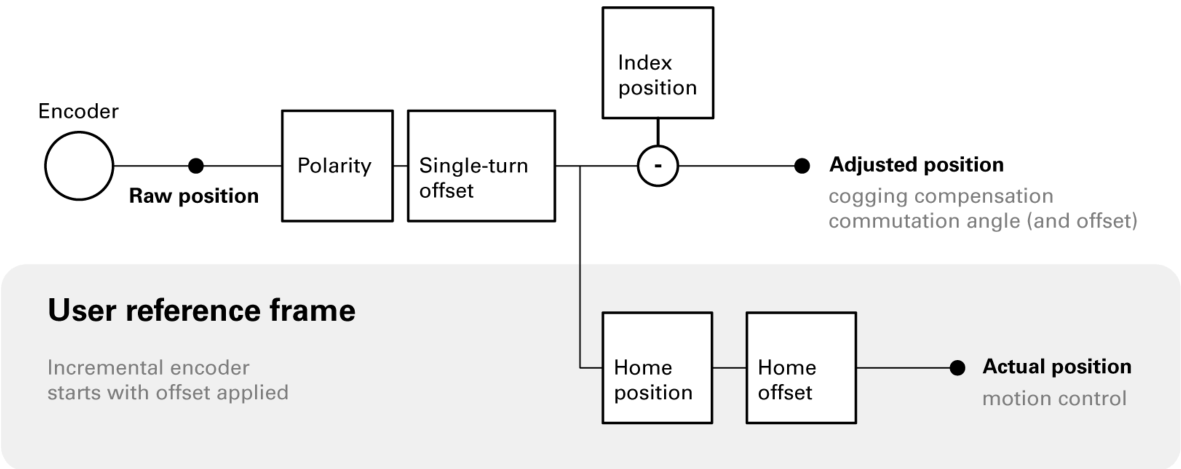
A drive system uses different reference frames with different positions that are connected to each other by offsets. Offsets perform a coordinate transformation.

This section provides information about position, offsets, limits and homing, and about their relationships. It also describes how homing works and how limits are related to frames.

14.5.1. Frames

There are different logical positions (in different frames/coordinate systems) that are located at the same physical position:

- Encoder frame position: position given by the encoder
- User frame position: position after homing with a user defined homing offset



Initially (before homing and with home offset = 0) all positions are the same.

14.5.1.1. Homing

After performing the homing procedure, the **home position*** is subtracted from the **encoder position** in such a way that the **homed position**** value at the homing location is **0** (home position = encoder position at home reference location).

Homed position = Encoder position - Home position

** object in the object dictionary*
*** location on the output shaft in which “zero” is defined*

14.5.1.2. Applying Home Offset

Any **home offset** can be added to the **homed position** as required. A common use case is when the position at the home location is not 0 but, for example, is 180° to avoid negative position values.

User frame position = Homed position + Home offset
User frame position = Encoder raw position - Home position + Home offset
→ user_position_0 = encoder_position_0 - **Home position + Home offset**

All position objects for actual, target, demand, limit and range values set by - or reported back to - the user refer to the user frame position.

In cyclic position mode, the calculation for the user position can handle an encoder position wrap around. The encoder limits do not need to be considered while commanding position beyond a full encoder rotation.

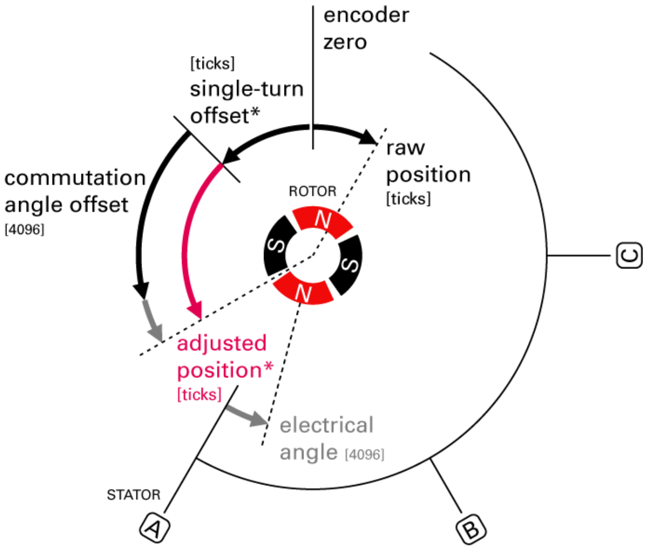
The feed factor will be applied to the user reference frame to change the units of the position. It will also be applied to the home offset. Therefore, the home offset will be in the same unit as the position itself.

When using OBLAC drives, the home offset will be rescaled when changing the Feed Constant. However, if the Feed Constant is changed outside OBLAC drives, for example, by an SDO write or manually changing the *config.csv*, the offset must be adapted manually as well.

14.5.1.3. Commutation Offset and Single turn Offset

Single turn offset is added to the raw encoder position before applying any other offset. It is like moving the encoder physically by the ticks applied by this parameter.

In most cases, the position sensor's zero position is not aligned with the motor magnets. In order to determine the motor magnet position that is required for the motor commutation algorithm, an "offset" value should be added to the measured value of the position sensor to provide the correct (electrical) rotor angle. This is the commutation offset.



2 pole pair motor
** sensor polarity inverted*
phase polarity normal
[units]

14.5.2. Homing, Homing Position and Offset

There are several homing methods to determine a specific position as the home position. All methods have the same purpose: to refer the position reported to a specific physical position independent of the encoder to zero position. This can occur by a switch or another impulse; for example, the reference impulse of an encoder, or by declaring the actual position as home position.

After homing, the homed frame position at the physical location of home reference is 0. The user can add any home offset to the homed frame position as required. A common use case is as follows:

- On home location, the position is not 0 but is, for example, 180° to avoid negative position values.

If the home offset is 0, the **user position** is identical to the **homed frame position**.

Even when the homing method 35/37 (set actual position as home position) is used, the home offset will be added to the position.

→ The **actual position** after homing with 35/37 without any movement will be the **home offset**.

On FW versions < 5.1, homing must be performed after every bootup as the home position is not accessible and not stored, while the home offset is stored.

From FW version >= 5.1, the home_position is stored in object 0x2005:1. To use this value on startup of the system (for example, with absolute encoders), object 0x2005:2 `**Restore Home Position on Startup**` must be set.

14.5.3. Limits

There are several limits to be considered in the control system:

- Encoder Limits
- User Position Limits
- Software Limits
- Physical Hardware Limits.

Each of these is described in the sections that follow.

14.5.3.1. Encoder Limits

The position value of a **single turn encoder** is limited to its resolution (from 0 to resolution-1). In regular operation, SOMANET drives continue counting of the encoder limits even on exceeding the encoder resolution (similar to multiturn encoders). However, after a power cycle, the actual position of the encoder will fall back to a value between 0 and resolution -1.

The position range of a **multiturn encoder** is related to its resolution and the supported multiturn range. Resolution and multiturn range are part of the encoder specification in the datasheet.

When moving over the limits, the encoder will perform a wrap-around in the values.

14.5.3.2. User Position Limits

14.5.3.2.1. Data Size Limits

The data size of position messages reported in a position object is limited by the firmware to a signed 32-bit (-2.147.483.648 to 2.147.483.647) independent of the encoder used.

14.5.3.2.2. Position Range Limit (0x607B)

This reports the position sensor limits and is updated when the encoder is reconfigured. On reaching or exceeding these limits, the sensor value will wrap automatically to the other end of the range.

The units are in increments of the position encoder or in Feed Constant units, if configured.

14.5.3.2.3. Target Values

The default value is the data size limit, which means that the position range is not limited.

For SOMANET drives, these values will be set automatically to the encoder limits or to the default values when incremental encoders are used and are read only.

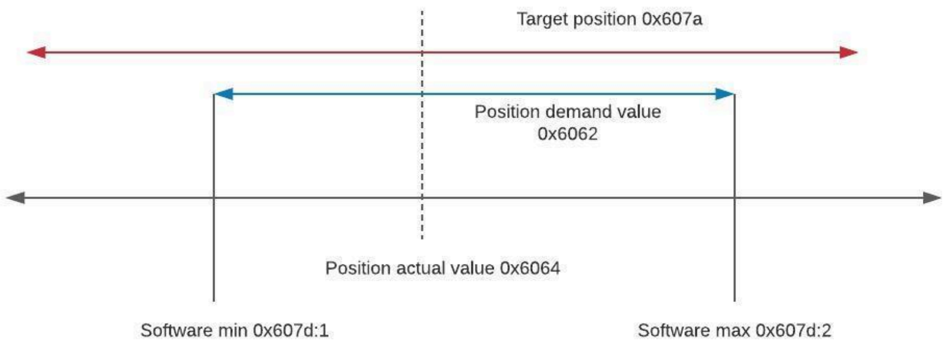
14.5.3.2.4. Software Limits (0x607D)

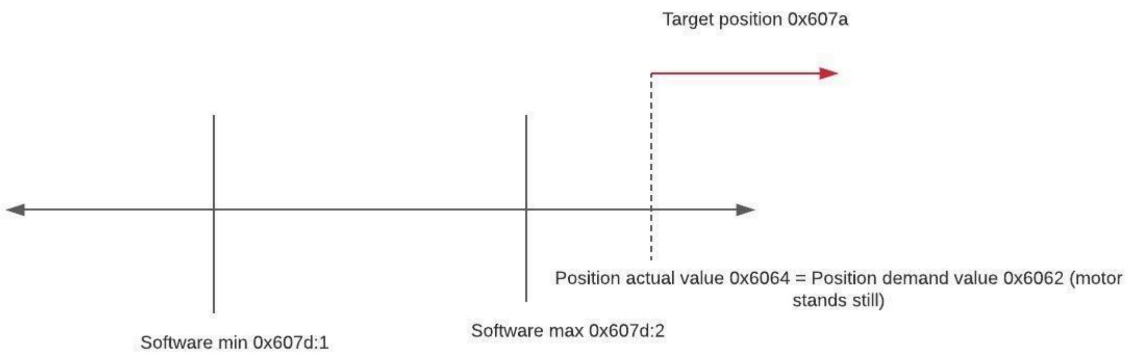
Position Control Mode

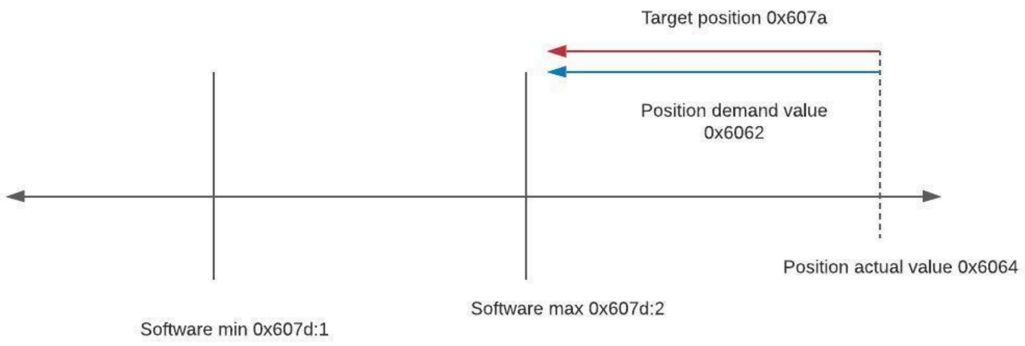
If in position control mode (CSP, PP) a target position value out of this min/max range is set, the demanded value will be limited to the values defined by the software limits. Therefore, the Position demand value 0x6062 is limited and can be different from Target position 0x607A. When a drive starts at a position outside the indicated limits, only motion towards the limits is allowed.

The units are in increments of the position encoder or in Feed Constant units, if configured.

> **NOTE**
> If the current position is outside the limits, the drive will only drive the motor towards the permitted position range, not further away from it.







NOTE

Homing modes are executed with disabled position software limits as limits are relative to the home position and can only be calculated after the home position has been found.

Because the cogging torque recording procedure cannot move the motor outside the position software limits, it is not advisable to perform the procedure near the limits. The procedure cannot be started if the motor starts outside the limits. In that case, the firmware will raise an error, where the error code is *CIA_402_ERROR_CODE_REFERENCE_LIMIT 0x8612* and the error report objects will output *SwPosLmt*.

Velocity Control Mode

The actual position is not controlled in velocity control mode (CSV, PV); therefore, the error SwPosLmt is raised when the actual position moves outside of the configured limits. This disables the drive and enters fault state.

When a drive starts at a position outside of the indicated limits in velocity control mode, the error SwPosLmt is raised if the velocity demand value tries to move the drive further away from the limits.

Torque Control Mode

The actual position is not controlled in torque control mode (CST, PT); therefore, the error SwPosLmt is raised as soon as the actual position is out of the limits. This disables the drive and enters fault state.

When a drive starts at a position outside of the indicated limits, velocity or position control mode must be used to move the drive back to the allowed range.

14.5.3.3. Physical Hardware Limits

To physically limit the movement of an axis, end stops and/or limit switches can be installed. They are functioning even when the drive is misconfigured or not working correctly. It’s recommended to use physical limits if moving the joints over the limits will damage the machinery or will lead to dangerous situations.

14.5.3.3.1. End Stops

End stops will mechanically limit the movement.

> **ATTENTION**
> End stops must be designed robust enough to endure stopping, even high speed movement.

Stopping the movement by a mechanical end stop can only be detected by a subsequent fault such as: Following Error, Over Current, etc., or by raising the Internal limit Active (ila) bit.

14.5.3.3.2. Limit Switches

Limit switches can be connected to any of the GPIO pins. With the right configuration, the movement into the switch will be stopped if the switch is activated; however, moving out of the switch is possible.

> **NOTE**
> Software Limits should be set so that physical limit switches are never reached.

14.6. Mitigating Transient Torque Spikes (while using the Cycle Synchronous Position mode)

14.6.1. Overview

The drive is configured to run in CSP mode. The master sends incremental target position values on every task cycle. Occasional spikes in torque are exhibited, which could be observed as sudden noise while running.

The data plots from the master, e.g., OBLAC or TwinCAT, show spikes in ‘Torque Demand Value’ in some cycles. This is observed more frequently when DC sync is set up.

14.6.2. The Cause

Consider a master task, e.g., TwinCAT/CodeSys, that is running at 250Hz (PDO cycle every 4ms). The ACTILINK-S control input frequency is 1KHz by default, i.e., it reads new setpoints from the Object Dictionary every 1 ms, synchronized to SYNC0. If the master's PDO data arrives in the Object Dictionary at almost the same moment the drive reads it, even tiny timing variations. e.g., master jitter, decide whether a new setpoint is picked up in the current cycle or the next one. When it lands one cycle late, the drive holds the old setpoint for 1 ms then catches up with an increased step, which the control loop turns into a torque spike.

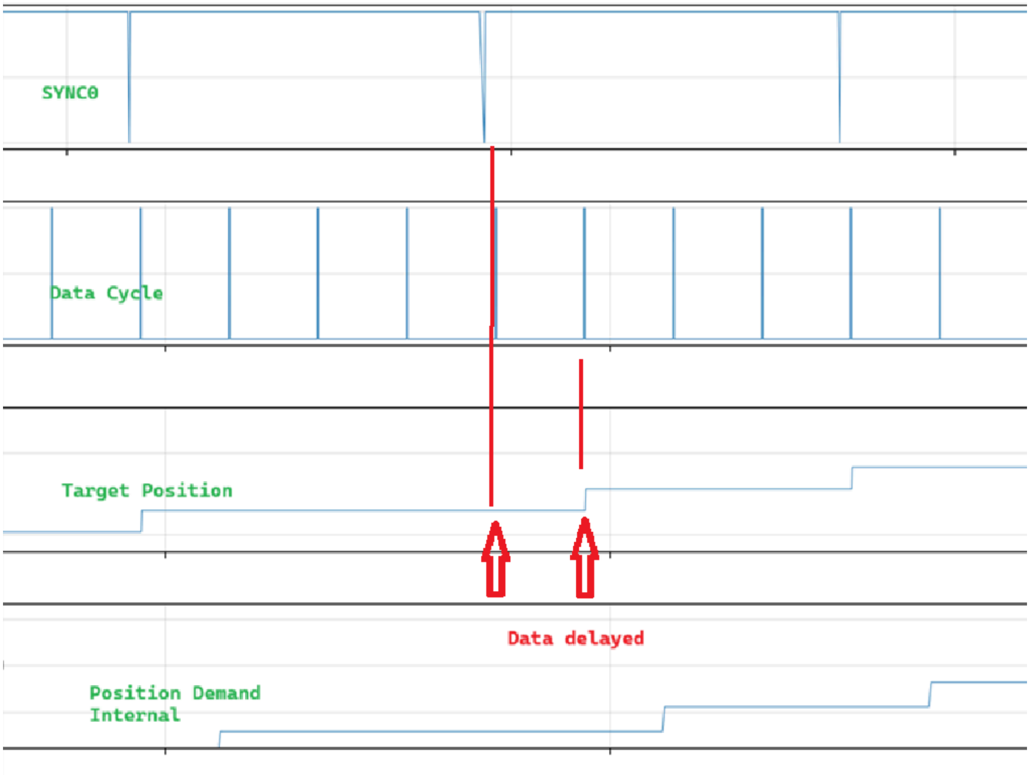


Figure 1 - Data cycle - Delayed data arrival

The delay could occur from various factors such as shift setting of master and also device, network setup and inconsistencies, master task cycle, and number of drives in the chain.

Additionally, the target position (profile) calculated by the master has an effect if the increment is not consistent with the data cycle.

This network trace is one such case that shows that the data frame arrives 1ms later than expected. Instead of 4ms, it arrives after 5ms.

9323	0.003938213	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9325	0.004071370	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9327	0.003991371	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9329	0.004026208	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9331	0.003916482	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9333	0.004081660	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9335	0.003934789	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9337	0.005131285	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9339	0.003927799	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9341	0.004013355	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9343	0.003935050	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9345	0.004019458	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9347	0.003972792	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9349	0.003896308	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9351	0.004018891	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9353	0.003990720	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM
9355	0.003955360	LCFCElectron_74:2e:…	Broadcast	ECAT	180	7 Cmds, SumLen 64, 'ARM

Figure 2 - Delayed network data frame

The graph below explains how the data is sampled internally and control parameters are calculated based on the sampled data. The position control loop with control input FIR filter is explained in Reference [1].

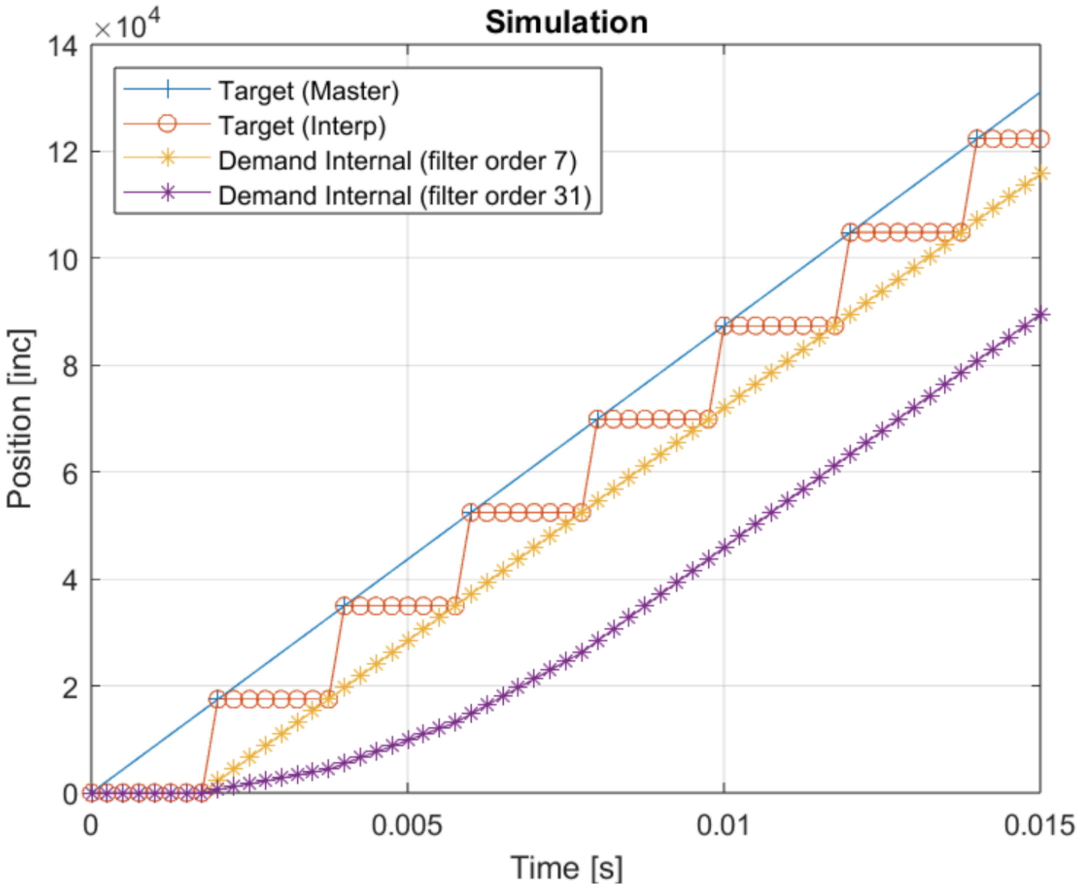
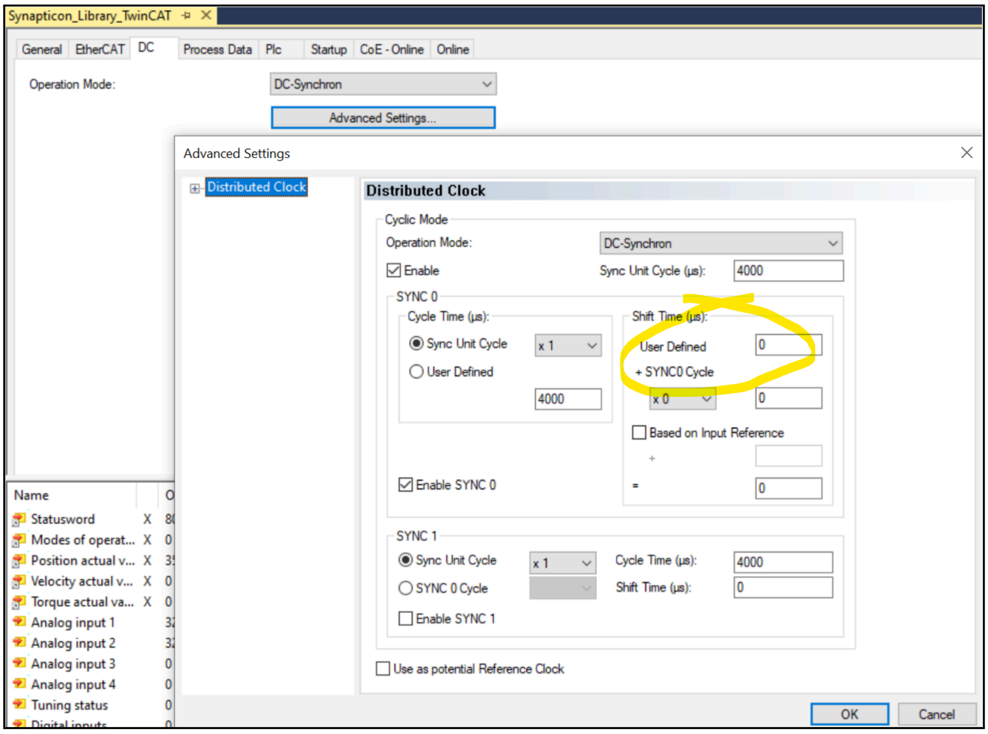


Figure 3 - Target demand

14.6.3. The Solution

1. Make sure the network is stable. Avoiding non-realtime (non-industrial) switches in the network might improve the data throughput.
2. Adjust the drift percentage and shift parameters in the master. This will improve the sync tolerance by reducing the jitter.
   For reference, refer to the images below from TwinCAT.



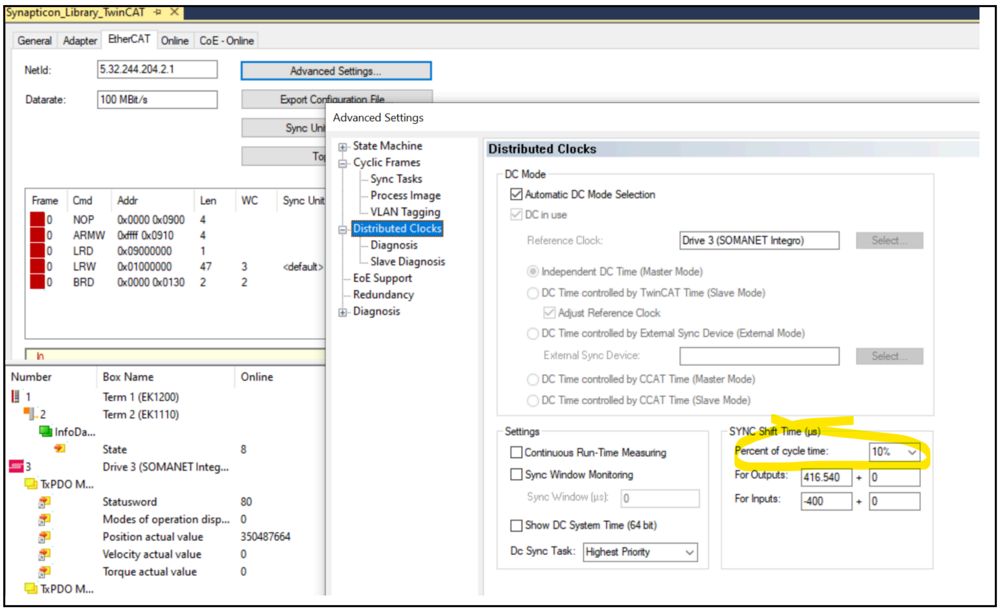


Figure 4 - Master DC setting in TwinCAT

3. Target setpoints issued by the master must not exhibit any jitter.
4. Tune properly to the expected step response based on the system. Tuning it for a sharp response tends to increase the occurrence of spikes.
5. Adjust the Input filter order. When the input FIR filter order is high, the input data would be smoother and the spikes are eliminated (0x2027 Control input FIR filter, 0x2015 Velocity feed forward)
6. Increasing the data read frequency (0x2500 Cyclic control input frequency) to 2KHz will increase the data read rate and smoothen the spikes.

14.6.4. References

[1] SoftwareReference 5.6 -> Motion Control -> Position Control Loops

14.7. 24 V - 60 V Operating ACTILINK-S Integro Outside Nominal Voltage

14.7.1. Overview

This document explains the behavior and characteristics of ACTILINK-S Integro devices when operated outside of their 48 V nominal DC bus.

It guides the user through:

- torque-speed performance below 48 V,
- the voltage ripple margin above 48 V, and
- the practical limits and precautions in each direction.

14.7.2. Introduction

ACTILINK-S Integro (200 W to 1000 W, models ASC1-061A through ASC1-082A) is designed and rated for a 48 V DC bus. Most datasheet performance figures - as well as validation and qualification - were established at this nominal 48 V supply voltage.

Additionally, the drive is capable of running outside of this nominal point,in both higher and lower voltages:

- **Lower voltage**, down to a minimum of 24 V DC. Any voltage between 24 V and 48 V is feasible. As the most commonly used case, this note details the 24 V operating point in Operating below 48 V DC - Specifically 24 V DC.

- **Higher voltage**, up to a maximum of 60 V DC. Towards the upper limit of this range (55 - 60 V), operation at high peak power may impose specific requirements on wiring and topology. See: Operating above 48 V DC.

Power Ratings across the Operating Range summarizes how peak and continuous power scale across this voltage range.

Accessories: Power Supplies and Braking Choppers describes the accessories (power supplies and braking choppers) used to establish a given bus voltage.

14.7.3. Power Ratings across the Operating Range

The peak and continuous power figures published in the ACTILINK-S Integro datasheet are measured at 48 V DC.

- Below 48 V, the maximum achievable speed or torque at a given speed is reduced; see: Operating below 48 V DC - Specifically 24 V DC. Therefore, both the maximum peak power and maximum continuous power are reduced accordingly.
- Above 48 V, the maximum available power might not increase. In some edge cases it might decrease because the drive may need to limit torque to keep operation stable against the higher DC-bus voltage ripple described in Operating above 48 V DC.

14.7.4. Operating below 48 V DC - Specifically 24 V DC

The 24 V operating point is the most commonly requested departure from nominal; specific illustrations are provided in this section.

14.7.4.1. Motor Curves

Figure 1 compares the 24 V torque-speed behavior against the 48 V datasheet reference for all five ACTILINK-S variants. Solid lines indicate the normal operating range while dashed lines mark the extended operating region at 24 V, discussed in Operating up to 4500 RPM on Lower Voltage DC Buses.

For the two 80-flange variants (ASC1-081A and ASC1-082A), the plotted 24 V continuous-torque curves are additionally constrained by the 25 A DC current limit of the power connector, since DC current at 24 V is approximately double that at 48 V for the same operating point. From the mid-speed range onward, the continuous torque of these two variants is therefore set by this current limit rather than by thermal capability.

NOTE 1

Connector limits: While the 25 A DC continuous limit of the I-Tec and Y-Tec connectors (32 A for a single M12) is rarely reached at the nominal 48 V, this is important at reduced bus voltage where the same operating point draws proportionally more DC current. Additionally, these limits are not enforced by the drive’s self-protection - it is the user or master controller’s responsibility to maintain the continuous DC current within the connector and cabling limits.

Example (I-Tec/Y-Tec at 24 V): 25 A DC continuous → 600 W continuous → at 3000 RPM, limits the commanded torque to approximately 1.9 Nm.

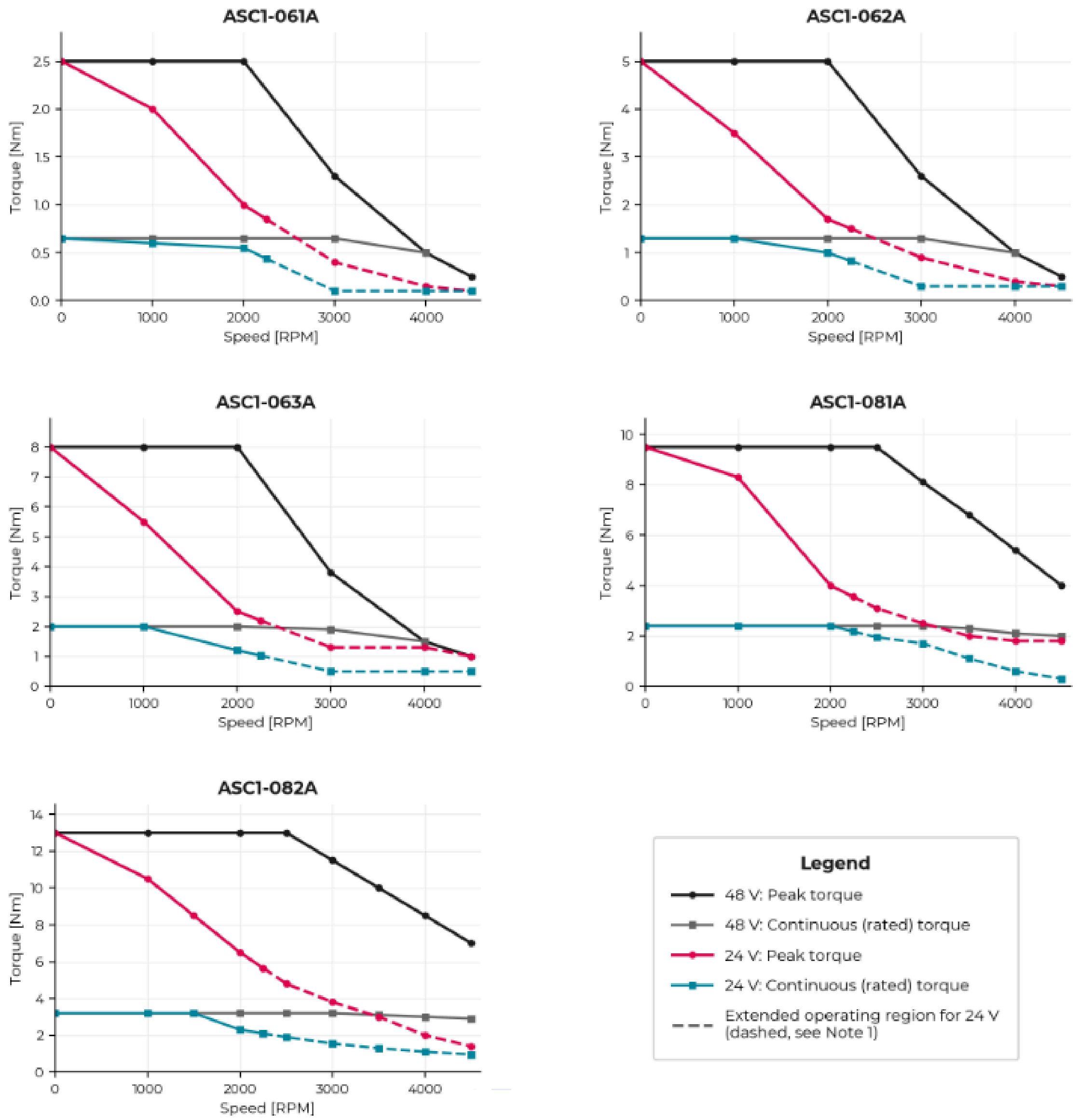


Figure 1 - Torque vs. speed at 48 V and 24 V DC bus voltage for all five ACTILINK-S Integro variants; line coding per legend

The extended operating region begins at ~2250 RPM at 24 V; refer to **NOTE 2**.

14.7.4.2. General Behavior

At 24 V, the ACTILINK-S Integro drive maintains full 48 V torque but only up to about half the rated speed. This is a rough guide: the drive's field weakening and MTPA current control strategy actively reshapes the torque speed envelope in real time; thus, the transition is more gradual and the usable range extends further than a simple voltage-halving would suggest.

14.7.4.3. Operating up to 4500 RPM on Lower Voltage DC Buses

The full rated speed of 4500 RPM remains achievable at 24 V; speed derating is not required by the drive itself. However, three effects apply in this extended operating region:

- Torque at these high speeds is significantly lower at 24 V than at 48 V. Refer to Figure 1.
- More heat is induced inside the motor at 24 V than at 48 V for a given operating point. As a result, continuous (rated) torque is also reduced and the motor can run comparatively hot even at low torque or no load.
- Switching the motor off, or removing its reference value, induces a voltage on the DC bus that can approach the full 48 V rating; refer to **NOTE 2**.

NOTE 2

DC-bus overvoltage at shut-off: When the motor is switched off, or its reference value is removed, it induces a voltage on the DC bus that can approach the full 48 V rating.

A battery on the bus can overcome this limitation by absorbing the regenerative energy such that the voltage does not spike as much, provided that its battery management system (BMS) accepts the charge. If no battery or other measures to limit the bus voltage are provided, all electronics on the DC bus must tolerate the excessive voltage; otherwise, they can be damaged. Before operating in the extended region (>~2250 RPM), confirm that the system setup is robust in this way.

The speed threshold beyond which the extended operating region precautions apply (~2250 RPM at 24 V) scales proportionally with DC bus voltage.

14.7.5. Operating above 48 V DC

Especially in battery-based applications, the DC bus voltage may typically be continuously above 48 V DC. ACTILINK-S Integro allows for permanent DC bus voltages as high as 60 V DC.

Note that, like any motor control device, ACTILINK-S Integro's switching elements cause a voltage ripple on the DC bus. The amplitude of this ripple depends on factors such as wiring topology, installed bus capacitance, cable length, operating point, and controller configuration.

At the nominal 48 V bus voltage, ACTILINK-S Integro is very robust to such ripple, even at significant amplitude. At higher voltage, especially in the 55-60 V range, there is less margin before the ripple encroaches on the drive's protection limits. If that margin is exceeded, the drive goes into fault mode to protect itself.

If this occurs, the first thing to try is shortening the DC bus cabling, which is the most effective lever available onsite to reduce ripple amplitude. Wiring topology and installed bus capacitance are the other contributing factors and may warrant review as well.

14.7.6. Accessories: Power Supplies and Braking Choppers

Power supplies and braking choppers offered by Synapticon are designed for a 48 V nominal bus and can only be adjusted within narrow limits of approximately 48 V.

If an application requires a different, continuously-held bus voltage, this is typically a battery application, since a battery naturally supplies a voltage away from 48 V.

When an application requires a distinct, sustained bus voltage, it most commonly involves a battery system, given that batteries inherently deliver voltages outside of the 48 V standard.

Alternatively, a third-party power supply rated for the desired voltage can be used instead of the Synapticon unit. Make sure to select all DC bus components in line with the respective requirements, e.g., in terms of voltage, currents, reverse currents, and applicable standards.

14.7.7. Conclusion

ACTILINK-S Integro operates reliably across a 24 V to 60 V DC bus, allowing applications to significantly deviate from the 48 V nominal rating.

Below 48 V, torque and speed scale down together with power; the 24 V case is validated in detail in Operating below 48 V DC - Specifically 24 V DC, including the **NOTE 2** precaution.

Above 48 V, the limiting factor is DC-bus voltage ripple margin rather than motor performance, and shorter cabling is the first remedy if the drive faults. Any non-48 V bus voltage that must be held continuously is best supplied by a battery or a third-party supply, since Synapticon's own accessories are specifically designed for 48 V.

14.8. Using OBLAC Drives to Configure the Feed Constant and Gear Ratio for a Linear Axis

To set the *Feed Constant* and *Gear Ratio* for systems with a rotary motor driven by Synapticon drives that move a linear axis, follow the steps below.

Required information:

- Mechanical feed per motor revolution
- Linear encoder single-turn resolution, in increments

> **NOTE**
> Throughout this procedure, *linear encoder single-turn resolution* always refers to the number of increments over the full single-turn range of the linear encoder..

14.8.1. Steps

Preliminary Step: Assign the Encoders

- Assign the motor-side encoder to commutation and velocity.
- Assign the linear encoder to position.
- Check the polarity of both encoders.

Step 1: Set the Feed Constant

1. Go to the "Feed Constant" menu.
2. Set the "Feed" parameter to the linear encoder single-turn resolution.
3. Set "Shaft revolutions" to 1.
4. Press the "Apply Changes to Feed Constant" button.
5. Review the Affected Parameters list and correct any errors reported.
6. Assign a unit in the "Position unit" parameter.

Step 2: Set the SI Unit Velocity

1. Go to the "SI Unit Velocity" menu.
2. Select "distance unit per second" in the "SI Unit Velocity" field.
3. Press the "Apply Changes to SI Unit Velocity" button.
4. Review the Affected Parameters list and correct any errors reported.

Step 3: Set the Gear Ratio

1. Go to the "Motor & Transmission" menu, "Transmission" area.
2. Set the "Motor revolutions" parameter to the linear encoder single-turn resolution divided by the mechanical feed per motor revolution.
    - This value must be an integer. If the calculation returns a decimal, shift the decimal point to the right until the value is a whole number, enter that number in "Motor revolutions", and enter the corresponding scaling factor (10, 100 or 1000) in "Shaft revolutions".

14.8.2. Practical Example

Setup:

- Rotary motor with an 18-bit integrated Synapticon encoder
- Linear axis with a 22-bit SSI encoder
- Overall transmission ratio: one motor revolution moves the linear axis by 40 mm

Applying the procedure:

Preliminary step — Assign / Configure the encoders

- Integrated encoder (motor side) for commutation and velocity
- External SSI encoder (linear axis) to position
- Polarity of both encoders checked

Step 1 — Feed Constant

- Feed = 4194304 (linear encoder single-turn resolution, 2^22)
- Shaft revolutions = 1
- Affected Parameters reviewed and corrected

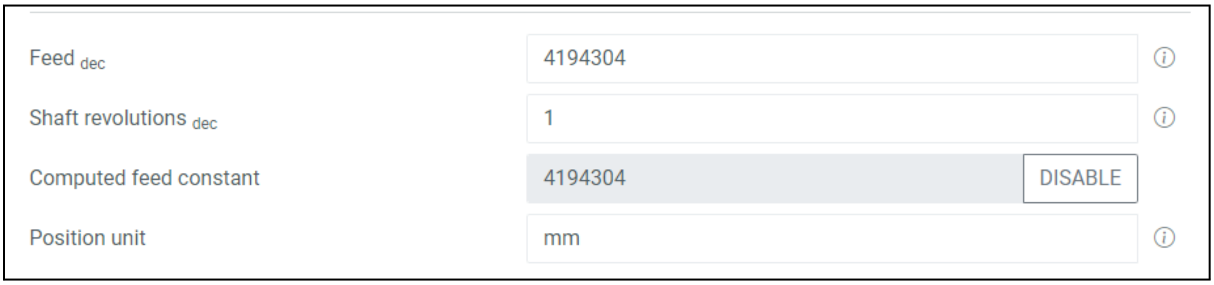


Figure 1 - Feed Constant screen with the values above

Step 2 — SI Unit Velocity

- SI Unit Velocity set to distance unit per second, to obtain usable velocity units
- Affected Parameters reviewed and corrected

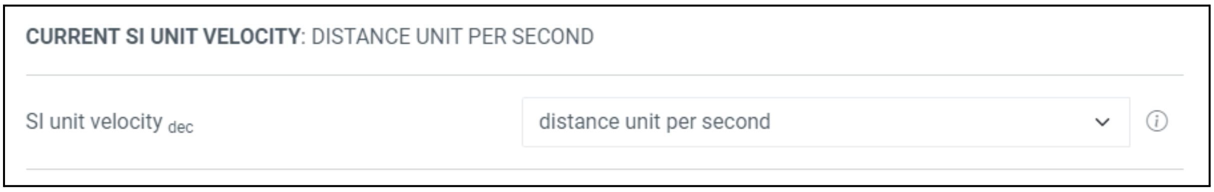


Figure 2 - SI Unit Velocity screen with the values above

Step 3 — Gear ratio

- 4194304 / 40 = 104857.6, which is not an integer
- Shifting the decimal point one place to the right gives 1048576
- Motor revolutions = 1048576
- Shaft revolutions = 10

Figure 3 - Motor & Transmission screen; Transmission area, with the values above