

Altivar Machine ATV350

Decentralized Variable Speed Drives for Asynchronous and Synchronous Motors

Project Planning Manual

Original Instructions written in English

JPT12598.01
12/2025



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Safety instructions

Basic safety instructions

Failure to follow the basic safety instructions and information may result in serious personal injury or property damage.

- Only use the product as directed.
- Never commission the product in the event of visible damage.
- Never make technical modifications to the product.
- Never commission the product before assembly has been completed.
- Connect/disconnect all pluggable connections only in deenergized condition!
- Only remove the product from the installation in the deenergized state.
- Depending on its degree of protection, the product may have live, movable, or rotating parts during or after operation. Surfaces may be hot.
- Observe the specifications of the corresponding documentation. This ensures safe, trouble-free operation and achievement of the specified product features.
- The procedural notes and circuit details given in the associated documentation are suggestions and their transferability to the respective application must be checked. The manufacturer of the product does not take responsibility for the suitability of the process and circuit proposals.
- All work with and on the product may only be carried out by qualified personnel. IEC 60364 and CENELEC HD 384 define the qualifications of such personnel, as follows:
 - They are familiar with installing, mounting, commissioning, and operating the product.
 - They have the corresponding qualifications for their work.
 - They know and can apply all regulations for the prevention of accidents, directives, and laws applicable at the place of use.

Please observe the specific safety information in the other sections!

Application as directed

- The product is a professional equipment intended for use by trades, specific professions or industry and not for sale to the general public. IEC 60050 [IEV 161-05-05]
- To prevent personal injury and damage to property, higher-level safety and protection systems must be used!
- The product may only be operated under the specified operating conditions and in the specified mounting positions.
- The product is exclusively suitable for installation in control cabinets and for wall/machine mounting.
- The product must only be actuated with motors that are suitable for the operation with drives.
- The product must not be operated in private areas, in potentially explosive atmospheres and in areas with harmful gases, acids and radiation.

NOTE: Areas with oils should be possible thanks to the IP54/IP66 degree of protection.

Additional information for the intended use in North America:

The cables must be installed in accordance with US National Electrical Code NFPA 70 or Canadian Electrical Code C22.1.

Use of explosion-protected motors

Explosion-protected motors that are not designed for use with an drive lose their approval if they are used for variable speed applications. Due to the many areas of liability that may arise when handling these applications, the following policy statement applies:

NOTE:

Schneider Electric drives are sold without warranty of suitability for use with explosion-protected motors. Schneider Electric assumes no responsibility for direct, incidental or consequential damages, costs or losses that may result from the use of AC drives with explosion-protected motors. The buyer expressly agrees to assume any risk of loss, expense or damage that may result from such application.

Foreseeable misuse

Altivar Machine ATV350 variable speed drives are not to be operated with DC motors.

Handling

Transport, storage

Observe the notes regarding transport, storage and correct handling. Ensure proper handling and avoid mechanical stress. Do not bend any components and do not change any insulation distances during transport or handling. Do not touch any electronic components and contacts. drives contain electrostatically sensitive components which can easily be damaged by inappropriate handling. Do not damage or destroy any electrical components since thereby your health could be endangered!

Installation

The technical data and supply conditions can be obtained from the nameplate and the documentation. They must be strictly observed.

The drives must be installed and cooled according to the instructions given in the corresponding documentation. Observe the climatic conditions according to the technical data.

Electrical connection

WARNING

ELECTRIC SHOCK CAUSED BY INSUFFICIENT GROUNDING

- Verify compliance with all local and national electrical code requirements as well as all other applicable regulations with respect to grounding of the entire installation.
- Ground the device before applying voltage.
- The cross section of the ground conductor must comply with the applicable standards.
- Do not use conduits as ground conductors; use a ground conductor inside the conduit.
- Do not consider cable shields to be ground conductors.

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

When working on energized drives, comply with the applicable national accident prevention regulations.

The electrical installation must be carried out according to the appropriate regulations (e. g. cable cross-sections, fuses, GND connection). Additional information can be obtained from the documentation.

The documentation contains information about installation according to EMC regulations (shielding, grounding, filters and cable routing). Please also observe this information for CE-marked drives. The manufacturer of the system or machine is responsible for adherence to the limit values required in connection with EMC legislation.

Protection in the event of short circuit or ground error

To ensure protection according to EN 61800-5-1 in the event of an electrical short circuit or ground error (protection against electric shock, thermal hazards and fire), the following must be taken into account in the installation:

- Use fuses according to the technical data.
- The installation must meet the requirements of the IEC 60364.
- The continuity of all associated protective conductors and equipotential bonding conductors including all connection points must be ensured.
- If the maximum permissible switch-off time according to IEC 60364 is exceeded with a high system impedance (especially with TT mains) or a high loop impedance with the prescribed fuses, a residual current device (RCD) can be used. Alternatively, other protective measures can be used, e. g. isolation from the environment by means of double or reinforced insulation, or isolation from the supply system by using a transformer.
- If a residual current device (RCD) is connected upstream of the drive for protection in the event of a ground error, only type B is permitted for three-phase devices.

Operation

If necessary, systems including drives must be equipped with additional monitoring and protection devices. Also comply with the safety regulations and provisions valid at the installation site.

After the drive has been disconnected from the supply voltage, all live components and power terminals must not be touched immediately because capacitors can still be charged. Please observe the corresponding stickers on the drive.

You may adapt the drives to your application by parameter setting within the limits available. For this, observe the notes in the documentation.

Safety functions

Certain drive versions support safety functions (e. g. "safe torque off", formerly "safe standstill") according to the requirements of the EC Machinery Directive 2006/42/EC [UKCA: S.I. 2008/1597] . The notes on the integrated safety function provided in this documentation must be observed.

The user is not allowed to change drives that come with integrated safety function. In the event of a defect, the drive must be replaced.

Maintenance and servicing

The drives do not require any maintenance if the prescribed operating conditions are observed.

Disposal

In accordance with the current provisions, Schneider Electric products and accessories have to be disposed of by means of professional recycling. Schneider Electric products contain recyclable raw material such as metal, plastics and electronic components.

Residual hazards

Even if notes given are taken into consideration and protective measures are implemented, the occurrence of residual risks cannot be fully prevented.

The user must take the residual hazards mentioned into consideration in the risk assessment their machine or system.

Failure to follow these instructions may result in serious personal injury or property damage property!

Product

Observe the warning labels on the product!

	Dangerous electrical voltage: Before working on the product, make sure there is no voltage applied to the power terminals! After mains disconnection, the power terminals will still carry the hazardous electrical voltage for the time given next to the symbol!
	Electrostatic sensitive devices: Before working on the product, the staff must ensure to be free of electrostatic charge!
	High leakage current: Carry out fixed installation and GND connection in compliance with: EN 61800-5-1 / EN 60204-1

**Hot surface:**

Use personal protective equipment or wait until the device has cooled down!

Degree of protection – Protecting personnel and device protection

- Information applies to the mounted and ready-for-use state.

Protecting personnel

Before working on the drive, check if no voltage is applied to the power terminals.

- Depending on the device, the power terminals X105 remain live for up to 15 minutes.
- The power terminals X100 and X105 remain live even when the motor is stopped.

Device protection

- The maximum test voltage for insulation tests between a control potential of 48 V and GND must not exceed 110 V DC (EN 61800-5-1).

Motor protection

With some settings of the drive, the connected motor can be overheated.

- For example, by longer operation of self-ventilated motors at low speed.
- For example, by longer operation of DC-injection braking.

Protection of the machine/system

Drives can reach dangerous overspeeds.

- For example by setting high output frequencies in connection with motors and machines not suitable for this purpose.
- The drives do not provide protection against such operating conditions. For this purpose, use additional components.

Motor

If there is a short circuit of two power transistors, a residual movement of up to $180^\circ/\text{number of pole pairs}$ can occur at the motor! (e.g., 4-pole motor: residual movement max. $180^\circ/2 = 90^\circ$).

About the book

Document description

This document only includes the most frequently asked questions and presents them in a simplified form for a better overview. Detailed technical and functional explanations can be found in the comprehensive product documentation. The complete documentation, further information and tools regarding Schneider Electric products can be found on the Internet: www.se.com

Validity Note

Original instructions and information given in the present document have been written in English (before optional translation).

This documentation is valid for the Altivar Machine ATV350 drives.

The characteristics of the products described in this document are intended to match the characteristics that are available on www.se.com. As part of our corporate strategy for constant improvement, we may revise the content over time to enhance clarity and accuracy. If you see a difference between the characteristics in this document and the characteristics on www.se.com, consider www.se.com to contain the latest information.

Step	Action
1	Go to the Schneider Electric home page www.se.com .
2	In the Search box type the reference of the product or the name of a product range. • Do not include blank spaces in the reference or product range. • To get information on grouping similar modules, use asterisks (*).
3	If you entered a reference, go to the Product Datasheets search results and click on the reference that interests you. If you entered the name of a product range, go to the Product Ranges search results and click on the product range that interests you.
4	If more than one reference appears in the Products search results, click on the reference that interests you.
5	Depending on the size of your screen, you may need to scroll down to see the data sheet.
6	To save or print a data sheet as a .pdf file, click Download XXX product datasheet .

Information on Non-Inclusive or Insensitive Terminology

As a responsible, inclusive company, Schneider Electric is constantly updating its communications and products that contain non-inclusive or insensitive terminology. However, despite these efforts, our content may still contain terms that are deemed inappropriate by some customers.

Related Documents

For certain tasks, information is available in Related Documents.

Title of Documentation	Reference Number
ATV350 Catalog	DIA2ED2251201EN (English); DIA2ED2251201FR (French)
Altivar Machine ATV350 Getting Started (including SCCR)	JPT12596 (English)
Altivar Machine ATV350 Project planning manual	JPT12598 (English)
Altivar Machine ATV350 Commissioning manual	JPT12599 (English)
Altivar Machine ATV350 Operating instructions manual	JPT12597 (English)

More information

For certain tasks, information is available in other media.

Medium	Contents/topics
Altivar ATV350 Drives Manager	For commissioning. You can download here: ATV350-Drives-Manager . When you install Altivar ATV350 Drives Manager, the following software components are installed: - Altivar ATV350 Drives Manager. - Altivar ATV350 Firmware Loader. - Altivar ATV350 Application Loader. - Altivar ATV350 Package Manager (includes firmware and device description).
CAD data	Download in different formats from se.com
EPLAN macros	Project planning, documentation and management of projects for EPLAN P8.

NOTE:

Information and tools with regard to the Schneider Electric products are available at: www.se.com

Notations and conventions

Conventions are used in this document to distinguish between different types of information.

Numeric notation		
Decimal separator	Point	Generally shown as a decimal point. Example: 1 234.56
Warnings		
UL warnings	UL	Are used in English and French.
UR warnings	UR	
Text		
Altivar ATV350 Drives Manager	" "	Software Example: "ATV350 Drives Manager", "ATV350 Firmware Loader"
Icons		

(Continued)

Numeric notation		
Page reference	¶	Reference to another page with additional information. Example: ¶ 16 = see page 16
Documentation reference	,	Reference to other documentation with additional information. Example: , JPTxxx = see documentation JPTxxx

NOTE:

In this document, "ATV350" is used as a wildcard for the "Altivar Machine ATV350" product series.

Layout of the safety instructions

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



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



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

DANGER

Indicates an extremely hazardous situation. Failure to comply with this instruction will result in severe irreparable injury and even death.

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

WARNING

Indicates an extremely hazardous situation. Failure to comply with this instruction may result in severe irreparable injury and even death.

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

CAUTION

Indicates a hazardous situation. Failure to comply with this instruction may result in slight to medium injury.

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

NOTICE

Indicates a material hazard. Failure to comply with this instruction may result in material damage.

Failure to follow these instructions can result in equipment damage.

Please Note

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

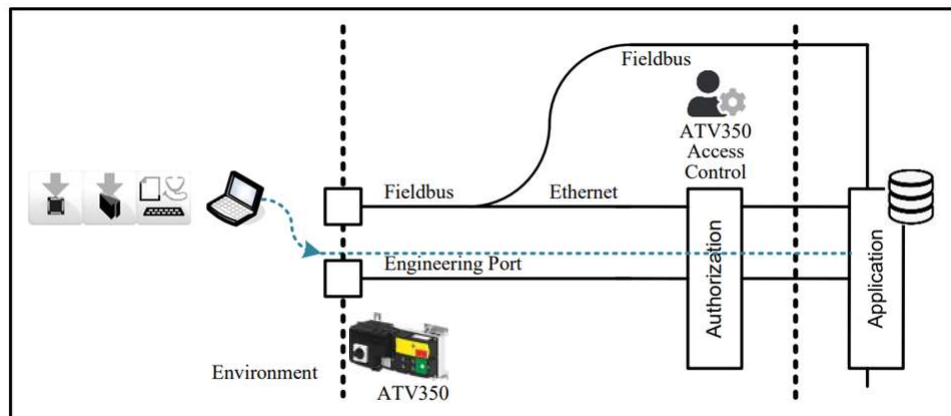
A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

Cybersecurity Generalities

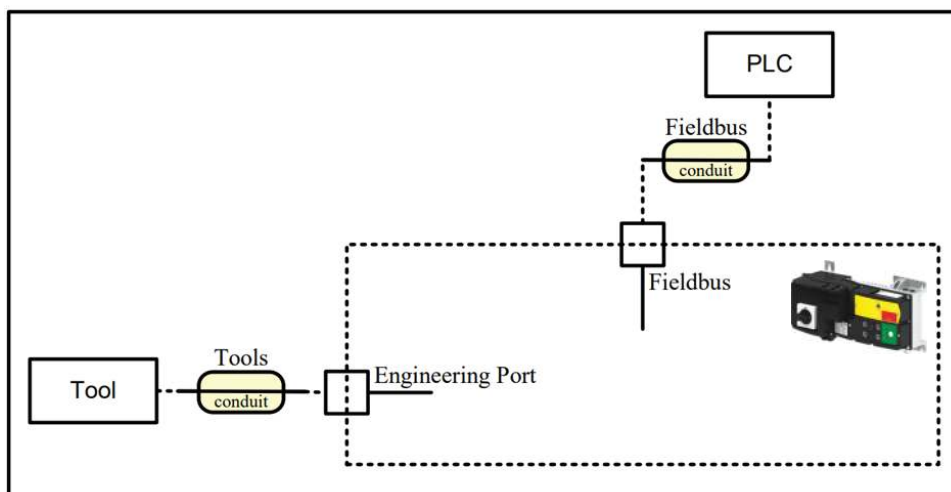
Security Mechanisms

Product Defense in Depth

The following image shows the Defense in Depth product concept. For the sake of clarity, some details have been deliberately omitted.



Expected Defense in Depth in the Environment



Conduit Tools:

- Access from Altivar ATV350 Drives Manager to the components must be limited in terms of organization and time.
- The corresponding Altivar ATV350 Drives Managers must be operated on an up-to-date and IT-security-secured computer.

Conduit Fieldbus:

- In most cases, the actual classic fieldbus protocol does not include any mechanisms to safeguard cyber security.
- Measures to safeguard confidentiality, integrity, and availability must be provided by the customer.

General Environment:

- General physical access protection must be provided for the components.
- Existing firmware updates for the ATV350 drives as well as for all other components in the network should be installed immediately.

Commissioning and hardening notes and organizational measures

General instructions

- The software must be installed on an up-to-date computer equipped with valid IT protection mechanisms.
- The software must be installed on a computer, which uses protection against unauthorized use.
- Use appropriate authentication mechanisms for the computer. This applies, for example, to passwords that have the necessary complexity and an appropriate life cycle. The current state of the art must be taken into account here.
- This computer is the responsibility of its owner and must be protected by valid IT protection systems such as firewall, IDS, IPS, etc.
- As far as possible, avoid connecting the ATV350 (and the upstream electronics required for operation) to open networks or the internet. We recommend organizational and technical actions for the ATV350 and the required upstream electronics.
- For protection, additionally use data link layers such as a VPN for remote access.
- Install Firewall mechanisms, IPS (Intrusion Prevention Systems) and IDS (Intrusion Detection Systems).
- Connect external devices upstream to provide protection against DoS (Denial of Service) or DDoS (Distributed Denial of Service).
- Restrict physical access to authorized personnel only.
- Change default passwords after the first startup. Continue to update them regularly. Please use only strong, high-complexity passwords.

Commissioning and hardening instructions

Activate "Default security" status (See section "Activate Access Control")

Periodic Security Maintenance

It is recommended to check the password policy periodically for updates and to adjust the requirements if necessary.

Decommissioning Instructions

- The device command 0x2022:052 "Secure Reset" must be executed (See section "Secure Reset Device"). This resets all application settings.
- It is recommended to update the firmware using the Altivar Firmware Loader.

Removal of product from environment

- This component, considered on its own, does not require any removal procedures from the environment.
- It is recommended to securely remove the login data for the controller to be removed, such as name and password for the necessary authentication, from all industrial communication partners.

Security Data

Account Management Guidelines

The Account Management Guidelines of the ATV350 drive are described below. The focus here is on User Management.

Default / Factory Settings

The Access Control of the ATV350 drive is deactivated and must be activated via the Altivar Drives Manager. If this is done, the following account is automatically created by default:

- Username: Administrator
- Password: Admin123

Policies

- The Runtime Password Policy is deactivated by default. It is recommended to activate it and adapt it to the current password strength restrictions. Current default settings after activation are:
 - Minimum length = 8
 - Requires at least 1 lowercase letter (a-z) = activated
 - Requires at least 1 uppercase letter (A-Z) = activated
 - Requires at least 1 digit (0-9) = activated
 - Must not contain username = activated
 - Special characters are allowed. List of special characters: (!"#\$%&'()*+,-./:;<=>?@[\\]^_`{|}~) and <space>
 - Special characters with accent marks such as ö, ü, ä é, è, ã, and so on are not allowed (warnings: Password does not match Password rules)

Security functions

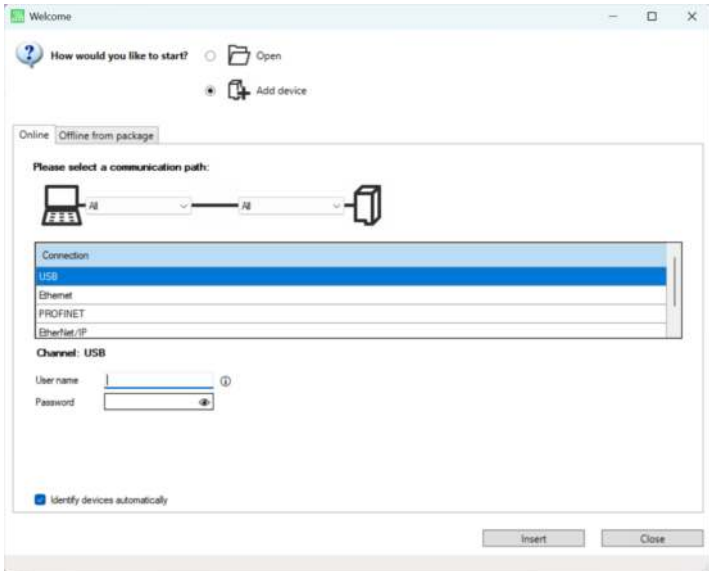
Security screen



Description	Detail explanation of the security screen
Preconditions	- ALTIVAR ATV350 Drives Manager is installed - Device must be supplied with at least 24V, a supply via USB alone is not sufficient
Details	1) Switch to the security tab 2) Current username*Only one user (Administrator -> not changeable) 3) Change password 10) Current security status 11) Change security status*Minimum security [1] (no user management): No login required, full access to anybodyDefault security [2] (active user management): Only one user (Administrator), login required, no access or full access 20) Secure reset Only via USB possible Power cycle needed at the device within a specified period of time
Limited functionalities (will be expanded in the next release)	

Access Control

Behavior in factory default status

Description	Add an online device to the device list using a communication path.
Preconditions	- ALTIVAR ATV350 Drives Manager is installed - Device must be supplied with at least 24V, a supply via USB alone is not sufficient - Connected device is supported by the tool
Use Case	 1. Connect the device with the PC via USB-C or Ethernet cable 2. Launch ALTIVAR ATV350 Drives Manager 3. Select symbol "Add devices" at the bottom left or press <i>Ctrl</i> + '+' 4. On the pop-up dialog, select the tab "Online" 5. Select a communication path: Connection type 6. Press the button "Insert": The connected device will be automatically identified and inserted
Results	The device is added to the "Online devices" as identified. All functions and interfaces can be operated; there are no restrictions.

Activate Access Control

Description	If the device is inserted into the ALTIVAR ATV350 Drives Manager in the "Minimum Security" state, the user can switch to the "Default security" state.
Preconditions	A supported device in "Minimum security" status is inserted successfully in the online devices folder of the ALTIVAR ATV350 Drives Manager

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Information

 **Authentication failed.**
The device rejected the specified user name and/or password.

Consequence:
Currently it is not possible to display parameters of this device.

Solution:
Renew authentication by using the refresh button under the device list.



Alternatively, the device can be reset to its delivery status.

This will cause all settings to be lost!
Only the device's firmware will remain unchanged by this command.
To reset the device, the power supply to the device must be switched off within 60 seconds of starting the function.

[Reset device to delivery status...](#)

 Missing authentication

NOTE: If you use the wrong username/password combination more than 4 times, access to the device is locked for 30 seconds.

Information

 **Authentication failure.**

Consequence:
Currently it is not possible to display parameters of this device.

 Missing authentication

Change password

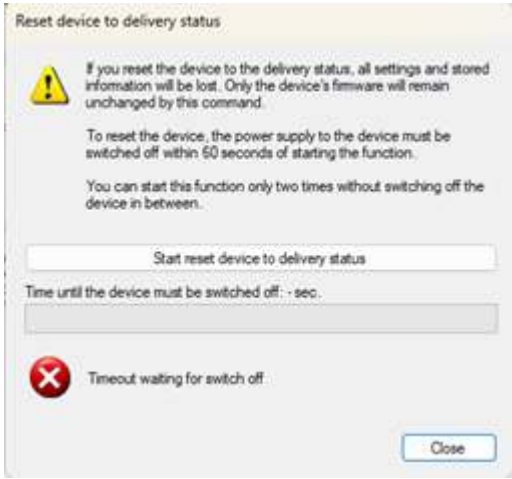
Description	If the device is inserted into the ALTIVAR ATV350 Drives Manager while in the "Default security" state, then you can change his password for the next login.
Preconditions	A supported device in "Default security" status is inserted successfully into the online devices folder of the ALTIVAR ATV350 Drives Manager

Use Case	 1. The user selects the device in folder online devices 2. The user selects the Security tab 3. The user clicks the button "Change password..." 4. A dialog "Change password" is displayed. 5. The dialog displays 2 password input fields and a hint for the password restrictions 6. The user enters the new password twice. 7. Only if the 2 passwords are identical and meet the requirements, the button "OK" is enabled 8. The user clicks "OK" 9. Restart the Drives Manager and wait 10 seconds to log in with the new password.
Results	If the device is removed from the device list, it can only be added with the new password.

Secure reset device

Description	You forget the password (default security status is active) or want to decommission the device. You can use the ALTIVAR ATV350 Drives Manager in conjunction with the device to reset the device to the default security settings.
Preconditions	• ALTIVAR ATV350 Drives Manager installed and started • Device supported by the tool available • Device has the security status "Default security" • (Username and password are active) • Communication connection via USB

Use Case	1. The device can be identified by the ALTIVAR ATV350 Drives Manager. 2. Authentication with username and password does not work on the device. 3. The device is added to the ALTIVAR ATV350 Drives Manager device list and is highlighted in grey. 4. If the device is selected in the device list, a tab appears with information text and the option to reset the security of the device. Reset device to delivery status  If you reset the device to the delivery status, all settings and stored information will be lost. Only the device's firmware will remain unchanged by this command. To reset the device, the power supply to the device must be switched off within 60 seconds of starting the function. You can start this function only two times without switching off the device in between. Start reset device to delivery status Time until the device must be switched off: 55 sec.  Close Reset device to delivery status  If you reset the device to the delivery status, all settings and stored information will be lost. Only the device's firmware will remain unchanged by this command. To reset the device, the power supply to the device must be switched off within 60 seconds of starting the function. You can start this function only two times without switching off the device in between. Start reset device to delivery status Time until the device must be switched off: - sec.  No access to set security status at device Close Resetting the device via Ethernet will result in this error. If the power supply is not switched off within 60 seconds, a timeout error will occur. The device only accepts two requests to trigger the security reset. After that the device must be power cycled. The device must be powered up again, to execute the next secure device reset.
----------	--

	
Results	The device is in factory default status. This means, that • The Device is in status minimum security • Access control is deactivated • Parameters are reset to factory default settings The user can re-insert the device into the ALTIVAR ATV350 Drives Manager without username and password.

Reconnect after interrupted connection

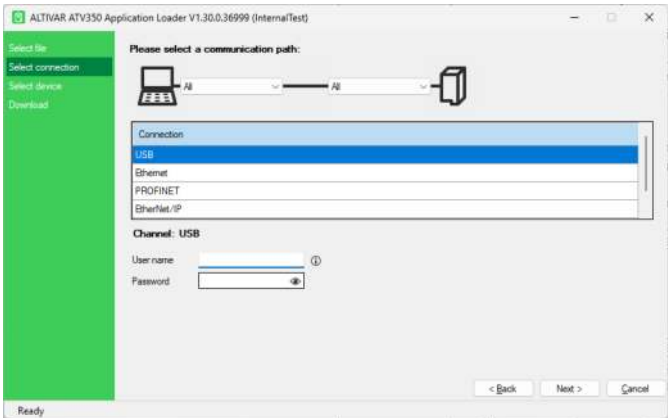
Description	Reconnect, if the connection is interrupted.
Preconditions	• ALTIVAR ATV350 Drives Manager installed and started • Device supported by the tool available • Device has the security status "Default security" (Username and password are active) • Communication connection via USB • Device must be supplied with at least 24V
Use Case	1. The device is identified, the login was successful, the device is added to the ALTIVAR ATV350 Drives Manager. 2. Disconnect the device (unplug the USB cable) 3. The device turns red in the device list and all parameters in the interfaces turn red. 4. Re-establish connection with USB cable 5. The device is now displayed in yellow in the device list, a few parameters can be retrieved from the device, most parameters cannot be retrieved from the device 6. The device must be removed from the device tree 7. The device must be added via the "Add devices" button at the bottom left or press <i>Ctrl</i> + '+' 8. Select a communication path 9. Click on the grey device in the device list, then log in
Results	The device turns yellow in the device list, and the device can be edited again.

Firmware Loader

Description	Firmware update with default security
Preconditions	• ALTIVAR ATV350 Drives Manager installed and started • Device supported by the tool available • Device has the security status "Default security" (Username and password are active) • Communication connection via USB • Device must be supplied with at least 24V •

Use case	- The device can be identified by the ALTIVAR ATV350 Drives Manager. - The user selects the Security tab - Select the "Reset device to delivery status" button - Follow the instructions - Start ALTIVAR Firmware Loader - Select the appropriate firmware - Select communication path - Select to Firmware loader overview screen - Start download
Result	The selected firmware will be installed and activated on the device

Application Loader

Description	Application restore with default security
Preconditions	- ALTIVAR ATV350 Drives Manager installed and started - Device supported by the tool available - Device has the security status "Default security" (Username and password are active) - Communication connection via USB - Device must be supplied with at least 24V
Use case	- Start ALTIVAR Application Loader - Select the appropriate *.gdc file (Parameter set) - Select communication path - Log in with your credentials (Username and Password) - Start file download  Start download
Result	The selected download will be taken out

Product information

Product description

The Altivar Machine ATV350 variable speed drive for wall mounting in protection class IP54/IP54/IP66 (UL Type 4X indoor) is the ideal decentralized drive solution. The drives integrates an extension box with disconnect switch (for all series) and local control elements (for the "I" and the "FS" series).

Fast mounting and easy commissioning thanks to user-friendly tools as well as plug and play connectors widely available on the market are the focus of these drives. Parameters, drive behavior and usability correspond to our proven variable speed drives. Rounded off by high energy efficiency, this provides a modern and sustainable drive solution.

The requirements of the Ecodesign Directive, standard EN IEC 61800-9-2, are met.

Application areas: material handling, conveying systems, packaging machines, and more.

Overview			
Power range	1 to 15 HP/0.75 to 11kW		
Mains connection	3 x 480V only	3 x 480V only	3 x 480V only
Degree of protection	IP54/IP66		
Communication	EtherCAT, EtherNet/IP, Modbus TCP, PROFINET		

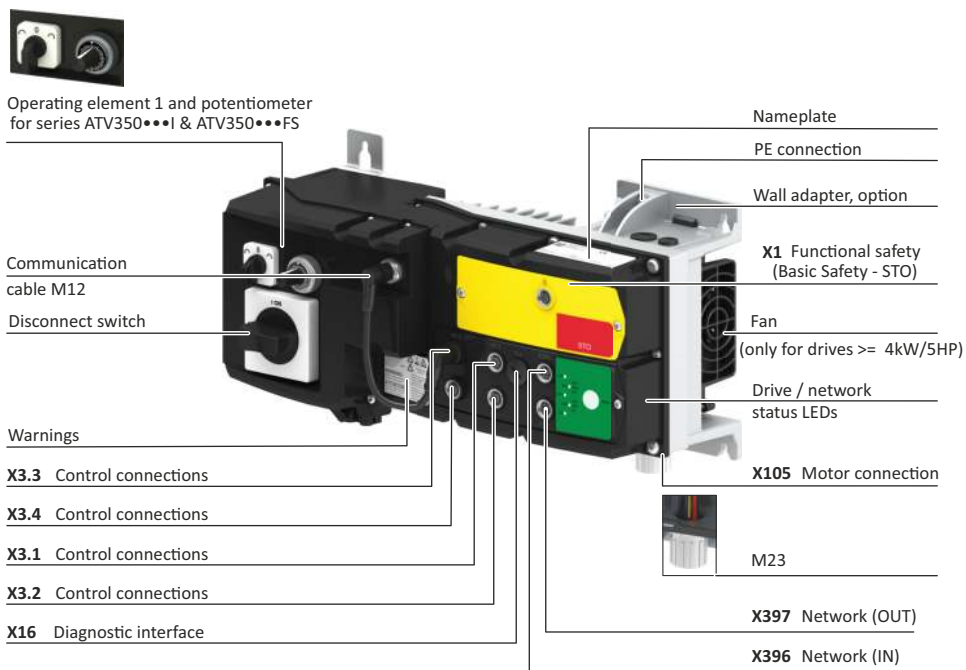
Highlights

- Compact solution for decentralized drive technology, wall-mounted, with high protection class IP54/IP66 (UL Type 4X indoor).
- Wall-mounted expandable: Extension box with disconnect switch, output for daisy chain connection, and operating elements.
- Fast mounting due to pluggable, standardized connections (plug & play).
- Four IO-Link® ports with limited master functionality for easy data exchange between IO-Link® sensors and actuators.
- Extended range of functions with the Altivar Machine ATV350:
 - "Safe Torque Off (STO)" over CIP Safety

Features

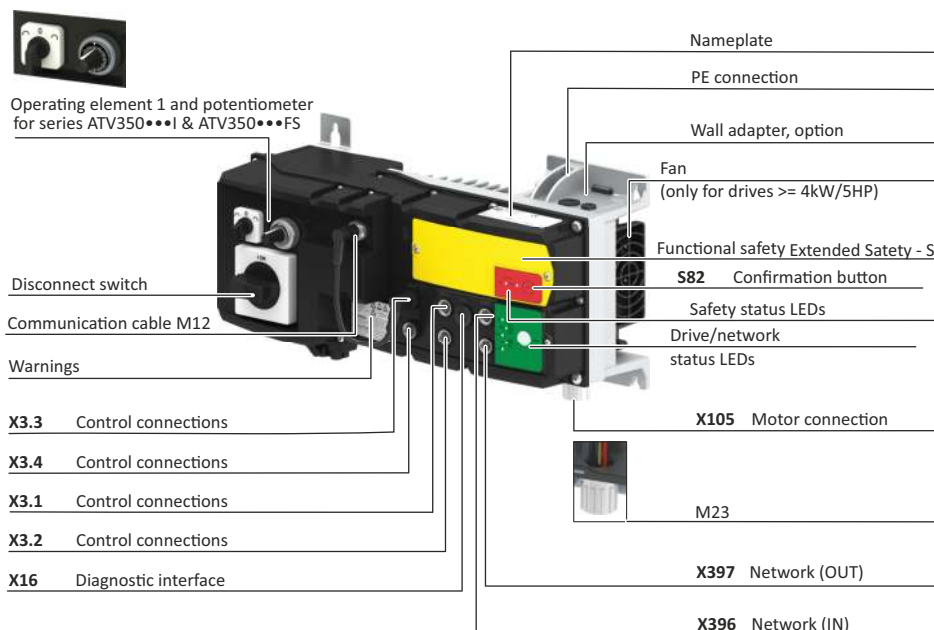
The following figures provide an overview of the elements and connections on the devices. Position, size and appearance of elements and connections may vary depending on the performance and size of the devices.

Example for Altivar Machine ATV350 with integrated safety technology and extension box with disconnect switch



Control element	Function
Disconnect switch	Mains voltage on/off
Operating element 1	Forward/Reverse/Stop
Operating element 2, lockable	Local control/network control
Potentiometer	Setpoint frequency

Example of Altivar Machine ATV350 with integrated safety function "Extended Safety – S"



Connections and interfaces

The Altivar Machine ATV350 variable speed drives have the following interfaces:

- External power supply DC 24 or 48 V (20.5 to 49.9 V) for control power daisy chain and use cases requiring more than 400mA for external sensors/actuators (an internal power supply unit with 400mA extra capacity is embedded by default in the drive).
- Motor PTC input
- Holding brake control
- Diagnostic interface (USB-C)
- Network interface (2 x M12 connector, D coded)
- Control connections
 - For the W series: 2 x M12 connector, A coded.
 - For the I and FS series: 4 x M12 connector, Hardwired Safety connections (W and I series) 1 x M12 connector, A coded.

Integrated safety function

For W and I series

- Stop functions:
 - Safe torque off (STO)
- Operation and diagnostics:
 - Safe input (M12 connector, A coded)

For the FS series:

- Stop functions:
 - Safe torque off (STO)
- Operation and diagnostics:
 - Safety bus (CIP Safety™)

Function assignment of the control terminals

By default, all control terminals are configured as digital inputs. Depending on the device version, different functions can be assigned to the M12 connectors X3.x.

ATV350...W series

X3.1	Function assignment			
Pin	default setting	Other possible settings		
1	24 V	24 V	24 V	
2	DI2	DI2	DI2	
3	GND	GND	GND	
4	DI1	DO1	Pulse train	

X3.2	Function assignment		
Pin	default setting	Other possible settings	
1	24 V	24 V	
2	DI4	Encoder (A)	
3	GND	GND	
4	DI3	Encoder (B)	

"DIx" function assignment:

- Normal digital inputs for control tasks.
- Logic level "HIGH-active" or "LOW-active", debounce time, and inversion can be programmed.

"DOx" function assignment:

- Normal digital outputs.
- Switch-on delay and switch-off delay can be programmed.

"Encoder" function assignment:

- For connecting a single-track or two-track HTL encoder (max. 200 kHz).
- A single-track HTL encoder (track A) cannot be used for motor speed feedback.
- A two-track HTL encoder (track A and B) must have a phase offset of exactly 90° between track A and B (error $\leq \pm 10^\circ$). inverse tracks are not required.
- Encoder increments: ≤ 16384 increments per revolution

"Pulse-Train" function assignment:

- For output of a reference frequency ("Pulse Train").
- Other drives can interpret this signal as a setpoint signal, for example.

ATV350...I and ATV350...FS series

X3.1	Function assignment				
Pin	default setting	Other possible settings			
1	24 V	24 V	24 V / L ₊	24 V	
2	DI2	DI2	DI2	DI2	
3	GND	GND	GND / L ₋	GND	
4	DI1	DO1	IO-Link® port 1	Pulse train	

X3.2	Function assignment							
Pin	default setting	Other possible settings						
1	24 V	24 V	24 V	24 V / L ₊	24 V	24 V	24 V / L ₊	24 V
2	DI4	Encoder (A)	DI4	DI4	Pulse-In	Pulse-In	Pulse-In	Pulse-In
3	GND	GND	GND	GND / L ₋	GND	GND	GND / L ₋	GND
4	DI3	Encoder (B)	DO2	IO-Link® port 2	DI3	DO2	IO-Link® port 2	Pulse-Direction

X3.3	Function assignment			
Pin	default setting	Other possible settings		
1	24 V	24 V	24 V / L ₊	
2	DI6	DI6	DI6	
3	GND	GND	GND / L ₋	
4	DI5	DO3	IO-Link® port 3	

X3.4	Function assignment			
Pin	default setting	Other possible settings		
1	24 V	24 V	24 V / L ₊	
2	DI8	DI8	DI8	
3	GND	GND	GND / L ₋	
4	DI7	DO4	IO-Link® port 4	

"DIx" function assignment:

- Normal digital inputs for control tasks.
- Assertion level "HIGH active" or "LOW active", debounce time and inversion are parameterizable.

"DOx" function assignment:

- Normal digital outputs.
- Switch-on delay and switch-off delay can be programmed.

"IO-Link® port x" function assignment:

- For communicating with sensors and actuators (IO-Link® devices) with port class A.
- The drive (IO-Link® master) supports IO-Link® version 1.1
- Further details: IO-Link®, page 90

"Pulse-Train" function assignment:

- For output of a reference frequency ("Pulse Train").
- Other drives can interpret this signal as a setpoint signal, for example.

"Pulse-In" function assignment:

- To evaluate the signal of a low-cost HTL encoder or a reference frequency ("Pulse-Train") and to accept it as a setpoint signal.
- The detection of a direction signal ("Pulse-Direction") is also supported.

"Encoder" function assignment:

- For connecting a single-track or two-track HTL encoder (max. 200 kHz).
- A single-track HTL encoder (track A) cannot be used for motor speed feedback.
- A two-track HTL encoder (track A and B) must have a phase offset of exactly 90° between track A and B (error $\leq \pm 10^\circ$). inverse tracks are not required.
- Encoder increments: ≤ 16384 increments per revolution

Further details on configuring the function assignment can be found in the commissioning document.

Status LEDs

You can quickly obtain information on some operating states via the large "DRIVE" LED status display on the drive. This status display is composed of a blue LED "RDY" and a red LED "ERR", which emit specific blinking patterns depending on the operating status:

"RDY" LED (blue)	"ERR" LED (red)	Status/meaning
off	off	No supply voltage
 on	 on	Initialization (drive is started)
 blinking (1 Hz)	off	Safe torque off (STO) active. The drive has been disabled by the integrated safety function. Safe torque off (STO)
	 blinking fast (4 Hz)	Safe torque off (STO) active, warning present. The drive has been disabled by the integrated safety function. Safe torque off (STO)
 blinking (2 Hz)	off	drive disabled
	 blinking fast (4 Hz)	drive disabled, warning present.
	 on	drive disabled, error active.
	 on briefly every 1.5 s	drive disabled, no DC-bus voltage.
 on	off	drive enabled. The motor rotates according to the specified setpoint or quick stop active.
	 blinking fast (4 Hz)	drive enabled, warning present. The motor rotates according to the specified setpoint or quick stop active.
	 blinking (1 Hz)	drive enabled, quick stop as response to error active.
 Both LEDs are blinking in a rapidly alternating mode		Firmware update is active
 Both LEDs are blinking in a very rapidly synchronous mode		"Visual tracking" function is active

For the meaning of the status LEDs for the network, see the commissioning document.

For the meaning of the status LEDs for safety see [Status LEDs](#).

Topologies / network

The drives can be equipped with different fieldbus networks.

The topologies and protocols typical for the prevailing networks are supported.

Currently available networks:

	The Modbus protocol is an open communication protocol based on a client/server architecture and developed for the communication with programmable logic controllers. Further development is carried out by the international user organization Modbus Organization, USA.
	EtherCAT® (Ethernet for Controller and Automation Technology) is an Ethernet-based fieldbus system meeting the application profile for industrial real-time systems. EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany. Device descriptions for download: XML/ESI files for Schneider Electric devices
	EtherNet/IP™ (EtherNet Industrial Protocol) is an Ethernet-based fieldbus system that uses Common Industrial Protocol™ (CIP™) to exchange data. EtherNet/IP™ and Common Industrial Protocol™ (CIP™) are trademarks and patented technologies, licensed by the user organization ODVA (Open DeviceNet Vendor Association), Inc., USA. Device descriptions for download: EDS files for Schneider Electric devices
	PROFINET® (Process Field Network) is a real-time capable fieldbus system based on Ethernet. PROFINET® is a registered trademark and patented technology licensed by the PROFIBUS & PROFINET International (PI) user organization. Device descriptions for download: GSDML files for Schneider Electric devices

To provide the user with the expected functionality of one of these systems, the drive is preset with EtherNet/IP per factory setting, any other protocol can be selected by modifying the parameter on adress 0x231-F:005 with the ATV350 Drives Manager software.

The drive itself has the firmware for all available networks on board and the user has the possibility to switch the drive to another network.

Functions

Overview

The functions of the variable speed drives Altivar Machine ATV350 are adapted to extensive applications.

Functions	
Motor control	Monitoring
V/f characteristic control linear/square-law (VFC plus)	Short circuit
V/f characteristic control (VFC closed loop)	Ground error
Energy-saving function (VFC-Eco)	Device overload (ixt)
Sensorless vector control (SLVC)	Motor overload (i²xt)
Sensorless control for synchronous motors (SL-PSM/SLSM-PSM)	Mains phase failure

(Continued)

Functions	
	Stalling protection
Servo control for asynchronous motors (SC-ASM)	Motor current limit
Motor functions	Maximum torque
Flying restart circuit	Ultimate motor current
Slip compensation	Motor speed
DC braking	Load loss detection
Oscillation damping	Motor temperature
Skip frequencies	Diagnostics
Automatic identification of the motor data	Error history buffer
Brake energy management	Logbook
Holding brake control	LED status displays
"Voltage add" function	Network
Rational Energy Ride Through (RERT)	EtherCAT
Speed feedback (HTL encoder)	EtherNet/IP
Frequency setpoint	Modbus TCP
Application functions	PROFINET
Process controller	Safety functions
Access protection	See section "Connections and interfaces, page 28".
Process controller sleep mode and rinse function	
Freely assignable favorite menu	
Parameter change-over	
S-shaped ramps for smooth acceleration	
Motor potentiometer	
Flexible I/O configuration	
Automatic restart	
OEM parameter set	
Frequency output via digital output DO1	

Motor functions

Motor setting range

Rated point 87 Hz

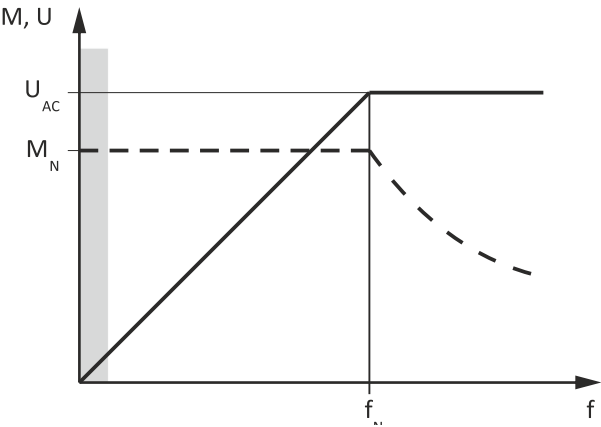
The rated motor torque is available up to 87 Hz.

Compared to the 60-Hz operation, the setting range increases by 1.45 times.

For this purpose, a motor with 230/400 V in a triangle is driven by a 400 V drive.

The drive must be dimensioned for a rated motor current of 230 V.

V/f at 87 Hz

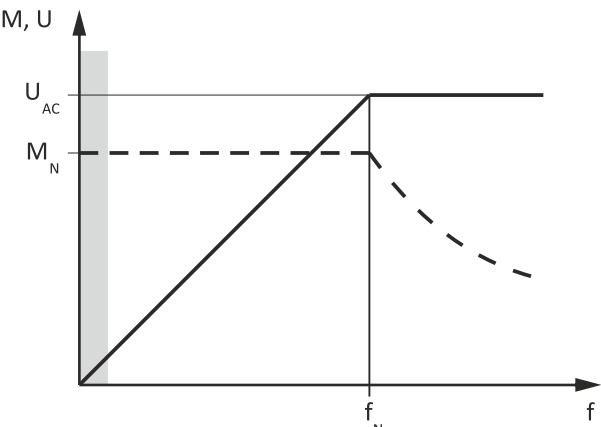


V	Voltage	U _{AC}	Mains voltage
M	Torque	M _{rated}	Rated torque
f	Frequency	f _{rated}	Rated frequency

Rated point 50 Hz

The rated motor torque is available up to 50 Hz.

V/f at 50 Hz



V	Voltage	U _{AC}	Mains voltage
M	Torque	M _{rated}	Rated torque
f	Frequency	f _{rated}	Rated frequency

Identification of the products

Product name and type code structure

		ATV	350	D	11	N4	..
Product Range							
ATV	Altivar						
Product Type							
350	Decentralized product						
Power factor							
U	power (in kW) x 0.1						
D	power (in kW) x1						
Nominal Power							
07 – 15 – 22 – 40 – 55 – 75 – 11							
Power block							
N4	3 phase 400..480Vac						
Suffix							
W	IP 66, standard interfaces						
I	IP54, Interface expansion : 8 DI/O, IO-Link® ports, pulse train in/out, pulse direction, local control						
FS	IP54, Fieldbus safety (safety function via fieldbus)						
HS	Hardwired safety						

Information on EC-Dual-Use Regulation

NOTE:

By limiting the maximum output frequency to ± 599 Hz, the devices are not subject to the export restrictions of the EU Dual-Use Regulation 2021/821.

Commissioning

The drive can be commissioned quickly and easily via the "ATV350 Drives Manager" PC software.

Thanks to Schneider Electric's engineering philosophy, the high functionality is still easy to grasp. Parameterization and commissioning are impressive thanks to clear structure and simple dialogs, leading to the desired outcome quickly and reliably.

**NOTE:**

Connect your engineering PC on which the software is installed to the diagnostic interface. This requires a USB cable with a USB-C plug.

Information on project planning

Project planning process

Dimensioning

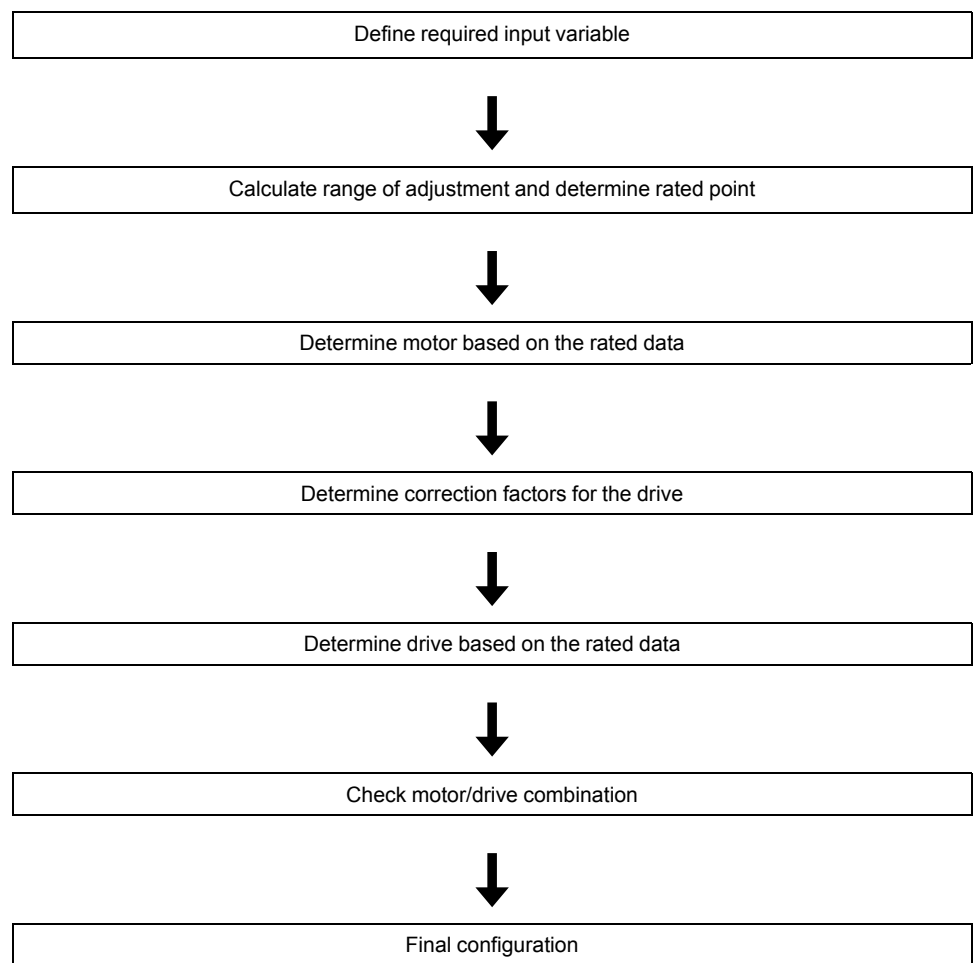
3 methods for dimensioning

Fast: Selection of the drive based on the motor data of a 4-pole asynchronous motor.

Detailed: In order to optimize the selection of the drive and all drive components, it is worthwhile to execute the detailed system dimensioning based on the physical requirements of the application.

Manual: The following section guides you step by step through the selection of a drive system.

Workflow of a configuration process



Define required input variables

Operating mode			S1 or S6
Max. load torque	$M_{L,max}$	Nm	
Max. load speed	$n_{L,max}$	rpm	
Min. load speed	$n_{L,min}$	rpm	
Site altitude	H	m	
Ambient temperature (drive)	T_U	°C	

Calculate range of adjustment and determine rated point

	Calculation
Setting range	$V = \frac{n_{L,max}}{n_{L,min}}$

	Setting range	Rated point
Motor with integral fan	≤ 2.50 (20 – 60 Hz)	50 Hz
	≤ 4.35 (20 – 87Hz)	87 Hz
	≤ 6 (20 – 120Hz)	120 Hz
Motor with blower	≤ 10.0 (5 – 60 Hz)	50 Hz
Motor with integral fan (reduced torque)	≤ 17.4 (5 – 87Hz)	87 Hz
	≤ 24 (5 – 120Hz)	120 Hz

Determine motor based on the rated data

			Check
Rated torque			
Operating mode S1	M_{rated}	Nm	$M_N \geq \frac{M_{L,max}}{T_{H,Mot} \times T_{U,Mot}}$
Operating mode S6	M_{rated}	Nm	$M_N \geq \frac{M_{L,max}}{2 \times T_{H,Mot} \times T_{U,Mot}}$
Rated speed	n_{rated}	rpm	$n_{rated} \geq n_{L,max}$ $\frac{n_n}{V} \leq n_{L,min}$

			Note
Rated torque	M_{rated}	Nm	→ Rated motor data
Rated speed	n_{rated}	rpm	

(Continued)

			Note
Rated point at		Hz	→ Setting range
Power factor	$\cos \phi$		→ Rated motor data
Rated current	$I_{N,MOT}$	A	
Rated power	P_{rated}	kW	
Correction factor – site altitude	$T_{H,MOT}$		→ Technical motor data
Correction factor – ambient temperature	$T_{U,MOT}$		
Select motor			

NOTE:

Keep in mind when sizing the motor: The maximum possible output voltage of the drive is approx. 87% of the mains voltage.

Correction factors for the drive

Site altitude AMSL	H				
	[m]	≤ 1000	≤ 2000	≤ 3000	≤ 4000
$k_{H,INV}$		1.00	0.95	0.90	0.85

Temperature in the control cabinet	T_U				
	[°C]	≤ 40	≤ 45	≤ 50	≤ 60
Switching frequency					
8, 12 or 16 kHz	$k_{TU,INV}$	1.00	0.875	0.750	0.50

Determine the drive based on the rated data

			Check
Output current			
Continuous operation	I_{out}	A	$I_{out} \geq I_{N,Mot} / (k_{H,INV} \times k_{TU,INV})$
Overcurrent operation cycle 15 s	I_{out}	A	$I_{out} \geq I_{N,Mot} \times 2 / (k_{H,INV} \times k_{TU,INV})$
Overcurrent operation cycle 180 s	I_{out}	A	$I_{out} \geq I_{N,Mot} \times 1.5 / (k_{H,INV} \times k_{TU,INV})$

Check motor/drive combination

			Calculation
Motor torque	M	Nm	$M = \sqrt{\left(\frac{I_{out,INV}}{I_{N,MOT}} \right)^2 - (1 - \cos^2 \phi)} \times \frac{M_N}{\cos \phi}$

	Check
drive overload capacity	$\frac{M_{L,max}}{M} \leq 1.5$

Operation in motor and generator mode

The energy analysis differs between operation in motor mode and generator mode.

During operation in motor mode, the energy flows from the supplying mains via the drive to the motor which converts electrical energy into mechanical energy (e. g. for lifting a load).

During operation in generator mode, the energy flows back from the motor to the drive. The motor converts the mechanical energy into electrical energy - it acts as a generator (e.g., when lowering a load). The drive brakes the load in a controlled manner. The excess energy is fed back into the mains.

Integrated regenerative module

The drive has an intelligent, integrated regenerative module that enables braking energy to be fed back into the mains. This function is always active and does not need to be programmed.

The regenerative module integrated into the drive offers important advantages:

- Braking energy can be used despite decentralized topology.
- Dimensioning and installation of a brake resistor is not required.
- Rated power specifications, including overload behavior, also apply to regenerative mode, with a few exceptions (see table below). The possible braking power can be increased without additional costs (compared to using a brake resistor). This enables:
 - Larger, regenerative power peaks
 - Shortening braking processes
 - Shorter consecutive braking processes
- The device structure is such that the system perturbations (harmonic currents) during motor and generator operation is below that of conventional industrial drives and the increased requirements for operation on public networks are met. See also section "Technical data" on "Operation on public networks". [EMC data, page 64](#)

In principle, the drive can be operated on all standard industrial and public networks. The occasional energy recovery into the mains in generator operation is also permitted in principle.

There are a few exceptions in which an individual assessment must be made and tests carried out if necessary:

- The mains has an Rsce value < 250. See also section "Technical data" on "Operation on public networks". [EMC data, page 64](#)
- The drive is operated on a mains transformer or generator with low rated power.
- The drive is operated on a three-phase UPS system.
 - The UPS system must generate a sinusoidal voltage.
 - The regenerative energy must be consumed in the UPS network.

NOTE:

- In motor operation, the usual short phase interruptions are not a problem. In regenerative operation, even short phase interruptions lead to a error state of the drive. This causes the motor to freewheel.
- A single-phase feed-in is not possible.

Overcurrent operation

The drives can operate at higher amperages beyond the rated current if the duration of overcurrent operation is time-limited.

Two utilization cycles of 15 s and 180 s are defined. Within these utilization cycles, an overcurrent is possible for a certain time if afterwards an accordingly long recovery phase takes place.

Cycle 15 s

During this operation, the drive may be loaded for 3 s with up to 200% of the rated current if afterwards a recovery time of 12 s with max. 75% of the rated current is observed. A cycle corresponds to 15 s.

Cycle 180 s

In this cycle, the drive may be loaded for 3 s with up to 200% of the rated current, followed by a 12 s recovery period at a maximum of 75% of the rated current.. One cycle corresponds to 180 s.

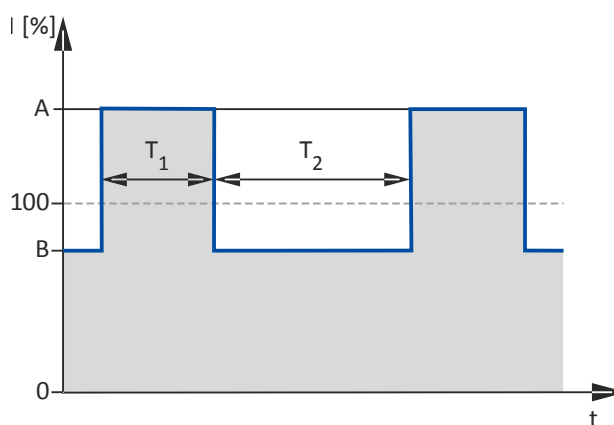
The monitoring of the device utilization (Ixt) triggers an error if the utilization value exceeds a threshold of 100 %.

NOTE:

The maximum output currents correspond to the switching frequencies and the overload behavior of the drives are given in the rated data.

At rotating frequencies < 10 Hz, the time-related overload behavior may be reduced.

The graphics shows a cycle. The basic conditions given in the table (graphics field highlighted in grey) have to be complied with in order that the drive will not be overloaded. Both cycles can be combined with each other.



Cycle	Max. output current	Max. overload time	Max. output current during the Recovery time	Min. recovery time
	A	T ₁	B	T ₂
s	%	s	%	s
15	200	3	75	12
180	150	60	75	120

Decentralized topologies

The variable speed drives ATV350 Altivar Machine support decentralized concepts for machines and electrical installation in particular.

Advantages

- Saves installation costs
 - Less expensive shielded motor cables, no EMC collective filters
 - Fewer circuit breakers, protection devices and mains cables
 - Fewer I/O gateways and cabling thanks to decentralized I/Os
 - Smaller control cabinet
- New solutions when less space is available
- Combination of functionally independent machine modules
- Less cooling units, higher efficiency

Cables

Requirements

- The cables used must correspond to the requirements at the location (e. g. EN 60204-1, UL).
- The cable cross-section must be dimensioned for the assigned fusing. Observe national and regional regulations.
- You must observe the regulations for minimum cross-sections of GND conductors. The cross-section of the GND conductor must be at least as large as the cross-section of the power connections.

Mechanical installation

Important notes

⚠ CAUTION

SHARP EDGES OR RESIDUAL BURRS

Wear suitable protective gloves against mechanical risks during mounting (PPE category II in accordance with EN 388).

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

Measures for cooling during operation

- Ensure unimpeded ventilation of cooling air and outlet of exhaust air.

Preparation

Clearance

- Maintain the specified Clearance to the other installations.

Mechanical fastening

- The mounting location and material must ensure a durable mechanical connection.
- Do not mount onto DIN rails!
- At continuous vibrations or shocks, use vibration dampers.

Mounting

Wall mounting

drives		Data for mounting the drive to M25/M40 wall adapter		
Mains connection	Rated power	Tool	Screws	Tightening torque
3/PE AC 400/480 V	1..7.5HP/ 0.75..5.5kW	Torx key 25	4x M5	2.5 Nm
	10..15HP/ 7.5..11kW	Torx key 30	4x M6	8 Nm

How to mount the drive with wall adapter on a mounting surface:

Required:

- Tool for drilling and thread cutting
- Screwdriver
- Screw and washer assemblies or hexagon socket screws with washers.

Steps:

1. Prepare mounting area with corresponding threaded holes.
2. Fit screws and washers (if applicable).

3. Do not yet tighten the screws.
4. Mount the drive on the prepared mounting area via keyhole suspension.
5. Only tighten the screws hand-tight.
6. Pre-assemble other devices if necessary.
 - a. Adjust the devices.
 - b. Screw the devices according to the specified tightening torque onto the mounting area.

Result: The drives are mounted on the mounting area. You can start wiring.

NOTE:

Note on floor mounting a drive without fan:

If the drive with wall adapter is mounted upright on the floor (i.e, the control connections are at the top), the rated output values must be reduced by approx. 15%. Your Schneider Electric contact will help you with a precise assessment.

Electrical installation

Important notes

DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Check that no voltage is present!
- After switching off the mains voltage, observe the warning signs on the product.
- After switching off, wait until the drive comes to a complete standstill before proceeding.
- Implement the measures required by EN 61800-5-1 or EN 60204-1, such as fixed installation and a standard-compliant GND connection.

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

DANGER

ELECTRIC SHOCK CAUSED BY INCORRECT POWER SUPPLY UNIT

For auxiliary power supply with DC 20.5 ... 49.9 V, only use a safely isolated power supply in accordance with the applicable SELV/PELV requirements.

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

The mains input is not fused internally.

NOTICE

NO PROTECTION AGAINST EXCESSIVELY HIGH MAINS VOLTAGE

Take note of the maximum permissible mains voltage.

On the mains supply side, use fuses to adequately protect the product against mains fluctuations and voltage peaks.

Failure to follow these instructions can result in equipment damage.

NOTICE

THE PRODUCT CONTAINS ELECTROSTATICALLY SENSITIVE DEVICES.

Before working in the connection area, the personnel must be free of electrostatic charge.

Failure to follow these instructions can result in equipment damage

NOTICE

HAZARD OF MOISTURE AND FOREIGN BODY PENETRATION

- All cable glands and mounting parts must at least correspond to the protection class of the drive.
- All openings in the housing must be sealed according to the protection class.
- Device screws must be tightened to the specified tightening torque.
- Reinstall protective caps on unused connectors.

Failure to follow these instructions can result in equipment damage.

NOTE:

When implementing machines and systems for the use in the UL/CSA scope, observe the relevant special notes.

These notes are marked with "UL marking".

Automatic disconnection of the supply according to IEC/HD 60364-4-41

IEC/HD 60364-4-41 (DIN VDE 0100-410; VDE 0100-410) requires error protection for the output circuits.

Preconditions

Installation in TN network and TT network

- The drives are installed according to the specifications in the documentation.
- The system complies with the requirements of the applicable standards of the series IEC/HD 60364 (DIN VDE 0100; VDE 0100).
- The continuity of all associated GND conductors and equipotential bonding conductors, including bonding and connection points, must be ensured..
- Additional measures in the TT network:
 - Use of ground-leakage circuit breakers or the additional grounding according to IEC 60361-4-41, section 415.

Under these conditions, the drives meet the protective measure "automatic disconnection of the supply" according to IEC/HD 60364-4-41 (DIN VDE 0100-410; VDE 0100-410):2007-06, section 411.3.2.5.

This means that in the event of a short circuit with negligible impedance to a protective conductor or to ground, the drives reduce the output voltage within the time required in table 41.1 of IEC/HD 60364-4-41 (DIN VDE 0100-410; VDE 0100-410):2007-06.

Preparation

Further data and information

EMC-compliant installation, page 47

Standards and operating conditions, page 63

EMC-compliant installation

The drive system only complies with the directive 2014/30/EU: EMC Directive [UKCA: S.I. 2016/1091 – The Electromagnetic Compatibility Regulations 2016] if it is installed according to the guidelines for CE-typical drive systems.

These guidelines should also be followed in installations requiring FCC Part 15 or ICES 001 compliance.

⚠ WARNING**UNANTICIPATED EQUIPMENT OPERATION DUE TO ELECTROMAGNETIC INTERFERENCES**

Use integrated conductive shield connections for control lines and motor lines.

Use central grounding points.

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

Mains connection

Drives may only be connected to the mains via unshielded single cores or unshielded cables.

Connection according to UL

Important notes

⚠ WARNING**UL marking**

The integral solid state short circuit protection included in the drive does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code / Canadian Electrical Code and any additional local codes.

Marquage UL

La protection statique intégrée contre les courts-circuits n'offre pas la même protection que le dispositif de protection du circuit de dérivation. Un tel dispositif doit être fourni, conformément au National Electrical Code / Canadian Electrical Code et aux autres dispositions applicables au niveau local.

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

⚠ WARNING**UL marking**

Use 75 °C copper wire only, except for control circuits.

Marquage UL

Utiliser exclusivement des conducteurs en cuivre 75 °C, sauf pour la partie commande.

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

⚠ WARNING**UL marking**

Suitable for motor group installation or use on a circuit capable of delivering not more than the RMS symmetrical amperes (SCCR) of the drive at its rated voltage.

Approved fusing is specified in SCCR tables below.

Marquage UL

Convient pour l'utilisation sur une installation avec un groupe de moteurs ou sur un circuit capable de fournir au maximum une valeur de courant efficace symétrique en ampères à la tension assignée de l'appareil.

Les dispositifs de protection adaptés sont spécifiés dans les SCCR tableaux suivants.

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

⚠ WARNING**UL marking**

The opening of the Branch Circuit Protective Device may be an indication that a error has been interrupted. To reduce the risk of fire or electric shock, current carrying parts and other components of the controller should be examined and replaced if damaged. If burnout of the current element of an overload relay occurs, the complete overload relay must be replaced.

Marquage UL

Le déclenchement du dispositif de protection du circuit de dérivation peut être dû à une coupure qui résulte d'un courant de défaut. Pour limiter le risque d'incendie ou de choc électrique, examiner les pièces porteuses de courant et les autres éléments du contrôleur et les remplacer s'ils sont endommagés. En cas de grillage de l'élément traversé par le courant dans un relais de surcharge, le relais tout entier doit être remplacé.

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

NOTICE**UL marking**

Internal overload protection rated for 125% of the rated FLA.

Marquage UL

Protection contre les surcharges conçue pour se déclencher à 125% de l'intensité assignée à pleine charge.

Failure to follow these instructions can result in equipment damage.

Fusing data

Branch Circuit Protection (BCP) with Standard Fuses or Circuit Breaker

Short Circuit Current Ratings (SCCR) with Standard Fuses or Circuit Breaker

(Tested per UL61800-5-1, reference UL file E116875)

These devices are suitable for motor group installation when used with Standard Fuses or Circuit Breaker. For single motor installation, if the fuse value indicated is higher than 400 % of the motor current (FLA), the fuse value must be calculated. If the value of the fuse is below two standard ratings, the nearest standard ratings less than the calculated value shall apply.

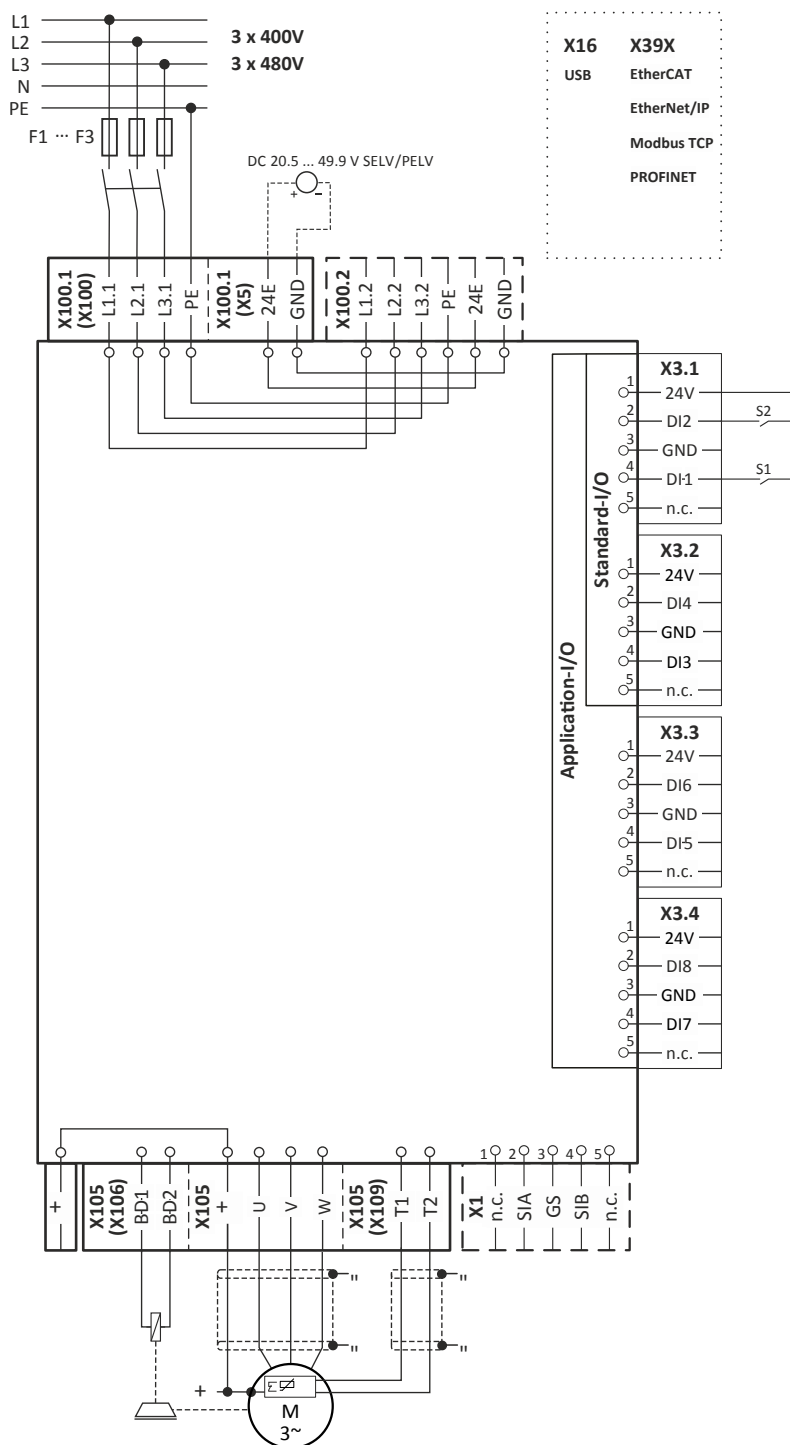
drive				Standard fuses (UL248)			Circuit breaker (UL489)	
	Mains	Rated power		SC-CR	Max. rated current	Class	SCCR	Max. rated current
		kW	hp	kA	A		kA	A
ATV350U07N4••	480 V, 3-ph	0.75	1	5	30	CC, CF, J, T	5	30
ATV350U15N4••	480 V, 3-ph	1.5	2	5	30	CC, CF, J, T	5	30
ATV350U22N4••	480 V, 3-ph	2.2	3	5	30	CC, CF, J, T	5	30
ATV350U40N4••	480 V, 3-ph	4	5	5	30	CC, CF, J, T	5	30
ATV350U55N4••	480 V, 3-ph	5.5	7.5	5	30	CC, CF, J, T	5	30
ATV350U75N4••	480 V, 3-ph	7.5	10	5	30	CC, CF, J, T	5	30
ATV350D11N4••	480 V, 3-ph	11	15	5	30	CC, CF, J, T	5	30

Wiring diagram

Unintended equipment behavior may occur if connector wiring is incorrect or physically inverted. This can lead to operational hazards and safety risks.

 WARNING
UNANTICIPATED EQUIPMENT OPERATION - During the initial installation phase, ensure physical identification and labeling of all connectors X3.x. - After initial wiring and any maintenance operation, perform a full commissioning test to verify correct wiring and connector orientation. Failure to follow these instructions can result in death, serious injury, or equipment damage.

The drives are connected directly to the AC mains. RFI filters are already integrated into all drives.



For the mains connection, the drive is equipped with Han-Q4/2 connectors.

Connection data

See section "Technical data":

- 3-phase mains connection 400 V Connection data, page 69
- 3-phase mains connection 480 V Connection data, page 74

For more information, refer to ATV350 Catalog, page 12.

Mains cables

Mains cables with Han-Q4/2 connectors are available for the drive as 4-pole cables (mains connection) or 6-pin cables (mains connection and 24 V supply) in the following versions:

- Connecting cable for mains/drive connection
- Extension for the drive/drive connection

Mains installation with several devices

Several drives in close proximity can be connected to the mains using the integrated Han-Q4/2 connectors. The mains cables are looped through from one drive to the next via the Han-Q4/2 connector.

Motor connection

Only use motors suitable for the drive operation.

Insulation resistance (EN 60034): max. $\hat{u} \geq 1.5 \text{ kV}$, max. $du/dt \geq 5 \text{ kV}/\mu\text{s}$

For the motor connection, the drive is equipped with M23 connector.

Connection data

See section "Technical data":

- 3-phase mains connection 400 V [Connection data, page 69](#)
- 3-phase mains connection 480 V [Connection data, page 74](#)

Motor cables

Pre-assembled motor cables in various designs are available for the drive.

Switching in the motor cable

Some applications require switching on the motor side of the drive. Switching on the motor side of the drive is permitted if the following basic conditions are met.

Preconditions:

- The switching elements on the motor side must be dimensioned for with the maximum occurring loads.
- Connect the shield of the motor cable to the mounting plate immediately before and after the switching element in an EMC-compliant manner.

Possible applications:

- Galvanic isolation of the motor from the drive
 - A controller must ensure that the switching element in the motor cable does not switch until the drive is inhibited.

- Operation of several motors on one drive in V/f characteristic control mode
 - Monitoring functions of the drive for motor protection (e.g., i^2xt) cannot be used.
 - Ensure temperature monitoring of all motors by external measures.
 - Disable the drive when overload protection and cable protection in the individual motor cables respond. Do not disconnect the motor circuit.

Please note the following:

- If switching is performed on the motor side when the drive is enabled, error messages can be triggered.
- It is not possible to predict whether an error message will be triggered or not. This can only be determined by testing under real operating conditions.
- Possible error messages:
 - Overcurrent
 - Motor phase failure

Connection of motor temperature monitoring

The drive offers extensive protection against overload through the use of an overcurrent relay or temperature monitoring. We recommend using a PTC thermistor or thermal contact to monitor the temperature of the motor. We also recommend using the "Motor overload monitoring (i^2xt)" function to monitor the motor.

NOTE:

In the Schneider Electric setting, the motor temperature monitoring is activated!

NOTE:

If the terminals T1 and T2 are used, e.g., to connect an external PTC thermistor or a thermal contact, ensure at least one basic insulation to the potentials of motor, mains, and M12 connectors as well as to the auxiliary power supply to not restrict the safe isolation of the M12 connectors.

Connection	Connections T1 and T2
Use	Connection of PTC or thermal contact
Sensor types	PTC single sensor (DIN 44081)
	PTC triple sensor (DIN 44082)
	Thermal contact
	Note: The PT1000 temperature sensor is not supported.

Depending on the version, the connections T1 and T2 are located at connector X105 or at terminal X105/X109.

Connection data

See section "Technical data":

- 3-phase mains connection 400 V [Connection data, page 69](#)
- 3-phase mains connection 480 V [Connection data, page 74](#)

Connecting the motor holding brake connection

An electromagnetically released spring-applied brake can be connected to the drive at terminals BD1 and BD2 as a motor holding brake.

- The voltage for controlling the motor holding brake is generated in the drive independently of the height of the mains voltage.
- Safe release of the motor holding brake is ensured by applying 133% of the nominal coil voltage to the coil for 0.5 s. The coil is then released. This is then reduced to 66% of the nominal coil voltage.

Motor holding brakes with the following technical data can be connected to the drive:

drive		Motor holding brake	
Mains connection	Rated power	Rated coil voltage	Max. rated power
3/PE AC 400/480 V	0.37 ... 45 kW	180 V DC	80 W
		205 V DC	
		215 V DC	

Depending on the version, the connections BD1 and BD2 are located at connector X105 or at terminal X105/X106.

When the motor adapter is used, the connection is made via an M12 cable gland.

Connection data

See section "Technical data":

- 3-phase mains connection 400 V [Connection data, page 69](#)
- 3-phase mains connection 480 V [Connection data, page 74](#)

Supply voltage connection

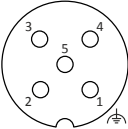
The connections 24E and GND are used for the mains-independent DC supply of the control electronics (including communication). The connections 24E and GND are located on the mains connection X100.1/X100.2 or on terminal X5, depending on the version.

Control connections

The control connections of the drive are designed as configurable connectors. By default, all control connections are configured as digital inputs.

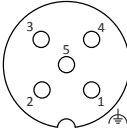
Details on configuring the function assignment can be found in the commissioning document.

For the W series

Connection designation	X3.1						X3.2					
Pin	1	2	3	4	5	Functional ground	1	2	3	4	5	Functional ground
Pin name	24V	DI2	GND	DI1	n.c.	Functional ground	24V	DI4	GND	DI3	n.c.	Functional ground
M12 (A coded)												
												

For the I and FS series

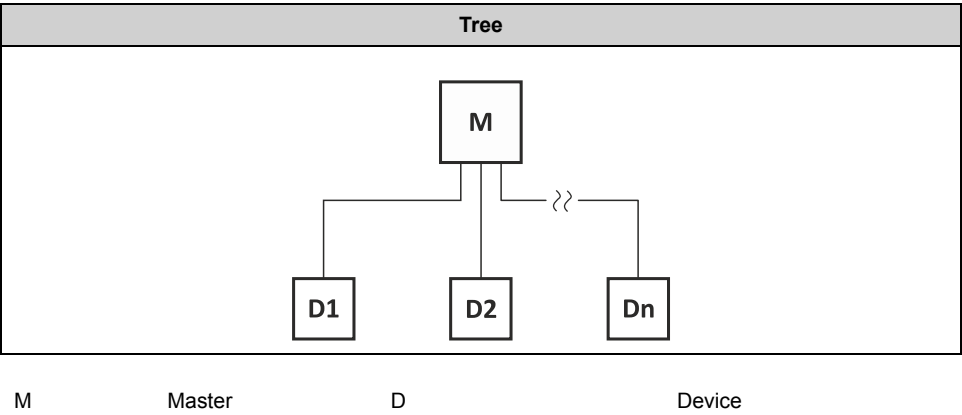
Connection designation	X3.1						X3.2					
Pin	1	2	3	4	5	Functional ground	1	2	3	4	5	Functional ground
Pin name	24-V	DI2	G-ND	DI1	n.c.	Functional ground	24-V	DI4	G-ND	DI3	n.c.	Functional ground

Connection designation	X3.3						X3.4					
Pin	1	2	3	4	5	Functional ground	1	2	3	4	5	Functional ground
Pin name	24-V	DI6	G-ND	DI5	n.c.	Functional ground	24-V	DI8	G-ND	DI7	n.c.	Functional ground
M12 (A coded)												
												

IO-Link®

The drive provides four IO-Link® master ports via the For the I and FS series. One IO-Link® device can be connected to each port (point-to-point communication).

Typical topologies



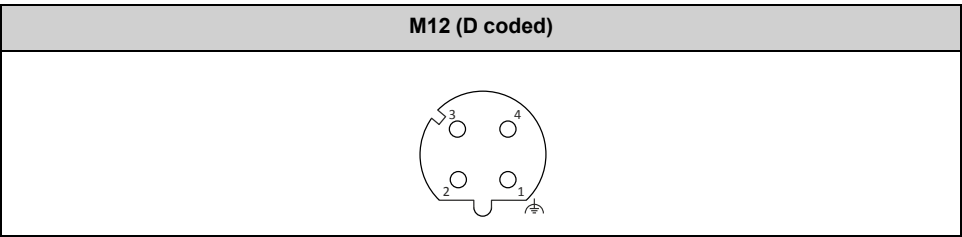
Networks

NOTE:

When planning networks, please observe the following recommendations for trouble-free operation, especially in the event of Ethernet-based networks.

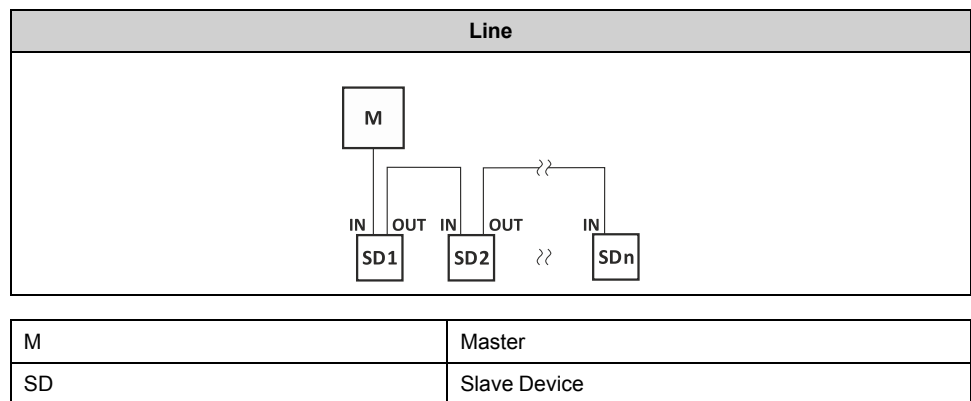
- Lay communication cables separately from power cables. Maintain as large a distance as possible to the motor cables which are subject to interference.
- To avoid compensating currents via the shielding of the communication cable, install an independent, low-resistance equipotential bonding over the shortest possible distance parallel to the communication cable. This applies in particular to long cables.
- CAT5 cables according to specification establish the shield connection via the M12 connectors (D coded). Additional shield connections are not required.
- Cables must comply with CAT5 and be suitable for ≥ 10 Mbps.
- Only certified, tested and prefabricated cables with M12 connectors from well-known manufacturers are recommended.
- Observe bending radii according to manufacturer information. Minimum bending radii of 10 x cable diameter or 20 x diameter for frequent manipulation of the cables are standard.

Connection designation			X396					X397				
Pin			1	2	3	4	Functional ground	1	2	3	4	Functional ground
Pin name			TX+0	RX+0	TX-0	RX-0	Functional ground	TX+0	RX+0	TX-0	RX-0	Functional ground



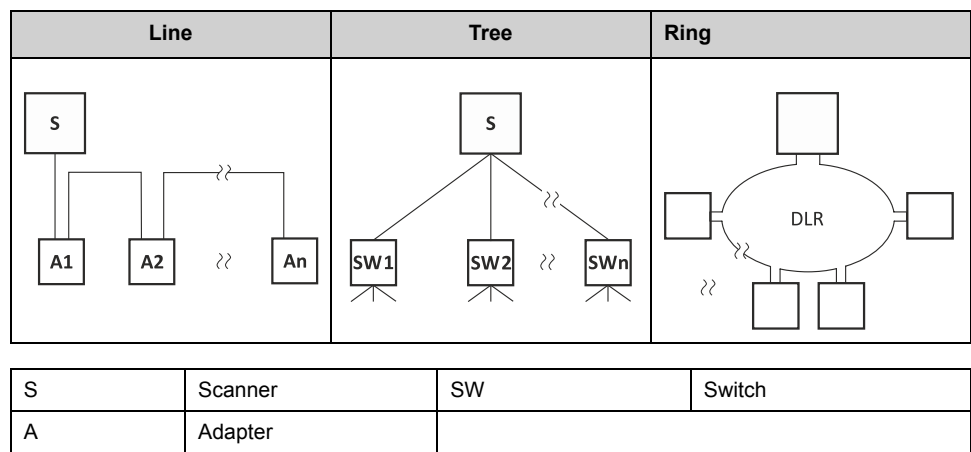
EtherCAT

Typical topologies



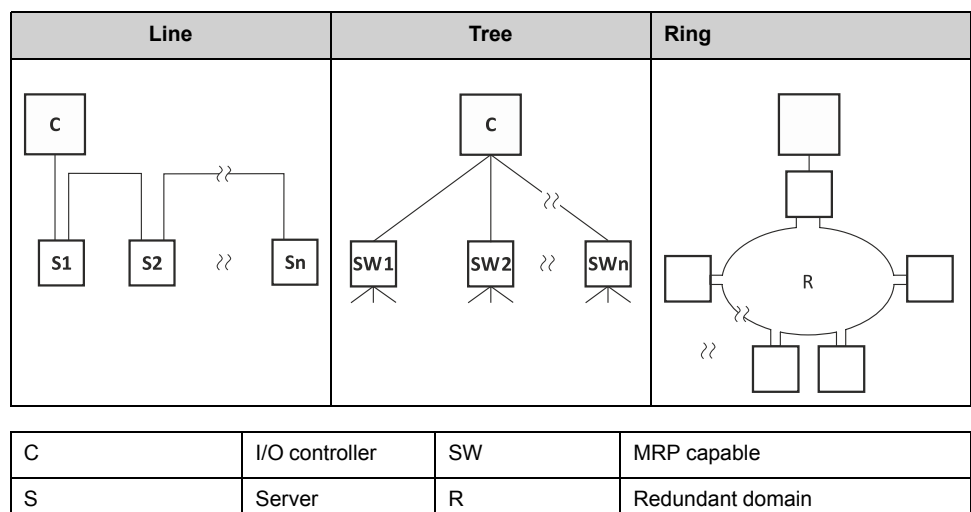
EtherNet/IP

Typical topologies



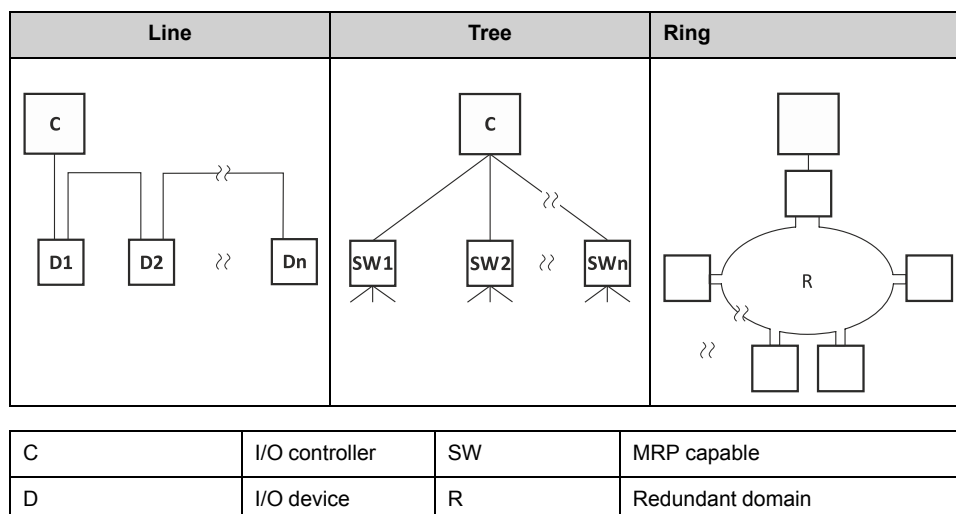
Modbus TCP

Typical topologies



PROFINET

Typical topologies



Safety function

⚠ DANGER

IMPROPER INSTALLATION OF THE SAFETY COMPONENTS CAN CAUSE AN UNCONTROLLED STARTING ACTION OF THE DRIVES.

- Safety components may only be installed and commissioned by qualified personnel.
- The complete wiring must be designed in accordance with EMC requirements.
- All control components (switch, relay, PLC, ...) must comply with the requirements of EN ISO 13849-1 and the EN ISO 13849-2.
- Switches, relays with at least IP54 degree of protection.
- Always mount drives, controllers and other safety components with a degree of protection lower than IP54 in control cabinets with a minimum degree of protection of IP54.
- The wiring must be shielded.
- It is essential to use insulated wire end ferrules for wiring.
- All safety-relevant cables outside the control cabinet must be protected, e.g., by means of a cable duct.
- Ensure that no short circuits can occur according to the specifications of the EN ISO 13849-2.
- Please refer to EN ISO 13849-1 and the EN ISO 13849-2. for all further requirements and measures.
- In the case of an external force effect on the drive axes, additional brakes are necessary, please observe the effect of gravitational force on hanging loads!
- For safety-related braking functions, use safety-rated brakes only.
- The user must ensure that the drive is only operated within the specified environmental conditions in its intended application. Only by doing so can the specified safety-related characteristics be adhered to.

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

⚠ DANGER**AUTOMATIC RESTART IF THE REQUEST OF THE SAFETY FUNCTION IS DEACTIVATED.**

You must provide external measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

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

NOTICE**EXCESSIVELY HIGH MOISTURE OR CONDENSATION**

Only commission the safety component when it has acclimated.

Failure to follow these instructions can result in equipment damage.

Basic Safety – STO

"Basic Safety – STO" is part of the product variants **ATV350D11N4••**

NOTICE**OVERVOLTAGE**

Make sure that the maximum voltage (maximum rated) at the safe inputs does not exceed 30 V DC.

Failure to follow these instructions can result in equipment damage.

With the "Safe torque off" (STO) function, no "emergency switching off" in terms with EN 60204-1 can be executed without additional measures.

There is no electrical isolation between the motor and drive and no service switch or maintenance switch!

⚠⚠ DANGER**HAZARD OF ELECTRIC SHOCK**

"Emergency switching off" requires electrical isolation, e. g. by a central mains contactor.

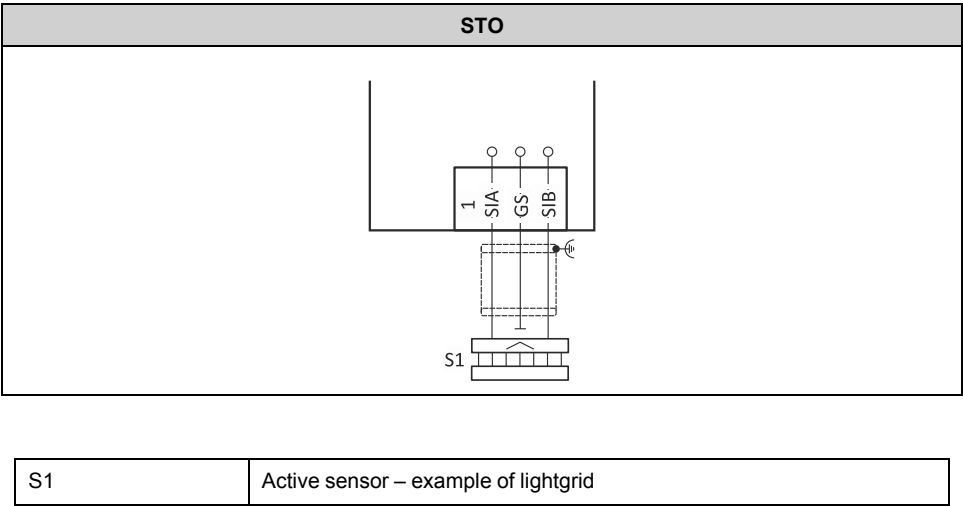
Failure to follow these instructions will result in death or serious injury.

Connection diagram

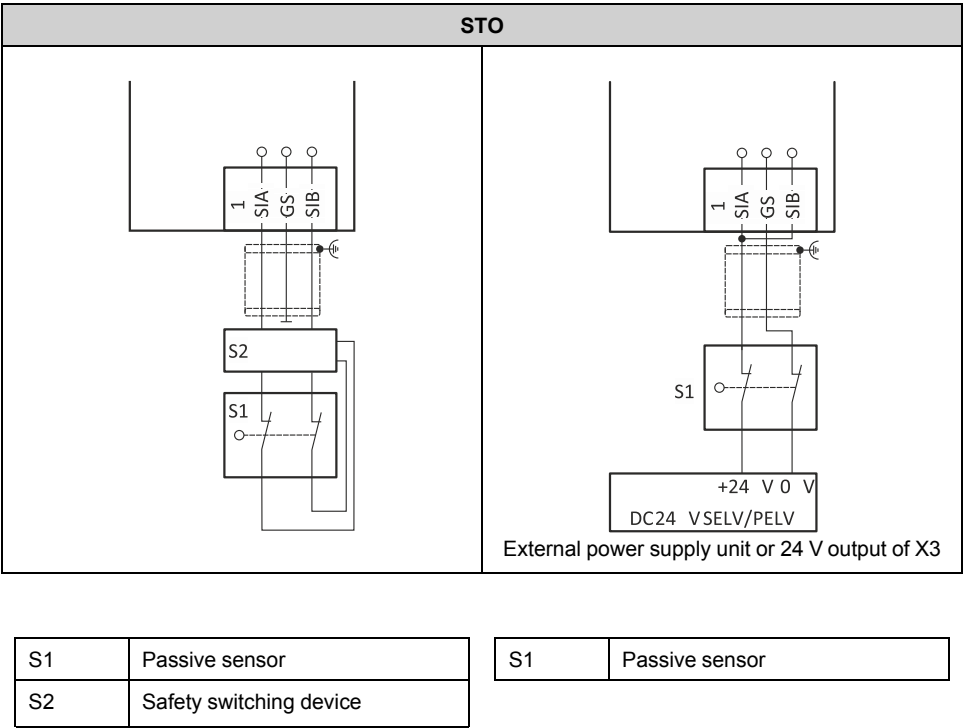
NOTE:

The connection diagrams shown are only example circuits. The user is responsible for the correct safety-related design and selection of the components!

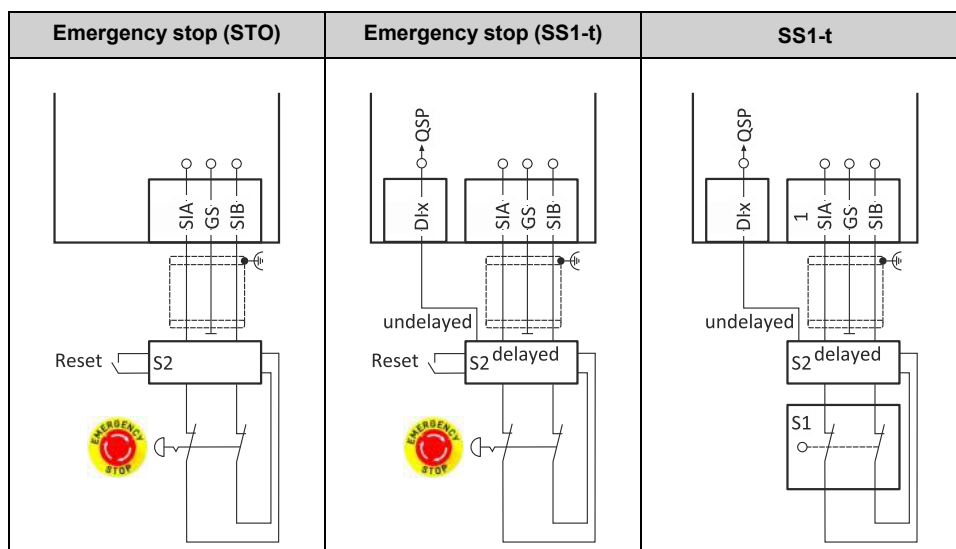
Active sensors



Passive sensors



Passive sensors – further examples



S2	Safety switching device
----	-------------------------

S2	Safety switching device with delayed contacts
QSP	"Quick stop" function

S1	Passive sensor
S2	Safety switching device with delayed contacts
QSP	"Quick stop" function

Connection data

Connection designation			X1					
Pin			1	2	3	4	5	Functional ground
Pin name			n.c.	SIA	GS	SIB	n.c.	Functional ground

M12 (A coded)								

Connection			STO
Connection designation			X1
Max. cable cross-section	mm ²		0.34
Max. cable cross-section	AWG		22
Min. cable cross-section	mm ²		0.34
Min. cable cross-section	AWG		22

X1	Specification	Unit	min.	typ.	max.
SIA, SIB	LOW signal	V	-3	0	+5
	HIGH signal	V	+15	+24	+30

(Continued)

X1	Specification	Unit	min.	typ.	max.
	Switch-on time	ms		3	
	Clear time	ms		50	60
	Input current SIA	mA		10	14
	Input current SIB	mA		7	12
	Input peak current	mA		100	
	Test pulse duration	ms			1
	Test pulse interval	ms	10		
GS	Reference potential for SIA and SIB				

- Maximum cable length: 100 m
- From 30 m cable length, a shielded version is required!

Extended Safety

"Extended Safety – S" is part of the product variant replace by **ATV350D11N4..**.

NOTE:

The "Extended Safety – S" version has no safe inputs for controlling the safety functions.

The safety functions are controlled exclusively via the safety bus.

Safe network interfaces

Safety functions

Technical data

Standards and operating conditions

Conformities and approvals

Conformities			
Approvals			
cULus	UL 61800-5-1		File No. E116875
			For USA and Canada

NOTE:

Declarations of conformity, certificates and approvals can be found on the Internet:

www.se.com at Products, drives, variable speed drives.

Protecting personnel and device protection

Degree of protection			Information applies to the mounted and ready-for-use state.
EN	EN IEC 60529	IP54	Extension box with disconnect switch with overload / short-circuit protection
			Extension box with disconnect switch and operating elements
		IP54/IP66	Extension box with disconnect switch
			drive without extension box
UL	UL 50E	Type 12 / 12K	Extension box with disconnect switch with overload / short-circuit protection
			Extension box with disconnect switch and operating elements
			UL 50E Type 12 / 12K comparable to NEMA 12 / 12K
		Type 4X indoor	Extension box with disconnect switch
			Housing parts UV-resistant (f1 rating)
			UL 50E Type 4X comparable to NEMA 4X
drive without extension box			
Protection against electric shock			
Isolation of control circuits	EN IEC 61800-5-1	Safe mains isolation	Double/reinforced insulation
Overvoltage category		II	>2000 m AMSL
		III	0 ... 2000 m AMSL
Degree of pollution	UL 61800-5-1	2	
Leakage current			
AC	EN IEC 61800-5-1	> 3.5 mA	Observe regulations and safety instructions!
DC		> 10 mA	
Starting current			
		≤ 3 x rated mains current	

(Continued)

Protective measures			
ground error strength			ground-error protected depending on operating status
Motor stalling protection			
Short-circuit strength			
Overvoltage resistance			
Motor overtemperature			PTC or thermal contact, I ² xt monitoring

EMC data

Operation on public supply systems			The machine or system manufacturer is responsible for compliance with the requirements for the machine/ system!
< 1 kW	EN IEC 61000-3-2	No additional measures	
> 1 kW, mains current ≤ 16 A			
Mains current > 16 A to ≤ 75 A	EN IEC 61000-3-12		When designed for rated power.
Rsce			≥ 250
Noise emission			
Category C1	EN IEC 61800-3		See rated data
Category C2			
Category C3			
Noise immunity			
	EN IEC 61800-3	Requirements fulfilled	

Motor connection

Requirements for the shielded motor cable			
Capacitance per unit length		< 150/300 pF/m	≥ 4 mm² / AWG 12
		< 75/150 pF/m	≤ 2.5 mm² / AWG 14
Electric strength			U _o /U = 0.6/1.0 kV
	U _o = r.m.s. value external conductor to PE		
	UL	U ≥ 600 V	U = r.m.s. value from external conductor to external conductor

Environmental conditions

Energy efficiency			
Efficiency level	EN IEC 61800-9-2	Energy efficiency class IE2	according to REGULATION (EU) 2019/1781
Climate			
Storage	EN 60721-3-1:1997	1K3 (-30 to +60°C)	

(Continued)

Transport	EN 60721-3-2:1997	2K3 (-30 to +70°C)	
Operation	EN 60721-3-3:1995 + A2:1997	3S3	For mechanically active substances
		3K3 (-30 to +60°C)	Operation at a switching frequency of 4, 8, 12 or 16 kHz: Above +40°C: reduce rated output current by 2.5%/°C
		3C3	For chemically active substances
Site altitude			
0 ... 1000 m AMSL			Without current derating
1000 ... 4000 m AMSL			Reduce rated output current by 5 %/1000 m
Vibration resistance			
Transport	EN 60721-3-2:1998	2M2 (sine, shock)	In original packaging
		Amplitude 3.5 mm	2 to 9 Hz
		Acceleration resistant up to 1 g	9 to 200 Hz
		Acceleration resistant up to 1.5 g	200 to 500 Hz
		Type 2	Peak acceleration value 30 g
Operation	DNV-CG-0339	Amplitude 1 mm	5 to 13.2 Hz
		Acceleration resistant up to 0.7 g	13.2 to 100 Hz
	EN 60721-3-3:1995 + A2:1997	3M6 (sine, shock)	at 3 to 11 kW
		3M7 (sine, shock)	up to 2.2 kW
		Amplitude 10 mm	2 to 9 Hz
		Amplitude 7 mm	
		Acceleration resistant up to 2 g	9 to 200 Hz
		Acceleration resistant up to 3 g	
		Type 2	Peak acceleration value 25 g
	EN 60721-3-3:2019	3M12	up to 11 kW
	EN IEC 61800-5-1	Amplitude 0.075 mm	10 to 57 Hz
		Acceleration resistant up to 1 g	57 to 150 Hz

Electrical supply conditions

Power systems			
TN			Voltage against ground: max. 300 V
TT			

The connection to different supply forms enables a worldwide application of the drives.

The following are supported:

- 3-phase mains connection 400 V, page 66
- 3-phase mains connection 480 V, page 70

Certification of the integrated safety function

The certification of the integrated safety is based on these test fundamentals:

EN ISO 13849-1:2023	Safety of machinery – Safety-related parts of control systems – Part 1
EN 61508, Part 1-7:2010	Safety function of electrical/electronic/programmable electronic safety-related systems
EN 61800-5-1:2007 + A1:2017 + A11:2021	Adjustable speed electrical power drive systems – Part 5-1: Safety requirements – Electrical, thermal and energy requirements
EN 61800-5-2:2007 EN 61800-5-2:2017	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – safety function

NOTE:

Declarations of conformity, certificates and approvals can be found on the Internet:

www.se.com Products > drives > variable speed drives

3-phase mains connection 400 V

Rated data

- The output currents apply to an ambient temperature of max. 40 °C (104 °F).
- The maximum possible output voltage is approx. 87 % of the mains voltage.

Product name			ATV350U07N4**	ATV350U15N4**	ATV350U22N4**	ATV350U40N4**
Rated power	P _{rated}	kW	0.75	1.5	2.2	4
Rated power	P _{rated}	hp	1	2	3	5
Mains voltage range			3/PE AC 340 V to 440 V, 45 Hz to 65 Hz			
Output voltage			3 AC 0 – 400/480 V			
Rated mains current						
without mains choke		A	2.2	3.5	5.0	8.6
with mains choke		A	-			
Apparent output power		kVA	1.4	2.4	3.4	5.7
Rated output current						
2 kHz		A	2.4	3.9	5.6	9.5
8 kHz		A	2.4	3.9	5.6	9.5
12 kHz		A	1.9	3.1	4.5	8.1
16 kHz		A	1.6	2.6	3.7	6.8
Power loss						
2 kHz		W	28	41	57	92
8 kHz		W	36	55	77	126
12 kHz		W	35	53	74	128
16 kHz		W	35	53	74	129
when the drive is disabled		W	6			
Overcurrent cycle 180 s						
Max. output current (≤ 8 kHz)		A	3.6	5.9	8.4	14.3
Overload time	T ₁	s	60	60	60	60

(Continued)

Product name			ATV350U07N4••	ATV350U15N4••	ATV350U22N4••	ATV350U40N4••
Rated power	P_{rated}	kW	0.75	1.5	2.2	4
Rated power	P_{rated}	hp	1	2	3	5
Recovery time	T ₂	s	120	120	120	120
Max. output current during the recovery time		A	1.8	2.9	4.2	7.1
Overcurrent cycle 15 s						
Max. output current (≤ 8 kHz)		A	4.8	7.8	11.2	19
Overload time	T ₁	s	3	3	3	3
Recovery time	T ₂	s	12	12	12	12
Max. output current during the recovery time		A	1.8	2.9	4.2	7.1
Cyclical mains switching			3 times per minute			
Max. shielded motor cable length						
without EMC category		m	50			
Category C1 (8 kHz)		m	-			
Category C2 (8 kHz)		m	10			
Category C3 (8 kHz)		m	35			
Max. unshielded motor cable length						
without EMC category		m	100			

Product name			ATV350U55N4••	ATV350U75N4••	ATV350D11N4••
Rated power	P_{rated}	kW	5.5	7.5	11
Rated power	P_{rated}	hp	7.5	10	15
Mains voltage range			3/PE AC 340 V to 440 V, 45 Hz to 65 Hz		
Output voltage			3 AC 0 – 400/480 V		
Rated mains current					
without mains choke		A	11.7	14	20
with mains choke		A	-		
Apparent output power		kVA	7.8	9.9	14.2
Rated output current					
2 kHz		A	13	16.5	23.5
8 kHz		A	13	16.5	23.5
12 kHz		A	11.1	14	20
16 kHz		A	9.3	11.9	17
Power loss					
2 kHz		W	124	155	218
8 kHz		W	171	215	303
12 kHz		W	173	217	307
16 kHz		W	174	222	313
when the drive is disabled		W	6		
Overcurrent cycle 180 s					
Max. output current (≤ 8 kHz)		A	19.5	24.8	35.3

(Continued)

Product name			ATV350U55N4**	ATV350U75N4**	ATV350D11N4**
Rated power	P _{rated}	kW	5.5	7.5	11
Rated power	P _{rated}	hp	7.5	10	15
Overload time	T ₁	s	60	60	60
Recovery time	T ₂	s	120	120	120
Max. output current during the recovery time		A	9.8	12.4	17.6
Overcurrent cycle 15 s					
Max. output current (≤ 8 kHz)		A	26	33	47
Overload time	T ₁	s	3	3	3
Recovery time	T ₂	s	12	12	12
Max. output current during the recovery time		A	9.8	12.4	17.6
Cyclical mains switching			3 times per minute		
Max. shielded motor cable length					
without EMC category		m	50		
Category C1 (8 kHz)		m	-		
Category C2 (8 kHz)		m	10		
Category C3 (8 kHz)		m	35		
Max. unshielded motor cable length					
without EMC category		m	100		

Fusing data (EN 60204-1)**NOTE:**

Fusing data for UL/NEC compliant installations:
Fusing data, page 50

drive	Fuse			Circuit breaker			RCD	
	I _{cc}	Characteristic	Max. rated current	I _{cc}	Characteristic	Max. rated current		Type
	kA		A	kA		A	mA	
ATV350U07N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350U15N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350U22N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350U40N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350U55N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350U75N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350D11N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B

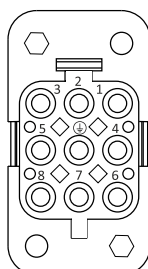
Connection data

Rated power	P _{rated}	kW	1to15HP/0.75to11kW													
Connection			Mains connection													
Connection type			Han Q4/2													
Connector name			Q4/2 male							Q4/2 female (Daisy Chain)						
Connection designation			X100.1							X100.2						
Pin			PE	1	2	3	4	11	12	PE	1	2	3	4	11	12
Pin name			PE	L1-.1	L2-.1	L3-.1	n.c.	24-E	G-ND	PE	L1-.2	L2-.2	L3-.2	n.c.	24-E	G-ND
Max. cable cross-section		mm ²	6	6	6	6	6	2.5	2.5	6	6	6	6	6	2.5	2.5
Max. cable cross-section		AWG	10	10	10	10	10	14	14	10	10	10	10	10	14	14
Min. cable cross-section		mm ²	1.5	1.5	1.5	1.5	1.5	0.-14	0.-14	1.5	1.5	1.5	1.5	1.5	0.-14	0.-14
Min. cable cross-section		AWG	16	16	16	16	16	26	26	16	16	16	16	16	26	26

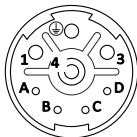
Rated power	P _{rated}	kW	1 to 7.5HP/0.75 to 5.5kW	10..15HP/7.5 to 11kW
Connection			Ground (GND)	
Connection designation			Symbol for Ground (GND)	
Connection system			Screw	
Max. cable cross-section		mm²	6	16
Max. cable cross-section		AWG	10	6
Min. cable cross-section		mm²	1.5	2.5
Min. cable cross-section		AWG	16	14
Stripping length		mm	10	12
Stripping length		in	0.4	0.47
Tightening torque		Nm	2	3.4
Tightening torque		lb-in	18	30
Required tool			Torx key 20	Torx key 25

Rated power	P _{rated}	kW	1 to 15HP/0.75to11kW									
Connection			Motor connection									
Connection designation			X105									
Connection type			Han Q8									
Pin			1	3	4	5	6	7	8	GND		
Pin name			U	W	BD1	T1	BD2	V	T2	Symbol for ground (GND)		

Han Q8



Rated power	P _{rated}	kW	1 to 15HP/0.75 to 11kW							
Connection			Motor connection							
Connection designation			X105							
Connection type			M23							
Pin			1	3	4	A	B	C	D	GND
Pin name			U	V	W	T1	T2	BD1	BD2	Symbol for ground (GND)

M23										
										

Rated power	P _{rated}	kW	7.5 to 45	
Connection			PTC, thermal contact	
Connection designation			X109	
Connection system			Spring terminal	
Pin name			T1	T2
Max. cable cross-section		mm²	1.5	
Max. cable cross-section		AWG	16	
Min. cable cross-section		mm²	0.25	0.25
Min. cable cross-section		AWG	26	26
Stripping length		mm	9	
Stripping length		in	0.3	
Required tool			Slotted screwdriver 0.4 x 2.5	

3-phase mains connection 480 V

Rated data

- The output currents apply to an ambient temperature of max. 40 °C (104 °F).
- The maximum possible output voltage is approx. 87 % of the mains voltage.

Product name			ATV350U07N4**							
Rated power	P _{rated}	kW	0.75							
Rated power	P _{rated}	hp	1							
Mains voltage range			3/GND AC 432 V to 528 V, 45 Hz to 65 Hz							
Output voltage			3 AC 0 – 400/480 V							
Rated mains current										
without mains choke		A	1.9							
with mains choke		A								
Apparent output power		kVA	1.5							
Rated output current										

(Continued)

Product name			ATV350U07N4**	
Rated power	P _{rated}	kW	0.75	
Rated power	P _{rated}	hp	1	
2 kHz		A	2.1	
8 kHz		A	2.1	
12 kHz		A	1.7	
16 kHz		A	1.4	
Power loss				
2 kHz		W	29	
8 kHz		W	38	
12 kHz		W	36	
16 kHz		W	36	
when the drive is disabled		W	6	
Overcurrent cycle 180 s				
Max. output current (≤ 8 kHz)		A	3.2	
Overload time	T ₁	s	60	
Recovery time	T ₂	s	120	
Max. output current during the recovery time		A	1.6	
Overcurrent cycle 15 s				
Max. output current (≤ 8 kHz)		A	4.2	
Overload time	T ₁	s	3	
Recovery time	T ₂	s	12	
Max. output current during the recovery time		A	1.6	
Cyclical mains switching			3 times per minute	
Max. shielded motor cable length				
without EMC category		m	50	
Category C1 (8 kHz)		m	-	
Category C2 (8 kHz)		m	10	
Category C3 (8 kHz)		m	35	
Max. unshielded motor cable length				
without EMC category		m	100	

Product name			ATV350U15N4**	ATV350U22N4**	ATV350U40N4**
Rated power	P _{rated}	kW	1.5	2.2	4
Rated power	P _{rated}	hp	2	3	5
Mains voltage range			3/GND AC 432 V to 528 V, 45 Hz to 65 Hz		
Output voltage			3 AC 0 – 400/480 V		
Rated mains current					
without mains choke		A	3.2	4.3	7.4
with mains choke		A	-		

(Continued)

Product name			ATV350U15N4**	ATV350U22N4**	ATV350U40N4**
Rated power	P _{rated}	kW	1.5	2.2	4
Rated power	P _{rated}	hp	2	3	5
Apparent output power		kVA	2.5	3.5	5.9
Rated output current					
2 kHz		A	3.5	4.8	8.2
8 kHz		A	3.5	4.8	8.2
12 kHz		A	2.8	3.8	7.0
16 kHz		A	2.3	3.2	5.9
Power loss					
2 kHz		W	44	58	95
8 kHz		W	59	79	131
12 kHz		W	57	75	132
16 kHz		W	57	75	134
when the drive is disabled		W		6	
Overcurrent cycle 180 s					
Max. output current (≤ 8 kHz)		A	5.3	7.2	12.3
Overload time	T ₁	s	60	60	60
Recovery time	T ₂	s	120	120	120
Max. output current during the recovery time		A	2.6	3.6	6.2
Overcurrent cycle 15 s					
Max. output current (≤ 8 kHz)		A	7	9.6	16.4
Overload time	T ₁	s	3	3	3
Recovery time	T ₂	s	12	12	12
Max. output current during the recovery time		A	2.6	3.6	6.2
Cyclical mains switching			3 times per minute		
Max. shielded motor cable length					
without EMC category		m	50		
Category C1 (8 kHz)		m	-		
Category C2 (8 kHz)		m	10		
Category C3 (8 kHz)		m	35		
Max. unshielded motor cable length					
without EMC category		m	100		

Product name			ATV350U55N4**	ATV350U75N4**	ATV350D11N4**
Rated power	P _{rated}	kW	5.5	7.5	11
Rated power	P _{rated}	hp	7.5	10	15
Mains voltage range			3/GND AC 432 V to 528 V, 45 Hz to 65 Hz		
Output voltage			3 AC 0 – 400/480 V		
Rated mains current					

(Continued)

Product name			ATV350U55N4**	ATV350U75N4**	ATV350D11N4**
Rated power	P _{rated}	kW	5.5	7.5	11
Rated power	P _{rated}	hp	7.5	10	15
without mains choke		A	9.9	11.9	17.9
with mains choke		A	-		
Apparent output power		kVA	8.0	10.1	15.2
Rated output current					
2 kHz		A	11	14	21
8 kHz		A	11	14	21
12 kHz		A	9.4	11.9	17.9
16 kHz		A	7.9	10.1	15.2
Power loss					
2 kHz		W	125	158	234
8 kHz		W	173	219	325
12 kHz		W	175	221	329
16 kHz		W	177	226	335
when the drive is disabled		W	6		
Overcurrent cycle 180 s					
Max. output current (≤ 8 kHz)		A	16.5	21	31.5
Overload time	T ₁	s	60	60	60
Recovery time	T ₂	s	120	120	120
Max. output current during the recovery time		A	8.3	10.5	15.8
Overcurrent cycle 15 s					
Max. output current (≤ 8 kHz)		A	22	28	42
Overload time	T ₁	s	3	3	3
Recovery time	T ₂	s	12	12	12
Max. output current during the recovery time		A	8.3	10.5	15.8
Cyclical mains switching			3 times per minute		
Max. shielded motor cable length					
without EMC category		m	50		
Category C1 (8 kHz)		m	-		
Category C2 (8 kHz)		m	10		
Category C3 (8 kHz)		m	35		
Max. unshielded motor cable length					
without EMC category		m	100		

Fusing data (EN 60204-1)

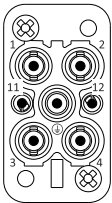
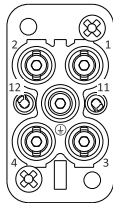
NOTE:

Fusing data for UL/NEC compliant installations:
Fusing data, page 50

drive	Fuse			Circuit breaker			RCD	
	I _{cc}	Characteristic	Max. rated current	I _{cc}	Characteristic	Max. rated current		Type
	kA		A	kA		A	mA	
ATV350U07N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350U15N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350U22N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350U40N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350U55N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350U75N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B
ATV350D11N4**	5	gG/gL, gRL	32	5	B	32	≥ 30	Type B

Connection data

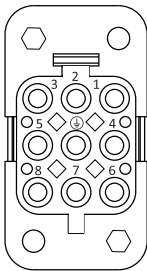
Rated power	P _{rated}	kW	1 to 15HP/0.75to11kW													
Connection			Mains connection													
Connection type			Han Q4/2													
Connector name			Q4/2 male							Q4/2 female (Daisy Chain)						
Connection designation			X100.1							X100.2						
Pin			GN-D	1	2	3	4	11	12	GN-D	1	2	3	4	11	12
Pin name			GN-D	L1.-1	L2.-1	L3.-1	n.c.	24E	GN-D	GN-D	L1.-2	L2.-2	L3.-2	n.c.	24E	GN-D
Max. cable cross-section		mm ²	6	6	6	6	6	2.5	2.5	6	6	6	6	6	2.5	2.5
Max. cable cross-section		AWG	10	10	10	10	10	14	14	10	10	10	10	10	14	14
Min. cable cross-section		mm ²	1.5	1.5	1.5	1.5	1.5	0.1-4	0.1-4	1.5	1.5	1.5	1.5	1.5	0.1-4	0.1-4
Min. cable cross-section		AWG	16	16	16	16	16	26	26	16	16	16	16	16	26	26

Han Q4/2 male	Han Q4/2 female
	

Rated power	P _{rated}	kW	15 to 45
Connection			Mains connection
Connection designation			X100
Connection system			Screw terminal
Connection type			Non-pluggable
Max. cable cross-section		mm ²	35
Max. cable cross-section		AWG	2
Min. cable cross-section		mm ²	0.5
Min. cable cross-section		AWG	20
Stripping length		mm	18
Stripping length		in	0.7
Tightening torque		Nm	3.8
Tightening torque		lb-in	33.6
Required tool			Torx key 20

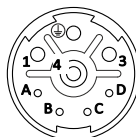
Rated power	P _{rated}	kW	0.37 to 5.5	7.5 to 11	15 to 45
Connection			Ground (GND)		
Connection designation			Symbol for ground (GND)		
Connection system			Screw		
Max. cable cross-section		mm ²	6	16	25
Max. cable cross-section		AWG	10	6	3
Min. cable cross-section		mm ²	1.5	2.5	4
Min. cable cross-section		AWG	16	14	12
Stripping length		mm	10	12	18
Stripping length		in	0.4	0.47	0.7
Tightening torque		Nm	2	3.4	4
Tightening torque		lb-in	18	30	35
Required tool			Torx key 20	Torx key 25	Torx key 30

Rated power	P _{rated}	kW	0.37 to 11							
Connection			Motor							
Connection designation			X105							
Connection type			Han Q8							
Pin			1	3	4	5	6	7	8	GND
Pin name			U	W	BD1	T1	BD2	V	T2	Symbol for ground (GND)

Han Q8										
										

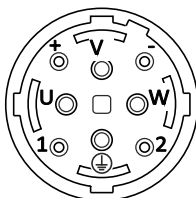
Rated power	P _{rated}	kW	0.37 to 11							
Connection			Motor							
Connection designation			X105							
Connection type			M23							
Pin			1	3	4	A	B	C	D	GND
Pin name			U	V	W	T1	T2	BD1	BD2	Symbol for ground (GND)

M23



Rated power	P _{rated}	kW	15 to 22							
Connection			Motor							
Connection designation			X105							
Connection type			M40							
Pin			-	+	1	2	GND	V	V	W
Pin name			BD2	BD1	T1	T2	Symbol for ground (GND)	U	V	W

M40



Rated power	P _{rated}	kW	0.37 to 5.5	7.5 to 11	15 to 45
Connection			Motor connection		
Connection designation			X105		
Connection system			Spring terminal		Screw terminal
Connection type			Non-pluggable		
Max. cable cross-section		mm ²	2.5	16	35
Max. cable cross-section		AWG	14	4	2
Min. cable cross-section		mm ²	0.14	0.75	0.5
Min. cable cross-section		AWG	26	20	20
Stripping length		mm	8	18	18
Stripping length		in	0.3	0.7	0.7
Tightening torque		Nm	-	-	3.8
Tightening torque		lb-in	-	-	33.6
Required tool			Slotted screwdriver 0.6 x 3.5	Slotted screwdriver 0.8 x 4.0	Torx key 20

Rated power	P _{rated}	kW	15 to 45	
Connection			24 V supply for control electronics	
Connection designation			X5	
Connection system			Spring terminal	
Pin name			24E	GND
Max. cable cross-section		mm ²	2.5	
Max. cable cross-section		AWG	12	
Min. cable cross-section		mm ²	0.25	0.25
Min. cable cross-section		AWG	26	26
Stripping length		mm	9	
Stripping length		in	0.3	
Required tool			Slotted screwdriver 0.5 x 3.0	

Rated power	P _{rated}	kW	7.5 to 45	
Connection			Motor brake	
Connection designation			X106	
Connection system			Spring terminal	
Pin name			BD2	BD1
Max. cable cross-section		mm ²	2.5	
Max. cable cross-section		AWG	12	
Min. cable cross-section		mm ²	0.25	0.25
Min. cable cross-section		AWG	26	26
Stripping length		mm	9	
Stripping length		in	0.3	
Required tool			Slotted screwdriver 0.5 x 3.0	

Rated power	P _{rated}	kW	7.5 to 45	
Connection			PTC, thermal contact	
Connection designation			X109	
Connection system			Spring terminal	
Pin name			T1	T2
Max. cable cross-section		mm ²	1.5	
Max. cable cross-section		AWG	16	
Min. cable cross-section		mm ²	0.25	0.25
Min. cable cross-section		AWG	26	26
Stripping length		mm	9	
Stripping length		in	0.3	
Required tool			Slotted screwdriver 0.4 x 2.5	

Ecodesign Directive

Product information acc. to REGULATION (EU) 2019/1781 (ANNEX I, Section 4)

Legend	
Operating point (f; I)	f = relative motor stator frequency; I = relative torque-producing current
Power losses	The power losses at the operating points (f; I) and in the standby state refer to the rated apparent output power. The power losses for options (e.g., for diagnostics) and for accessories can be found in the additional product documentation on the Internet.

Performance losses					
0; 25	f; I	%	1.8	1.5	1.6
0; 50	f; I	%	1.9	1.7	1.8
0; 100	f; I	%	2.4	2.2	2.3
50; 25	f; I	%	1.8	1.6	1.6
50; 50	f; I	%	2.0	1.8	1.9
50; 100	f; I	%	2.5	2.3	2.4
90; 50	f; I	%	2.1	1.8	1.9
90; 100	f; I	%	2.4	2.2	2.3
In standby mode		%	0.4	0.2	0.1
Efficiency level			IE2	IE2	IE2
Model identifier of the product			ATV350U07N4**	ATV350U15N4**	ATV350U22N4**
Apparent output power		kVA	1.5	2.4	3.3
Indicative rated output power of the motor		kW	0.75	1.5	2.2
Rated output current		A	4.2	7	9.6
Maximum operating temperature		°C	40		
Rated input frequency		Hz	50		
Rated input voltage		V	230		
Switching frequency		kHz	8		
Rated apparent output power		kVA	1.71	3.3	4.44

Performance losses					
0; 25	f; I	%	2.1	1.4	1.3
0; 50	f; I	%	2.3	1.5	1.5
0; 100	f; I	%	2.6	1.8	1.8
50; 25	f; I	%	2.2	1.4	1.3
50; 50	f; I	%	2.3	1.5	1.5
50; 100	f; I	%	2.7	1.9	1.9
90; 50	f; I	%	2.3	1.6	1.5
90; 100	f; I	%	2.4	1.7	1.8
In standby mode		%	0.4	0.2	0.1
Efficiency level			IE2	IE2	IE2
Model identifier of the product			ATV350U07N4**	ATV350U15N4**	ATV350U22N4**
Apparent output power		kVA	1.5	2.4	3.4
Indicative rated output power of the motor		kW	0.75	1.5	2.2
Rated output current		A	2.4	3.9	5.6

(Continued)

Maximum operating temperature		°C	40		
Rated input frequency		Hz	50		
Rated input voltage		V	400		
Switching frequency		kHz	8		
Rated apparent output power		kVA	1.71	3.3	4.44

Data of control connections

Digital inputs | For the W series

Connection		X3.1 / DI1 + DI2 X3.2 / DI3 + DI4	
Switching type		PNP, NPN	Parameterizable
PNP switching level			
LOW	V	< +5	IEC 61131-2, type 1
HIGH	V	> +15	
NPN switching level			
LOW	V	> +15	
HIGH	V	< +5	
Input resistance	kΩ	4.6	
Cycle time	ms	1	
External-voltage protection	V	±30	The following restriction applies to DI1 due to the switchability to DO1: External-voltage protection = +30 V. In the event of a negative voltage, the integrated freewheeling diode conducts.

Digital inputs | For the I and FS series

Connection		X3.1 / DI1 + DI2 X3.2 / DI3 + DI4 X3.3 / DI5 + DI6 X3.4 / DI7 + DI8	
Switching type		PNP, NPN	Parameterizable
PNP switching level			
LOW	V	< +5	IEC 61131-2, type 1
HIGH	V	> +15	
NPN switching level			
LOW	V	> +15	
HIGH	V	< +5	
Input resistance	kΩ	4.6	

(Continued)

Cycle time	ms	1	
External-voltage protection	V	±30	

Encoder input			
Type		Incremental HTL encoder	
Two-track connection		X3.2 / DI3 X3.2 / DI4	Track A Track B
Frequency range	kHz	0 ... 200	

Digital outputs | For the W series

Connection		X3.1 / DO1	
Switching level			
LOW	V	< +5	IEC 61131-2, type 1
HIGH	V	> +15	
max. output current	mA	100	
Cycle time	ms	1	
Short-circuit strength		Unlimited period	
External-voltage protection	V	+30	In the event of a negative voltage, the integrated freewheeling diode conducts.
Polarity reversal protection		Integrated freewheeling diode for switching the inductive load	
Overload behavior		Voltage reduction or switching off and on periodically	
Reset or switch-on behavior		Output is switched off	LOW

Digital outputs | For the I and FS series

Connection		X3.1 / DO1 X3.2 / DO2 X3.3 / DO3 X3.4 / DO4	
Switching level			
LOW	V	< +5	IEC 61131-2, type 1
HIGH	V	> +15	
max. output current	mA	100	
Cycle time	ms	1	
Short-circuit strength		Unlimited period	
External-voltage protection	V	±30	
Polarity reversal protection		Integrated freewheeling diode for switching the inductive load	
Overload behavior		Voltage reduction or switching off and on periodically	
Reset or switch-on behavior		Output is switched off	LOW

DC input

Use		Input for mains-independent DC supply of the control electronics (including communication)	
Connection		X100.1 / 24E + GND X100.2 / 24E + GND	Applies to drives: • 1 to 15HP/0.75to11kW and mains voltage 400/480 V
		X5 / 24E + GND	Applies to drives: • 1 to 15HP/0.75to11kW and mains voltage 400/480 V
Capacity to be charged	μF	440	
Polarity reversal protection		At polarity reversal: No function and no destruction	
Suppression of voltage pulses		Suppressor diode 48 V, bidirectional	
Power supply unit		SELV/GNDLV	Externally to create a mains-independent DC supply
Rated current	A	10	While looping-through

Rated data DC input for version with For the W series

DC input voltage			
Typical	V	24 or 48	IEC 61131-2
Range	V	20.5 to 49.9	
Input power			Depending on the use and state of inputs and outputs.
Typical	W	3.6	
Max.	W	13.2	
Input current			
Typical	A	0.15	
Max.	A	0.55	
Short-term inrush current			
Typical	A	2.5	
Max.	A	8.5	

Rated data DC input for version with For the I and FS series

DC input voltage			
Typical	V	24 or 48	IEC 61131-2
Range	V	20.5 to 49.9	
Input power			Depending on the use and state of inputs and outputs.
Typical	W	3.6	
Max.	W	27.6	
Input current			
Typical	A	0.15	
Max.	A	1.15	
Short-term inrush current			
Typical	A	3	
Max.	A	9.5	

24 V outputs | Standard-I/O

Application		Primarily for the supply of digital inputs.	
Connection		X3.1 / 24 V X3.2 / 24 V	
DC output voltage			
Typical	V	24	SELV/GNDLV
Range	V	16 ... 28	
max. output current	mA	400	Total current for all I/Os (M12 plug connector) - The maximum output current is limited to 400 mA even with an external supply. - Above +40°C the max. output current is reduced by 2.5%/°C
Short-circuit strength		Unlimited period	
External-voltage protection	V	+30	
Overcurrent fusing		Automatically resettable	

24 V outputs | For the I and FS series

Application		Primarily for the supply of digital inputs.	
Connection		X3.1 / 24 V X3.2 / 24 V X3.3 / 24 V X3.4 / 24 V	
DC output voltage			
Typical	V	24	SELV/GNDLV
Range	V	16 ... 28	
max. output current	mA	400/1000	Total current for all I/Os (M12 plug connector) - The maximum output current of 1000 mA is only possible with an external power supply. Otherwise, the maximum output current is limited to 400 mA. - Above +40°C the max. output current is reduced by 2.5%/°C - An external power supply is recommended for IO-Link®.
Short-circuit strength		Unlimited period	
External-voltage protection	V	+30	
Overcurrent fusing		Automatically resettable	

Extension box

Current consumption	mA	60	Current consumption of the Extension Box in operation Applies to Extension Box - with disconnect switch with status feedback and operating elements - with disconnect switch with status feedback, operating element and potentiometer
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Dimensions

Drives with extension box, wall-mounted

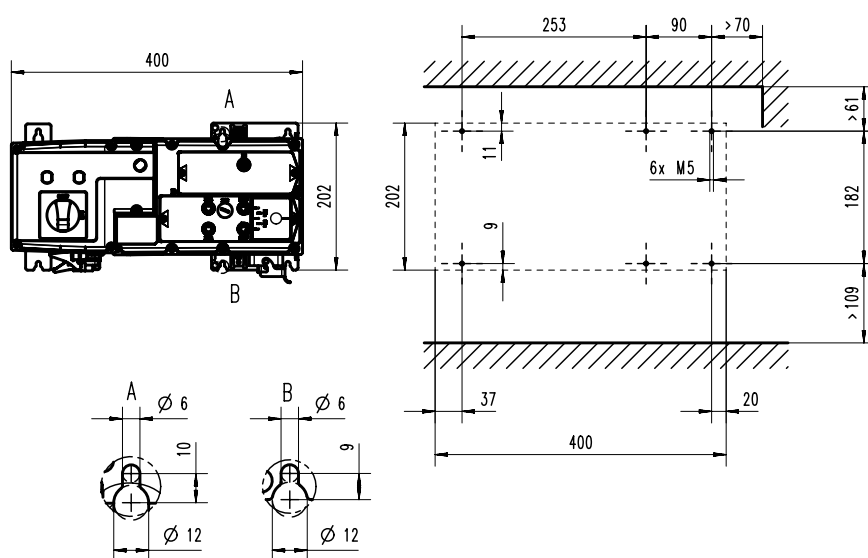
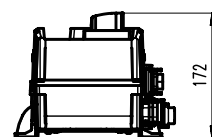
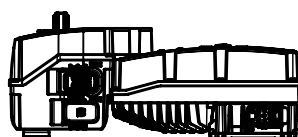
NOTE:

The specified installation clearances are minimum dimensions to ensure sufficient air circulation for cooling purposes. They do not take into account the bend radii of the connecting cables.

0,75 to 2.2 kW (1 to 3 HP)

The dimensions in mm apply to:

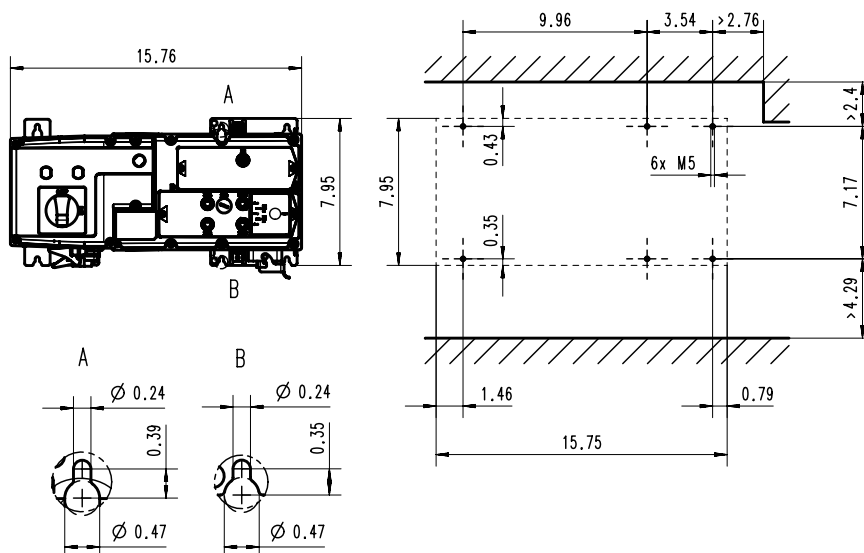
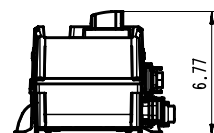
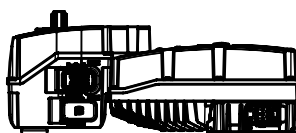
0.75 kW / 1HP	ATV350U07N4••
1.5 kW / 2HP	ATV350U15N4••
2.2 kW / 3HP	ATV350U22N4••
Weight	4.3 kg / 9.5 lb



8801653

The dimensions in inches apply to:

0.75 kW / 1HP	ATV350U07N4••
1.5 kW / 2HP	ATV350U15N4••
2.2 kW / 3HP	ATV350U22N4••
Weight	4.3 kg / 9.5 lb

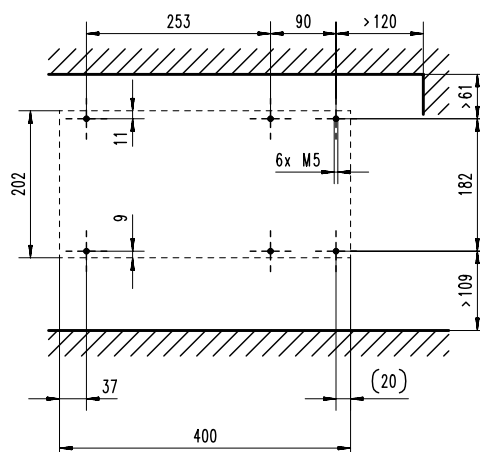
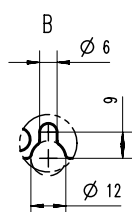
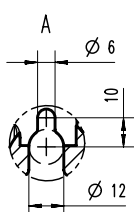
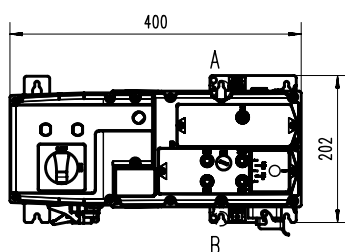
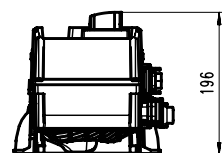
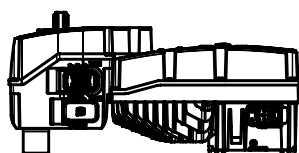


8801654

4 kW to 5.5 kW (5 HP to 7.5 HP)

The dimensions in mm apply to:

4 kW / 5 HP	ATV350U40N4••
5.5 kW / 7,5 HP	ATV350U55N4••
Weight	5 kg / 11 lb

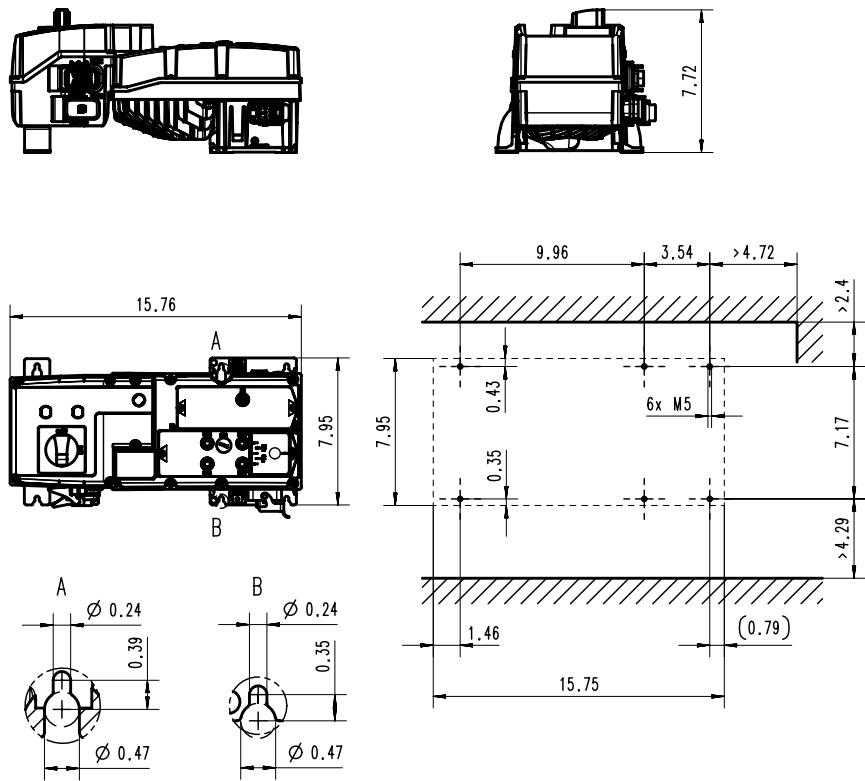


8801655

5 HP to 7.5 HP

The dimensions in inches apply to:

4 kW / 5 HP	ATV350U40N4••
5.5 kW / 7,5 HP	ATV350U55N4••
Weight	5 kg / 11 lb

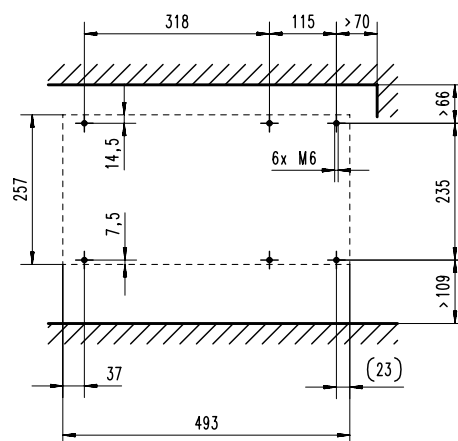
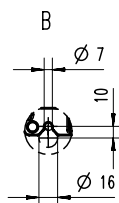
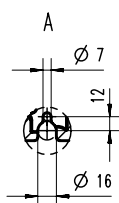
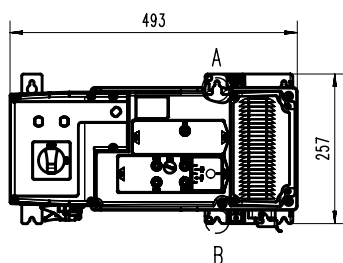
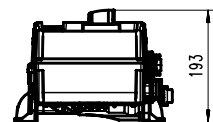
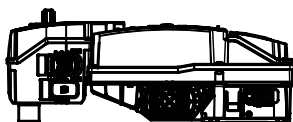


8801656

7.5 kW to 11 kW (10 HP to 15 HP)

The dimensions in mm apply to:

7.5 kW / 10 HP	ATV350U75N4••
11 kW / 15 HP	ATV350D11N4••
Weight	7.4 kg / 16.3 lb

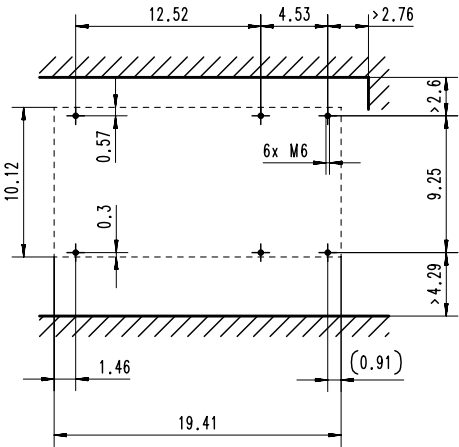
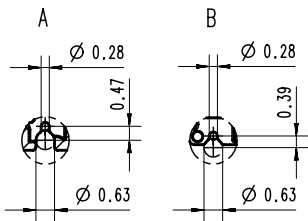
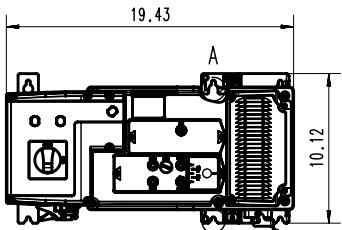
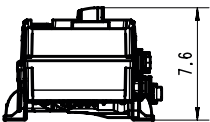
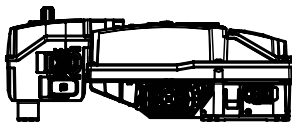


8801726

10 hp to 15 hp

The dimensions in inches apply to:

7.5 kW / 10 HP	ATV350U75N4••
11 kW / 15 HP	ATV350D11N4••
Weight	7.4 kg / 16.3 lb



8801727

Product extensions

Overview

I/O extensions

By default, the drives are equipped with either For the W series or For the I and FS series. In the device version with For the I and FS series, four ports can be configured as IO-Link® master ports to communicate with sensors and actuators (IO-Link® devices).

IO-Link®, page 90

Networks

By default, the drives are equipped with a network interface. When ordering, select the network required for your application. The ordered network is then preset in the drive.

The following networks are available for selection:

EtherCAT, page 91

EtherNet/IP, page 92

Modbus TCP, page 93

PROFINET, page 95

The drive itself has the firmware for all available networks on board and the user has the possibility to switch the drive to another network.

Safety function

The drives can **optionally** be equipped with integrated Safety function.

Safety function

I/O extensions

I/O extensions

Depending on the device version (with For the W series or For the I and FS series), various functions are available that can be assigned to M12 connectors X3.1 to X3.4.

Further details can be found in the following sections.

HTL encoder

Both For the W series and For the I and FS series support the connection of a single or dual track HTL encoder.

- A single-track HTL encoder (track A) cannot be used for motor speed feedback.

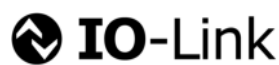
- A two-track HTL encoder (track A and B) must have a phase offset of exactly 90° between track A and B (error $\leq \pm 10^\circ$). Inverted tracks are not required.
- Encoder increments: ≤ 16384 increments per revolution

Pulse-Train/Pulse-In

Both For the W series and For the I and FS series support the output of a reference frequency ("pulse train"). Other drives can interpret this signal as a setpoint signal, for example.

The For the I and FS series can also evaluate the signal of a low-cost HTL encoder or a reference frequency and accept it as a setpoint signal ("Pulse-In"). The detection of a direction signal ("pulse direction") is also supported here.

IO-Link®



IO-Link® is a registered trademark. It may only be used by members of the IO-Link® community and non-members that have purchased the corresponding license. Detailed information on use can be found in the IO-Link® Community Rules:

<https://IO-Link®.com>

IO-Link® is the standardized I/O technology (IEC 61131-9) for communication with sensors and actuators. Point-to-point communication is based on the three-wire sensor and actuator connection without additional requirements on cable material.

IO-Link® is not a fieldbus, but rather an advancement of existing connection technology for sensors and actuators..

Bus-related information			
Name		IO-Link® V 1.1	
Communication medium		Unshielded 3-wire standard cable	
Use		Connection of I/O-Link devices (port class A) to the drive (I/O-Link master)	
Connection technology		M12 connector (A coded)	
Status display		1 LED	
Connection designation		X3.x: L+, C/Q, L-	

Technical data			
Topology			
Master – device		Tree (point to point)	
Station			
Type		Master	
Master – device		1:1	
Baud rate	kbps	230.4	COM3
Max. length	m	20	
Max. cable length between IO-Link® master and IO-Link® device	m	20	
Process data IO-Link® master			
Input		32 Byte	

(Continued)

Output		32 Byte	
Processing time of process data			
Cycle time	ms	2	

Networks

EtherCAT

EtherCAT® (Ethernet for Controller and Automation Technology) is an Ethernet-based fieldbus system which fulfils the application profile for industrial plant systems.

General information			
Version		Optionally	
DC supply of the control electronics and optional fieldbus		Internally via the drive	Network-dependent
		Alternatively: External supply to X100/ 24E to GND	Mains-independent DC 24 to 48 V (20.5 to 49.9 V)

Bus-related information			
Name		EtherCAT	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Connection as EtherCAT slave	
Status display		2 LEDs (RUN, ERR)	
Connection designation		X396 (IN)	
		X397 (OUT)	

Technical data			
Communication profile		EtherCAT	
		CANopen over EtherCAT	
		File over Ethernet (FoE)	
		Ethernet over EtherCAT (EoE)	
Safety over EtherCAT (FSoE)		No	
Vendor ID [hex]		0x3B	
Network topology		Line, tree, ring	
Device			
Type		EtherCAT slave	
Max. number		65535	In the entire network
Max. cable length	m	Not limited	The length between the devices is decisive.
Max. cable length between two devices	m	100	
Process data			PDOs can be configured for 1-, 2- and 4-byte parameters of the device
Transmit PDOs	Bytes	max. 32	

(Continued)

Receive PDOs	Bytes	max. 32	
Cycle time	ms	Integer multiple of 1 ms	

Communication time			
Communication time depends on		Processing time in the drive	Time between start of a request and arrival of response
		Telegram runtime (baud rate, telegram length)	
		Nesting depth of network	
		Bus load	

Processing time of process data			
Update cycle	ms	1	In the drive
Processing time	ms	0 to 1	
Application task runtime of the technology application used (tolerance)	ms	1 to x	

Other data			
Note: There are no interdependencies between parameter data and process data.			

EtherNet/IP

EtherNet/IP is a common fieldbus for the connection of drives to different control systems in plants.

General information			
Version		Optionally	
DC supply of the control electronics and optional fieldbus		Internally via the drive	Network-dependent
		Alternatively: External supply to X100/ 24E ... GND	Mains-independent DC 24 to 48 V (20.5 to 49.9 V)

Bus-related information			
Name		EtherNet/IP	
Communication medium		Ethernet 10 Mbps, 100 Mbps, half duplex, full duplex	
Use		Connection as EtherNet/IP adapter	
Status display		2 LEDs (CIP Module Status, CIP Network Status)	
Connection designation		X396 (IN) X397 (OUT)	

Technical data			
Communication profile		EtherNet/IP	
		AC Drive	
Bus terminating resistor		Not required	

(Continued)

Integrated bus terminating resistor		No	
Network topology			
Without repeater		Line, tree, ring	
With repeater		-	
Device			
Type		Adapter (Device)	
Max. number		254	Per subnetwork
Address		Station name	
Max. cable length	m	Not limited	The length between the devices is decisive
Max. cable length between two devices	m	100	
Process data			PDOs can be configured for 1-, 2- and 4-byte parameters of the device
Transmit PDOs	Bytes	max. 32	
Receive PDOs	Bytes	max. 32	
Cycle time	ms	> 4	
Switching method		Store and forward Cut-through	
Switch latency	µs	~ 125	With maximum telegram length
Other data		Additional TCP/IP channel	

Communication time			
Communication time depends on		Processing time in the drive	Time between start of a request and arrival of response
		Telegram runtime (baud rate, telegram length)	
		Nesting depth of network	
		Bus load	

Processing time of process data			
Update cycle	ms	1	In the drive
Processing time	ms	0 to 1	
Application task runtime of the technology application used (tolerance)	ms	1 to x	

Other data			
Note: There are no interdependencies between parameter data and process data.			

Modbus TCP

Modbus is an internationally approved Ethernet-based communication protocol, designed for commercial and industrial automation applications.

General information			
Version		Optionally	

(Continued)

DC supply of the control electronics and optional fieldbus		Internally via the drive	Network-dependent
		Alternatively: External supply to X100/ 24E ... GND	Mains-independent DC 24 to 48 V (20.5 to 49.9 V)

Bus-related information			
Name		Modbus TCP	
Communication medium		Ethernet 10 Mbps, 100 Mbps, half duplex, full duplex	
Use		Connection as a Modbus TCP server (secondary) to a client (primary)	
Status display		2 LEDs	
Connection designation		X396 (IN) X397 (OUT)	

Technical data			
Communication profile		Modbus/TCP	
Bus terminating resistor		Not required	
Integrated bus terminating resistor		No	
Network topology			
Without repeater		Line, tree, ring	
With repeater		-	
Device			
Type		Server	
Max. number		254	Per subnetwork
Address		Station name	
Max. Cable length	m	Not limited	The length between the devices is decisive
Max. cable length between two devices	m	100	
Process data			
Transmit PDOs	Bytes	256	
Receive PDOs	Bytes	256	
Cycle time	ms	> 4	
Switching method		-	
Switch latency	µs	~ 125	At maximum telegram length
Other data		Additional TCP/IP channel	

Communication time			
Communication time depends on		Processing time in the drive	Time between start of a request and arrival of response
		Telegram runtime (baud rate, telegram length)	
		Nesting depth of network	
		Bus load	

Processing time of process data			
Update cycle	ms	1	In the drive
Processing time	ms	0 to 1	
Application task runtime of the technology application used (tolerance)	ms	1 to x	

Other data
Note: There are no interdependencies between parameter data and process data.

PROFINET

PROFINET is a common fieldbus for the connection of drives to different control systems in plants.

General information			
Version		Optionally	
DC supply of the control electronics and optional fieldbus		Internally via the drive	Network-dependent
		Alternatively: External supply to X100/ 24E ... GND	Mains-independent DC 24 to 48 V (20.5 to 49.9 V)

Bus-related information			
Name		PROFINET RT	
Communication medium		Ethernet 100 Mbps, full duplex	
Use		Integration as PROFINET I/O device	
Status display		2 LEDs (Ready, Error)	
Connection designation		X396 (IN) X397 (OUT)	

Technical data			
Communication profile		PROFINET	
Bus terminating resistor		Not required	
Integrated bus terminating resistor		Yes	
Network topology			
Without repeater		Line, tree, ring	
With repeater		-	
Device			
Type		I/O device with real-time communication properties (RT) Conformance class B	
Max. number		255	Per subnetwork
Address		Station name	
Max. cable length	m	Not limited	The length between the devices is decisive.
Max. cable length between two devices	m	100	
Process data			PDOs can be configured for 1-, 2- and 4-byte parameters of the device

(Continued)

Transmit PDOs	Bytes	max. 32	
Receive PDOs	Bytes	max. 32	
Cycle time	ms	1, 2, 4, 8, 16	
Switching method		Cut-through	
Other data		Additional TCP/IP channel	

Other data

Note: There are no interdependencies between parameter data and process data.

Safety function

General information and basics

Safety function describes the necessary measures that need to be taken by means of electrical or electronic equipment to prevent or eliminate dangers due to functional errors.

Protective devices prevent any human access to hazardous areas during normal operation. However, persons may have to be in hazardous areas in certain operating modes. The machine operator is protected by internal drive and control measures in these operating modes.

Integrated safety function

Integrated safety function provides the conditions in the controls and drives to implement protective functions. Planning and installation effort is reduced. Using integrated safety function increases machine functionality and availability. Integrated safety function can be used to protect personnel working on machines in accordance with the Machinery Directive.

Safety component

The safety component in the drive provides the safe interfaces (e.g., safe inputs or safe network interfaces). If the STO safety function is requested, the safety component immediately brings about the torque-free state according to EN 61800-5-2.

In the "Fieldbus Safety" version, the safety component also monitors safe compliance with the limit values. If monitored limit values are exceeded, the safety component reacts with safety functions according to EN 61800-5-2.

Safety components are marked in red.

Standards

Safety regulations are established by laws, governmental guidelines, and expert consensus, e.g., technical regulations

The regulations and rules to be applied must be observed in accordance with the application.

Risk assessment

This documentation can only accentuate the need for a risk assessment. The user of the integrated safety function must read up on standards and the legal situation.

Before a machine can be placed on the market, the manufacturer of the machine must conduct a risk assessment according to the 2006/42/EC: Machinery Directive [UKCA: S.I. 2008/1597 – The Supply of Machinery (Safety) Regulations 2008] to determine the hazards associated with the use of the machine.

The Machinery Directive refers to three basic principles for the highest possible level of safety:

- Hazard elimination / minimization by the construction itself.

- Taking the protective measures required against hazards that cannot be removed.
- Existing residual hazards must be documented and the user must be informed of them.

Detailed information on the risk assessment is provided in the DIN EN ISO 12100:2013-08: Safety of machinery – General principles for design – Risk assessment and risk reduction. The result of the risk assessment determines the category for safety-related control systems according to EN ISO 13849-1. Safety-oriented parts of the machine control must be compliant.

Service life

The service life of the used components must be complied with.

At a defect or when the service life of a component has expired, the complete component must be replaced. Continued operation is not permitted!

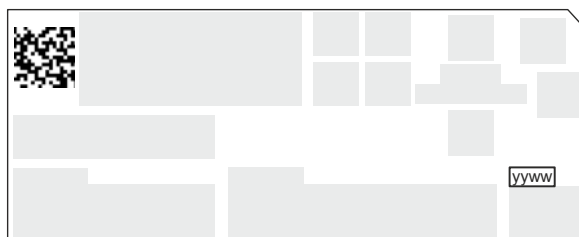
NOTE:

The service life for the safety functions cannot be reset by a special proof test. The specified service life starts at the date of manufacture.

service life [Safety-related data](#), page 134

Manufacturing date

The manufacturing date can be found on the nameplate:



yyww	Year of manufacture and week of manufacture (2144 = CW 44 2025)
------	---

Stop functions

The stop functions differ according to how they are triggered:

- Normal stop (simple stop)
 - Triggering via a safe input (if available) with the programmed stop function (e.g., STO or SS1).
 - Triggering via a safety bus by activating the corresponding bit (e.g., STO or SS1) in the control data.
- Error stop
 - Triggered as a response to an error.

Prioritization

Stop functions with higher priority override lower-order functions which have already been initiated.

Hierarchy:

1. Safe torque off (STO)
 - STO has the highest priority and takes precedence over all other functions.
 - Functions that have already been initiated (e.g., SS1) are canceled and the drive is switched off.
2. Safe stop 1 (SS1)
 - Observing the defined stop time for SS1 as well as the SS1 mode, the drive is rendered torque-free.

The monitoring functions have equal priority and can be executed simultaneously with the stop function.

Acceptance

The machine manufacturer must check and prove the operability of the safety functions used.

- The machine manufacturer must authorize a person as an inspector who can carry out the test on the basis of their technical training and knowledge of the safety functions.
- The inspector must document and sign the result of the test of each safety function in a test report.

A complete test includes:

- Document the installation including the safety functions:
 - Create an overview image of the installation.
 - Describe the installation.
 - Describe safety devices.
 - Document the safety functions used.
 - Complete validation of the safety functions used, including tests under fault conditions.
- Create test report:
 - Document the functional test.
 - Check parameters.
 - Sign test report.
- Create an annex with test records:
 - Protocols for the installation.
 - External recordings

Periodic inspections

After installation and after every modification, the user must check and validate the safety function.

The user must document these tests.

The correct sequence of the safety functions must be checked in periodic inspections. The risk analysis or applicable regulations determine the intervals between the tests.

The inspection interval should not exceed one year.

Device exchange

Replace a maximum of one safety device before recommissioning.

NOTE:

The following procedure assumes that the safe parameter set for the application is available as a file. Otherwise, a complete commissioning of the safety function must be carried out.

How to replace a safety device with Extended Safety:

Preconditions:

- The safe parameter set for the application is available as a file.
 - There is an online connection between the engineering tool and the replacement device.
1. Check the compatibility of the replacement device.
 2. Reset the safe parameter set to the default settings if the replacement device was previously used for test purposes or for another application:
 - a. In the **+Safety parameter list+**, execute the command "Reset safe parameter set in device".
 - b. Type the password (default setting: `Schneider Safety`).
 - c. Confirm the prompt to reset the safe parameter set in the device by selecting "Yes."
 3. Load the safe parameter set for the application from the file into the replacement device:
 - a. In the **+Safety parameter list+**, execute the command "Load safe parameter set from file".
 - b. Type the password (default setting: `Schneider Safety`).
 - c. Confirm the prompt to overwrite the existing safe parameter set with the file parameter set by selecting "Yes."
 4. Transfer the safe parameter set to the replacement device.
 5. Carry out a functional test.

Safe parameter setting

Safety parameters can only be set and transferred in the "Altivar ATV350 Drives Manager" via the **+safety parameter list+**. This dialog is available when you select a device with integrated safety technology or a safety module.

Open **+safety parameter list+**:

- "Altivar ATV350 Drives Manager": Open the **+safety parameter list+** tab.

NOTE:

The safe parameterization is checked for plausibility.

The plausibility check rejects ambiguous or contradictory settings until they have been programmed correctly. Only then can the parameters be saved.

Safety address

The unambiguousness of an axis with safety functions in a drive system can be achieved by means of the safety address. The parameter set is saved in the safety option (and, depending on the device, on the SD card) with a unique safety address. When initializing the safety option, i.e., when loading the safe parameter set, the safety address is checked for conformity. If compliance is not met, an initialization error is reported.

- In drive systems without activated safety bus or with CIP Safety™ safety bus, unambiguousness and correct assignment of the safety address must be checked. For this purpose, use the "Altivar ATV350 Drives Manager".

NOTE:

Clearly define the safety address in a drive system or plant.

Document the safety address in circuit diagrams and markings.

NOTE:

If the device detects a changed safety address during initialization, it requests an acknowledgment with confirmation button S82.

Parameter

Address	Name / Setting range / [default setting]		Information
0x2110:011	Safety commands: Reset safety address		
	0	Off / ready	Only status feedback
	1	On / start	Execute device command
	2	In progress	Only status feedback
	3	Action cancelled	
	4	No access	
0x2110:012	Safety commands: Verify safety address		
	0	Off / ready	Only status feedback
	1	On / start	Execute device command
	2	In progress	Only status feedback
	3	Action cancelled	
	4	No access	

acknowledgment with confirmation button S82

If the device detects a modified parameter set or a changed safety address during initialization, for example, it requests an acknowledgment with confirmation button S82.

Display for requested acknowledgment

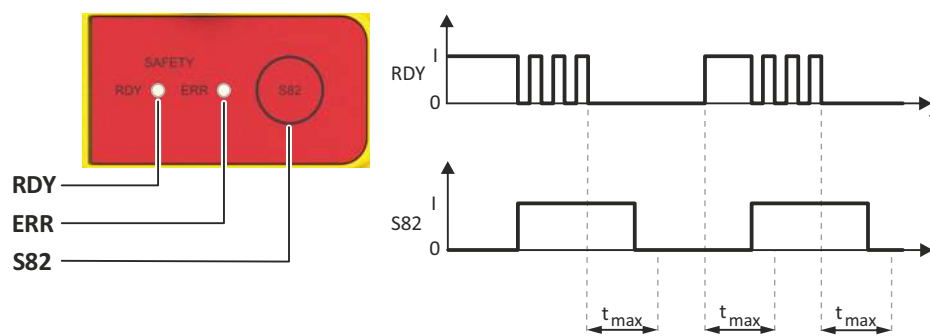
LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
 on	off	Restart acknowledgment requested	The device is working correctly.
	 blinking red 1 Hz		During start-up, a modified parameter set was detected in the "Init" state.
	 blinking red 2 Hz		During start-up, a changed safety address was detected in the "Init" state.

NOTE:

All requests are acknowledged with the same steps.

The acknowledgment procedure is aborted if the reaction time of 2.5 seconds is exceeded. The acknowledgment procedure must be repeated.

Sequence of the acknowledgment procedure



RDY	LED "RDY"
S82	Confirmation button S82
t	Time axis
t _{max}	Maximum permissible response time

To acknowledge the request with the S82 confirmation button:

Precondition:

- The "RDY" LED is lit.
- The "ERR" LED is blinking.

1. Press and hold the S82 button.
 - The "RDY" LED starts blinking.
2. The "RDY" LED goes off after 3 seconds.
3. Release the S82 button after a maximum of 2.5 seconds.
 - The "RDY" LED is lit.
4. Press and hold the S82 button after a maximum of 2.5 seconds.
 - The "RDY" LED starts blinking.
5. The "RDY" LED goes off after 3 seconds.
6. Release the S82 button after a maximum of 2.5 seconds.
 - The acknowledgment is successfully completed.

The action is recorded in the drive logbook.

7. Use a function test to ensure that the acknowledgment has led to the correct result.

NOTE:

If the parameter set is invalid, an error is reported and the "ERR" LED starts blinking.

Parameter set information

Parameter

Address	Name / setting range / [default setting]	Information
0x2114:0-01	Parameter set: Version • Safety parameter (+Safety parameter list+)	Display of the version of the safe parameter set. Changes can be made via the +Safety parameter list+ dialog.
	10-40-5 iSM ES V1.4	

(Continued)

Address	Name / setting range / [default setting]	Information
0x2114:0-02	Parameter set: Project CRC 0 ... [0] to 4294967295	Project CRC of the safe parameter set.
0x2115:0-01	Parameter set: Status • Read only	Current status of the safe parameter set.
	0 No parameter set	
	1 Valid parameter set	
	4 CRC error	
	5 Version error	
	7 Plausibility error	
	8 Assignment error	
	9 Local read error	
	10 Communication error with basic device	
	11 error release	
	12 Different CRCs	
	13 Changed parameter set	
	14 Parameter set checked	
	15 Parameter set check active	
0x2115:0-02	Parameter set: Current CRC • Read only	Display of the current parameter CRC from the safe parameter set.
0x2115:0-03	Parameter set: Last valid CRC • Read only	Display of the last valid parameter set CRC.
0x2115:0-04	Parameter set: Parameter setting time stamp • Read only: x s	Time when the parameter set is taken over from the device as the value of the power-on time meter.
0x2115:0-05	Parameter set: Error information 1 • Read only	Error number at a plausibility error (0x2115:001 = 7). Details: Safety – Parameter set plausibility errors
0x2115:0-06	Parameter set: Error information 2 • Read only	Reserved
0x2115:0-07	Parameter set: Error information 3 • Read only	
0x2115:0-08	Parameter set: Current CRC without specific identifiers • Read only	Display of the current parameter CRC from the safe parameter set without taking into account the following device-specific identifiers: • Safety address (0xF980:002) • CIP Safety – Node ID (0x212A:0050x212A:005, page 114) • CIP Safety – SNN Date (0x212A:0060x212A:006, page 114) • CIP Safety – SNN Time (0x212A:0070x212A:007, page 114) • CIP Safety – SCTS Date (0x212A:0080x212A:008, page 114) • CIP Safety – SCTS Time (0x212A:0090x212A:009, page 115) This parameter makes it possible to effectively check the consistency of safety function configurations across different devices.

Commands

Parameter

Address	Name / Setting range / [default setting]	Information
0x2110:0-01	Safety commands: STO and service state	
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-02	Safety commands: SS1 and service state	
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-03	Safety commands: Change to service state	
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-05	Safety commands: Load and check parameters	
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-06	Safety commands: Accept parameters	
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-07	Safety commands: Discard parameters	
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-09	Safety commands: Export all parameters	

(Continued)

Address	Name / Setting range / [default setting]	Information
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-13	Safety commands: Enable parameters	
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-15	Safety commands: Activate muting	Command: Activate the Safe Muting (MUT) function.
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-16	Safety commands: Reset error	
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-17	Safety commands: Acknowledge restart	
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2110:0-20	Safety commands: Reset Output Ownership	
	0 Off / ready	Only status feedback
	1 On / start	Execute device command
	2 In progress	Only status feedback
	3 Action cancelled	
	4 No access	
0x2111:0-01	Safety commands: State • Read only	
0x2111:0-02	Safety commands: Password 0 ... [0] ... 4294967295	

Safe interfaces

Overview: Safe interfaces in ATV350 drives

safety function design	Products	Safe inputs	Safe output	Safe network interfaces	
				FSOE	CIP Safe-ty™
Basic Safety – STO	ATV350	1 (STO)			
Extended Safety – S	Altivar Machine ATV350				•

Abbreviations used:		
CIP	Common Industrial Protocol	CIP Safety connection, page 107
FSOE	FailSafe over EtherCAT	-
STO	Safe torque off (STO)	Safe torque off (STO), page 120

The Altivar Machine ATV350 variable speed drive is available in the following safety function versions:

- Basic Safety – STO
- Extended Safety – S

Safe inputs

Function included in variant:	Basic Safety – STO
-------------------------------	--------------------

The components used must comply with the risk reduction required for the application.

Passive sensors

Passive sensors are 2-channel switching elements with contacts.

Please note the following:

- The switches must be wired according to the closed-circuit principle.
- Passive sensors are connected to the drive via a safety switching device.
- An external safety component must monitor the connecting cables and the function of the sensors if complete exclusion of errors cannot be guaranteed.

The contacts must switch at the same time (equivalent). Safety functions will be activated if only one channel is switched. Switching of only one channel points to error sensors or impermissible wiring.

Examples of passive sensors:

- Door contact switch
- Emergency stop control units

Active sensors

Active sensors are units with 2-channel semiconductor outputs (OSSD outputs).

Test pulses for monitoring the outputs and cables are permissible.

P/M-switching sensors switch the positive and negative cables, or the signal and ground cables, of a sensor signal.

Please note the following:

- The maximum permissible connection capacity of the outputs.
- Active sensors are connected directly to the drive.
- Monitoring for short circuits must be carried out by the active sensor.

The outputs must switch at the same time (equivalent). Safety functions will be activated if only one channel is switched. The active control of only one channel points to error sensors or impermissible wiring.

Examples of active sensors:

- Lightgrid
- Laser scanner
- Controllers

Safe network interfaces

Function included in variant:	Extended Safety
-------------------------------	-----------------

Parameter

Address	Name / Setting range / [default setting]	Information
0x2128	S-Bus configuration • Safety parameter (+Safety parameter list+)	Configuration of safe bus system.
	0 No safety bus	
	20 CIP Safety / EtherNet/IP	

CIP Safety connection

Function included in variant:	Extended Safety
-------------------------------	-----------------



CIP Safety™ is the certified safety protocol for the transmission of safety-related data via EtherNet/IP® in accordance with the specification "The CIP Networks Library Volume 5 CIP Safety" of the Open DeviceNet Vendor Association (ODVA).

Communication-specific properties	
RPI for CIP Safety inputs/outputs	10 to 1000 ms
Number of simultaneous CIP Safety I/O connections	1 Singlecast Safety Output and 1 singlecast safety input or 5 multicast safety outputs
Connection types of the CIP Safety output connection	Singlecast
Connection types of the CIP Safety input connection	Singlecast or multicast (maximum 5 consumers)

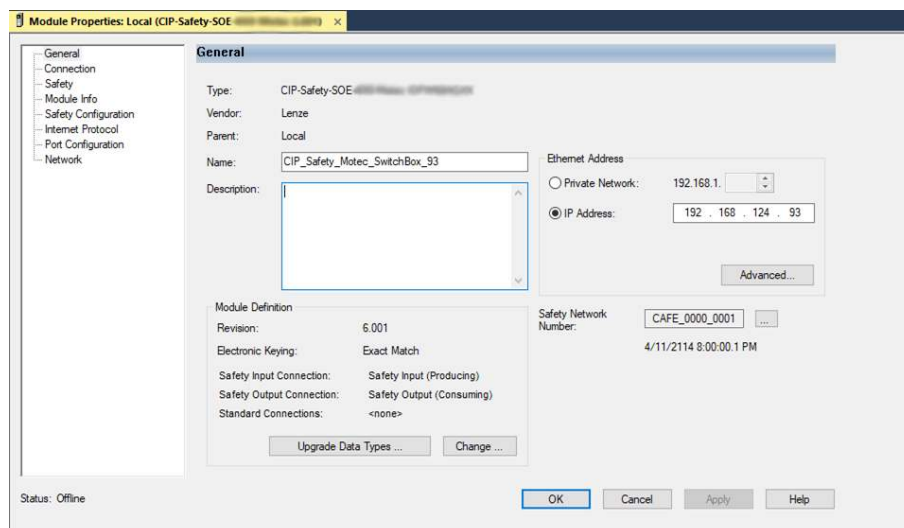
(Continued)

Communication-specific properties	
Supported CIP Safety I/O format	Extended Format
Supported Safety Open Types	Type 2a and 2b

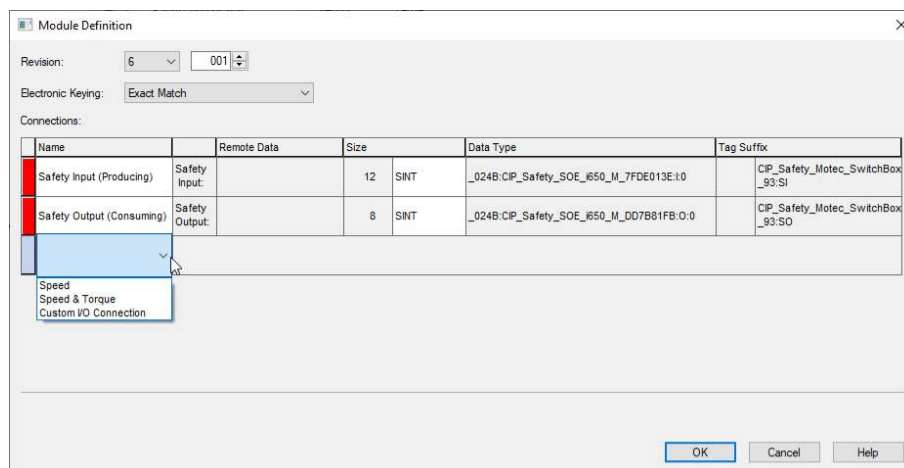
Commissioning

Example: CIP Safety connection of the device in the "Studio 5000 Logix Designer®"

1. Add the EDS file in "Studio 5000 Logix Designer®" and specify the device name, IP address and Safety Network Number (SNN):

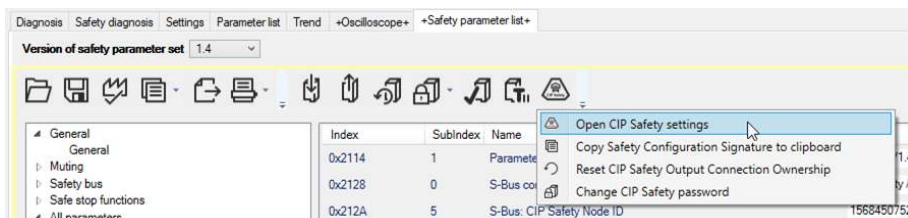


You can then change the Module Definition according to the requirements of your application:

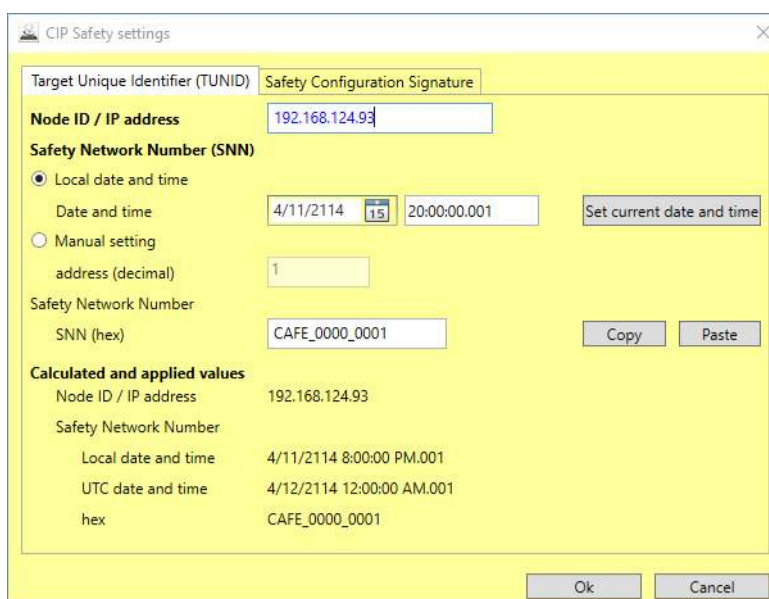


2. Set the IP address, subnet and gateway in the "Altivar ATV350 Drives Manager".
(Settings: Communication – Fieldbus – EtherNet/IP)
3. Optional: Reset the safe parameter set to the default settings:
 - a. In the **+Safety parameter list+**, execute the command "Reset safe parameter set in device".
 - b. Type the password (default setting: "Schneider Safety").
 - c. Confirm the query as to whether the safe parameter set in the device should be reset with "Yes".

4. Set the following parameters in the **+Safety parameter list+** under "All parameters":
 - a. S-Bus configuration (0x2128, page 107) = "CIP Safety / EtherNet/IP"
 - b. STO Source S-Bus (0x2891, page 126) = "Activated"
 - c. STO: Restart (0x2892:001, page 126)
5. In the **+Safety parameter list+**, open the CIP Safety settings via the **CIP Safety menu**:



6. In the "Target Unique Identifier (TUNID)" tab:



- a. Set the IP address to the same value as previously under Communication – Fieldbus – EtherNet/IP (step 2).
- a. Set the Safety Network Number (SNN) to the same value as previously in "Studio 5000 Logix Designer®" (step 1).

7. Set the Safety Configuration Time Stamp (SCTS) in the "Safety Configuration Signature" tab.

The screenshot shows the 'CIP Safety settings' dialog box with the 'Safety Configuration Signature' tab selected. The 'Safety Configuration Time Stamp' section has a date field set to '5/24/2024', a time field set to '15', and a time zone field set to '10:34:43.600'. There is a 'Set current date and time' button. The 'Safety Configuration CRC' section shows an 'ID (hex)' of 'A40D_6989'. The 'Calculated and applied values' section shows the 'Safety Configuration Time Stamp' with 'Local date and time' as '5/24/2024 10:34:43 AM.600', 'UTC date and time' as '5/24/2024 2:34:43 PM.600', and a 'hex' value of '4AC1_0320_D610'. At the bottom are 'Ok' and 'Cancel' buttons.

The Safety Configuration Time Stamp (SCTS) can be set manually or automatically to the current date and time of the PC. The signature of the safety configuration (SCID) results from the Safety Configuration Time Stamp (SCTS) and the Safety Configuration CRC (SCCRC).

NOTE:

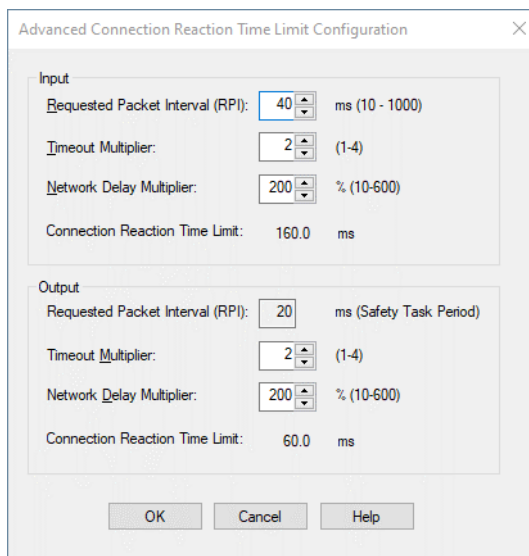
For PCs with different time zones, please note that the UTC time between the device and PLC device settings must match. This is the time that is transmitted when the security connection is checked.

8. In the **+Safety parameter list+**, copy the signature of the safety configuration (SCID) to the clipboard via the **CIP Safety menu**.
9. In the "Studio 5000 Logix Designer®" in the "Safety" tab, use the "Paste" button to paste the previously copied signature of the safety configuration (SCID):

The screenshot shows the 'Module Properties: Local (CIP-Safety-SOE)' window in Studio 5000 Logix Designer. The 'Safety' tab is selected. It contains a table for connection parameters, a 'Configuration Ownership' section with a 'Reset Ownership' button, and a 'Configuration Signature' section. The 'Configuration Signature' section has fields for 'ID' (Hex), 'Date', and 'Time' (ms), along with 'Copy' and 'Paste' buttons. The status at the bottom is 'Offline'. Buttons for 'OK', 'Cancel', 'Apply', and 'Help' are at the bottom right.

Connection Type	Requested Packet Interval (RPI) (ms)	Connection Reaction Time Limit (ms)	Max Observed Network Delay (ms)
Safety Input	40	160.0	Reset
Safety Output	20	60.0	Reset

10. Define the extended EtherNet/IP settings in the "Studio 5000 Logix Designer®" (RPI, timeout according to the application requirements):



The dialog box is titled "Advanced Connection Reaction Time Limit Configuration". It contains two sections: "Input" and "Output".

Input Section:

- Requested Packet Interval (RPI): 40 ms (10 - 1000)
- Timeout Multiplier: 2 (1-4)
- Network Delay Multiplier: 200 % (10-600)
- Connection Reaction Time Limit: 160.0 ms

Output Section:

- Requested Packet Interval (RPI): 20 ms (Safety Task Period)
- Timeout Multiplier: 2 (1-4)
- Network Delay Multiplier: 200 % (10-600)
- Connection Reaction Time Limit: 60.0 ms

At the bottom are buttons for "OK", "Cancel", and "Help".

- This completes the CIP Safety connection of the device.

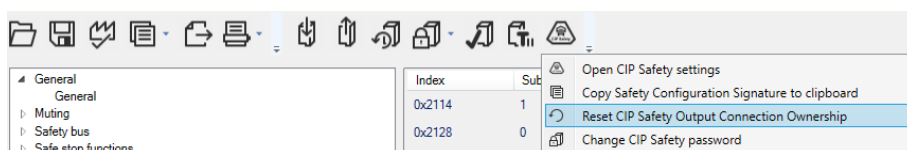
Reset CIP Safety Output Connection Ownership

This function is used to administratively separate an existing CIP Safety output connection, which controls the safety functions of the drive, from a safety controller ("Originator").

The first safety controller that successfully establishes a CIP Safety output connection to the drive controls its safety functions as the sole owner ("Owner"). This safety function is critical to prevent error connections from taking control of initial resources in a validated safety system. To transfer this ownership ("Ownership"), for example if the safety controller is replaced and its SNN or node ID is changed as a result, the ownership must be reset.

To cancel an existing CIP Safety output connection:

1. In the "Altivar ATV350 Drives Manager" in the **+Safety parameter list+**, execute the "Reset CIP Safety Output Connection Ownership" command via the **CIP Safety menu**.



2. Check that the correct device is being used:

Reset CIP Safety Output Connection Ownership

Device type: Identify device

Device name: Confirm

Serial number: Cancel

Safety address:

CIP Safety TUNID Node ID / IP address:

SNN (hex):

Confirmation state:

Close

a. Check that all identification data matches the expectations.

a. Click on the "Identify device" button to activate the optical device identification. This function can be used to localize the drive by means of flashing LEDs.

3. Click on the "Confirm" button to reset the CIP Safety Output Connection Ownership:

Reset CIP Safety Output Connection Ownership

Device type: Identify device

Device name: Confirm

Serial number: Cancel

Safety address:

CIP Safety TUNID Node ID / IP address:

SNN (hex):

Confirmation state:

Close

4. Click on the "Close" button to close the dialog.

NOTE:

The execution of this function can optionally be protected by the CIP Safety password. The default setting is that no password is set (display "0" in the parameter "S-Bus: CIP Safety – Password" 0x212A:0110x212A:011, page 115).

The CIP Safety password can be set up or changed via the "Change CIP Safety Password" dialog (see following section).

NOTE:

The originator ID of the output connection (OCPUNID) is also reset if the safe parameter set is reset.

Set up/change CIP Safety password

1. In the "Altivar ATV350 Drives Manager" in the **+Safety parameter list+**, execute the "Change CIP Safety password" command via the **CIP Safety menu**.



2. Change password:

3. Click on the "Ok" button to apply the settings.
4. Transfer safe parameter set to device for the change to take effect. Otherwise the old password remains valid.

Reset CIP Safety password

1. In the "Altivar ATV350 Drives Manager" in the **+Safety parameter list+** set the parameter "S-Bus: CIP Safety – Password" (0x212A:0110x212A:011, page 115) = 0.
2. Transfer safe parameter set to device for the change to take effect. Otherwise the old password remains valid.

0x04-Assembly Object

The drive optionally supports additional CIP Safety relevant assembly object instances:

Attribute (Instance ID)	Name	Information	
161	Safety Output with STO	CIP Safety output data	For structure see the following sections
171	Safety Input with STO	CIP Safety input data	

0x04-Assembly Object

Parameter

Address	Name / Setting range / [default setting]	Information
0x212-A:005	S-Bus: CIP Safety – Node-ID 0 ... [276605120] ... 4278190079 Safety parameter (+Safety parameter list+)	IP address of the drive in the CIP Safety network. - The IP address can only be set in the "Altivar ATV350 Drives Manager" via the +safety parameter list+. Assignment via the CIP Safety Services "Propose_TUNID/Apply_TUNID" is not supported. - The default setting "276605120" corresponds to the IP address 192.168.124.16
0x212-A:006	S-Bus: CIP Safety – SNN Date 1 ... [4] ... 65534 Safety parameter (+Safety parameter list+)	DATE portion of the DATE_AND_TIME format of the Safety Network Number (SNN) specified by CIP. - The SNN is an identifier with which a CIP Safety network can be uniquely identified across all networks of the safety system. - The SSN can only be set in the "Altivar ATV350 Drives Manager" via the +safety parameter list+. Assignment via the CIP Safety Services "Propose_TUNID/Apply_TUNID" is not supported. - The default setting "4" corresponds to the value "manual setting EIP" specified in CIP Volume 5.
0x212-A:007	S-Bus: CIP Safety – SNN Time 0 ... [1] ... 86399999 Safety parameter (+Safety parameter list+)	TIME portion of the DATE_AND_TIME format of the Safety Network Number (SNN) specified by CIP. - The SNN is an identifier with which a CIP Safety network can be uniquely identified across all networks of the safety system. - The SSN can only be set in the "Altivar ATV350 Drives Manager" via the +safety parameter list+. Assignment via the CIP Safety Services "Propose_TUNID/Apply_TUNID" is not supported. - The default setting "1" corresponds to the value "manual setting EIP" specified in CIP Volume 5.
0x212-A:008	S-Bus: CIP Safety – SCTS Date 0 ... [18993] ... 65534 Safety parameter (+Safety parameter list+)	DATE portion of the DATE_AND_TIME format of the Safety Configuration Time Stamp (SCTS) specified by CIP. - The Safety Configuration Time Stamp (SCTS) and the Safety Configuration CRC (SCCRC) together form the signature of the safety configuration (SCID). - The SCTS can only be set in the "Altivar ATV350 Drives Manager" via the +safety parameter list+. Assignment via the CIP Safety Service "Validate_Configuration" is not supported. - The SCCRC corresponds to the value displayed in 0x2115:002, page 103.

(Continued)

Address	Name / Setting range / [default setting]	Information
0x212-A:009	S-Bus: CIP Safety – SCTS Time 0 ... [43200000] ... 86399999 Safety parameter (+Safety parameter list+)	TIME portion of the DATE_AND_TIME format of the Safety Configuration Time Stamp (SCTS) specified by CIP. - The Safety Configuration Time Stamp (SCTS) and the Safety Configuration CRC (SCCRC) together form the signature of the safety configuration (SCID). - The SCTS can only be set in the "Altivar ATV350 Drives Manager" via the +safety parameter list+. Assignment via the CIP Safety Service "Validate_Configuration" is not supported. - The SCCRC corresponds to the value displayed in 0x2115:002, page 103.
0x212-A:011	S-Bus: CIP Safety – Password 0 ... [0] ... 4294967295 Safety parameter (+Safety parameter list+)	Optional password for activating the "Reset CIP Safety Output Connection Ownership" function. 0 = No password set or existing password is reset.

Preconditions

- The CIP Safety™ protocol is supported (bit 2 in 0x212C:003 is set).
- The network selection is set to "EtherNet/IP". 0x231F:005
- Current EDS file
 - The EDS file can be used to integrate EtherNet/IP devices into the EtherNet/IP configuration software of PLC manufacturers.
 - Download the EDS file

Configure safety configuration

- Before integrating the drive into a safety network, the safe parameter set must be reset for each device.
- The "Safety Network Number" (SNN) must be unique for each safety network or safety subnet in the entire system.
- The user must carefully check the effects of device combinations with different SIL levels in the safety network.

Verify safety configuration

- The signature of the safety configuration (SCID) is automatically verified via the checksums.
- The user must visually check whether all safe configuration data has been correctly downloaded to the drive.
- When a safety device is configured directly from a workstation, the user must compare the transferred SCID data and configuration data with the SCID data and configuration data originally viewed in the workstation.
- If the user configures safety connections with a SCID = 0, the user is responsible for ensuring that the originator (safety master) and target (drive) are configured correctly.

NOTE:

Please note the following:

- This configuration setting bypasses the standard, automated safety configuration check!
- This poses a higher risk to the safety integrity of the system.

Test and validate safety configuration

- After installation, after each change to the safety configuration, and after device replacement, users must test the safety configuration loaded into the drive:
 - To test and verify the configuration of an originator with connection data, it must first be downloaded to the drive. This is the only way to confirm the SCID of the drive.
 - Check the signature of the safety configuration (SCID). Only then can the safety configuration be considered verified.
 - Check and prove the operability of the safety configuration used.
 - Test the configurations of the safety connections after they have been applied in the originator (safety master). Only then is it ensured that the target connection functions as intended.
- Further information:
 - Acceptance, page 99
 - Periodic inspections, page 99
 - Device exchange, page 99

Extended Safety

Structure of the CIP Safety output data (instance ID: 161)

The safety controller transmits CIP Safety output data (control commands) to the drive:

- Data length: 24 bytes
- Control commands are LOW-active, the bit state "0" activates the function.
- Exceptions: See details in the table.
The detail "0↗1" means a change of state from "0" to "1".

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	AIE (0↗1)	-	-	-	-	-	SS1	STO
Byte 1	-	-	-	-	-	-	-	AIS (0↗1)
Byte 2	-	-	-	-	-	-	-	-
Byte 3	-	-	-	-	-	-	-	-
Byte 4	-							
Byte 5	-							
Byte 6	-							
Byte 7	-							
Byte 8	Mode Byte							
Byte 9	CRC-S3 (low-byte)							
Byte 10	CRC-S3 (high-byte)							
Byte 11	Complement Data							
Byte 12								
Byte 13								
Byte 14								
Byte 15								
Byte 16								
Byte 17								

(Continued)

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 18								
Byte 19	CRC-S5_0							
Byte 20	CRC-S5_1							
Byte 21	Timestamp16 (low-byte)							
Byte 22	Timestamp16 (high-byte)							
Byte 23	CRC-S5_2							

Structure of the CIP Safety input data (instance ID: 171)

The drive transmits CIP Safety input data (status information) to the safety controller:

- Data length: 32 bytes
- Status information is HIGH-active, the bit status "1" indicates the active status information.

The drive sends the CIP Safety input data (status information) to the safety controller:

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 0	Error active	-	-	-	-	-	-	STO active
Byte 1	-	-	-	-	-	-	-	SS1 active
Byte 2	-	-	-	-	-	-	-	-
Byte 3	-	-	-	-	-	-	-	-
Byte 4	-	-	-	-	-	-	-	-
Byte 5	-	-	-	-	MUT active	-	-	-
Byte 6	-	-	-	-	-	-	-	-
Byte 7	-	-	-	-	-	-	-	-
Byte 8	-							
Byte 9	-							
Byte 10	-							
Byte 11	-							
Byte 12	Mode Byte							
Byte 13	CRC-S3 (low-byte)							
Byte 14	CRC-S3 (high-byte)							
Byte 15	Complement Data							
Byte 16								
Byte 17								
Byte 18								
Byte 19								
Byte 20								
Byte 21								
Byte 22								

(Continued)

Byte offset	Bit offset							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 23								
Byte 24								
Byte 25								
Byte 26								
Byte 27	CRC-S5_0							
Byte 28	CRC-S5_1							
Byte 29	Timestamp16 (low-byte)							
Byte 30	Timestamp16 (high-byte)							
Byte 31	CRC-S5_2							

Additionally supported CIP Safety relevant CIP objects

- 0x39-Safety Supervisor Object
- 0x3A-Safety Validator Object

Diagnostics

Status LEDs

When CIP Safety communication is set, the network status LEDs "MS" and "NS" display CIP Safety status information.

 **DANGER**

UNRELIABLE STATUS INFORMATION POSSIBLE DUE TO LEDS.
Only use LEDs for general diagnostics during commissioning or troubleshooting.
Do not use LEDs as status displays.
Failure to follow these instructions will result in death or serious injury.

The "MS" LED indicates the CIP Safety Supervisor State:

LED "MS" (green/red)	CIP Safety Supervisor State	State/meaning
off	No Power	The device is not supplied with power.
 on (green)	Executing	The device is ready for operation and the secure I/O connection has been established.
 blinking green	Idle	No IP address or no safe I/O connection.
 blinking red	Abort	The device has a rectifiable error. There is an addressing conflict with the node ID.

(Continued)

LED "MS" (green/red)	CIP Safety Supervisor State	State/meaning
 on (red)	Critical error	The device has an error that cannot be rectified.
 blinking green/red	Device Self- Testing	The device performs a self-test.

The "NS" LED indicates the CIP Safety network status:

LED "NS" (green/red)	CIP Safety- network status	State/meaning
off	No IP address	The network option is not supplied with power or has not yet received an IP address.
 on (green)	Connected	The network option is working properly and has established a connection to the originator.
 blinking green	No connections	The network option • works perfectly, • has been assigned an IP address, • has not yet been integrated into the network by the originator.
 blinking red	Connection Timeout	A timeout has occurred.
 on (red)	Duplicate IP	The network option cannot access the network (IP address conflict).
 blinking green/red	Device Self- Testing	The network option performs a self-test.

Diagnostic parameter

Address	Name / Setting range / [default setting]	Information
0x212-A:010	S-Bus: CIP Safety – status • Read only	Display of the current CIP Safety status of the device. Corresponds to Safety Supervisor Object Attribute 11 (Device Status).
	0 Undefined	Undefined state
	1 Self-Testing	A self-test is performed after switching on.
	2 Idle	Self-test successfully completed, a valid configuration is available.
	3 Self-Test Exception	Self-test has failed.
	4 Executing	At least one safety connection has been established.
	5 Abort	A recoverable error has occurred.
	6 Critical error	A non-recoverable error has occurred. The CIP Safety connections are not processed any further.
0x2134:-001	S-Event history CSS: Internal event 1 • Read only	Internal event history from CIP Safety Stack (CSS).

(Continued)

Address	Name / Setting range / [default setting]	Information
0x2134:-002	S-Event history CSS: Internal event 2 • Read only	
0x2134:-003	S-Event history CSS: Internal event 3 • Read only	

Safety functions

The Altivar Machine ATV350 variable speed drive is available in the following safety function versions:

- Basic Safety – STO
- Extended Safety – S

The "Extended Safety – S" version of the Altivar Machine ATV350 variable speed drive supports the CIP Safety™ protocol. Further information can be found in the section "Safe network interfaces, page 107".

Note on the function diagrams shown in this section

In the function diagrams shown for each safety function, the y-axis is indicated by "n" (for speed).

In contrast to a servo drive, the output frequency is decisive for a frequency drive. Therefore, all trigger thresholds and limits for the frequency drive must also be set in the form of frequency values in [Hz].

Safe torque off (STO)

The "Safe Torque Off (STO)" safety function safely switches off the drive. The drive coasts down.

STO corresponds to an uncontrolled shutdown according to EN 60204-1, category 0.

With STO, additional measures are required for an "emergency switching off" according to EN 60204-1.

Basic Safety – STO, page 120

Extended Safety, page 123

Basic Safety – STO

Function included in variant:	Basic Safety – STO
-------------------------------	--------------------

Preconditions

- Additional measures are required to prevent movement caused by external forces.
- When assessing risk, also take into account overtravel distances.

Important notes

The safety function STO only removes power to the motor. The DC bus voltage and the mains voltage to the drive are still present.

⚠️ DANGER

HAZARD OF ELECTRIC SHOCK

- Do not use the safety function STO for any other purposes than its intended function.
- Use an appropriate switch, that is not part of the circuit of the safety function STO, to disconnect the product from the mains power.

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

⚠️ DANGER

UNCONTROLLED ROTATION OF THE MOTOR POSSIBLE

Set the motor to standstill mechanically.

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

⚠️ DANGER

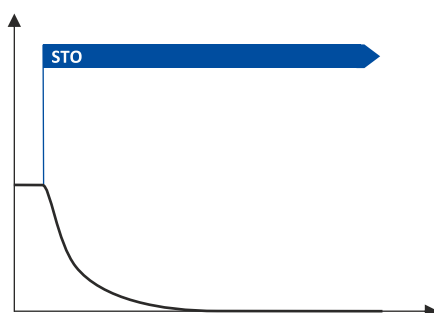
AUTOMATIC RESTART CAN OCCUR IF THE REQUEST OF THE SAFETY FUNCTION IS DEACTIVATED

You must provide external measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

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

Functional description

STO



- The transmission of the pulse width modulation is safely switched off by STO. The power drivers do not generate a rotating field anymore.
- The motor is safely switched to torque-free operation.

Activation

STO is activated via the safe input X1 with the channels SIA and SIB:

Safe input X1		drive device state
SIA	SIB	
LOW	LOW	STO active
LOW	HIGH	Impermissible state (drive disabled)

(Continued)

Safe input X1		drive device state
SIA	SIB	
HIGH	LOW	
HIGH	HIGH	Drive enabled

NOTE:

If the GS connection is interrupted, or at a short circuit/cross-circuit of GS to SIA/SIB, STO is active.

Status messages**Status message via network****NOTE:**

This status message is sent via **non-secure** interfaces. The status message must not be used to control other safety functions!

The drive status word (0x282A:004) and the CiA status word (0x6041) contain the status of the STO function according to the following truth table. These two parameter objects can be read via non-secure network interfaces.

Status			Status message		
Safe input / channel		drive device state	drive status word (Object 0x282A:004)		CiA status word (Object 0x6041)
SIA	SIB		Bit 10	Bit 11	Bit 15
LOW	LOW	STO active	1	1	0
LOW	HIGH	Impermissible state (drive disabled)	1	0	0
HIGH	LOW		1	0	0
HIGH	HIGH	Drive enabled	0	0	1

Status message via digital outputs**NOTE:**

This status message is sent via **non-secure** interfaces. The status message must not be used to control other safety functions!

In 0x2634:xxx you set the function of the digital outputs. By selecting [55], you can output the "drive disabled (safety)" status and by selecting [155], you can output the "STO active" status via a non-safe output (e.g., digital output 1).

Status			Status message	
Safe input / channel		drive device state	Function of digital outputs 0x2634:xxx	
SIA	SIB		"drive disabled (safety)" [55]	"STO active" [155]
LOW	LOW	STO active	1	1
LOW	HIGH	Impermissible state (drive disabled)	1	0
HIGH	LOW		1	0
HIGH	HIGH	Drive enabled	0	0

Setting

Functional sequence and error response have no adjustable parameters.

Parameter

Address	Name / Setting range / [default setting]	Information
0x2024:-002	Special settings: Configure STO 0 ... [0] ... 65535 • Setting can only be changed if the drive is disabled.	Different drive behavior with reference to the CiA402 state machine.
	Bit 0 Activate STO locked	0 = After "STO active", the drive is in the "Ready to switch on [4]" device status. 1 = After "STO active", the drive is in the "Switch on disabled [3]" device status. In order to restart the drive from this device state, the following conditions must be met: • No STO activation AND • Transition (FALSE $\rightarrow$ TRUE) of the configured start signal 0 = standard behavior: After STO is activated, the device status changes to "Switched on". 1 = After STO is activated, the device status changes to "Switch-on disabled". Device states

Extended Safety

Function included in variant:	Extended Safety
-------------------------------	-----------------

Preconditions

- Additional measures are required to prevent movement caused by external forces.
- When assessing risk, also take into account overtravel distances.

Important notes

The safety function STO only removes power to the motor. The DC bus voltage and the mains voltage to the drive are still present.

⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK

- Do not use the safety function STO for any other purposes than its intended function.
- Use an appropriate switch, that is not part of the circuit of the safety function STO, to disconnect the product from the mains power.

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

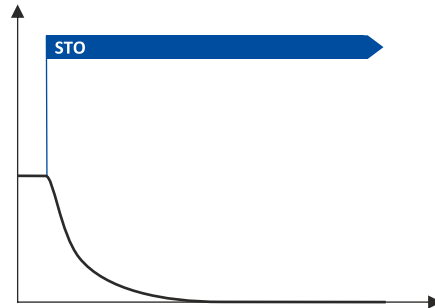
⚡⚠ DANGER**UNCONTROLLED ROTATION OF THE MOTOR POSSIBLE.**

Set the motor to standstill mechanically.

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

Functional description

STO



- The transmission of the pulse width modulation is safely switched off by STO. The power drivers do not generate a rotating field anymore.
- The motor is safely switched to torque-free operation.

Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

Automatically after the safety functions have expired:

- Safe stop 1 (SS1)

Status messages

Status message via safety bus

When the safety bus is activated, a safe status message is sent via the safety input data (status information) of the safety protocol used.

Status message via network

NOTE:

This status message is sent via **non-secure** interfaces. The status message must not be used to control other safety functions!

The drive status word (0x282A:004) and the CiA status word (0x6041) contain the status of the STO function according to the following truth table. These two parameter objects can be read via non-secure network interfaces.

Status			Status message		
Safe input / channel		drive device state	drive status word (Object 0x282A:004)		CiA status word (Object 0x6041)
SIA	SIB		Bit 10	Bit 11	Bit 15
LOW	LOW	STO active	1	1	0
LOW	HIGH	Impermissible state (drive disabled)	1	0	0
HIGH	LOW		1	0	0
HIGH	HIGH	Drive enabled	0	0	1

Status message via digital outputs

NOTE:

This status message is sent via **non-secure** interfaces. The status message must not be used to control other safety functions!

In 0x2634:xxx you set the function of the digital outputs. By selecting [55], you can output the "drive disabled (safety)" status and by selecting [155], you can output the "STO active" status via a non-safe output (e.g., digital output 1).

Status			Status message	
Safe input / channel		drive device state	Function of digital outputs 0x2634:xxx	
SIA	SIB		"drive disabled (safety)" [55]	"STO active" [155]
LOW	LOW	STO active	1	1
LOW	HIGH	Impermissible state (drive disabled)	1	0
HIGH	LOW		1	0
HIGH	HIGH	Drive enabled	0	0

Setting

NOTE:

Adapt the restart to your application.

If the setting 0x2892:001 = 1, an automatic restart takes place when the request for the safety function is canceled.

DANGER

AUTOMATIC RESTART CAN OCCUR IF THE REQUEST OF THE SAFETY FUNCTION IS DEACTIVATED.

You must provide external measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

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

Parameter

Address	Name / Setting range / [default setting]		Information
0x2024:-002	Special settings: Configure STO 0 ... [0] ... 65535 • Setting can only be changed if the drive is disabled.		Different drive behavior with reference to the CiA402 state machine.
	Bit 0	Activate STO locked	0 = After "STO active", the drive is in the "Ready to switch on [4]" device status. 1 = After "STO active", the drive is in the "Switch on disabled [3]" device status. In order to restart the drive from this device state, the following conditions must be met: - No STO activation AND - Transition (FALSE ↗ TRUE) of the configured start signal 0 = standard behavior: After STO is activated, the device status changes to "Switched on". 1 = After STO is activated, the device status changes to "Switch-on disabled". Device states
0x2024:-003	Special settings: STO reaction		Selection of the response to STO. - With the "No response" setting, no logging takes place in the logbook. This setting is useful if STO is used as a valid stop method for normal operation in order to limit the number of entries in the logbook. Associated event ID: 65285 0xFF05 – Safe torque off (STO) activated
	0	No response	Severity
	11	Information	
	12	Warning	
0x2891	STO Source S-Bus • Safety parameter (+Safety parameter list+)		Selection of the safety bus as the trigger source for the function.
	0	Disabled	
	1	Activated	
0x2892:-001	STO: Restart • Safety parameter (+Safety parameter list+)		Restart behavior after the function has been canceled.
	0	Acknowledged restart	
	1	Automatic restart	

Safe stop 1 (SS1)

Function included in variant:

Extended Safety

The "Safe Stop 1 (SS1)" safety function monitors whether a deceleration ramp in the application causes the drive to come to a standstill.

SS1 corresponds to a controlled stop according to EN 60204-1, stop category 1.

Safe stop 1 time controlled (SS1-t)

Function included in variant:	Extended Safety
-------------------------------	-----------------

SS1-t triggers the normal stop STO after the stop time has elapsed or after reaching standstill.

Preconditions

- A deceleration ramp in the application guides the drive to standstill.
- Additional measures are required to prevent movement caused by external forces.

Important notes

⚠ DANGER

THE POWER SUPPLY IS NOT SAFELY DISCONNECTED.

Turn off the power supply.

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

⚠ DANGER

UNCONTROLLED ROTATION OF THE MOTOR POSSIBLE.

Set the motor to standstill mechanically.

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

⚠ DANGER

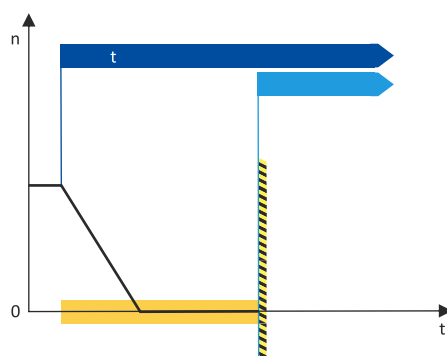
AUTOMATIC RESTART CAN OCCUR IF THE REQUEST OF THE SAFETY FUNCTION IS DEACTIVATED.

You must provide external measures according to EN ISO 13849-1 which ensure that the drive only restarts after a confirmation.

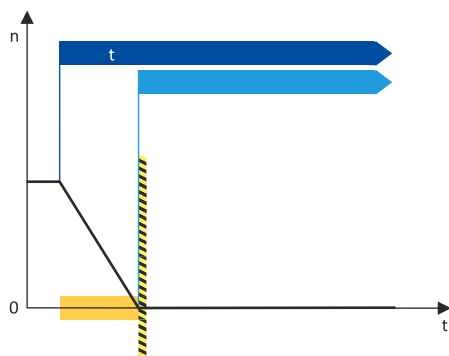
Failure to follow these instructions will result in death or serious injury.

Functional description

SS1-t (STO after stop time)



- SS1-t activates the normal stop STO when the programmed stop time has elapsed.
- If standstill has not yet been reached, the motor coasts down.

SS1-t (STO at standstill)

- SS1-t activates the normal stop STO when standstill is detected.
- A waiting time can also be programmed.
 - The waiting time starts when the standstill is detected.
 - SS1-t activates the normal stop STO when the waiting time has elapsed.
- Detection of standstill:
 - Output frequency of the drive ≤ 0.5 Hz for 100 ms

Activation

Directly:

- Via a safety bus
- Via a safe input (depending on the version)

Restart

- The restart sets the drive in motion after it was previously brought to a standstill via a stop function.
- Restarting is only possible after the stop time has elapsed completely.
- Whether the restart needs to be acknowledged or if it launches automatically can be programmed based on the preceding stop function.

Error behavior

States that trigger an event and an error stop:

- The drive does not stop after the stop time has elapsed.
 - Event: SS1 – Stop time exceeded (0x2A00FF88)
 - Error stop STO

Setting

Please note when setting the parameters:

- Defining the stop time:
 - Consider the closing time of the brake.
 - For applications without an encoder, the stop time must be 0.5 s longer than the deceleration time programmed in the drive.
- Depending on the selected operating mode (0x6060), the following quick stop delay is used to bring the drive to a standstill:
 - 0x6060 = 2 (CiA: Velocity mode (vI)): Quick stop deceleration (0x6085)
 - 0x6060 = -2, -1 (manufacturer-specific mode): Quick stop deceleration time (0x291C)

NOTE:

The execution of the quick stop delay is not safety-rated.

NOTE:

The mode of action of the parameters can be found in the dialog box for the function in the "+Safety parameter list+" in the engineering tool used.

Parameter

Address	Name / Setting range / [default setting]	Information
0x2894:-001	SS1: Stopping time 0 ... [0] ... 30000 ms • Safety parameter (+Safety parameter list+)	Monitored stopping time for SS1.
0x2896	SS1 Source S-Bus • Safety parameter (+Safety parameter list+)	Selection of the safety bus as the trigger source for the function.
	0 Disabled	
	1 Activated	
0x2897:-001	SS1: Mode • Safety parameter (+Safety parameter list+)	Condition at which STO is triggered.
	0 STO after stopping time	STO is only processed after the programmed stopping time has elapsed.
	1 STO at n=0	STO is already triggered after reaching n=0.

Safe Muting (MUT)

Function included in variant:	Extended Safety
-------------------------------	-----------------

This function deactivates all functions of the safety bus.

"Safe Muting" is used to move the drive even if the drive is in a safety state.

- The function may only be used during commissioning or for maintenance work.
- The function is active for a maximum of 30 minutes.
- It can be ended at any time.

Preconditions

To activate the Safe Muting function, you need:

- A PC with "Altivar ATV350 Drives Manager".
- A permanent communication link between engineering tool and drive.
- In a network, the Safe Muting function can only be activated for one drive at a time.
- The muting password was assigned via the password dialog in the **+Safety parameter list+**.
- The active safe parameter set in the drive must contain the settings for safe muting:
 - The sources to be hidden.
 - The muting password.

Important notes

⚠ DANGER

ACTIVATING THE SAFE MUTING FUNCTION DEACTIVATES SAFETY FUNCTIONS

Only authorized personnel may activate the Safe Muting function.

An emergency stop switch-off must be present that cannot be deactivated by Safe Muting.

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

Activation

How to activate and deactivate Safe Muting:

1. Open **+Safety parameter list+**:
 - a. "Altivar ATV350 Drives Manager": Open the **+Safety parameter list+** tab.
 - a. "PLC Designer": Open the **Safe parameter set** object under the axis in the device tree.
2. Click the muting dialog.
 - The password dialog opens.
3. Enter muting password.
 - The muting dialog opens.
4. Use the displayed data to ensure that the correct drive has been selected.
 - Optical device identification is activated automatically. The two LEDs "RDY" and "ERR" on the front of the selected drive flash rapidly.
5. **Start** activates the function.
 - The function is now active for a maximum of 30 minutes. The remaining time is displayed.
6. End function
 - a. The function is automatically ended after 30 minutes.
 - a. **Stop** ends the function manually.
 - a. If the connection between engineering tool and drive is disconnected, the function is aborted immediately with an error message.
 - The monitored operation is reactivated immediately.

All previously deactivated safety functions are active again.

Setting

Reset muting password

The muting password can be reset in the **+Safety parameter list+**: 0x213B:001, page 131 (MUT: Password) = 0

Parameter

Address	Name / Setting range / [default setting]	Information
0x213B:001	MUT: Mute S-Bus • Safety parameter (+Safety parameter list+)	Selection of sources to be hidden.
	0 No muting	

(Continued)

Address	Name / Setting range / [default setting]	Information
	3 Mute completely	
0x213-B:001	MUT: Password 0 ... [0] ... 4294967295 • Safety parameter (+Safety parameter list+)	Password to activate the function. Enter "0" to reset the password.
0x213-B:002	MUT: Remaining time • Read only: x s	Remaining time until the function is automatically terminated. The function is active for a maximum of 30 minutes.

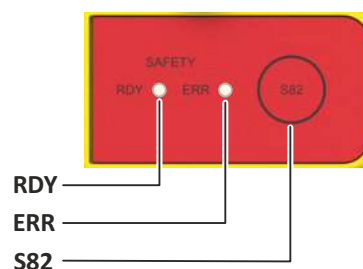
Diagnostics

Status LEDs

Function included in variant:	Extended Safety
-------------------------------	-----------------

The LEDs "RDY" and "ERR" show the current safety status:

Position of the RDY and ERR LEDs



⚠ DANGER

UNRELIABLE STATUS INFORMATION POSSIBLE DUE TO LEDS.

Only use LEDs for general diagnostics during commissioning or troubleshooting.

Do not use LEDs as status displays.

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

LED "RDY" (yellow)		Status	Meaning
off		-	No status message active.
 blinking yellow 1 Hz		Service status	Transfer of parameter set requested.

Display for requested acknowledgment

LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
 on	off	Restart acknowledgment requested	The device is working correctly.
	 blinking red 1 Hz		During start-up, a modified parameter set was detected in the "Init" state.
	 blinking red 2 Hz		During start-up, a changed safety address was detected in the "Init" state.

Display in the event of errors

	LED "ERR" (red)	Status	Meaning
	off	-	The device is working correctly.
	 blinking red 1 Hz	Error	One of the following errors has been detected: • A monitoring device has been activated. • An acknowledgeable error is active. • Discrepancy of the inputs
 blinking yellow 1 Hz	 blinking red 1 Hz		One of the following errors has been detected: • Discrepancy of the configuration parameters • CRC checksum error
	 blinking red 2 Hz	Safety bus error	Communication via the safety bus is not established: • There is no valid configuration. • The start-up has not been completed yet.

Display for critical device errors

LED "RDY" (yellow)	LED "ERR" (red)	Status	Meaning
 blinking yellow	 blinking red	Critical system error	• "Lock-out" (CPU stopped) • STO is active. • If the system error occurs again after switching the 24 V supply, the device is defective. It must be replaced.

Event history

Parameter

Address	Name / Setting range / [default setting]		Information
0x2130:001	Safety event history: Current severity		Severity of the current event in 0x2130:002, page 132
	• Read only		
	0	No response	Severity
	1	Warning	
	2	Trouble	
0x2130:002	Safety event history: Internal event 1		Currently active event
	• Read only		
0x2130:003	Safety event history: Internal event 2		Second most recent stored event
	• Read only		

(Continued)

Address	Name / Setting range / [default setting]	Information
0x2130:004	Safety event history: Internal event 3 • Read only	...
0x2130:005	Safety event history: Internal event 4 • Read only	
0x2130:006	Safety event history: Internal event 5 • Read only	
0x2130:007	Safety event history: Internal event 6 • Read only	
0x2130:008	Safety event history: Internal event 7 • Read only	
0x2130:009	Safety event history: Internal event 8 • Read only	
0x2130:010	Safety event history: Internal event 9 • Read only	
0x2130:011	Safety event history: Internal event 10 • Read only	
0x2130:012	Safety event history: Internal event 11 • Read only	
0x2130:013	Safety event history: Internal event 12 • Read only	
0x2130:014	Safety event history: Internal event 13 • Read only	
0x2130:015	Safety event history: Internal event 14 • Read only	
0x2130:016	Safety event history: Internal event 15 • Read only	
0x2130:017	Safety event history: Internal event 16 • Read only	Oldest stored event

Diagnostic parameters

NOTE:

The diagnostic parameters for the safety functions can be found in the "Diagnostics and error elimination" section of the ATV350 commissioning Manual.

Safety diagnostics

Safety-related data

Safety-related characteristics Basic Safety – STO

Basics of the safety-related characteristics			
	Source of failure rates	SN-29500	When no values from the component manufacturers were available.
	Average max. ambient temperature	60°C	
Basic Safety – STO			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 3	
	PFH [1/h]	< 1 E-09	< 1% of SIL 3
	PFD _{avg} (T)	< 1 E-04	< 10% of SIL 3 after T = 20 years
	Proof test interval T	20 years	service life
EN ISO 13849-1	Category	4	
	Performance Level	e	
	MTTF _d	High	> 3200 years
	Mean diagnostic coverage DC _{avg}		99 %

NOTE:

Further data and information can be found in the corresponding project planning document in the "Electrical installation" section.

Safety-related characteristics Extended Safety

Basics of the safety-related characteristics			
	Source of failure rates	SN-29500	When no values from the component manufacturers were available.
	Average max. ambient temperature	60°C	
Extended Safety – S			
EN IEC 61508, part 1-7 EN 62061	Safety Integrity Level	SIL 3	
	PFH [1/h]	< 1 E-09	< 1% of SIL 3
	PFD _{avg} (T)	< 1 E-04	< 10% of SIL 3 after T = 20 years
	Proof test interval T	20 years	service life
EN ISO 13849-1	Category	4	
	Performance Level	e	
	MTTF _d	High	> 130 years
	Mean diagnostic coverage DC _{avg}		95%

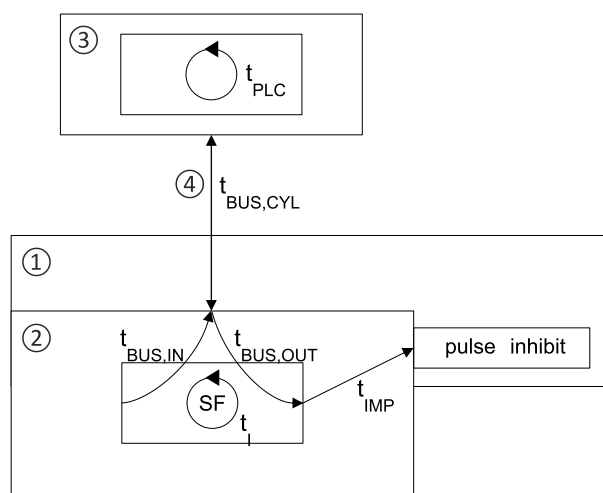
NOTE:

Further data and information can be found in the corresponding project planning document in the "Electrical installation" section.

Response times of the safety unit

For the calculation of the response time to the request of a safety function, the overall system must be taken into account:

- Response time of the connected safety sensors.
- Internal processing time.
- Deceleration times, braking times, and stop times from the programmed safety functions.
- Safety bus:
 - Monitoring time for cyclic services.
 - Monitoring time in the safety PLC.
 - Processing time in the safety PLC
- Deceleration times due to further components.



1	Basic device
2	Integrated safety technology
3	Safety PLC
4	Safety bus
SF	Triggered safety function

Response times of the safety modules		
t _i	Processing time of the integrated safety function technology (taking into account the feedback from the status flags to the input)	4 ms
t _{BUS,IN}	Sending a secure telegram to the controller CIP Safety	20 ms
t _{BUS,OUT}	Receiving a safe telegram from the controller CIP Safety	32 ms
t _{BUS,CYL}	Cycle time safety bus CIP Safety	See project planning in the controller
t _{PLC}	Cycle time controller	See manufacturer's specifications for the controller
t _{IMP}	Time delay of the safe pulse inhibit	6 ms

Response times of a function		
Triggering STO via safety bus	t _{PLC} + t _{BUS,CYL} + t _{BUS,OUT} + t _{IMP}	t _{PLC} + t _{BUS,CYL} + 32 ms + 6 ms
Feedback STO status flag via safety bus	t _{PLC} + t _{BUS,CYL} + t _{BUS,OUT} + t _i + t _{BUS,IN} + t _{PLC}	t _{PLC} + t _{BUS,CYL} + 32 ms + 4 ms + 20 ms + t _{PLC}

NOTE:

- Information on how to calculate the processing time and transmission time of the safety bus can be found in the documentation of the safety PLC used.
- When the safety bus communication is disturbed, it is changed to the fail-safe state after the safety bus monitoring time has elapsed. The safety bus communication is passivated.
- Include the times of the safety functions in the calculation, e.g., for SS1 the stop time until STO is active (0x2894:001, page 129).

Environmental notes and recycling

Schneider Electric has been certified to the worldwide environmental management standard for many years (DIN EN ISO 14001). As part of our environmental policy and the associated climate responsibility, please note the following information on hazardous substances and the recycling of Schneider Electric products and their packaging:

	The crossed-out wheeled bin symbol is located on the equipment. This symbol indicates that used electrical and electronic products must not be disposed of with normal household waste. The EU Directive 2012/19/EU: Directive on waste electrical and electronic equipment (WEEE) [UKCA: S.I. 2013/3113 – The Waste Electrical and Electronic Equipment Regulations 2013], which has been transposed into national law by the respective EU member states, applies to the disposal of equipment. As a customer, you have the option of disposing of the electrical and electronic equipment that you have purchased from us and that is subject to WEEE via the Schneider Electric branch in your country. Schneider Electric addresses in Europe: https://www.se.com Some Schneider Electric products contain batteries/rechargeable batteries in accordance with EU Directive 2006/66/EC: Battery Directive [UKCA: S.I. 2009/890 – The Waste Batteries and Accumulators Regulations 2009]. Any batteries/rechargeable batteries included are designed to last the life of the product and do not need to be replaced or otherwise removed by the end user.
	Schneider Electric products are usually sold with cardboard or plastic packaging. This packaging complies with EU Directive 94/62/EC: Directive on packaging and packaging waste [UKCA: S.I. 1997/648 – The Producer Responsibility Obligations (Packaging Waste) Regulations 1997]. The required disposal route is indicated by material-specific labels with the recycling triangle (e.g., "21 – other cardboard").
REA-CH	Schneider Electric products are subject to REGULATION (EC) No 1907/2006: REACH Regulation [UKCA: S.I. 2008/2852 – The REACH Enforcement Regulations 2008]. When used as intended, exposure of substances to humans, animals and the environment is excluded.

Schneider Electric products are industrial electrical and electronic products and must be disposed of professionally. Both the mechanical and electrical components such as electric motors, gearboxes or drives contain valuable raw materials that can be recycled and reused. Proper recycling, and maintaining the highest possible level of recyclability, is essential from both economic and ecological perspectives.

- Coordinate professional disposal with your waste disposal company.
- Separate mechanical and electrical components, packaging, hazardous waste (e.g., gear oils) and batteries/rechargeable batteries wherever possible.
- Dispose of the separated waste in an environmentally sound and proper manner (no household waste or municipal bulky waste).

What?	Material	Disposal instructions
Pallets	Wood	Return to manufacturers, freight forwarders or reusable materials collection system
Packaging material	Paper, cardboard, pasteboard, plastics	Collect and dispose of separately
Products		
Electronic devices	Metal, plastics, circuit boards, heatsinks	As electronic waste give to professional disposer for recycling

NOTE:

Further information on Schneider Electric's environmental and climate responsibility and on the topic of energy efficiency can be found on the Internet:

www.se.com > search word: "Sustainability"

Appendix

Good to know

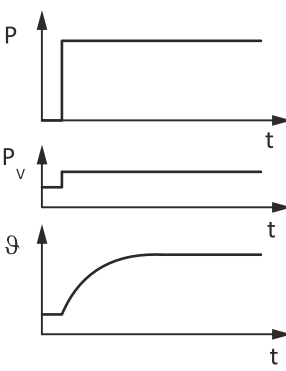
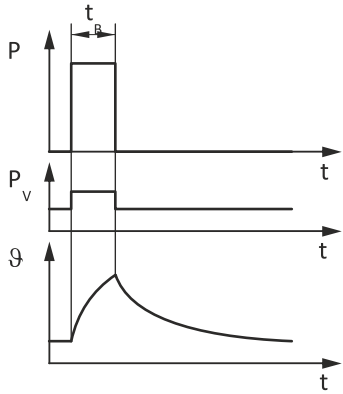
Operating modes of the motor

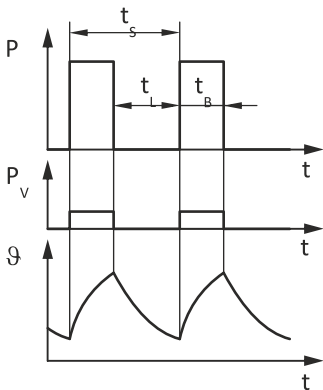
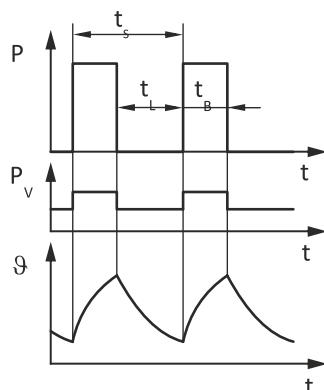
Operating modes S1 to S10 as specified by EN 60034-1 describe the basic stress of an electrical machine.

In continuous operation a motor reaches its permissible temperature limit if it outputs the rated power dimensioned for continuous operation. However, if the motor is only subjected to load for a short time, the power output by the motor may be greater without the motor reaching its permissible temperature limit. This behavior is referred to as overload capacity.

Depending on the duration of the load and the resulting temperature rise, the required motor can be selected reduced by the overload capacity.

Key operating modes

Continuous operation S1	Short-time operation S2
	
Operation with a constant load until the motor reaches the thermal steady state. The motor may be actuated continuously with its rated power.	Operation with constant load; however, the motor does not reach the thermal steady state. During the following standstill, the motor winding cools down to the ambient temperature again. The increase in power depends on the load duration.

Intermittent operation S3	Non-intermittent periodic operation S6
 Sequence of identical duty cycles comprising operation with a constant load and subsequent standstill. Start-up and braking processes do not have an impact on the winding temperature. The steady-state is not reached. The guide values apply to a cycle duration of 10 minutes. The power increase depends on the cycle duration and on the load period-to-downtime ratio.	 Sequence of identical duty cycles comprising operation with a constant load and subsequent no-load operation. The motor cools down during the no-load operation. Start-up and braking processes do not have an impact on the winding temperature. The steady-state is not reached. The guide values apply to a cycle duration of 10 minutes. The power increase depends on the cycle duration and on the load period-to-idle time ratio.

P Power
 t Time
 t_L Idle time
 θ Temperature

P_V Power loss
 t_B Load period
 t_S Cycle duration

Motor control types

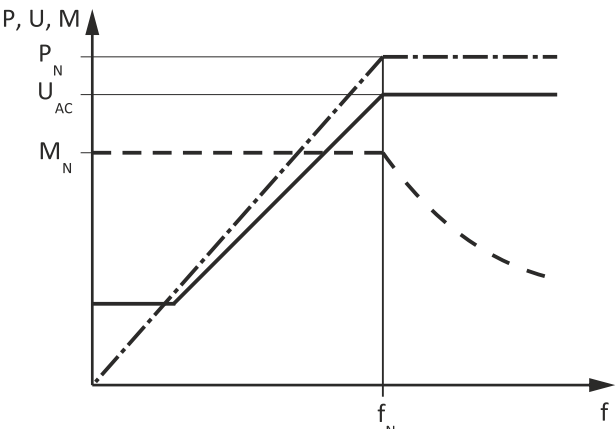
The drive provides various motor control types.

Linear V/f characteristic control

The output voltage increases proportionally to the output frequency.

At low output frequencies, the motor voltage can be increased to ensure a minimum current for the breakaway torque. In the field weakening range, the output voltage of the drive is constant (mains voltage) and the frequency can be further increased depending on the load. The maximum torque of the motor decreases proportionally to the square of the frequency increase, the maximum output power of the motor being constant.

Application areas include single drives with constant load.



P	Power	P _N	Rated power
V	Voltage	U- AC	Mains voltage
M	Torque	M _N	Rated torque
f	Frequency	f _N	Rated frequency

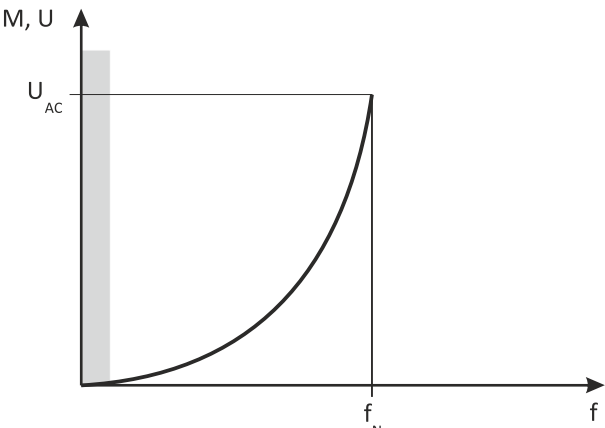
Square-law V/f characteristic control

The output voltage increases proportionally to the square of the output frequency.

At low output frequencies, the motor voltage can be increased to ensure a minimum current for the breakaway torque. In the field weakening range, the output voltage of the drive is constant (mains voltage) and the frequency can be further increased depending on the load. The maximum torque of the motor decreases proportionally to the square of the frequency increase, the maximum output power of the motor being constant.

Application areas include:

- Pumps
- Fans
- Ventilators

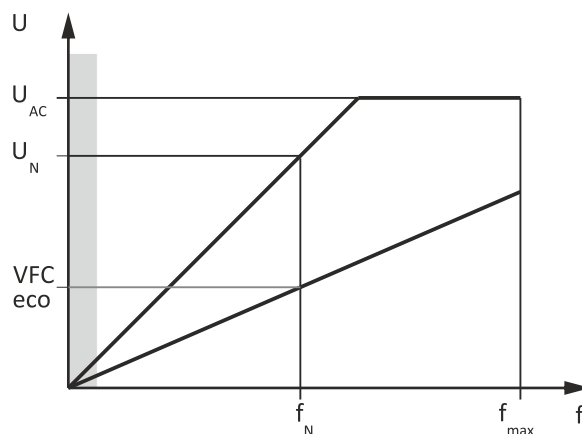


V	Voltage	U- AC	Mains voltage
f	Frequency	f _N	Rated frequency
M	Torque		

VFCeco

VFCeco mode has a special effect in the partial load operating range. Usually, three-phase AC motors are supplied there with a higher magnetizing current than

required by the operating conditions. The VFCeco mode reduces the losses in the partial load operating range so that savings up to 30% are possible.



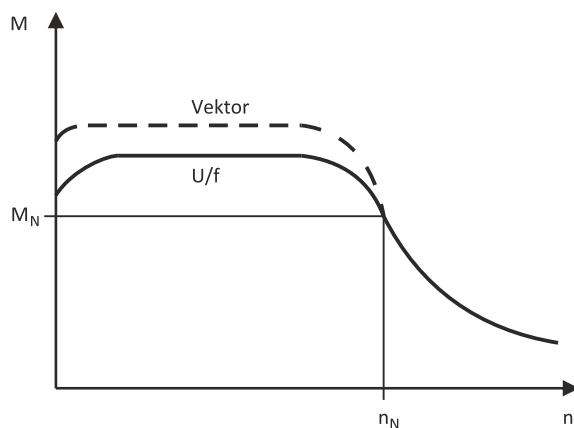
V	Voltage	f	Frequency
U_{AC}	Mains voltage	f_N	Rated frequency
U_N	Rated voltage	f_{max}	Max. frequency

Sensorless vector control (SLVC)

In vector control, an inverse voltage model is used for calculation. The parameters are detected via a parameter identification. The drive determines the angle between current and voltage. This imposes a current on the motor.

Compared to V/f characteristic control, vector control achieves improved drive characteristics, including:

- higher torque across the entire speed range
- higher speed accuracy and higher concentricity factor
- higher efficiency



M	Torque	M_N	Rated torque
n	Speed	n_N	Rated speed

Application areas include:

- Single drives with changing loads
- Single drives with high starting duty
- Sensorless speed control of three-phase AC motors

Switching frequencies

On an drive, the term "switching frequency" refers to the frequency with which the input and outputs of the output module (drive) are switched. The switching frequency can generally be set to values between 2 and 16 kHz, with selection based on the respective power output.

Because switching the modules causes heat loss, the drive can provide higher output currents at low switching frequencies than at high frequencies. Additionally, it is distinguished between the operation at a permanently set switching frequency and a variably set switching frequency. Here, the switching frequency is automatically reduced based on device utilization.

At higher switching frequencies, noise generation is reduced..

Options for the switching frequency:

- 8 kHz
- 12 kHz
- 16 kHz
- variable (automatic adaptation)

Enclosures

The protection class indicates the suitability of a product for specific ambient conditions with regard to moisture as well as the protection against contact and the ingress of foreign particles. The protection classes are classified in the EN 60034-5/ EN IEC 60529.

The first code number after the code letters IP indicates the protection against the ingress of foreign particles and dust. The second code number refers to the protection against the ingress of moisture.

Code number 1	Degree of protection	Code number 2	Degree of protection
0	No protection	0	No protection
1	Protection against the ingress of foreign particles $d > 50$ mm. No protection at deliberate access.	1	Protection against vertically dripping water (dripping water).
2	Protection against medium-sized foreign particles, $d > 12$ mm, keeping away fingers etc.	2	Protection against diagonally falling water (dripping water), 15° compared to normal service position.
3	Protection against small foreign particles $d > 2.5$ mm. Keeping away tools, wires etc.	3	Protection against spraying water, up to 60° from vertical.
4	Protection against granular foreign particles, $d > 1$ mm, keeping away tools, wire etc.	4	Protection against spraying water from all directions.
5	Protection against dust deposits (dust-protected), complete protection against contact.	5	Protection against water jets from all directions.
6	Protection against the ingress of dust (dust-proof), complete protection against contact.	6	Protection against choppy seas or heavy water jets (flood protection).

Glossary

Definitions in safety function

Abbreviation	Meaning
AIE	Acknowledge In Error, error acknowledgment
AIS	Acknowledge In Stop, restart acknowledgment
OFF state	Triggered signal status of the safety sensors
CCF	Common Cause Error (also β -value)
EC_FS	Error Class Fail Safe
EC_STO	Error Class Safe Torque Off Stop 0
ON state	Signal status of the safety sensors in normal operation
FIT	Failure In Time, 1 FIT = 10 ⁻⁹ Error/h
FMEA	Failure Mode and Effect Analysis
FSOE	FailSafe over EtherCAT
GSDML	Device description file with PROFINET-specific data to integrate the configuring software of a PROFINET controller.
HFT	Hardware Failure Tolerance
Cat.	Category according to EN ISO 13849-1
nBD	Speed value Base-Drive, internally determined actual speed from standard application
nSD	Safe-Drive speed value, internally determined actual speed from the safety application
n_safe	Actual speed determined from validation of nBD and nSD. Enters the further processing of the speed-dependent safety functions.
OSSD	Output Signal Switching Device, tested signal output
pBD	Base-Drive position value, internally determined actual position from standard application
pSD	Safe-Drive position value, internally determined actual position from the safety application
p_safe	Actual position determined from validation of pBD and pSD. Enters the further processing of the position-dependent safety functions.
PELV	Protective Extra Low Voltage
PL	Performance Level according to EN ISO 13849-1
PM	Plus-Minus – switched signal paths
PP	Plus-Plus – switched signal paths
PWM	Pulse Width Modulation
SCS	Safe Creeping Speed
SD-In	Safe Digital Input
SD-Out	Safe Digital Output
SELV	Safety Extra Low Voltage
SFF	Safe Failure Fraction
SIL	Safety Integrity Level according to EN IEC 61508

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