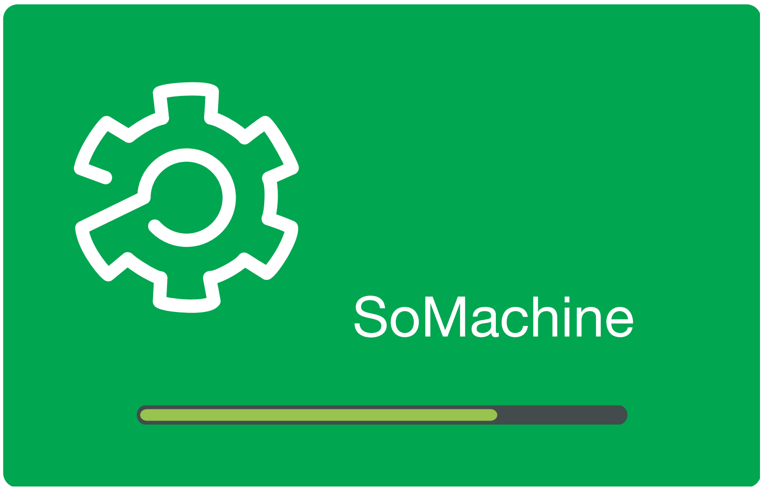
Altivar Library

Function blocks

Software manual

V2.09, 03.2012



0198441113880, V2.09, 03.2012

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Schneider Electric

Important information

This manual is part of the product.

Carefully read this manual and observe all instructions.

Keep this manual for future reference.

Hand this manual and all other pertinent product documentation over to all users of the product.

Carefully read and observe all safety instructions and the chapter "Before you begin - safety information".

Some products are not available in all countries.
For information on the availability of products, please consult the catalog.

Subject to technical modifications without notice.

All details provided are technical data which do not constitute warranted qualities.

Most of the product designations are registered trademarks of their respective owners, even if this is not explicitly indicated.

Table of contents

About this manual

This manual is an extract of the SoMachine Online Help. Fully read and understand all manuals of the SoMachine Online Help and of the products used.

Purpose of this document

This document describes the functions of the Altivar Library.

Software environment	Devices	Fieldbus
SoMachine	ATV31/ATV312	CANopen
Device Descriptions of version 4.0.0.0 and higher are supported.	ATV71/ATV32	

Validity note

This document is valid for SoMachine as of Version 2.0.

Source manuals

The latest versions of the manuals can be downloaded from the Internet at:

http://www.schneider-electric.com

Corrections and suggestions

We always try to further optimize our manuals. We welcome your suggestions and corrections.

Please get in touch with us by e-mail:
techcomm@schneider-electric.com.

Work steps

If work steps must be performed consecutively, this sequence of steps is represented as follows:

■ Special prerequisites for the following work steps
▸ Step 1
◃ Specific response to this work step
▸ Step 2

If a response to a work step is indicated, this allows you to verify that the work step has been performed correctly.

Unless otherwise stated, the individual steps must be performed in the specified sequence.

SI units

SI units are the original values. Converted units are shown in brackets behind the original value; they may be rounded.

Example:
Minimum conductor cross section: 1.5 mm^2 (AWG 14)

Glossary

Explanations of special technical terms and abbreviations.

Index

List of keywords with references to the corresponding page numbers.

Disclaimer

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

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

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

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

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

1 Before you begin - safety information

1.1 Qualification of personnel

Only appropriately trained persons who are familiar with and understand the contents of this manual and all other pertinent product documentation are authorized to work on and with this product. In addition, these persons must have received safety training to recognize and avoid hazards involved. These persons must have sufficient technical training, knowledge and experience and be able to foresee and detect potential hazards that may be caused by using the product, by changing the settings and by the mechanical, electrical and electronic equipment of the entire system in which the product is used.

All persons working on and with the product must be fully familiar with all applicable standards, directives, and accident prevention regulations when performing such work.

1.2 Intended use

This product is a library for industrial use with the appropriate controllers and drives.

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

Prior to using the product, you must perform a risk assessment in view of the planned application. Based on the results, the appropriate safety measures must be implemented.

Since the product is used as a component in an entire system, you must ensure the safety of persons by means of the design of this entire system (for example, machine design).

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

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel.

1.3 Hazard categories

Safety instructions to the user are highlighted by safety alert symbols in the manual. In addition, labels with symbols and/or instructions are attached to the product that alert you to potential hazards.

Depending on the seriousness of the hazard, the safety instructions are divided into 4 hazard categories.

⚠ DANGER

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

⚠ WARNING

WARNING indicates a potentially hazardous situation, which, if not avoided, **can result** in death, serious injury, or equipment damage.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation, which, if not avoided, **can result** in injury or equipment damage.

CAUTION

CAUTION used without the safety alert symbol, is used to address practices not related to personal injury (e.g. **can result** in equipment damage).

1.4 Basic information

⚠ WARNING

LOSS OF CONTROL

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

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

1) For USA: Additional information, refer to NEMA ICS 1.1 (latest edition), “Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control” and to NEMA ICS 7.1 (latest edition), “Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems”.

⚠ WARNING

UNINTENDED BEHAVIOR DUE TO IMPROPER ERROR HANDLING

Improper error handling can change movements or signals or deactivate monitoring functions.

- Carefully program the error handling routines.
- Verify the effectiveness of error handling.

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

⚠ WARNING

UNINTENDED BEHAVIOR DUE TO CHANGES TO THE LIBRARY

- Do not change or manipulate the library in any way whatsoever.

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

1.5 Standards and terminology

Technical terms, terminology and the corresponding descriptions in this manual are intended to use the terms or definitions of the pertinent standards.

In the area of drive systems, this includes, but is not limited to, terms such as "safety function", "safe state", "fault", "fault reset", "failure", "error", "error message", "warning", "warning message", etc.

Among others, these standards include:

- IEC 61800: "Adjustable speed electrical power drive systems"
- IEC 61158: "Digital data communications for measurement and control – Fieldbus for use in industrial control systems"
- IEC 61784: "Industrial communication networks – Profiles"
- IEC 61508: "Functional safety of electrical/electronic/programmable electronic safety-related systems"

Also see the glossary at the end of this manual.

2 Altivar Library Guide

2

Library name

Altivar Library (ATV)

Software environment	Devices	Fieldbus
SoMachine Device Descriptions of version 4.0.0.0 and higher are supported.	ATV31/ATV312 ATV71/ATV32	CANopen

The function blocks described here are used to control ATV drives in CANopen fieldbuses under the SoMachine software environment. The function blocks are compliant with the IEC 61131-3 standard.

Naming conventions

- Function blocks with the prefix MC_ ("Motion Control") are compliant with the PLCopen specifications. They conform to a global standard for programming motion control applications.
- Function blocks without a prefix are vendor-specific (Schneider Electric); however, they comply with the general PLC open rules.

Simple application

- The function blocks are used in the same way.
- The function blocks comply with the PLCopen state diagram.
- The function blocks feature a visualization that can be easily integrated into the application.

Categorization of the function blocks

- Single axis: These function blocks are used for movements or functions of a single, independent axis.
- Administrative: These function blocks are used for configuration tasks (such as reading and writing of parameters, restoring a device configuration, etc.).
- Device Function: These function blocks support you in commissioning a drive at a controller. Before these function blocks can be used, you must correctly set the communication parameters baud rate and node address.

Preparing the drive

Before you can access the drive via CANopen or CANmotion, you must make a number of settings. Among others, these settings include:

- Address and baud rate
- Access Level (LAC) = Expert (L3)
- Profile (CHCF) = Separate
- Reference 1 (Fr1) = CAN
- Control channel (Cd1) = CAN
- Control channel switching (CSS) = Cd1
- Reference switching (rFC) = C214

Note the pertinent information in the product manual.

If you do not know the existing configuration, it may be useful to restore the factory settings. See "2.4.2.4 ResetParameters_ATV".

2.1 List of the function blocks

Category	Subcategory	Function block	Type	ATV31/ ATV312	ATV71	ATV32
Single axis						
	Initialization	"2.3.1.1 MC_Power_ATV"	PLCopen	X	X	X
	Operating mode Jog	"2.3.2.1 MC_Jog_ATV"	PLCopen	X	X	X
	Operating mode Speed Control	"2.4.1.5 Velocity-ControlAnalogInput_ATV"	Vendor-specific	X	X	X
		"2.4.1.6 Velocity-ControlSelectAI_ATV"	Vendor-specific	X	X	X
	Operating mode Profile Velocity	"2.3.3.1 MC_Move-Velocity_ATV"	PLCopen	X	X	X
	Stopping	"2.3.4.1 MC_Stop_ATV"	PLCopen	X	X	X

Category	Subcategory	Function block	Type	ATV31/ ATV312	ATV71	ATV32
Administrative						
	Reading a parameter	"2.4.1.1 MC_ReadActualVelocity_ATV"	PLCopen	X	X	X
		"2.4.1.2 MC_ReadActualTorque_ATV"	PLCopen	X	X	X
		"2.4.1.3 MC_ReadStatus_ATV"	PLCopen	X	X	X
		"2.4.1.4 MC_ReadParameter_ATV"	PLCopen	X	X	X
		"2.4.1.7 GetSupplierVersion"	Vendor-specific	X	X	X
	Writing a parameter	"2.4.2.1 MC_WriteParameter_ATV"	PLCopen	X	X	X
		"2.4.2.2 SetDriveRamp_ATV"	Vendor-specific	X	X	X
		"2.4.2.3 SetFrequencyRange_ATV"	Vendor-specific	X	X	X
		"2.4.2.4 ResetParameters_ATV"	Vendor-specific	X	X	X
		"2.4.2.5 StoreParameters_ATV"	Vendor-specific	X	X	X
	Saving and restoring device configuration	"2.4.3.1 UploadDriveParameter_ATV"	Vendor-specific	X	X	X
		"2.4.3.2 DownloadDriveParameter_ATV"	Vendor-specific	X	X	X
	Inputs and outputs		Vendor-specific	X	X	X
		"2.4.4.2 MC_ReadDigitalInput_ATV"	PLCopen	X	X	X
		"2.4.4.3 MC_ReadDigitalOutput_ATV"	PLCopen	X	X	X
		"2.4.4.4 MC_WriteDigitalOutput_ATV"	PLCopen	X	X	X
	Error handling	"2.4.5.1 MC_ReadAxisError_ATV"	PLCopen	X	X	X
		"2.4.5.2 MC_Reset_ATV"	PLCopen	X	X	X

Category	Subcategory	Function block	Type	ATV31/ ATV312	ATV71	ATV32
Device Function						
	Startup	"2.5.1.1 Altivar_Startup"	Vendor-specific	X	X	X
	Control	"2.5.2.1 Altivar31_Control"	Vendor-specific	X	-	-
		"2.5.2.2 Altivar71_Control"	Vendor-specific	-	X	-
		"2.5.2.3 Altivar32_Control"	Vendor-specific	-	-	X

2.2 Basic inputs and outputs

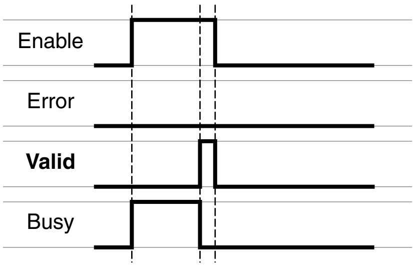
Input/output	Data type	Description
Axis	Axis_Ref_ATV	Name of the axis (instance) for which the function block is to be executed. The name must be declared in the PLC configuration. The name of the axis can be found to the left in the tree structure of your software.
Input	Input_Ref_ATV	Input is a special data type for digital and analog inputs. The data type corresponds to the name of the axis (instance) to which the inputs belong (similar to Axis). In the case of function blocks specifically provided for reading analog and digital inputs, Input replaces the input Axis.
Output	Output_Ref_ATV	Output is a special data type for digital and outputs. The data type corresponds to the name of the axis (instance) to which the outputs belong (similar to Axis). In the case of function blocks specifically provided for writing and reading analog and digital inputs, Output replaces the input Axis.

Input	Data type	Description
Enable	BOOL	Value range: TRUE, FALSE Initial value: FALSE The input Enable starts or terminates the execution of a function block. (exception "2.3.1.1 MC_Power_ATV") FALSE: Execution of the function block is terminated. The outputs Valid, Busy, CommandAborted and Error are set to FALSE. TRUE: The function block is executed repeatedly.
Execute	BOOL	Value range: TRUE, FALSE Initial value: FALSE The input Execute starts the execution of a function block in the case of a rising edge (FALSE->TRUE). If a second rising edge is detected during the execution of the function block, the current execution is aborted and the function block is executed again. Execution is terminated as soon as the output Busy is FALSE. FALSE and, at the same time, Busy = FALSE: Either Done, Error or CommandAborted are set to TRUE for one call. TRUE and, at the same time, Busy = FALSE: Either Done, Error or CommandAborted are set to TRUE and remain TRUE until Execute is set to FALSE.

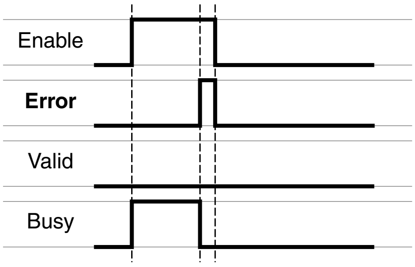
Output	Data type	Description
`Done`	`BOOL`	Value range: TRUE, FALSE Initial value: FALSE FALSE: Execution has not (yet) been terminated without an error. TRUE: Execution has been completed without an error.
`Valid`	`BOOL`	Value range: TRUE, FALSE Initial value: FALSE FALSE: Execution has not (yet) been terminated without an error. The values at the outputs are not (yet) valid. TRUE: Execution has been completed without an error. The values at the outputs are valid and can be further processed.
`Busy`	`BOOL`	Value range: TRUE, FALSE Initial value: FALSE FALSE: Execution of the function block has been terminated. TRUE: Function block is being executed. NOTE: In the operating mode Profile Velocity, the output remains TRUE even when the target velocity has been reached or `Execute` becomes FALSE. The output `Busy` is set to FALSE as soon as another function block such as MC_Stop is executed.
`CommandAborted`	`BOOL`	Value range: TRUE, FALSE Initial value: FALSE FALSE: Execution has not (yet) been canceled without an error. TRUE: Execution has been aborted by another function block.
`Error`	`BOOL`	Value range: TRUE, FALSE Initial value: FALSE FALSE: Execution of the function block is running, nor error has occurred up until now. TRUE: An error has occurred in the execution of the function block.

2.2.1 Signal behavior of function blocks with the input `Enable`

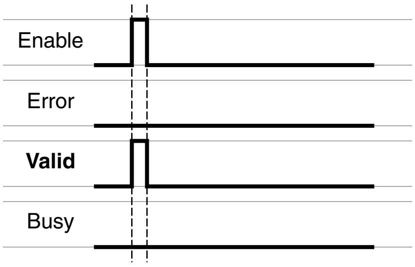
Example 1 Single execution without error (execution requires more than one call).



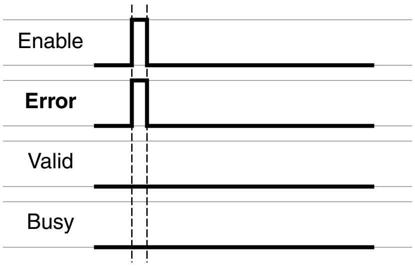
Example 2 Single execution with error (execution requires more than one call).



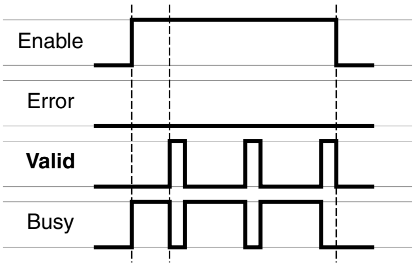
Example 3 Single execution without error (execution requires only one call).



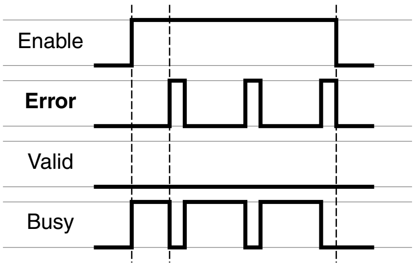
Example 4 Single execution with error (execution requires only one call).



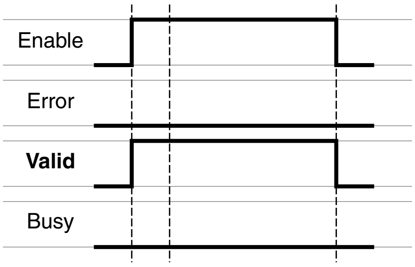
Example 5 Repeated execution without error (execution requires more than one call).



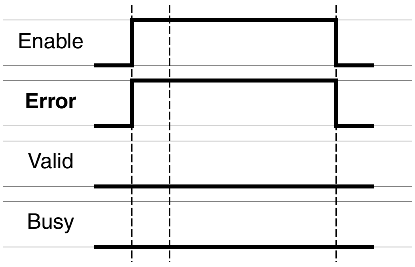
Example 6 Repeated execution with error (execution requires more than one call).



Example 7 Repeated execution without error (execution requires only one call).

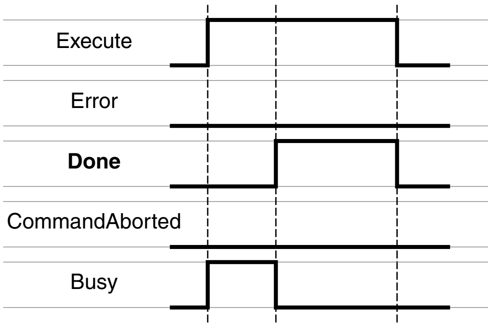


Example 8 Repeated execution with error (execution requires only one call).

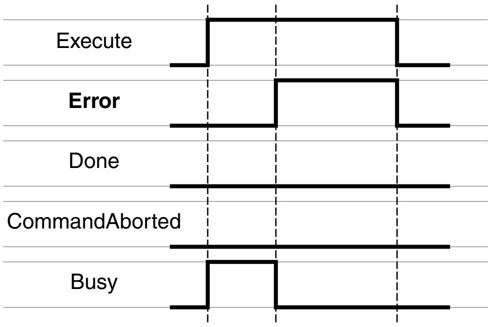


2.2.2 Signal behavior of function blocks with the input `Execute`

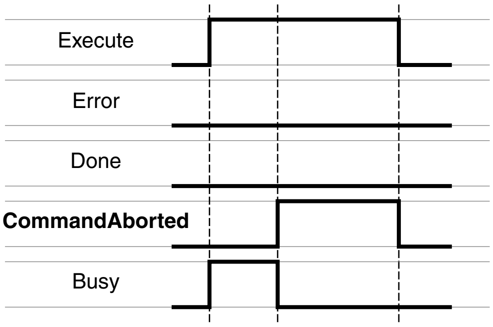
Example 1 Execution terminated without error.



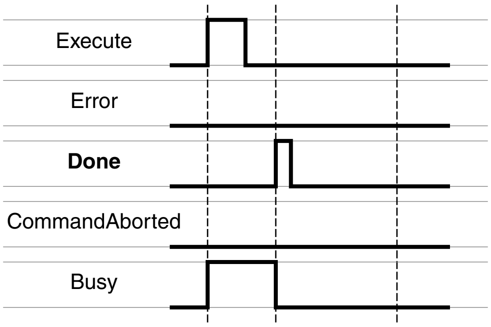
Example 2 Execution terminated with error.



Example 3 Abortion of the execution because another function block takes over control.



Example 4 Execution completed without error after Execute has been set to FALSE during execution.



2.3 Single axis

2.3.1 Initialization

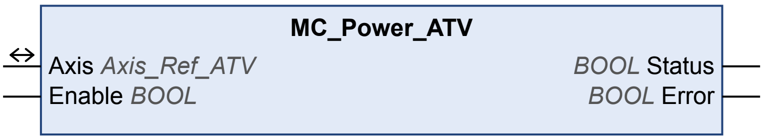
The initialization function block enables or disables the power stage. Other function blocks can only be used when the power stage is enabled.

2.3.1.1 MC_Power_ATV

Function description

The function block enables or disables the power stage. TRUE at the input `Enable` enables the power stage. Once the power stage is enabled, the output `Status` is set. FALSE at the input `Enable` disables the power stage. Once the power stage is disabled, the output `Status` is reset. If errors occur during execution, the output `Error` is set.

Graphical representation



Compatible devices

ATV31/ATV312 and ATV71/ATV32

Inputs/outputs

The table below shows the outputs.

Output	Data type	Description
`Status`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE FALSE: Power stage is disabled. TRUE: Power stage is enabled.

"2.2 Basic inputs and outputs"

Notes

In the case of a Node Guarding error, the error memory must be reset by means of the function block "2.4.5.2 MC_Reset_ATV" before the power stage can be enabled again.

- An asynchronous motor has no torque when it is at a standstill. Enabling the power stage does not automatically generate torque.
- If the input Enable = TRUE, one of the following errors is signaled if the power supply is lost.
  - 3120_h (undervoltage)
  - ATV71/ATV32: $FF34_h$ (PowerOnTimeout_ATV)
  - If the 24V power supply is lost: $8100h_h$ (NodeguardError_ATV)
  - The output `Status` is set to FALSE and the output `Error` to TRUE. Once the power supply is available again, the output `Status` is set back to TRUE.

2.3.2 Operating mode Jog

In the operating mode Jog, a movement is made from the actual motor position in the desired direction. The velocity can be set. As long as the signal for the direction is available, a continuous movement is made in the desired direction.

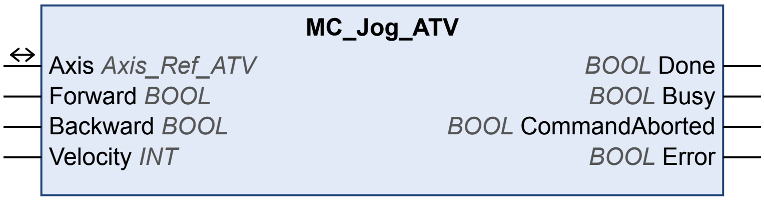
If movements in positive and negative directions are requested at the same time, there is no motor movement.

2.3.2.1 MC_Jog_ATV

Function description

The function block starts the operating mode Jog. TRUE at the input `Forward` or the input `Backward` starts the jog movement. If both the inputs `Forward` and `Backward` are FALSE, the operating mode is terminated and the output `Done` is set. If both the inputs `Forward` and `Backward` are TRUE, the operating mode remains active, the jog movement is stopped and the output `Busy` remains set.

Graphical representation



Compatible devices

ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
Forward	BOOL	Value range: FALSE, TRUE Initial value: FALSE Forward = FALSE and Backward = FALSE: Movement is terminated. Forward = TRUE and Backward = FALSE: Movement in positive direction is started if Velocity >0. Movement in negative direction is started if Velocity <0. Forward = FALSE and Backward = TRUE: Movement in negative direction is started if Velocity >0. Movement in positive direction is started if Velocity <0. Forward = TRUE and Backward = TRUE: If both the inputs Forward and Backward are TRUE, the operating mode remains active, the jog movement is stopped and the output Busy remains set.
Backward	BOOL	Value range: FALSE, TRUE Initial value: FALSE Forward = FALSE and Backward = FALSE: Movement is terminated. Forward = TRUE and Backward = FALSE: Movement in positive direction is started if Velocity >0. Movement in negative direction is started if Velocity <0. Forward = FALSE and Backward = TRUE: Movement in negative direction is started if Velocity >0. Movement in positive direction is started if Velocity <0. Forward = TRUE and Backward = TRUE: The movement in the current direction continues. If the inputs Forward or Backward are set to FALSE, the movement is continued in the direction and at the velocity valid at that point in time.
Velocity	INT	Value range: -5000 ... +5000 Initial value: 0 Target velocity for the operating mode. Adjustable in increments of 0.1 Hz. NOTE: The values for LowFrequency and HighFrequency are set in the function block SetFrequencyRange_ATV. If the value for the target velocity velocity is less than the value for LowFrequency, the movement is made with the velocity value for LowFrequency. No error is signaled. If the value for the target velocity velocity is greater than the value for HighFrequency, the movement is made with the velocity value for HighFrequency. No error is signaled.

"2.2 Basic inputs and outputs"

2.3.3 Operating mode Profile Velocity

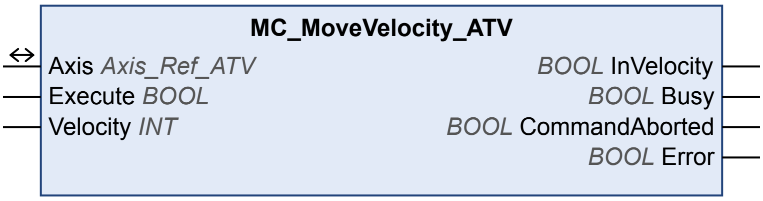
You can set a target velocity in the operating mode Profile Velocity. The movement is performed with this target velocity in the operating mode Profile Velocity. The movement continues until a new target velocity is set or until the operating mode is aborted.

Transitions between two target velocities are performed on the basis of a motion profile. The motion profile is determined by the profile generator in the drive on the basis of the actual velocity, the target velocity and the acceleration and deceleration ramps.

2.3.3.1 MC_MoveVelocity_ATV

Function description The function block starts the operating mode Profile Velocity with the velocity `Velocity`. When the target velocity is reached, `InVelocity` is set.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
`Velocity`	`INT`	Value range: -5000 ... +5000 Initial value: 0 Target velocity in [0.1Hz] NOTE: The values for `LowFrequency` and `HighFrequency` are set in the function block SetFrequencyRange_ATV. If the value for the target velocity `velocity` is less than the value for `LowFrequency`, the movement is made with the velocity value for `LowFrequency`. No error is signaled. If the value for the target velocity `velocity` is greater than the value for `HighFrequency`, the movement is made with the velocity value for `HighFrequency`. No error is signaled.

The table below shows the outputs.

Output	Data type	Description
`InVelocity`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE FALSE: Target velocity not yet reached. TRUE: Target velocity reached.

"2.2 Basic inputs and outputs"

Notes In the operating mode Profile Velocity, a position overtravel does not trigger an error. A position overtravel results in a loss of the zero point.

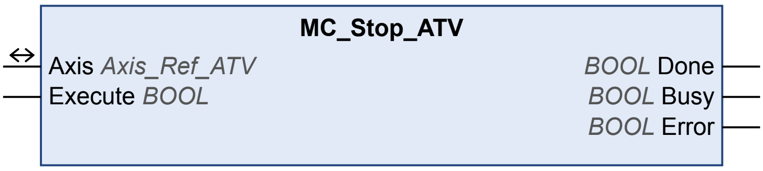
2.3.4 Stopping

Each operating mode can be canceled by stopping. Stopping the operating mode does not generate an error.

2.3.4.1 MC_Stop_ATV

Function description The function block is used to stop the current movement. The operating mode is stopped by the function block.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs "2.2 Basic inputs and outputs"

Notes

The type of deceleration (deceleration ramp, coasting down without braking) is set via the parameter `Stt`. Note the pertinent information in the product manual.

- The deceleration ramp is set with the function block "2.4.2.2 SetDriveRamp_ATV".
- The function block can only be interrupted by disabling the power stage via the function block "2.3.1.1 MC_Power_ATV".
- As long as the input `Execute` is TRUE, no other function block with the exception of "2.3.1.1 MC_Power_ATV" can be started.

2.4 Administrative

2.4.1 Reading a parameter

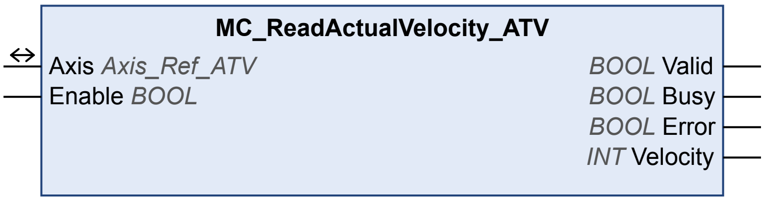
The following functions blocks allow you to read drive parameters such as the actual position or the actual velocity.

An additional function block provides read access to individual parameters of the device. See the product manual for a description of the parameters.

2.4.1.1 MC_ReadActualVelocity_ATV

Function description The function block is used to read the actual velocity of the motor.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the outputs.

Output	Data type	Description
`Velocity`	`INT`	Value range: -5000 ... +5000 Initial value: Actual velocity in min^{-1}

"2.2 Basic inputs and outputs"

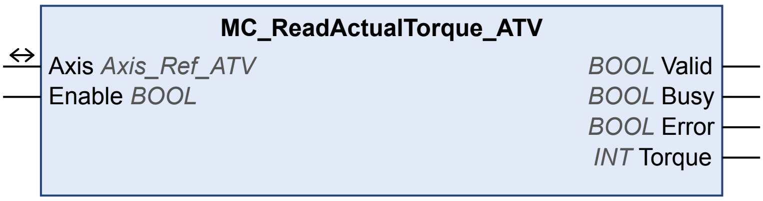
Notes The function block uses Service Data Objects (SDO) to read the parameter from the device. Therefore, it is strongly recommended not to permanently set the input `Enable` to TRUE. This may cause overload on the fieldbus. It is recommended to deactivate the function block when the output `Busy` is set to FALSE.

The value is specified in min^{-1}. Example: At a frequency of 3 Hz and 2 pairs of poles, this results in a velocity of 90 min^{-1}. (3 Hz * 60 s / 2 pairs of poles = 90 min^{-1}). Note that the reference value for the velocity ("2.3.3.1 MC_MoveVelocity_ATV") is specified in increments of 0.1 Hz (3 Hz -> `Velocity` = 30).

2.4.1.2 MC_ReadActualTorque_ATV

Function description The function block is used to read the actual torque of the motor.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the outputs.

Output	Data type	Description
`Torque`	`INT`	Value range: -3276.7 ... 3276.7 Initial value: Actual torque of the motor on increments of 0.1 %.

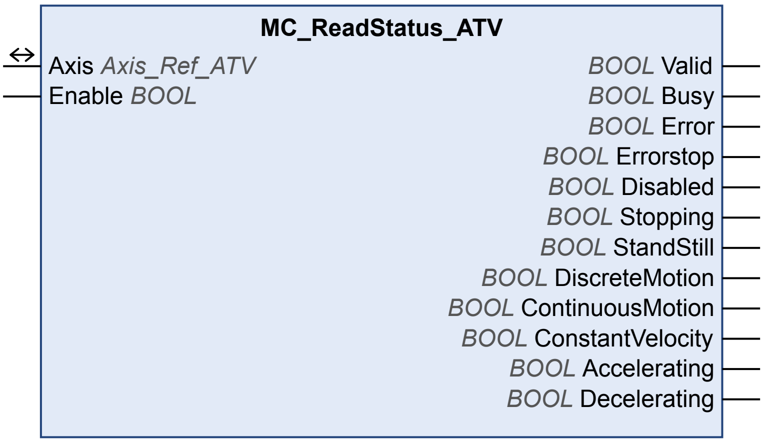
"2.2 Basic inputs and outputs"

Notes The function block uses Service Data Objects (SDO) to read the parameter from the device. Therefore, it is strongly recommended not to permanently set the input `Enable` to TRUE. This may cause overload on the fieldbus. It is recommended to deactivate the function block when the output `Busy` is set to FALSE.

2.4.1.3 MC_ReadStatus_ATV

Function description The function block is used to read the current status of the device.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the outputs.

Output	Data type	Description
`ErrorStop`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE TRUE: The movement has been interrupted by an error.
`Disabled`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE FALSE: Power stage is enabled. TRUE: Power stage is disabled
`Stopping`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE TRUE: The function block "2.3.4.1 MC_Stop_ATV" is being executed or the movement is being stopped.
`StandStill`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE TRUE: The movement hast been stopped.
`DiscreteMotion`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE TRUE: The operating mode Profile Position has been started.
`ContinuousMotion`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE TRUE: The operating mode Profile Velocity has been started.
`ConstantVelocity`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE TRUE: A movement at a constant velocity is performed.
`Accelerating`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE TRUE: The motor accelerates.
`Decelerating`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE TRUE: The motor decelerates.

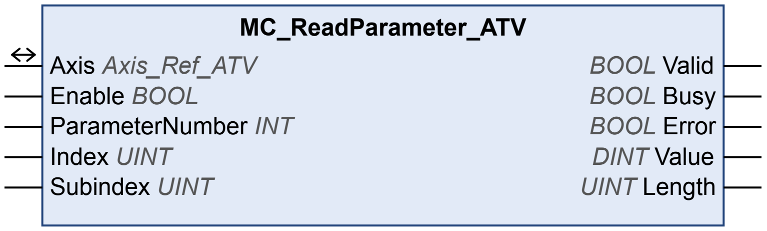
"2.2 Basic inputs and outputs"

Notes At any given point in time, the drive is in one of the states: StandStill, DiscreteMotion, ContinuousMotion, Stopping, Disabled or ErrorStop. The corresponding output is then TRUE.

2.4.1.4 MC_ReadParameter_ATV

Function description The function block reads an object from the device parameter list.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
`ParameterNumber`	`INT`	Value range: 0 ... 65535 Initial value: 1000 Number of the parameter: 10: Actual velocity. 11: Target velocity. 1000: Selection via index and subindex.
`Index`	`UINT`	Value range: 0 ... 65535 Initial value: Index of parameter to be read. Only valid if `ParameterNumber` = 1000. See the product manual for an overview of the parameters.
`Subindex`	`UINT`	Value range: 0 ... 255 Initial value: Subindex of parameter to be read. Only valid if `ParameterNumber` = 1000. See the product manual for an overview of the parameters.

The table below shows the outputs.

Output	Data type	Description
`Value`	`DINT`	Value range: -2147483648 ... 2147483647 Initial value: 0 Value of the parameter.
`Length`	`UINT`	Value range: 1 ... 4 Initial value: 4 Length of the parameter in bytes.

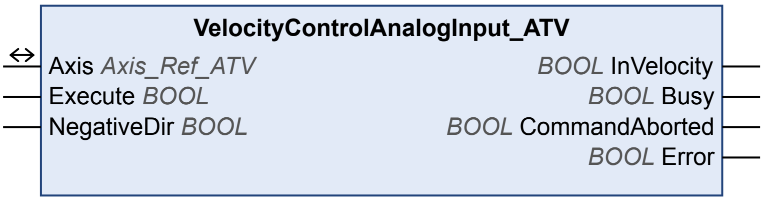
"2.2 Basic inputs and outputs"

Notes The function block uses Service Data Objects (SDO) to read the parameter. Therefore, it is strongly recommended not to permanently set the input `Enable` to TRUE. This may cause overload on the fieldbus. It is recommended to deactivate the function block when the input `Busy` is set to FALSE.

2.4.1.5 VelocityControlAnalogInput_ATV

Function description The function block uses the reference values supplied by the analog input selected with the function block "2.4.1.6 VelocityControlSelectAI_ATV".

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs

The table below shows the inputs.

Input	Data type	Description
`NegativeDir`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE FALSE: Clockwise rotation. TRUE: Counter-clockwise rotation.

The table below shows the outputs.

Output	Data type	Description
`InVelocity`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE FALSE: The velocity does not correspond to the reference value. FALSE: The velocity corresponds to the reference value.

"2.2 Basic inputs and outputs"

Notes

Observe the information provided in chapter "Preparing the drive".

See also "2.4.2.3 SetFrequencyRange_ATV" and "2.4.1.6 VelocityControlSelectAI_ATV".

If voltage levels -10V ... 10V are used, the direction of movement (rotation) is inversed when the sign changes. If the voltage is 0 V, this may result in jumps in the direction of movement, in the minimum frequency and in jumps at standstill.

NOTE for ATV31: If you have selected the analog current input (0 mA ... 20 mA), the following frequency levels are used:

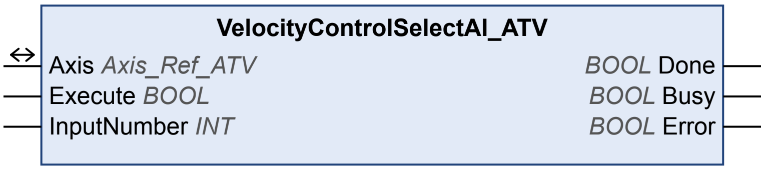
- The minimum frequency is used below 4 mA.
- The medium frequency is used at 12 mA.
- The maximum frequency is used at 20 mA.

2.4.1.6 VelocityControlSelectAI_ATV

Function description

This function block is used to select the analog input for supplying the reference value. See also "2.4.1.5 VelocityControlAnalogInput_ATV".

Graphical representation



Compatible devices

ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
`InputNumber`	`INT`	Value range: 1 ... 16 Initial value: 1 1: AI1 2: AI2 3: AI3 (ATV71 only with expansion card) 4: AI4 (ATV71 only and only with expansion card) 16: AIP (internal potentiometer, ATV31/312 only)

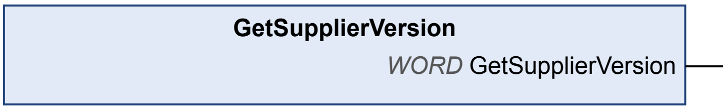
"2.2 Basic inputs and outputs"

Notes The function block can only be executed if the drive is in the operating state **3** Switch On Disabled (operating state of drive). To transition to this state, disable the power stage with the function block "2.3.1.1 MC_Power_ATV".

2.4.1.7 GetSupplierVersion

Function description The function returns the version of the library of the device.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the outputs.

Output	Data type	Description
`GetSupplierVersion`	`WORD`	The output provides the version number of the library. Convert the decimal value to hex. Example: GetSupplierVersion = 12368 = 3050$_h$ = Version 3.0.5.0

2.4.2 Writing a parameter

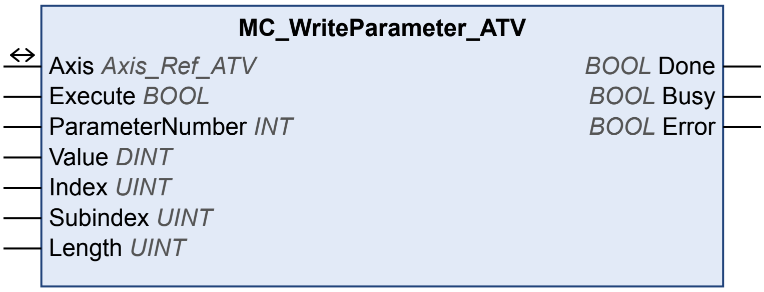
The following function bocks allow you to write drive parameters, for example the values for the acceleration and deceleration ramps.

An additional function block provides write access to individual parameters of the device. See the product manual for a description of the parameters.

2.4.2.1 MC_WriteParameter_ATV

Function description The function block is used to write a value to a specific parameter.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
`ParameterNumber`	`INT`	Value range: 1000 Initial value: 1000 Reserved.
`Value`	`DINT`	Value range: -2147483648 ... 2147483647 Initial value: 0 New value to be written to the parameter.
`Index`	`UINT`	Value range: 0 ... 65535 Initial value: 0 Index of the parameter to be written. See the product manual for a list of the parameters with the corresponding CANopen address.
`Subindex`	`UINT`	Value range: 0 ... 255 Initial value: 0 Subindex of the parameter to be written. See the product manual for a list of the parameters with the corresponding CANopen address.
`Length`	`UINT`	Value range: 0 ... 4 Initial value: 0 Length of the parameter to be written in bytes.

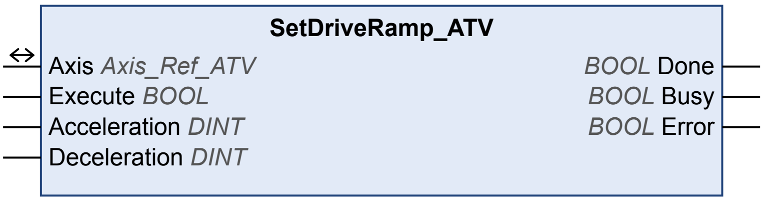
"2.2 Basic inputs and outputs"

Notes If the inputs `ParameterNumber`, `Index` or `Subindex` are changed while `Busy` is TRUE, the function block uses the previous values. The next time the function block is executed, the new values will be used.

2.4.2.2 SetDriveRamp_ATV

Function description The function block configures the acceleration ramp and the deceleration ramp of the device.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
`Acceleration`	`DINT`	Value range: 1 ... 9999 Initial value: 30 Time for the acceleration ramp in 0.1 s. Example: With a value of 30, 3 seconds are required to accelerate from 0 to the nominal frequency of the motor. It must be possible to reach the value with the available nominal torque of the motor.
`Deceleration`	`DINT`	Value range: 1 ... 9999 Initial value: 30 Time for the deceleration ramp in 0.1 s. Example: With a value of 30, 3 seconds are required to decelerate from 0 to the nominal frequency of the motor. It must be possible to reach the value with the available nominal torque of the motor.

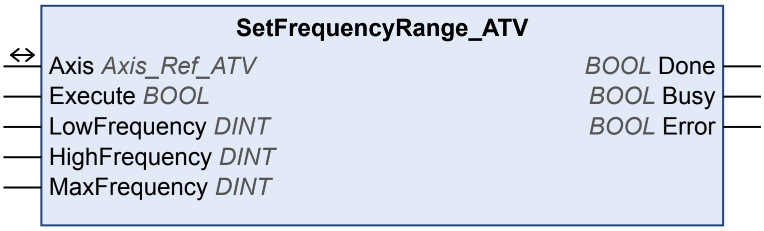
"2.2 Basic inputs and outputs"

Notes Note the following for drives with high external moments of inertia or for highly dynamic applications: The motors regenerate energy during deceleration. The DC bus can absorb a limited amount of energy in the capacitors. Connecting additional capacitors to the DC bus increases the amount of energy that can be absorbed. If the capacity of the capacitors is exceeded, the excess energy must be discharged via internal or external braking resistors. If the energy is not discharged, an overvoltage monitor will shut off the power stage. Overvoltages can be limited by adding a braking resistor with a corresponding braking resistor controller. This converts the regenerated energy to heat energy during deceleration.

2.4.2.3 SetFrequencyRange_ATV

Function description The function block is used to configure the frequency ranges of the device for the function blocks MC_MoveVelocity and MC_Jog. If the frequency (speed of rotation) falls below the value in `LowFrequency`, the device uses the frequency specified in `LowFrequency` without triggering an error message. If the frequency (speed of rotation) exceeds the value in `HighFrequency`, the device uses the frequency specified in `HighFrequency` without triggering an error message.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
`LowFrequency`	`DINT`	Value range: 0 ... `HighFrequency` Initial value: 0 Motor frequency at minimum reference value. NOTE: If the value of `LowFrequency` exceeds the value of `HighFrequency`, the value of `HighFrequency` is used.
`HighFrequency`	`DINT`	Value range: `LowFrequency` ... `MaxFrequency` Initial value: 500 Motor frequency at maximum reference value. NOTE: If the value of `HighFrequency` exceeds the value of `MaxFrequency`, the value of `MaxFrequency` is used.
`MaxFrequency`	`DINT`	Value range: 100 ... 5000/10000 (see product manual) Initial value: 600 Maximum permissible motor frequency Adapt the value to the motor and the mechanical situation. The maximum frequency depends on certain parameters. Note the pertinent information in the product manual.

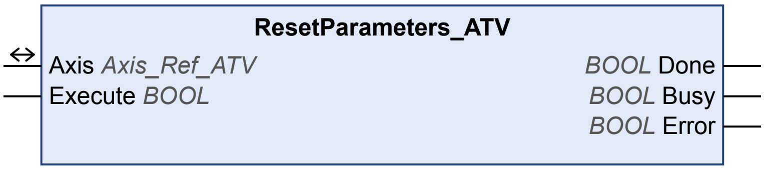
"2.2 Basic inputs and outputs"

Notes The function block can only be executed if the drive is in the operating state **3** Switch On Disabled (operating state of drive). To transition to this state, disable the power stage with the function block "2.3.1.1 MC_Power_ATV".

2.4.2.4 ResetParameters_ATV

Function description This function block restores all parameters to the factory settings.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs "2.2 Basic inputs and outputs"

Notes Observe the information provided in chapter "Preparing the drive".

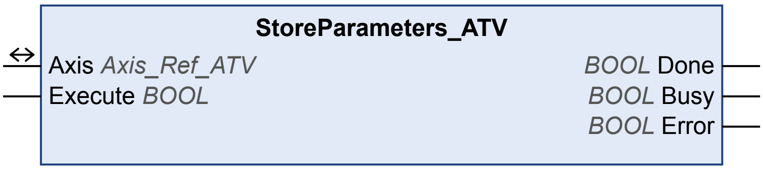
- The new settings are not saved to the EEPROM. Use "2.4.2.5 StoreParameters_ATV" to save the new settings to the EEPROM.

2.4.2.5 StoreParameters_ATV

Function description

The function block saves the parameter values to the EEPROM.

Graphical representation



Compatible devices

ATV31/ATV312 and ATV71/ATV32

Inputs/outputs

"2.2 Basic inputs and outputs"

2.4.3 Saving and restoring device configuration

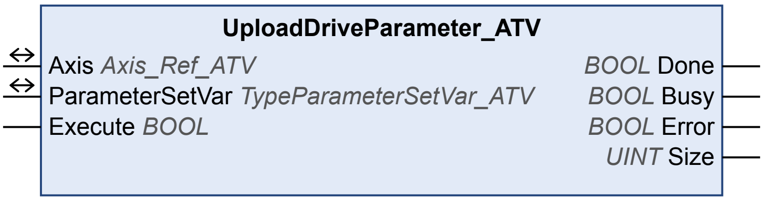
Using a function block, you can upload the device configuration from the drive to the controller. A further function block lets you download a device configuration stored on the controller to a drive.

2.4.3.1 UploadDriveParameter_ATV

Function description

The function blocks reads the parameter values that can be modified from the device. See also "2.4.3.2 DownloadDriveParameter_ATV".

Graphical representation



Compatible devices

ATV31/ATV312 and ATV71/ATV32

Inputs/outputs

The table below shows the inputs/outputs.

Input/output	Data type	Description
`ParameterSetVar`	`TypeParameterSetVar_ATV`	Value range: Initial value: List of the device parameters. Predefined data structure (array of DINT).

The table below shows the outputs.

Output	Data type	Description
`Size`	`UINT`	Value range: Initial value: 0 Number of parameters read. In the case of an incorrect upload, the value remains 0.

"2.2 Basic inputs and outputs"

Notes

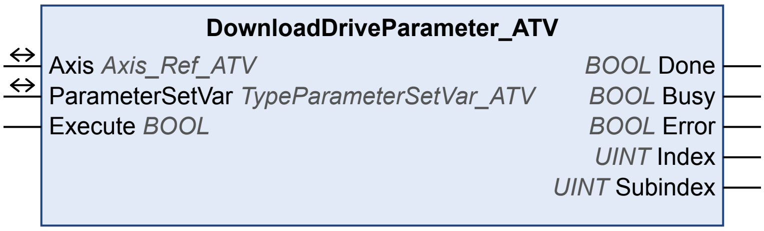
- The two function blocks "2.4.3.2 DownloadDriveParameter_ATV" and "2.4.3.1 UploadDriveParameter_ATV" allow you to save the parameters stored in a device to an identical device without using the commissioning software.

2.4.3.2 DownloadDriveParameter_ATV

Function description

The function blocks writes the parameter values that can be modified to the device. Before calling the function block, you must execute "2.4.3.1 UploadDriveParameter_ATV". If not, an error message will be generated.

Graphical representation



Compatible devices

ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs/outputs.

Input/output	Data type	Description
`ParameterSetVar`	`TypeParameterSetVar_ATV`	Value range: Initial value: List of device parameters

The table below shows the outputs.

Output	Data type	Description
`Index`	`UINT`	Value range: 0 ... 65535 Initial value: Index of the parameter. See the product manual for an overview of the parameters.
`Subindex`	`UINT`	Value range: 0 ... 255 Initial value: Subindex of the parameter. See the product manual for an overview of the parameters.

"2.2 Basic inputs and outputs"

Notes

- The function block can only be executed if the drive is in the operating state **3** Switch On Disabled (operating state of drive). To transition to this state, disable the power stage with the function block "2.3.1.1 MC_Power_ATV".
- In order to permanently store the parameters, you must save them to the EEPROM using the function block "2.4.2.5 StoreParameters_ATV".
- The two function blocks "2.4.3.2 DownloadDriveParameter_ATV" and "2.4.3.1 UploadDriveParameter_ATV" allow you to save the parameters stored in a device to an identical device without using the commissioning software.

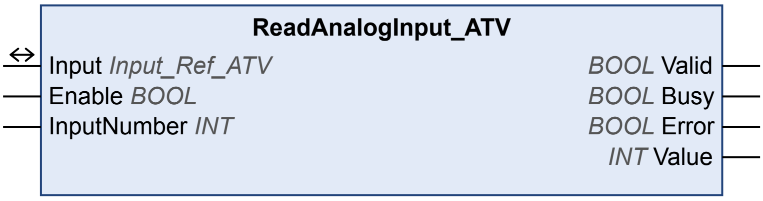
2.4.4 Inputs and outputs

The following function blocks allow you to access the digital and analog inputs and outputs of all CAN nodes in the system..

2.4.4.1 ReadAnalogInput_ATV

Function description The function block reads the current value of an analog input.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
`InputNumber`	`INT`	Value range: 1 ... 4 Initial value: 1 1: AI1 2: AI2 3: AI3 (ATV71 only with expansion card) 4: AI4 (ATV71 only and only with expansion card)

The table below shows the outputs.

Output	Data type	Description
`Value`	`INT`	Value range: - Initial value: 0 Corresponds to the input voltage in [mV] or the input current in 0.001 [mA] increments at the selected analog input.

"2.2 Basic inputs and outputs"

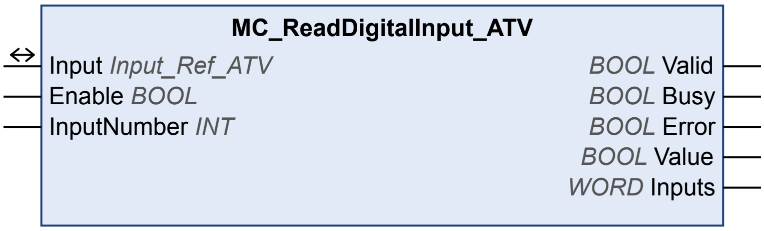
Notes

- The analog inputs of ATV31/ATV312 and ATV71/ATV32 are different. See the product manual for additional information.
- The function block uses Service Data Objects (SDO) to read the parameter from the device. Therefore, it is strongly recommended not to permanently set the input `Enable` to TRUE. This may cause overload on the fieldbus. It is recommended to deactivate the function block when the output `Busy` is set to FALSE.

2.4.4.2 MC_ReadDigitalInput_ATV

Function description Reads the current state of the digital inputs of the drive.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
`InputNumber`	`INT`	Value range: 1 ... 14 (product-dependent) Initial value: 1 Number of the input to be read. Assignment of the inputs of the drive. 1: IL1 2: IL2 3: IL3 4: IL4 5: IL5 6: IL6 Inputs of the I/O expansion card (ATV71): 7: IL7 8: IL8 9: IL9 10: IL10 Inputs of the I/O expansion card (ATV71): 11: IL11 12: IL12 13: IL13 14: IL14 15: Reserved. Value = 0.

The table below shows the outputs.

Output	Data type	Description
`Value`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE FALSE: Level at selected input is 0 V. TRUE: Level at selected input is 24 V.
`Inputs`	`WORD`	Value range: 0000_h ... $3FFF_h$ Initial value: 0000_h Image of the inputs as a bit pattern. Bit 0: IL1 Bit 1: IL2 Bit 2: IL3 Bit 3: IL4 Bit 4: IL5 Bit 5: IL6 Inputs of the I/O expansion card (ATV71): Bit 6: IL7 Bit 7: IL8 Bit 8: IL9 Bit 9: IL10 Inputs of the I/O expansion: Bit 10: IL11: Bit 11: IL12 Bit 12: IL13 Bit 13: IL14 Bit 14 and bit 15: Reserved. Value = 0.

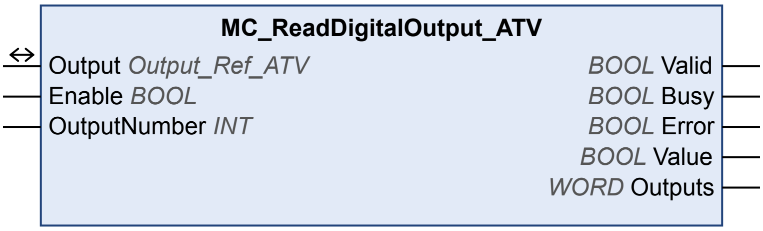
"2.2 Basic inputs and outputs"

Notes See the product manual for a description of the digital inputs.

2.4.4.3 MC_ReadDigitalOutput_ATV

Function description The function block is used to get the current state of the digital outputs.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
`OutputNumber`	`INT`	Value range: 1 ... 8 (product-dependent) Initial value: 1 Number of the output to be read. ATV31/312/32: 1: Relay1 2: Relay2 3: LO ATV71: 1: Relay1 2: Relay2 3: Relay3 4: Relay4 5: LO1 6: LO2 7: LO3 8: LO4

The table below shows the outputs.

Output	Data type	Description
`Value`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE FALSE: Level at selected output is 0 V. TRUE: Level at selected output is 24 V.
`Outputs`	`WORD`	Value range: 00_h ...$0F_h$ Initial value: 00_h Image of the outputs as a bit pattern. ATV31/312/32: Bit 0: Relay1 Bit 1: Relay2 Bit 2: LO ATV71: Bit 0: Relay1 Bit 1: Relay2 Bit 2: Relay3 Bit 3: Relay4 Bit 4: LO1 Bit 5: LO2 Bit 6: LO3 Bit 7: LO4 The value of the other bits is 0.

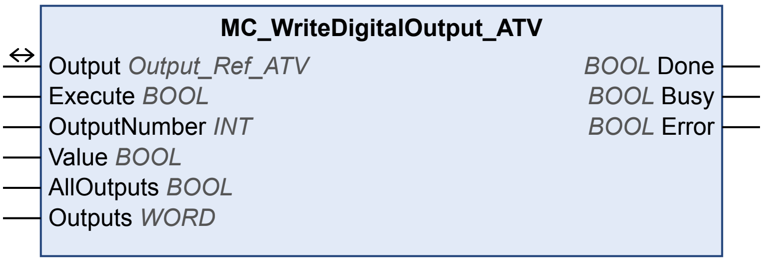
"2.2 Basic inputs and outputs"

Notes See the product manual for a description of the digital outputs.

2.4.4.4 MC_WriteDigitalOutput_ATV

Function description The function blocks writes values to the digital outputs.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
`OutputNumber`	`INT`	Value range: 1 ... 8 (product-dependent) Initial value: 1 Signal output to which to write. ATV31/312/32: 1: Relay1 2: Relay2 3: LO ATV71: 1: Relay1 2: Relay2 3: Relay3 4: Relay4 5: LO1 6: LO2 7: LO3 8: LO4.
`Value`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE FALSE: 0V is written to the selected signal output. TRUE: 24V is written to the selected signal output.
`AllOutputs`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE: The signal output to be written to is set via input `OutputNumber`. TRUE: The signal outputs to be written to are set via input `Outputs`.
`Outputs`	`WORD`	Value range: 0000_h ... 0003_h Initial value: 0 0: 0 V is written to the selected signal output. 1: 24V is written to the selected signal output. 0000 0000 0000 0001_2 (0001_h) = Signal output/relay 1 24V 0000 0000 0000 0010_2 (0002_h) = Signal output/relay 2 24V 0000 0000 0000 0011_2 (0003_h) = Signal output/relay 1 and signal output/relay 2 24V

"2.2 Basic inputs and outputs"

2.4.5 Error handling

For error handling, each function block has an output `Error` which is set if a synchronous or asynchronous error occurs.

The function block MC_ReadAxisError_xxx is called to analyze the cause of the error. The function block contains the stored error information.

The function block MC_Reset_xxx deletes the error information entered. Future error information can now be stored.

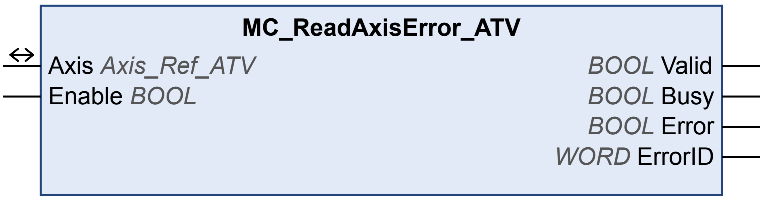
If an additional error occurs, the error information is only stored if no stored error information already exists. If there is still information pertaining to a previous error, the new error message is ignored.

2.4.5.1 MC_ReadAxisError_ATV

Function description

The function block reads the error information pertaining to the most recent error.

Graphical representation



Compatible devices

ATV31/ATV312 and ATV71/ATV32

Inputs/outputs

The table below shows the outputs.

Output	Data type	Description
`ErrorID`	`WORD`	Value range: 0000_h ... $FFFF_h$ Initial value: 0000_h 0: No error stored. >0: Stored error number. See the product manual for an overview of the error numbers.

"2.2 Basic inputs and outputs"

Table of error numbers

The table below shows the error numbers of the library. See the product manual for the error numbers of the drive.

ErrorID hexadecimal	ErrorID decimal	HMI	Description
1000$_h$	4096	CrF oLF SoF	Capacitor error Motor overload Speed of rotation too high
2310$_h$	8976	oCF	Motor overcurrent
2320$_h$	8992	SCF	Motor short circuit
2330$_h$	9008	SCF	Short circuit motor phases (ground fault)
2340$_h$	9024	SCF	Short circuit motor phase (phase to phase)
3110$_h$	12560	oSF	Overvoltage mains supply
3120$_h$	12576	uSF	Undervoltage mains supply
3130$_h$	12592	PhF	Error mains phases
3310$_h$	13072	obF oPF	DC bus overvoltage Error motor phase
4210$_h$	16912	ohF	Overtemperature
5520$_h$	21792	EEF	EEPROM error
6100$_h$	24832	inF	Internal event
6300$_h$	25344	CCF	Parameter out of permissible range
7300$_h$	29440	LFF	Error at AI3
7510$_h$	29968	SLF	Modbus communication error
8100$_h$	33024	CoF	CANopen communication error, Heartbeat or Life Guard error
9000$_h$	36864	EPF	External error
A309$_h$	41737		Drive not in operating state**6** Operation Enabled
FE00$_h$	65024	tnF	Error during autotuning
FE01$_h$	65025	bLF	Error brake controller
FF00$_h$	65280	-	Toggle bit unchanged
FF01$_h$	65281	-	SDO timeout
FF02$_h$	65282	-	Server / client command specifier invalid or unknown
FF03$_h$	65283	-	Invalid block size (only in Block Mode)
FF04$_h$	65284	-	Invalid sequence number (only in Block Mode)
FF05$_h$	65285	-	CRC error (only in Block Mode)
FF06$_h$	65286	-	No memory available
FF07$_h$	65287	-	Access to object not possible
FF08$_h$	65288	-	No read access, because write-only object (wo)
FF09$_h$	65289	-	No write access, because read object (ro)
FF0A$_h$	65290	-	Object does not exist in object dictionary
FF0B$_h$	65291	-	Object does not support PDO mapping
FF0C$_h$	65292	-	Number or length of objects exceed the byte length of the PDO
FF0D$_h$	65293	-	Parameters are incompatible
FF0E$_h$	65294	-	Device detects internal incompatibility
FF0F$_h$	65295	-	Hardware error, access denied
FF10$_h$	65296	-	Data type and parameter length do not match
FF11$_h$	65297	-	Data type does not match, parameter too long

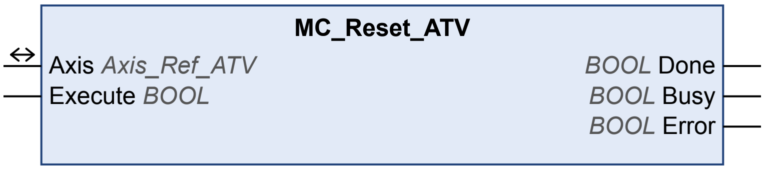
ErrorID hexadecimal	ErrorID decimal	HMI	Description
FF12$_h$	65298	-	Data type does not match, parameter too short
FF13$_h$	65299	-	Subindex not supported
FF14$_h$	65300	-	Value range of parameter too large (relevant only for write access)
FF15$_h$	65301	-	Parameter values too great
FF16$_h$	65302	-	Parameter values too small
FF17$_h$	65303	-	Upper value is less than lower value
FF18$_h$	65304	-	General error
FF19$_h$	65305	-	Data can neither be transmitted to the application nor saved.
FF1A$_h$	65306	-	Local access channel is used, data can neither be transmitted nor saved.
FF1B$_h$	65307	-	Device status keeps data from being transmitted and saved.
FF1C$_h$	65308	-	Object dictionary does not exist or cannot be generated (for example, if data error occurs during generation from file)
FF1D$_h$	65309	-	Reserved
FF1E$_h$	65310	-	Reserved
FF1F$_h$	65311	-	Reserved
FF20$_h$	65312	-	Unknown status
FF21$_h$	65313	-	Input variable was changed before response was received ("2.4.1.4 MC_ReadParameter_ATV", "2.4.2.1 MC_WriteParameter_ATV")
FF22$_h$	65314	-	Attempt to interrupt a non-interruptible function block ("2.3.1.1 MC_Power_ATV", "2.3.4.1 MC_Stop_ATV")
FF34$_h$	65332	-	Power stage does not switch to operating state **6** Operation Enabled
FF37$_h$	65335	-	Power stage is not in operating state **6** Operation Enabled
FF38$_h$	65336	-	Parameter list has not yet been read from the device via "2.4.3.1 UploadDriveParameter_ATV".
FF39$_h$	65337	-	Parameter list and device do not match
FF3A$_h$	65338	-	Drive in state PreOperational
FF3B$_h$	65339	-	Drive is not in operating state **3** Switch On Disabled
FF3C$_h$	65340	-	STO "Safe Torque Off" (Power Removal) active
FF3D$_h$	65341	-	Drive is not compatible
FF3E$_h$	65342	-	Error in mapping
FF50$_h$	65360	-	Initialization error of function block "2.5.1.1 Altivar_Startup"
FF51$_h$	65361	-	The function block "2.5.1.1 Altivar_Startup" cannot be controlled via the application since i_iControlMode = 1.
FF52$_h$	65362	-	The function block "2.5.1.1 Altivar_Startup" cannot be controlled via the visualization since i_iControlMode = 0.
FF53$_h$	65363	-	The value at the input i_iControlMode is outside of the valid value range.

ErrorID hexadecimal	ErrorID decimal	HMI	Description
FF54h	65364	-	The value at the input `iq_iCmd` is outside of the valid value range.
FF55h	65365	-	The function block and the connected device are incompatible.

2.4.5.2 MC_Reset_ATV

Function description The function block is used to acknowledge an error. The error memory is cleared so that it is available for future error messages. If the power stage has been disabled by the automatic error response, it can be enabled again, provided that the cause of the error has been rectified when the error message is acknowledged.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs "2.2 Basic inputs and outputs"

2.5 Device Function

2.5.1 Startup

These function blocks "Startup" support you in commissioning a drive system at a controller. Before these function blocks can be used, you must set the communication parameters baud rate and node address in the drive and in the controller. Function blocks and the visualization cannot be used simultaneously.

The function blocks "Startup" with visualization elements have the following functions:

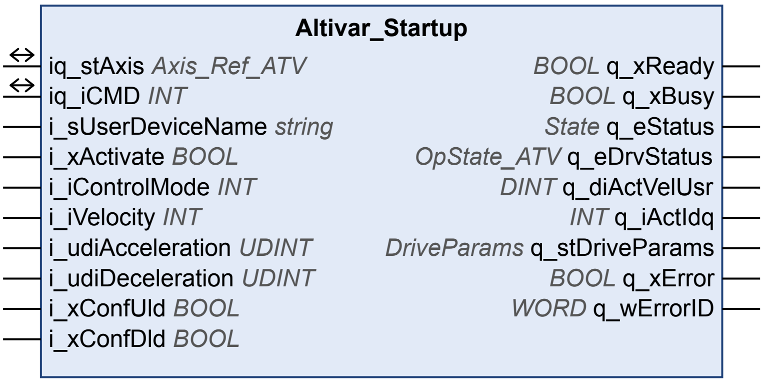
- Switching on the drive system.
- Displaying the status of the drive system.
- Fast access to frequently used parameters.
- The parameters are accessed via their index and subindex.
- Transmitting a device parameter list from the drive to the controller and from the controller to the drive (upload and download).
- Using the operating mode Jog.
- Using the operating mode Profile Velocity (movement at defined velocity).
- Displaying and acknowledging error messages.

2.5.1.1 Altivar_Startup

Function description

This function block supports you in commissioning a frequency inverter for the first time. The function block comprises two visualizations to facilitate usage of the function block. Function blocks and the visualization cannot be used simultaneously.

Graphical representation



Compatible devices ATV31/ATV312 and ATV71/ATV32

Inputs/outputs The table below shows the inputs/outputs.

Input/output	Data type	Description
iq_stAxis	Axis_Ref_ATV	Value range: Initial value: Corresponds to the input/output Axis. See "2.2 Basic inputs and outputs".
iq_iCMD	INT	Value range: Initial value: Commands: -1: command is active 0: no ongoing command 1: ENABLE (enable power stage) 2: DISABLE (disable power stage) 3: Reset 4: Stop 9: MoveVel The function to be executed is written by the application as a command and overwritten by the function block when it is processed. Condition: The input is only effective if the value of Control-Mode is 1. To start the selected function, the value in the parameter CMD must be written once. As soon as the command is executed, the value is overwritten by -1. When the execution of the command is terminated, the value is overwritten by 0.

The table below shows the inputs.

Input	Data type	Description
i_sUserDeviceName	string	Value range: Initial value: Name of the axis. The name is defined by the user. If no name is entered, the node ID is displayed.
i_xActivate	BOOL	Value range: FALSE, TRUE Initial value: The selected ControlMode is activated with a rising edge. If all requirements for the selected ControlMode are met, the selected ControlMode is started. If the requirements are not met, the selection is canceled with an error message.
i_iControlMode	INT	Value range: Initial value: ControlMode = 0: The functions are controlled via the visualization. ControlMode = 1: The functions are controlled via the application. The visualization is deactivated.
i_iVelocity	INT	Value range: Initial value: Target velocity in [usr]
i_udiAcceleration	UDINT	Value range: Initial value: 30 Acceleration ramp in [usr].
i_udiDeceleration	UDINT	Value range: Initial value: 30 Deceleration ramp in [usr]
i_xConfUld	BOOL	Value range: FALSE, TRUE Initial value: A rising edge triggers an upload (saving parameters from device to controller).
i_xConfDld	BOOL	Value range: FALSE, TRUE Initial value: A rising edge triggers a download (stored parameters from controller to device).

The table below shows the outputs.

Output	Data type	Description
q_xReady	BOOL	Value range: FALSE, TRUE Initial value: Function block has been activated and is ready for operation.
q_xBusy	BOOL	Value range: FALSE, TRUE Initial value: A function is being performed via the function block. If a new function is started, the currently active function is canceled.
q_eStatus	State	Value range: Initial value: State as per PLCopen state diagram: 0: Undefined 1: Errorstop 2: Disabled 3: Stopping 4: StandStill 5: DiscreteMotion 6: ContinuousMotion 7: SynchronizedMotion 8: Homing
q_eDrvStatus	OpState_ATV	Value range: Initial value: Operating state of the drive: 1: init 2: nrdy 3: dis 4: rdy 5: son 6: run 7: stop 8: flt
q_diActVelUsr	DINT	Value range: Initial value: Actual velocity in [usr]
q_iActIdq	INT	Value range: Initial value: Actual current in [A_{rms}]
q_stDriveParams	DriveParams	Value range: Initial value: Data structure, consisting of STRING: Device identification REAL: Firmware version of the device
q_xError	BOOL	Value range: FALSE, TRUE Initial value: FALSE: No error has been detected. TRUE: An error has been detected.
q_wErrorID	WORD	Value range: Initial value: Error number. See "Table of error numbers".

Notes

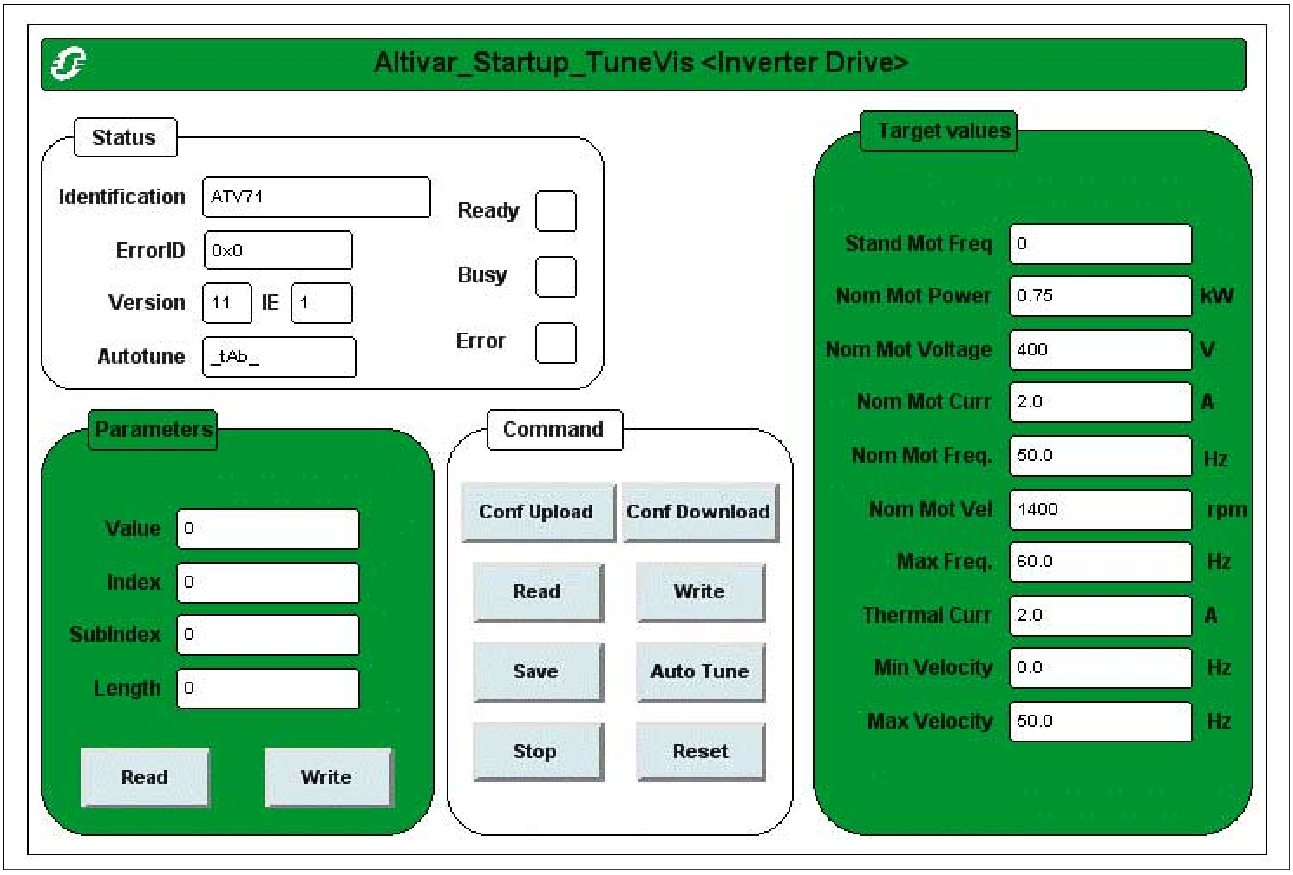
⚠ WARNING

UNINTENDED BEHAVIOR DUE TO INCONSISTENT COMMANDS

If you have activated this function block, simultaneous use of other function blocks of the library leads to unintended behavior.

- Only activate this function block when all other function blocks of the library are inactive.
- Deactivate this function block before activating any other function block of the library.

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



Altivar_Startup_TuneVis <Inverter Drive>

Status

Identification	ATV71
ErrorID	0x0
Version	11 IE 1
Autotune	_tAb_
Ready	□
Busy	□
Error	□

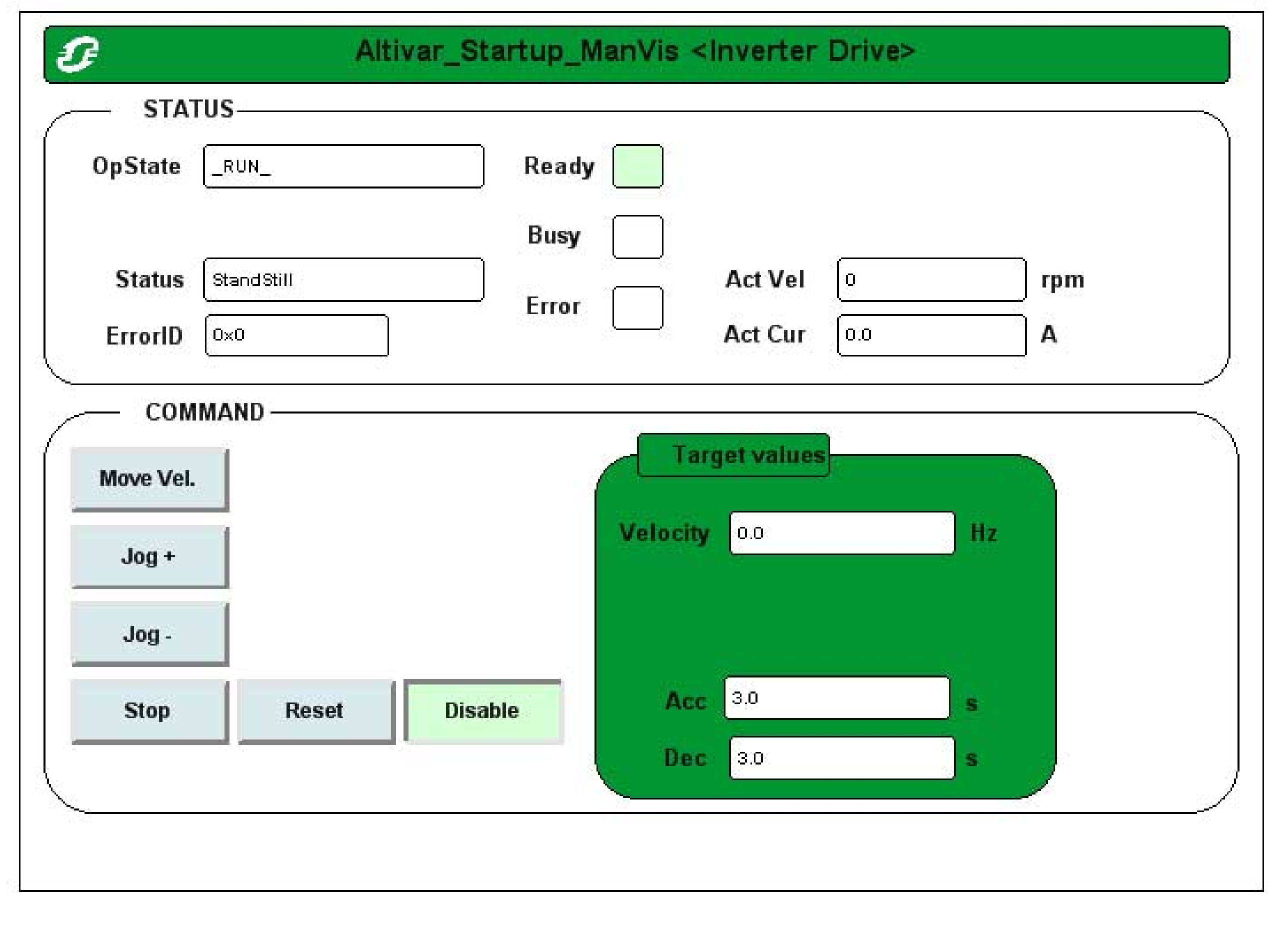
Parameters

Value	0
Index	0
SubIndex	0
Length	0

Target values

Stand Mot Freq	0	
Nom Mot Power	0.75	kW
Nom Mot Voltage	400	V
Nom Mot Curr	2.0	A
Nom Mot Freq.	50.0	Hz
Nom Mot Vel	1400	rpm
Max Freq.	60.0	Hz
Thermal Curr	2.0	A
Min Velocity	0.0	Hz
Max Velocity	50.0	Hz

The visualization `Altivar_Startup_TuneVis` provides direct access to many of the parameters of the drive. The parameters are addressed by means of index and subindex. Parameter values can be read and written. An image of defined parameter values can be saved from the drive to the controller. The stored parameter values can also be transferred from the controller to the drive as a unit. "Conf Download" corresponds to the function block "2.4.3.2 DownloadDriveParameter_ATV". "Conf Upload" corresponds to the function block "2.4.3.1 UploadDriveParameter_ATV".



Altivar_Startup_ManVis <Inverter Drive>

STATUS

OpState: _RUN_

Status: StandStill

ErrorID: 0x0

Ready: 🟩

Busy: □

Error: □

Act Vel: 0 rpm

Act Cur: 0.0 A

COMMAND

Target values

Velocity: 0.0 Hz

Acc: 3.0 s

Dec: 3.0 s

The visualization `Altivar_Startup_ManVis` allows you to display the status of the drive. You can start the operating mode Profile Velocity (movement at defined velocity) or the operating mode Jog.

Table of error numbers

The table below shows the error numbers of the library. See the product manual for the error numbers of the drive.

ErrorID hexadecimal	ErrorID decimal	HMI	Description
1000$_h$	4096	CrF oLF SoF	Capacitor error Motor overload Speed of rotation too high
2310$_h$	8976	oCF	Motor overcurrent
2320$_h$	8992	SCF	Motor short circuit
2330$_h$	9008	SCF	Short circuit motor phases (ground fault)
2340$_h$	9024	SCF	Short circuit motor phase (phase to phase)
3110$_h$	12560	oSF	Overvoltage mains supply
3120$_h$	12576	uSF	Undervoltage mains supply
3130$_h$	12592	PhF	Error mains phases
3310$_h$	13072	obF oPF	DC bus overvoltage Error motor phase
4210$_h$	16912	ohF	Overtemperature
5520$_h$	21792	EEF	EEPROM error
6100$_h$	24832	inF	Internal event
6300$_h$	25344	CCF	Parameter out of permissible range
7300$_h$	29440	LFF	Error at AI3
7510$_h$	29968	SLF	Modbus communication error
8100$_h$	33024	CoF	CANopen communication error, Heartbeat or Life Guard error
9000$_h$	36864	EPF	External error
A309$_h$	41737		Drive not in operating state**6** Operation Enabled
FE00$_h$	65024	tnF	Error during autotuning
FE01$_h$	65025	bLF	Error brake controller
FF00$_h$	65280	-	Toggle bit unchanged
FF01$_h$	65281	-	SDO timeout
FF02$_h$	65282	-	Server / client command specifier invalid or unknown
FF03$_h$	65283	-	Invalid block size (only in Block Mode)
FF04$_h$	65284	-	Invalid sequence number (only in Block Mode)
FF05$_h$	65285	-	CRC error (only in Block Mode)
FF06$_h$	65286	-	No memory available
FF07$_h$	65287	-	Access to object not possible
FF08$_h$	65288	-	No read access, because write-only object (wo)
FF09$_h$	65289	-	No write access, because read object (ro)
FF0A$_h$	65290	-	Object does not exist in object dictionary
FF0B$_h$	65291	-	Object does not support PDO mapping
FF0C$_h$	65292	-	Number or length of objects exceed the byte length of the PDO
FF0D$_h$	65293	-	Parameters are incompatible
FF0E$_h$	65294	-	Device detects internal incompatibility
FF0F$_h$	65295	-	Hardware error, access denied
FF10$_h$	65296	-	Data type and parameter length do not match
FF11$_h$	65297	-	Data type does not match, parameter too long

ErrorID hexadecimal	ErrorID decimal	HMI	Description
FF12h	65298	-	Data type does not match, parameter too short
FF13h	65299	-	Subindex not supported
FF14h	65300	-	Value range of parameter too large (relevant only for write access)
FF15h	65301	-	Parameter values too great
FF16h	65302	-	Parameter values too small
FF17h	65303	-	Upper value is less than lower value
FF18h	65304	-	General error
FF19h	65305	-	Data can neither be transmitted to the application nor saved.
FF1Ah	65306	-	Local access channel is used, data can neither be transmitted nor saved.
FF1Bh	65307	-	Device status keeps data from being transmitted and saved.
FF1Ch	65308	-	Object dictionary does not exist or cannot be generated (for example, if data error occurs during generation from file)
FF1Dh	65309	-	Reserved
FF1Eh	65310	-	Reserved
FF1Fh	65311	-	Reserved
FF20h	65312	-	Unknown status
FF21h	65313	-	Input variable was changed before response was received ("2.4.1.4 MC_ReadParameter_ATV", "2.4.2.1 MC_WriteParameter_ATV")
FF22h	65314	-	Attempt to interrupt a non-interruptible function block ("2.3.1.1 MC_Power_ATV", "2.3.4.1 MC_Stop_ATV")
FF34h	65332	-	Power stage does not switch to operating state **6** Operation Enabled
FF37h	65335	-	Power stage is not in operating state **6** Operation Enabled
FF38h	65336	-	Parameter list has not yet been read from the device via "2.4.3.1 UploadDriveParameter_ATV".
FF39h	65337	-	Parameter list and device do not match
FF3Ah	65338	-	Drive in state PreOperational
FF3Bh	65339	-	Drive is not in operating state **3** Switch On Disabled
FF3Ch	65340	-	STO "Safe Torque Off" (Power Removal) active
FF3Dh	65341	-	Drive is not compatible
FF3Eh	65342	-	Error in mapping
FF50h	65360	-	Initialization error of function block "2.5.1.1 Altivar_Startup"
FF51h	65361	-	The function block "2.5.1.1 Altivar_Startup" cannot be controlled via the application since `i_iControlMode` = 1.
FF52h	65362	-	The function block "2.5.1.1 Altivar_Startup" cannot be controlled via the visualization since `i_iControlMode` = 0.
FF53h	65363	-	The value at the input `i_iControlMode` is outside of the valid value range.

ErrorID hexadecimal	ErrorID decimal	HMI	Description
FF54$_h$	65364	-	The value at the input `iq_iCmd` is outside of the valid value range.
FF55$_h$	65365	-	The function block and the connected device are incompatible.

2.5.2 Control

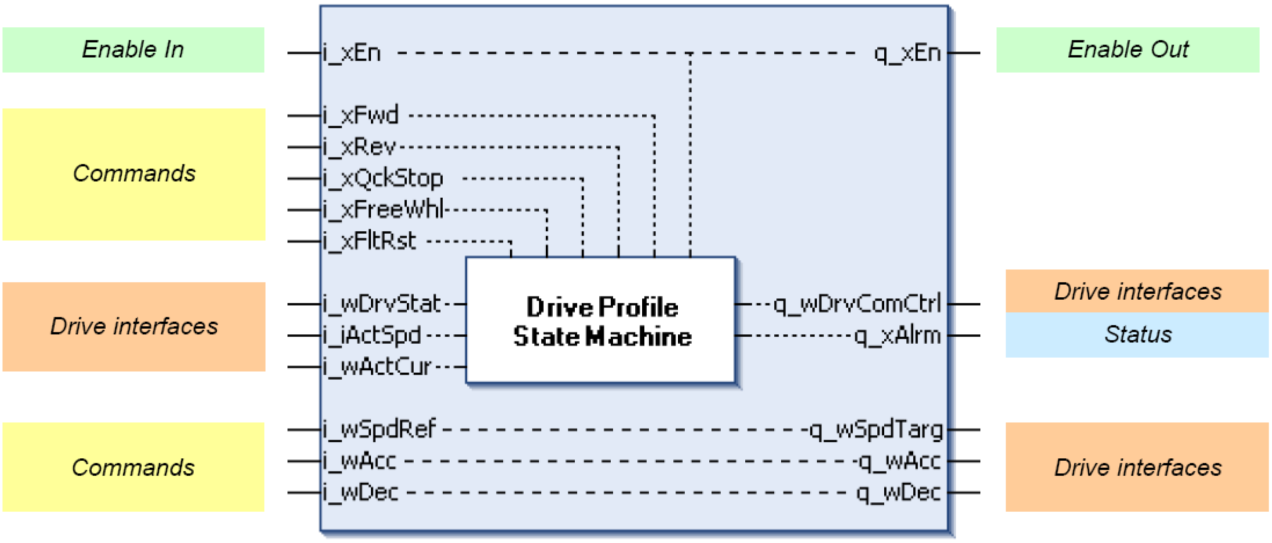
2.5.2.1 Altivar31_Control

Function description

The function block manages the control word (`q_wDrvComCtrl`) of the drive via its status word (`i_wDrvStat`) and the other inputs.

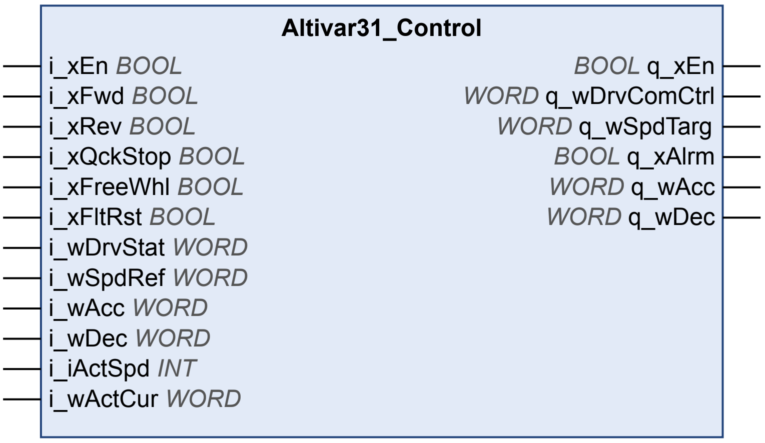
Internal structure of the function block

The following illustration shows an overview of the internal structure of the function block.



Acceleration, deceleration and reference velocity are directly copied from the input to the output. The reference velocity can be forced via the visualization of the function block.

Graphical representation



Compatible devices

ATV31/ATV312

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
i_xEn	BOOL	Value range: FALSE, TRUE Initial value: FALSE Command for activating or deactivating the function block. FALSE: • The output q_wDrvComCtrl is set to 16#0000 • The output q_wSpdTarg is set to 16#0000 • The output q_xAlrm is set to FALSE TRUE: Function block is active
i_xFwd	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: Stops a movement in positive direction TRUE: If the drive is in the operating state "Switched On" and if there is no local forcing active, a movement is started in positive direction (Forward) with the velocity reference value i_wSpdRef. The command "Forward" is triggered with a rising edge. The movement stops when the level is FALSE.
i_xRev	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: Stops a movement in negative direction. TRUE: If the drive is in the operating state "Switched On" and if there is no local forcing active, a movement is started in negative direction (Reverse) with the velocity reference value i_wSpdRef. The command "Reverse" is triggered with a rising edge. The movement stops when the level is FALSE.
i_xQckStop	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: If there is a motor movement, the drive triggers a Quick Stop. The output q_wDrvComCtrl is set to 16#0002. TRUE: Normal behavior of the function block. After a Quick Stop, the drive automatically switches to the operating state "Switched On ". when the actual velocity and the actual current values have reached a value of zero and if the commands Forward and Reverse are both FALSE. The Quick Stop must be deactivated (set i_xQckStop to TRUE) to restart the motor.
i_xFreeWhl	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: If there is a motor movement, the drive triggers a "Free Wheel Stop". The output q_wDrvComCtrl is set to 16#0000. TRUE: Normal behavior of the function block.
i_xFltRst	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: Normal behavior of the function block. TRUE: The output q_wDrvComCtrl is set to 16#0080.

Input	Data type	Description
i_wDrvStat	WORD	Value range: Initial value: 0 Must be mapped directly to the status word of the drive (CANopen object 6041). This value must not be modified between the CANopen interface and the function block.
i_wSpdRef	WORD	Value range: Initial value: 0 Reference velocity for the drive. Is copied directly to the target velocity q_wSpdTarg when the function block is activated and if the visualization does not force the velocity to a specific value.
i_wAcc	WORD	Value range: - Initial value: - Acceleration: Is copied directly to the output q_wAcc when the function block is activated.
i_wDec	WORD	Value range: -- Initial value: - Deceleration: Is copied directly to the output q_wDec when the function block is activated.
i_iActSpd	INT	Value range: Initial value: 0 Actual velocity of the drive. This input must be mapped directly to the PDO (CANopen object 2002 / subindex 03 to get the speed in 0.1 Hz).
i_wActCur	WORD	Value range: Initial value: 16#FFFF Actual current of the drive. This input must be mapped directly to the PDO (CANopen object 2002 / subindex 05, unit 0.1 A). This input is used to detect whether the motor current is equal to zero or not equal to zero.

The table below shows the outputs.

Output	Data type	Description
q_xEn	BOOL	Value range: FALSE, TRUE Initial value: FALSE Function block activated/deactivated. Direct copy from i_xEn.
q_wDrvComCtrl	WORD	Value range: Initial value: Must be mapped directly to the control word of the drive (CANopen object 6040). This value must not be modified between the CANopen interface and the function block.
q_wSpdTarg	WORD	Value range: Initial value: Target velocity for the drive. Is copied directly from the reference velocity i_wSpdRef when the function block is activated and if the visualization does not force the velocity to a specific value. The target velocity is set to 0 if the function block is not active. This output must be mapped directly to the PDO (CANopen object 6042 to transmit it in rpm).
q_xAlrm	BOOL	Value range: FALSE, TRUE Initial value: FALSE Is set to FALSE when the function block is deactivated and when the drive transitions to operating state "Switch On Disabled" (see state diagram of the drive profile). Is set to TRUE when the drive detects an error (bit 3 of the status word).
q_wAcc	WORD	Value range: - Initial value: - Acceleration: Is copied directly from the input i_wAcc when the function block is activated. This output must be mapped directly to the PDO (CANopen object 203C:2).
q_wDec	WORD	Value range: - Initial value: - Deceleration: Is copied directly from the input i_wDec when the function block is activated. This output must be mapped directly to the PDO (CANopen object 203C:3).

Notes

⚠ **WARNING**

UNINTENDED BEHAVIOR DUE TO INCONSISTENT COMMANDS

If you have activated this function block, simultaneous use of other function blocks of the library leads to unintended behavior.

- Only activate this function block when all other function blocks of the library are inactive.
- Deactivate this function block before activating any other function block of the library.

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

Note the following:

- After a "Quick Stop", the operating state "Quick Stop Active" (see state diagram below) is automatically left when the actual velocity and the actual current values have reached a value of zero and if the commands Forward and Reverse are both FALSE. To restart the motor, deactivate the Quick Stop (set i_xQckStop to TRUE).
- A "Quick Stop" has a higher priority than a regular stop ("Forward" and "Reverse" set to FALSE).
- A "Free Wheel Stop" has a higher priority than a "Quick Stop".
- If the drive displays the flashing message CoF on the 7-segment display after a download of an application to the drive, a rising edge and then a falling edge are required at the Fault Reset input (`i_xFltRst`) to restart proper communication with the drive.

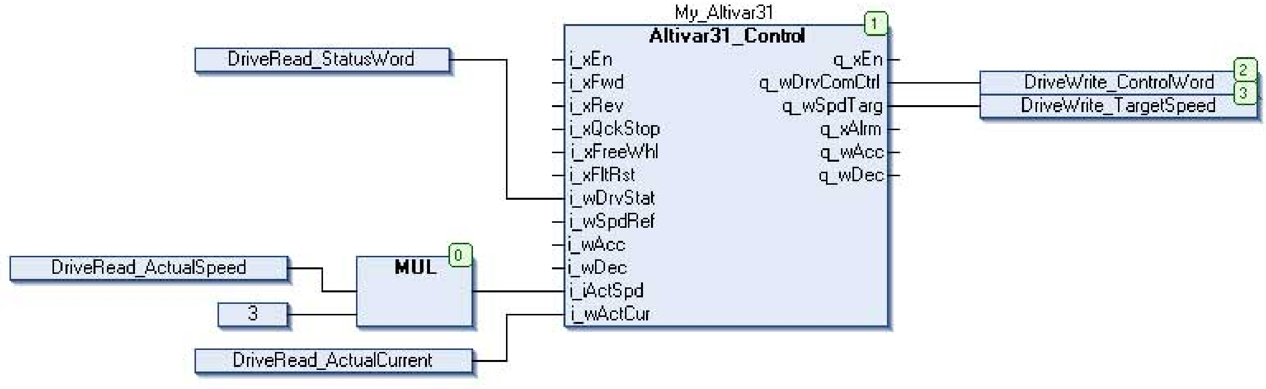
Using the function block

Starting the function block with the default settings:

Step	Action
1	Map the status word and the control word to the PDOs: • Map `i_wDrvStat` to a PDO from the drive to the controller • Map `q_wDrvComCtrl` to a PDO from the controller to the drive
2	Map the actual velocity and the actual current to a PDO from the drive to the controller • i_wActCur • i_iActSpd
3	Deactivate "Free Wheel": set `i_xFreeWhl` to TRUE.
4	Deactivate "Quick Stop": set `i_xQckStop` to TRUE.
5	Activate the function block: set `i_xEn` to TRUE.
6	Set a reference velocity: Set `i_wSpdRef` to a value not equal to zero.
7	Start a movement in positive ("Forward") or negative ("Reverse") direction: Set `i_xFwd` or `i_xRev` to TRUE.

Direct mapping PDOs - CANopen

Interface for direct PDO - CANopen mapping:



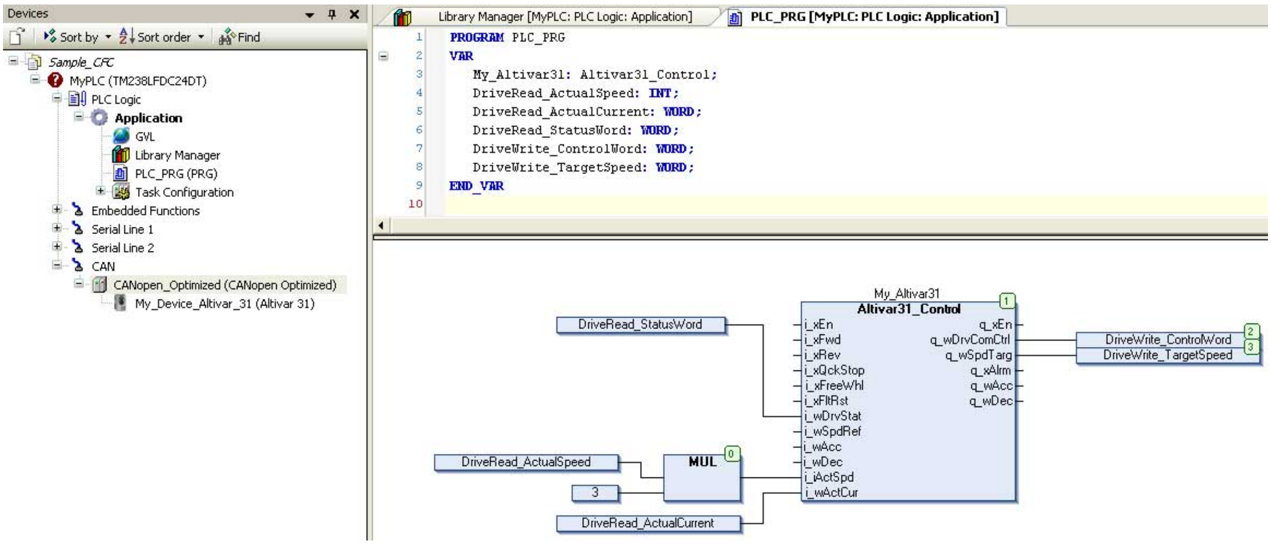
The actual velocity is read in 0.1 Hz (from 0 to 500 if HSP = 50 Hz)

The frequency must be:

- divided by 10 (to get the velocity in Hz)
- divided by 2 (2 pairs of poles)
- multiplied by 60 (60 to get the velocity in rpm)

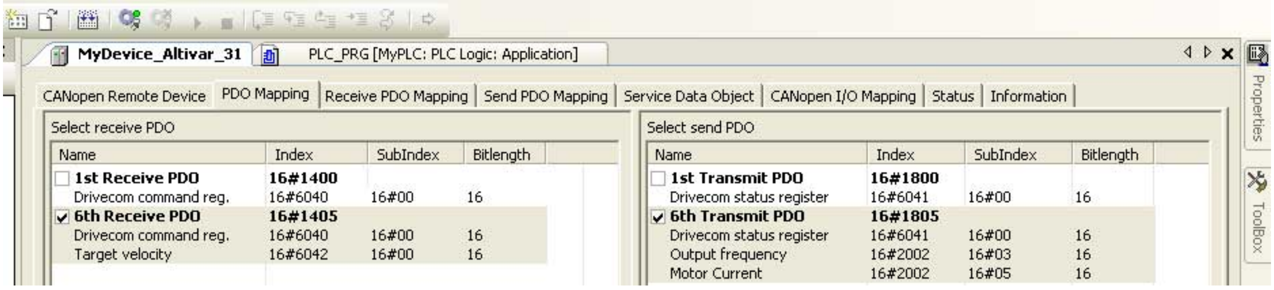
Calculation for motors with 2 pairs of poles:

Actual velocity multiplied by 3 converts 0.1 Hz to rpm (min^{-1}).



```
PROGRAM PLC_PRG
VAR
    My_Altivar31: Altivar31_Control;
    DriveRead_ActualSpeed: INT;
    DriveRead_ActualCurrent: WORD;
    DriveRead_StatusWord: WORD;
    DriveWrite_ControlWord: WORD;
    DriveWrite_TargetSpeed: WORD;
END_VAR
```

PDO configuration:



Select receive PDO

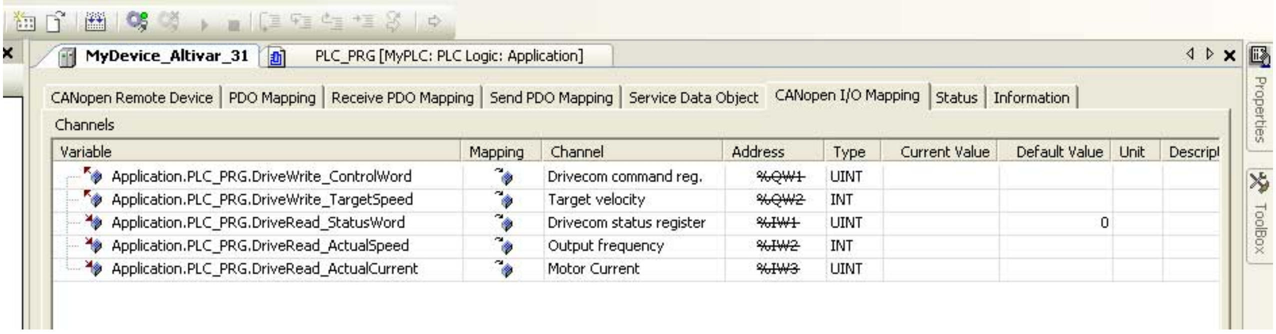
Name	Index	SubIndex	Bitlength
□ **1st Receive PDO**	**16#1400**		
Drivecom command reg.	16#6040	16#00	16
☑ **6th Receive PDO**	**16#1405**		
Drivecom command reg.	16#6040	16#00	16
Target velocity	16#6042	16#00	16

Select send PDO

Name	Index	SubIndex	Bitlength
□ **1st Transmit PDO**	**16#1800**		
Drivecom status register	16#6041	16#00	16
☑ **6th Transmit PDO**	**16#1805**		
Drivecom status register	16#6041	16#00	16
Output frequency	16#2002	16#03	16
Motor Current	16#2002	16#05	16

The figure shows a sample configuration. Other configurations of the PDOs are possible.

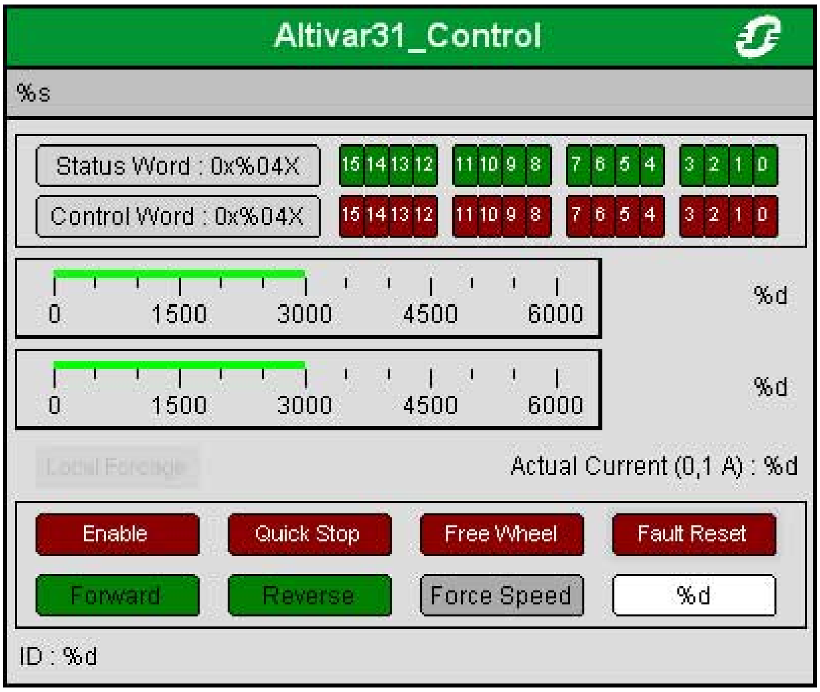
Mapping of the data to the PDO:



Variable	Mapping	Channel	Address	Type	Current Value	Default Value	Unit	Descripti
Application.PLC_PRG.DriveWrite_ControlWord		Drivecom command reg.	~~%QW1~~	UINT				
Application.PLC_PRG.DriveWrite_TargetSpeed		Target velocity	~~%QW2~~	INT				
Application.PLC_PRG.DriveRead_StatusWord		Drivecom status register	~~%IW1~~	UINT		0		
Application.PLC_PRG.DriveRead_ActualSpeed		Output frequency	~~%IW2~~	INT				
Application.PLC_PRG.DriveRead_ActualCurrent		Motor Current	~~%IW3~~	UINT				

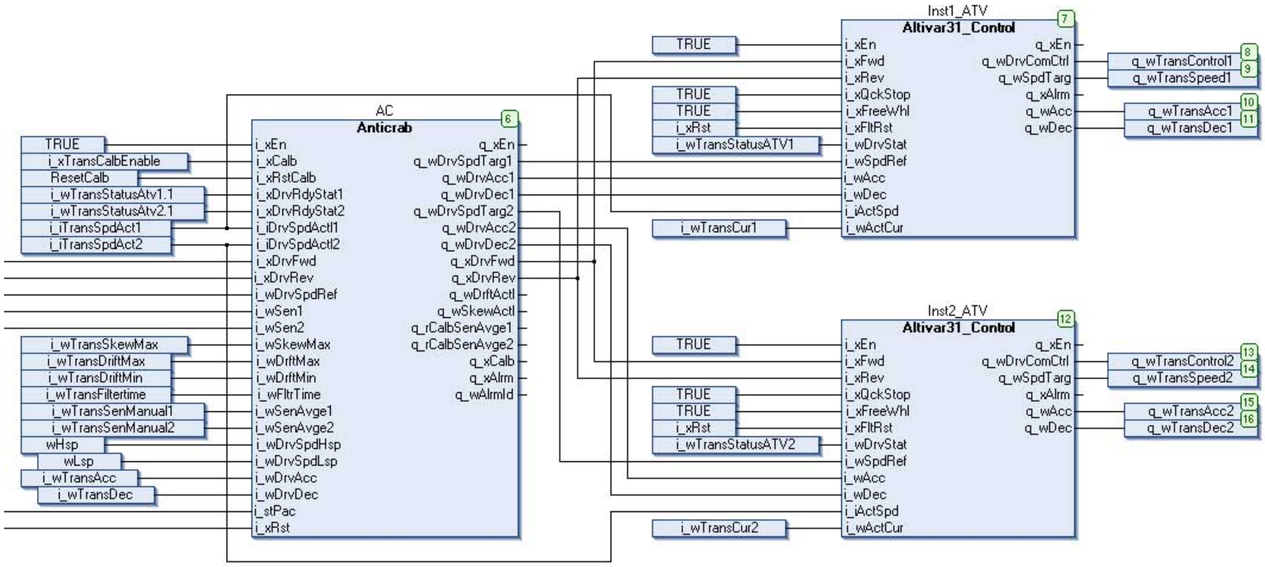
Visualization

With the above minimum configuration, the visualization of this function block can be used to control the drive. After the PDO mapping of the 5 data specified above, the drive can be started with the following sequence of steps:



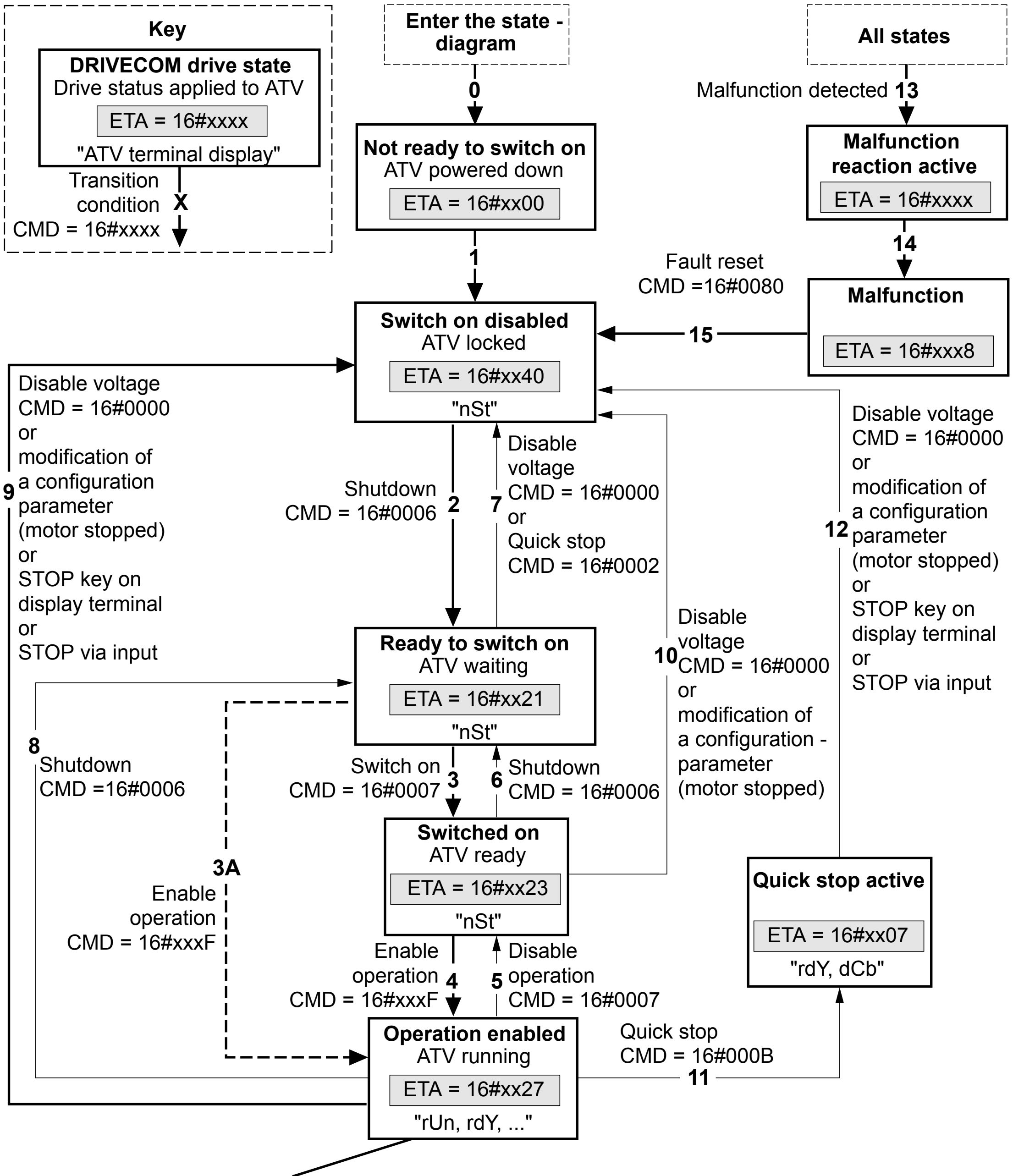
Step	Action
1	Click the button "Enable" to activate the function block
2	Click the button "Quick Stop" to deactivate "Quick Stop"
3	Click the button "Free Wheel" to deactivate "Free Wheel"
4	Enter a velocity value not equal to zero in revolutions per minute (in the field next to the Force Speed button).
5	Click the button "Force Speed"
6	Click the button "Forward" or "Reverse": The motor runs

Example of an application that uses the function block:



Altivar 31 drive profile CiA402 state diagram:

DRIVECOM state diagram



Examples:	Examples (default configuration):
ETA = 16#0627 : Normal stop or	CMD = 16#000F : Forward operation
- Forward operation, speed reached	CMD = 16#080F : Reverse operation
ETA = 16#8627 : Reverse operation, speed reached	CMD = 16#100F : Stop (configured by "Stt")
ETA = 16#0227 : Forward operation, ACC or DEC	CMD = 16#200F : DC injection stop
ETA = 16#8227 : Reverse operation, ACC or DEC	CMD = 16#400F : Fast stop

Exiting the state "Operation Enabled" via "Disable Voltage" (9) or "Shutdown" (8) triggers a "Free Wheel Stop".

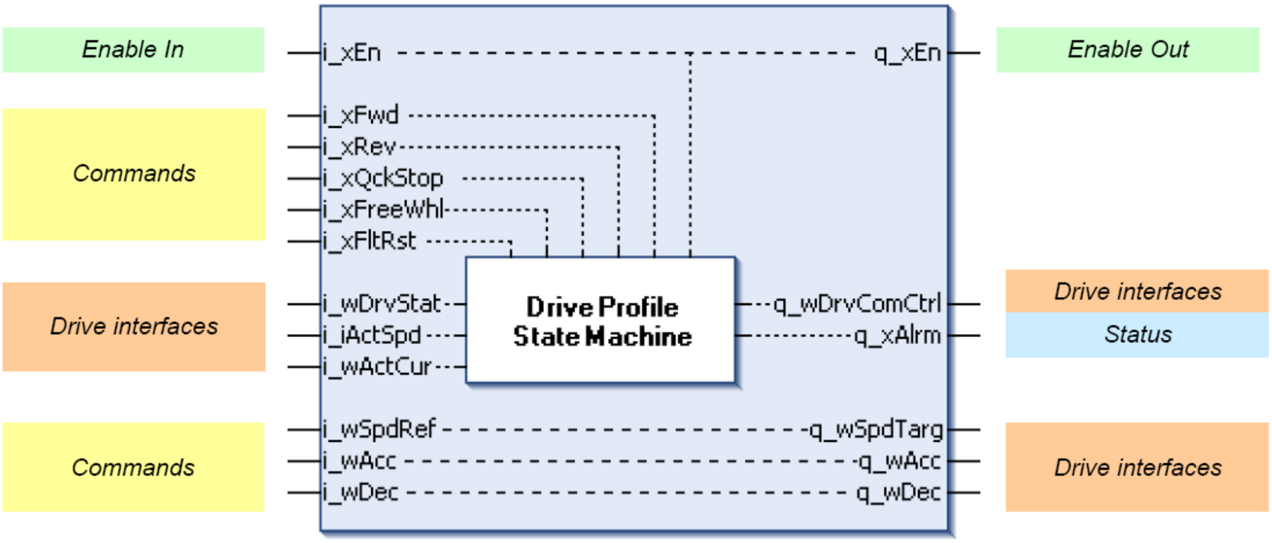
2.5.2.2 Altivar71_Control

Function description

The function block manages the control word (`q_wDrvComCtrl`) of the drive via its status word (`i_wDrvStat`) and the other inputs.

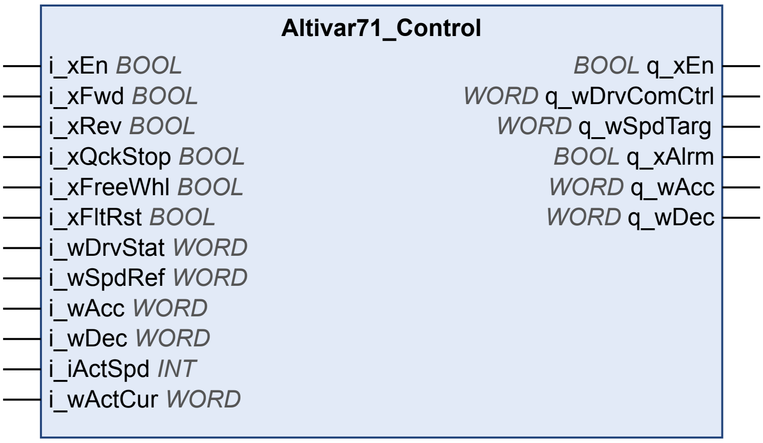
Internal structure of the function block

The following illustration shows an overview of the internal structure of the function block.



Acceleration, deceleration and reference velocity are directly copied from the input to the output. The reference velocity can be forced via the visualization of the function block.

Graphical representation



Compatible devices

ATV71

Inputs/outputs

The table below shows the inputs.

Input	Data type	Description
i_xEn	BOOL	Value range: FALSE, TRUE Initial value: FALSE Command for activating or deactivating the function block. FALSE: • The output q_wDrvComCtrl is set to 16#0000 • The output q_wSpdTarg is set to 16#0000 • The output q_xAlrm is set to FALSE TRUE: Function block is active
i_xFwd	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: Stops a movement in positive direction TRUE: If the drive is in the operating state "Switched On" and if there is no local forcing active, a movement is started in positive direction (Forward) with the velocity reference value i_wSpdRef. The command "Forward" is triggered with a rising edge. The movement stops when the level is FALSE.
i_xRev	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: Stops a movement in negative direction. TRUE: If the drive is in the operating state "Switched On" and if there is no local forcing active, a movement is started in negative direction (Reverse) with the velocity reference value i_wSpdRef. The command "Reverse" is triggered with a rising edge. The movement stops when the level is FALSE.
i_xQckStop	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: If there is a motor movement, the drive triggers a Quick Stop. The output q_wDrvComCtrl is set to 16#0002. TRUE: Normal behavior of the function block. After a Quick Stop, the drive automatically switches to the operating state "Switched On ". when the actual velocity and the actual current values have reached a value of zero and if the commands Forward and Reverse are both FALSE. The Quick Stop must be deactivated (set i_xQckStop to TRUE) to restart the motor.
i_xFreeWhl	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: If there is a motor movement, the drive triggers a "Free Wheel Stop". The output q_wDrvComCtrl is set to 16#0000. TRUE: Normal behavior of the function block.
i_xFltRst	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: Normal behavior of the function block. TRUE: The output q_wDrvComCtrl is set to 16#0080.

Input	Data type	Description
i_wDrvStat	WORD	Value range: Initial value: 0 Must be mapped directly to the status word of the drive (CANopen object 6041). This value must not be modified between the CANopen interface and the function block.
i_wSpdRef	WORD	Value range: Initial value: 0 Reference velocity for the drive. Is copied directly to the target velocity q_wSpdTarg when the function block is activated and if the visualization does not force the velocity to a specific value.
i_wAcc	WORD	Value range: - Initial value: - Acceleration: Is copied directly to the output q_wAcc when the function block is activated.
i_wDec	WORD	Value range: - Initial value: - Deceleration: Is copied directly to the output q_wDec when the function block is activated.
i_iActSpd	INT	Value range: Initial value: 0 Actual velocity of the drive. This input must be mapped directly to the PDO (CANopen object 2002 / subindex 03 to get the speed in 0.1 Hz).
i_wActCur	WORD	Value range: Initial value: 16#FFFF Actual current of the drive. This input must be mapped directly to the PDO (CANopen object 2002 / subindex 05, unit 0.1 A). This input is used to detect whether the motor current is equal to zero or not equal to zero.

The table below shows the outputs.

Output	Data type	Description
q_xEn	BOOL	Value range: FALSE, TRUE Initial value: FALSE Function block activated/deactivated. Direct copy from i_xEn.
q_wDrvComCtrl	WORD	Value range: Initial value: Must be mapped directly to the control word of the drive (CANopen object 6040). This value must not be modified between the CANopen interface and the function block.
q_wSpdTarg	WORD	Value range: Initial value: Target velocity for the drive. Is copied directly from the reference velocity i_wSpdRef when the function block is activated and if the visualization does not force the velocity to a specific value. The target velocity is set to 0 if the function block is not active. This output must be mapped directly to the PDO (CANopen object 6042 to transmit it in rpm).
q_xAlrm	BOOL	Value range: FALSE, TRUE Initial value: FALSE Is set to FALSE when the function block is deactivated and when the drive transitions to operating state "Switch On Disabled" (see state diagram of the drive profile). Is set to TRUE when the drive detects an error (bit 3 of the status word).
q_wAcc	WORD	Value range: - Initial value: - Acceleration: Is copied directly from the input i_wAcc when the function block is activated. This output must be mapped directly to the PDO (CANopen object 203C:2).
q_wDec	WORD	Value range: - Initial value: - Deceleration: Is copied directly from the input i_wDec when the function block is activated. This output must be mapped directly to the PDO (CANopen object 203C:3).

Notes

⚠ WARNING

UNINTENDED BEHAVIOR DUE TO INCONSISTENT COMMANDS

If you have activated this function block, simultaneous use of other function blocks of the library leads to unintended behavior.

- Only activate this function block when all other function blocks of the library are inactive.
- Deactivate this function block before activating any other function block of the library.

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

Note the following:

- After a "Quick Stop", the operating state "Quick Stop Active" (see state diagram below) is automatically left when the actual velocity and the actual current values have reached a value of zero and if the commands Forward and Reverse are both FALSE. To restart the motor, deactivate the Quick Stop (set i_xQckStop to TRUE).
- A "Quick Stop" has a higher priority than a regular stop ("Forward" and "Reverse" set to FALSE).
- A "Free Wheel Stop" has a higher priority than a "Quick Stop".
- If the drive displays the flashing message CoF on the 7-segment display after a download of an application to the drive, a rising edge and then a falling edge are required at the Fault Reset input (`i_xFltRst`) to restart proper communication with the drive.

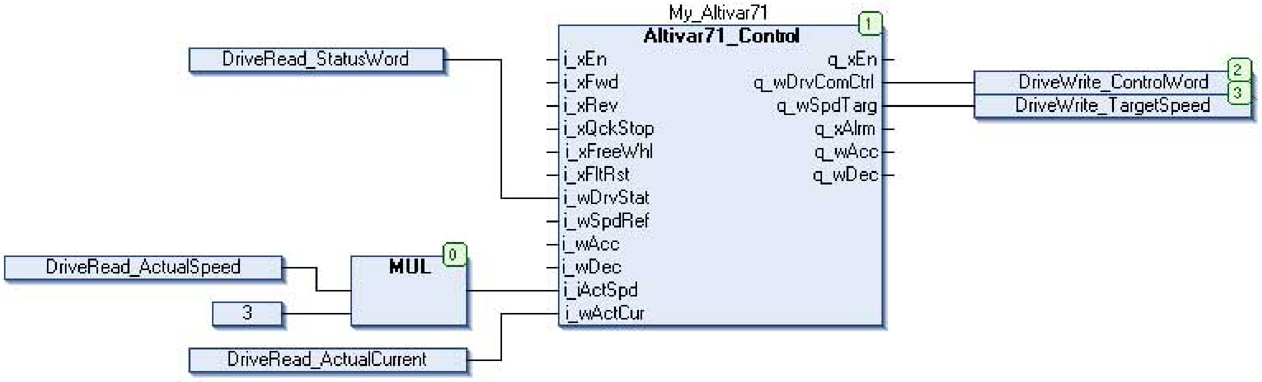
Using the function block

Starting the function block with the default settings:

Step	Action
1	Map the status word and the control word to the PDOs: • Map `i_wDrvStat` to a PDO from the drive to the controller • Map `q_wDrvComCtrl` to a PDO from the controller to the drive
2	Map the actual velocity and the actual current to a PDO from the drive to the controller • i_wActCur • i_iActSpd
3	Deactivate "Free Wheel": set `i_xFreeWhl` to TRUE.
4	Deactivate "Quick Stop": set `i_xQckStop` to TRUE.
5	Activate the function block: set `i_xEn` to TRUE.
6	Set a reference velocity: Set `i_wSpdRef` to a value not equal to zero.
7	Start a movement in positive ("Forward") or negative ("Reverse") direction: Set `i_xFwd` or `i_xRev` to TRUE.

Direct mapping PDOs - CANopen

Interface for direct PDO - CANopen mapping:



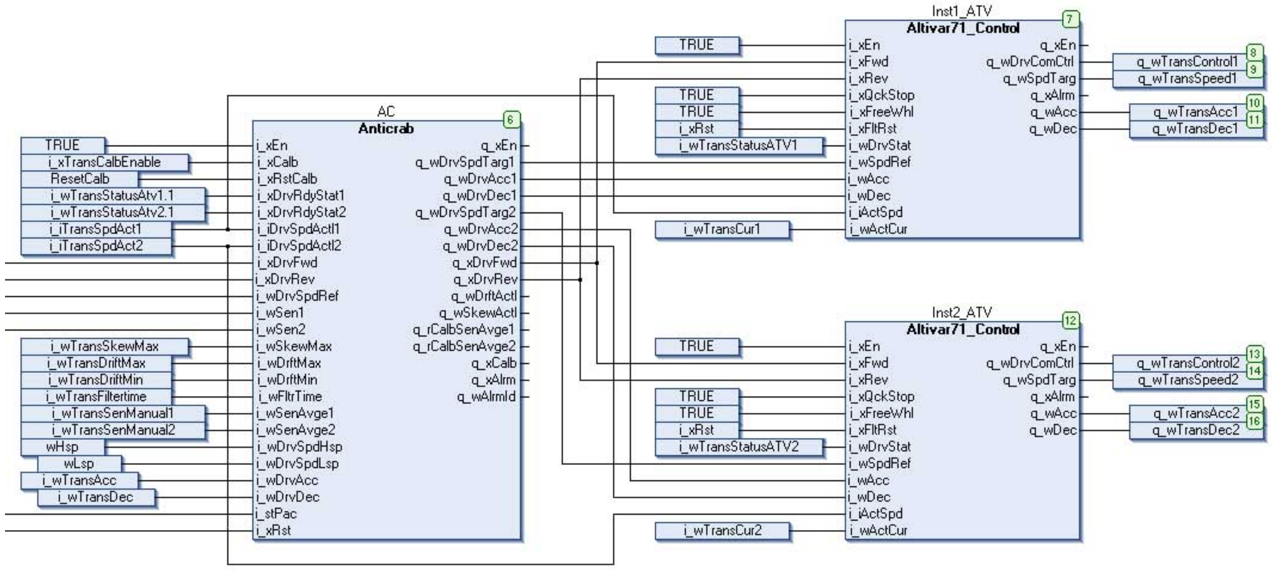
The actual velocity is read in 0.1 Hz (from 0 to 500 if HSP = 50 Hz)

The frequency must be:

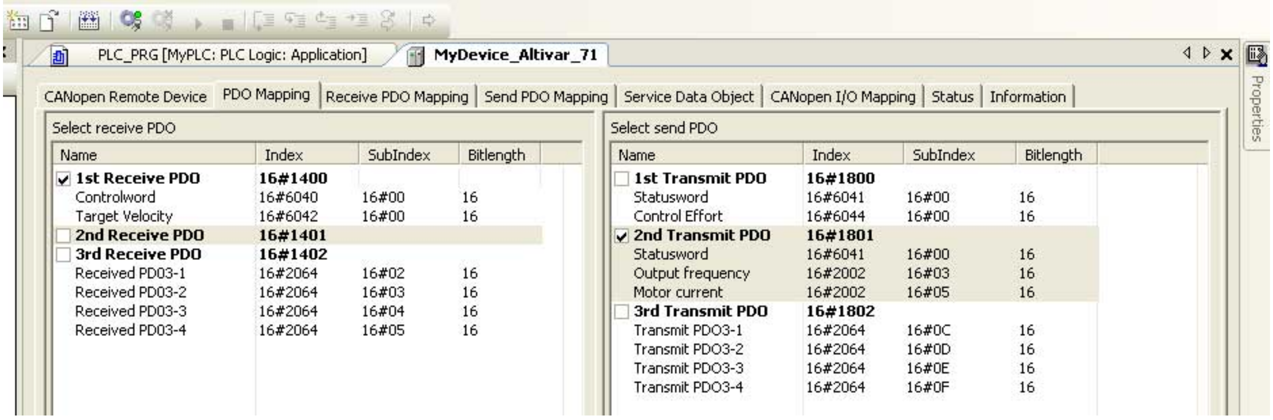
- divided by 10 (to get the velocity in Hz)
- divided by 2 (2 pairs of poles)
- multiplied by 60 (60 to get the velocity in rpm)

Calculation for motors with 2 pairs of poles:

Actual velocity multiplied by 3 converts 0.1 Hz to rpm (min^{-1}).



PDO configuration:



Select receive PDO

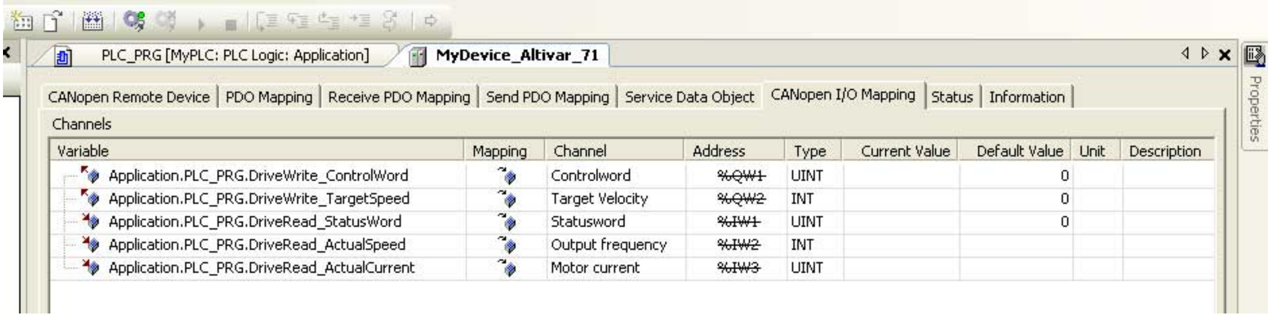
Name	Index	SubIndex	Bitlength
☑ **1st Receive PDO**	**16#1400**		
Controlword	16#6040	16#00	16
Target Velocity	16#6042	16#00	16
☐ **2nd Receive PDO**	**16#1401**		
☐ **3rd Receive PDO**	**16#1402**		
Received PD03-1	16#2064	16#02	16
Received PD03-2	16#2064	16#03	16
Received PD03-3	16#2064	16#04	16
Received PD03-4	16#2064	16#05	16

Select send PDO

Name	Index	SubIndex	Bitlength
☐ **1st Transmit PDO**	**16#1800**		
Statusword	16#6041	16#00	16
Control Effort	16#6044	16#00	16
☑ **2nd Transmit PDO**	**16#1801**		
Statusword	16#6041	16#00	16
Output frequency	16#2002	16#03	16
Motor current	16#2002	16#05	16
☐ **3rd Transmit PDO**	**16#1802**		
Transmit PDO3-1	16#2064	16#0C	16
Transmit PDO3-2	16#2064	16#0D	16
Transmit PDO3-3	16#2064	16#0E	16
Transmit PDO3-4	16#2064	16#0F	16

The figure shows a sample configuration. Other configurations of the PDOs are possible.

Mapping of the data to the PDO:



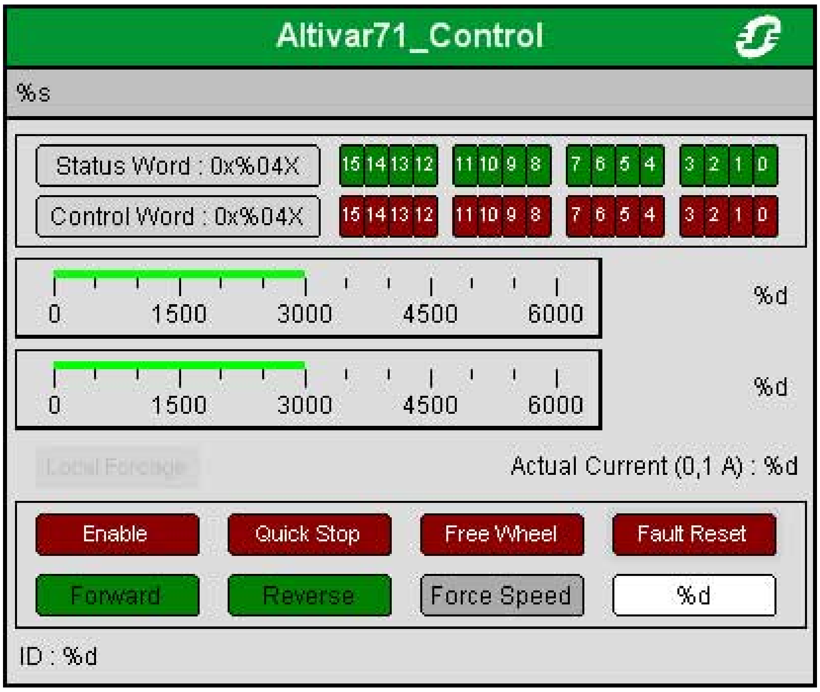
Channels

Variable	Mapping	Channel	Address	Type	Current Value	Default Value	Unit	Description
Application.PLC_PRG.DriveWrite_ControlWord		Controlword	~~%QW1~~	UINT		0		
Application.PLC_PRG.DriveWrite_TargetSpeed		Target Velocity	~~%QW2~~	INT		0		
Application.PLC_PRG.DriveRead_StatusWord		Statusword	~~%IW1~~	UINT		0		
Application.PLC_PRG.DriveRead_ActualSpeed		Output frequency	~~%IW2~~	INT				
Application.PLC_PRG.DriveRead_ActualCurrent		Motor current	~~%IW3~~	UINT				

0198441113880, V2.09, 03.2012

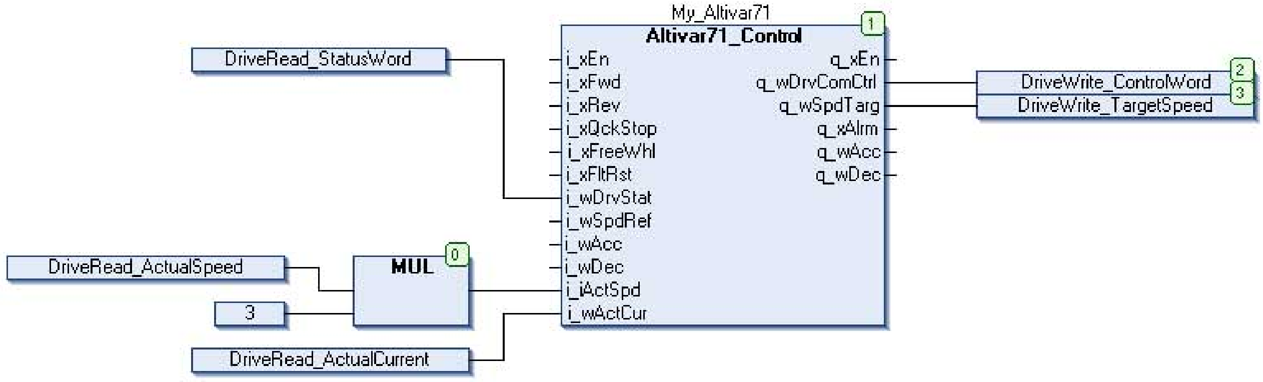
Visualization

With the above minimum configuration, the visualization of this function block can be used to control the drive. After the PDO mapping of the 5 data specified above, the drive can be started with the following sequence of steps:

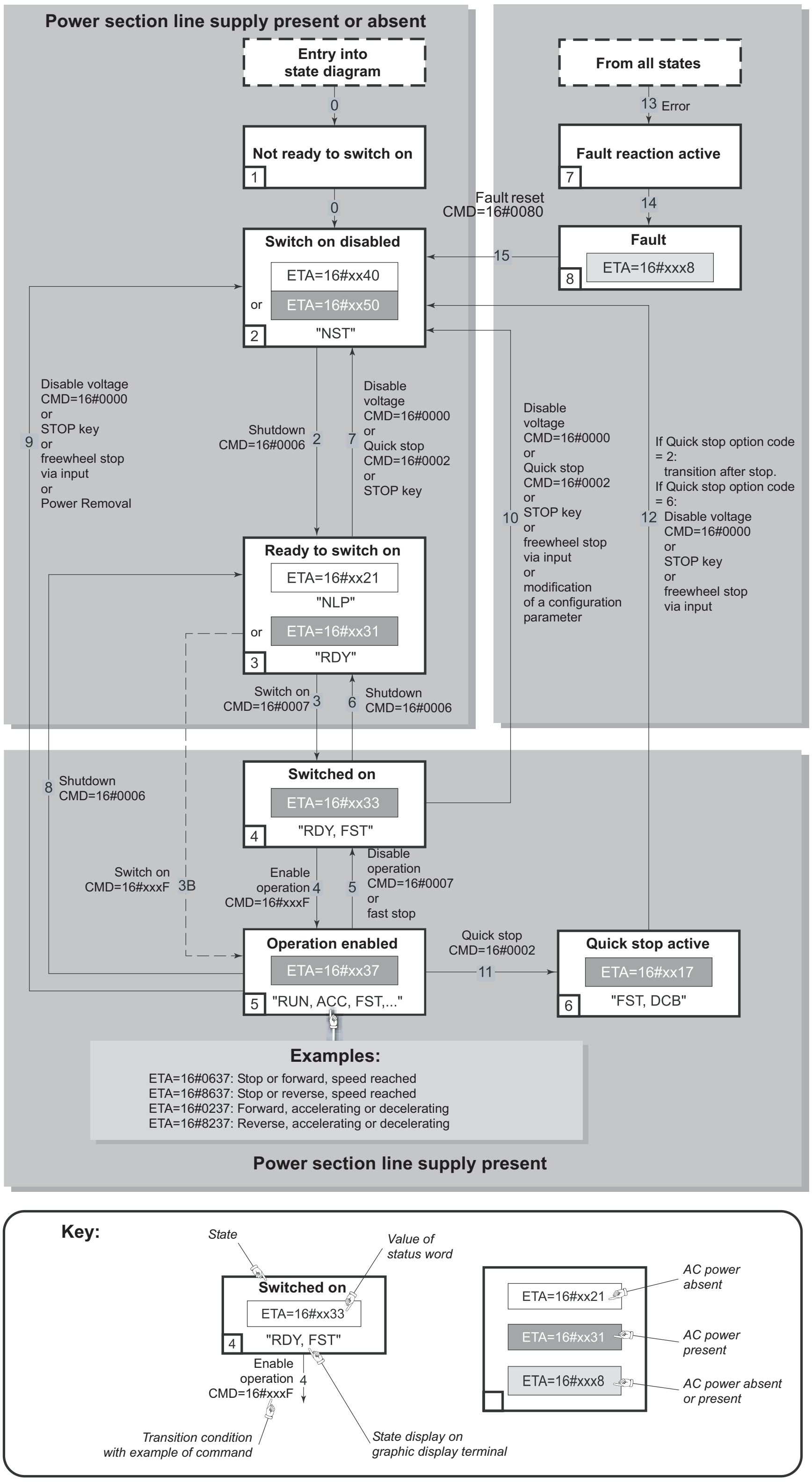


Step	Action
1	Click the button "Enable" to activate the function block
2	Click the button "Quick Stop" to deactivate "Quick Stop"
3	Click the button "Free Wheel" to deactivate "Free Wheel"
4	Enter a velocity value not equal to zero in revolutions per minute (in the field next to the Force Speed button).
5	Click the button "Force Speed"
6	Click the button "Forward" or "Reverse": The motor runs

Example of an application that uses the function block (as Altivar31_Control):



Altivar 71 drive profile CiA402 state diagram:

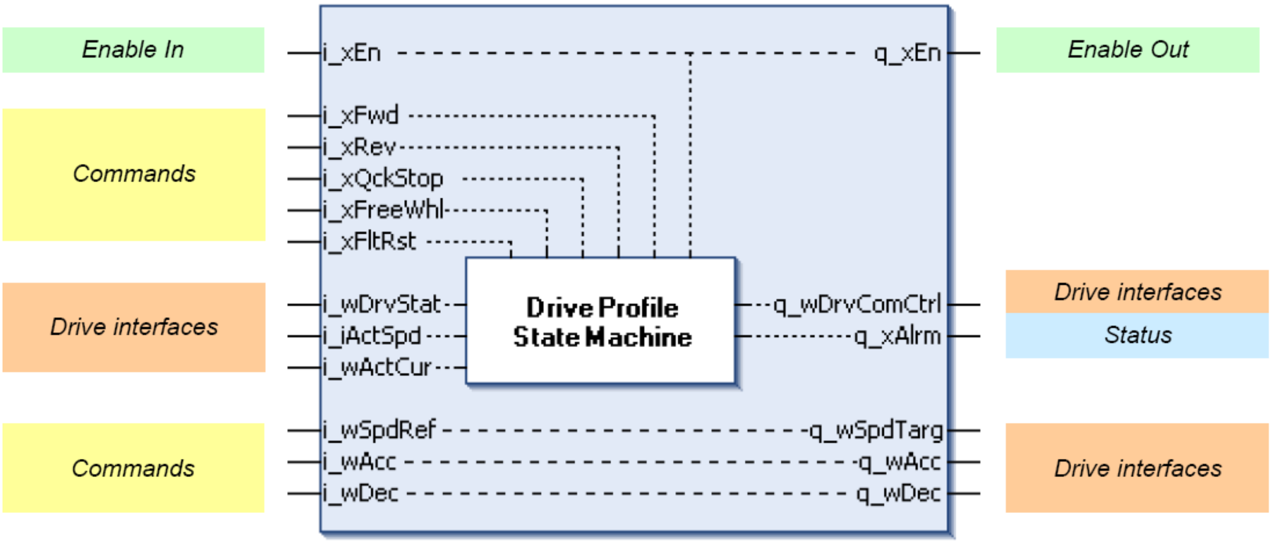


2.5.2.3 Altivar32_Control

Function description The function block manages the control word (`q_wDrvComCtrl`) of the drive via its status word (`i_wDrvStat`) and the other inputs.

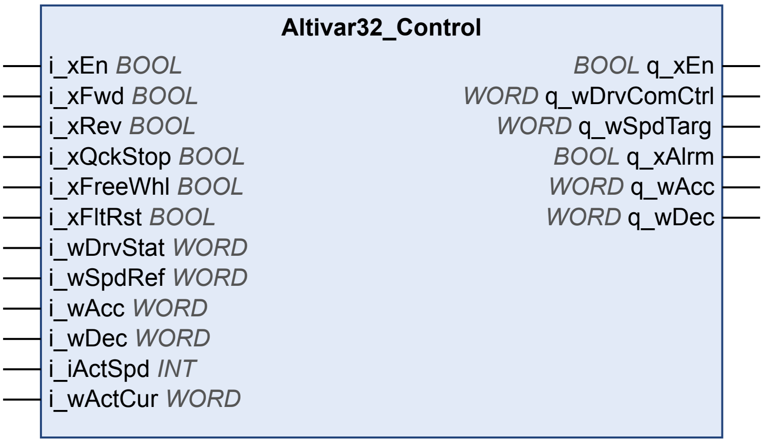
Internal structure of the function block

The following illustration shows an overview of the internal structure of the function block.



Acceleration, deceleration and reference velocity are directly copied from the input to the output. The reference velocity can be forced via the visualization of the function block.

Graphical representation



Compatible devices ATV32

Inputs/outputs The table below shows the inputs.

Input	Data type	Description
i_xEn	BOOL	Value range: FALSE, TRUE Initial value: FALSE Command for activating or deactivating the function block. FALSE: • The output q_wDrvComCtrl is set to 16#0000 • The output q_wSpdTarg is set to 16#0000 • The output q_xAlrm is set to FALSE TRUE: Function block is active
i_xFwd	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: Stops a movement in positive direction TRUE: If the drive is in the operating state "Switched On" and if there is no local forcing active, a movement is started in positive direction (Forward) with the velocity reference value i_wSpdRef. The command "Forward" is triggered with a rising edge. The movement stops when the level is FALSE.
i_xRev	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: Stops a movement in negative direction. TRUE: If the drive is in the operating state "Switched On" and if there is no local forcing active, a movement is started in negative direction (Reverse) with the velocity reference value i_wSpdRef. The command "Reverse" is triggered with a rising edge. The movement stops when the level is FALSE.
i_xQckStop	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: If there is a motor movement, the drive triggers a Quick Stop. The output q_wDrvComCtrl is set to 16#0002. TRUE: Normal behavior of the function block. After a Quick Stop, the drive automatically switches to the operating state "Switched On ". when the actual velocity and the actual current values have reached a value of zero and if the commands Forward and Reverse are both FALSE. The Quick Stop must be deactivated (set i_xQckStop to TRUE) to restart the motor.
i_xFreeWhl	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: If there is a motor movement, the drive triggers a "Free Wheel Stop". The output q_wDrvComCtrl is set to 16#0000. TRUE: Normal behavior of the function block.
i_xFltRst	BOOL	Value range: FALSE, TRUE Initial value: FALSE FALSE: Normal behavior of the function block. TRUE: The output q_wDrvComCtrl is set to 16#0080.

Input	Data type	Description
i_wDrvStat	WORD	Value range: Initial value: 0 Must be mapped directly to the status word of the drive (CANopen object 6041). This value must not be modified between the CANopen interface and the function block.
i_wSpdRef	WORD	Value range: Initial value: 0 Reference velocity for the drive. Is copied directly to the target velocity q_wSpdTarg when the function block is activated and if the visualization does not force the velocity to a specific value.
i_wAcc	WORD	Value range: - Initial value: - Acceleration: Is copied directly to the output q_wAcc when the function block is activated.
i_wDec	WORD	Value range: - Initial value: - Deceleration: Is copied directly to the output q_wDec when the function block is activated.
i_iActSpd	INT	Value range: Initial value: 0 Actual velocity of the drive. This input must be mapped directly to the PDO (CANopen object 2002 / subindex 03 to get the speed in 0.1 Hz).
i_wActCur	WORD	Value range: Initial value: 16#FFFF Actual current of the drive. This input must be mapped directly to the PDO (CANopen object 2002 / subindex 05, unit 0.1 A). This input is used to detect whether the motor current is equal to zero or not equal to zero.

The table below shows the outputs.

Output	Data type	Description
`q_xEn`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE Function block activated/deactivated. Direct copy from i_xEn.
`q_wDrvComCtrl`	`WORD`	Value range: Initial value: Must be mapped directly to the control word of the drive (CANopen object 6040). This value must not be modified between the CANopen interface and the function block.
`q_wSpdTarg`	`WORD`	Value range: Initial value: Target velocity for the drive. Is copied directly from the reference velocity `i_wSpdRef` when the function block is activated and if the visualization does not force the velocity to a specific value. The target velocity is set to 0 if the function block is not active. This output must be mapped directly to the PDO (CANopen object 6042 to transmit it in rpm).
`q_xAlrm`	`BOOL`	Value range: FALSE, TRUE Initial value: FALSE Is set to FALSE when the function block is deactivated and when the drive transitions to operating state "Switch On Disabled" (see state diagram of the drive profile). Is set to TRUE when the drive detects an error (bit 3 of the status word).
`q_wAcc`	`WORD`	Value range: - Initial value: - Acceleration: Is copied directly from the input `i_wAcc` when the function block is activated. This output must be mapped directly to the PDO (CANopen object 203C:2).
`q_wDec`	`WORD`	Value range: - Initial value: - Deceleration: Is copied directly from the input `i_wDec` when the function block is activated. This output must be mapped directly to the PDO (CANopen object 203C:3).

Notes

⚠ WARNING

UNINTENDED BEHAVIOR DUE TO INCONSISTENT COMMANDS

If you have activated this function block, simultaneous use of other function blocks of the library leads to unintended behavior.

- Only activate this function block when all other function blocks of the library are inactive.
- Deactivate this function block before activating any other function block of the library.

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

Note the following:

- After a "Quick Stop", the operating state "Quick Stop Active" (see state diagram below) is automatically left when the actual velocity and the actual current values have reached a value of zero and if the commands Forward and Reverse are both FALSE. To restart the motor, deactivate the Quick Stop (set i_xQckStop to TRUE).
- A "Quick Stop" has a higher priority than a regular stop ("Forward" and "Reverse" set to FALSE).
- A "Free Wheel Stop" has a higher priority than a "Quick Stop".
- If the drive displays the flashing message CoF on the 7-segment display after a download of an application to the drive, a rising edge and then a falling edge are required at the Fault Reset input (`i_xFltRst`) to restart proper communication with the drive.

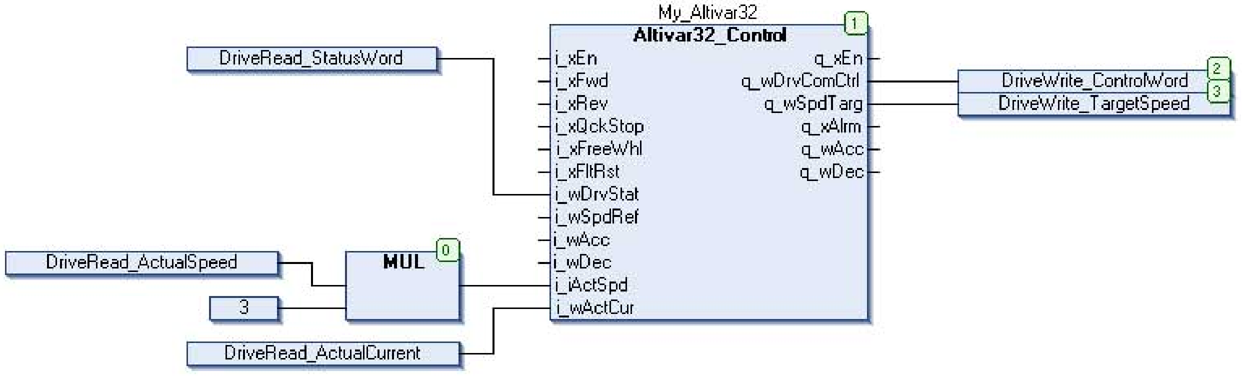
Using the function block

Starting the function block with the default settings:

Step	Action
1	Map the status word and the control word to the PDOs: • Map `i_wDrvStat` to a PDO from the drive to the controller • Map `q_wDrvComCtrl` to a PDO from the controller to the drive
2	Map the actual velocity and the actual current to a PDO from the drive to the controller • i_wActCur • i_iActSpd
3	Deactivate "Free Wheel": set `i_xFreeWhl` to TRUE.
4	Deactivate "Quick Stop": set `i_xQckStop` to TRUE.
5	Activate the function block: set `i_xEn` to TRUE.
6	Set a reference velocity: Set `i_wSpdRef` to a value not equal to zero.
7	Start a movement in positive ("Forward") or negative ("Reverse") direction: Set `i_xFwd` or `i_xRev` to TRUE.

Direct mapping PDOs - CANopen

Interface for direct PDO - CANopen mapping:



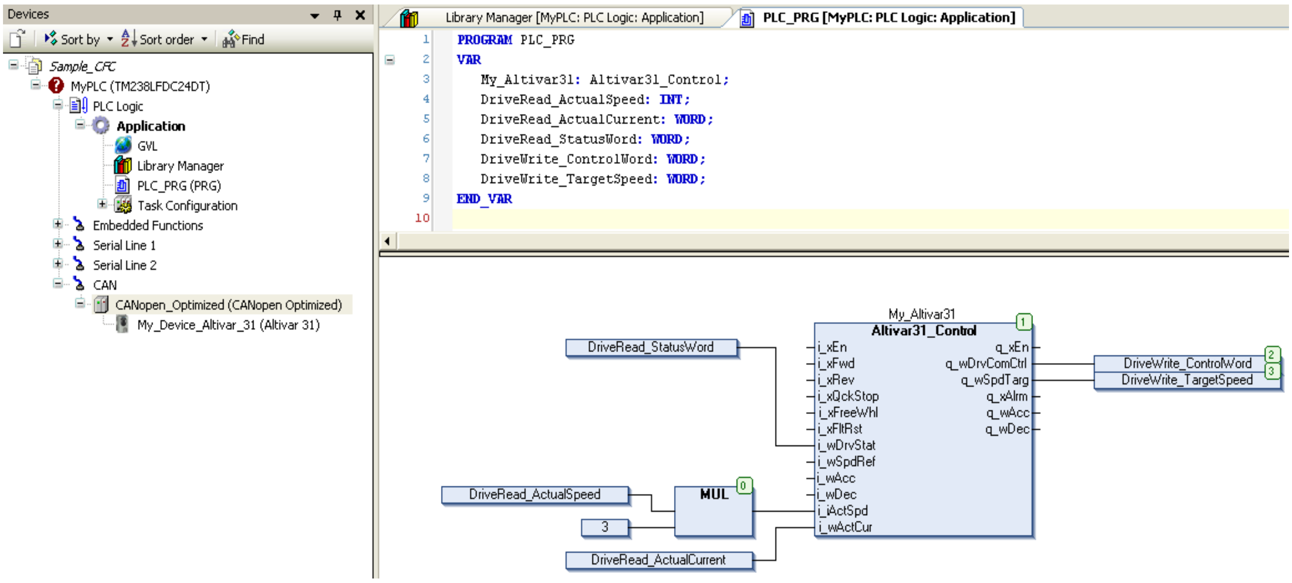
The actual velocity is read in 0.1 Hz (from 0 to 500 if HSP = 50 Hz)

The frequency must be:

- divided by 10 (to get the velocity in Hz)
- divided by 2 (2 pairs of poles)
- multiplied by 60 (60 to get the velocity in rpm)

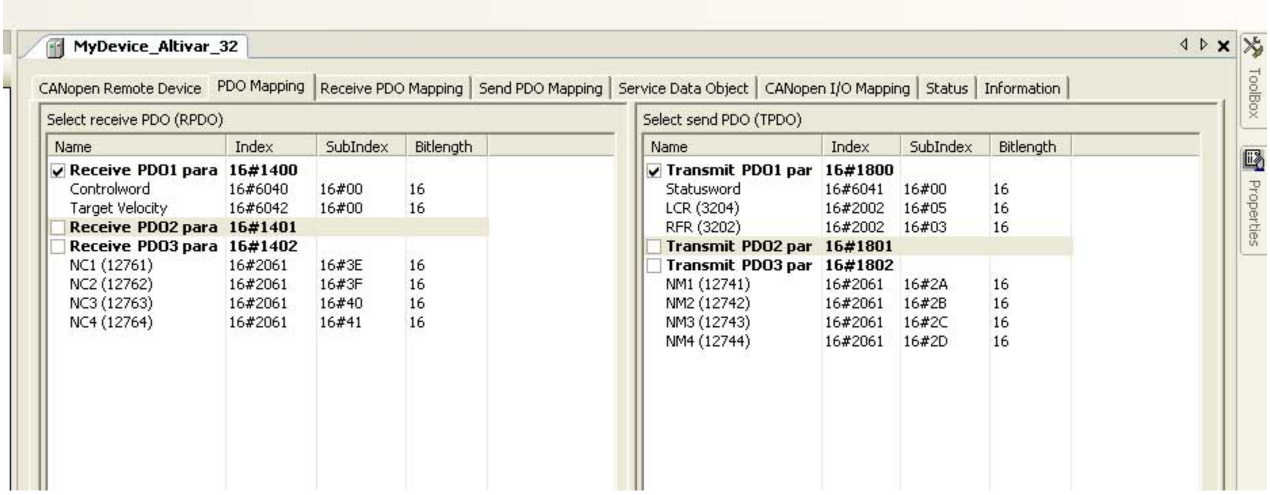
Calculation for motors with 2 pairs of poles:

Actual velocity multiplied by 3 converts 0.1 Hz to rpm (min^{-1}).



```
PROGRAM PLC_PRG
VAR
    My_Altivar31: Altivar31_Control;
    DriveRead_ActualSpeed: INT;
    DriveRead_ActualCurrent: WORD;
    DriveRead_StatusWord: WORD;
    DriveWrite_ControlWord: WORD;
    DriveWrite_TargetSpeed: WORD;
END_VAR
```

PDO configuration:



Select receive PDO (RPDO)

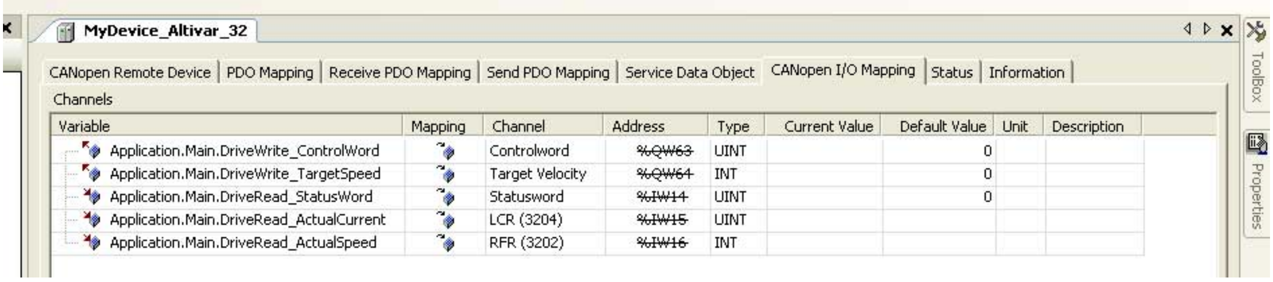
Name	Index	SubIndex	Bitlength
☑ **Receive PDO1 para**	**16#1400**		
Controlword	16#6040	16#00	16
Target Velocity	16#6042	16#00	16
☐ **Receive PDO2 para**	**16#1401**		
☐ **Receive PDO3 para**	**16#1402**		
NC1 (12761)	16#2061	16#3E	16
NC2 (12762)	16#2061	16#3F	16
NC3 (12763)	16#2061	16#40	16
NC4 (12764)	16#2061	16#41	16

Select send PDO (TPDO)

Name	Index	SubIndex	Bitlength
☑ **Transmit PDO1 par**	**16#1800**		
Statusword	16#6041	16#00	16
LCR (3204)	16#2002	16#05	16
RFR (3202)	16#2002	16#03	16
☐ **Transmit PDO2 par**	**16#1801**		
☐ **Transmit PDO3 par**	**16#1802**		
NM1 (12741)	16#2061	16#2A	16
NM2 (12742)	16#2061	16#2B	16
NM3 (12743)	16#2061	16#2C	16
NM4 (12744)	16#2061	16#2D	16

The figure shows a sample configuration. Other configurations of the PDOs are possible.

Mapping of the data to the PDO:

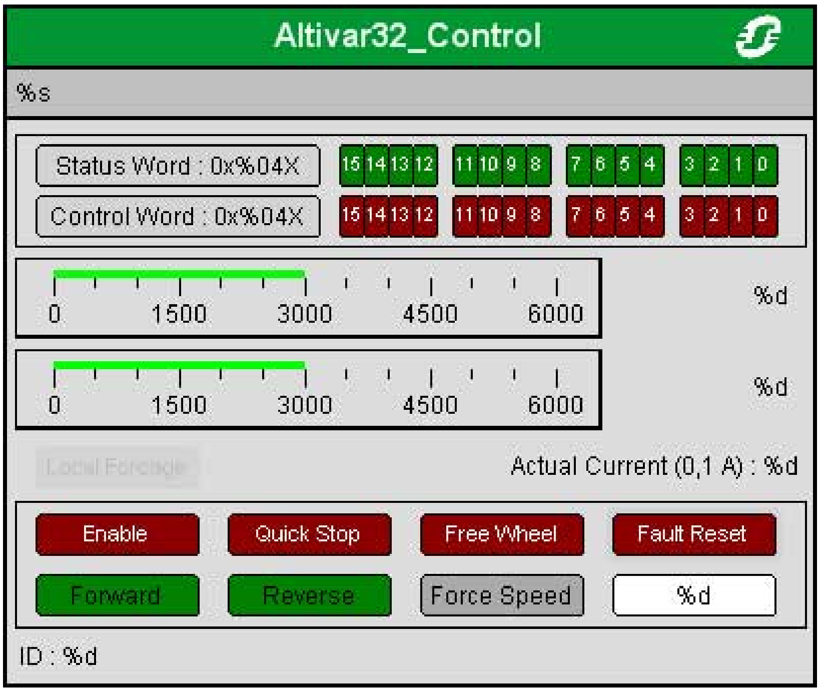


Channels

Variable	Mapping	Channel	Address	Type	Current Value	Default Value	Unit	Description
Application.Main.DriveWrite_ControlWord		Controlword	~~%QW63~~	UINT		0		
Application.Main.DriveWrite_TargetSpeed		Target Velocity	~~%QW64~~	INT		0		
Application.Main.DriveRead_StatusWord		Statusword	~~%IW14~~	UINT		0		
Application.Main.DriveRead_ActualCurrent		LCR (3204)	~~%IW15~~	UINT				
Application.Main.DriveRead_ActualSpeed		RFR (3202)	~~%IW16~~	INT				

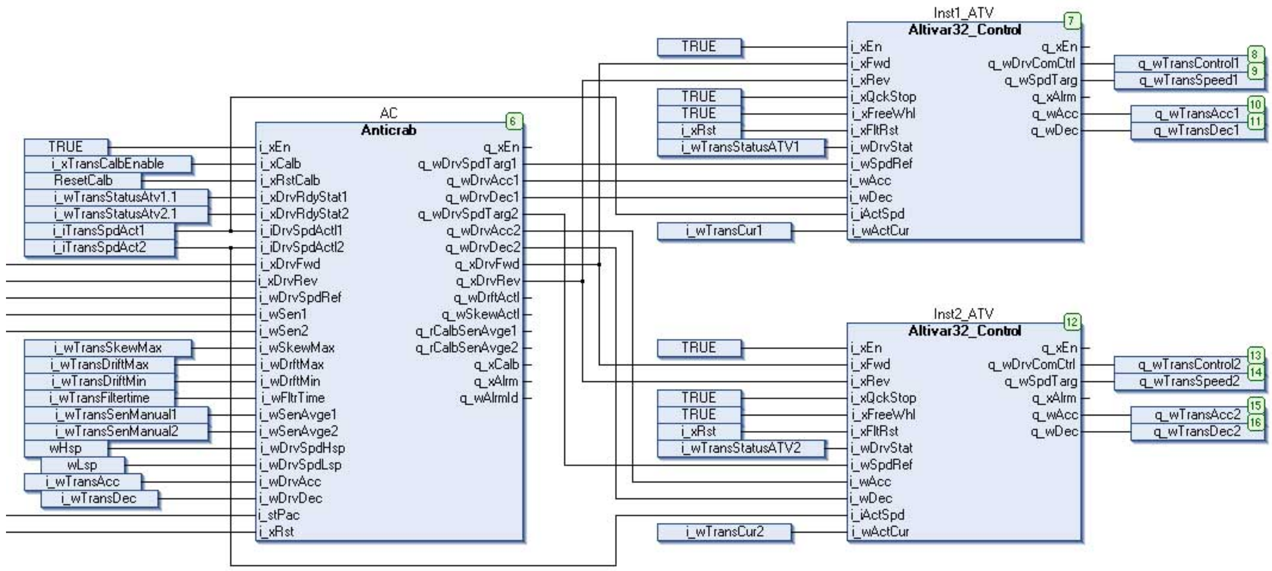
Visualization

With the above minimum configuration, the visualization of this function block can be used to control the drive. After the PDO mapping of the 5 data specified above, the drive can be started with the following sequence of steps:

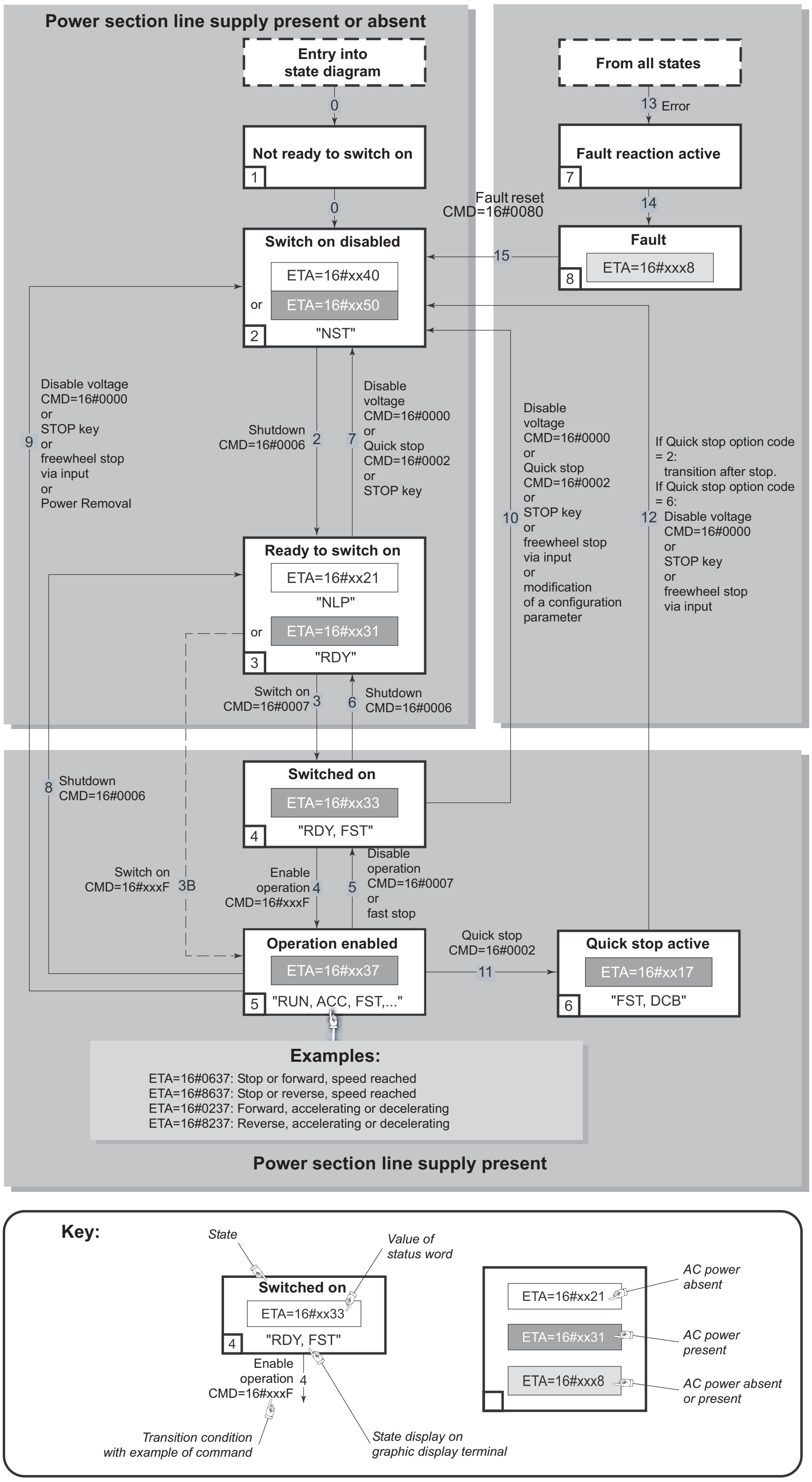


Step	Action
1	Click the button "Enable" to activate the function block
2	Click the button "Quick Stop" to deactivate "Quick Stop"
3	Click the button "Free Wheel" to deactivate "Free Wheel"
4	Enter a velocity value not equal to zero in revolutions per minute (in the field next to the Force Speed button).
5	Click the button "Force Speed"
6	Click the button "Forward" or "Reverse": The motor runs

Example of an application that uses the function block:



Altivar 32 drive profile CiA402 state diagram:



3 Glossary

3.1 Units and conversion tables

The value in the specified unit (left column) is calculated for the desired unit (top row) with the formula (in the field).

Example: conversion of 5 meters [m] to yards [yd]
5 m / 0.9144 = 5.468 yd

3.1.1 Length

	in	**ft**	**yd**	**m**	**cm**	**mm**
in	-	/ 12	/ 36	* 0.0254	* 2.54	* 25.4
ft	* 12	-	/ 3	* 0.30479	* 30.479	* 304.79
yd	* 36	* 3	-	* 0.9144	* 91.44	* 914.4
m	/ 0.0254	/ 0.30479	/ 0.9144	-	* 100	* 1000
cm	/ 2.54	/ 30.479	/ 91.44	/ 100	-	* 10
mm	/ 25.4	/ 304.79	/ 914.4	/ 1000	/ 10	-

3.1.2 Mass

	lb	**oz**	**slug**	**kg**	**g**
lb	-	* 16	* 0.03108095	* 0.4535924	* 453.5924
oz	/ 16	-	* 1.942559*10^{-3}	* 0.02834952	* 28.34952
slug	/ 0.03108095	/ 1.942559*10^{-3}	-	* 14.5939	* 14593.9
kg	/ 0.45359237	/ 0.02834952	/ 14.5939	-	* 1000
g	/ 453.59237	/ 28.34952	/ 14593.9	/ 1000	-

3.1.3 Force

	lb	**oz**	**p**	**N**
lb	-	* 16	* 453.55358	* 4.448222
oz	/ 16	-	* 28.349524	* 0.27801
p	/ 453.55358	/ 28.349524	-	* 9.807*10^{-3}
N	/ 4.448222	/ 0.27801	/ 9.807*10^{-3}	-

3.1.4 Power

	HP	**W**
HP	-	* 746
W	/ 746	-

3.1.5 Rotation

	min^{-1} (RPM)	rad/s	deg./s
min^{-1} (RPM)	-	* π / 30	* 6
rad/s	* 30 / π	-	* 57.295
deg./s	/ 6	/ 57.295	-

3.1.6 Torque

	lb·in	lb·ft	oz·in	Nm	kp·m	kp·cm	dyne·cm
lb·in	-	/ 12	* 16	* 0.112985	* 0.011521	* 1.1521	* 1.129*10^6
lb·ft	* 12	-	* 192	* 1.355822	* 0.138255	* 13.8255	* 13.558*10^6
oz·in	/ 16	/ 192	-	* 7.0616*10^{-3}	* 720.07*10^{-6}	* 72.007*10^{-3}	* 70615.5
Nm	/ 0.112985	/ 1.355822	/ 7.0616*10^{-3}	-	* 0.101972	* 10.1972	* 10*10^6
kp·m	/ 0.011521	/ 0.138255	/ 720.07*10^{-6}	/ 0.101972	-	* 100	* 98.066*10^6
kp·cm	/ 1.1521	/ 13.8255	/ 72.007*10^{-3}	/ 10.1972	/ 100	-	* 0.9806*10^6
dyne·cm	/ 1.129*10^6	/ 13.558*10^6	/ 70615.5	/ 10*10^6	/ 98.066*10^6	/ 0.9806*10^6	-

3.1.7 Moment of inertia

	lb·in^2	lb·ft^2	kg·m^2	kg·cm^2	kp·cm·s^2	oz·in^2
lb·in^2	-	/ 144	/ 3417.16	/ 0.341716	/ 335.109	* 16
lb·ft^2	* 144	-	* 0.04214	* 421.4	* 0.429711	* 2304
kg·m^2	* 3417.16	/ 0.04214	-	* 10*10^3	* 10.1972	* 54674
kg·cm^2	* 0.341716	/ 421.4	/ 10*10^3	-	/ 980.665	* 5.46
kp·cm·s^2	* 335.109	/ 0.429711	/ 10.1972	* 980.665	-	* 5361.74
oz·in^2	/ 16	/ 2304	/ 54674	/ 5.46	/ 5361.74	-

3.1.8 Temperature

	°F	°C	K
°F	-	(°F - 32) * 5/9	(°F - 32) * 5/9 + 273.15
°C	°C * 9/5 + 32	-	°C + 273.15
K	(K - 273.15) * 9/5 + 32	K - 273.15	-

3.1.9 Conductor cross section

AWG	1	2	3	4	5	6	7	8	9	10	11	12	13
mm^2	42.4	33.6	26.7	21.2	16.8	13.3	10.5	8.4	6.6	5.3	4.2	3.3	2.6

AWG	14	15	16	17	18	19	20	21	22	23	24	25	26
mm^2	2.1	1.7	1.3	1.0	0.82	0.65	0.52	0.41	0.33	0.26	0.20	0.16	0.13

3.2 Terms and Abbreviations

See chapter "1.5 Standards and terminology" for information on the pertinent standards on which many terms are based. Some terms and abbreviations may have specific meanings with regard to the standards.

Asynchronous error Asynchronous errors are signaled without a request. Example of an asynchronous error: Power stage overtemperature.

Device data The term device data refers to the parameter values of a device. The data is stored in the EEPROM of the device (persistent memory).

Error Discrepancy between a detected (computed, measured or signaled) value or condition and the specified or theoretically correct value or condition.

Error class Classification of errors into groups. The different error classes allow for specific responses to errors, for example by severity.

Factory setting Factory settings when the product is shipped

Fatal error In the case of fatal error, the product is no longer able to control the motor so that the power stage must be immediately disabled.

Fault Fault is a state that can be caused by an error. Further information can be found in the pertinent standards such as IEC 61800-7, ODVA Common Industrial Protocol (CIP).

Fault reset A function used to restore the drive to an operational state after a detected error is cleared by removing the cause of the error so that the error is no longer active.

LED Light Emitting Diode

Limit switch Switches that signal overtravel of the permissible range of travel.

Node guarding Monitoring of the connection to the slave at an interface for cyclic data traffic.

Parameter Device data and values that can be read and set (to a certain extent) by the user.

Power stage The power stage controls the motor. The power stage generates current for controlling the motor on the basis of the positioning signals from the controller.

RS485 Fieldbus interface as per EIA-485 which enables serial data transmission with multiple devices.

Synchronous error Error signaled by the controller if it is unable to execute a command received from the master.

Warning If the term is used outside the context of safety instructions, a warning alerts to a potential problem that was detected by a monitoring function. A warning does not cause a transition of the operating state.

4 Index