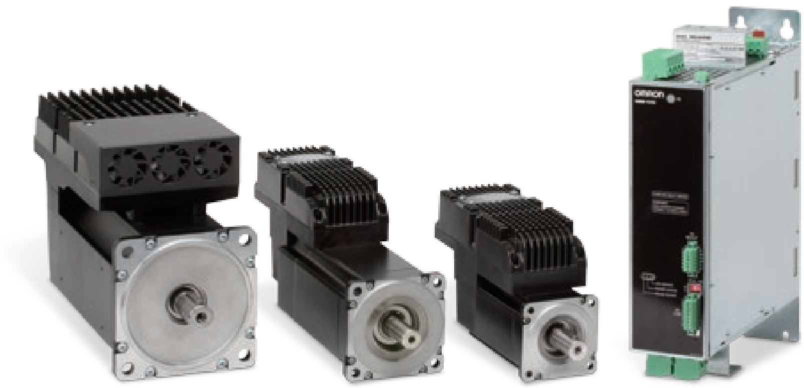
Servo Systems

Integrated Servo Motors

User's Manual

R88E-AECT (Integrated Servo Motor)
R88S-EAD (DC Power Supply Unit)



I103E-EN-02

Trademarks

- Sysmac and SYSMAC are trademarks or registered trademarks of OMRON Corporation in Japan and other countries for OMRON factory automation products.
- Windows, Windows XP, Windows Vista, Windows 7, Windows 8, Windows 10 and Excel are registered trademarks of Microsoft Corporation in the USA and other countries.
- EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.
- ODVA, CIP, CompoNet, DeviceNet, and EtherNet/IP are trademarks of ODVA.

Other company names and products names in this document are the trademarks or registered trademarks of their respective companies.

Introduction

Thank you for purchasing an Integrated Servo Motor Series. This manual explains how to install and wire the Integrated Servo Motor, set parameters needed to operate the Integrated Servo Motor, and remedies to be taken and inspection methods to be used if problems occur.

Intended Readers

This manual is intended for the following individuals.

Those having electrical knowledge (certified electricians or individuals having equivalent knowledge) and also being qualified for one of the following:

- Introducing FA equipment
- Designing FA systems
- Managing FA sites

Notice

This manual contains information you need to know to correctly use the Integrated Servo Motor and peripheral equipment. Before using the Integrated Servo Motor, read this manual and gain a full understanding of the information provided herein.

After you finished reading this manual, keep it in a convenient place so that it can be referenced at any time.

Make sure this manual is delivered to the end user.

Read and Understand this Manual

Warranty and Limitations of Liability

WARRANTY
OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON. OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NONINFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY
OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY. In no event shall the responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted. IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE
OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the products. At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use. The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products: • Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this manual. • Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations. • Systems, machines, and equipment that could present a risk to life or property. Please know and observe all prohibitions of use applicable to the products. NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCTS ARE PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

PROGRAMMABLE PRODUCTS
OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

Disclaimers

CHANGE IN SPECIFICATIONS
Product specifications and accessories may be changed at any time based on improvements and other reasons. It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the products may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased products.

DIMENSIONS AND WEIGHTS
Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

PERFORMANCE DATA
Performance data given in this manual is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

ERRORS AND OMISSIONS
The information in this manual has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

Safety Precautions

- To ensure that the Integrated Servo Motor as well as peripheral equipment are used safely and correctly, be sure to read this Safety Precautions section and the main text before using the product in order to learn items you should know regarding the equipment as well as required safety information and precautions.
- Make an arrangement so that this manual also gets to the end user of this product.
- After reading this manual, keep it in a convenient place so that it can be referenced at any time.

Definition of Precautionary Information

- The precautions explained in this section describe important information regarding safety and must be followed without fail.
- The display of precautions in this manual and their meanings are explained below.

DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Additionally, there may be severe property damage.
Caution	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

Even those items denoted by the caution symbol may lead to a serious outcome depending on the situation. Accordingly, be sure to observe all safety precautions.

Precautions for Safe Use

Indicates precautions on what to do and what not to do to ensure using the product safely.

Precautions for Correct Use

Indicates precautions on what to do and what not to do to ensure proper operation and performance.

Additional Information

Indicates an item that helps deepen your understanding of the product or other useful tip.

Explanation of Symbols

Example of symbols	
	△ This symbol indicates danger and caution. The specific instruction is indicated using an illustration or text inside or near △. The symbol shown to the left indicates “beware of electric shock.”
	⊘ This symbol indicates a prohibited item (an item you must not do). The specific instruction is indicated using an illustration or text inside or near ⊘. The symbol shown to the left indicates “disassembly prohibited,”
	● This symbol indicates a compulsory item (an item that must be done). The specific instruction is indicated using an illustration or text inside or near ●. The symbol shown to the left indicates “grounding required,”

Recipients

- Only specialized staff can modify the drives of the Integrated Servo Motor series and use them, who previously read the manual and all the documents related to the product. Specialized staff must have been adequately trained about safety in order to prevent any possible risks. The technical training, foreground and experience of the specialized staff must help them preventing from any possible risk occurring during the product use, from the settings modification to the functioning of the mechanical, electrical and electronic equipment of the device. The specialized staff must know all the current regulations and safe working practices in case of any intervention on the product.
- This manual must be read by the following staff members:
    - Transport: Only for personnel expert in handling sensitive parts of electrostatic charges.
    - Unpacking: Only for qualified electricians.
    - Installation: Only for qualified electricians.
    - Use: Only for qualified staff expert in electro-technology and activation technology.
- The qualified staff must know and follow these rules:
    - EN 12100, EN 60364 and EN 60664.
    - National safe working practices.
- This manual is addressed to all users of the Integrated Servo Motor.

DANGER

During the drive functioning beware of danger of death, serious injuries or material damage. For a safe functioning, follow all the safety instructions in this manual. The security officer must check that the staff working with the drives read and understood this manual before using them.

Responsibilities

Caution

OMRON can modify the described products in this manual in any time and without any notice.

This manual was written by OMRON only for their customers use providing the most updated version of the products.

The responsibility to use this manual belongs to every user and the use of some functions must be under strict care to avoid any danger for the staff and the equipment.

No other warranty is provided by OMRON in particular for possible imperfections, incompleteness, and/or any other difficulties.

Precautions for Safe Use of This Product

- Illustrations contained in this manual sometimes depict conditions without covers and safety shields for the purpose of showing the details. When using this product, be sure to install the covers and shields as specified and use the product according to this manual.
- If the product has been stored for an extended period of time, contact your OMRON sales representative.

General Dangers and Cautions

DANGER

Always connect the ground terminals to a type-D or higher ground. Improper grounding may result in electrical shock.

This product is intended to be exclusively used in machines and systems in industrial environment, respecting the described application, environmental and functioning conditions. Follow the safety regulations and the ordinances of the country in which the product (or the relative control and command system) is used.

Never touch the parts inside the Integrated Servo Motor. Electric shock may result.

While the power is supplied, do not remove the front cover, terminal covers, cables, and options. Electric shock may result.

Installation, operation, and maintenance or inspection by unauthorized personnel is prohibited. Electric shock or injury may result.

Before carrying out wiring or inspection, turn OFF the main circuit power and wait for at least 1 minute. Electric shock may result.

Do not damage, pull, stress strongly, or pinch the cables or place heavy articles on them. Electric shock, stopping of Drive operation, or burn damage may result.

Never touch the rotating part of the Integrated Servo Motor during operation. Injury may result.

Never modify the products. Injury or equipment damage may result.

Install a stopping device on the machine to ensure safety.
* The holding brake is not a stopping device to ensure safety. Injury may result.

Install an immediate stop device externally to the machine so that the operation can be stopped and the power supply cut off immediately. Injury may result.

When the power is restored after a momentary power interruption, the machine may restart suddenly. Never come close to the machine when restoring power.
* Implement measures to ensure safety of people nearby even when the machine is restarted. Injury may result.

After an earthquake, be sure to conduct safety checks. Electric shock, injury, or fire may result.

Never drive the Integrated Servo Motor using an AC Power Supply. Fire may result.

Never drive the Integrated Servo Motor using an external drive source. Fire may result.

Do not place flammable materials near the Integrated Servo Motor or DC Power Supply Unit. Fire may result.

Install the Integrated Servo Motor and DC Power Supply Unit on non-flammable materials such as metals. Fire may result.

Do not use the cable when it is laying in oil or water. Electric shock, injury, or fire may result.

Use always a suitable power supply like the R88S-EA to supply the Integrated Servo Motor. Fire or failure may result.

Do not perform wiring or any operation with wet hands. Electric shock, injury, or fire may result.

Do not touch the key grooves with bare hands if a Integrated Servo Motor with shaft-end key grooves is being used. Injury may result.

The Integrated Servo Motor and DC Power Supply Unit may become hot while the power is supplied or remain hot for a while even after the power supply is cut off. Never touch these components. A burn injury may result.

Storage and Transportation

Caution

	Do not store or install the Integrated Servo Motor in the following locations: •Location subject to direct sunlight •Location where the ambient temperature exceeds the specified level •Location where the relative humidity exceeds the specified level •Location subject to condensation due to rapid temperature changes •Location subject to corrosive or flammable gases •Location subject to high levels of dust, salt content, or iron dust •Location subject to splashes of water, oil, chemicals, etc. •Location where the Integrated Servo Motor may receive vibration or impact directly Installing or storing the Integrated Servo Motor in any of these locations may result in fire, electric shock, or equipment damage.
	Do not overload the Integrated Servo Motor. (Follow the instructions on the product label.) Injury or failure may result.
	Use the original box to transport the Integrated Servo Motor. Product damage may occur.
	Do not transport the Integrated Servo Motor by holding it by the shaft. Product damage may occur.

Installation and Wiring

Caution

Do not step on the Integrated Servo Motor or place heavy articles on it. Injury may result.

Install the Integrated Servo Motor in a place with sufficient ventilation. Fire or failure may result.

Be sure to observe the mounting direction of the DC Power Supply Unit. Failure may result.

Do not apply strong impact on the Integrated Servo Motor shaft or DC Power Supply Unit. Failure may result.

Wire the cables correctly and securely. Runaway Integrated Servo Motor, injury, or failure may result.

Securely tighten the mounting screws, terminal block screws, and cable screws. Failure may result.

Use crimp terminals for wiring. If simple twisted wires are connected directly to the protective ground terminal, fire may result.

Only use the power supply voltage specified in this manual. Burn damage may result.

In locations where the power supply infrastructure is poor, make sure the rated voltage can be supplied. Equipment damage may result.

Provide safety measures, such as a breaker, to protect against short circuiting of external wiring. Fire may result.

If the Integrated Servo Motor is used in the following locations, provide sufficient shielding measures.

- Location subject to noise e.g., due to static electricity
- Location subject to a strong electric or magnetic field
- Location where exposure to radioactivity may occur
- Location near power supply lines

Using the Integrated Servo Motor in any of these locations may result in equipment damage

Connect a 24 VDC control power supply with enough current capacity, specially if motor with brake is used. Injury or failure may result.

When connecting the power supply, make sure the polarity is correct. The drive is not protected against reversed polarity. Damage or explosion may result.

Operation and Adjustment

Caution

Conduct a test operation after confirming that the equipment is not affected.
Equipment damage may result.

Before operating the Integrated Servo Motor in an actual environment, check if it operates correctly based on the parameters you have set. Equipment damage may result.

Never adjust or set parameters to extreme values, because it will make the operation unstable. Injury may result.

Separate the Integrated Servo Motor from the mechanical system and check its operation before installing the Integrated Servo Motor to the machine. Injury may result.

If an error occurs, remove the cause of the error and ensure safety, and then reset the alarm and restart the operation. Injury may result.

Do not use the built-in brake of the Integrated Servo Motor for normal braking operation.
Failure may result.

Do not operate the Integrated Servo Motor connected to an excessive load inertia. Failure may result.

Install safety devices to prevent idling or locking of the electromagnetic brake or the gear head, or leakage of grease from the gear head. Injury, damage, or taint damage result.

If the Integrated Servo Motor fails, cut off the power supply to the Integrated Servo Motor at the power supply. Fire may result.

Do not turn ON and OFF the main Integrated Servo Motor power supply frequently.
Failure may result.

Maintenance and Inspection

Caution

After replacing the Integrated Servo Motor, transfer to the new Integrated Servo Motor all data needed to resume operation, before restarting operation. Equipment damage may result.

Never repair the Integrated Servo Motor by disassembling it. Electric shock or injury may result.

Be sure to turn OFF the power supply when the Integrated Servo Motor is not going to be used for a prolonged period of time. Injury may result.

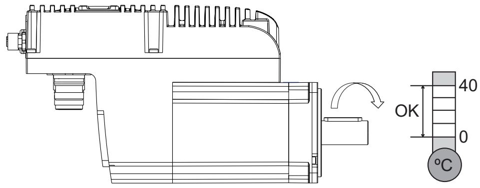
The drive has rotary DIP switches to set the node number. All this settings must be made when the drive is switched off. To prevent damages to the drive it's recommended to pay particular attention when working on this settings because in the drive there are some components that are sensitive to the electrostatic discharge. It's in particular advisable to preventively discharge the static electricity, to place the drive on a conductive support and to avoid contact with highly insulating materials. BEFORE TO POWER THE SYSTEM, REMEMBER TO FASTEN THE TRANSPARENT COVER (if it has been removed).

When there is a fault, the drive is disabled; before enabling it again by rebooting the system or by some correct commands through the field bus, remove the cause generating the fault.

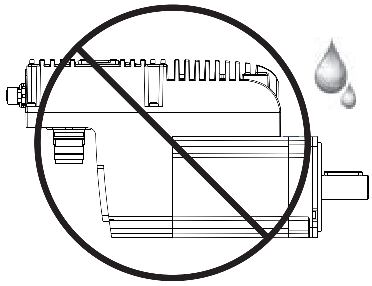
Mechanical Installation Precaution

Caution

Ambient temperature: 0 to 40ºC

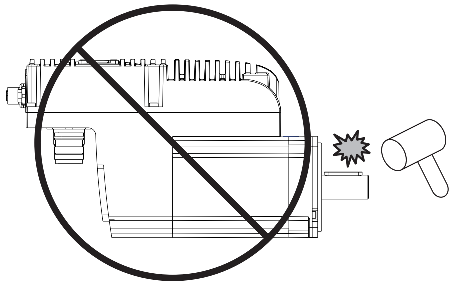


Ambient humidity: 95% RH max. (with no condensation)



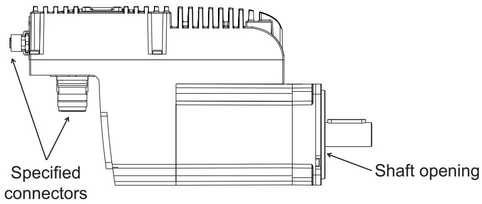
Vibration resistance: According to IEC 60068-2-6 (5 to 500 Hz, 1 and 2 G in 3 axes)

Shock resistance: According to IEC 60068-2-27 (3 shock per axis, 11 ms, 14G)

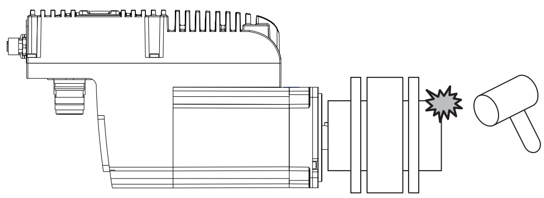


The protection class indicates the degree of protection required to keep dust and water from entering.

Protection class: IP65



Be careful not to subject the shafts to any force or shock when installing the coupling. When connecting with machines, make sure the axial load and thrust loads do not exceed the maximum allowable values specified in the user's manual.

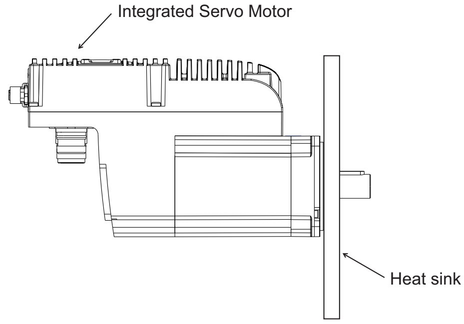


Caution

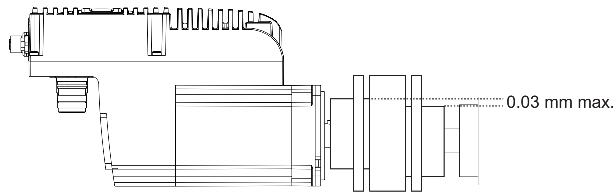
Never insert insulators, such as packings, in the joint between the Integrated Servo Motor and the heat sink.

The insulator will not only cause the motor temperature to rise but also affect the noise immunity and result in Integrated Servo Motor failure.

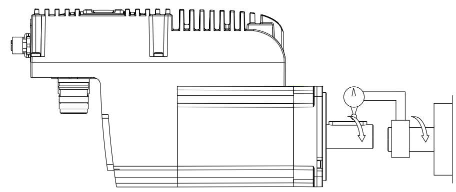
Install the Integrated Servo Motor in a well ventilated place and attached to a heatsink or machine frame with suitable dimensions to guarantee a heat dissipation. Motor failure may happen.



The required accuracy for alignment differs depending on the Integrated Servo Motor speed and the model of the coupling. The maximum allowed deviation for alignment is 0.03 mm. If unusual sounds come from the coupling, readjust the alignment of the coupling until the sound is gone.



Turn both the Integrated Servo Motor shaft and the machine shaft to align the coupling.



Disposal

- Dispose of the Integrated Servo Motor and the DC Power Supply Unit as industrial wastes.

Items to Check after Unpacking

After unpacking, check the following items.

- Is this the model you ordered?
- Was there any damage sustained during shipment?

Accessories

The Integrated Servo Motor package includes:

- Integrated Servo Motor
- Plastic cap for the M8 connector
- “Dust cover” plastic cap for the M23 I/O connector
- Torx key
- Integrated Servo Motor instruction sheet

Note No flying connector or cable is included in the standard equipment.

The DC Power Supply Unit package includes:

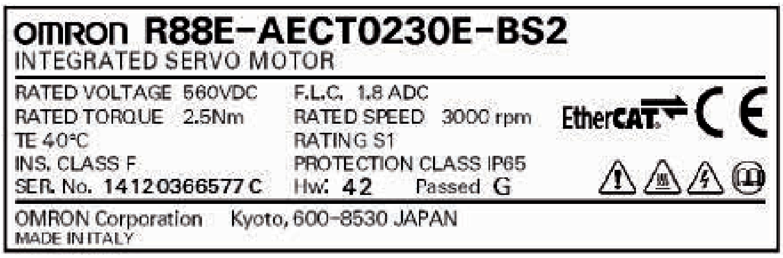
- DC Power Supply Unit
- 2 flanges for connection of power cable shield
- x1, x2, x3, x5, x6, x7, x8 connectors
- DC Power Supply instruction sheet

Note No cable is included as standard.

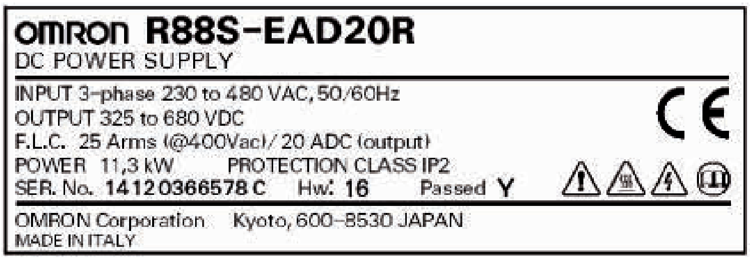
Before you start working with the Integrated Servo Motor and the DC Power Supply Unit, verify that there are not visible damages. Be sure that the Integrated Servo Motor and the DC Power Supply Unit that you have taken from the package are the correct models for your application, that corresponds to what you have ordered and that you can provide a voltage supply as prescribed for the system.

Checking the nameplate

Integrated Servo Motor nameplate



DC Power Supply Unit nameplate



Revision History

The manual revision code is a number appended to the end of the catalog number found in the bottom left-hand corner of the front or back cover.

Example

Cat. No. I103E-EN-02

Revision code

Revision code	Revision Date	Revised content
01	May 2015	Original production

02	October 2017	Manual updated for R88E-AECT firmware 32:
		• Section 7-2-4 Gear Mode was included
		• New parameters included:
		    • FieldWeakeningFilterType [3520.06]
		    • FeedbackSensorResolution [36C0.02]
		    • FeedbackSensorPhasing [36C2.xx]
		    • MasterPositionSettings [4288.xx]
		    • TargetGearRatio [4289.xx]
		    • StartGearRatio [428A.xx]
		    • EtcResetPdoRxLostMaxConsecReset [5FF6.10]
		    • SysMngStatus [5FF7.02]
		    • SysMngMicroStepCurrent [5FF7.0A]
		• Parameters updated:
		    • CaptureSources_A [4003.xx]
		    • CaptureSources_B [4013.xx]
		    • HomingStatus [42A1.00]
		    • SysMngCommand [5FF7.01]
		    • SysMngError [5FF7.03]
		    • FirmwareStatus [5FFE.01]
		    • QuickStopConfiguration [605A.00]
		    • ModesOfOperation [6060.00]
		    • ModesOfOperationDisplay [6061.00]
		    • HomingMethod [6098.00]
		    • MotorTemperatureSensorType [6410.0F]

Structure of This Document

This manual consists of the following chapters.

Read the necessary chapter or chapters referring the following table.

		Outline
Chapter 1	Features and System Configuration	This section explains the features of the Integrated Servo Motor, name of each part and applicable EC Directives.
Chapter 2	Models and External Dimensions	This section explains the models of Integrated Servo Motor and peripheral devices, and provides the external dimensions and mounting dimensions.
Chapter 3	Specifications	This section provides the general specifications, characteristics, connector specifications, and I/O circuits of the Integrated Servo Motor as well as the general specifications, characteristics, encoder specifications and other peripheral devices.
Chapter 4	System Design	This section explains the installation conditions for the Integrated Servo Motor and DC Power Supply Unit, wiring methods including wiring conforming to EMC Directives and regenerative energy calculation methods.
Chapter 5	EtherCAT Communications	This section describes EtherCAT communications under the assumption that the Integrated Servo Motor is connected to a Machine Automation Controller NX/NY/NJ-series.
Chapter 6	DC Power Supply Unit Setup	This section describes how to setup the Power Supply Unit.
Chapter 7	Basic Control Modes	This section describes the modes that is used to control the Integrated Servo Motor.
Chapter 8	Applied Functions	This section outlines the applied functions and explains the settings.
Chapter 9	/STOP Function	This section gives an outline of application functions and explains the settings.
Chapter 10	Details of Objects	This section explains the set values and contents of each object.
Chapter 11	Operation	This section gives the operating procedures and explains how to operate in each mode.
Chapter 12	Adjustment Functions	This section explains the functions, setting methods, and items to note regarding various gain adjustments.
Chapter 13	Troubleshooting and Maintenance	This section explains the items to check when problems occur, error diagnosis using the error display and measures, error diagnosis based on the operating condition and measures, and periodic maintenance.
Appendices		The appendix provides the lists of objects, Sysmac Studio setup and other information.

CONTENTS

Section 3 Specifications

Section 4 System Design

Section 5 EtherCAT Communications

Section 6 DC Power Supply Unit Setup

Section 7 Basic Control Modes

Section 8 Applied Functions

Section 9 /STOP Function

Section 10 Details of Objects

Section 11 Operation

Section 12 Adjustment Functions

Section 13 Troubleshooting and Maintenance

Section A Appendices

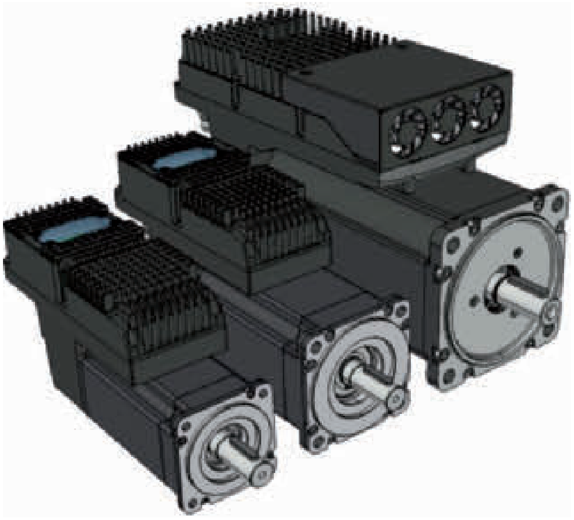
1

Features and System Configuration

This section explains the features of the Integrated Servo Motor, name of each part and applicable EC Directives.

1-1 Outline

The Integrated Servo Motors are digital drives for three-phase sinusoidal brushless motors with permanent magnets. In particular, the Integrated Servo Motor is composed by a brushless motor, a feedback position sensor, static brake (optional), interface to EtherCAT industrial bus, power module and control logical section. All versions of this drive type have digital I/O, analog input, LEDs and rotary switches. There is also a permanent memory and an auxiliary serial port in which the protocol Modbus has been implemented.



Features	Specifications
Motor size	880 W to 7.85 kW
Range of supply of the power section	Nominal 560 VDC, Minimum 275 VDC, Maximum 740 VDC
Range of supply of the logic section	Without brake: 24 VDC (-15% / +15%) With brake: 24 VDC (-10% / +6%)
Feedback sensor	Incremental: 15 bit/revolution Absolute: 20 bit/revolution (18 bit real accuracy + 2 bit interpolated), 12 bit multiturn
Main communication port (field bus)	EtherCAT with CiA402 device profile
Auxiliary communication port	Modbus on RS232
Rotary switches	Setting the node number and/or communication speed of the main bus
LEDs	Information and local diagnostics through transparent window
Differential bidirectional I/O	3 differential bidirectional lines (RS485 compatible) for presettable default functions (auxiliary encoder input, pulse-dir#, others)
Number of digital bidirectional I/O	1
Number of digital inputs	6
Number of digital outputs	3
Number of analog inputs	1
Dedicated /STOP input	1
Permanent memory	Yes

The firmware provides some different working operating modes that can be divided into three classes:

- Position modes: The drive receives a position reference and follows the motion in order to minimize the error between the reference value and the current position.
- Speed modes: The drive receives a speed reference and runs the motion in order to minimize the error between the reference value and the current speed.
- Torque modes: The drive receives a torque reference and runs the motion in order to minimize the error between the torque reference and the actual torque.

1-1-1 Features of R88E-AECT Integrated Servo Motor

The Integrated Servo Motors have the following features:

Optimal Functionality Using EtherCAT Communications

Combining the R88E-EACT Integrated Servo Motor with Machine Automation Controller NX/NY/NJ-series or other EtherCAT master that supports CoE DS402 enables you to exchange all position information with the controller in high-speed deterministic data communication with the EtherCAT interface.

CANopen DS402 Servo profile is implemented in the servo allowing to work in different modes like CSP, CSV, CST, Homing, etc.

Space Optimization

The architecture of the Integrated Servo Motor with several integrated motor and drive in the machine and common DC Power Supply Unit in the cabinet minimizes the needed space in the control cabinet and reduces the peripheral components needed.

Wiring Simplification

One power cable goes from the power supply to the different motors. The architecture allows different wiring configuration to adapt to any machine need.

Wide range of available torque and options

A wide range of motor matches with any application requirements.

Rated torque going from 2.55 to 25 Nm at 3000 rpm. Absolute and incremental encoders, brake option, smooth or keyed and tap shaft.

Energy saving

The architecture with common DC-Bus optimizes the energy as the energy regenerated by one motor is immediately used by another motor minimizing the total energy used from the supply.

1-1-2 What is EtherCAT?

EtherCAT is an open high-speed industrial network system that conforms to Ethernet (IEEE 802.3). Each node achieves a short cycle time by transmitting Ethernet frames at high speed. A mechanism that allows sharing clock information enables high-precision synchronization control with low communications jitter.

EtherCAT is a registered trademark of Beckhoff Automation Gmbh (Germany). EtherCAT technology is protected by patents.

1-1-3 Object Dictionary

An object is a special data structure inside a device that consists of data, parameters and methods.

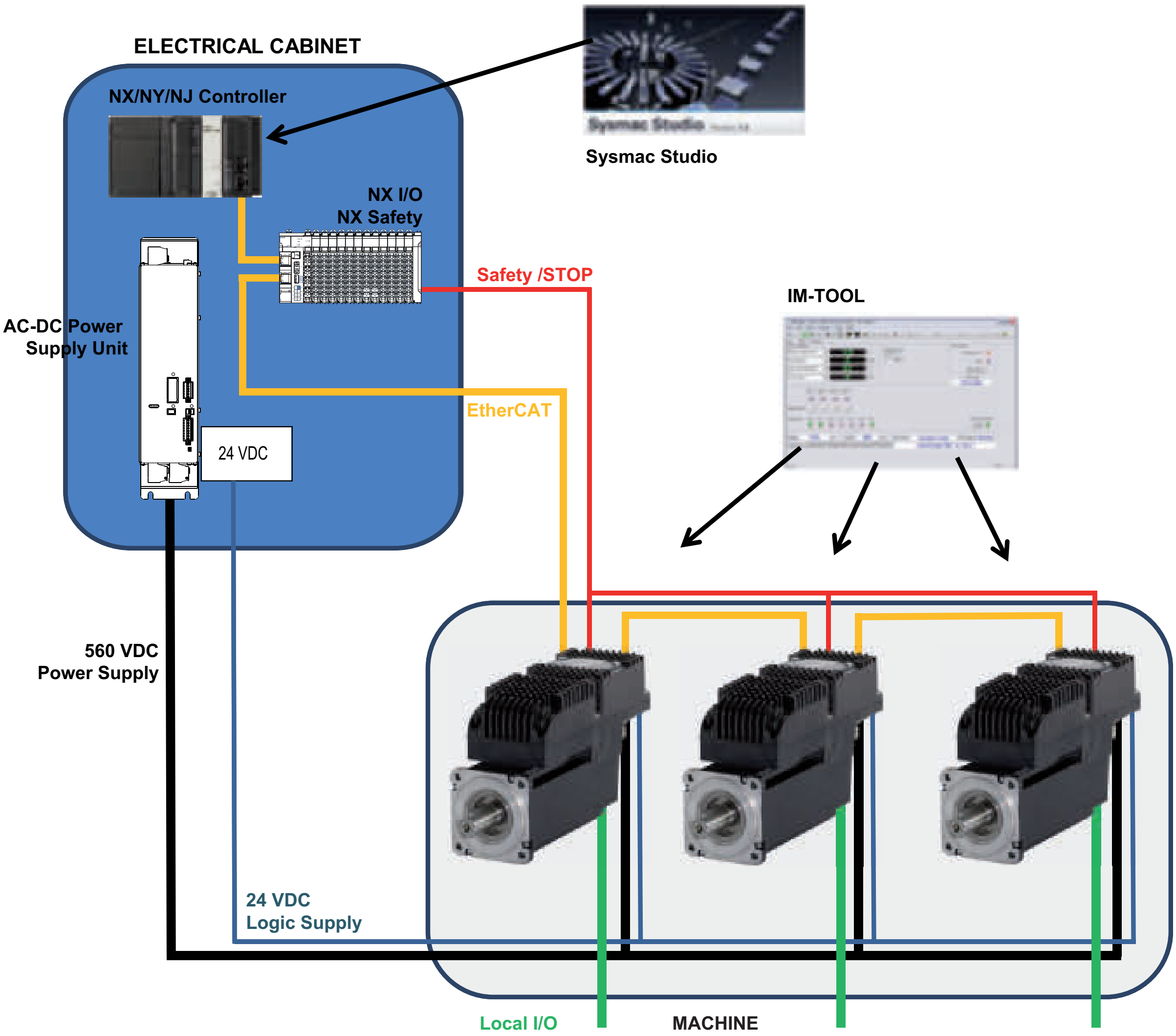
An object dictionary is a data structure that describes the data type objects, communication objects and application objects.

The objects are classified in next groups:

Integrated Servo Motor	DC Power Supply Unit
Initial configuration, update and board identity	Initial configuration, update and board identity
EtherCAT communication port	Auxiliary communication port
Auxiliary communication port	Monitor and diagnostic of the power supply unit
Motor, drive and I2T	Power supply unit configuration
Tuning	Fault and warning
Loop	Output channels monitor
Power Pwm	Internal diagnostic
Drive status	
Fault and warning	
CiA402 state machine	
System manager	
Capture peripherals	
Feedback sensor	
Motion	
Brake	
Auxiliary position sensor	
Digital inputs and outputs	
Analog input	
Sync manager and PDOs managed by the EtherCAT port	

1-2 System Configuration

The system configuration for an Integrated Servo Motor with EtherCAT communication is shown below:



1-3 Names and Functions

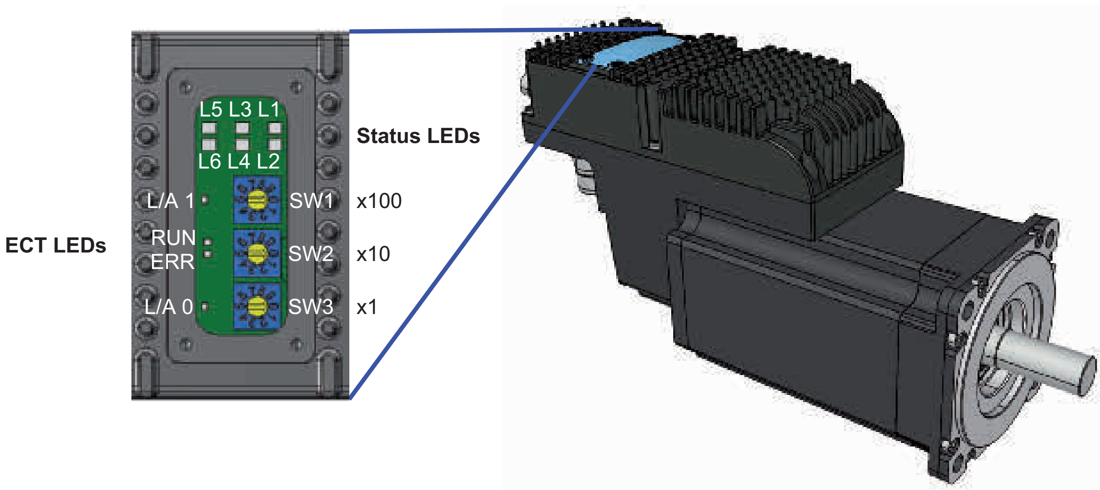
This section describes the names and functions of the Integrated Servo Motor and DC Power Supply Unit parts.

1-3-1 Integrated Servo Motor Part Names

The Integrated Servo Motor part names are given below.

R88E-AECT0230/0330/0430/0530 models

R88E-AECT1130/2530 models



1-3-2 Integrated Servo Motor Functions

The functions of each part as described below.

Auxiliary - RS232 serial port (CN1)

Connector for the auxiliary bus with protocol Modbus on RS232, M8 female, 4 poles.

Main bus - ECT (CN2-OUT/CN3-IN)

Connectors for the main bus with protocol EtherCAT, M12 female, 4 poles, D-code, CN2 output, CN3 input.

Input/Output signals (CN4)

Connector for the digital and analog inputs and outputs, M23 male, 19 poles (16+3), Hummel.

DC power supply and logic supply (CN5)

Connector for the supply of the power section and of the logical section, plus two digital inputs /STOP and IN9, M23 male, 8 poles (4+3+PE), Hummel.

Status LEDs

L1, L2: Drive status (fault, warning, enabling).

L3, L5: Reserved (LED OFF).

L4: Overload (I2T) status.

L6: Input status /STOP.

ECT LEDs

L/A 0: Status of the physical link/activity of the EtherCAT port on the CN3 connector.

L/A 1: Status of the physical link/activity of the EtherCAT port on the CN2 connector.

ERR: EtherCAT error LED

RUN: EtherCAT run LED

Rotary switches

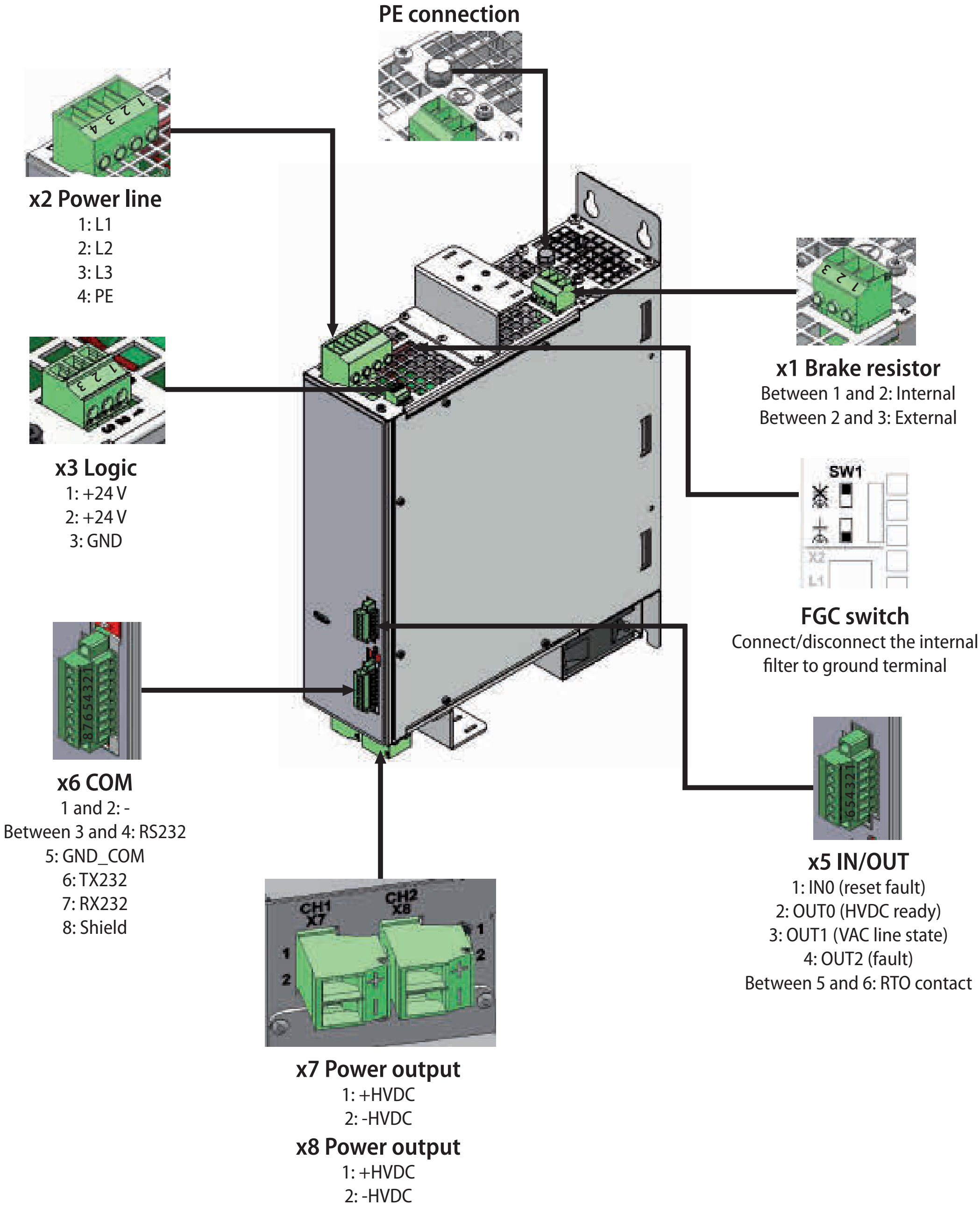
SW1: EtherCAT user address (station alias) x100

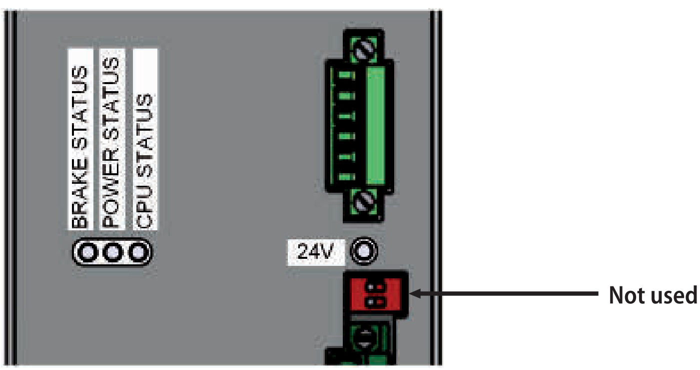
SW2: EtherCAT user address (station alias) x10

SW3: EtherCAT user address (station alias) x1

1-3-3 DC Power Supply Unit Part Names

The DC Power Supply Unit part names are given below.





1-3-4 DC Power Supply Unit Functions

The functions of each part as described below.

24V logic voltage LED

OFF: Without logic voltage.

ON (GREEN): With logic voltage.

CPU status LED

OFF: The CPU doesn’t work (see logic voltage).

ON (GREEN): CPU works in firmware mode.

ON (ORANGE): CPU works in boot mode.

ON (RED): CPU in reset.

Power status LED

OFF: Power OFF or in boot mode.

ON (blink GREEN): Boot sequence (voltage/current monitor).

ON (GREEN): Operating power supply, output current <70% nominal current (no warning and fault).

ON (GREEN/ORANGE): Operating power supply, output current >70% nominal current (no warning and fault).

ON (ORANGE): Power supply in warning (power running, one or more active warning).

ON (RED): Power supply fault (power not working, one or more active fault).

Brake status LED

OFF: Without brake.

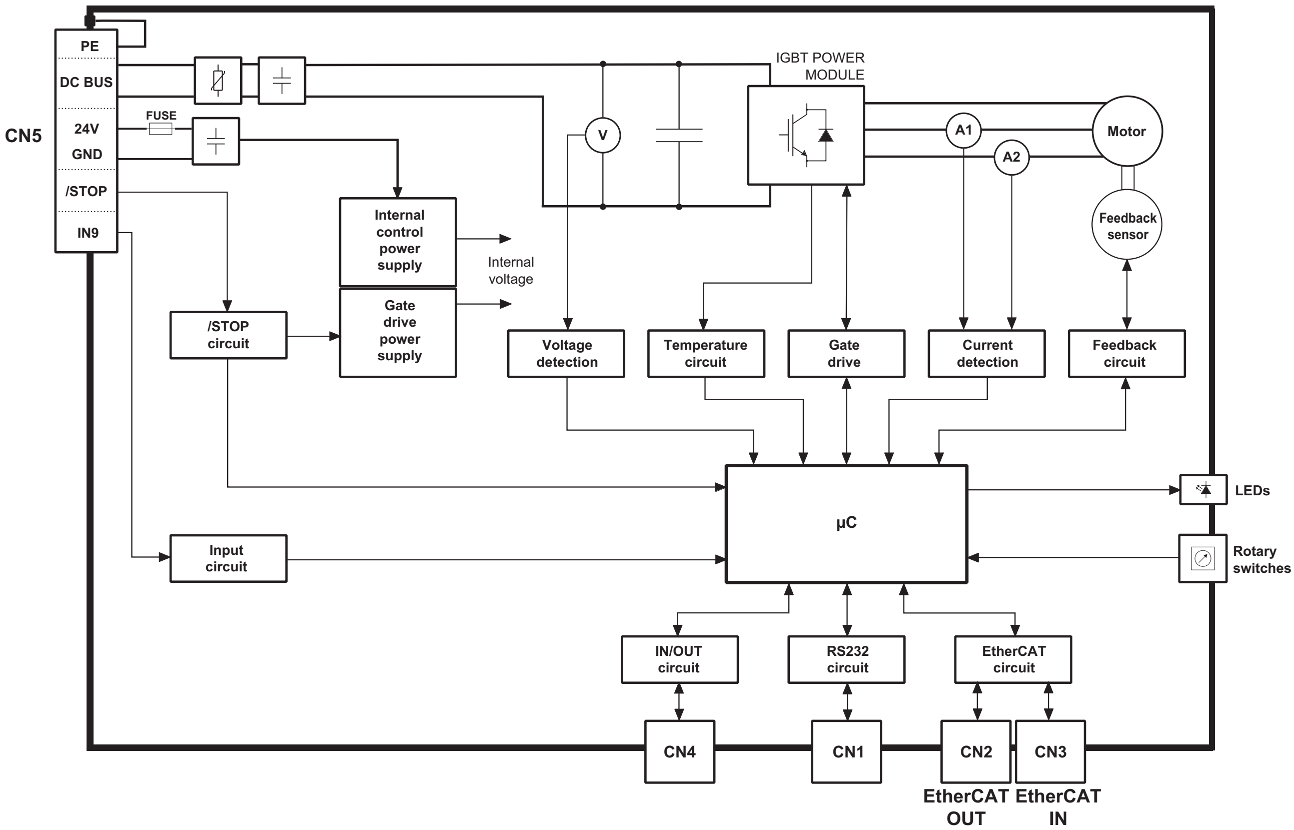
ON (ORANGE): With brake (<50% of the maximum energy).

ON (RED): With brake (>50% of the maximum energy).

1-4 System Block Diagram

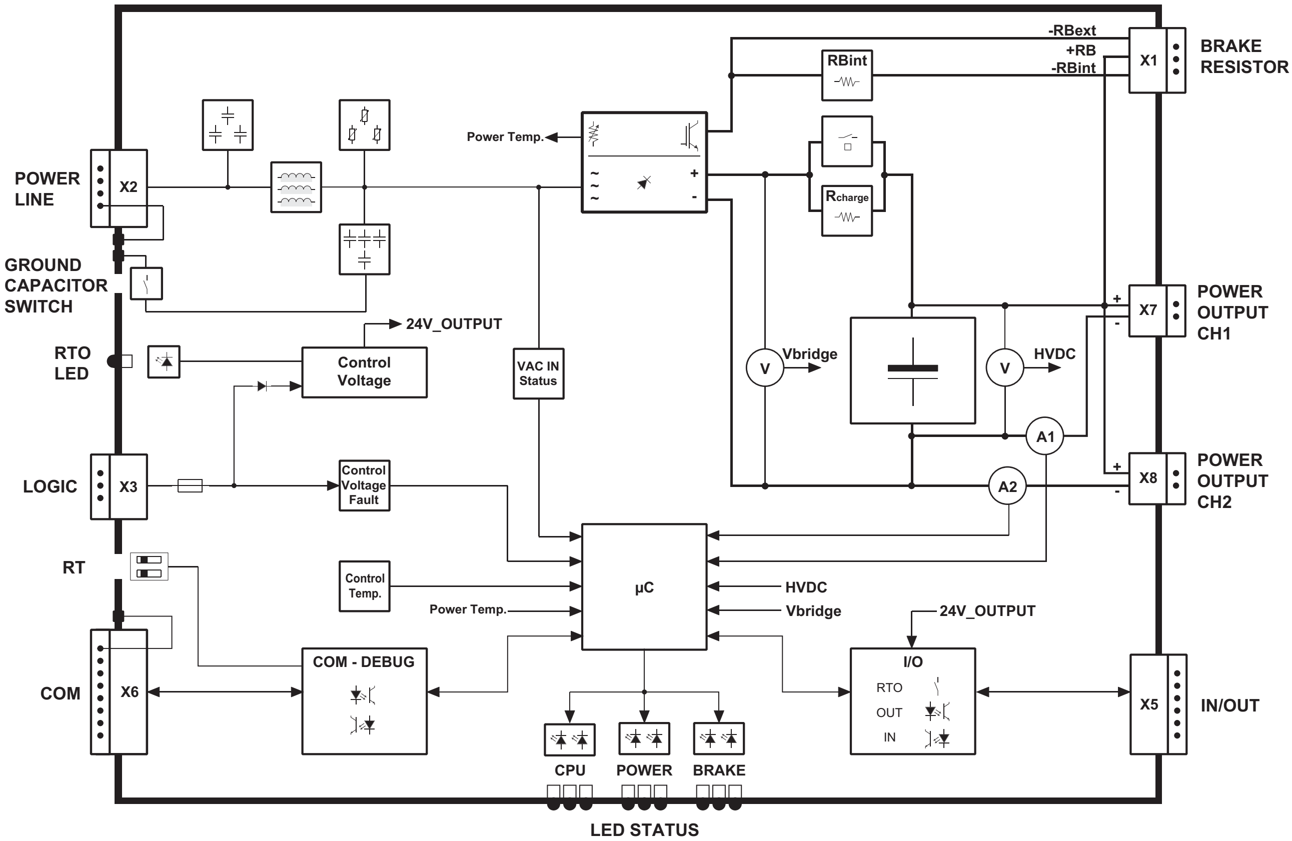
1-4-1 Integrated Servo Motor Block Diagram

This is the block diagram of the Integrated Servo Motor with EtherCAT communications.



1-4-2 DC Power Supply Unit Block Diagram

This is the block diagram of the DC Power Supply Unit.



1-5 Applicable Standards

This section describes applicable EMC Directives.

1-5-1 EC Directives

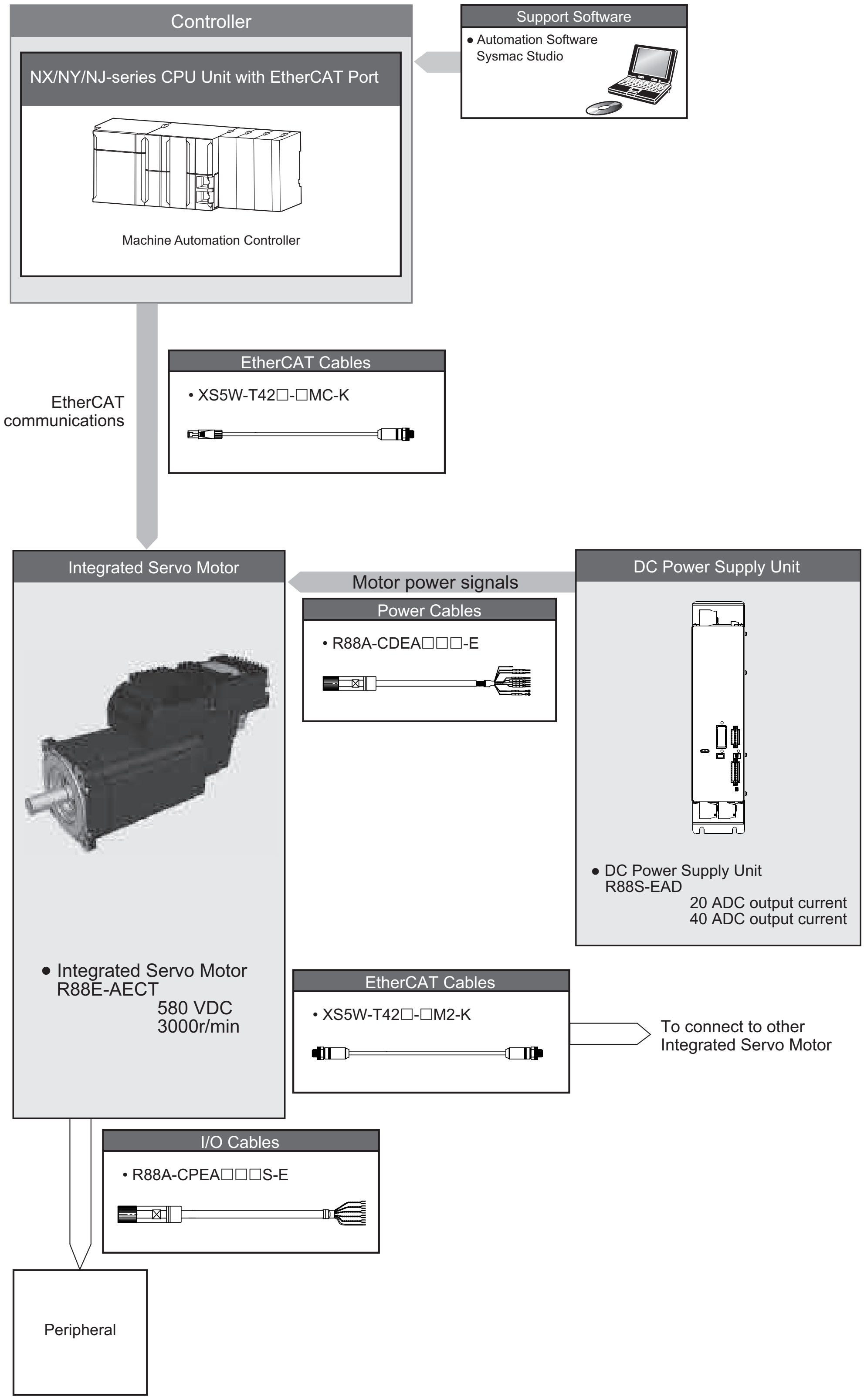
Product	EC Directive	Applicable standard
Integrated Servo Motor	Low voltage directive	EN 61800-5-1
	EMC directive	EN 55011
		EN 61800-3
		EN 61000-6-2
	Machine directive	EN 61204-1
DC Power Supply Unit	Low voltage directive	EN 61800-5-1
	EMC directive	EN 55011
		EN 61800-3
		EN 61000-6-2

2

Models and External Dimensions

This section explains the models of Integrated Servo Motor and peripheral devices, and provides the external dimensions and mounting dimensions.

2-1 Integrated Servo Motor Configuration

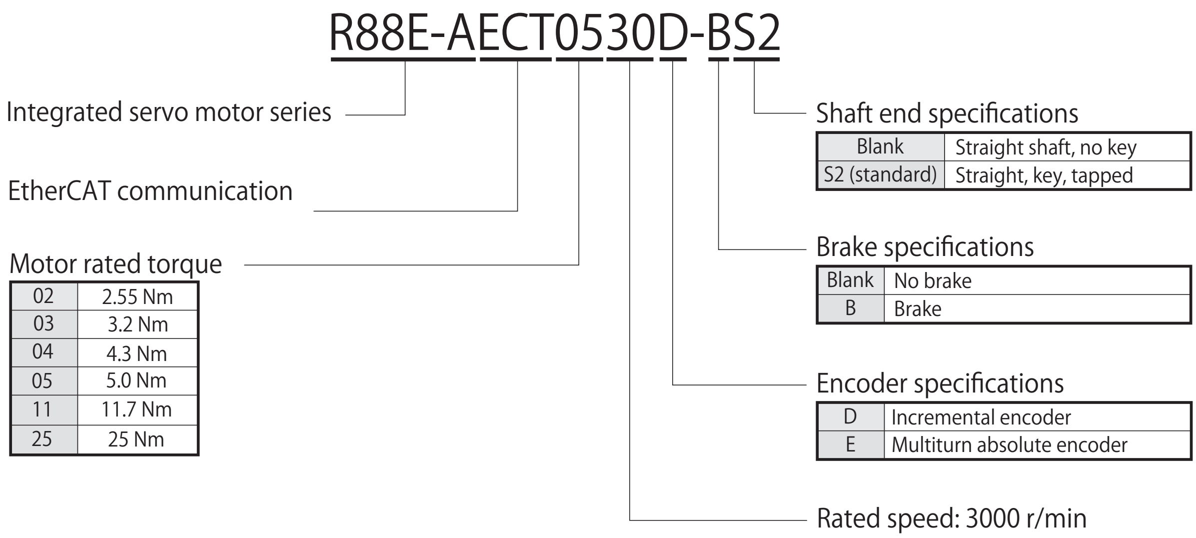


2-2 How to Read Model Numbers

This section describes how to read and understand the model numbers of Integrated Servo Motor and DC Power Supply Unit.

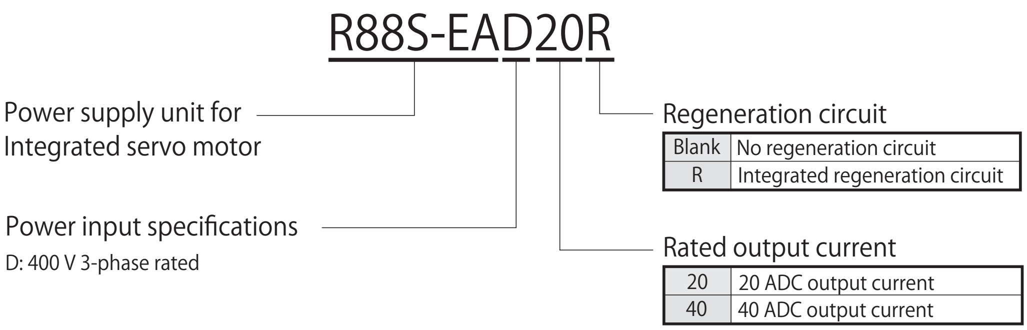
2-2-1 Integrated Servo Motor

The Integrated Servo Motor model number provides information such as the motor torque, encoder specifications, options, etc.



2-2-2 DC Power Supply Unit

The DC Power Supply Unit model number provides information such as the power input, output current, etc.



2-3 Model Tables

This section lists the models of Integrated Servo Motor, DC Power Supply Unit and peripheral equipment.

2-3-1 Integrated Servo Motor Model Table

The table below lists the Integrated Servo Motor models.

3,000-r/min Integrated Servo Motors, 560 VDC

Specifications		Model			
		Incremental encoder		Multiturn absolute encoder	
		Straight shaft, no key	Straight, key, tapped (standard)	Straight shaft, no key	Straight, key, tapped (standard)
Without brake	880 W, 2.55 Nm	R88E-AECT0230D	R88E-AECT0230D-S2	R88E-AECT0230E	R88E-AECT0230E-S2
	1000 W, 3.2 Nm	R88E-AECT0330D	R88E-AECT0330D-S2	R88E-AECT0330E	R88E-AECT0330E-S2
	1350 W, 4.3 Nm	R88E-AECT0430D	R88E-AECT0430D-S2	R88E-AECT0430E	R88E-AECT0430E-S2
	1750 W, 5.0 Nm	R88E-AECT0530D	R88E-AECT0530D-S2	R88E-AECT0530E	R88E-AECT0530E-S2
	3670 W, 11.7 Nm	R88E-AECT1130D	R88E-AECT1130D-S2	R88E-AECT1130E	R88E-AECT1130E-S2
	7850 W, 25 Nm	R88E-AECT2530D	R88E-AECT2530D-S2	R88E-AECT2530E	R88E-AECT2530E-S2
With brake	880 W, 2.55 Nm	R88E-AECT0230D-B	R88E-AECT0230D-BS2	R88E-AECT0230E-B	R88E-AECT0230E-BS2
	1000 W, 3.2 Nm	R88E-AECT0330D-B	R88E-AECT0330D-BS2	R88E-AECT0330E-B	R88E-AECT0330E-BS2
	1350 W, 4.3 Nm	R88E-AECT0430D-B	R88E-AECT0430D-BS2	R88E-AECT0430E-B	R88E-AECT0430E-BS2
	1750 W, 5.0 Nm	R88E-AECT0530D-B	R88E-AECT0530D-BS2	R88E-AECT0530E-B	R88E-AECT0530E-BS2
	3670 W, 11.7 Nm	R88E-AECT1130D-B	R88E-AECT1130D-BS2	R88E-AECT1130E-B	R88E-AECT1130E-BS2
	7850 W, 25 Nm	R88E-AECT2530D-B	R88E-AECT2530D-BS2	R88E-AECT2530E-B	R88E-AECT2530E-BS2

2-3-2 DC Power Supply Unit Model Table

Specifications				Model
Voltage input	Output current	Output power	Regeneration circuit	
400 V, 3-phase	20 A	11.3 kW	Integrated	R88S-EAD20R
	40 A	22.5 kW		R88S-EAD40R

2-3-3 Cable and Peripheral Device Model Table

The following tables list the models of cables and peripheral devices. The cables include EtherCAT communication cables, motor power cables, I/O cables and serial cables. The peripheral devices include connectors.

EtherCAT Communications Cable

Specifications			Model
EtherCAT RJ45 to M12 communication cable	M12 straight connector	0.3 m	XS5W-T421-AMC-K
		0.5 m	XS5W-T421-BMC-K
		1 m	XS5W-T421-CMC-K
		2 m	XS5W-T421-DMC-K
		3 m	XS5W-T421-EMC-K
		5 m	XS5W-T421-GMC-K
		10 m	XS5W-T421-JMC-K
		15 m	XS5W-T421-KMC-K
	M12 L right angle connector	0.3 m	XS5W-T422-AMC-K
		0.5 m	XS5W-T422-BMC-K
		1 m	XS5W-T422-CMC-K
		2 m	XS5W-T422-DMC-K
		3 m	XS5W-T422-EMC-K
		5 m	XS5W-T422-GMC-K
		10 m	XS5W-T422-JMC-K
		15 m	XS5W-T422-KMC-K
EtherCAT M12 to M12 communication cable	M12 straight connector	0.5 m	XS5W-T421-BM2-K
		1 m	XS5W-T421-CM2-K
		2 m	XS5W-T421-DM2-K
		3 m	XS5W-T421-EM2-K
		5 m	XS5W-T421-GM2-K
		10 m	XS5W-T421-JM2-K
		15 m	XS5W-T421-KM2-K
	M12 L right angle connector	0.5 m	XS5W-T422-BM2-K
		1 m	XS5W-T422-CM2-K
		2 m	XS5W-T422-DM2-K
		3 m	XS5W-T422-EM2-K
		5 m	XS5W-T422-GM2-K
		10 m	XS5W-T422-JM2-K
		15 m	XS5W-T422-KM2-K

Motor Power Cables

Specifications		Model
[560 VDC] Motor Power cable with straight connector For all Integrated Servo Motor models	1.5 m	R88A-CDEA001-5-E
	3 m	R88A-CDEA003-E
	5 m	R88A-CDEA005-E
	10 m	R88A-CDEA010-E
	15 m	R88A-CDEA015-E
	20 m	R88A-CDEA020-E

I/O Cables

Specifications		Model
I/O cable with straight connector	1 m	R88A-CPEA001S-E
	2 m	R88A-CPEA002S-E
	5 m	R88A-CPEA005S-E

Serial Port Cables

Specifications		Model
Serial port cable with straight connector for Integrated Servo Motor	2 m	R88A-CCEA002P2-E
Serial port cable with straight connector for DC Power Supply Unit	2 m	R88A-CCSE002P2-E

Connectors

Specifications		Model
Power cable connectors	M23 straight connector	R88A-CNEA01P-E
	M23 right angle 90º connector	R88A-CNEA02P-E
I/O cable connectors	M23 straight connector	R88A-CNEA01C-E
	M23 right angle 90º connector	R88A-CNEA02C-E

Blind Plugs

Specifications		Model
For EtherCAT connectors	IP65 blind plug for M12 socket	R88A-PCVEA01-E
For power and I/O connectors	IP67 blind plug for M23 socket	R88A-PCVEA02-E

2-4 External and Mounting Dimensions

This section describes the external dimensions and the mounting dimensions of Integrated Servo Motor and DC Power Supply Unit.

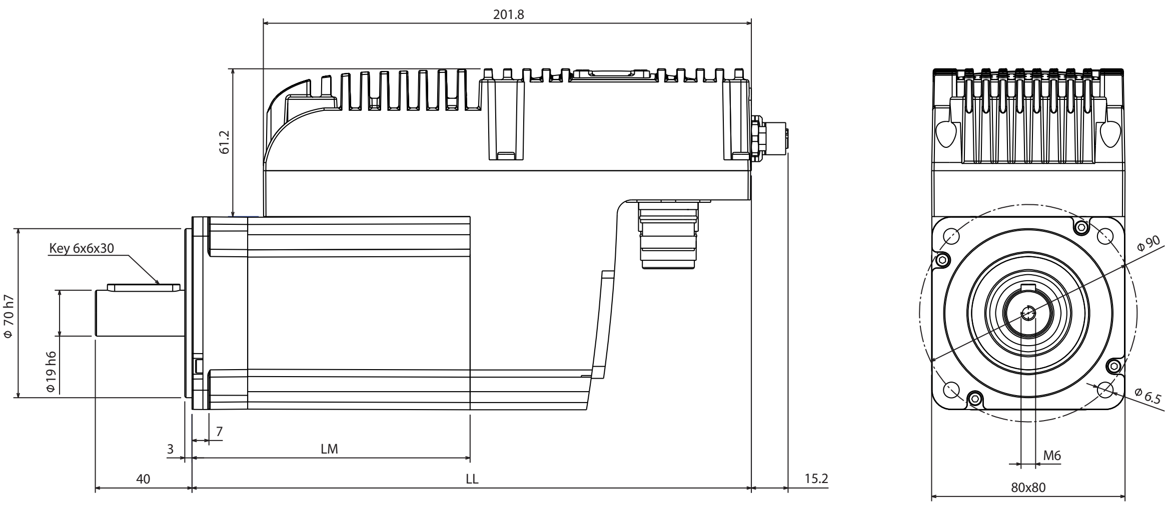
2-4-1 Integrated Servo Motor Dimensions

The dimensional description starts with an Integrated Servo Motor of the smallest capacity, which is followed by the next smallest, and so on.

3,000-r/min Integrated Servo Motors (560 VDC)

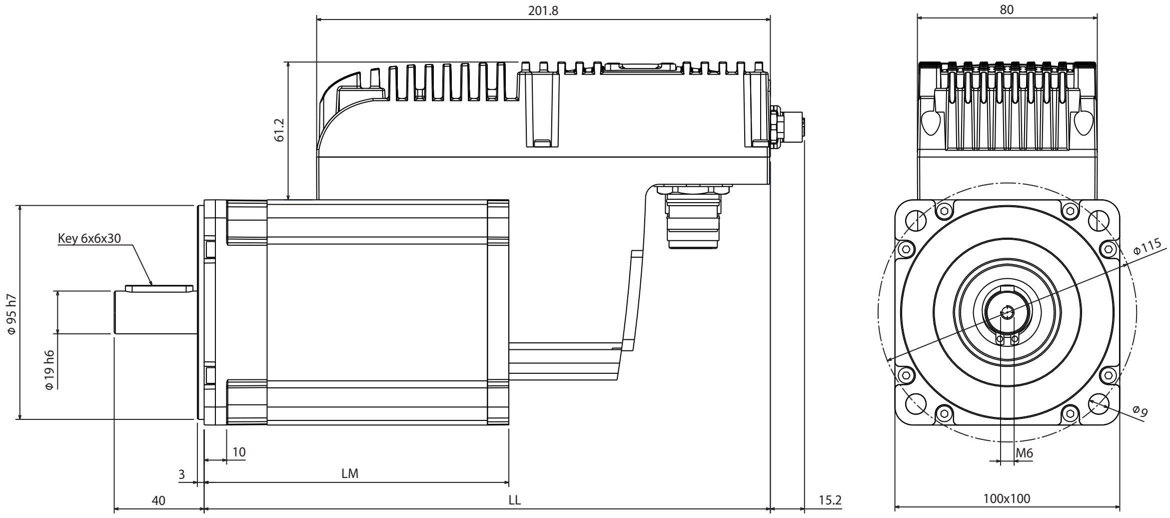
R88E-AECT0230□/0330□ (880 W to 1 kW)

Dimensions (mm)		Without brake		With brake		Flange	Approx. mass (kg)	
Voltage	Model	LM	LL	LM	LL		Without brake	With brake
560 VDC	R88E-AECT0230□	115	231.3	157	273.3	80	4.1	4.5
	R88E-AECT0330□	140	256.3	182	298.3	80	5.1	5.6



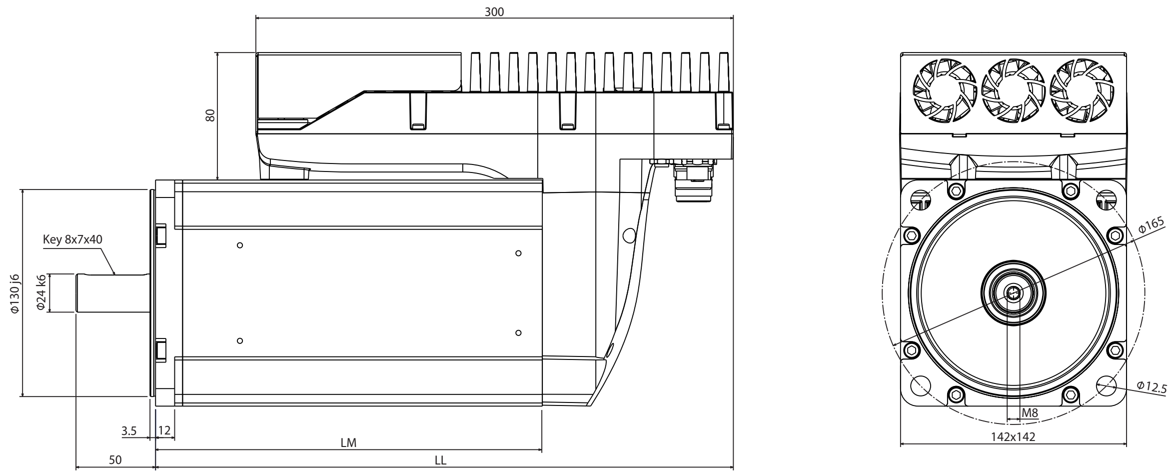
R88E-AECT0430□/0530□ (1.35 kW to 1.75 kW)

Dimensions (mm)		Without brake		With brake		Flange	Approx. mass (kg)	
Voltage	Model	LM	LL	LM	LL		Without brake	With brake
560 VDC	R88E-AECT0430□	135.5	251.8	186	302.3	100	6.7	7.3
	R88E-AECT0530□	165.5	281.8	216	332.3	100	8.4	9.0



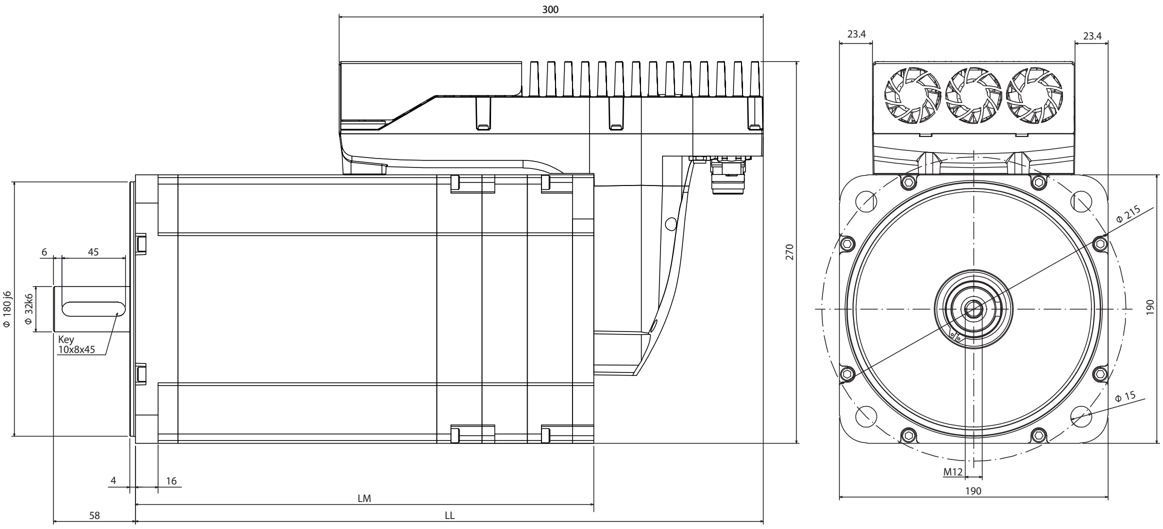
R88E-AECT1130□ (3.67 kW)

Dimensions (mm)		Without brake		With brake		Flange	Approx. mass (kg)	
Voltage	Model	LM	LL	LM	LL		Without brake	With brake
560 VDC	R88E-AECT1130□	238	363	268	388	142	17	18.5



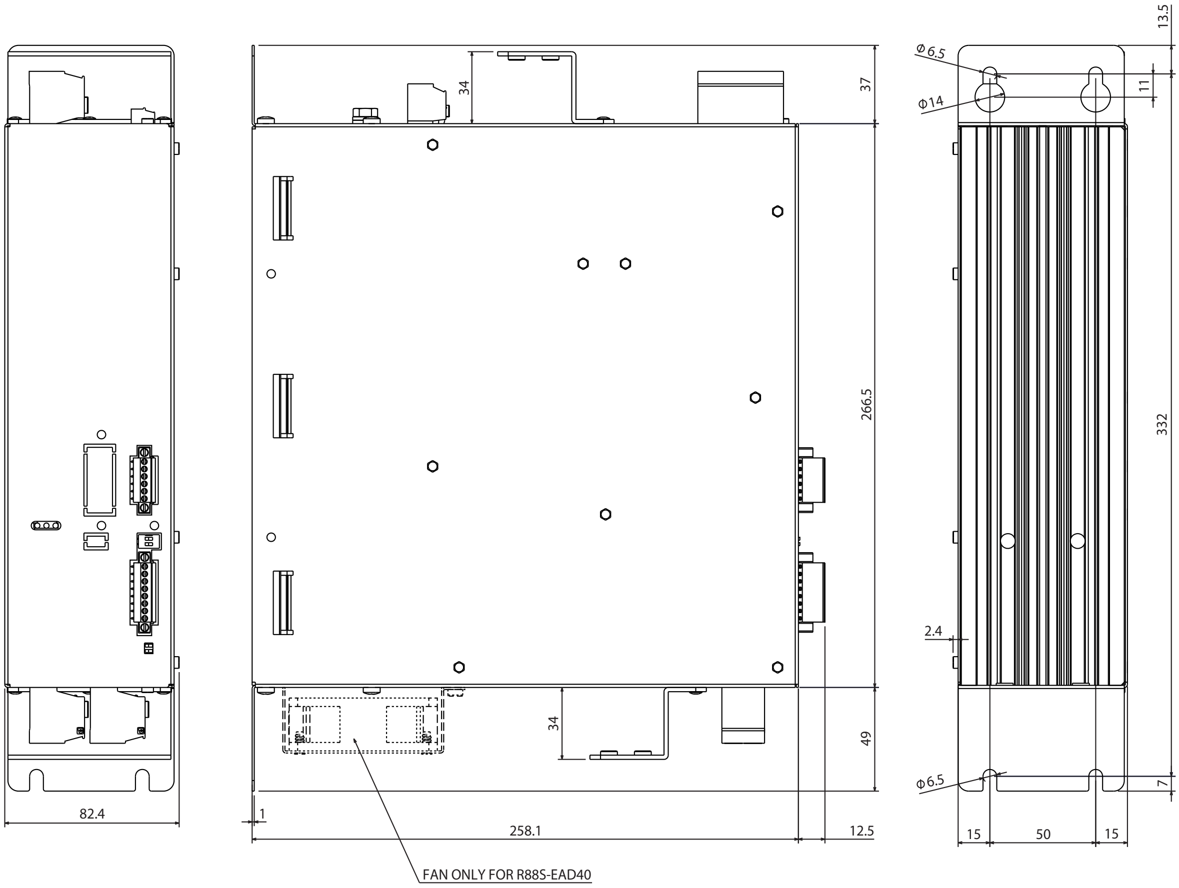
R88E-AECT2530□ (7.85 kW)

Dimensions (mm)		Without brake		With brake		Flange	Approx. mass (kg)	
Voltage	Model	LM	LL	LM	LL		Without brake	With brake
560 VDC	R88E-AECT2530□	303.5	423.5	333.5	453.5	190	25	27



2-4-2 DC Power Supply Unit Dimensions

R88S-EAD20R/40R



3

Specifications

This section provides the general specifications, characteristics, connector specifications, and I/O circuits of the Integrated Servo Motor as well as the general specifications, characteristics, encoder specifications and other peripheral devices.

3-1 Integrated Servo Motor Specifications

There are various options available, such as models with brakes, or shaft options.

Select the Integrated Servo Motor based on the mechanical system's load conditions and the installation environment.

3-1-1 General Specifications

Item		Specifications
Ambient operating temperature and operating humidity		0 to 40ºC, 5 to 95% max. (without condensation)
Storage ambient temperature and humidity		-20 to 70ºC, 5 to 95% max. (without condensation)
Maximum installation altitude (m)		3000 r.s.l.
Ventilation		**R88E-AECT0230/0330/0430/0530 models:** Natural **R88E-AECT1130/2530 models:** Forced with integrated fans
Protection degree		IP65, if the connectors are inserted
Power section	Supply voltage	Nominal 560 VDC, Minimum 275 VDC, Maximum 740 VDC
	Over voltage error fault/warning level	840 VDC / 800 VDC
	Under voltage error fault/warning level	150 VDC / 200 VDC
Logical section	Rated voltage without brake	24 VDC, (-15% / +15%)
	Rated voltage with brake	24 VDC, (-10% / +6%)
	Logic voltage error	20.9 VDC
	Threshold drive disabling	18.3 VDC
	Absorbed current @24VDC	**Drive:** Nominal 250 mA, Maximum 500 mA **Brake:** 500 mA with 4.5 Nm brake, 750 mA with 9 Nm brake, 1 A with 15 Nm brake, 1.1 A with 32 Nm brake
	Internal fuse	4 A-T not replaceable

3-1-2 Characteristics

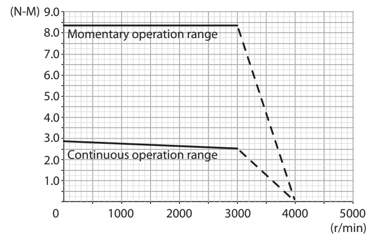
3,000-r/min Integrated Servo Motors

Voltage			**560 VDC**					
Integrated Servo Motor model R88E-AECT□		**Incremental encoder**	**0230D-□**	**0330D-□**	**0430D-□**	**0530D-□**	**1130D-□**	**2530D-□**
		Multiturn absolute encoder	**0230E-□**	**0330E-□**	**0430E-□**	**0530E-□**	**1130E-□**	**2530E-□**
Rated output		W	880	1000	1350	1750	3670	7850
Rated torque		N·m	2.55	3.2	4.3	5	11.7	25
Instantaneous peak torque		N·m	8.4	12	22	22	45	70
Rated current at rated speed		A (DC)	1.8	2.15	2.85	3.3	7.7	16.5
Instantaneous max. current		A (DC)	5.55	7.9	14.5	14.5	30	46
Rated speed		min^{-1}	3000					
Rotor moment of inertia (JM)		$kg·m^2×10^{-4}$ (without brake)	1.16	1.58	2.8	4	11.5	74
		$kg·m^2×10^{-4}$ (with brake)	1.38	1.80	3.6	5.06	13.2	106
Max. radial load		N	350	350	626	626	700	1000
Max. axial load		N	110	110	225	225	70	100
Approx. mass		kg (without brake)	4.1	5.1	6.7	8	17	38
		kg (with brake)	4.8	5.8	7.9	9.2	18.5	43
Minimum radiator plate dimensions			300 x 300 x 6 mm					
Brake	Holding brake moment of inertia J	$kg·m^2×10^{-4}$	0.22	0.22	0.8	1.06	1.7	32
	Current consumption	A	0.50	0.50	0.75	0.75	1.0	0.85
	Static friction torque	N·m	4.5	4.5	9	9	15	47
Logic	Rated voltage	Without brake	24 VDC (-15%, +15%)					
		With brake	24 VDC (-10%, +6%)					
	Internal protection		Fuse: 4 A-T not replaceable					
	Current consumption		Nominal 250 mA, max. 500 mA					
Basic	IP rating		IP65					
	Number of poles		8 poles					10 poles
	Insulation class		Type F					
	Ambient operating/storage temperature		0 to 40°C/–20 to 70°C					
	Ambient operating/storage humidity		5% to 95% (without condensation)					
	Ventilation		Natural				Forced with integrated fans	
	Shock resistance		According to IEC 60068-2-27 (3 shock per axis, 11 ms, 14G)					
	Vibration resistance		According to IEC 60068-2-6 (5 to 500 Hz, 1 and 2 G in 3 axes)					
Encoder	Incremental		15-bit turn					
	Absolute multiturn		20-bit resolution (18-bit real accuracy + 2-bit interpolated) 12-bit resolution					

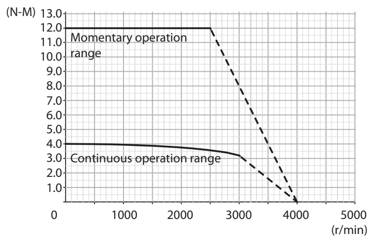
• Torque-Rotation Speed Characteristics for a 3,000-r/min Integrated Servo Motors at 560 VDC

The following graphs show the characteristics of the Integrated Servo Motors:

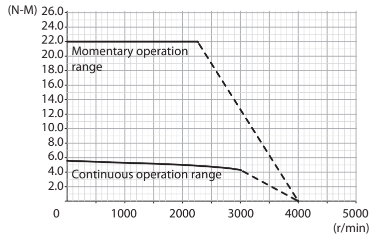
R88E-AECT0230D/E (880 W)



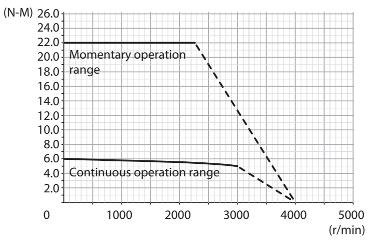
R88E-AECT0330D/E (1 kW)



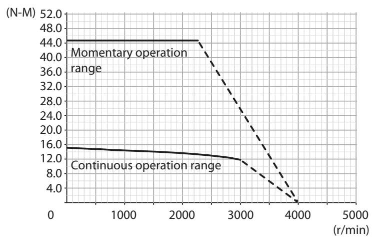
R88E-AECT0430D/E (1.35 kW)



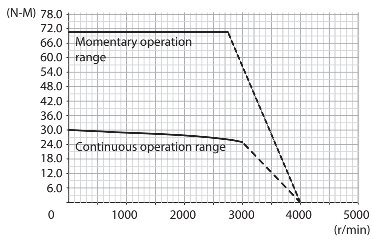
R88E-AECT0530D/E (1.75 kW)



R88E-AECT1130D/E (3.67 kW)



R88E-AECT2530D/E (7.85 kW)



3-1-3 Supply Voltages

The drives of the Integrated Servo Motors have two separated sections, logics and power, that must be separately supplied with direct voltage (galvanic isolation). See the data in the following chart and check if the voltage values are respected.

Section	Connector	Parameter	Value
Power charge	CN5	Rated voltage	560 VDC
		MaxSupplyVoltage [6510.03]	740 VDC
		Over voltage power section error fault level	840 VDC
		Over voltage power section error warning level	800 VDC
		Under voltage power section error warning level	200 VDC
		Under voltage power section error fault level	150 VDC
Logic charge	CN5	Rated voltage without brake	24 VDC (-15% / +15%)
		Rated voltage with brake	24 VDC (-10% / +6%)
		Error threshold for the brake (Logic voltage error)	20.9 VDC
		Threshold drive disabling	18.3 VDC

While choosing the voltage of the DC bus (power section supply) you need to consider:
- Any possible voltage changes in order to avoid any fault notifications or unwanted warnings
- The drive cannot dissipate the energy of regeneration (see **Section 4-7 Regenerative Energy Absorption**)
- The drop in the motor performances, decreasing the supply voltage

Note Supplying the power section with the rated voltage value.

When the supply voltage of the logical section goes below the lowest threshold, the drive is disabled. In the previous chart you can find the value of this threshold.

There is a threshold, on brake-equipped motors, causing the drive fault when the supply voltage of the logical section is not sufficient for guaranteeing the safe delay of the brake. In the previous chart you can find the value of this threshold.

Note Under voltage power section error it can be of self-restoring type. Furthermore you can choose if enabling or not the fault in case of Logic voltage error. Fur further details please see **Section 13-2 Fault and Warning (Integrated Servo Motor)**.

3-1-4 Encoder Specifications

Incremental Encoder Specifications

Item	Specifications
Encoder resolution	15 bits
Index	Phase Z: 1 pulse/rotation

Multiturn Absolute Encoder Specifications

Item	Specifications
Encoder resolution	20-bit (18-bit real accuracy + 2-bit interpolated) 12-bit multiturn
Index	Phase Z: 1 pulse/rotation

3-1-5 EtherCAT Communication Specifications

Item	Specifications
Communications standard	IEC 61158 Type 12, IEC 61800-7 CiA 402 Drive Profile
Physical layer	100BASE-TX (IEEE802.3)
Connectors	M12 female connector x 2 CN3: EtherCAT input CN2: EtherCAT output
Communications media	Ethernet Category 5 (100BASE-TX) or higher is recommended
Communications distance	Distance between nodes: 30 m max.
Process data	Configurable PDO mapping
Mailbox (CoE)	Emergency messages, SDO requests, SDO responses and SDO information
Distributed clock (DC)	Synchronization in: • Free Run • Soft Sync • Hard Sync: DC 0 mode DC cycles: 500 μs to 8 ms in increments of 100 μs*1
Indicators	L/A IN (Link/Activity IN) x 1 L/A OUT (Link/Activity OUT) x 1 RUN x 1 ERR x 1
CiA402 drive profile	• Profile Position Mode • Interpolated Position Mode • Cyclic Synchronous Position Mode • Profile Velocity Mode • Profile Velocity AI Mode • Cyclic Synchronous Velocity Mode • Torque Mode • Torque AI Mode • Cyclic Synchronous Torque Mode • Homing Mode • Standard Touch Probe • Vendor Specific Touch Probe

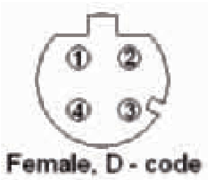
*1. Integrated Servo Motor does not impose restrictions to EtherCAT cycle times set by the EtherCAT masters. Nevertheless, the next rules must be observed:

- Short cycle times with big PDO data may result in EtherCAT synchronization errors.
- Cycles that are multiple of 100 μs are recommended because the internal drive loops are synchronized with EtherCAT communication cycles.
- Long cycles are not recommended when using Cyclic Synchronous Modes.

3-1-6 EtherCAT Connections

Main bus - ECT (CN2-OUT/CN3-IN)

Connectors for the main bus with protocol EtherCAT, M12 female, 4 poles, D-code, CN2 output, CN3 input.



PIN	Signal	Description
1	TX Data+	Transmit data (+)
2	RX Data+	Receive data (+)
3	TX Data-	Transmit data (-)
4	RX Data-	Receive data (-)
Chassis	PE	Protection earth

3-1-7 Power and Logic Supply Connections

DC Power Supply and Logic Supply (CN5)

Connector for the supply of the power section and of the logical section, plus two digital inputs /STOP and IN9, M23 male, 8 poles (4+3+PE), Hummel.

PIN	Signal	Description
1	HV-	DC power supply (negative pole)
3	-	Not used. Do not connect
4	HV+	DC power supply (positive pole)
⏚	PE	Protection earth
A	/STOP	Safety loop (the signal is at reversed logic)
B	0V	Ground logic supply
C	IN9	Digital input 9
D	+24 V	+24 VDC logic supply
Chassis	PE	Protection earth

3-1-8 I/O Connections

Input/Output signals (CN4)

Connector for the digital and analog inputs and outputs, M23 male, 19 poles (16+3), Hummel.

Note The PNP digital inputs (24 V) have the common ground internally connected to the system on the GND signal, that is the 24 V supply ground present on CN5 pin B. For this reason it's sufficient to connect on the inputs a signal which level is referred to this ground.

PIN	Signal	Description
1	IN/OUT1-	Differential line driver digital input/output 1 (-)
2	IN/OUT2-	Differential line driver digital input/output 2 (-)
3	AN_IN-	Analog input (-)
4	AN_IN+	Analog input (+)
5	IN/OUT2+	Differential line driver digital input/output 2 (+)
6	GND_5V	Ground of +5V
7	+5V	+5V supply output (max 150 mA) for auxiliary encoder
8	IN8	Digital input 8 PNP 24V
9	OUT5	Digital output 5 PNP 24V
10	IN/OUT3	Digital input/output 3 PNP 24V
11	IN7	Digital input 7 PNP 24V
12	IN/OUT0-	Differential line driver digital input/output 0 (-)
13	IN/OUT0+	Differential line driver digital input/output 0 (+)
14	IN/OUT1+	Differential line driver digital input/output 1 (+)
15	IN4	Digital input 4 PNP 24V
16	OUT4	Digital output 4 PNP 24V
17	OUT6	Digital output 6 PNP 24V
18	IN6	Digital input 6 PNP 24V
19	IN5	Digital input 5 PNP 24V (the function simulated GND is available)
Chassis	PE	Protection earth

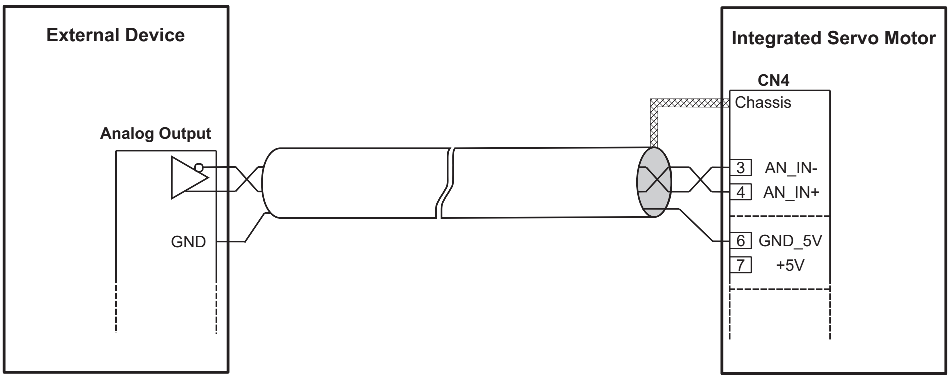
Note In/Out0, In/Out1, In/Out2 are differential inputs they don't have to be connected to 24V signals. It's recommended to respect the maximum differential voltage and to report this voltage to the GND_5V grounding [CN4 pin 6].

3-1-9 I/O Circuits & Wiring

Analog Input

The drive has a differential analog input (CN4 connector: pin 3 and 4) to which different functionalities can be associated.

Note It's recommended to refer the analog device supply ground to the GND_5V signal [pin 6 of CN4], as reported in the next picture:

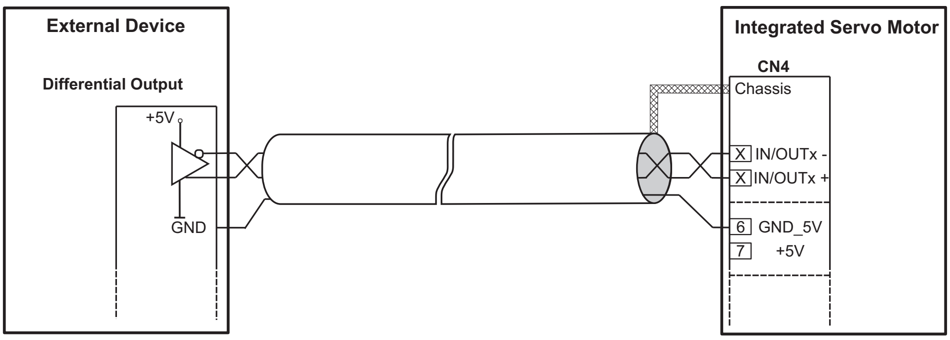


It is suggested the usage of a shielded cable with twisted pairs to make the connection. To ensure the maximum noise immunity it can be used a double shielded cable (shield on each single pair plus whole cable shield). It's suggested to connect the shield to the ground (connector chassis) only in the Integrated Servo Motor side. If possible the cable must not be interrupted. If the interruptions cannot be avoided, ensure that the shield is continuous and that the not shielded parts has the minimum possible length.

Line Drive I/O

Generic differential IN/OUT

The IN/OUT0, IN/OUT1, IN/OUT2 inputs (line-driver differentials), can be even used as normal digital inputs (general purpose functionality). In this case, the voltage levels are not 24V as for the PNP inputs, but they are referred to the line-drive specific levels.

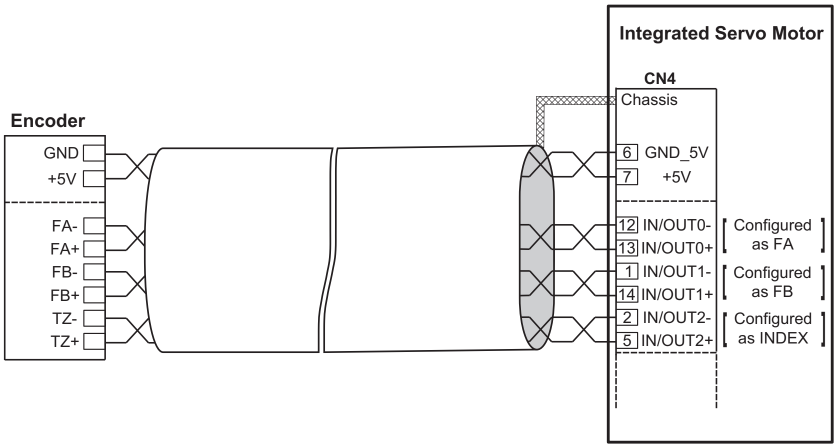


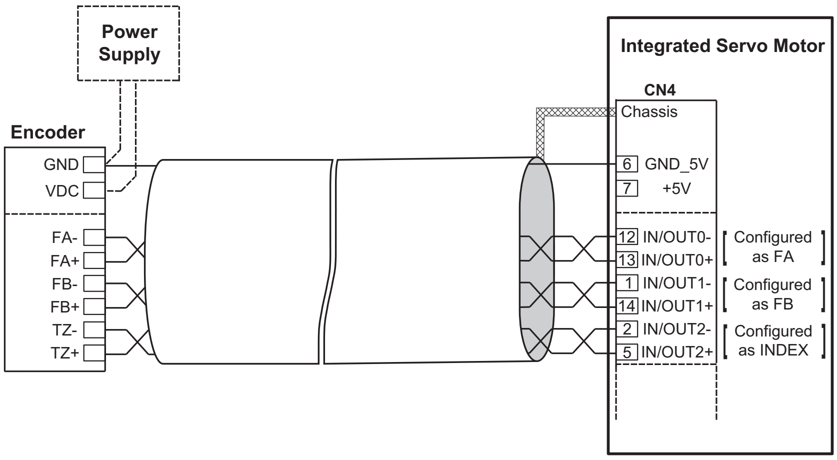
Note The differential IN/OUT, even if used with general purpose functionality, are differential line-drive type. Do not connect signals with 24V levels! Please, refer to the electrical features described in this manual.

Master encoder input (differential IN/OUT)

The IN/OUT0, IN/OUT1, IN/OUT2 inputs (line-driver differentials), as well as with general purpose functionality, can be used as incremental encoder inputs (phase A and phase B). If used as encoder inputs, IN/OUT0 and IN/OUT1 must be respectively connected to the encoder phase A and phase B and IN/OUT2 can be eventually used for the zero mark connection. They can be used incremental encoders whose supply can be provided externally or directly by the drive. For this purpose, on the CN4 connector of the Integrated Servo Motor is available a 5V voltage (max 150 mA). In case the encoder is externally powered, or a simulated encoder is used, in addition to the differential signals (phase A, phase B and the index eventually) the encoder ground must be connected to the GND_5V signal of the Integrated Servo Motor (pin 6 of CN4).

For the external encoder connection on CN4, please refer to the next picture in which are showed both, the wirings when the supply is provided by the Integrated Servo Motor and when the supply is external.

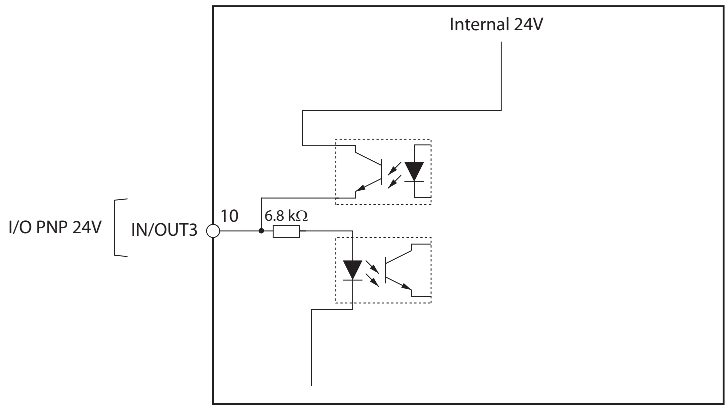




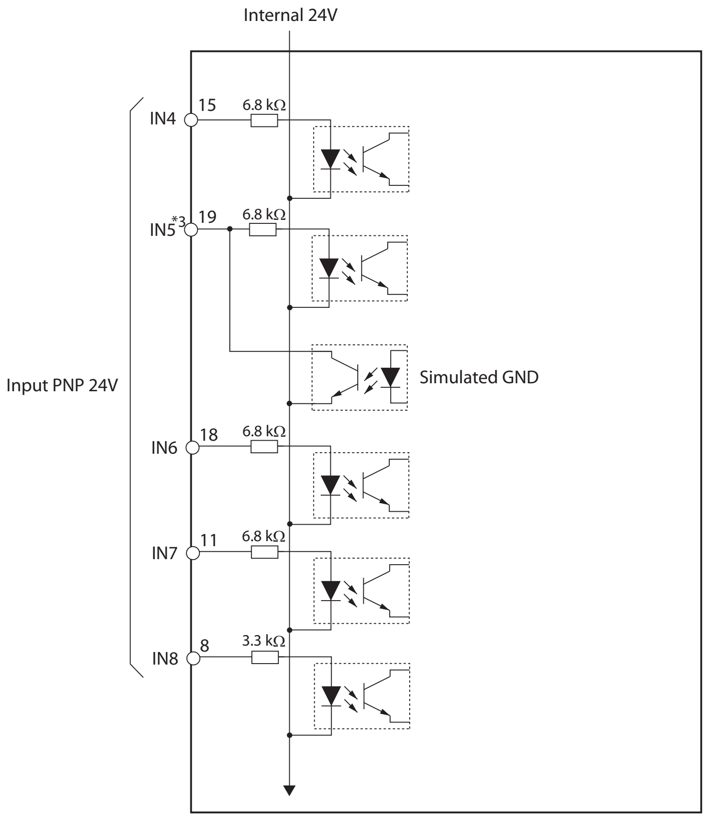
Note The encoder outputs must be differential line-drive type. Do not connect signals with 24V levels! Please, refer to the electrical features described in this manual.

Note It is suggested the usage of a shielded cable with twisted pairs to make the connection. To ensure the maximum noise immunity it can be used a double shielded cable (shield on each single pair plus whole cable shield). It’s suggested to connect the shield to the ground (connector chassis) only in the Integrated Servo Motor side. If possible the cable must not be interrupted. If the interruptions cannot be avoided, ensure that the shield is continuous and that the not shielded parts has the minimum possible length.

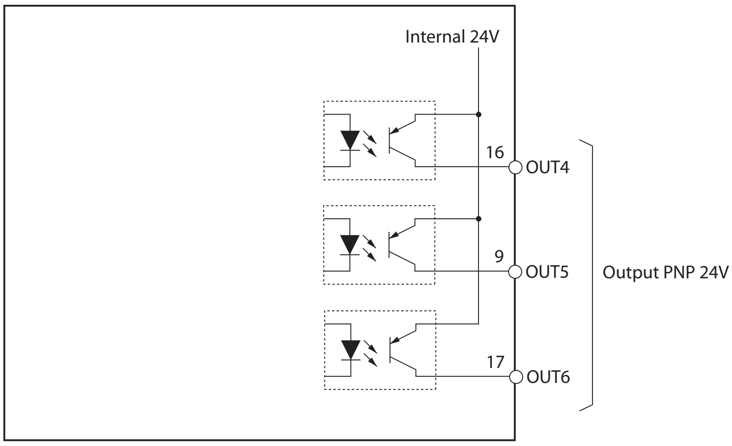
Bidirectional I/O



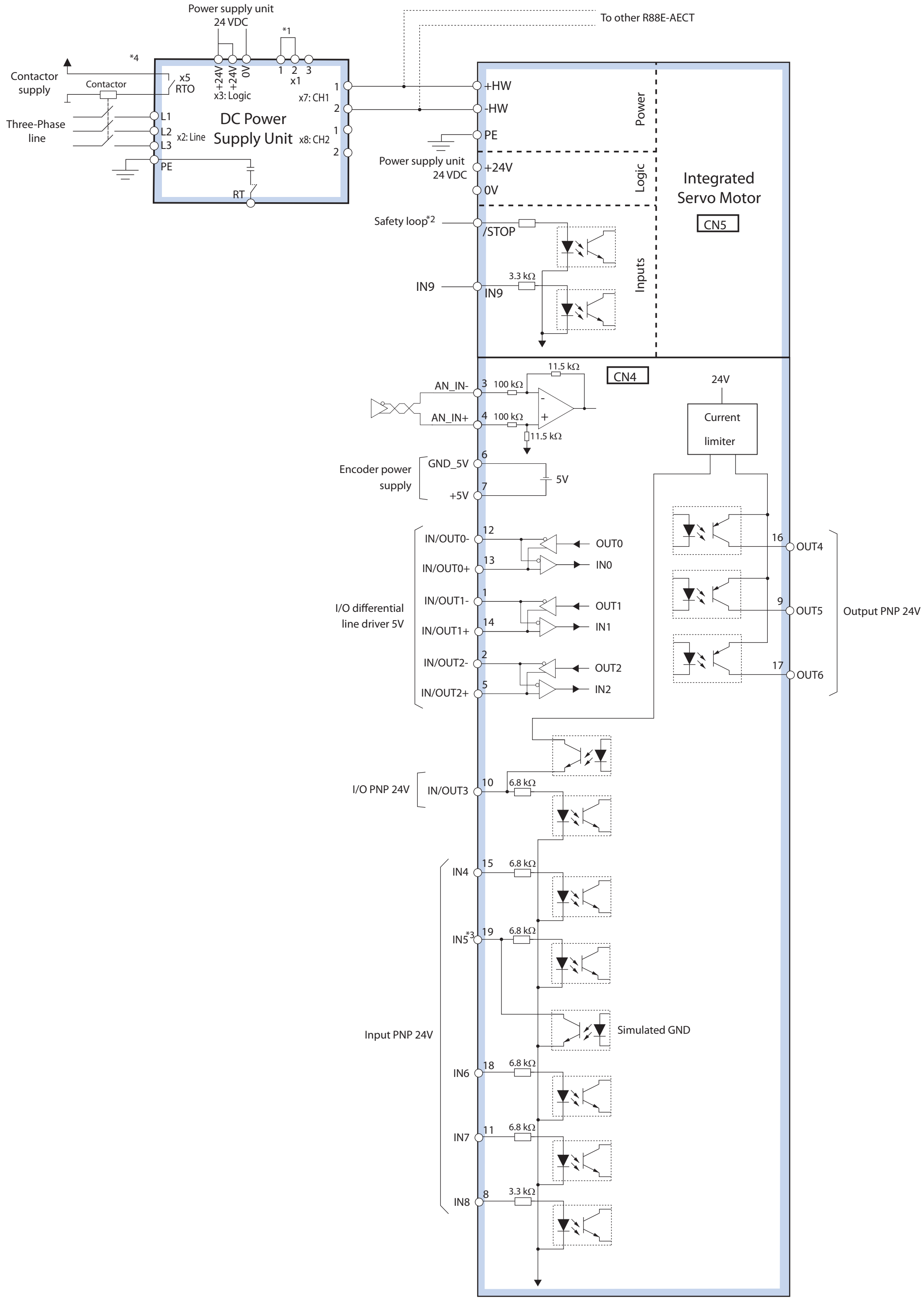
Digital inputs



Digital outputs



Wiring



*1. 1 and 2 are short-circuited. If the internal regenerative resistor is insufficient, remove the wire between 1 and 2 and connect an external regenerative resistor between 2 and 3.

*2. If security device is not used, connect /STOP to +24V.

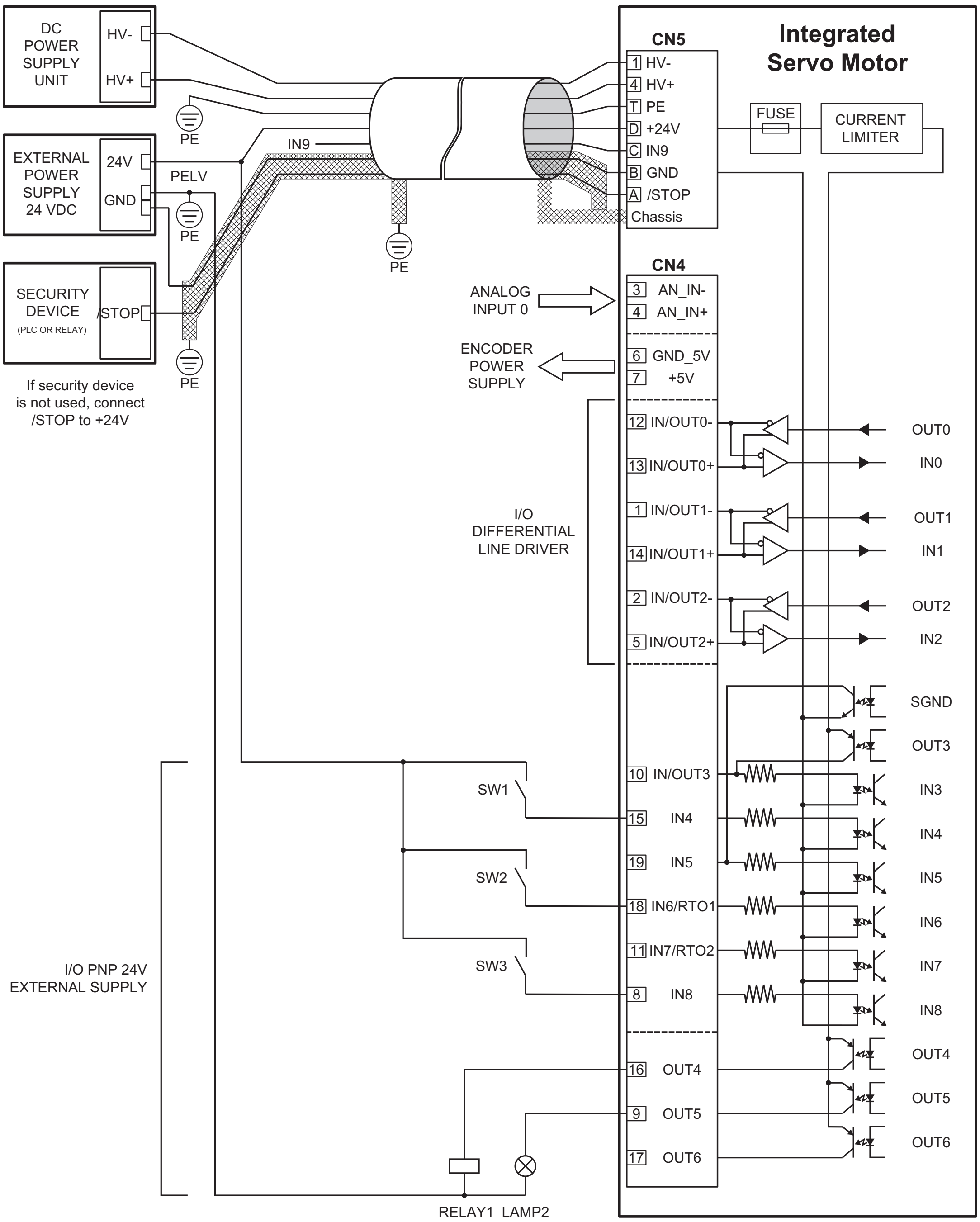
*3. IN5 can be used as GND.

*4. Important to install a contactor that removes the supply in case of power supply unit error.

Example of PNP 24V inputs and outputs wiring

On the Integrated Servo Motor system, PNP inputs may be connected some devices with PNP 24V output. The ground reference of these outputs must be the same on which the Integrated Servo Motor system logic supply is referred (pin B of CN5, GND signal). In fact, as you can see on the following diagram, the inputs have a system internal common ground that's reported on the GND signal. Similarly, the Integrated Servo Motor system outputs are internally powered by the 24V with which the logic section is powered (pin D of CN5). On this voltage there is a current limiter that is a protection in case of overload or short circuit on the outputs themselves. The ground of the loads that are connected to the outputs must be the same one of which the Integrated Servo Motor system logic supply is referred (pin B of CN5, GND signal).

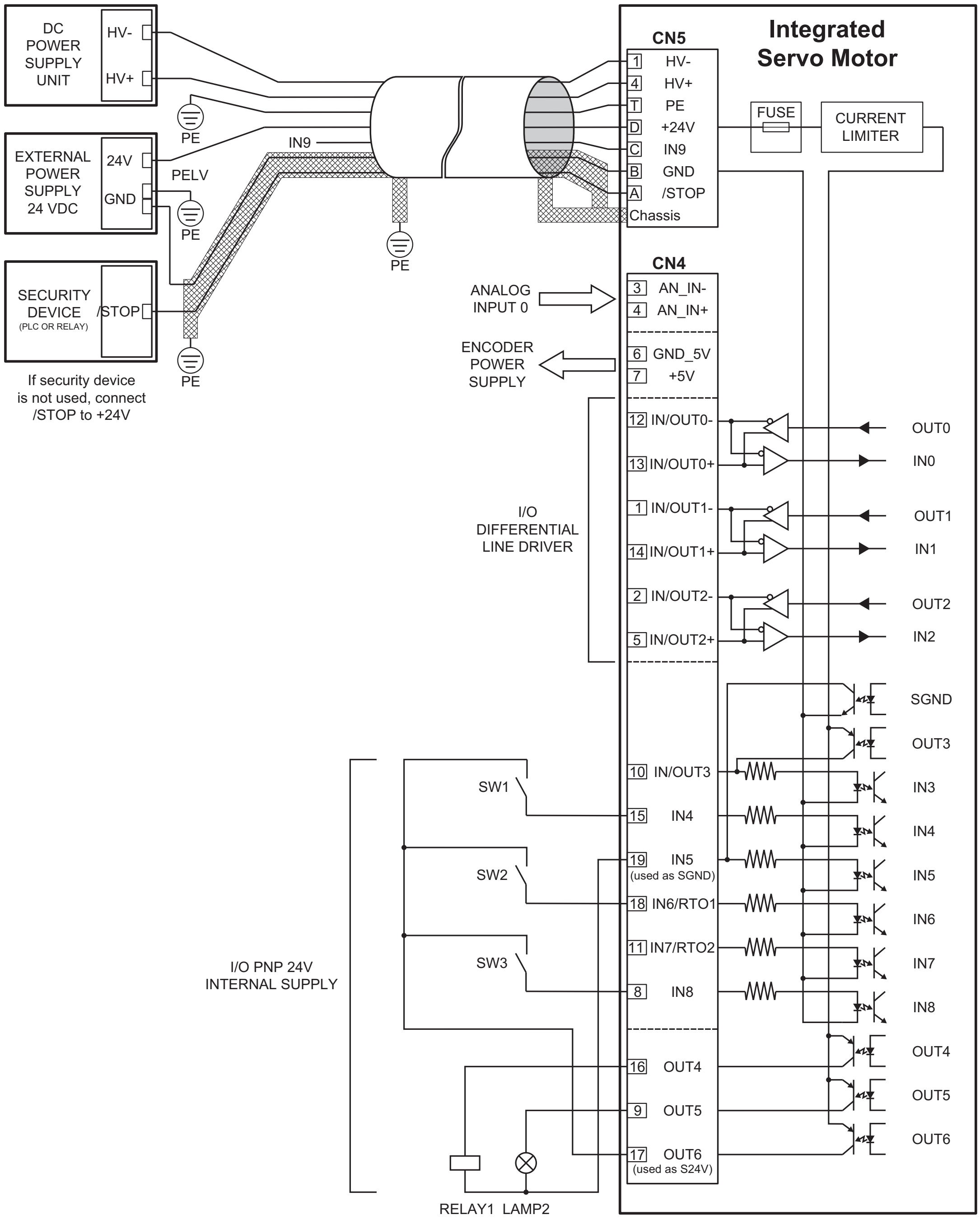
In the following figure an outputs and inputs connection example is reported in which the 24V voltage for the inputs supply and the outputs ground reference are made through some connections that are external to the Integrated Servo Motor.



It’s possible to make these connections directly on the Integrated Servo Motor system (as reported on the next picture). Through the software settings it’s possible to configure the IN5 input (pin 19 of CN4) as “SIMULATED GROUND”. In this case the IN5 can’t be no more used as input because it is, internally to the system, connected to the GND (the same ground of pin B of CN5). This pin can be used to connect the output ground references. In the same way an one (or more) outputs it’s possible to configure through software the “SIMULATED 24V” functionality. In this case the configured as described output can’t be no more used as output because it is, internally to the system, connected to 24V (the same 24V of pin D of CN5). The pin that’s related to this output can be used to provide the supply 24V.

On the S24V configured pins a protection for the overcurrent or short circuits is present. The pin 19 of CN4 (IN5) configured as SGND is not protected from the overcurrent. Is therefore recommended to respect the maximum declared current absorption. If a greater absorption is needed it’s necessary to connect the ground externally from the Integrated Servo Motor.

Note Absolutely avoid to place the I/O signals cable in parallel to the power cables by suitably selecting separated paths. It’s recommended to use a shielded cable for the connection and to connect the shield to the metallic part of the M23 circular connector. On the controller/PLC side follow the constructor instructions about the shield connection.


DC POWER SUPPLY UNIT
HV-
HV+
PE
EXTERNAL POWER SUPPLY 24 VDC
24V
GND
PELV
PE
SECURITY DEVICE
(PLC OR RELAY)
/STOP
PE
If security device is not used, connect /STOP to +24V
IN9
PE
Integrated Servo Motor
CN5
1 HV-
4 HV+
T PE
D +24V
C IN9
B GND
A /STOP
Chassis
FUSE
CURRENT LIMITER
CN4
ANALOG INPUT 0
3 AN_IN-
4 AN_IN+
ENCODER POWER SUPPLY
6 GND_5V
7 +5V
I/O DIFFERENTIAL LINE DRIVER
12 IN/OUT0-
13 IN/OUT0+
1 IN/OUT1-
14 IN/OUT1+
2 IN/OUT2-
5 IN/OUT2+
OUT0
IN0
OUT1
IN1
OUT2
IN2
SGND
OUT3
I/O PNP 24V INTERNAL SUPPLY
SW1
SW2
SW3
10 IN/OUT3
15 IN4
19 IN5
(used as SGND)
18 IN6/RTO1
11 IN7/RTO2
8 IN8
IN3
IN4
IN5
IN6
IN7
IN8
16 OUT4
9 OUT5
17 OUT6
(used as S24V)
OUT4
OUT5
OUT6
RELAY1 LAMP2

3-2 Overload (Electronic Thermal Function) and Derating Curves

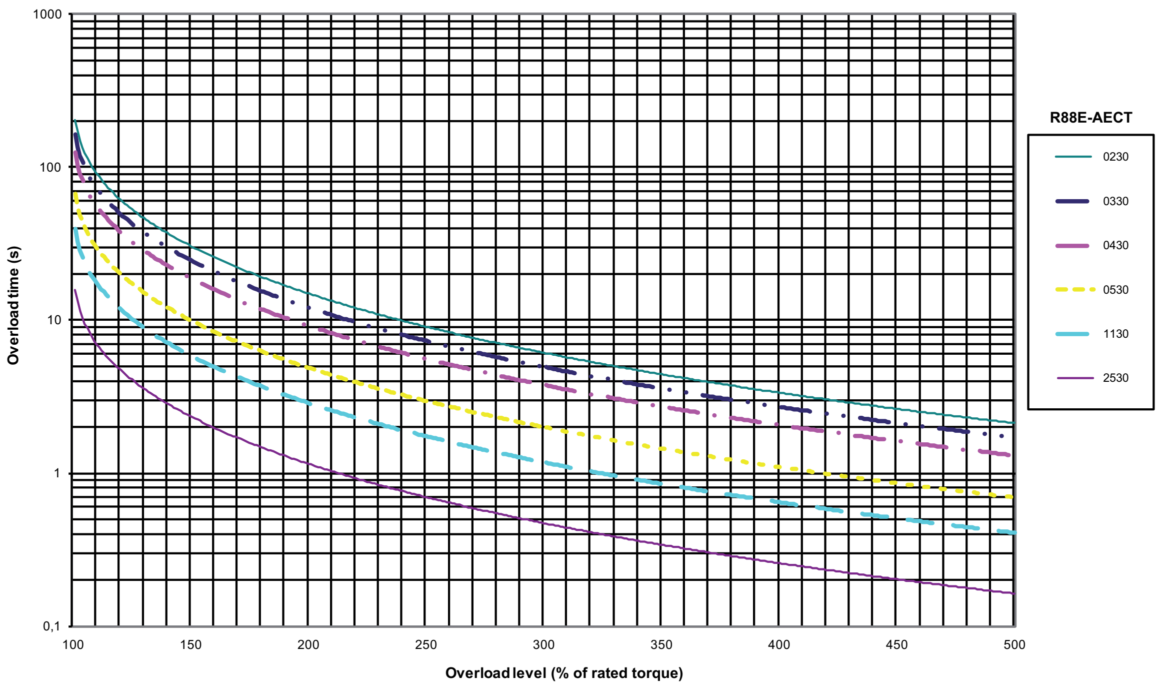
An overload protection function (electronic thermal) is built into the Integrated Servo Motor to protect the drive and motor from overloading.

If an overload does occur, first eliminate the cause of the error and then wait at least 1 minute for the motor temperature to drop before turning ON the power again.

If the error reset is repeated at short intervals, the motor windings may burn out.

Overload Curve

The following graphs show the characteristics of the load ratio and electronic thermal function's operation time.



When the torque command = 0 and a constant torque of a certain value is applied, the Integrated Servo Motor will give overload alarm in a time specified by:

t [s] = –Overload time constant [s] × log$_e$ (1 – Overload level [%] / Torque command [%])^2

The above graph shows the curve for default settings for the different motors.

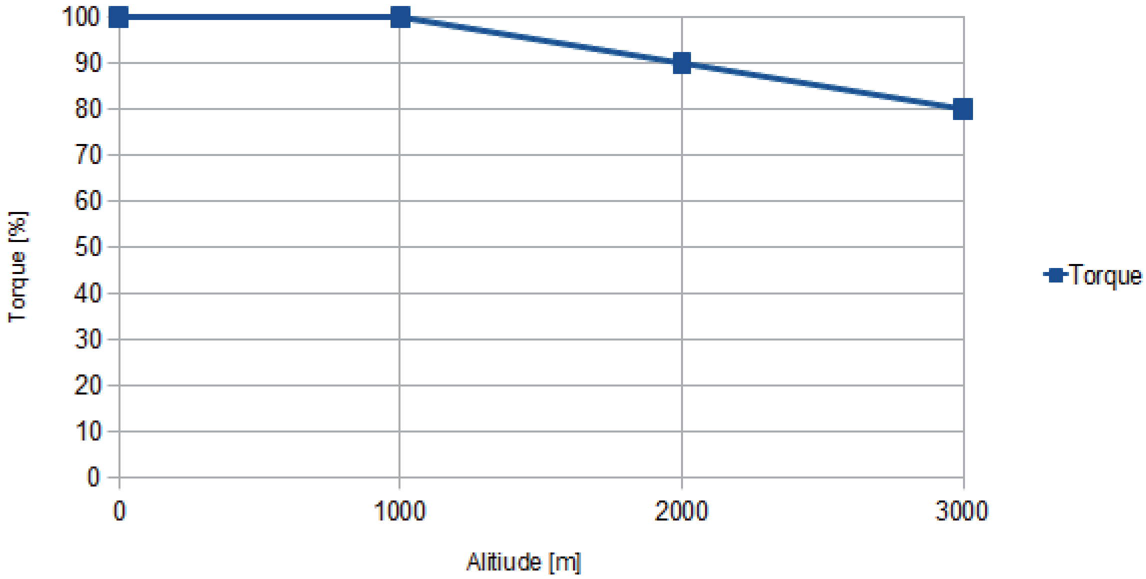
Is it possible to modify the overload curve by, indirectly, change the thermal time constant. The values that can be adjusted are:

- Maximum current to the motor: the value is adjustable to the maximum limit of the motor or the electronics.
- Maximum continuous time giving maximum current. The maximum is limited by the maximum I2t limit of the electronics.

Read **Section 8-4-2 I2T Limits** for more details.

Derating Curve

The following graph shows the characteristics of the derating curve.



3-3 DC Power Supply Unit Specifications

Select the DC Power Supply Unit to be used.

3-3-1 Characteristics

DC Power Supply unit model R88S-EAD□		20R			40R		
Three-phase rated voltage	VAC	230	400	480	230	400	480
Absolute range voltage		180 to 520 VAC, 50/60 Hz					
Unbalance voltage		<3% of the main voltage					
Main filter		Integrated					
Line fuses: quick acting (by user)		32 A - I2T max = 700 A^2s			50 A - I2T max = 1300 A^2s		
Input current[*1]	Arms	22	25	23	42.5	47	42
Input current with power chokes	Arms	-	17[*2]	-	-	34[*3]	-
Rated output voltage	VDC	324	564	677	324	564	677
Rated output current	A	20	20	16.7	40	40	33
Max. current (≤ 5 sec)	A	40	40	33.4	80	80	66
Rated output power	kW	6.5	11.3	11.3	13	22.5	22.5
Pulse power (≤ 5 sec)	kW	13	22.6	22.6	26	46	46
Internal capacitance	uF	940			1500		
Thermal dissipation (without brake dissipation)	W	100			200		
Logic	Rated voltage	24 VDC, ±10%					
Logic	Internal protection	Fuse: 4 AT, reverse polarity					
Logic	Current consumption	0.6 A (digital output OFF)[*4]					
Logic	Digital output	Type: PNP Output voltage / current: 24 VDC / 0.3 A					
Relay	Rated voltage	30 VAC / VDC					
Relay	Rated current	Max. 1 A					
Braking circuit		Maximum pulse current: 50 A Maximum switch on threshold: 785 VDC Hysteresis threshold: 20 VDC Pulse power rating: 20 kW (0.3 sec) Minimum braking resistor: 17 Ω					
Internal braking resistor		Resistance: 33 Ω Power rating: 120 W continuous					
Power and logic protection		Overload output current: > 2 rated output current (t = 5 sec) Short circuit brake circuit: yes Overload brake energy / Overload charge energy: yes /yes Cable current limit: > 1.3 cable current limit (t = 1 hour) Under voltage / Over voltage HVDC: < 100 VDC / > 830 VDC Over temperature: Power (> 90ºC), Logic (> 85ºC) Under voltage LOGIC: < 18.3 VDC					
Ambient temperature		+5 to +40ºC, 90% RH or less (without condensation)					

*1. Input current without line inductance.

*2. Value with a line inductance of 1 mH.

*3. Value with a line inductance of 0.5 mH.

*4. 1.4 A for 100 ms when AC line is applied to the DC Power Supply Unit.

Logic section

Item	Description
Rated voltage	24 VDC, ±10%
Internal protection	Fuse: 4 AT, reverse polarity
Current consumption	0.6 A (digital output OFF)*1
Digital output	Type: PNP Output voltage: 24 VDC Output current: 0.3 A
Input voltage	Nominal: +24 VDC For low signal (physical 0): -30 to +5 VDC For high signal (physical 1): +15 to +30 VDC
Input current (at 24 VDC)	4.8 mA

*1. 1.4 A for 100 ms when AC line is applied to the DC Power Supply Unit.

Digital outputs specifications	
Type	PNP
Number of outputs	3
Galvanic isolation	Yes, through optoisolators
Protection	Polarity reversal, overcurrent, short-circuit
Voltage supply	24 V
Max. output current (for each output)	300 mA

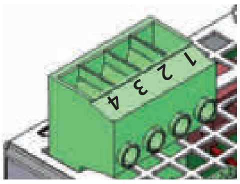
Type	NO (normally open) electronic contact
Max. input voltage (OFF state)	30 VAC / VDC
Max. output current (ON state)	1 A
Short-circuit protection	No

3-3-2 Power Input and DC Output Connector

Power line (x2)

Three-phase power supply connector.

Item	Specifications
Connector type	Removable female
Number of poles	4
Wire size	0.75 to 16 mm^2
Tightening torque	1.8 Nm



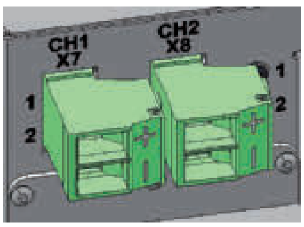
PIN	Name	Description
1	L1	Line 1 of the three-phase source
2	L2	Line 2 of the three-phase source
3	L3	Line 3 of the three-phase source
4	PE	Three-phase protection earth

Note This system has a high leakage current (> 3.5 mA). Refer to connection grounding screw.

Power output (x7 and x8)

Power output HVDC connector.

Item	Specifications
Connector type	Removable female
Number of poles	2
Wire size	0.75 to 16 mm^2
Tightening torque	1.8 Nm



PIN	Name	Description
1	+HVDC	+HVDC power output
2	-HVDC	-HVDC power output

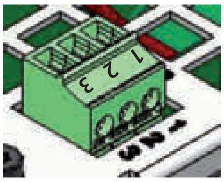
Description	R88S-EAD20R	R88S-EAD40R
Max. output one channel	20 ADC	25 ADC
Max. output both channel	20 ADC	40 ADC

3-3-3 Logic Connector

Logic (x3)

Logic supply connector (24 VDC).

Item	Specifications
Connector type	Removable female
Number of poles	3
Wire size	0.14 to 1.5 mm^2
Tightening torque	0.25 Nm



PIN	Name	Description
1	+24 V	+24 VDC control supply
2	+24 V	+24 VDC control supply
3	GND	Ground control supply

Note Pin 1 and 2 are electrically the same point.

3-3-4 IN/OUT Connector

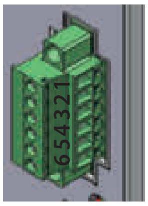
IN/OUT (x5)

Digital inputs/outputs connector.

Item	Specifications
Connector type	Removable female
Number of poles	5
Wire size	0.13 to 1.5 mm^2
Tightening torque	0.2 Nm

Note Make sure that the wiring, cables and interface are connected to PELV (Protective Extra-Low Voltage).

Note The digital input IN0 PNP (24V) have the internally ground connected to the system on the GND signal, which is the mass of the 24V power supply present on x3 Logic connector.



PIN	Name	Description
1	IN0	Reset fault
2	OUT0	HVDC ready
3	OUT1	VAC line state
4	OUT2	Fault
5	RTO contact	RTO contact
6		

In the DC Power Supply Unit are provided the following optoisolated digital inputs and outputs:

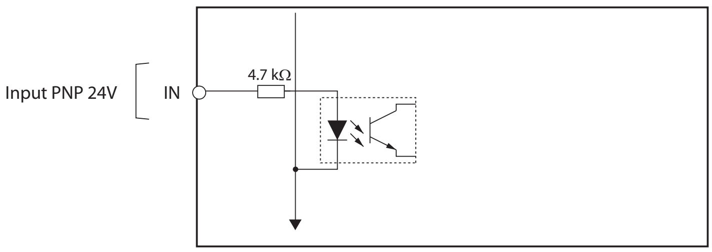
On the x5 IN/OUT connnector are presents:

- 1 PNP digital input (24 VDC)
- 3 PNP digital outputs (24 VDC, max 300 mA)

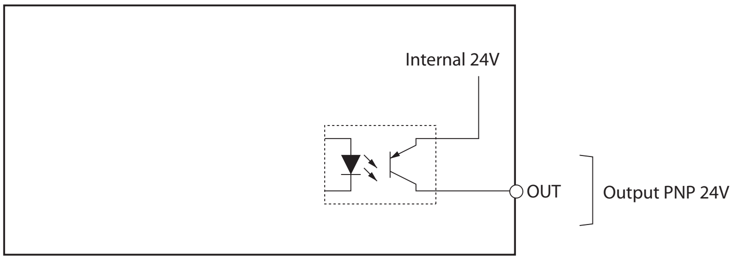
Digital I/O's at disposal for the R88S-EA

Name	Resource/logic type	Details
In 0	Input, PNP, 24V	Reset fault, connection: pin 1 of the x5 IN/OUT connector
Out 0	Output, PNP, 24V	HVDC ready, connection: pin 2 of the x5 IN/OUT connector
Out 1	Output, PNP, 24V	VAC line state, connection: pin 3 of the x5 IN/OUT connector
Out 2	Output, PNP, 24V	Fault, connection: pin 4 of the x5 IN/OUT connector

Digital inputs specifications	
Number of inputs	1
Galvanic isolation	Yes, through optoisolators
Protection	Polarity reversal
Input voltage	Nominal: +24 VDC Low signal (physical status 0): -30 to 3 VDC High signal (physical status 1): 15 to 30 VDC
Input current (typical) with Vin = 24 VDC	3.3 mA

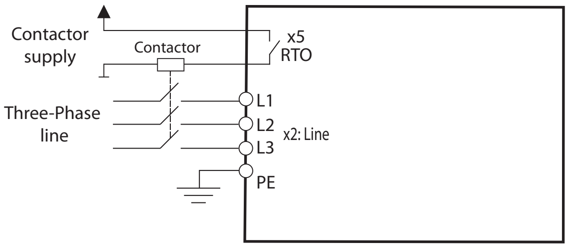


Digital outputs specifications	
Output type	PNP
Number of outputs	3
Galvanic isolation	Yes, through optoisolators
Protection	Polarity reversal, overcurrent, short circuit
Supply voltage	24 V (internally obtained from the 24 V that are presents on the x3 Logic connector)
Maximum output current (for each output)	300 mA



Note In relation to what's reported in the above table, on the 24 V the absorption may increase up to 900 mA if the 3 outputs are all on and with the maximum load connected.

RTO relay specifications	
Maximum input voltage (OFF state)	30 VAC/VDC
Maximum output current (ON state)	1 A
Short circuit protection	No



Functionalities

Here you can find the functionalities related to the I/O resources of the DC Power Supply Unit.

Functionalities	Assigned to...
Reset fault	In 0
HVDC ready	Out 0
VAC line state	Out 1
Fault	Out 2

Reset fault

The function assigned to digital input In 0 is Fault Reset. When active tries to restart the drive. For details about the Fault status restoring, refer to **Section 13-3 Fault and Warning (DC Power Supply Unit)**. To force a Reset function it's necessary to apply a positive pulse of at least 100 ms.

Note When the Reset fault is forced, a new restore attempt is started, with the generation of the HVDC voltage from the x7 and x8 Power output connector (Power Output). Do not install any connections or make inspections when the power supply is charged. In such cases switch the power off, wait for at least 10 minutes, otherwise there can be risks of electric shock and/or damaging.

HVDC ready

The Out 0 output is active (ON state, transistor on) when the power supply is in the operative status and without faults.If a fault is reported, with the consequent RTO contact deactivation, the output becames inactive (OFF status, transistor off). This output can then provide the consent for the motion of the motors that are supplied by the R88S-EA HVDC voltage.

VAC line state

The Out 1 output indicates the alternate voltage status on the x2 Power line connector (Power Line). This output is active (ON state, transistor on) when valid supply is detected in input. The delay time since when the alternate current is missing is about 20 ms.

Fault

The Out 2 output indicates the power supply fault status, when it is on it indicates that a fault has been detected with consequent deactivation of the HVDC output voltage.

RTO

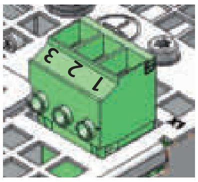
When the logical part is supplied and there is no alarm or malfunction in the power supply, the RTO contact closes and the contactor is activated connecting the power supply. If any alarm occurs in the power supply (overtemperature, overload, …) the RTO contact opens and interrupts the AC Power supply.

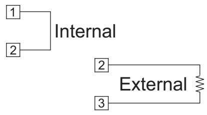
3-3-5 Brake Resistor Connector

Brake resistor (x1)

Braking resistor connector.

Item	Specifications
Connector type	Removable female
Number of poles	3
Wire size	0.2 to 6 mm^2
Tightening torque	0.8 Nm



PIN	Name	Description
1		To use the internal braking resistor, short pins 1 and 2
2		To use an external braking resistor, connect it between pins 2 and 3
3		

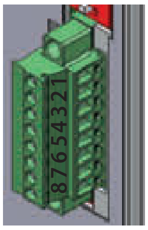
3-3-6 Serial Communication Connector

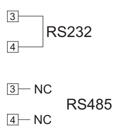
COM port (x6), RS232/RS485 serial port

Communication connector for Modbus RS232 or RS485.

Item	Specifications
Connector type	Removable female
Number of poles	8
Wire size	0.13 to 1.5 mm^2
Tightening torque	0.2 Nm
Address	1
Baudrate	57600,E,8,1

Note This serial port is isolated. The shield cable must be connected to earth by the host side (PC) and the pin 8 of the x6 COM connector.



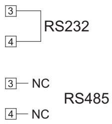
PIN	Name	Description
1	-	Not connected
2	-	Not connected
3		Short circuit: RS232
4		Open circuit: Not implemented
5	GND_COM	Ground RS232
6	TX232	Transmit data RS232
7	RX232	Receive data RS232
8	Shield	Shield

Connection of the serial port

For a detailed control of all the provided functionalities of the R88S-EA, connect the RS232 serial port to the x6 COM port connector of the power supply.

Note Connect and disconnect the communication connector only when the power supply is switched off. Check if the pin 5 (Ground Control supply) of x6 COM port connector, the power supply and the PC are correctly connected to the protection conductor.

To connect the pins of x6 COM port connector, please pay attention to what is shown in the following table:

PIN	Name	Description
1	-	Not connected
2	-	Not connected
3		Short circuit: RS232
4		Open circuit: Not implemented
5	GND_COM	Ground RS232
6	TX232	Transmit data RS232
7	RX232	Receive data RS232
8	Shield	Shield

Confirmation of the connections

After having completed the connections, check if they are correctly connected and switch on the power supply of the logic section (24 VDC) and of the power section. The LEDs on the R88S-EA front, should have the following configuration:

- LED “RTO” GREEN ON: Closed contact
- LED “CPU STATUS” GREEN ON: CPU working in firmware mode
- LED “POWER STATUS” GREEN ON: Power section correctly supplied
- LED “BRAKE STATUS” OFF: Brake not active

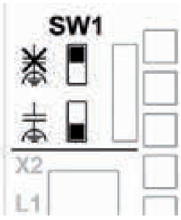
If the LEDs status is not one of the above described, see Section **1-3-4 DC Power Supply Unit Functions**.

3-3-7 Switches

The parameters that are defined by the DC Power Supply Unit switches are shown in the following tables.

Mains filter ground switch (FGC switch)

This DC Power Supply Unit has in it’s interior a filter that attenuates the noise and is connected to ground via a capacitor. The switch SW1 allows to disconnect the capacitor and therefore reduce the possible leakage current to ground and the load on the capacitor.



Note Disconnection of the capacitor results in non-compliance with the EMC standards. In any case, always turn off the line voltage before use SW1.

Note The default parameter of the SW1 with the capacitor is connected to ground terminal.

Terminating resistance (RT switches)

The RT switch, which is located next to the x6 COM connector, set the terminating resistor for the RS485 Modbus network.

The combinations of the switches are shown in the following table:

State	Switch 1	Switch 2
Termination not inserted	OFF	OFF
Configuration not allowed	OFF	ON
	ON	OFF
Termination inserted	ON	ON

Note Remember that the standard system comes with the termination resistor not inserted.

Note RS485 will be implemented in future firmware releases.

3-4 Cable and Connector Specifications (Integrated Servo Motor)

The specifications of the cables to connect Integrated Servo Motors are shown below. The information on the cable types are also provided. Select the optimum cable.

3-4-1 Cable and Connector Specifications for CN1 Communication Connector

This cable is used for the auxiliary bus with protocol Modbus on RS232.

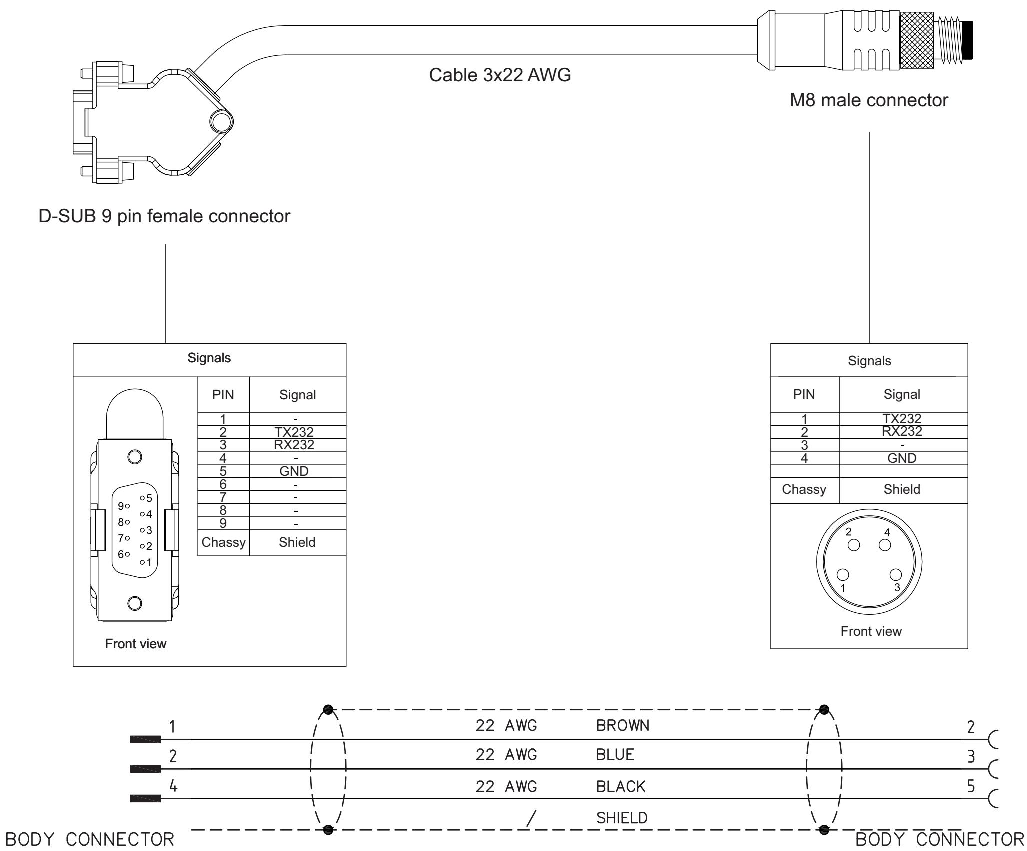
● R88A-CCEA002P2-E

Serial port cable for Integrated Servo Motor with straight connector

Model	Length (L)
R88A-CCEA002P2-E	2 m

Connection configuration and external dimensions

[R88A-CCEA002P2-E: 2 m]



3-4-2 Cable and Connector Specifications for CN2 and CN3 EtherCAT Ports

These cables are used to connect the Integrated Servo Motors to EtherCAT.

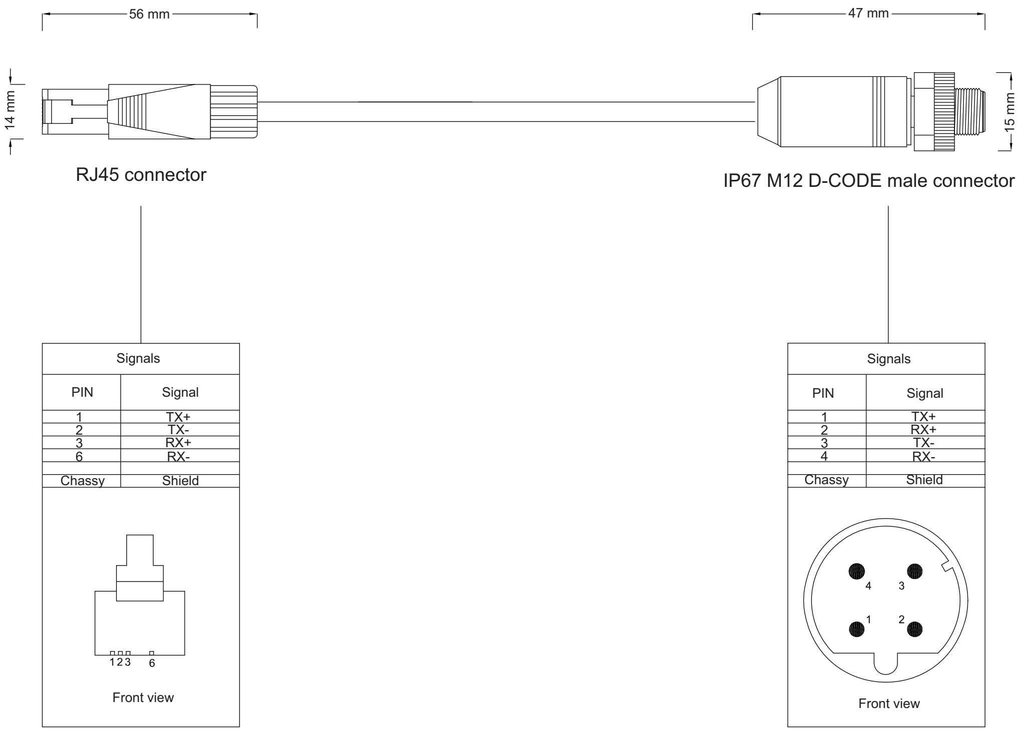
- **XS5W-T42□-□MC-K**

EtherCAT RJ45 to M12 cable

Model with straight connector	Model with L right angle connector	Length (L)	Outer diameter of sheath
XS5W-T421-AMC-K	XS5W-T422-AMC-K	0.3 m	ø7.1
XS5W-T421-BMC-K	XS5W-T422-BMC-K	0.5 m	
XS5W-T421-CMC-K	XS5W-T422-CMC-K	1 m	
XS5W-T421-DMC-K	XS5W-T422-DMC-K	2 m	
XS5W-T421-EMC-K	XS5W-T422-EMC-K	3 m	
XS5W-T421-GMC-K	XS5W-T422-GMC-K	5 m	
XS5W-T421-JMC-K	XS5W-T422-JMC-K	10 m	
XS5W-T421-KMC-K	XS5W-T422-KMC-K	15 m	

Connection configuration and external dimensions

[XS5W-T42□-□MC-K: 0.3 to 15m]



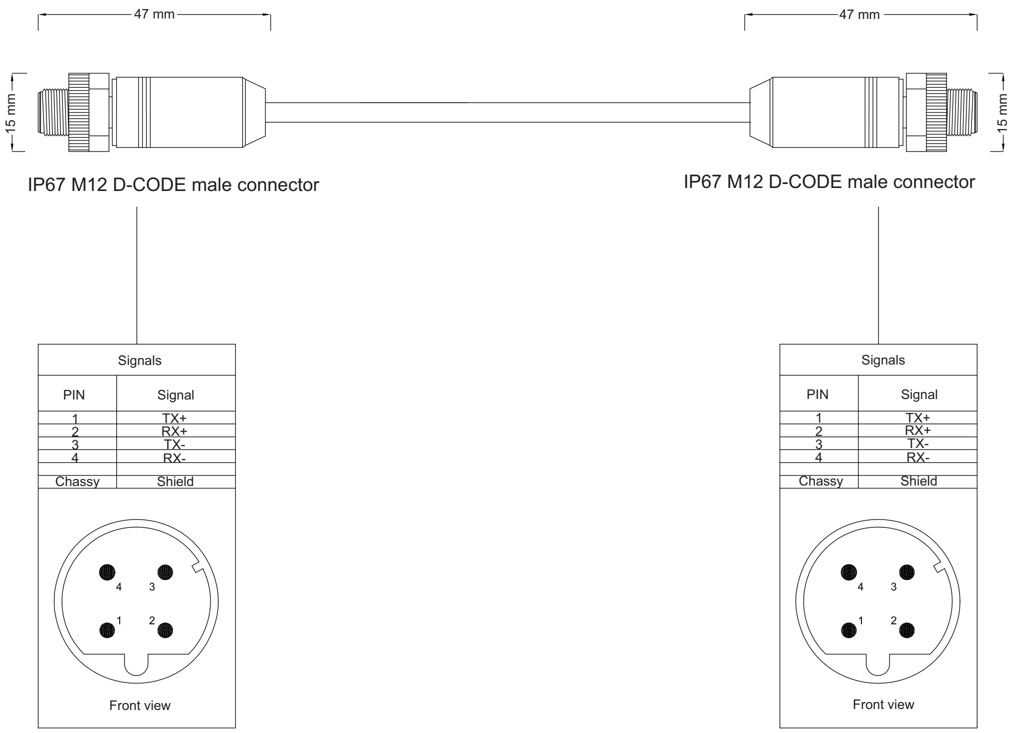
● XS5W-T42□-□M2-K

EtherCAT M12 to M12 cable

Model with straight connector	Model with L right angle connector	Length (L)	Outer diameter of sheath
XS5W-T421-BM2-K	XS5W-T422-BM2-K	0.5 m	ø7.1
XS5W-T421-CM2-K	XS5W-T422-CM2-K	1 m	
XS5W-T421-DM2-K	XS5W-T422-DM2-K	2 m	
XS5W-T421-EM2-K	XS5W-T422-EM2-K	3 m	
XS5W-T421-GM2-K	XS5W-T422-GM2-K	5 m	
XS5W-T421-JM2-K	XS5W-T422-JM2-K	10 m	
XS5W-T421-KM2-K	XS5W-T422-KM2-K	15 m	

Connection configuration and external dimensions

[XS5W-T42□-□M2-K: 0.5 to 15m]



3-4-3 Cable and Connector Specifications for CN4 I/O Connector

This cable is used for the digital and analog inputs and outputs.

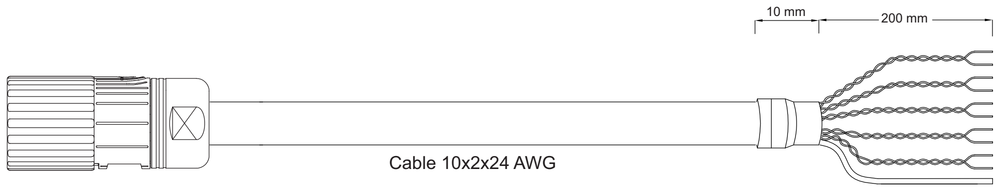
● R88A-CPEA□□□S-E

I/O cable for Integrated Servo Motor with straight connector

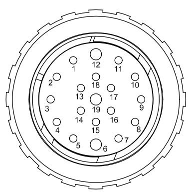
Model	Length (L)
R88A-CPEA001S-E	1 m
R88A-CPEA002S-E	2 m
R88A-CPEA005S-E	5 m

Connection configuration and external dimensions

[R88A-CPEA□□□S-E: 1 to 5 m]



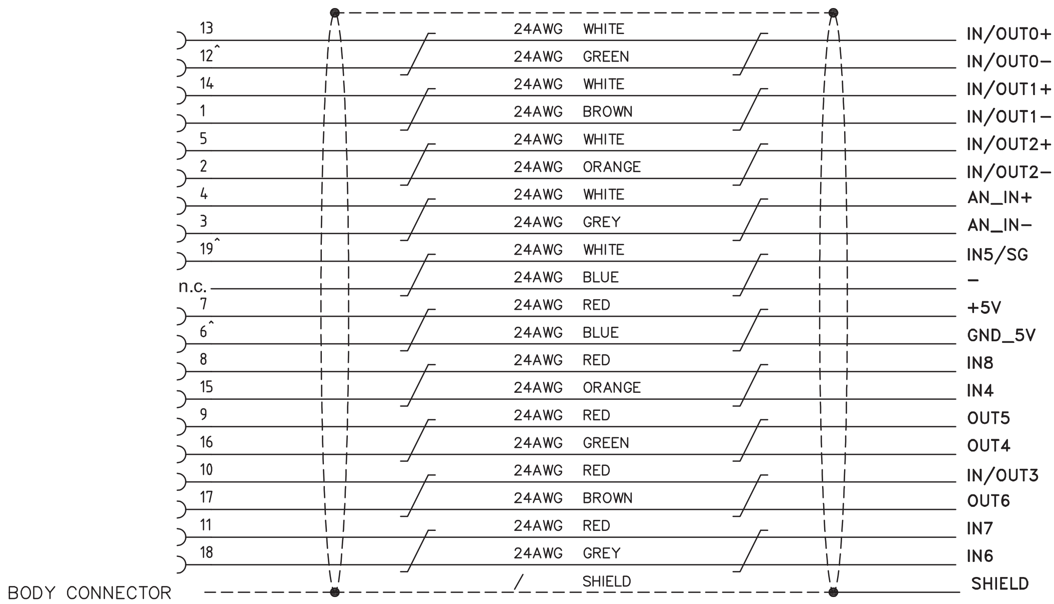
Signals



PIN	Signal
1	IN/OUT1-
2	IN/OUT2-
3	AN_IN-
4	AN_IN+
5	IN/OUT2+
6	GND_5V
7	+5V
8	IN8
9	OUT5
10	IN/OUT3
11	IN7
12	IN/OUT0-
13	IN/OUT0+
14	IN/OUT1+
15	IN4
16	OUT4
17	OUT6
18	IN6
19	IN5/SG
Chassy	Shield

Signals

Wire identification		Signal
White/green pair	White	IN/OUT0+
	Green	IN/OUT0-
White/brown pair	White	IN/OUT1+
	Brown	IN/OUT1-
White/orange pair	White	IN/OUT2+
	Orange	IN/OUT2-
White/grey pair	White	AN_IN+
	Grey	AN_IN-
White/blue pair	White	IN5/SG
	Blue	-
Red/blue pair	Red	+5V
	Blue	GND_5V
Red/orange pair	Red	IN8
	Orange	IN4
Red/green pair	Red	OUT5
	Green	OUT4
Red/brown pair	Red	IN/OUT3
	Brown	OUT6
Red/grey pair	Red	IN7
	Grey	IN6
Black 1mm^2	Chassy	Shield



3-4-4 Cable and Connector Specifications for CN5 Power Supply Connector

This cable is used for the supply of the power section and of the logical section.

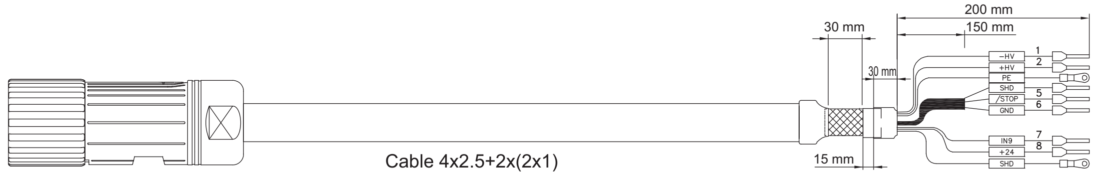
● R88A-CDEA□□□-E

Power cable for Integrated Servo Motor with straight connector

Model	Length (L)
R88A-CDEA001-5-E	1.5 m
R88A-CDEA003-E	3 m
R88A-CDEA005-E	5 m
R88A-CDEA010-E	10 m
R88A-CDEA015-E	15 m
R88A-CDEA020-E	20 m

Connection configuration and external dimensions

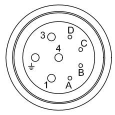
[R88A-CDEA□□□-E: 1.5 to 20 m]



IP67 M23 female connector

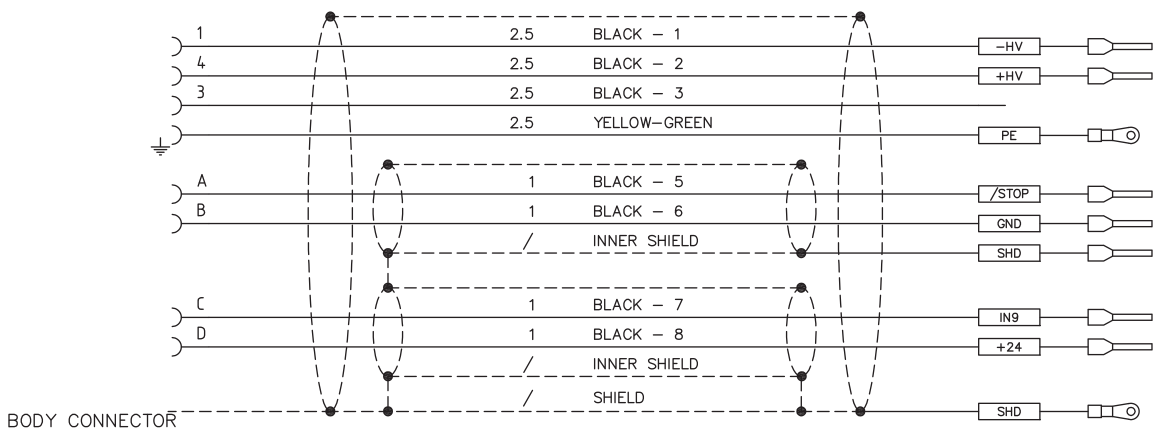
Stripped cable with wire markers

PIN	Signal
1	-HV
4	+HV
3	-
A	$\overline{\text{STOFF}}$
B	GND
C	IN9
D	+24V
⏚	PE
Chassy	Shield (cable+pair1+pair2)



Front view

Wire identification	Signals	Wire marker
3	-	-
1	-HV	-HV
2	+HV	+HV
5	$\overline{\text{STOFF}}$	/STOP
6	GND	GND
7	IN9	IN9
8	+24V	+24V
Yellow/green	PE	PE
Black + end-sleeve	Shield cable + pair 2	SHD
Black + ring terminal	Shield pair 1	SHD



3-5 Cable and Connector Specifications (DC Power Supply Unit)

The specifications of the cables to connect DC Power Supply Unit are shown below. The information on the cable types are also provided.

3-5-1 Cable and Connector Specifications for Communication Connector

This cable is used for the auxiliary bus with protocol Modbus on RS232.

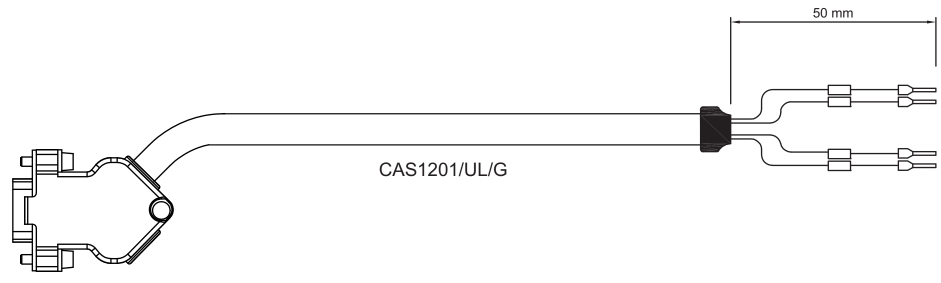
● R88A-CCSE002P2-E

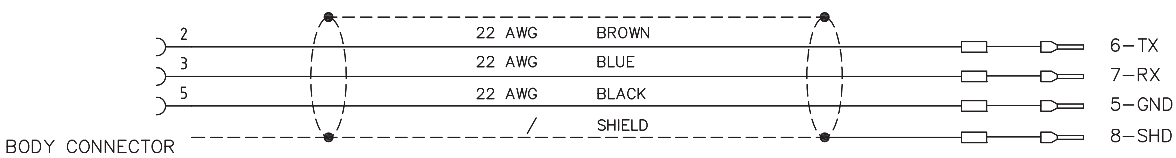
Serial port cable for DC Power Supply Unit with straight connector

Model	Length (L)
R88A-CCSE002P2-E	2 m

Connection configuration and external dimensions

[R88A-CCSE002P2-E: 2 m]





4

System Design

This section explains the installation conditions for the Integrated Servo Motor and DC Power Supply Unit, wiring methods including wiring conforming to EMC Directives and regenerative energy calculation methods.

4-1 Power Supply Mechanical and Environmental Installation

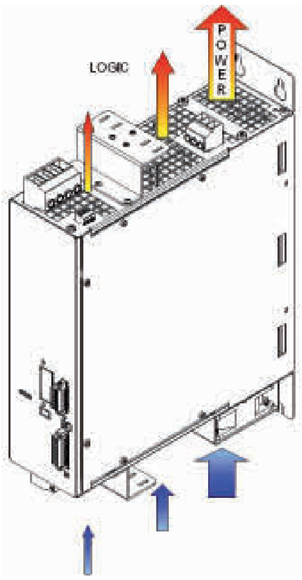
The DC Power Supply Unit must be installed inside an industrial electrical cabinet. Make sure that the specified temperature and humidity limits are not exceeded.

The power supply must be installed in a vertical position and secured to the bottom of the cabinet. Leave at least 10cm free on the upper and lower parts and 5cm free on the sides. Make sure not to block the hot spots (see below picture).

The output power depends on the degree of dissipation of the power supply with the external environment; in case of insufficient dissipation intervenes the over temperature alarm.

The thermal protection of the power section is activated when the heat sink exceeds the temperature of 90ºC.

The output current is maintained if the ambient temperature exceeds 40ºC and if the braking resistor doesn't generate excessive heat.



It's recommended don't touch the power supply while power is ON: it's surface may be hot. Immediately after turning off the box and/or the flap may still be hot; wait for it to cool before you touch with your hands.

Installation precautions

- The presence of conductive external elements inside the product, as chippings, screws or pieces of metallic wire, can lead to system malfunction.
- An inadequate grounding exposes to electric shock.
- Connect the system to ground before to apply the voltage.
- Don’t use cable holder pipes as protection conductors.
- The protection conductor section must comply with the regulations in force.
- Connect the cables shields to the ground.

Note Differential switch use: this product may cause the presence of a leakage current in the protection conductor. If the installation regulations prescribe a protection for the direct or indirect contact connected upstream, that has to be done with a differential switch (RCD) or a leakage current monitoring device (RCM), on the power supplies must be installed a device of “type B”.

Note If two of the three line phases are interrupted, the leakage current may reach higher levels (7-8 times) compared to the values that there are with all the three phases present.

- Depending on the functioning conditions, the produced metallic surface may reach temperature higher than 90°C. Avoid any contact with the metallic parts. Do not put near any flammable or sensitive to the heat components. Observe the precautions about the heat dissipation.
- The ventilation system in the electrical cabinet must be able to dissipate the heat that's produced by all the devices and components that are inside installed.

Mechanical installation

For the system installation use the 4 holes on the rear flange of the power supply. The dimensions are reported on the **Section 2-4-2 DC Power Supply Unit Dimensions**. Be sure that the ventilation is free, respecting however the maximum admitted environment temperature.

4-2 Power Supply Electrical Installation and Wiring

4-2-1 General Consideration

Considering that the system input voltages has been correctly selected even the following points have to be considered. For the correct functioning of the DC Power Supply Unit, protection included, the installation of the following components is required:

- **Short circuit protection device (fuses on the LINR power input):** It has to promptly protect the internal power electronic of the R88S-EA when a short circuit happens on HVDC. The system instead automatically protects itself in case of overload, overtemperature, etc.
- **Power contactor commanded by the RTO contact:** The RTO contact allows to activate/deactivate the power contactor. If a Fault is detected or there are not the right conditions, the RTO contact opens, cuts the supply to the contactor and the power supply input voltage is cut off.
- **Brake Resistor connection:** Check that the x1 Brake resistor connector is configured and inserted in the system.

There are other aspects to be considered that, unlike the previous ones, don’t cause any damage to the power supply, but may cause a fault.

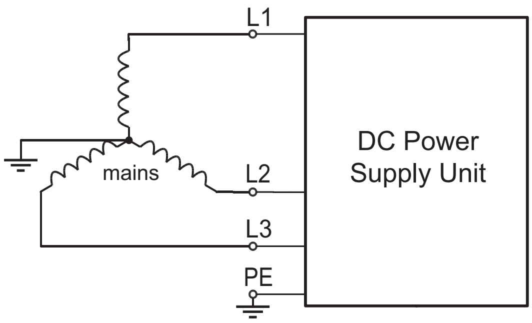
- **Hold Up 24V time check (x3 Control supply):** In absence of the control section voltage the controls and the pilotages of the internal circuits of the power supply don't work. In particular, when the control section voltage decreases under the power section undervoltage threshold value the RTO contact is immediately opened. It must be guaranteed the voltage to the control section for at least 10 seconds since the input alternate line voltage is missing.
- **HVDC Ready status check:** In order to move the servomotors that are connected to the power supply without fall in Fault situations, undervoltage or excessive ripple on the HVDC voltage, it's necessary to wait that the power supply is in the operative status. A way to verify this status is to refer to the OUT0 digital output logical state.

Voltage supply network

This power supply is made for a fixed connection on a TT and TN electrical network.

The short circuit nominal current of the electric line must be ≤ 5kA.

Be sure that the input protection devices of the R88S-EA power supply unit have an adequate interruption capacity.



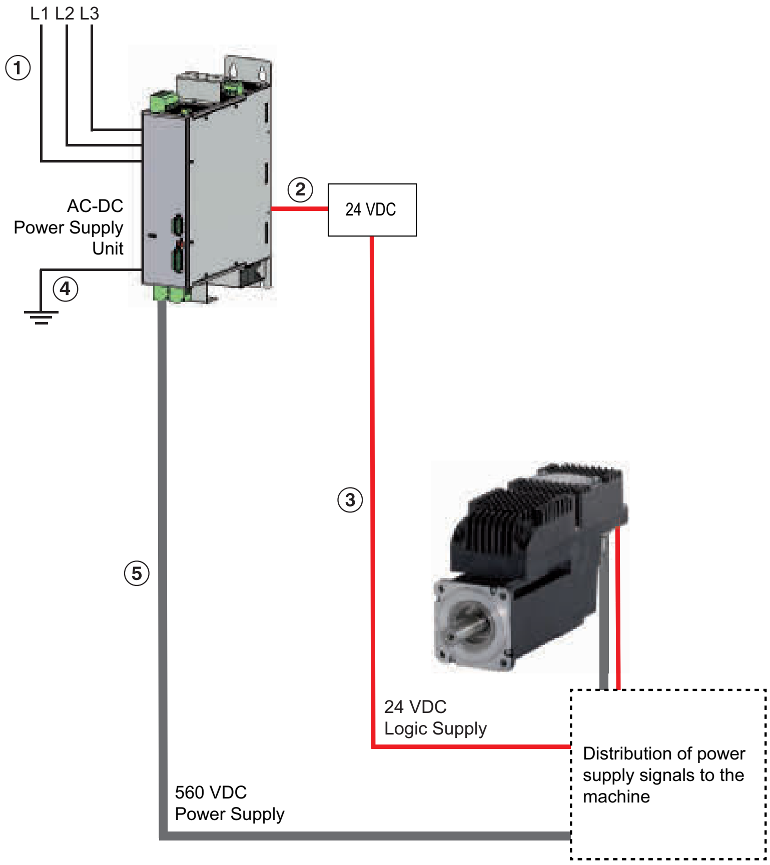
Note The line-ground voltage must be not be greater than 300 VAC.

Note The line inductance use on the power supply input reduces the risk of damage against the voltage displacement between the line phases or the noises in the supply network. If the line inductances has to be used, the recommended reactance values are about 2%. If necessary, higher values can be selected, that may cause a greater voltage dip and on consequence, in the connected servomotors, a torque reduction with high speed.

Connection of the protection conductors

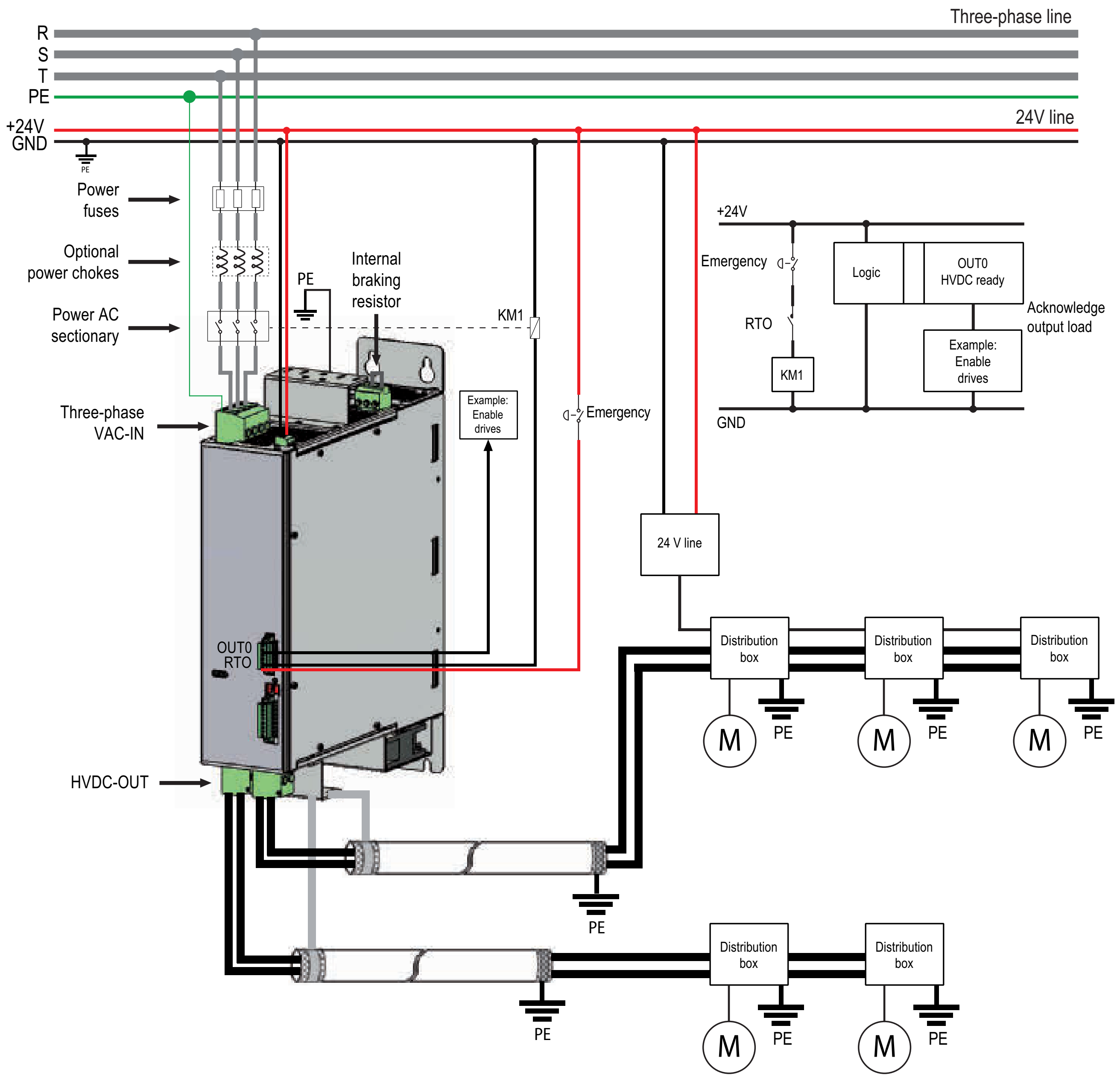
Two grounding connection are provided: one through the x2 Power line connector (functional ground), the other through Grounding screw connection (protection earth).

4-2-2 Cable Sections



Item		Specifications
1 (Three-phase line)	Rated current	R88S-EAD20R: 25 A AC R88S-EAD40R: 47 A AC
	Wire size	R88S-EAD20R: 4 mm^2 min. R88S-EAD40R: 10 mm^2 min.
	Tightening torque	1.8 Nm
2 (24 V line)	Rated current	1.5 A DC max. (with 3 digital output ON)
	Wire sizes	1 mm^2
	Tightening torque	0.2 Nm
3 (24 VDC logic supply)	Rated current	Assuming 15 A DC
	Wire size	2.5 mm^2
4 (Ground connection)	Wire size	4 mm^2 min.
5 (560 VDC power supply)	Rated current	R88S-EAD20R: 20 A DC R88S-EAD40R: 40 A DC
	Wire size	R88S-EAD20R: 2.5 mm^2 min. R88S-EAD40R: 4 mm^2 min. if cable is connected to a single output channel (max. I_{DC} = 25 A) 10 mm^2 min. if both output channels are connected together (max. I_{DC} = 40 A)
	Tightening torque	1.8 Nm (DC Power Supply Unit connector)

4-2-3 Wiring


R
S
T
PE
+24V
GND
Three-phase line
24V line
Power fuses
Optional power chokes
Power AC sectionary
Three-phase VAC-IN
PE
Internal braking resistor
KM1
Example: Enable drives
Emergency
+24V
Emergency
RTO
KM1
Logic
OUT0 HVDC ready
Acknowledge output load
Example: Enable drives
GND
24 V line
OUT0
RTO
HVDC-OUT
Distribution box
M
PE

Input section connection

The connector for the control section is x3 logic, the one for the power section supply is x2 power.

In order to ensure the safety, to a well functioning of the power supply and to a better behaviour against the noises, it's necessary to make the ground connection through a low impedance conductor (see grounding screw connection). This conductor must be referred to the grounded equipotential collector of the machine.

There are no restrictions about the supply sequence: it can be provided the control voltage supply first and then the power one, and vice versa. But without the logic section voltage the system doesn't turn on, therefore in this situation the LED’s don't light and it's not possible any communication (even if the power voltage is present).

Note The power section is activated/deactivated by the contactor through the RTO contact. Check it’s correct connection.

Note Never apply an alternate or a DC voltage out of the provided range or with an inverted polarity: this may cause damage on the power and/or logic section and the risk of fire or electric arc.

Note The power supply is provided of a control in case of overvoltage or undervoltage, so that the power supply is disabled if there are some supply problem, but this doesn't exclude to maintain the voltage between the limits, in particular in case of overvoltage.

Note Refer the GND potential of the control supply to PE.

Note The logic voltage supply must be guarantee “on the system connector level”. Be sure that this range is respected in particular if a long cable is used (eventually compensate the voltage drop in the cable by giving a higher voltage upstream).

Connect the right input protection and peripheral devices as described in **Section 4-2-4 Peripheral Selection**.

To connect the pins of x2 Power line connector, please pay attention to what is shown in the following table:

PIN	Name	Description
1	L1	Line 1 of the three-phase source
2	L2	Line 2 of the three-phase source
3	L3	Line 3 of the three-phase source
4	PE	Three-phase protection earth

To connect the pins of x3 Logic connector, please pay attention to what is shown in the following table:

PIN	Name	Description
1	+24 V	+24 VDC control supply
2	+24 V	+24 VDC control supply
3	GND	Ground control supply

For the system functioning two supplies are necessaries:
- For the Logic section: a DC voltage (continuous voltage)
- For the Power section: an AC three-phase voltage (alternate voltage)

Note The contactor that controls the power section supply is commanded by the logic section through the RTO contact.

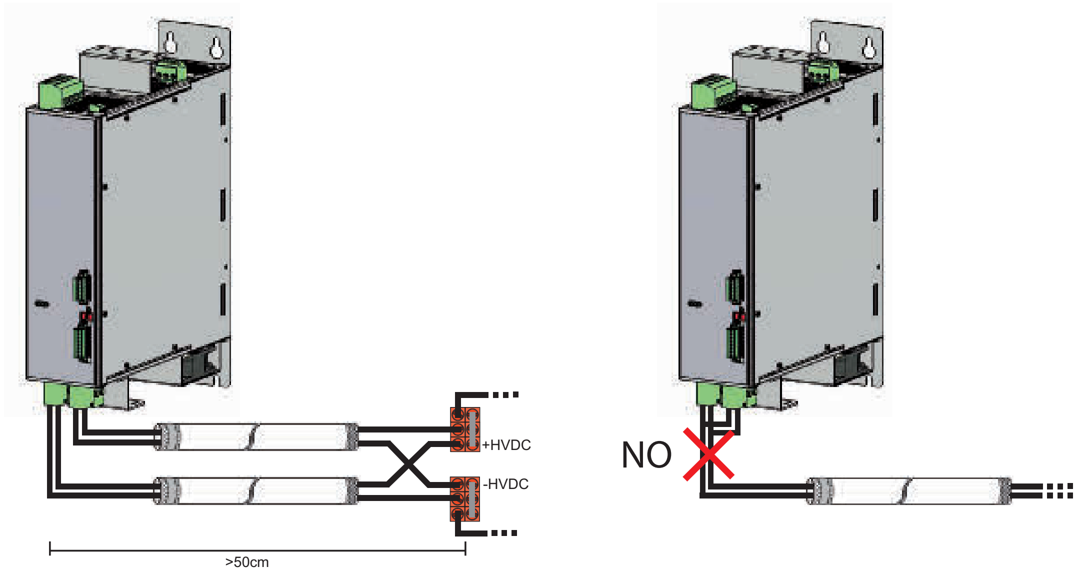
Note This contactor must respect the Opening < 150 ms time (that is the contactors opening time when the supply is cut off from the inductance). The Opening time increases about 10 times if on the inductance diode snubbers are inserted.

There are no restrictions about the supply sequence: it can be provided the logic voltage supply first and then the power one, and vice versa. But without the logic section voltage the system doesn't turn on, therefore in this situation the LEDs don't light and it's not possible any communication (even if the power voltage is present).

Output section connection

Two type of connections can be distinguished:

- Output channels separated connection
- Output channels parallel connection (see below picture)



In particular, for both the connection type, even the cases with the shielded or not shielded cable can be considered:

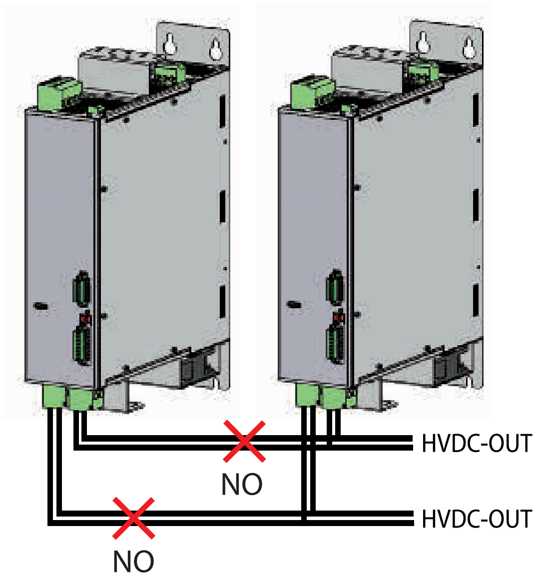
- Connection with not shielded cable: when the cable length from the connector to the terminal board is not greater than 1 m
- Connection with shielded cable: when the cable length from the connector to the terminal board is within 1 and 50 m (when the cable length is greater than 50 m, please contact your OMRON representative)

Use a metallic ring appropriate to the selected cable diameter for a good shield connection to ground.

Note The cable must be fixed through a cable tie, applied on the power supplier superior bracket. For the ring installation use the threaded holes that are present on the metallic inferior flange.

Note Never apply an alternate or a DC voltage to the output connectors: this may cause damage on the power and/or control section and the risk of fire or electric arc.

An incorrect connection is next:



Do not connect the DC output of different power supplies together to increase the output current.

Brake resistor connection

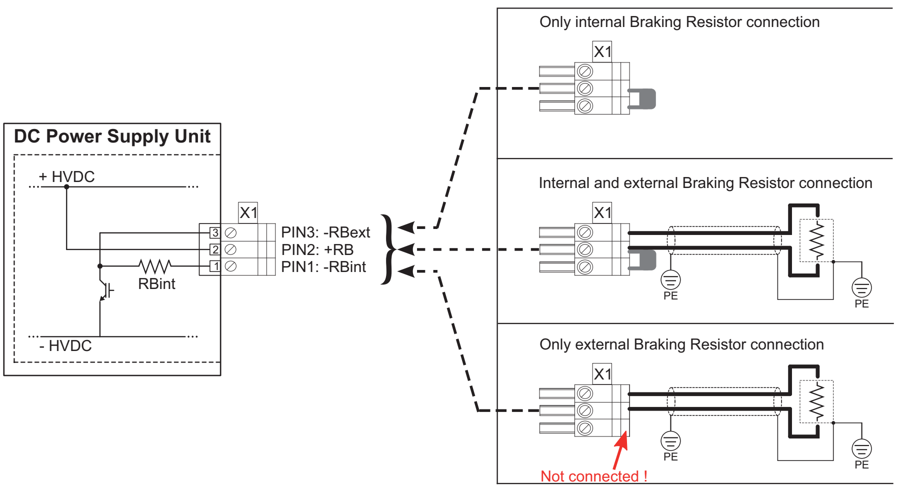
Note Before turn ON the power, make sure that the x1 Brake resistor connector is armed and properly configured.

Note In case of the braking resistor is insufficient, or not present, may present overvoltages on the DC bus (HVDC) and consequently the load connected at it's output will not be more appropriately actively braked.

Note Failure to these precautions can result in death, serious injury or property damage.

In general, you can perform the following configurations:

- Internal braking resistor (normal applications)
- Internal + External braking resistors (intermittent applications with considerable inertia loads)
- External braking resistor (continuous applications with considerable inertia loads)



Note For the connection/configuration of the braking resistor, cut the power on all connections. Make sure that the residual voltage on the power connectors are not such as to cause electric shock. Check with the help of the voltmeter the voltage between +HVDC and -HVDC (x7 and x8 Power output) has dropped below 50 VDC.

Note Do not disconnect the x1 Brake resistor connector and any wires with the power still ON. May form arcs that damage the connector, and the power supply may cause fire hazard.

Note Failure to follow the below instructions can result in serious injury or property damage:

- Depending on the operating conditions, the braking resistor can reach temperatures over 250ºC.
- Avoid direct contact with the braking resistor.
- Do not place flammable or heat-sensitive components near the braking resistor.
- Provide a good heat dissipation.
- In difficult cases, check the temperature of the braking resistor with an operating cycle test.

Note Do not connect an external resistor with a value of:

- Less than 33 Ohm when the internal and external resistor are connected at the same time.
- Less than 16.5 Ohm when only the external resistor is connected.

Not doing so will destroy the braking circuit.

4-2-4 Peripheral Selection

Fuses

- **Logic section:** The power supply is provided, internally to the logic section, of a NON REPLEACABLE (and non auto-restoring) fuse. The fuse breaking probably implies a damage of the electronics: in this case please contact your OMRON representative.
- **Power section:** Internally to the power section there are no fuses. It must be the user that externally provides with the insertion of 3 fuses in the three-phase lines, according to the regulations.

It is recommended to install input line fuses to protect the power supply against sudden short-circuits in the load.

The line fuses should be of quick acting type with next characteristics:

- 32 A - I2T max = 700 A^2s for the 20 A DC Power Supply Unit[*1]
- 50 A - I2T max = 1300 A^2s for the 40 A DC Power Supply Unit[*2]

*1. Example: Bussmann cod. FWP-32A14F, or ITALWEBER AQS-F14x51 cod.1480032.
*2. Example: ITALWEBER cod. AQS-F22x58 Cod.1482050.

Line inductance

The line inductances in the input reduce the risk of damage against the voltage displacement between the line phases or the noises in the supply network. If the network doesn't have any voltage displacement, the R88S-EA doesn't need line inductances. When, instead, it's necessary to use them, reactance values causing a voltage drop of 2-4% are recommended. If necessary, higher values may be chosen, that may imply a reduction of the performance on the connected systems (torque reduction at high speeds), due to the voltage dip.

For example, high noises can be caused by the following factors:

- Devices for the power factor adjustment, connected near the converter
- Big converters in DC without line inductances or with inadequate components connected to the supply
- Motor/s with direct start-up in line connected to the voltage supply so that, at the motion start of one of this motors, the voltage decreasing is higher than the 20%

Note These noises may provoke the passage of excessive peak currents in the power supply power input circuit, causing not expected alarms.

For the line inductances current dimensioning, the following rules must be respected:

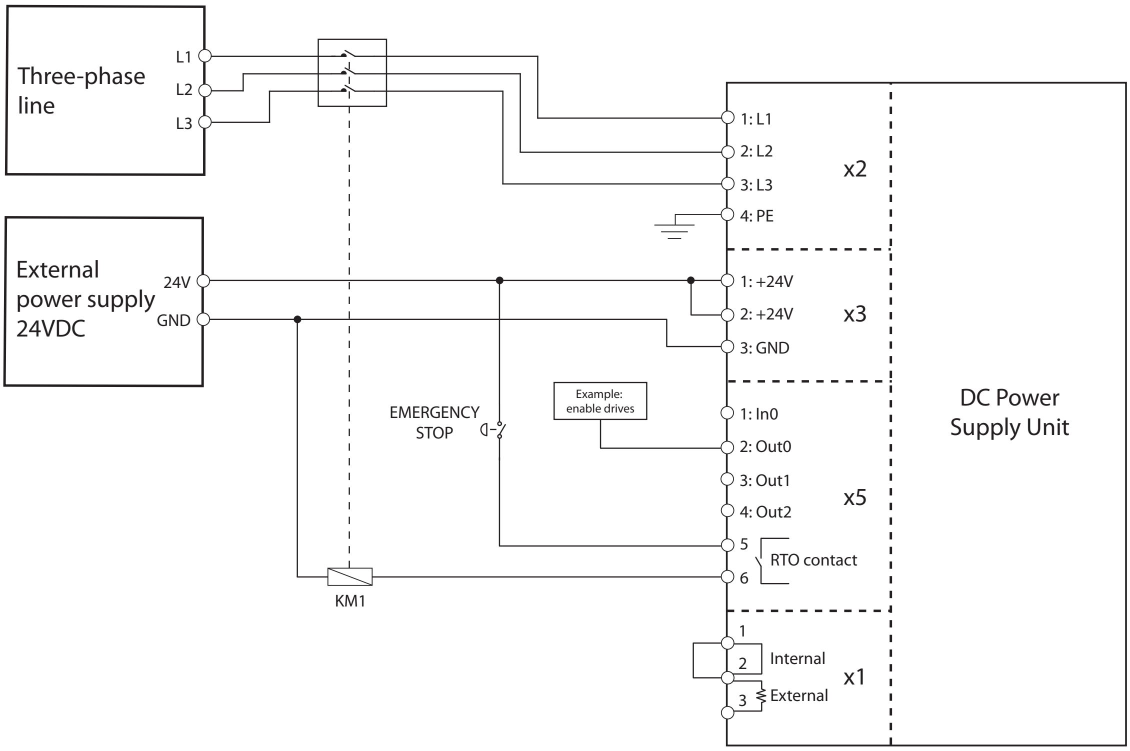
- Continuous service current: not lower than the input current in continuous service to the power supply unit
- Repetitive peak current: not lower than twice the input current in continuous service to the power supply unit
- Values around 1 mH for the 20 A power supply and 0.5 mH for the 40 A power supply are reasonable.

AC contactor

Always install a contactor that interrupts the AC power supply in case of alarm or malfunction. The contactor must be activated with RTO contact in the power supply as follows.

Connect the supplies and RTO contact to the power supplies as shown in the following scheme.

Note Before proceeding, check if the power and control supplies are switched off and there is no more voltage in the connection terminal boards.



RTO (Ready To Operate) is a normally opened contact.

When the logical part is supplied and there is no alarm or malfunction in the power supply, the RTO contact closes and the contactor is activated connecting the power supply.

If any alarm occurs in the power supply (overtemperature, overload, …) the RTO contact opens and interrupts the AC Power supply.

Note Is it possible to configure In 0 as RESET input to clear the error and continue the operation once the reason for the alarm has been solved.

4-3 Motor Mechanical and Environmental Installation

Install the motor in an industrial environment (normally a machine working inside a factory).

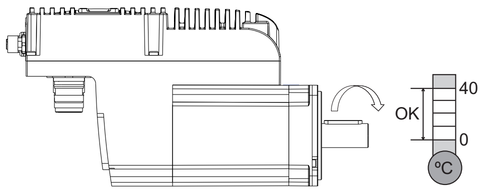
Install the motor with the flange attached to a metallic surface with, at least 300 mm x 300 mm x 6 mm size in a place with sufficient ventilation.

The motor can be installed in any direction.

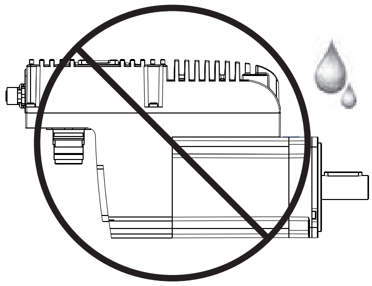
Make sure to respect the servomotor specification limits according to:

- Environment (humidity, temperature, altitude)
- Vibration
- Altitude
- Axial and thrust maximum loads

Ambient temperature: 0 to 40ºC

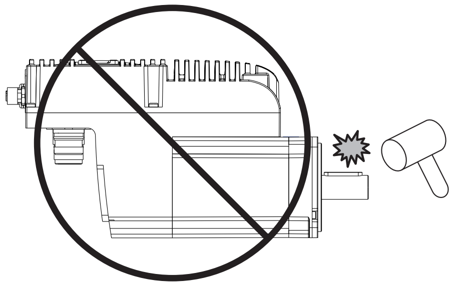


Ambient humidity: 95% RH max. (with no condensation)



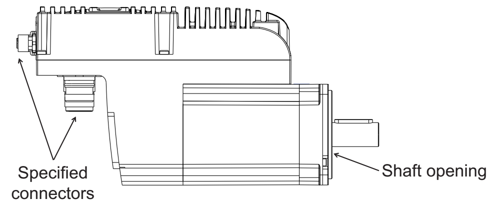
Vibration resistance: According to IEC 60068-2-6 (5 to 500 Hz, 1 and 2 G in 3 axes)

Shock resistance: According to IEC 60068-2-27 (3 shock per axis, 11 ms, 14G)

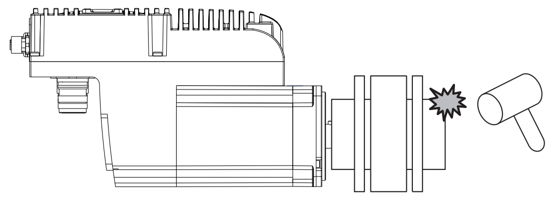


The protection class indicates the degree of protection required to keep water from entering.

Protection class: IP65



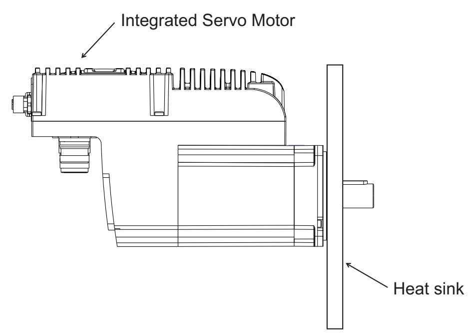
Be careful not to subject the shafts to any force or shock when installing the coupling. When connecting with machines, make sure the axial load and thrust loads do not exceed the maximum allowable values specified in the user's manual.



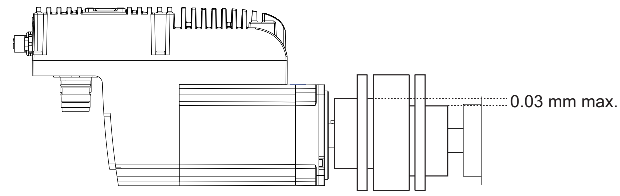
Never insert insulators, such as packings, in the joint between the Integrated Servo Motor and the heat sink.

The insulator will not only cause the motor temperature to rise but also affect the noise immunity and result in Integrated Servo Motor failure.

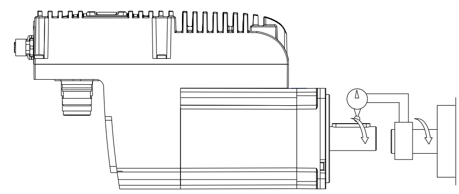
Install the Integrated Servo Motor in a well ventilated place and attached to a heatsink or machine frame with suitable dimensions to guarantee a heat dissipation. Motor failure may happen.



The required accuracy for alignment differs depending on the Integrated Servo Motor speed and the model of the coupling. The maximum allowed deviation for alignment is 0.03 mm. If unusual sounds come from the coupling, readjust the alignment of the coupling until the sound is gone.

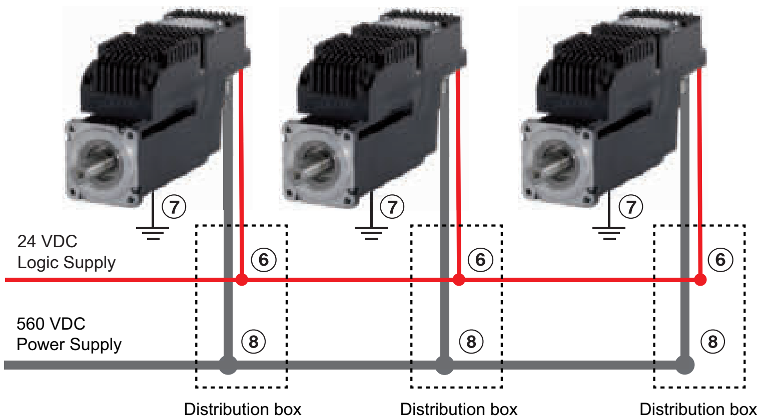


Turn both the Integrated Servo Motor shaft and the machine shaft to align the coupling.



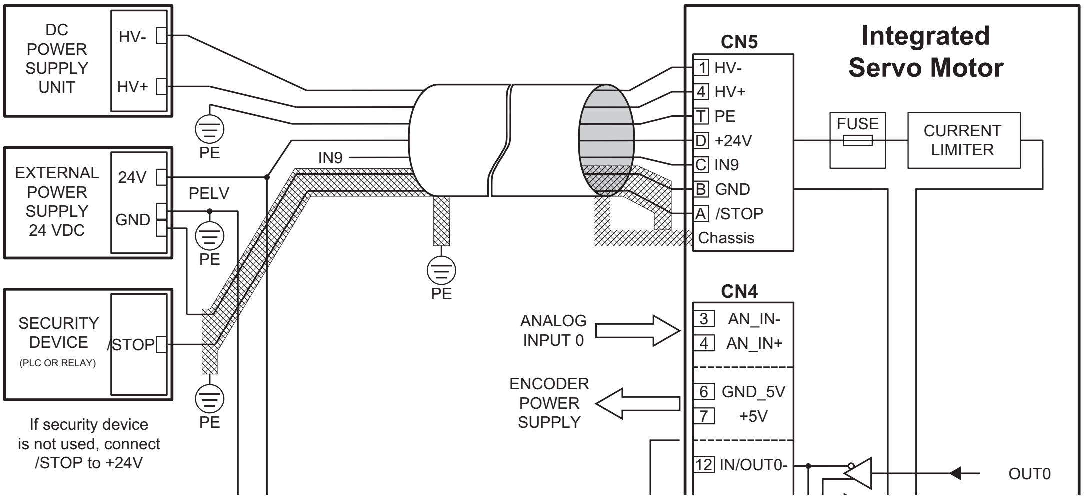
4-4 Motor Wiring and Electrical

4-4-1 Cable Sections



Item		Specifications
6 (Logic section)	Rated current	2.5 A max. (with brake activated and several digital output ON)
	Wire size	1 mm^2 min.
7 (Ground connection)	Wire size	4 mm^2 min.
8 (Power section)	Rated current	7.7 A DC max.
	Wire size	2.5 mm^2 min.

4-4-2 Wiring



Power connector wiring

Supply the suitable VDC voltage from the R88S-EAD Power Supply Unit.

Make sure that the right polarity is respected, otherwise there will be damage in the drive.

Provide 24 VDC from any commercial power supply.

The Power connector also include the /STOP PNP digital input and IN9 PNP digital input. As this digital signals are close to High Voltage power lines, provide enough isolation between them. The easier way to provide that isolation is by shielding.

The overall power cable must be shielded and shield connected to the ground.

EtherCAT cables

Use EtherCAT cables with M12 connector with Cat-5 or upper.

For long distances (Eg. From controller in electrical cabinet to first motor in the machine) use installation cable.

Grounding

Note Make sure the power connector ground pin is connected.

Note Make sure the connector shield is connected to motor body.

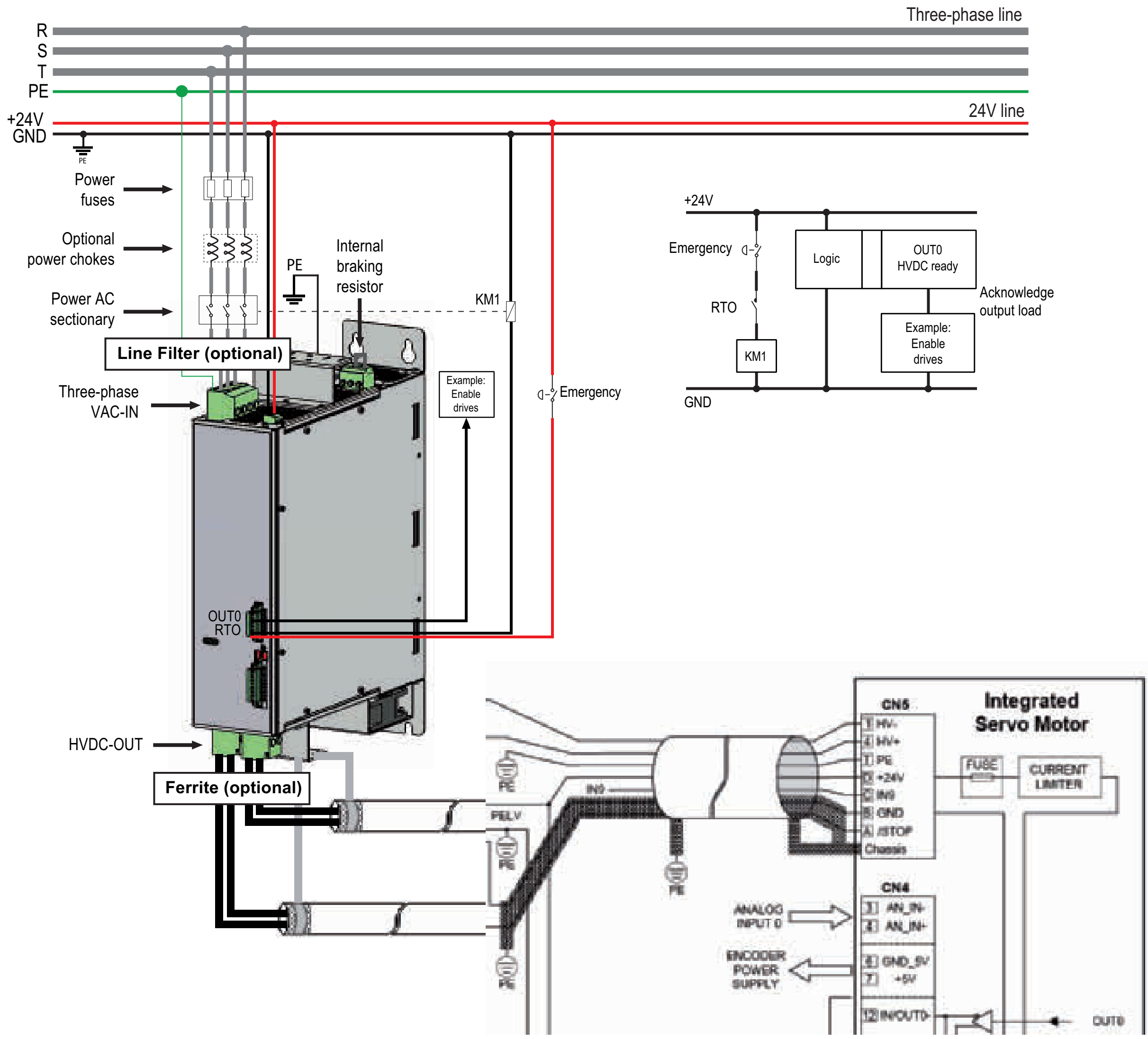
Note Make sure the motor frame makes a good electrical contact to the machine frame and that the machine is connected to a low impedance ground

4-4-3 Peripheral Selection

No particular peripheral devices are needed in the Integrated Servo Motor installation.

4-5 Wiring for EMC

When wiring your installation to reduce the EMC emission and increase the EMC protection follow the next guidelines.

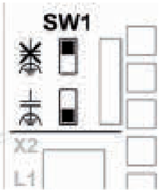


Filter

The power supply has an integrated filter that is suitable for C3 environmental installation. If higher level of filtering is required, install a suitable low-leakage line input filter.

In this case, follow the next precautions:

- Install the filter as close as possible to the AC input of the power supply.
- Make sure that the ground is connected to a low-impedance ground terminal.
- Make sure to disconnect the internal power supply filter if an external one is used by SW1.



DC OUTPUT/INPUT

Use shielded cable to connect the DC output from the power supply to the DC input of the motor.

Connect the shield of the cable in the DC power supply output using the provided accessory for 360º shield connection.

If you have to use some kind of DC Distribution system, do not break the shielding path.

Connect the shield to the connector body with 360º connection in the motor side.

If it is necessary to reduce the radiated disturbance emission, install a ferrite core in the DC cables at the output of the power supply.

4-6 Selection

4-6-1 DC Power Supply Unit Selection

The selection of the DC Power Supply Unit depends on the operation of the different motors connected to it and the simultaneity of the operation.

We offer here a simplified system to calculate the necessary DC Power Supply Unit following the next simple steps:

Step 1: Motor application curves

Collect the application Torque-time and Speed-time curves that have been calculated in order to make the motor selection.

Also consider the relative timing between the curves in the different motors. The resultant power supply may be different if all motors accelerate at the same time or if they make the same acceleration in different instant of time.

Step 2: Power curves

Multiply the Torque curve and Speed curve of each motor to produce the “Power-time” curve and sum all curves to produce the total “Power-time” requirements for the application.

Step 3: Power supply current curves

Considering the DC-bus voltage constant and equal to $V_{DC} = V_{AC} \cdot \sqrt{2}$ we can obtain the curve of I_{DC} respect of the time by using: $I_{DC} = \frac{Power}{V_{DC}}$

Note that the DC-Bus voltage decreases if the motors are absorbing energy (motoring) and increases if the motors are regenerating.

Step 4: Current requirements

From the DC-Current versus time curve you have to obtain next values:

IDC_peak: Maximum instantaneous current in the curve.

IDC_rms: Rms value calculated in the usual way as: $I_{DC\_rms} = \sqrt{\frac{\sum_n I_{DC}^2 \cdot t_n}{\sum_n t_n}}$

(The expression is true for constant segments)

Step 5: DC Power Supply Unit selection

You have to select the power supply that:

- Is able to provide the peak current for a limited time.
- Is able to provide the rms current continuously (20 A or 40 A).

As this calculation is simplified, add a safety margin of, at least, 10% to cover the inaccuracies in the data and the calculation.

Note In the R88S-EAD40R power supply, each single DC channel can provide a maximum of 25 A. If the application require more rms current, distribute the motors in the 2 channels or join both channels together following the wiring rules.

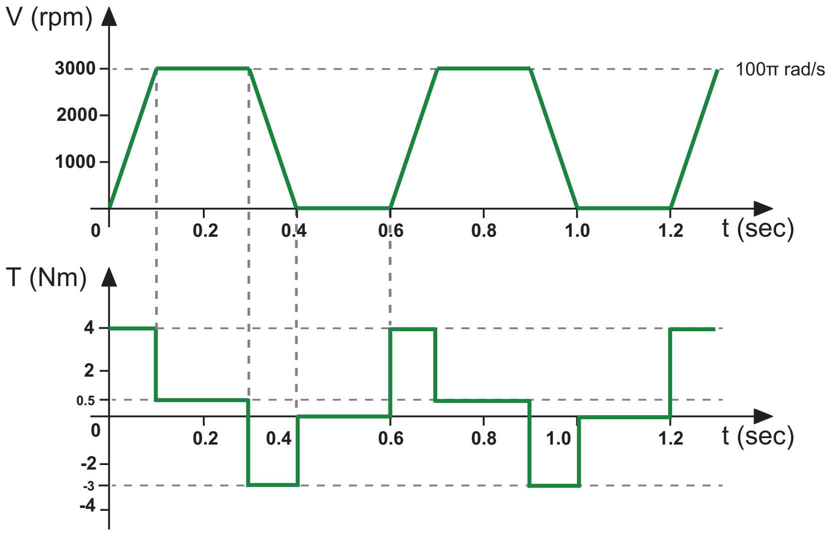
Calculation example

For this example we create an application with 10 R88E-AECT0230D-S2 motors and 6 R88E-AECT1130D-S2 motors.

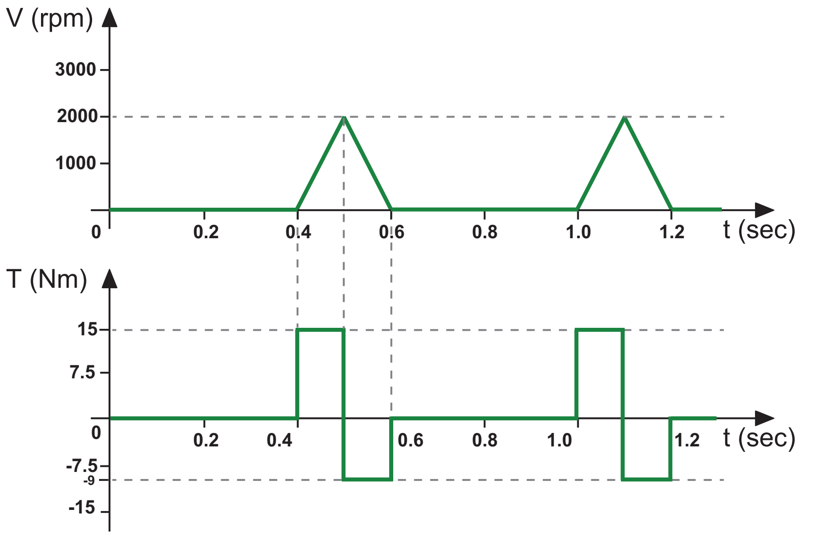
STEP 1: MOTOR APPLICATION CURVES

Torque-time and Speed-time curves according to the motor selection.

R88E-AECT0230D-S2 x 10



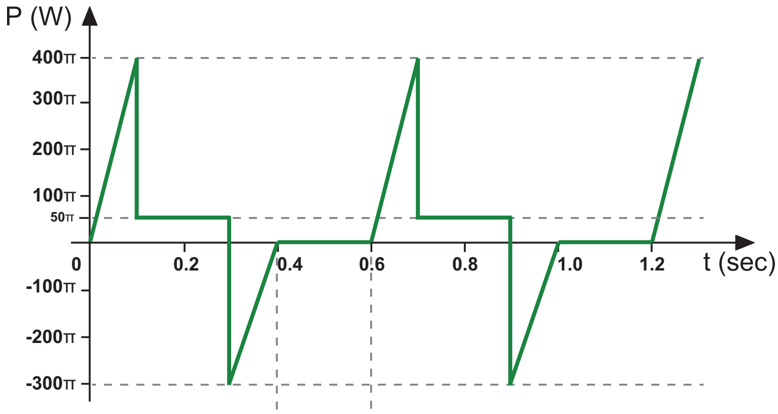
R88E-AECT1130D-S2 x 6



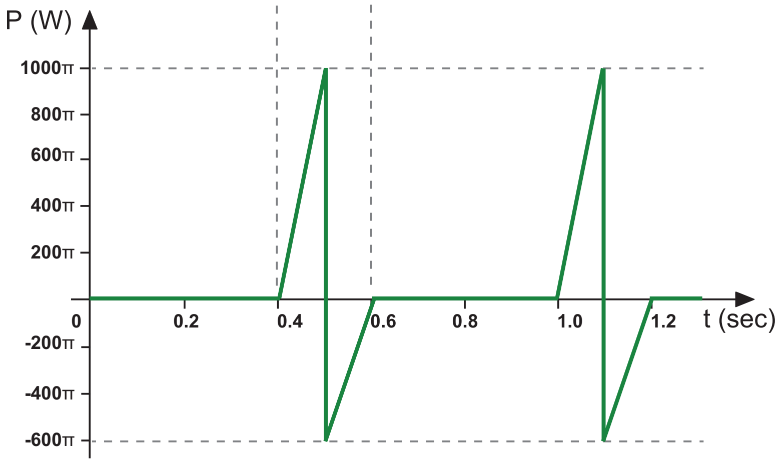
STEP 2: POWER CURVES

Power (W) = Speed (rad/s) x Torque (Nm)

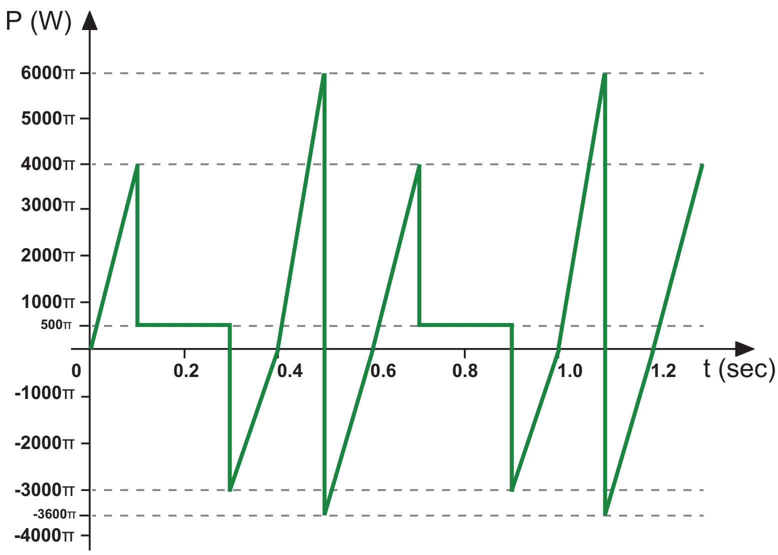
R88E-AECT0230D-S2 x 10



R88E-AECT1130D-S2 x 6



Application curve (10 x first + 6 x second)

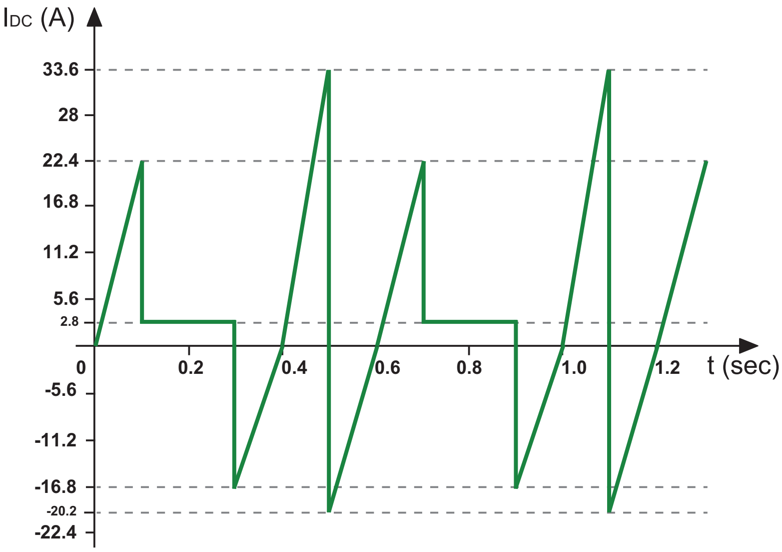


STEP 3: POWER SUPPLY CURRENT CURVES

VDC = 400 V

$$V_{DC} = 400\ V \cdot \sqrt{2} = 560\ V$$

$$I_{DC} = \frac{P_{application}}{V_{DC}}$$



STEP 4: CURRENT REQUIREMENTS

Application requirements for I_{DC} current.

I_{DC} peak = 33.6 A DC

I_{DC} rms = 11.42 A DC

STEP 5: DC POWER SUPPLY UNIT SELECTION

Selection of the power supply: R88S-EAD20R

4-7 Regenerative Energy Absorption

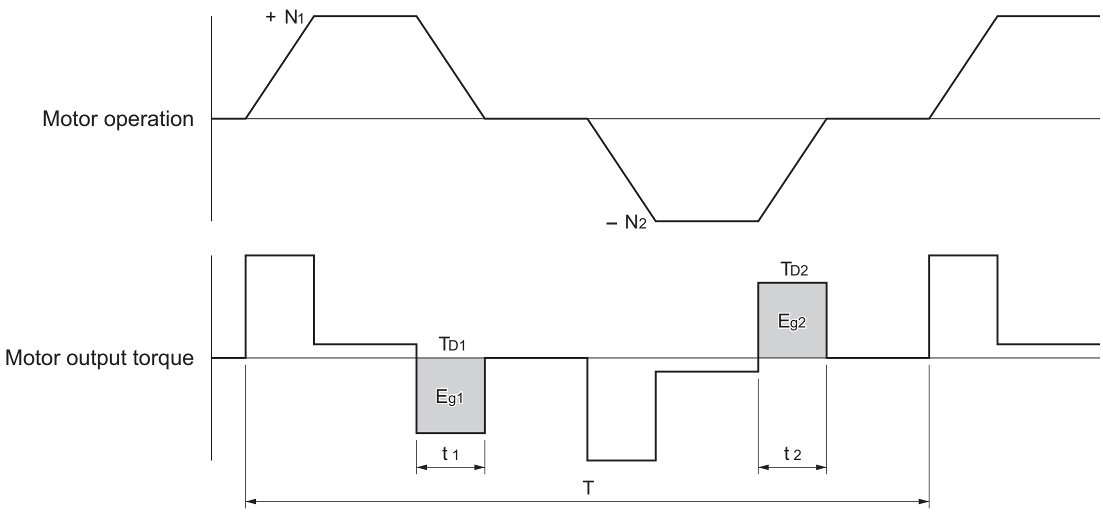
The regeneration is a drive working phase in which the drive brings energy to the DC bus during the motor deceleration. If this energy is not absorbed or dissipated, the DC bus voltage can increase and provoke the drive fault. The Integrated Servo Motors are not able to dissipate this energy internally. In order to dissipate the regeneration energy, it is necessary to supply the DC bus with a bidirectional power supply or with brake resistances, which can limit the DC bus voltage and let the drive work normally also during the motor deceleration.

Note To evaluate the level of the drive regeneration, it is necessary to take into account the peak of kinetic energy generated by the motor during its deceleration and the total energy continuously generated. These data are fundamental in order to choose the DC power supply. It is advisable to read the manual and the power supply technical documents.

4-7-1 Calculating the Regenerative Energy

The motor regeneration occur when the motor works as a generator. This happen when the motor decelerates rapidly one inertia or when the load is pulled externally, like in vertical axes.

Horizontal axis



- In the output torque graph, acceleration in the forward direction is shown as positive, and acceleration in the reverse direction is shown as negative.
- The regenerative energy values in each region can be derived from the following equations.

$$E_{g1} = \frac{1}{2}\frac{2\Omega}{60} \cdot N_1 \cdot T_{D1} \cdot t_1 \ [\mathrm{J}]$$

$$E_{g2} = \frac{1}{2}\frac{2\Omega}{60} \cdot N_2 \cdot T_{D2} \cdot t_2 \ [\mathrm{J}]$$

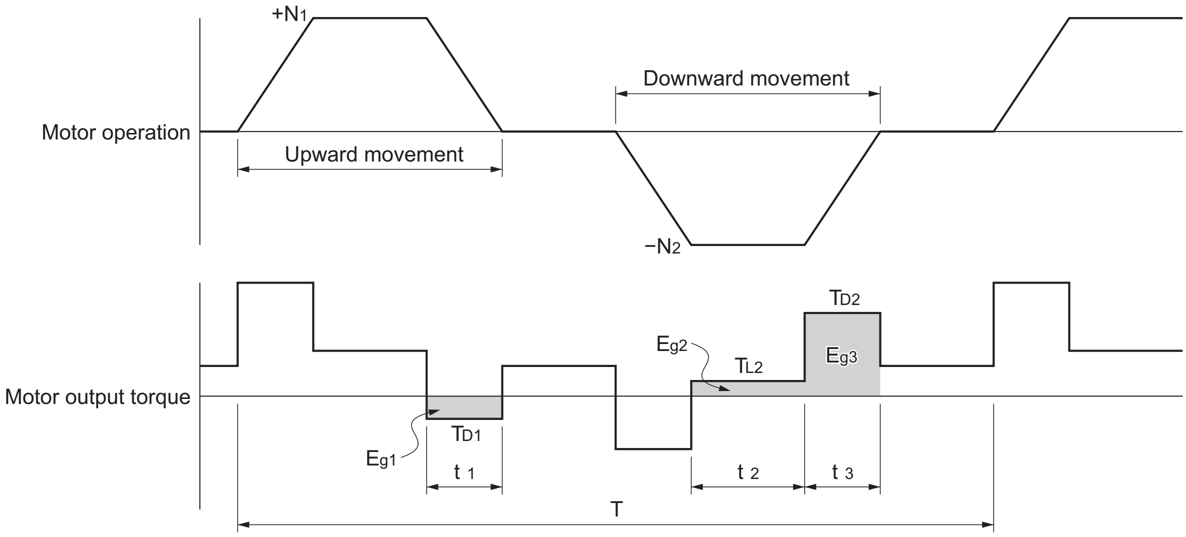
N_1, N_2: Rotation speed at start of deceleration [r/min]

T_{D1}, T_{D2}: Deceleration torque [N·m]

t_1, t_2: Deceleration time [s]

Note Due to the loss of motor winding resistance and PWM, the actual regenerative energy will be approx. 90% of the values derived from these equations.

Vertical axis



- In the output torque graph, acceleration in the forward direction (rising) is shown as positive, and acceleration in the reverse direction (falling) is shown as negative.
- The regenerative energy values in each region can be derived from the following equations.

$$E_{g1} = \frac{1}{2}\frac{2\Omega}{60} \cdot N_1 \cdot T_{D1} \cdot t_1 \text{ [J]}$$

$$E_{g2} = \frac{1}{2}\frac{2\Omega}{60} \cdot N_2 \cdot T_{L2} \cdot t_2 \text{[J]}$$

$$E_{g3} = \frac{1}{2}\frac{2\Omega}{60} \cdot N_2 \cdot T_{D2} \cdot t_3 \text{[J]}$$

N_1, N_2: Rotation speed at start of deceleration [r/min]

T_{D1}, T_{D2}: Deceleration torque [N·m]

T_{L2}: Torque during downward movement [N·m]

t_1, t_3: Deceleration time [s]

t_2: Constant speed driving time during downward movement [s]

Note Due to the loss of motor winding resistance, the actual regenerative energy will be approx. 90% of the values derived from these equations.

As the Integrated Servo Motors share a common DC-Bus, the power regenerated in one motor is immediately used in other motors that are “motoring”.

Only in the case that the sum of the instantaneous regenerated power returned by the motors that are regenerating is bigger that the power consumed by the motors that are motoring it is necessary to dissipate the difference (**Power_regenerated** – **Power_consumed**).

To calculate this total regenerated energy, follow Steps 1 and 2 of **Section 4-6-1 DC Power Supply Unit Selection**. The areas of the application Power–time graph with negative power are the areas that needs that the power supply accumulate or dissipate the power.

4-7-2 DC Power Supply Unit Regeneration Absorption Capacity

The DC Power Supply Unit absorbs regenerative energy internally with built in capacitors. The amount of energy that can be stored in the capacitor depends on the supply voltage and the braking circuit operation voltage, as follows:

$$Energy_{absorbable}(J) = \frac{1}{2}C \cdot (V_{braking} - V_{dc})^2$$

Where:

$V_{braking}$= Voltage threshold to activate the braking circuit. It is adjustable and the default value is 785 VDC

V_{DC}= Normal operating DC bus voltage, it is VAC * $\sqrt{2}$

C = Capacity of the DC Power Supply Unit: 940 uF for the R88S-EAD20R and 1500 uf for the R88S-EAD40R

For a 400 V power supply we have:

Model	Absorbed energy
R88S-EAD20R	23 J
R88S-EAD40R	36.6 J

Returning energy exceeding those values needs to be dissipated in the braking circuit of the power supply:

Model	Internal resistor average dissipation	Internal resistor	Allowable minimum regeneration resistor
R88S-EAD20R	120 W	33 Ω	16 Ω
R88S-EAD40R	120 W	33 Ω	16 Ω

4-7-3 Regenerative Energy Absorption with an External Regeneration Resistor

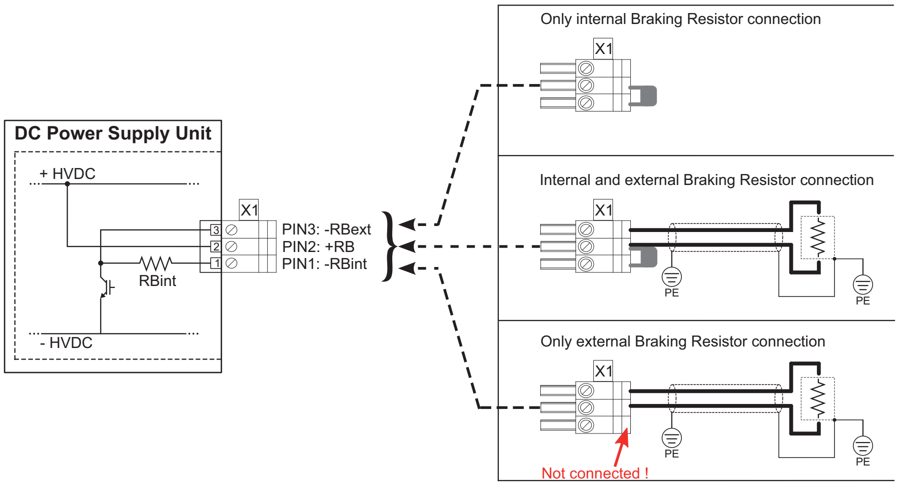
If the regenerative energy exceed the absorption capacity of the power supply (energy absorbed by the capacitors and power dissipated in the internal resistor) it is necessary to connect an external regeneration resistor.

Note Connect a resistor of 16 Ω or more.

The Maximum power pulse of the power supply braking circuit is 20 KW for 300 ms.

The power capacity of the resistor must be selected according to the application regenerated Power to be dissipated.

If you connect an external regeneration resistor make sure to remove the Jumper installed between Pin 1 and Pin 2.

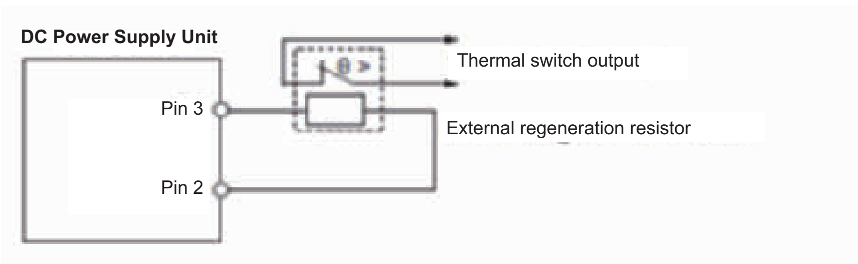


It is possible to install an external resistor in combination (parallel) to the internal one provided that:

- The external resistor ohmic value is 33 Ohm (so, the result of the parallel resistance is 16 Ohm)
- The average power to be dissipated do not exceed 240 W

4-7-4 Connecting an External Regeneration Resistor

Install a thermal switch in the resistor and use it to stop the operation of the machine in case of overheating. For example, in series with RTO contact.



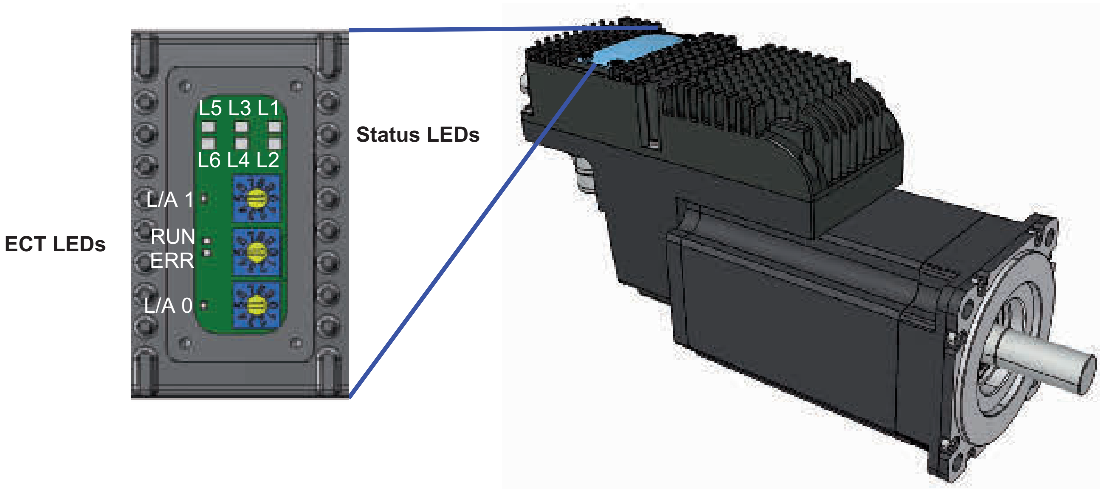
5

EtherCAT Communications

This section describes EtherCAT communications under the assumption that the Integrated Servo Motor is connected to a Machine Automation Controller NX/NY/NJ-series.

5-1 Display Area and Settings

5-1-1 LEDs



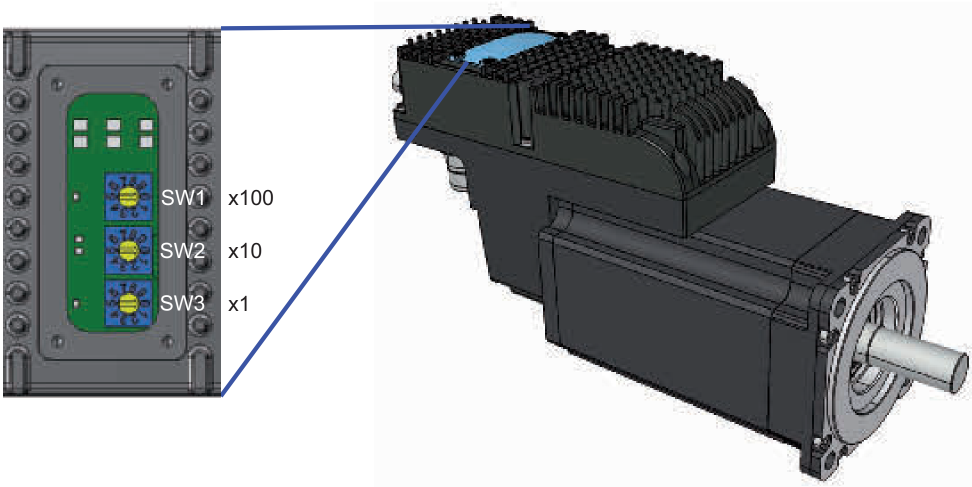
The LEDs can have the following status:

- **OFF:** LED switched OFF
- **ON:** Fixed LED switched ON
- **BLK (blinking):** LED 200 ms ON, 200 ms OFF
- **1 FL (1 flash):** LED 200 ms ON, 1 s OFF
- **2 FL (2 flash):** LED 200 ms ON, 200 ms OFF, 200 ms ON, 1 s OFF
- **3 FL (3 flash):** LED 200 ms ON, 200 ms OFF, 200 ms ON, 200 ms OFF, 200 ms ON, 1 s OFF
- **FLK (flicker):** LED 50 ms ON, 50 ms OFF

The notifications meaning, shown through LEDs, can be found in the following table:

LEDs	Description
L1, L2	Drive status (fault, warning, enabling)
L3, L5	Reserved (LED OFF)
L4	Overload (I2T) status
L6	Input status /STOP
L/A 0	Status of the physical link/activity of the EtherCAT port on the CN3 connector
L/A 1	Status of the physical link/activity of the EtherCAT port on the CN2 connector
ERR	EtherCAT error LED
RUN	EtherCAT run LED

5-1-2 Rotary Switches

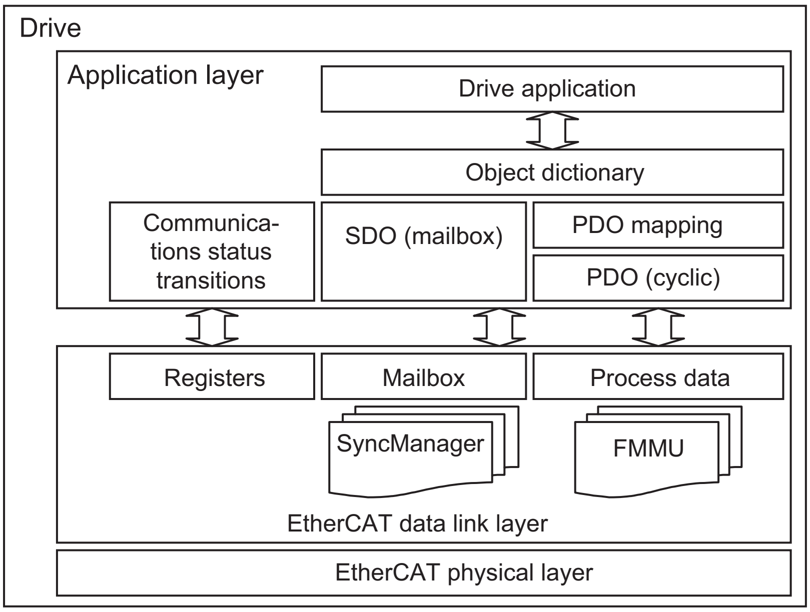


The parameters defined by the rotary switches can be found in the following table:

Rotary switch	Description
SW1	EtherCAT user address (station alias) x100
SW2	EtherCAT user address (station alias) x10
SW3	EtherCAT user address (station alias) x1

5-2 Structure of the CAN Application Protocol over EtherCAT

The structure of the CAN application protocol over EtherCAT (CoE) for a Integrated Servo Motor series with built-in EtherCAT communications is described in this section.



Normally, multiple protocols can be transmitted using EtherCAT. The IEC 61800-7 (CiA 402) drive profile is used for Integrated Servo Motor series with Built-in EtherCAT Communications.

The object dictionary in the application layer contains parameters and application data as well as information on the PDO mapping between the process data servo interface and drive application.

The process data object (PDO) consists of objects in the object dictionary that can be mapped to the PDO. The contents of the process data are defined by the PDO mapping.

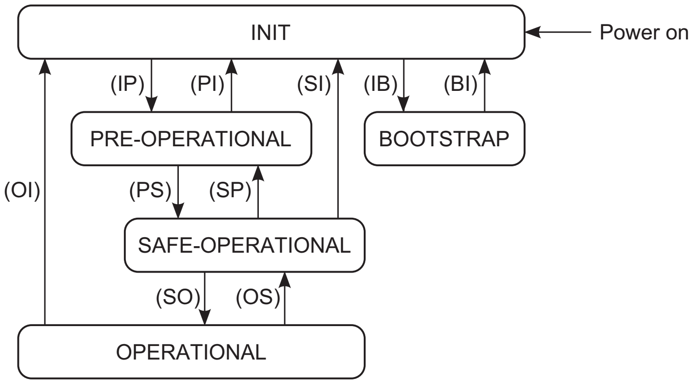
Process data communications cyclically reads and writes the PDO. Mailbox communications (SDO) uses asynchronous message communications where all objects in the object dictionary can be read and written.

5-3 EtherCAT State Machine

Note About the communication settings with a EtherCAT master, please refer to **Section 11-3 Communicating with EtherCAT Master**.

The communication port EtherCAT is the interface of the main bus for the drives. The main bus must be connected to the connectors CN2 e CN3. The implemented protocol EtherCAT respects the specifications of the organization EtherCAT Technology Group (ETG). In the drives of the Integrated Servo Motors the interface towards the network EtherCAT is constituted by the ASIC ET1100.

To check the flow of the messages of the communication port, the nodes EtherCAT are equipped with a state machine.



The statuses of the EtherCAT state machine have the following meaning:

- INIT: initialization of the drive; no protocol and no service are enabled; to recognize and set the drive the master can have access only to the registers of the ET1100
- PRE-OPERATIONAL: configuration of the drive and of the PDOs; all communication protocols are enabled but the PDO service is disabled
- SAFE-OPERATIONAL: all communication protocols are enabled and the PDO service is enabled only during transmission (PDO TX)
- OPERATIONAL: all communication protocols are enabled and the PDO service is completely enabled
- BOOTSTRAP: only the update of the drive firmware with the protocol File access over EtherCAT is enabled

After the Power on the drive runs the operations scheduled in the INIT status and remains in such status waiting for the commands coming from the master. The LED RUN shows the status of the EtherCAT state machine.

Status	Available services			
	CoE	FoE	PDO TX	PDO RX
INITIALIZATION	-	-	-	-
PRE-OPERATIONAL	Yes	Yes	-	-
SAFE-OPERATIONAL	Yes	Yes	Yes	-
OPERATIONAL	Yes	Yes	Yes	Yes
BOOTSTRAP	-	Yes	-	-

5-3-1 Sync Manager (SM)

The management of the messages of the EtherCAT communication port is carried out through the Sync manager (SM). In the following table you can find the features of the Sync managers that can be used in the Integrated Servo Motors.

SM	Communication mode	Starting address	Dimension (byte)	Available services
0	Mailbox RX	0x1000	128	CoE, FoE
1	Mailbox TX	0x1080	124	
2	Buffered RX	0x1100	64	PDO RX
3	Buffered TX	0x1180	64	PDO TX

The communication modes of the Sync managers show how the data are exchanged between the master and the drives:

- Mailbox mode: mechanism of handshake guaranteeing the complete reading of the message before sending next message; it is used for the communication protocols
- Buffered mode: access to the buffers of the data in a substantial way in any moment; it is used for the PDOs

The parameters of the Sync managers are described in **Section 10-3-19 Sync Manager and PDOs managed by the EtherCAT Port**.

Note The following paragraphs describe how the functionalities for the EtherCAT communication port have been implemented in the Integrated Servo Motor.

5-3-2 Protocol CANopen over EtherCAT (CoE)

The CoE implements in the EtherCAT drives the application layer of the CANopen protocol (see specifications of DS-301).

The CoE provides the Service data object (SDO) to exchange data with confirmation. The SDOs are used to access all parameters of the dictionary (**Section 10-3 Object Details (Integrated Servo Motor)**). Their messages have the same dimension as the whole mailbox of the protocol CoE. The drives of the Integrated Servo Motor support two types of data transfer with the SDOs:

- Mode expedited: SDO is composed by one message of request and one message of answer; it is possible to transfer up to four bytes of data through this mode
- Mode normal: it is used for the transfer of data with a dimension bigger than four bytes

The SDOs are used to configure the drive and the PDOs (see the below **Section 5-4 Process Data Objects (PDOs)**), and are used generally for the low priority communication between the drives and the master.

The CoE also provides the service SDO information to read the information on the parameters of the dictionary: the whole list of all parameters, the list of the parameters mappable on PDO, information on the single parameters, etc.

5-4 Process Data Objects (PDOs)

The PDOs are used for the exchange of data in real time without any confirmation by the one receiving them; in this way the network is less overloaded.

The PDOs are based on the relation producer - consumer, in which the producer sends the PDO message and the consumer receives it. In the network EtherCAT it is always the master who starts the communication and sends the PDOs; depending on the type of PDOs, the drives in the network can be producer and complete the outgoing PDOs, or consumer with the incoming PDOs. The drives of the Integrated Servo Motor offer the possibility to manage up to 4 outgoing PDOs (PDO TX) and 4 incoming PDOs (PDO RX). Every PDO must be assigned to a Sync manager (SM). The association of type of PDO and number of Sync manager (SM) is reported in the above **Sync manager (SM) table**.

The PDOs must be configured and enabled in the PRE-OPERATIONAL status before being used. Their configuration implies the writing of two parameter groups:

- Mapping parameters: parameters used to manage the mapping in the PDOs of the mappable parameters (addresses CANopen from 0x1800 to 0x1803 for the PDO RX and from 0x1A00 to 0x1A03 for the PDO TX)
- Sync manager PDO assignment parameters: parameters to assign the PDOs to the Sync manager (SM) (addresses CANopen from 0x1C10 to 0x1C13)

Note The PDOs TX are enabled in the statuses SAFE-OPERATIONAL and OPERATIONAL; the PDOs RX are enabled only in the status OPERATIONAL.

5-4-1 PDO Mapping

The PDOs allows the overall exchange of 64 bytes in reception (for the 4 PDO RX) and others 64 byte in transmission (for the 4 PDO TX). Each PDO can contain up to 8 parameters independently by their dimension. If, for example, 2 PDO TX are mapped with 8 parameter of 4 byte each, will be used all the 64 bytes that are available in the PDOTX reserved exchange area and, therefore, it's not possible to map other PDOs (naturally the same applies for PDO RX).

The mappable parameters are identified through the writing “YES” in the “PDO” field of the table that describe them (see **Section 10-1 Agreements on the Parameters Description**).

Both the incoming PDO RX interpretation and the outgoing PDO TX construction have to respect the order in which the parameters are mapped in the PDO, starting from the 1° till the last one. So it's important to pay attention on the parameters insertion order during the PDO mapping operation.

In particular, to use the PDO RX to execute an axis movement, it's necessary to insert the moving parameters first (eg. Velocity, target Position, ...) and at last, as last parameter mapped on PDO, the **ControlWord** to command the movement. (Please refer to the PdoRx3_MappingParameters and PdoRx4_MappingParameters default PDO RX).

The whole list of all useful parameters to manage the PDOs is reported in **Section 10-3-19 Sync Manager and PDOs managed by the EtherCAT Port**.

Note The procedures to manage the PDOs are in compliance with the specifications shown by EtherCAT Technology Group (ETG).

5-4-2 Missing or Corrupted PDO RX Management

The EtherCAT field bus is not tolerant about the messages that are lost in the network and, on consequence, doesn't manage their automatic retransmission (as instead happens in the CANopen field bus). That implies that if a PDO RX is corrupted or doesn't arrive in correspondence of the synchronization reference (see **Section 5-6 Synchronization**), the drive immediately generates an alarm and disables the motor. To avoid this inconvenience OMRON has implemented in the drive of the Integrated Servo Motor a PDO RX monitoring and management system.

This system has been introduced to avoid that the drive goes in alarm state if the consecutive missing of a certain number of PDO RX is not considered serious (see **EtcPdoRxMissingTollerance**). Until the loss is lower or equal to this value the movement will proceeds with the last valid received data. In the particular case of Interpolated Position Mode the drive cannot command to continue the motion because it needs to receive regularly the velocity and position targets (see **Section 7-2-2 Interpolated Position Mode**), then it will move the motor by reconstructing the profile coherently with the last received valid data (then referring to the last valid PDO RX), and so continuing the movement that it was making before the PDO RX loss.

This means that the more is high the number of tolerated consecutive and not valid PDO RX, the more long may be the movement that's defined by the previous parameters and not controlled by the master.

Note The corrupted or missing PDO RX management is active only when the drive is in OPERATIONAL state (see EtherCAT state machine). Exceeded the corrupted or missing PDO tolerance (see **EtcPdoRxMissingTolerance [5FF6.02]**) the drive goes in synchronization error. The occurrence of this alarm condition implies the transition from the OPERATIONAL to the SAFE-OPERATIONAL state.

Note If the PDOs RX arrive too close, the alarm is immediately generated independently of the set tolerance. For a complete diagnostic see the **EtherCAT_Diagnostics [5FF6.xx]** parameter group.

5-5 Service Data Objects (SDOs)

The SDOs are objects whose aim is exchanging data with confirmation and are used to access all the parameters of the dictionary. The size of their messages is set at 8 bytes: some are used as control bytes and others for sending data.

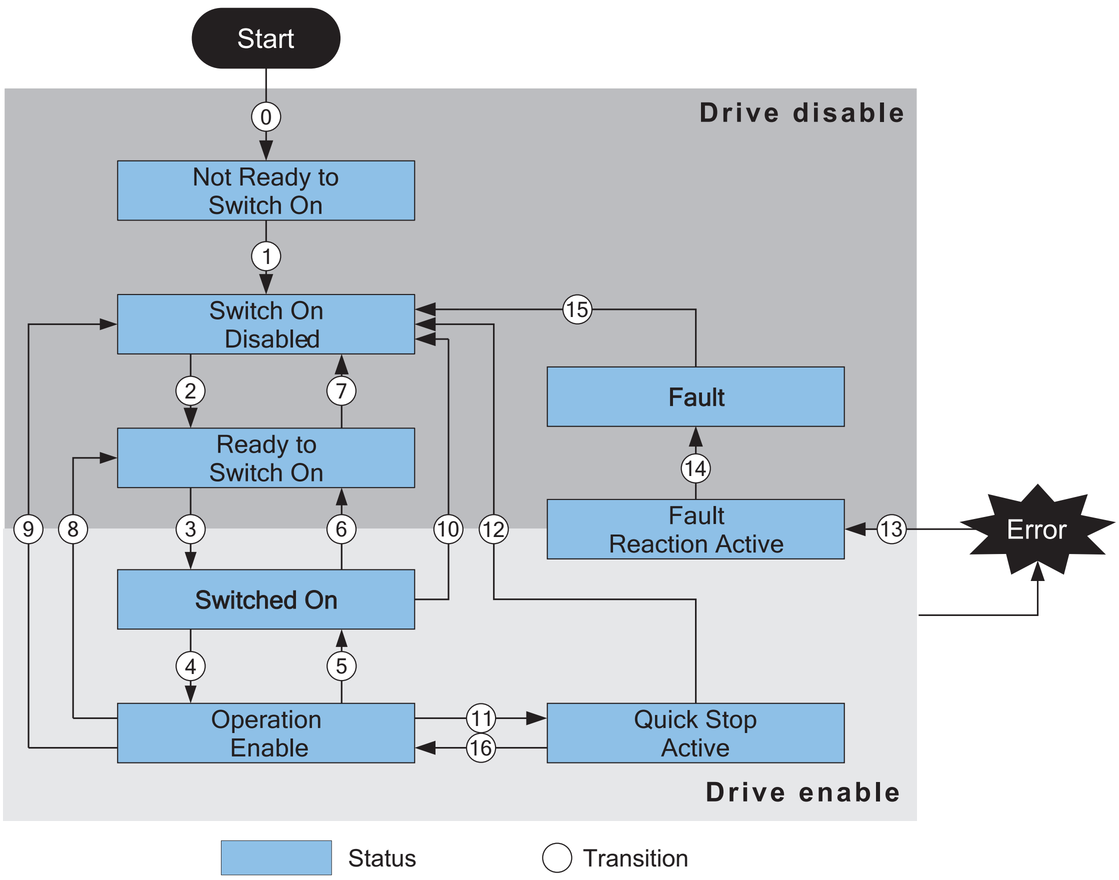
The Integrated Servo Motors supports two types of data transfer with this service:

- **Mode expedited:** SDO is made up by a single request message and a single answer message, in which 4 bytes are used for the control (type of operation to be run, indexes and subindex). You can transfer up to 4 bytes of effective data
- **Mode normal:** the transfer is an initial negotiation between master and slave where you can find the size of the data to be transferred; the data are later sent through the transmission of 8-byte-messages containing one single control byte and 7 data bytes

The SDOs are used to configure the drive and the PDOs (see the above section), and are used generally for the low priority communication between the drives and the master.

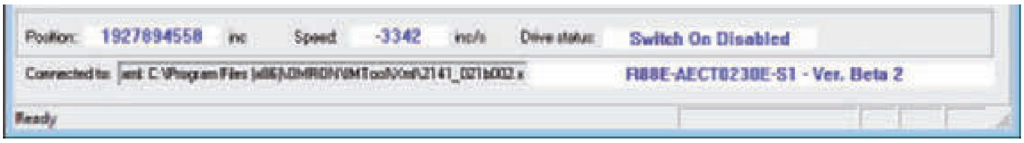
5-5-1 CiA402 State Machine

To manage the drives, the specifications of the CiA402 need the implementation of a state machine which scheme can be found in the following picture. The drives of the Integrated Servo Motor respect the CiA402 specifications.



To enable or disable the drive and the motor motion, to stop and reset any error you need to ask for the right transitions to the CiA402 state machine so that it can reach the desired status. The parameter **Statusword [6041.00]** shows the status of the CiA402 state machine. Access with IM-TOOL:

Tab Main > Drive status



The status of the CiA402 state machine is partly shown also with the L1 and L2 LEDs, according to the following chart. The encoding of the errors can be found in **Section 13-2-1 Monitoring the Errors on the Status LEDs**.

Status of the drive	LED L1	LED L2
Drive enable no error	GREEN ON	GREEN ON
Drive disable no error	GREEN ON	BLINKING GREEN
There are some errors of warning type and not of fault type	ORANGE VARIOUS STATUS (See **Section 13-2-1**)	
There are some errors of fault type	RED VARIOUS STATUS (See **Section 13-2-1**)	

In the following chart you can find all the possible statuses and their features. The bits shown with an 'x' are not important to determine the status.

Statusword	Status	Description	Drive enable	Operation enable	PLC running	Communication drive
xxxx xxxx x0xx 0000	Not ready to switch on	Initializing	-	-	-	-
xxxx xxxx x1xx 0000	Switch on disabled	Drive disabled	-	-	Yes	Yes
xxxx xxxx x01x 0001	Ready to switch on	Preparation to enabling	-	-	Yes	Yes
xxxx xxxx x01x 0011	Switched on	Drive enabled without commanding the motor motion	Yes	-	Yes	Yes
xxxx xxxx x01x 0111	Operation enable	Drive enabled and possibility to command the motor motion	Yes	Yes	Yes	Yes
xxxx xxxx x00x 0111	Quick stop active	Running a Quick stop	Yes	-	Yes	Yes
xxxx xxxx x0xx 1111	Fault reaction active	Reaction to a fault situation. The drive can be enabled or not, depending on the situation before the error occurred	-	-	Yes	Yes
xxxx xxxx x0xx 1000	Fault	Fault state, finished reaction	-	-	Yes	Yes

In the following table you can find the description of the single bits of the **Statusword [6041.00]** parameter; some bits have a different meaning depending on the value of **ModesOfOperationDisplay [6061.00]**, indicated in the Mode column.

Bit	Mode	Name	Description
0	All	Ready to switch on	Encoding the status CiA402 state machine (see above table)
1		Switched on	
2		Operation enabled	
3		Fault	Bit which is set when a fault is detected
4		Voltage enabled	Bit that indicates if the HV supply voltage is applied or not on the drive power section
5		Quick stop	Encoding the status CiA402 state machine (see the above table)
6		Switch on disabled	
7		Warning	Bit which is set when a warning is detected
8		Reserved	
9		Remote	Bit which is set when the **Controlword [6040.00]** is processable from the CiA402 state machine. If you write the parameter **Controlword [6040.00]** when this bit is equal to 0, the operation does not have any effect
10	8, 9 and 10	Reserved	
	Others	Target reached	Bit which is set when the motor reaches the set-point (see Position target reached, Speed target reached or Torque target reached). In the Homing Mode it is set when the procedure ends. It's always reset on the homing operative mode entrance (writing 6 on the operative mode, when the **ModesOfOperationDisplay [6061.00]** has a different value) or when a new procedure is started. For the Gear Mode see **Section 7-2-4 Gear Mode**
11	All	Interval limit active	Bit that must be set when at least one position limit is reached, speed or torque (see the limits in the **Section 8 Applied Functions**)
12	1	Set-point acknowledge	Status of capture / processing of the position set-point (see **Section 7-2-1 Profile Position Mode**)
	3, -113 and -111	Speed	Bit which is set to Stopped motor
	6	Homing attained	Bit which is set when the homing procedure is regularly completed (see **Section 7-5 Homing Mode**). It continues to indicate the last executed homing status, until a new procedure is started. For the drives in which the feedback sensor absolute mode management use is programmed, the homing status remains stored in the drive even if it is turned off and on again.
	7	Ip mode active	Status of the Interpolated Position Mode (see **Section 7-2-2 Interpolated Position Mode**)
	8	Target position ignored	Bit which is set when the **TargetPosition [607A.00]** is used (see **Section 7-2-3 Cyclic Synchronous Position Mode**)
	9	Target velocity ignored	Bit which is set when the **TargetVelocity [60FF.00]** is used (see **Section 7-3-4 Cyclic Synchronous Velocity Mode**)
	10	Target torque ignored	Bit which is set when the **TargetTorque [6071.00]** is used (see **Section 7-4-3 Cyclic Synchronous Torque Mode**)
	Others	Reserved	
13	1, 8 and -126	Following error	Presence or absence of the Error of position tracking
	6	Homing error	Bit which is set when an error is detected during the homing procedure (see **Section 7-5 Homing Mode**). It continues to indicate the last executed homing status, until a new procedure is started. For the drives in which the feedback sensor absolute mode management use is programmed, the homing status remains stored in the drive even if it is turned off and on again.
	Others	Reserved	

Bit	Mode	Name	Description
14	All	Reserved	
15		Reserved	

To run some operations with the CiA402 state machine, you need to write some commands of the parameter **Controlword [6040.00]**. The bits of the parameter **Controlword [6040.00]** are divided in the following way:

- Bit 0 to 3 and 7 to run the Transition of the CiA402 state machine
- Bit 8 to manage the Halt command
- Bit 4 to 6 to ask for some specific commands that change depending on the value of **ModesOfOperationDisplay [6061.00]**
- Bit 9 to 12 Reserved
- Bit 13 to 15 for the Gear Mode operation

To change the status of the CiA402 state machine, write in the parameter **Controlword [6040.00]** the commands in the following chart. The bits shown with a 'x' are not important to determine the command and the symbol / shows a transition from 0 to 1 of the related bit.

Command	Controlword	Transitions
Shutdown	xxxx xxxx 0xxx x110	2, 6, 8
Switch on	xxxx xxxx 0xxx 0111	3
Switch on + enable operation	xxxx xxxx 0xxx 1111	3 + 4
Disable voltage	xxxx xxxx 0xxx xx0x	7, 9, 10, 12
Disable operation	xxxx xxxx 0xxx 0111	5
Enable operation	xxxx xxxx 0xxx 1111	4, 16
Quick stop	xxxx xxxx 0xxx x01x	7, 10
		11
Fault reset	xxxx xxxx /xxx xxxx	15

Note In the command Switch on + enable operation, the transition 4 is automatically run after the running of the transition 3.

In the following chart you can find the description of the single bits of the parameter **Controlword [6040.00]**; some of them have a different meaning depending on the value of **ModesOfOperationDisplay [6061.00]**: the column Mode shows the value that the parameter **ModesOfOperationDisplay [6061.00]** must have so that the bit shown has the specified meaning.

Bit	Mode	Name	Description
0	All	Switch on	Bit used to encode the commands of the status transitions of the CiA402 state machine (see above table)
1		Enable voltage	
2		Quick stop	
3		Enable operation	
4	1	New set-point	A rising edge of this bit enables the trajectory generator that controls the profile parameters, processes them and runs the positioning (see **Section 7-2-1 Profile Position Mode**)
	6	Homing operation start	Bit enabling the start/stop of the homing procedure (see **Section 7-5 Homing Mode**)
	7	Enable ip mode	Bit used for the enabling/disabling of the Interpolated Position Mode (see Section **7-2-2 Interpolated Position Mode**)
	Others	Reserved	
5	1	Change set immediately	Selector of the positioning mode between Single set-point and Set of set-point, to be set with the transition of the bit New set-point (see **Section 7-2-1 Profile Position Mode**)
	Others	Reserved	
6	1	Absolute / Relative	Selector of the mode used to interpret the position target, to be set with the transition of the bit New set-point (see **Section 7-2-1 Profile Position Mode**)
	Others	Reserved	

Bit	Mode	Name	Description
7	All	Fault reset	Bit used to encode the commands of the status transitions of the CiA402 state machine (see above table)
8		Halt	Bit used to run a stop of the motor
9 - 12		Reserved	
13	-126	Start gear ratio disable	Bit used to define the starting following ratio of the adjustment ramp (see **Section 7-2-4 Gear Mode**)
14		Reset trigger	Bit used to set the adjustment ramp starting (see **Section 7-2-4 Gear Mode**)
15		Start gear	Bit used to start the movement in Gear Mode (see **Section 7-2-4 Gear Mode**)

Please remember that a single writing of the **Controlword [6040.00]** cannot run either a transition or the start of a motion at the same time. In particular if the bits causing changes of the status (bit 0 to 3 and 7) are different from those written with the precedent access to the **Controlword [6040.00]**, the other bits (bit 4 to 6, 8 to 15) are not taken into consideration. Vice versa, if the bits causing changes of the status (bit 0 to 3 and 7) do not change, other bits are also taken into consideration, but only if the drive is in the Operation enable status.

Note During the access in writing to the **Controlword [6040.00]** no bits changes are accepted during a status transition of the CiA402 state machine. This condition is reported by the Remote bit of the **Statusword [6041.00]**.

5-6 Synchronization

The synchronization of the PDOs is managed through the Sync manager (SM) by setting the related registers of the ET1100. The related settings can be read in the parameters Sync manager synchronization (see **Section 10-3-19 Sync Manager and PDOs managed by the EtherCAT Port**).

In the drive of the Integrated Servo Motor have been implemented three synchronization modes:

- Free run
- Soft sync
- Hard sync

Free run

The Free run mode does not have any mechanism of synchronization of the PDOs, they are managed at low priority.

Soft sync

The Soft sync mode synchronizes the outgoing PDOs TX with the incoming PDOs RX. This synchronization way is useful when the master does not support the synchronization of Hard sync and/or when there is no need for a correction because of the delays of the network EtherCAT (for example on networks of small dimension). To use this mode it is necessary to set the Sync managers of the PDOs in order to get in the parameters SM2_SynchronizationType and SM3_SynchronizationType the values respectively 1 and 34 and it is necessary to set the T_{SYNC} through the parameter **CommunicCyclePeriod [1006.00]**.

Hard sync

The Hard sync mode can be used only with the masters that manage the functionality Distributed clocks. The distributed clocks is used to synchronize the drive more precisely by cancelling any errors generated by propagation times, offset and derive. With the synchronization way Hard sync it is possible to synchronize up to 65535 drives (highest limit allowed by a EtherCAT network). To use this mode it is necessary (for every drive):

- To run with the master the sequence of operations to calculate the corrections of the times for the distributed clocks and to apply them
- To write the cycle time T_{SYNC} in the registers of the ET1100 for the cyclic generation of the **SyncSignal** signal
- To set the registers of the Sync managers of the PDOs in order to get the value 2 in the parameters **SM2_SynchronizationType [1C32.01]** and **SM3_SynchronizationType [1C33.01]**

PDO transmission/sending/analysis sequence

The order with which the messages are transmitted/sent/analyzed is the following:

- The master sends the PDO(s) RX
- The synchronism signal is activated. The signal is the signal of Sync Signal if the used synchronism is the Hard sync, or the same PDO RX message if the used synchronism is the Soft sync
- The drive composes and sends the PDO TX
- The drive analyzes and executes the operations that are required by the PDO RX

5-7 Emergency Objects

Through the **ErrorCode [603F.00]** parameter the code of the last error is reported. The code contains all the informations that are useful to identify the error type and is composed by 8 bytes that are divided in three parts: Emergency Error Code (EEC, byte 0-1), **ErrorRegister [1001.00]** (byte 2) and Reserved (byte 3-7, not used). In the following table the values of the EEC part, according to the detected error, are reported:

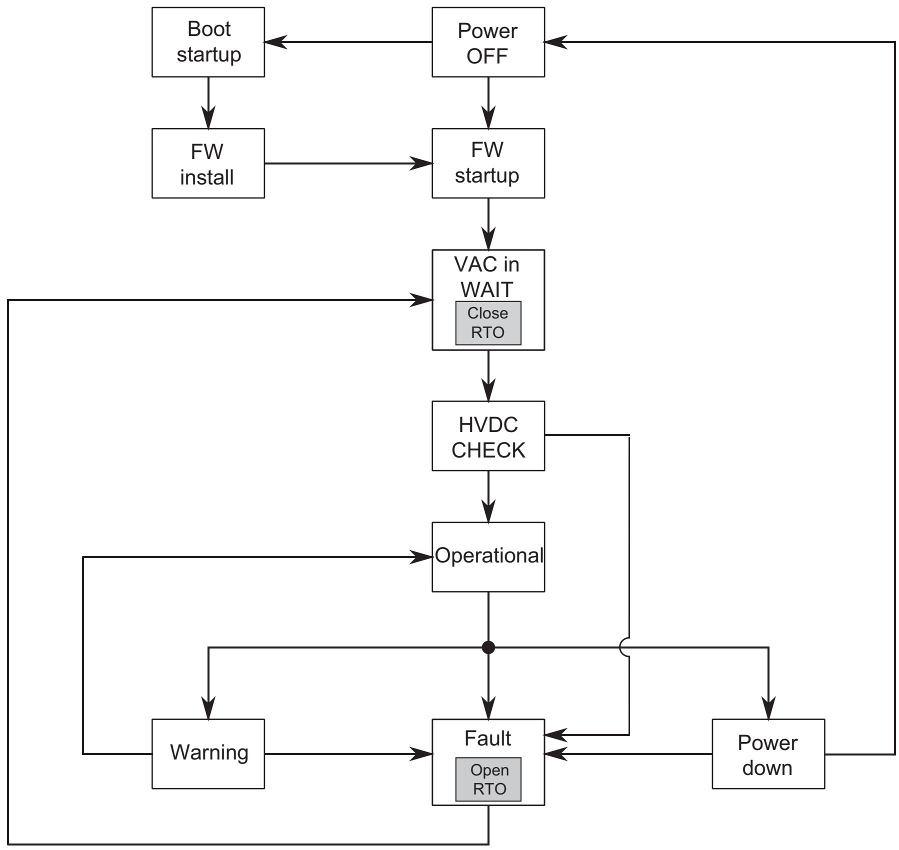
EEC	Description
0x0000	Reset error or no error
0x2250	Power or motor short circuit error
0x2310	Power or motor over current error
0x2350	I2T limit reached error
0x3210	Over voltage power section error
0x3220	Under voltage power section error
0x4210	Thermal management error: Over temperature of logic section
	Thermal management error: Over temperature of motor
0x4310	Thermal management error: Over temperature of power section
0x5114	Logic voltage error: Logic voltage too low for brake
0x6320	Parameters serious error
	Digital IO configuration error
0x7200	Thermal management error: Power Temp Sensor hardware failure
	Thermal management error: Logic Temp Sensor hardware failure
	Thermal management error: Motor Temp Sensor hardware failure
0x7300	Unable to align due to Hardware problems - please contact your OMRON representative
0x8611	Following position error
0x8700	Sync controller error
0xFF00	Real time mode error
0xFF01	User fault error
0xFF04	/STOP = 0V with drive enabled error
0xFF05	Last command requested failed

6

DC Power Supply Unit Setup

This section describes how to setup the Power Supply Unit.

6-1 Logical States



Status	Description
Power OFF	Logic section 24 V supply missing, through the hardware circuit the RTO contact is kept disabled.
Boot startup	24 V supply present, boot start-up to fill a firmware anomaly (corrupted firmware or hardware and boot incompatibility).
FW install	Updating the firmware through the debug serial port.
FW startup	24 V supply present, correct firmware start-up.
VAC in WAIT	The RTO contact is closed and the VAC input voltage is controlled, the next status is reached only if an input voltage included in the functioning limits is detected, otherwise the VAC in WAIT status remains.
HVDC CHECK	The output voltage trend is analyzed: within the capacitors charging time the voltage must grow until a value within VOUT_MIN and VOUT_MAX and the ripple must be lower than a safety threshold. At the end of this phase, if all the parameters are within the limits, the system is in normal functioning conditions and the device switches to the Operative status, otherwise it switches to the Fault status.
Operational	The power supply works normally, no warnings or faults are detected.
Warning	The power supply works normally, but some parameter has exceed the warning threshold (voltage/current/temperature).

Status	Description
Fault	The power supply is in this status when one of the type of the monitored faults happens, so the RTO contact is opened and the timer of Fault restore waiting starts. When the restore waiting time is elapsed it is verified if the fault is solved, and in this case the power supply returns in the VAC in WAIT status, according to available restore sources (In 0 input, automatic restore, restore via software with IM-TOOL); otherwise the Fault status remains.
Power down	The power supply is in this status when the 24 VDC voltage fall down below 18 VDC, in this case the RTO contact is opened. If the voltage supply restores, the power supply switches to the “NO 24V IN” status and returns the Input voltage missing on control section status.

6-2 Parametrization

These are the limits that can be set by the user:

Parameter name	Description	R88S-EAD20R		R88S-EAD40R	
		Default	Range	Default	Range
OutputCurrentLimit [Modbus 2134]	Total positive current CH1+CH2 (outgoing)	20 A	1 to 20 A	40 A	1 to 40 A
CableCurrentLimit(CH1) [Modbus 2142]	RMS current on CH1	10 A	1 to 25 A	20 A	1 to 25 A
CableCurrentLimit(CH2) [Modbus 2145]	RMS current on CH2	10 A	1 to 25 A	20 A	1 to 25 A
OvervoltageLimit [Modbus 2135]	Once this value is reached the R88S-EA immediately switches in fault	830 V	100 to 830 V	830 V	100 to 830 V
BrakingCircuitActivation-Voltage [Modbus 2136]	Once this value is reached the brake circuit is activated and the voltage increasing is limited	785 V	100 to 785 V	785 V	100 to 785 V

The **CableCurrentLimit(CH1) [Modbus 2142]** and **CableCurrentLimit(CH2) [Modbus 2145]** parameters are independent each other, and their value must be adequate to the section of the cables that are connected to the outputs. The **OutputCurrentLimit [Modbus 2134]** parameter determines the maximum value of the total output current, but it doesn't affect on the current limit values that can be set on each single output. In the following table some possible combinations are reported:

	CableCurrentLimit(CH1)	CableCurrentLimit(CH2)
R88S-EAD20R	1 A	19 A
	5 A	15 A
R88S-EAD40R	1 A	25 A
	15 A	25 A

OutputCurrentLimit

This parameter refers to the **RMS_OutputCurrent [Modbus 2052]**.

When **RMS_OutputCurrent [Modbus 2052]** > **OutputCurrentLimit [Modbus 2134]** the **DeviceEnergyOver-loadPercentage [Modbus 2913]** variable increases and when it reaches the 100% the fault intervenes: Device energy overload exceeds the limit.

The intervention time is obtained from the I2T internal calculation, in particular it takes the value of 5 sec when the following conditions occur: line 400 VAC, **RMS_OutputCurrent [Modbus 2052]** equal to 2***OutputCurrentLimit [Modbus 2134]**.

CableCurrentLimit(CH1)

This parameter refers to the **RMS_CurrentCH1 [Modbus 2548]**.

When **RMS_CurrentCH1 [Modbus 2548]** > 1,3***CableCurrentLimit(CH1) [Modbus 2142]** the **CableEnergy-OverloadPercentageCH1 [Modbus 2534]** variable increases and when it reaches the 100% the fault intervenes: Cable energy overload exceeds the limit on channel 1.

The intervention time is obtained from the I2T internal calculation, in particular it takes the value of 3600 sec (1 hour) when the following conditions occur: line 400 VAC, **RMS_CurrentCH1 [Modbus 2548]** equal to 1,3***Cable-CurrentLimit(CH1) [Modbus 2142]**.

CableCurrentLimit(CH2)

This parameter refers to the **RMS_CurrentCH2 [Modbus 2648]**.

When **RMS_CurrentCH2 [Modbus 2648]** > 1,3***CableCurrentLimit(CH2) [Modbus 2145]** the **CableEnergy-OverloadPercentageCH2 [Modbus 2634]** variable increases and when it reaches the 100% the fault intervenes: Cable energy overload exceeds the limit on channel 2.

The intervention time is obtained from the I2T internal calculation, in particular it takes the value of 3600 sec (1 hour) when the following conditions occur: line 400 VAC, **RMS_CurrentCH2 [Modbus 2648]** equal to 1,3***Cable-CurrentLimit(CH2) [Modbus 2145]**.

OvervoltageLimit

This parameter refers to the **HVDC_OutputVoltage [Modbus 2001]**.

When **HVDC_OutputVoltage [Modbus 2001]** > **OvervoltageLimit [Modbus 2135]** the fault status activates: Overvoltage of power section.

BrakingCircuitActivationVoltage

This parameter refers to the **HVDC_OutputVoltage [Modbus 2001]**.

When **HVDC_OutputVoltage [Modbus 2001]** > **BrakingCircuitActivationVoltage [Modbus 2136]** the Brake Circuit activates to limit the **HVDC_OutputVoltage [Modbus 2001]**. Consequently, if the power that is absorbed by the Brake Circuits greater than the **IntBrakeResistorNominalPower [Modbus 2110]** or the **ExtBrakeResistor-NominalPower [Modbus 2140]**, the **BrakeEnergyOverloadPercentage [Modbus 2031]** variable increases and when it reaches the 100% the fault status activates: Braking circuit energy overload exceeds the limit.

RMS_Average_CalculationPeriod

It is applied to all the RMS, AVG variables of CH1, CH2 and total. An example of RMS and AVG variables is the following: RMS current, RMS output current, RMS backfeeding current, AVG current, AVG power referred to both CH1 and CH2.

Summary

The following table summarizes the description of the user parameters above described.

The reference variable value variation determines the increment variable value variation (when it's present, otherwise the comparison is made with the same reference variable).

When this one exceeds the set limit value (User parameter) the system enters in the related fault status.

Reference variable	User parameter	Increment variable	Fault
RMS_OutputCurrent [Modbus 2052]	OutputCurrentLimit [Modbus 2134]	DeviceEnergyOverload-Percentage [Modbus 2030]	Device energy overload exceeds the limit
RMS_CurrentCH1 [Modbus 2548]	CableCurrentLimit(CH1) [Modbus 2142]	CableEnergyOverload-PercentageCH1 [Modbus 2534]	Cable energy overload exceeds the limits on channel 1
RMS_CurrentCH2 [Modbus 2648]	CableCurrentLimit(CH2) [Modbus 2145]	CableEnergyOverload-PercentageCH2 [Modbus 2634]	Cable energy overload exceeds the limits on channel 2
HVDC_OutputVoltage [Modbus 2001]	OvervoltageLimit [Modbus 2135]	-	Overvoltage of power section
HVDC_OutputVoltage [Modbus 2001]	BrakingCircuitActivation-Voltage [Modbus 2136]	BrakeEnergyOverload-Percentage [Modbus 2031]	Braking circuit energy overload exceeds the limit
-	RMS_Average_Calcula-tionPeriod [Modbus 2112]	-	-

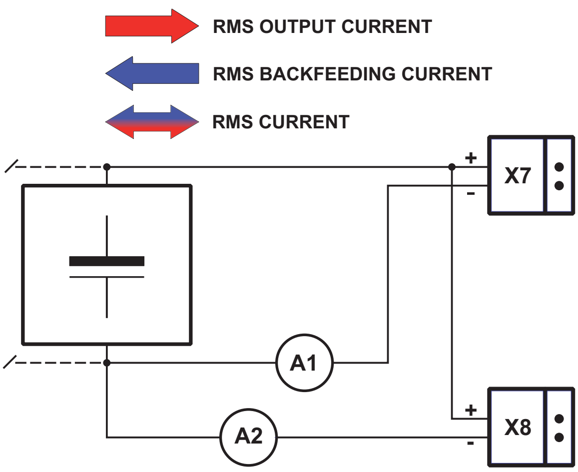
6-3 Functions

6-3-1 Output Section

The DC Power Supply Unit provides the output HVDC voltage through the x7 and x8 Power output connectors (CH1 and CH2). This voltage is contemporary present in both channels. If one of them goes in error, then the entire system switches in fault status and, on consequence, the voltage will not be present neither on the other one.

Note The CH1 and CH2 channels are not electrically isolated, so the voltage is always present on both. If, for example, only one channel is used, the voltage is anyway present even on the other one that's not used.

The current data (Nominal output current @ 40°C) correspond to the total value of the current that's provided by the power internal section. This current is divided in the CH1 and CH2 outputs, that respectively measure their values through two amperometers A1 and A2, as showed in the following diagram:



The **RMS_OutputCurrent [Modbus 2052]**, **RMS_BackfeedingCurrent [Modbus 2054]** and **RMS_Current [Modbus 2048]** currents can be distinguished for each output or overall (calculated from the values that are detected by the 2 amperometers A1 and A2).

- **RMS_OutputCurrent [Modbus 2052]**: is the provided current (positive component only)
- **RMS_BackfeedingCurrent [Modbus 2054]**: is the return current (negative component only)
- **RMS_Current [Modbus 2048]**: is the total current (provided and return) that includes both the current values (positive and negative)

The means that, for each current measurement, we will have a value that's related to the single output and a total one, as reported in the following table:

Channel 1	Channel 2	Total
RMS_OutputCurrentCH1 [Modbus 2552]	RMS_OutputCurrentCH2 [Modbus 2652]	RMS_OutputCurrent [Modbus 2052]
RMS_BackfeedingCurrentCH1 [Modbus 2554]	RMS_BackfeedingCurrentCH2 [Modbus 2654]	RMS_BackfeedingCurrent [Modbus 2054]
RMS_CurrentCH1 [Modbus 2548]	RMS_CurrentCH2 [Modbus 2648]	RMS_Current [Modbus 2048]

In the following table are reported the power outputs electrical features:

Features	R88S-EAD20R	R88S-EAD40R	Description
Output nº	2		CH1 and CH2 outputs through x7 and x8 Power output connectors
CH1 and CH2 parallel connection possibility	Yes		Through appropriate wiring
CH1 and CH2 cables protection current separated setting possibility	Yes		To set the current limits on the output cables, use the **CableCurrentLimit(CH1) [Modbus 2142]** and **CableCurrentLimit(CH2) [Modbus 2145]** parameters
Maximum total current that can be provided (CH1 + CH2)	20 A	40 A	**R88S-EAD20R:** the maximum current can be obtained in 3 different modes, through a single output (see the following description), through the two separates outputs that provide 10A each one (default setting) and through the parallel connection
Maximum current that can be provided by a single output (with the other one disconnected or without load)	20 A	25 A	For example: if the load is connected only on CH1, the maximum current that can be set on the **CableCurrentLimit(CH1) [Modbus 2142]** parameter is 20A for the R88S-EAD20R and 25A for the R88S-EAD40R
Maximum protection RMS current on each output	25 Arms		Fixed value, cannot be set, that protects the device

6-3-2 Charge Circuit and Start-up Phase

The charge circuit limits the capacitor charging current at the start-up of the power supply unit.

In the circuit an over energy and a voltage level control have been implemented against the over heating or the breaking of the circuit itself.

Note Repetitive start-up may cause to the charge circuit a fault situation due to an excessive transferred energy. It's advisable to not activate/deactivate too frequently the power supply unit. In general it do not cycle power more than 20 times/hour.

In general, the dissipated energy on the start-up depends on the VAC Line voltage on the system input and on the load current that's present on the power supply output. The worst cases will be with the maximum voltage on VAC line and a high output current.

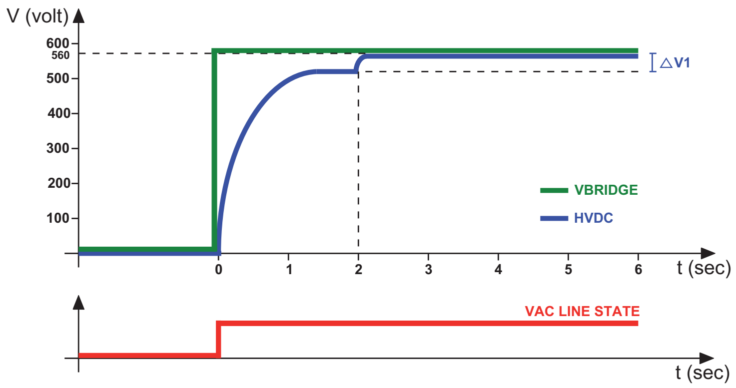
About the output current value, it is usually negligible because the connected devices don't absorb current during the start-up phase (e.g. servo drive).

- The power supply unit start-up takes about 2 sec to 4 sec

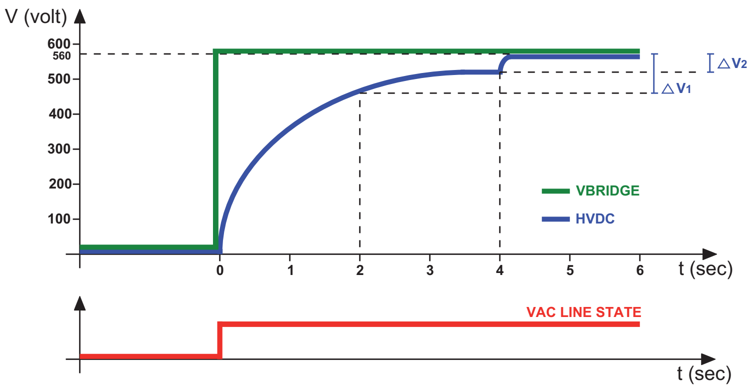
Charge circuit functioning

Note In order to understand the meaning of the signals that are analyzed in the following graphs, please refer to Section **1-4-2 DC Power Supply Unit Block Diagram**.

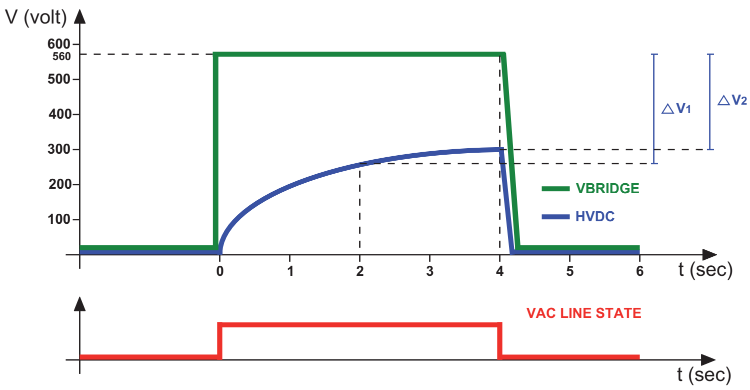
- Normal start-up: during the start-up, the charging time is about 2 sec. During this time the HVDC voltage value must increase until it's within 50 V from the VBRIDGE, that is ΔV1 (difference between VBRIDGE and HVDC) must be less or equal to 50 V. If this situation, represented in the following chart, verifies, then the start-up phase finishes and the power supply unit switches to the next phase (OPERATIONAL logic status).



- Prolonged start-up: in this case the HVDC voltage increasing is very slowed due to a big capacitive load connected to the output, and that determines a considerable increasing of the charging time. In fact it happens that, unlike the previous case, the voltage value is not sufficient to obtain a ΔV1 lower than 50 V within 2 sec, and so the charging time is prolonged to 4 sec and a new control is done (ΔV2). As in the previous phase, if the difference between VBRIDGE and HVDC reaches a value that's lower than 50 V, that charging phase successfully ends and the power supply unit switches to the next phase (OPERATIONAL logic status) and no fault condition is reported. This second case is reported in the following chart.



- Prolonged start-up with fault: if neither after 4 sec the HVDC voltage value has reached the [VBRIDGE - 50V] threshold because of the excessive load on the output, the power supply unit switches to the Fault status (Internal circuit ripple exceeds the limit on power section). This failed start-up case is reported in the following chart.



During the charging phase some other fault types may happen, and the most probable one is Charge circuit energy overload.

6-3-3 Brake Resistor

This device limits the voltage on HVDC during the regeneration operations by the Integrated Servo Motors, for example during the braking phase. If the voltage exceeds the threshold value (**BrakingCircuitActivationVoltage [Modbus 2136]**) the brake resistor is activated. In this case the exchanged energy between Integrated Servo Motors and DC Power Supply Unit turns into heat.

If the energy that's regenerated by the motors is higher that the expected one (see **IntBrakeResistorNominalEnergy [Modbus 2108]** if internal resistor and **ExtBrakeResistorNominalEnergy [Modbus 2138]** if external resistor) the Overvoltage of HVDC output during braking warning or the Braking circuit energy overload exceeds the limit fault may appear. It's required the use of an external resistor that has higher electrical features, compared to the internal resistor ones.

Note The brake resistor use assure HVDC voltages within the range. A wrong dimensioning (OVERLOAD) may break the resistor or the electric circuit and damage the machine/system. Furthermore it can cause grave injuries, for example in lifting up operations.

Note In case of Braking circuit energy overload exceeds the limit fault condition, some residual voltages will be present. Before to execute any inspection operation on the R88S-EA wait at least 10 minutes.

During the test and the calculations keep in mind that, in case of a higher network voltage, in the DC bus capacitors can be stored a lower quantity of braking energy and that this energy is absorbed by the braking circuit.

To evaluate the usage level of the circuit that commands the braking resistor, it's possible to control the status and the colour of the BRAKE STATUS LED (for details see **Section 1-3-4 DC Power Supply Unit Functions**). This shows the brake resistor activation (ON = active, OFF = not active). If activates and the LED colour is green, it means that the braking circuit energy is lower than the 50%, instead if the LED becames red it means that the energy is higher or equal to the 50%, if the energy exceeds the limit value (Braking circuit energy overload exceeds the limit) the RTO contact is opened and the functioning status switches from OPERATIONAL to FAULT.

The RTO contact opening deactivates the R88S-EA input power supply. On consequence, the HVDC output voltage will decrease according to the applied load.

If the external brake has been configured, the following table report the admitted values range:

External brake resistor	
Energy	100 - 2000000 [J]
Power	100 - 40000 [W]
Resistor	16 - 1000 [Ω]

7

Basic Control Modes

This section describes the modes that is used to control the Integrated Servo Motor.

7-1 Operation Mode

This section describes the profile that is used to control the Integrated Servo Motor.

7-1-1 Modes of Operation

Using the Integrated Servo Motors, the motor motion can be commanded by devices with the following features:

- Master EtherCAT (with CANopen over EtherCAT - CoE DS402)
- Master that is not CiA402
- Digital outputs to connect to the drive digital inputs
- Analog output to connect to the drive analog input

The drive makes it possible to carry out motions by controlling the torque, the speed and the motor position according to the operating mode set in the parameter **ModesOfOperation [6060.00]**. In the following chart you can find the features of the available operating modes.

Motion type	ModesOfOperation	Standard CiA402	Real-time	Digital I/O	Analog input	Enable automatic
Position	Profile Position Mode	Yes	-	-	-	-
	Interpolated Position Mode	Yes	Yes	-	-	-
	Cyclic Synchronous Position Mode	Yes	Yes	-	-	-
	Gear Mode	-	-	-	-	-
Velocity	Profile Velocity Mode (CiA402)	Yes	-	-	-	-
	Profile Velocity Mode (CUSTOM)	-	-	-	-	-
	Profile Velocity AI Mode	-	-	-	Yes	Yes
	Cyclic Synchronous Velocity Mode	Yes	Yes	-	-	-
Torque	Torque Mode	Yes	-	-	-	-
	Torque AI Mode	-	-	-	Yes	Yes
	Cyclic Synchronous Torque Mode	Yes	Yes	-	-	-
Other	Homing Mode	Yes	-	-	-	-

Note To command the drive by using any Master it is necessary to know and use the CiA402StateMachine, the features of which are in **Section 5-5-1 CiA402 State Machine**.

7-1-2 Changing the Mode of Operation

Note The change **ModesOfOperation [6060.00]** in Operation enable is currently available only writing the parameters of additional bus Modbus.

This kind of change of **ModesOfOperation [6060.00]** is also called on-the-fly mode change and it makes possible to move from any operating mode to another one without stopping the motor and keeping the drive in Operation enable. The operating modes allowing the change are:

- Profile Position Mode
- Homing Mode
- Interpolated Position Mode
- Gear Mode
- Profile Velocity Mode (CUSTOM)

The management of the on-the-fly mode change can be parametrized and commanded by using the following parameters:

Parameter	Description
ApplyModeOperationCommand [42C0.01]	Desired operating mode
ApplyModeOperationStatus [42C0.02]	Status of the change operating mode
ApplyModeOperationParameters [42C0.03 to 42C0.09]	Group of 7 parameters to set the mode change. The meaning of each of these parameters changes when **ApplyModeOperationCommand [42C0.01]** changes, as shown in the below table

Nº	Profile Position Mode	Homing Mode	Interpolated Position Mode	Gear Mode	Profile Velocity Mode (CUSTOM)
1	TargetPosition [607A.00]	HomingMethod [6098.00]	IpPosFirstParameter [60C1.01]	See the below table	TargetVelocity [60FF.00]
2	ProfileVelocity [6081.00]	SpeedForSwitch [6099.01]	IpPosSecondParameter [60C1.02]	GearMasterTriggerPosition [4288.02]	-
3	EndVelocity [6082.00]	SpeedForZero [6099.02]	-	GearMasterRampPosition [4288.03]	EndVelocity [6082.00]
4	ProfileAcceleration [6083.00]	HomingAcceleration [609A.00]	IpPosSubModeSelect [60C0.00]	TargetGearRatioNumerator [4289.01]	ProfileAcceleration [6083.00]
5	ProfileDeceleration [6084.00]	IndexPulseDeadZone [4285.02]	-	TargetGearRatioDivisor [4289.02]	ProfileDeceleration [6084.00]
6	EndIncrements [4284.01]	HomeOffset [607C.00]	-	StartGearRatioNumerator [428A.01]	-
7	StartVelocity [4244.00]	-	-	StartGearRatioDivisor [428A.02]	StartVelocity [4244.00]

Bit	Value	Description
0	0	Valid trigger position: The adjustment to the following ratio starts when the new trigger position is exceeded (**GearMasterTriggerPosition [4288.02]**), the position exceed direction is defined by the bit 1 of this parameter.
	1	Not valid trigger position: The adjustment beginning of the new following ratio starts when the new trigger operative mode change start command is given (writing of the **ApplyModeOperationCommand [42C0.01]** parameter).
1	0	The trigger position (**GearMasterTriggerPosition [4288.02]**) is reached if it is exceeded by the increasing position of the master.
	1	The trigger position (**GearMasterTriggerPosition [4288.02]**) is reached if it is exceeded by the decreasing position of the master.

Bit	Value	Description
2	0	On the adjustment beginning is assumed that the starting following ratio (**StartGearRatio [428A.00]**) is the actual one.
	1	On the adjustment beginning is assumed that the starting following ratio (**StartGearRatio [428A.00]**) is the one that's set in the parameters 6 and 7 of **ApplyModeOperationParameters [42C0.03 to 42C0.09]**.

Note The writing of this group of parameters follows the same writing restrictions as the single parameters in their original addresses.

To start a change of the on-the-fly operating mode the drive must be in Operation enable. Run this operations sequence:

- Configure the change of the operating mode by properly setting **ApplyModeOperationParameters [42C0.03 to 42C0.09]**
- Write the code of the new operating mode in **ApplyModeOperationCommand [42C0.01]**
- Verify the result of the change by reading the parameter **ApplyModeOperationStatus [42C0.02]**

For some values of **ApplyModeOperationCommand [42C0.01]**, there can be some peculiarities. Here you can find them:

- **Profile Position Mode:** With the functionality on-the-fly mode change, the Profile Position Mode runs positions absolute in mode Single set-point. For details on the operating mode please see **Section 7-2-1 Profile Position Mode**.

7-2 Position Mode

In the Integrated Servo Motors, some functionalities (common to all position modes) have been implemented and through these it is possible to check if the motion is run in conformity with the parameterization made by the user.

Position

To check the motor position, read the parameter **PositionActualValue [6064.00]**.

Position reached target

If in **ModesOfOperationDisplay [6061.00]** a position mode is set, to check if the motor reached its final position it is sufficient to check if the bit Target reached in **Statusword [6041.00]** is equal to 1. Such bit is set when the difference between **PositionActualValue [6064.00]** and the requested position is below **PositionWindow [6067.00]** (in absolute value) for a time at least equal to **PositionWindowTime [6068.00]**. The bit is reset when the difference gets over the window.

Error of position tracking

If in **ModesOfOperationDisplay [6061.00]** a position mode is set, it is possible to check the **PositionFollowingError [60F4.00]** during the motor motion. By configuring properly the **FollowingErrorWindow [6065.00]** and **FollowingErrorWindowWarn [4282.01]** parameters it is possible to enable the Position following error (fault and warning respectively), if the **PositionFollowingError [60F4.00]** gets over the window for a time equal to **FollowingErrorTimeOut [6066.00]** or longer. Furthermore, in some operating modes, when **PositionFollowingError [60F4.00]** goes over the fault threshold for a time at least equal to the time out, also the bit Following error of **Statusword [6041.00]** is set. The bit is reset when **PositionFollowingError [60F4.00]** is lower in absolute value than the fault window. For any further information on the error notice please see **Section 13-2 Fault and warning (Integrated Servo Motor)**.

7-2-1 Profile Position Mode

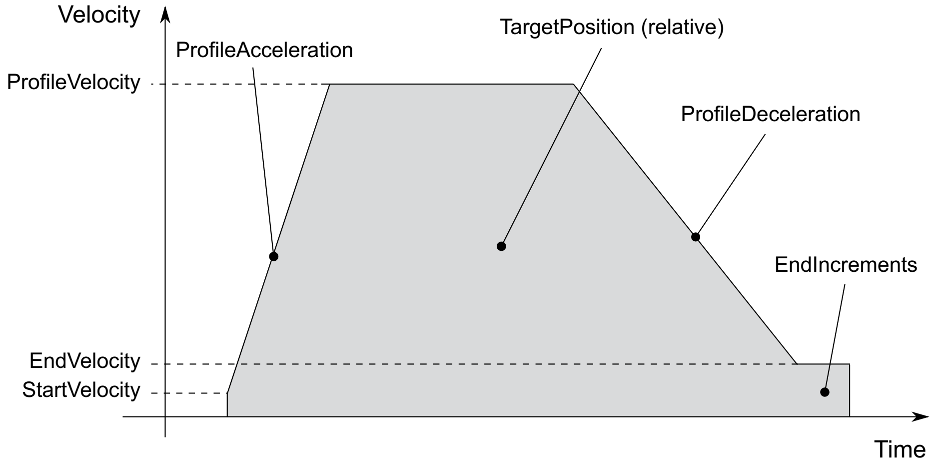
The Profile Position Mode is used to run a motion in position, absolute or relative, where the positioning profile is created by the drive. This operating mode follows the specifications of the CiA402.

To use this mode you need first of all to set the **ModesOfOperation [6060.00]** with the value 1 (Profile Position Mode), the **MotionProfileType [6086.00]** and the options that set the behavior of the profiler with **PositioningOptionCode [60F2.00]**. Finally you can proceed with the writing of the parameters defining how the position profile must be run:

- TargetPosition [607A.00]
- EndIncrements [4284.01]
- ProfileVelocity [6081.00]
- StartVelocity [4244.00]
- EndVelocity [6082.00]
- ProfileAcceleration [6083.00]
- ProfileDeceleration [6084.00]

Note If the value of **ProfileVelocity [6081.00]** is lower than **StartVelocity [4244.00]** or **EndVelocity [6082.00]**, its value is internally set at the highest value of the two.

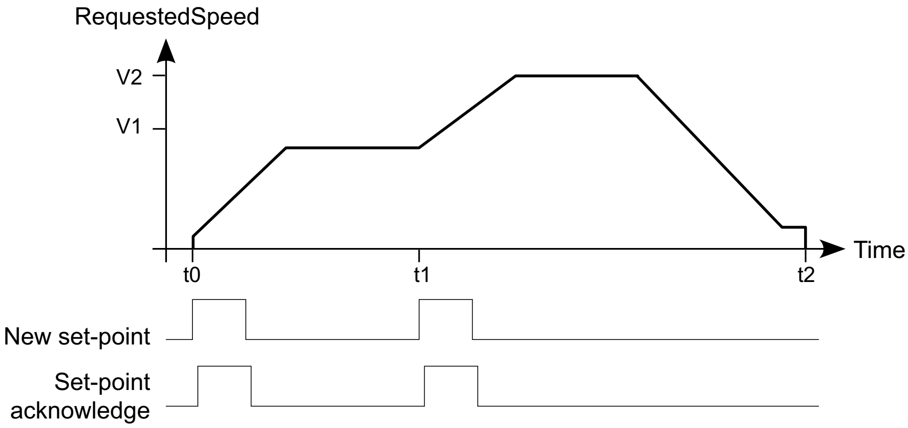
You can find an example of profile and the meaning of the parameters defining it.



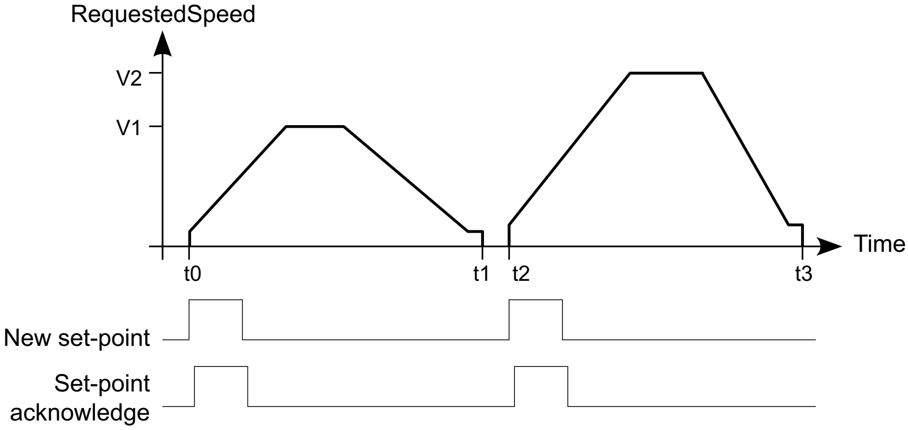
After having parametrized the drive and set it in the status Operation enable, you can run the commands to start the positionings and to check the status. To command a positioning you have to write the **Controlword [6040.00]** and read the **Statusword [6041.00]** following the procedures described in the CiA402. Particularly, through this operating mode it is possible to run a positioning by commanding the following bits in the **Controlword [6040.00]**:

- Bit New set-point: bit that, on the rising edge, it enables the application of the new position set-point, provided that it is allowed by the bit Set-point acknowledge of the **Statusword [6041.00]**
- Bit Change set immediately: through this bit it is possible to choose the mode of positioning between Single set-point (if the bit is set to 1) and Set of set-point (if the bit is set to 0). In the Set of set-point mode you can find only a buffer of data, the one for the data used during the positioning. In the Single set-point mode the positioning acts as described in the bit Change immediately option in the parameter **PositioningOptionCode [60F2.00]**. The bit must be set with the transition of the bit New set-point
- Bit Absolute/Relative: through this bit it is possible to choose the mode to read the parameter **TargetPosition [607A.00]**: for absolute positionings if the bit is set to 0, for relative positionings if the bit is set to 1. The bit must be set with the transition of the bit New set-point

Timing chart Profile Position Mode in Single set point mode:



Timing chart Profile Position Mode in Set of set points mode:



Note After having reached the requested position at the end of the profile, the bit is set to Target reached of the **Statusword [6041.00]** (see Position reached target).

In the **Statusword [6041.00]** there are three bits showing the status of the positioning:
- Bit Target reached showing the status of Position reached target
- Bit Set-point acknowledge showing if a new set point of positioning can be accepted (bit equal to 0) or not (bit equal to 1)
- Bit Following error showing the status of Error of position tracking

Note If a new positioning is started in the Single set-point mode, the ongoing one is aborted and the new one is started without motor stopping.

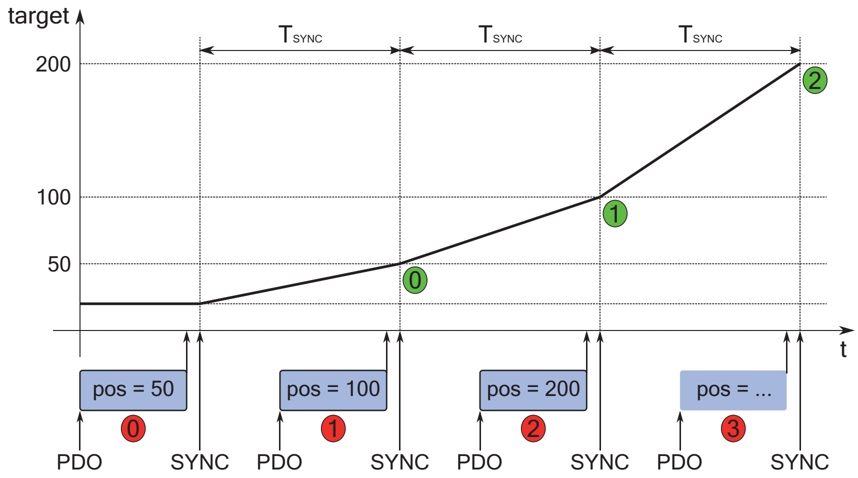
7-2-2 Interpolated Position Mode

Note To command the drive by this operating mode it is necessary to have a Master supporting at least a Real-time protocol on EtherCAT bus.

The Interpolated Position Mode is an operating mode enabling the control in Real-time of the motor by using an EtherCAT master. This operating mode fulfils the specifications of the CiA402.

To work, this mode requires the cyclic sending from the master within a defined time (which will be later called T_{SYNC}, synchronization time) of the following parameters:
- **IpPosFirstParameter [60C1.01]**: position reached when the T_{SYNC} expires. This datum is necessary in all kinds of interpolation implemented in the drive.
- **IpPosSecondParameter [60C1.02]**: speed reached when the T_{SYNC} expires. This datum is not used in the linear interpolation.

The writing of the **IpPosFirstParameter [60C1.01]** and **IpPosSecondParameter [60C1.02]** parameters does not use the SDOs, but the PDOs combined with some techniques used for the synchronization with the other nodes linked to the bus. In the below picture appears an example of linear interpolation with the Hard sync synchronization technique is reported. This technique is used in the EtherCAT field bus through the SyncSignal synchronization signal (SYNC).

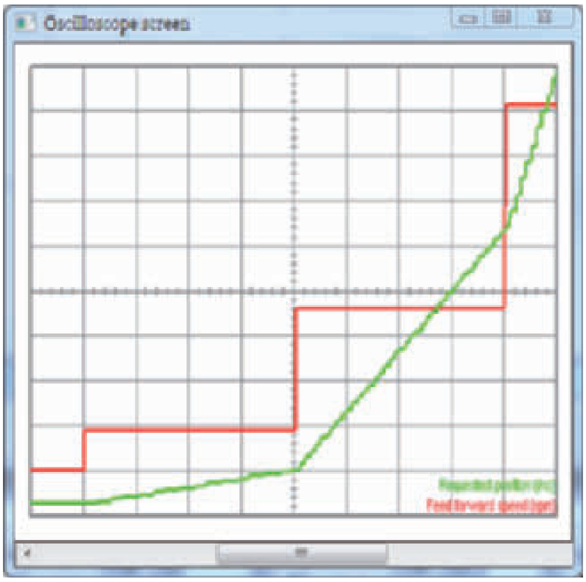


Note The position and velocity parameters are therefore contained in the PDO RX (see the related communication interfaces chapters) and determine the movement profile construction. When an EtherCAT Master is used, if a PDO RX is lost, it's not automatically re-sent. To avoid this drawback OMRON has implemented in the drives of the Integrated Servo Motors a monitoring and management functionality for the corrupted or missing PDO RX (see **Section 5-4-2 Missing or Corrupted PDO RX Management**).

The kind of interpolation can be set through the **IpPosSubModeSelect [60C0.00]** parameter and the following methods are available:

Linear interpolation

The drive runs the interpolation only of the position by linking with a straight line the set-point of a previous position, reached at the beginning of the new period of T_{SYNC}, with the position set point sent to the master in the **IpPos-FirstParameter [60C1.01]** parameter. The FeedForwardSpeed is calculated by the drive and is constant during the whole T_{SYNC} period. Below you can find an example of linear interpolation:

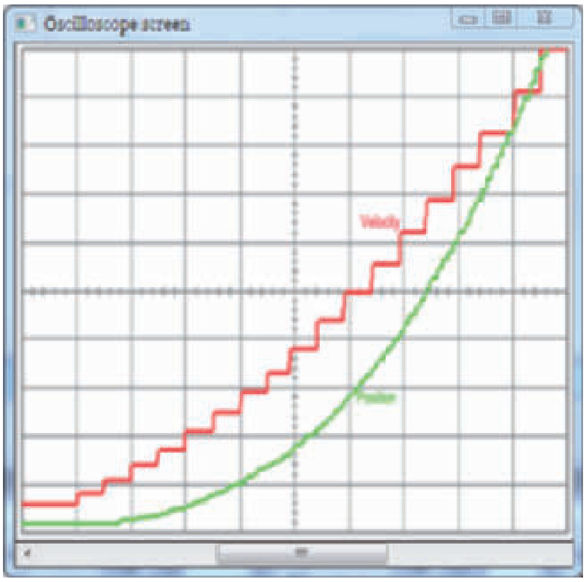


Linear interpolation with FeedForwardSpeed

The drive runs the interpolation only of the position by linking with a straight line the set-point of a previous position, reached at the beginning of the new period of T_{SYNC}, with the position set point sent by the master in the **IpPos-FirstParameter [60C1.01]** parameter. The necessary FeedForwardSpeed to command the control loops is obtained from the set-point of the speed sent by the master in the **IpPosSecondParameter [60C1.02]** parameter and is constant during the whole T_{SYNC} period. This kind of interpolation allows a better motion fluidity compared to the simple linear interpolation.

Cubic interpolation

The drive runs the interpolation of both the position and the velocity by linking with segments of curve line, cubic for the position and quadratic for the velocity, the initial values (actual theoretical values obtained at the beginning of the T_{SYNC} period) with the end values (target values received by the master **IpPosFirstParameter [60C1.01]** and **IpPosSecondParameter [60C1.02]**). The movement fluidity of this kind of interpolation respect to the other ones is better, as you can observe by comparing Cubic interpolation example with Linear interpolation example. In fact considering that these two pictures have been created using the same parameters (except of course the interpola-tion type selector **IpPosSubModeSelect [60C0.00]**) and with a T_{SYNC} of medium duration, it is evident how the below curves have a trend with less abrupt movements.



Note In the linear interpolation with or without feed-forward (values 0 and -10 in the **IpPosSubModeSelect [60C0.00]** parameter) the set T_{SYNC} period must be greater then **MotionLoopPeriod [3521.04]**. In the cubic interpolation (value -1 in the **IpPosSubModeSelect [60C0.00]** parameter) the set T_{SYNC} period must be 4 times greater than **MotionLoopPeriod [3521.04]** parameter.

Note The cubic interpolation use is advantageous only if the T_{SYNC} time has a middle-long duration (about over 4 ms) while, for interpolations that have short T_{SYNC} times (about up to 4ms), these advantages are not, so it's better to use the linear interpolation.

To command the drive with the interpolated mode it is necessary:

(a) To set the **ModesOfOperation [6060.00]** with the value 7 (Interpolated Position Mode)

(b) To configure the communication parameters of the field bus (PDO configuration and mapping, setting of the synchronization system, ...)

(c) To set the **IpPosSubModeSelect [60C0.00]**

(d) To enable in the master the management enabling, at regular intervals, the sending of the set-points via PDO in the **IpPosDataRecord [60C1.xx]** and the synchronism management

(e) To take the drive in the Operation enable status

(f) To enable the position interpolator by setting the bit Enable ip mode of the **Controlword [6040.00]** and checking that the bit Ip mode active is enabled in the **Statusword [6041.00]**

(g) At this point it is possible to command the drive

Note If you reset the bit Enable ip mode of the **Controlword [6040.00]**, the motion is stopped and the motor stops with maximum deceleration by resetting RequestedSpeed to zero.

7-2-3 Cyclic Synchronous Position Mode

Note To command the drive by this operating mode it is necessary to have a Master supporting at least a Real-time protocol on EtherCAT bus.

The Cyclic Synchronous Position Mode is an operative mode that allows to control the motor in Real-time by using a EtherCAT master. This operative mode respects the CiA402 specifications.

To work, this mode requires to the master the cyclic sending, within a defined time (which will be later called T_{SYNC}, synchronization time) of the **TargetPosition [607A.00]** parameter (the synchronization techniques are described in the chapter of the communication interfaces):

In case of cubic interpolated mode use, even the **VelocityOffset [60B1.00]** parameter will be necessary.

There are other parameters that are not required by the drive to generate the movement (they are not necessary), but can be useful to improve it. These parameters are:

- **PositionOffset [60B0.00]**: position that will be added to the **TargetPosition [607A.00]**.
- **VelocityOffset [60B1.00]**:
    - In case of cubic interpolation, this parameter is necessary because it is the velocity that the drive needs to make the interpolation calculations
    - In case of non cubic interpolation: if the **CyclicSynchronousSubMode [42D0.00]** indicates that the **KVff [60FB.02]** internal calculation is disabled, it will be used as **KVff [60FB.02]**
    - In all the other cases, it is not used
- **TorqueOffset [60B2.00]**: It is used as **KAff [60F9.16]** if the **CyclicSynchronousSubMode [42D0.00]** parameter indicates that the **KAff [60F9.16]** internal calculation is disabled, otherwise it's not used.

The writing of the **TargetPosition [607A.00]** parameter does not use the SDO, but the PDO combined with some techniques that allow the synchronization with the other nodes that are connected to the bus. In the above **Section 7-2-2 Interpolated Position Mode** it is reported an example of linear interpolation with the Hard sync synchronization technique, used in the EtherCAT field bus with the SyncSignal synchronization signal (SYNC).

Note The parameters are so contained in the PDO RX and determine the construction of the movement profile. If a PDO RX is lost, it's not automatically re-sent. To avoid this drawback, Omron has implemented in the drives of the R88E-AECT series a monitoring and management functionality for the corrupted or missing PDO RX (see **Section 5-4-2 Missing or Corrupted PDO RX Management**).

The kind of interpolation can be set through the **CyclicSynchronousSubMode [42D0.00]** parameter and the following methods are available:

No interpolation

The drive executes the movement without interpolating the position target, that will be directly applied on the T_{SYNC} signal. The **FeedForwardSpeed** and the **FeedForwardAcceleration** can be set by the master or internally calculated by the drive.

Linear interpolation

The drive runs the interpolation only of the position by linking with a straight line the set-point of a previous position, with the position set point sent by the master in the **TargetPosition [607A.00]** parameter. The **FeedForward-Speed** and the **FeedForwardAcceleration** can be set by the master or internally calculated by the drive.

Cubic interpolation

The drive executes the interpolation both of the position and of the velocity, linking with a cuved lines, cubic for the position and quadratics for the velocity, the initial values (values of **TargetPosition [607A.00]** and **VelocityOffset [60B1.00]** received from the master with the previous T_{SYNC} period) with the final ones (values of **TargetPosition [607A.00]** and **VelocityOffset [60B1.00]** received by the master). This interpolation type, allows a movement improved fluidity respect to all the other interpolation modes. In fact, bearing in mind that the two figures have been created by using the same parameters (except for the **CyclicSynchronousSubMode [42D0.00]** interpolation type selector, of course) and by using a T_{SYNC} with medium duration, it's evident how the curves have a trend with less abrupt deviations. The **FeedForwardAcceleration** can be set by the master or internally calculated by the drive.

Note In case of no interpolation or linear interpolation (different values from -147 and -148 in the **CyclicSynchronousSubMode [42D0.00]** parameter) with or without feed-forward, the set T_{SYNC} period must be greater than **MotionLoopPeriod [3521.04]**. In the cubic interpolation (values -147 and -148 in the **CyclicSynchronousSubMode [42D0.00]** parameter) the set T_{SYNC} period must be greater than 4 times the **MotionLoop-Period [3521.04]** parameter.

Note The cubic interpolation use is advantageous only if the T_{SYNC} time has a middle-long duration (about over 4 ms) while, for interpolations that have short T_{SYNC} times (about up to 4ms), these advantages are not, so it's better to use the linear interpolation.

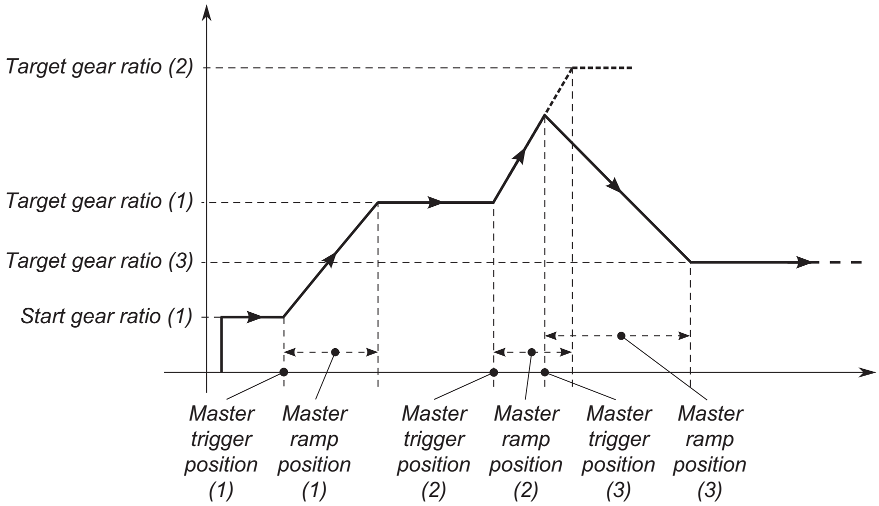
To command the drive with this mode it is necessary:

- To configure the communication parameters of the bus field (PDO configuration and mapping, setting of the synchronization system, ...)
- To activate in the master the management that allows, at regular intervals, to send the set-points through PDO and the synchronism management; the number and the type of the data (set-point) that have to be sent, depends on the **CyclicSynchronousSubMode [42D0.00]** that has been set
- To set the **CyclicSynchronousSubMode [42D0.00]**
- To set the **ModesOfOperation [6060.00]** with the value 8 (Cyclic Synchronous Position Mode)
- To take the drive in the Operation enable state
- At this point it is possible to command the drive

Note By selecting a value of **CyclicSynchronousSubMode [42D0.00]** that assigns to the master the **KVff [60FB.02]** and **KAff [60F9.16]** calculation, it will be obtained a smoother motor motion. Pay attention that is a master duty to ensure that these data are sent, because the drive does not verify their receiving. If this last configuration is selected and the master doesn't anyway send the necessary feed forward values, the motion profile may be not the desired one.

7-2-4 Gear Mode

The Gear Mode is used to move the drive axis with position reference, according to a following ratio between the drive axis itself (slave axis) and the master axis. If during the motion the following ratio changes, then the drive executes an acceleration ramp in order to linearly join the actual following ratio with the set one. The below figure shows an example of how the following ratio can be changed by the user.



In the above example, when the master axis position exceeds the **GearMasterTriggerPosition [4288.02]** that has been set Master trigger position (1), the drive executes an adjustment ramp in order to reach the new following ratio **TargetGearRatio [4289.00]** (Target gear ratio (1)) in an adjustment master space equal to **GearMasterRampPosition [4288.03]** (Master ramp position (1)). Subsequently the following ratio can be changed again by updating the parameters (case 2: Master trigger position (2), Target gear ratio (2) and Master ramp position (2)) and by starting a new adjustment procedure. As can be seen in the figure, all the parameters can be changed and a new adjustment procedure can be started even during and adjustment procedure already in process (case 3: Master trigger position (3), Target gear ratio (3) and Master ramp position (3)).

The master axis role is taken on by the auxiliary encoder that, depending on the **AuxiliaryEncoderSelector [36CA.02]** parameter configuration, can be virtual or real. For further information please refer to **Section 8-1-2 Auxiliary encoder**.

Gear Mode parameters configuration

The Gear Mode configuration includes the setting of several parameters that allows to define the initial following ratio (**StartGearRatio [428A.00]**), the final following ratio (**TargetGearRatio [4289.00]**) and how the master axis must be interpreted (**MasterPositionSettings [4288.00]**). In addition to these parameters it must be configured the **ProfileDeceleration [6084.00]**, if the Halt command has to be used.

For the description of the various commands that will be used in this section, please refer to below subsection “Start a movement in Gear Mode”.

Now consider the following initial condition as a demonstrative example:

- Increasing master axis position: **AuxiliaryEncoderPosition [36CA.01]** = 100...200...300
- Increasing configured activation direction: **GearMasterTriggerDirection [4288.01]** = 0

Consider the following command sequence:

- Writing of the **TargetGearRatio [4289.00]**, **GearMasterRampPosition [4288.03]** parameters, eventually **StartGearRatio [428A.00]** and setting of the Master trigger position to 1000.
- Sending of the first Start gear command (bit Reset trigger = 0).
- Writing of the **TargetGearRatio [4289.00]**, **GearMasterRampPosition [4288.03]** parameters, eventually **StartGearRatio [428A.00]** and setting of the Master trigger position to 2000.
- Sending of the second Start gear command (bit Reset trigger = 0).
- Writing of the **TargetGearRatio [4289.00]**, **GearMasterRampPosition [4288.03]** parameters, eventually **StartGearRatio [428A.00]**.
- Sending of the third Start gear command (bit Reset trigger = 0).

After the receiving of the first Start gear command, the axis starts the adjustment ramp only when the master position has exceeded the position 1000. Similarly, after the reception of the second Start gear command the axis starts the adjustment ramp only when the master position has exceeded the position 2000. The third adjustment ramp will be started in correspondence to the receiving of the third Start gear command, because the **GearMasterTriggerPosition [4288.02]** parameter has never been written after the second Start gear command. The same effect would have been obtained if before the third command, once the **GearMasterTriggerPosition [4288.02]** had been written, the adjustment procedure would have been started by sending the Start gear command with the Reset trigger bit set to 1.

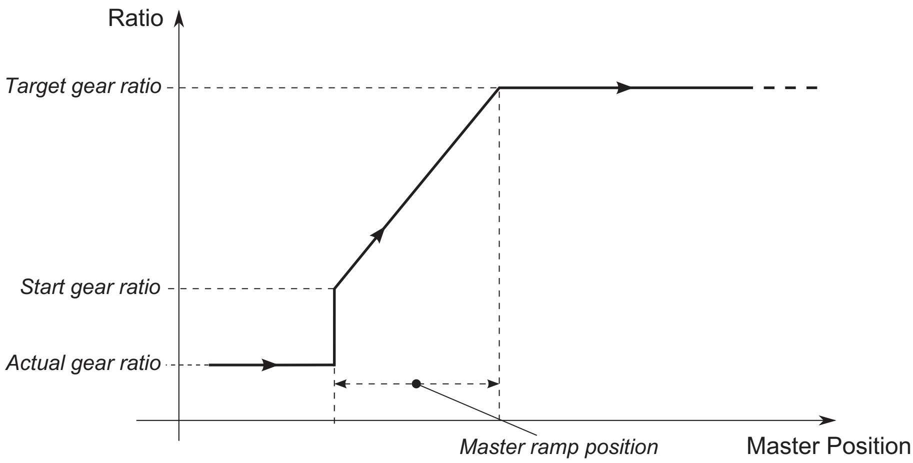
The adjustment to reach the new **TargetGearRatio [4289.00]** can happen in different ways depending on the settings of **StartGearRatio [428A.00]**, the following ratio in which the axis is when the adjustment ramp starts (Actual gear ratio) and the command given to start the adjustment itself. In order to clarify the possible dynamics, here follows the examples that explain the three possible cases.

For simplicity, consider in the examples that the master axis position is always increasing (**AuxiliaryEncoderPosition [36CA.01]** = 100...200...300...), that the trigger position (**GearMasterTriggerPosition [4288.02]**) is not used and that the Actual gear ratio is always lower than **TargetGearRatio [4289.00]**.

CASE 1: In this case the following condition is assumed:

- Actual gear ratio < **StartGearRatio [428A.00]** < **TargetGearRatio [4289.00]**.
- The start gear command sending is made through the Start gear ratio disable bit set to 0.

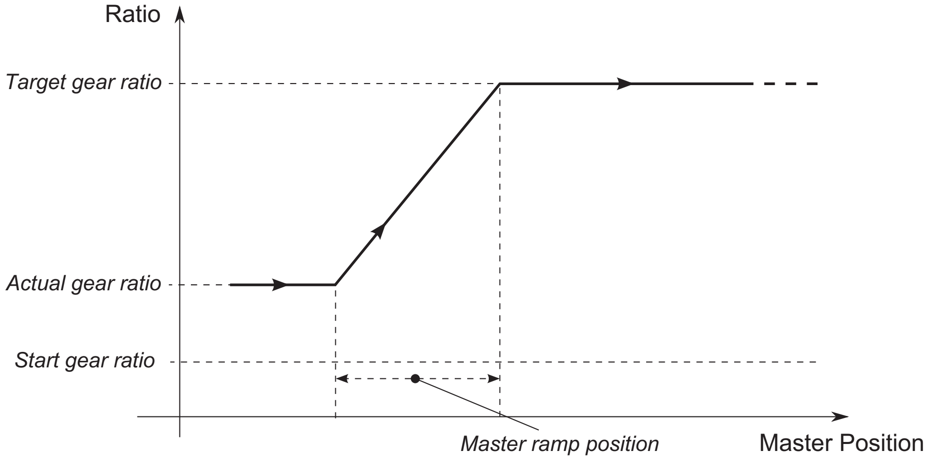
The axis behaviour is showed in the figure below: as soon as the Start gear command has been received by the drive, the following ratio is instantly set to the **StartGearRatio [428A.00]** value, then the adjustment ramp is started and when it will end the following ratio will be **TargetGearRatio [4289.00]**.



CASE 2: This case may arise from two different conditions:

- First condition:
  - **StartGearRatio [428A.00]** < Actual gear ratio < **TargetGearRatio [4289.00]**.
  - The start gear command sending is made through the Start gear ratio disable bit set to 0.
- Second condition:
  - The start gear command sending is made through the Start gear ratio disable bit set to 1.

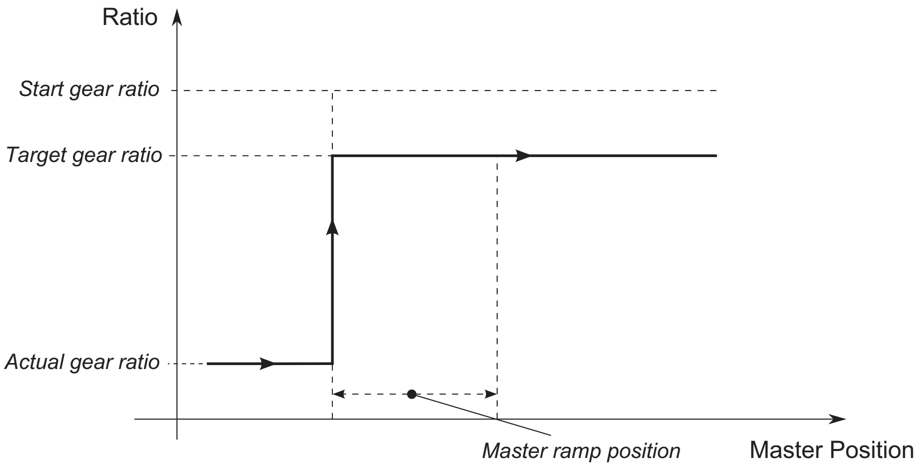
The axis behaviour is showed in the figure below: as soon as the Start gear command has been received by the drive, the **StartGearRatio [428A.00]** parameter value is disregarded at all, then the adjustment ramp is started and when it will end the following ratio will be **TargetGearRatio [4289.00]**.



CASE 3: In this case the following condition is assumed:

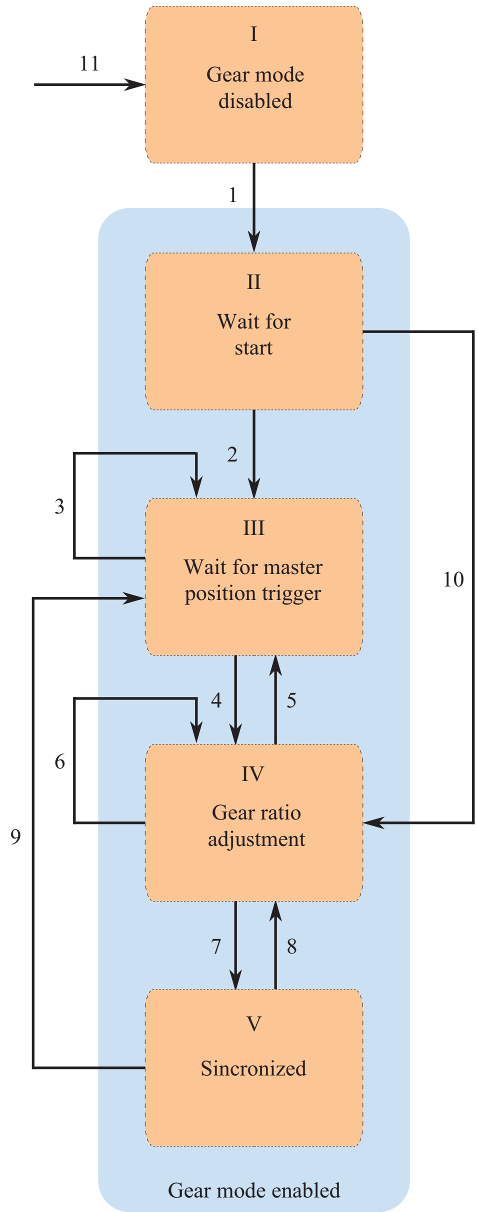
- Actual gear ratio < **TargetGearRatio [4289.00]** < **StartGearRatio [428A.00]**.
- The start gear command sending is made through the Start gear ratio disable bit set to 0.

The axis behaviour is showed in the figure below: the Start gear command has not been received by the drive, the following ratio is instantly set to the **TargetGearRatio [4289.00]** final value, without to execute the adjustment ramp.



Start a movement in Gear Mode

The procedure to start an Gear Mode movement is difficult and, in order to understand it better, it's necessary to refer to the Gear Mode state machine diagram of the figure below and to the next table that describes its transitions.



Status	Description	GearStatus
I	The axis is not in Gear Mode due to one of the following reasons: •The Gear Mode has not been set (**ModesOfOperationDisplay [6061.00]** different from -126) •The drive is not in the Operation enable status •The Halt or Quick stop command is in progress or is finished	0
II	The Gear Mode is enabled, the drive is waiting for the first Start gear command.	1
III	The drive has received the Start gear command and is waiting for the exceeding of the trigger master position (**GearMasterTriggerPosition [4288.02]**) to start the new adjustment ramp. When it is in this status, the axis could already be moving, either already synchronized or within an adjustment ramp, as a result of a preceding Start gear command.	2
IV	The drive is executing an adjustment ramp between two different following ratios.	3
V	The drive has completed the adjustment ramp and has reached the following ratio set (**TargetGearRatio [4289.00]**).	4

The states that may take the Gear Mode are described in the table below, while the actual status can be read in the **GearStatus [42A2.00]** parameter.

Trans.	Action	Description
1	Writing of the value -126 in the **ModesOfOperation [6060.00]** parameter and writing in **Controlword [6040.00]** of the values indicated in the **Section 5-5-1 CiA402 State Machine** to bring the drive in the Operation enable status.	The Gear Mode is selected and the drive switches to the Operation enable status.
2	Writing of a new **GearMasterTriggerPosition [4288.02]** and sending of a Start gear command with Reset trigger bit = 0.	The drive moves in the state II waiting for the master axis exceeds the trigger position (**GearMasterTriggerPosition [4288.02]**).
3	Writing of a new trigger position (**GearMasterTrigger-Position [4288.02]**) and receiving of a Start gear command with Reset trigger bit = 0 before the master axis has reached the previous trigger position.	The drive remains in the state II waiting for the master axis exceeds the new trigger position (**GearMasterTriggerPosition [4288.02]**).
4	The transition is due to one of the following causes: •The master axis has exceeded the trigger positio (**GearMasterTriggerPosition [4288.02]**) •A new Start gear command has been received without a previous writing of the trigger position (**GearMasterTriggerPosition [4288.02]**). •A new Start gear command has been received with Reset trigger = 1.	The drive starts the adjustment ramp in order to reach the following ratio that has been set (**TargetGearRatio [4289.00]**).
5	Writing of a new **GearMasterTriggerPosition [4288.02]** and receiving of a new Start gear command with Reset trigger bit = 0.	The drive moves in the state II waiting for the master axis exceeds the trigger position (**GearMasterTriggerPosition [4288.02]**).
6	The transition is due to one of the following causes: •A Start gear command has been received without a previous writing of the trigger position (**GearMasterTriggerPosition [4288.02]**). •A Start gear command has been received with Reset trigger = 1.	The drive remains the execution of the adjustment ramp and acquires as set point the new following ratio that has been set (**TargetGearRatio [4289.00]**).
7	The drive has completed the following ratio that has been set (**TargetGearRatio [4289.00]**) and has not received any other Start gear command.	The drive moves with following ratio equal to **TargetGearRatio [4289.00]**.
8	The transition is due to one of the following causes: •A Start gear command has been received without a previous writing of the trigger position (**GearMasterTriggerPosition [4288.02]**). •A Start gear command has been received with Reset trigger = 1.	The drive starts the adjustment ramp in order to reach the following ratio that has been set (**TargetGearRatio [4289.00]**).
9	Writing of a new **GearMasterTriggerPosition [4288.02]** and receiving of a new Start gear command with Reset trigger bit = 0.	The drive keeps the following ratio reached waiting the master axis position exceeds the trigger position (**GearMasterTriggerPosition [4288.02]**).
10	The transition is due to one of the following causes: •A Start gear command has been received without a previous writing of the trigger position (**GearMasterTriggerPosition [4288.02]**). •A Start gear command has been received with Reset trigger = 1.	The drive starts the adjustment ramp in order to reach the following ratio that has been set (**TargetGearRatio [4289.00]**).
11	This transition occurs from any of the states of the Gear Mode when a Quick stop, Halt, axis disable, operative mode change on fly command has been received, if a fault occurs or if the drive exceeds one of the position limits.	The drive switched to the status with Gear Mode disabled.

Here follows the procedure for starting an Gear Mode movement:

- Bring the drive to the status I, so that to enable the Gear Mode. The drive, at the start-up, is usually already in this condition unless there is a fault (in this case it will be necessary to remove cause and to reset the state machine of the drive, as indicated in **Section 5-5-1 CiA402 State Machine**).
- Select the Gear Mode by writing the value -126 in the **ModesOfOperation [6060.00]** parameter and set the master axis following the indications reported in the manual Section for Auxiliary position sensor. Bear in mind that the master axis role is performed by the Auxiliary encoder.
- Bring the axis in the Operation enable status of CiA402 state machine (transition 1, to switch from the status I to II).
- Parametrize the Gear Mode by following the indications of Gear Mode parameters configuration.
- Start of the Gear Mode movement by sending the Start gear command. According to the parametrization made and to the sent command, the drive can execute the transition 2 to switch to the status III or can follow the transition 10 and switch to the status IV: if the **GearMasterTriggerPosition [4288.02]** parameter has not been written or if the Start gear sent command has the Reset trigger bit set to 1 then, when the command is received, the drive goes immediately to the status IV (transition 10). Otherwise the drive switches to the status III (transition 2).

After the Start gear command has been sent, the drive independently executes the various transitions waiting for the trigger position (if set), for the adjustment of the new following ratio and for the successive synchronization with the master axis.

It's possible to reconfigure the Gear Mode parameters and send a Start gear command in anyone of the statuses between the II and the V: if the drive is in the status III or IV the previous command is aborted in order to allow to start the new one.

In the tables below the Operation mode specific of the **Controlword [6040.00]** and **Statusword [6041.00]** parameters are described. These are necessary to control the Gear Mode (for the bit with general use refer to the description of the **Controlword [6040.00]** and **Statusword [6041.00]** parameters).

Operation mode specific of the Statusword parameter

Bit	Action	Value	Description
0 - 9	See the **Statusword [6041.00]** parameter		
10	Target reached	0	Halt = 0: the set point has not been reached yet.
			Halt = 1: the axis is decelerating.
		1	Halt = 0: the set point has been reached.
			Halt = 1: the axis is stationary.
11	Internal limit active	See **Section 5-5-1 CiA402 State Machine**	
12	Reserved		
13	Following error	0	There is no position following error.
		1	Position following error present.
14 - 15	Reserved		

Operation mode specific of the Controlword parameter

Bit	Action	Value	Description
0 - 3	See the **Controlword [6040.00]** parameter		
4 - 6	Reserved		
7	See the **Controlword [6040.00]** parameter		
8	Halt	0	The drive can execute the Gear Mode movement commanded through the bit 15 Start gear.
		1	The drive executes an axis stop with deceleration equal to **ProfileDeceleration [6084.00]**.
9 - 10	See the **Controlword [6040.00]** parameter		
11 - 12	Reserved		
13	Start gear ratio disable	0	The starting following ratio of the adjustment ramp is the one set in the **StartGearRatio [428A.00]** parameter.
		1	The starting following ratio of the adjustment ramp is equal to one.

Bit	Action	Value	Description
14	Reset trigger	0	The adjustment ramp starts when the master axis position exceeds the **GearMasterTriggerPosition [4288.02]** parameter value (if set).
		1	The adjustment ramp starts as soon as the Start gear command is received.
15	Start gear	1	Command for the start of an Gear Mode movement.

Gear Mode movement conclusion

An Gear Mode movement may end due to one of the following reasons:

- **Halt command:** Setting to 1 the bit 8 Halt of the **Controlword [6040.00]** a stop command is executed: the axis is stopped with the deceleration ramp that has been set in the **ProfileDeceleration [6084.00]** parameter and the drive is brought to the status 0. When the axis is stopped the bit 10 Target reached is set to 1 indicating that the Halt command is complete. To start a new Gear Mode movement the Halt bit must be reset and the drive must be re-brought to the status II by executing the transition 1.
- **Quick stop command:** The execution of this command causes the transition 11 which leads back to status I. The axis is stopped and the Gear Mode is disabled. To exit from this status the transition 1 must be executed. It is advisable to use this command only to quickly stop the axis in case of emergency.
- **Fault condition:** If a fault occurs the Gear Mode movement is aborted and the CiA402 state machine switches from the Operation enable status to the Fault Reaction Active one (for further details see **Section 5-5-1 CiA402 State Machine** in the manual). The Gear Mode state machine, executing the transition 11, switches to the status I.
- **Axis disabling:** If the drive receives a transition command to Switch On Disabled or Ready to Switch On states (see **Section 5-5-1 CiA402 State Machine** in the manual), the Gear Mode movement is aborted and the axis power voltage is disconnected, leaving it free to rotate. The Gear Mode state machine, executing the transition 11, switches to the status I.
- **Reaching a position limit:** If one of the set position limits is reached the positioning is stopped (for further details see the **Section 8-2-2 Software Limits** in the manual). The Gear Mode state machine switches to the status I and, once the axis is stopped, automatically executes the transition 1 and switches to the status II.
- **On-the-fly operative mode change:** By using this functionality, the axis is driven to follow the new set points according to the new selected operating mode (see **Section 7-1-2 Changing the Mode of Operation**); The Gear Mode state machine switches to the status I.

7-3 Velocity Mode

In the Integrated Servo Motors, the drives have been implemented some functionalities (common to all the velocity modes) that permit to control if the movement is executed according to the user parametrization.

Speed

To check the motor speed you can use the only-reading-parameter **VelocityActualValue [606C.00]**.

Speed target reached

If in the **ModesOfOperationDisplay [6061.00]** a speed mode is set, it is sufficient to check if the bit Target reached of the **Statusword [6041.00]** is equal to 1 to check if the drive reached the final speed. This bit is set when the difference between the motor speed and the speed target is lower (in absolute value) to **VelocityWindow [606D.00]** for a time period at least equal to **VelocityWindowTime [606E.00]**. The bit is reset when the difference gets over the window.

Stopped motor

If in the **ModesOfOperationDisplay [6061.00]** a speed mode is set, to check if the motor is stopped it is sufficient to check if the bit Speed of the **Statusword [6041.00]** is equal to 1. This bit is set when the motor speed is lower (in absolute speed) to **VelocityThreshold [606F.00]** for a period of time at least equal to **VelocityThresholdTime [6070.00]**. The bit is reset as soon as the difference is higher than the threshold.

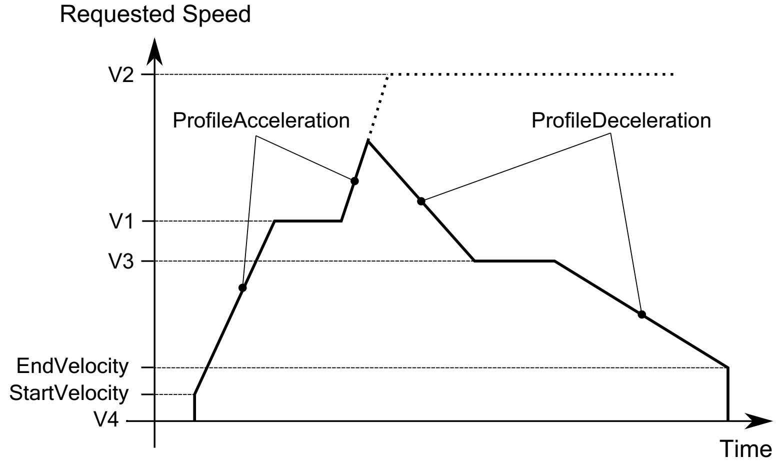
7-3-1 Profile Velocity Mode (CiA402)

The Profile Velocity Mode (CiA402) is used to carry out a speed motion, in which the speed profile is created by the drive. This operating mode follows the specifications of the CiA402.

To use this mode you need to set the **ModesOfOperation [6060.00]** with the value 3 (Profile Velocity Mode (CiA402)). Then you can proceed to write the parameters defining how to run the speed profile:

- MotionProfileType [6086.00]
- StartVelocity [4244.00]
- EndVelocity [6082.00]
- ProfileAcceleration [6083.00]
- ProfileDeceleration [6084.00]
- TargetVelocity [60FF.00]

In the below figure you can find an example showing how it is possible to change the **TargetVelocity [60FF.00]** and the other profile parameters in any moment. In the first phase the motor is accelerated until it reaches the V1 speed; later it is accelerated again to reach the V2 speed but it does not reach it because it gets a new request for reaching the V3 speed. At last the motor slows down until it stops since the V4 speed is equal to 0. You can notice that the acceleration and deceleration ramps are broken, near the value of zero, respectively from **StartVelocity [4244.00]** and from **EndVelocity [6082.00]**.



After the drive is parametrized and set to the Operation enable mode, the motor will start moving as soon as a **TargetVelocity [60FF.00]** is written with an absolute value higher than **EndVelocity [6082.00]** and **StartVelocity [4244.00]**.

In the **Statusword [6041.00]** there are two bits showing the motion status:
- Bit Target reached: bit showing the status of the Speed target reached
- Bit Speed: bit showing if the drive has the Stopped motor

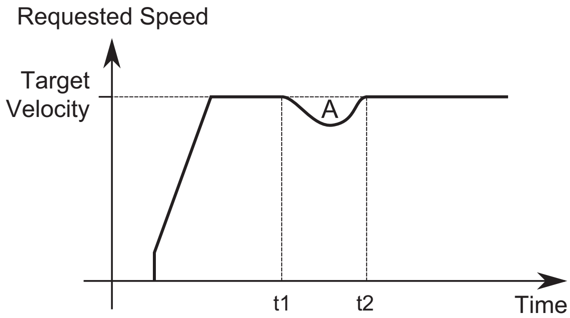
Note If with the motor in motion in mode Profile Velocity Mode (CiA402) the **TargetVelocity [60FF.00]** is written in an absolute value which is lower than **EndVelocity [6082.00]** or **StartVelocity [4244.00]**, the motor slows down with a deceleration equal to **ProfileDeceleration [6084.00]** until it reaches the **EndVelocity [6082.00]** and then it stops.

Note If with the motor in motion in mode Profile Velocity Mode (CiA402) the **EndVelocity [6082.00]** or the **StartVelocity [4244.00]** are written in an absolute value which is higher than **TargetVelocity [60FF.00]**, the motor stops with maximum deceleration resetting RequestedSpeed to zero.

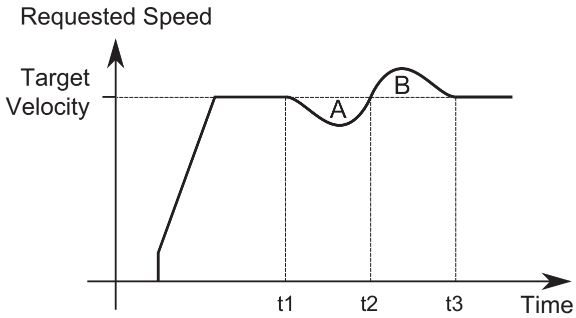
7-3-2 Profile Velocity Mode (CUSTOM)

The Profile Velocity Mode (CUSTOM) is used to run a motion in speed whose position is controlled, in which the speed profile is created from the drive. This operating mode works like the Profile Velocity Mode (CiA402) with the only difference that the position control is enabled. In the below figure you can notice a difference in the behavior of the motor speed between the two operating modes, when a brake torque is applied at the instant t1.

Profile velocity mode (CiA402)



Profile velocity mode (CUSTOM)



In the previous picture you can notice that starting from the instant t2, the two operating modes behave in a different way:

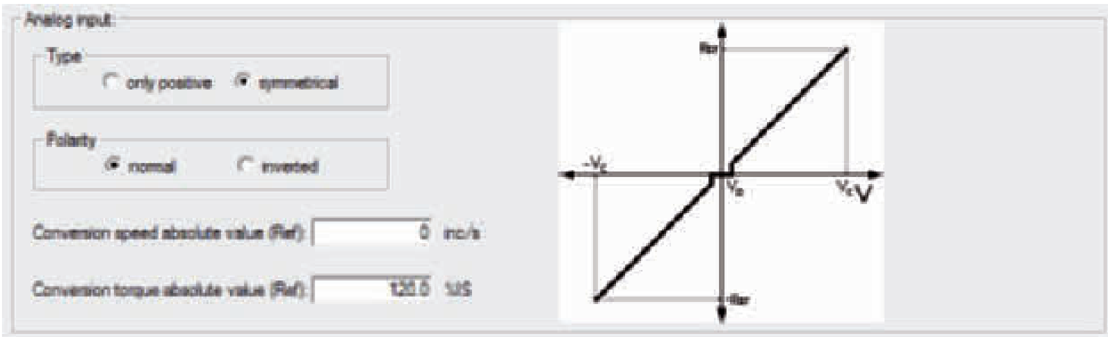
- **Profile Velocity Mode (CiA402):** The drive compensates for the brake torque and returns to the speed **TargetVelocity [60FF.00]**.
- **Profile Velocity Mode (CUSTOM):** The drive returns to the speed **TargetVelocity [60FF.00]** after regaining the lost position. This means that a speed overshoot is created in the time interval t2-t3, so that the A area is equal to the B area (A area = lost position = regained position = B area). At the instant t3, when the lost position is fully regained, the drive returns to the speed **TargetVelocity [60FF.00]**.

Note With the Profile Velocity Mode (CUSTOM), the control of the Error of position tracking is enabled.

To use this operating mode it is sufficient to write 143 in **ModesOfOperation [6060.00]** and, so, to follow the instructions described in the above **Section 7-3-1 Profile Velocity Mode (CiA402)**.

7-3-3 Profile Velocity AI Mode

The Profile Velocity AI Mode is used to run a motion in speed, in which the speed profile is created from the drive as it happens for the Profile Velocity Mode (CiA402), but in this case the requested speed is not set through the **TargetVelocity [60FF.00]** parameter but it is obtained from **AI0FilteredVoltage [3330.02]**.



Note For the Profile Velocity AI Mode you can apply all the considerations related to the Profile Velocity Mode (CiA402) and its parameters, as explained in the above **Section 7-3-1 Profile Velocity Mode (CiA402)**, except from what was stated for the **TargetVelocity [60FF.00]** parameter.

To enable the Profile Velocity AI Mode you must write the 145 value in the **ModesOfOperation [6060.00]** parameter. The Profile Velocity AI Mode has the automatic Enable functionality.

Note The filter that's applied on the analog input may limit the dynamic of the velocity reference and of the profiler ramps. To have a velocity reference that varies quickly you have to remove the filter and to increase the profiler ramps (**ProfileAcceceleration [6083.00]** and **ProfileDeceleration [6084.00]**).

7-3-4 Cyclic Synchronous Velocity Mode

Note To command the drive by this operating mode it is necessary to have a Master supporting at least a Real-time protocol on EtherCAT bus.

The Cyclic Synchronous Velocity Mode is an operative mode that allows the motor control in Real-time by using a EtherCAT master. This operative mode respects the CiA402 specifications.

To work, this mode requires to the master the cyclic sending, within a defined time (which will be later called T_{SYNC}, synchronization time) of the **TargetVelocity [60FF.00]** parameter (the synchronization techniques are described in the chapter of the communication interfaces):

There are other parameters that are not required by the drive to generate the movement (they are not necessary), but can be useful to improve it. These parameters are:

- **VelocityOffset [60B1.00]**: Velocity that will be added to **TargetVelocity [60FF.00]**.
- **TorqueOffset [60B2.00]**: It is used as **KAff [60F9.16]** if the **CyclicSynchronousSubMode [42D0.00]** parameter indicates that the **KAff [60F9.16]** internal calculation is disabled, otherwise it's not used.

The writing of the **TargetVelocity [60FF.00]** parameter does not use the SDO, but the PDO combined with some techniques that allow the synchronization with the other nodes that are connected to the bus. In the above **Section 7-2-2 Interpolated Position Mode** it is reported an example of linear interpolation with the Hard sync synchronization technique, used in the EtherCAT field bus with the SyncSignal synchronization signal (SYNC).

Note The parameters are so contained in the PDO RX and determine the construction of the movement profile. If a PDO RX is lost, it's not automatically re-sent. To avoid this drawback, Omron has implemented in the drives of the R88E-AECT series a monitoring and management functionality for the corrupted or missing PDO RX (see **Section 5-4-2 Missing or Corrupted PDO RX Management**).

The kind of interpolation can be set through the **CyclicSynchronousSubMode [42D0.00]** parameter and the following methods are available:

No interpolation

The drive executes the movement without interpolate the velocity target, that will be directly applied on the T_{SYNC} signal arrival. The **FeedForwardAcceleration** can be set by the master or internally calculated by the drive.

Linear interpolation

The drive executes the interpolation of the velocity only, by linking with a straight line the previous velocity set-point with the set-point that has been sent to the master in the **TargetVelocity [60FF.00]** parameter. The **FeedForwardAcceleration** can be set by the master or internally calculated by the drive.

Note The T_{SYNC} period that has been set must be greater than **MotionLoopPeriod [3521.04]**.

To command the drive with this mode it is necessary:

- To configure the communication parameters of the bus field (PDO configuration and mapping, setting of the synchronization system, ...)
- To activate in the master the management that allows, at regular intervals, to send the set-points through PDO and the synchronism management; the number and the type of the data (set-point) that have to be sent, depends on the **CyclicSynchronousSubMode [42D0.00]** that has been set
- To set the **CyclicSynchronousSubMode [42D0.00]**
- To set the **ModesOfOperation [6060.00]** with the value 9 (Cyclic Synchronous Velocity Mode)
- To take the drive in the Operation enable state
- At this point it is possible to command the drive

Note By selecting a value of **CyclicSynchronousSubMode [42D0.00]** that assigns to the master the **KAff [60F9.16]** calculation, it will be obtained a smoother motor motion. Pay attention that is a master duty to ensure that these data are sent, because the drive does not verify their receiving. If this last configuration is selected and the master doesn't anyway send the necessary feed forward values, the motion profile may be not the desired one.

7-4 Torque Mode

In the drives of the Integrated Servo Motors, some functionalities (common to all torque modes) have been implemented and through these it is possible to check if the motion is run in conformity with the parameterization made by the user.

Note The speed limit is not enabled with the torque modes. With an incorrectly high torque reference, the motor can reach a wrongly high speed.

Torque

To check the torque created by the motor, read the **ActualTorque [6077.00]** parameter or the **ActualFilteredTorque [4210.00]** parameter.

Torque target reached

If in the **ModesOfOperationDisplay [6061.00]** only one torque mode is set, to check if the motor reached the requested torque it is sufficient to check that the bit Target reached of the **Statusword [6041.00]** is equal to 1. This bit is set when the difference between **RequestedTorqueCurrent** and **ActualTorqueCurrent [3320.03]** is lower (in absolute value) than the 5% of **MotorStallCurrent [6410.01]** for a time period of at least 1ms. The bit is reset when the difference gets over the window.

7-4-1 Torque Mode

The Torque Mode is used to check the motor with a torque reference. To use this mode it's necessary to set the **ModesOfOperation [6060.00]** with the value 4 (Torque Mode) and then set the drive to the Operation enable status as described in the **Section 5-5-1 CiA402 State Machine**. Later you can run the motion by writing the torque reference **TargetTorque [6071.00]**.

The parameters that define how the torque referred movement has to be executed are:

- TargetTorque [6071.00]
- TorqueSlope [6087.00]
- TorqueProfileType [6088.00]

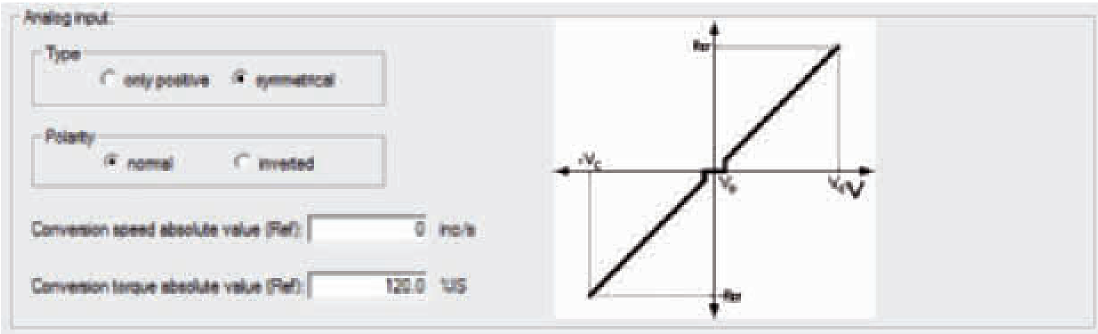
After the drive is parametrized and set to the Operation enable mode, a torque with module and direction consistent with the value in the **TargetTorque [6071.00]** parameter is applied on the motor.

In the **Statusword [6041.00]** there is a bit that shows the motion status:

- Bit Target reached: bit showing the status of the Torque target reached

7-4-2 Torque AI Mode

The Torque AI Mode is used to run a motion in torque created from the drive as it happens for the Torque Mode, but in this case the requested torque is not set through the **TargetTorque [6071.00]** parameter but it is obtained from **AI0FilteredVoltage [3330.02]**



Note For the Torque AI Mode you can apply all the considerations related to the Torque Mode and its parameters, as explained in the above **Section 7-4-1 Torque Mode**, except from what was stated for the **TargetTorque [6071.00]** parameter.

To enable the Torque AI Mode you must write the 155 value in the **ModesOfOperation [6060.00]** parameter. The Torque AI Mode is provided of the automatic Enable functionality.

Note The filter that's applied on the analog input may limit the dynamic of the torque reference. To have a torque reference that varies quickly you have to remove the filter.

7-4-3 Cyclic Synchronous Torque Mode

Note To command the drive by this operating mode it is necessary to have a Master supporting at least a Real-time protocol on EtherCAT bus.

The Cyclic Synchronous Torque Mode is an operative mode that allows the motor control in Real-time by using a EtherCAT master. This operative mode respects the CiA402 specifications.

To work, this mode requires to the master the cyclic sending, within a defined time (which will be later called T_{SYNC}, synchronization time) of the **TargetTorque [6071.00]** parameter (the synchronization techniques are described in the chapter of the communication interfaces):

There are other parameters that are not required by the drive to generate the movement (they are not necessary), but can be useful to improve it. These parameters are:

- **TorqueOffset [6071.00]**: Torque that will be added to the **TargetTorque [6071.00]**.

The writing of the **TargetTorque [6071.00]** parameter does not use the SDO, but the PDO combined with some techniques that allow the synchronization with the other nodes that are connected to the bus. In the above **Section 7-2-2 Interpolated Position Mode** it is reported an example of linear interpolation with the Hard sync synchronization technique, used in the EtherCAT field bus with the SyncSignal synchronization signal (SYNC).

Note The parameters are so contained in the PDO RX and determine the construction of the movement profile. If a PDO RX is lost, it's not automatically re-sent. To avoid this drawback, Omron has implemented in the drives of the R88E-AECT series a monitoring and management functionality for the corrupted or missing PDO RX (see **Section 5-4-2 Missing or Corrupted PDO RX Management**).

The kind of interpolation can be set through the **CyclicSynchronousSubMode [42D0.00]** parameter and the following methods are available:

No interpolation

The drive executes the movement without interpolating the torque target, that will be directly applied on the T_{SYNC} signal.

Linear interpolation

The drive runs the interpolation only of the torque by linking with a straight line the set-point of a previous position, reached at the beginning of the new period of the T_{SYNC}, with the torque set-point sent to the master in the **TargetTorque [6071.00]** parameter.

Note The T_{SYNC} period that has been set must be greater than **MotionLoopPeriod [3521.04]**.

To command the drive with this mode it is necessary:

- To configure the communication parameters of the bus field (PDO configuration and mapping, setting of the synchronization system, ...)
- To activate in the master the management that allows, at regular intervals, to send the set-points through PDO and the synchronism management; the number and the type of the data (set-point) that have to be sent, depends on the **CyclicSynchronousSubMode [42D0.00]** that has been set
- To set the **CyclicSynchronousSubMode [42D0.00]**
- To set the **ModesOfOperation [6060.00]** with the value 10 (Cyclic Synchronous Torque Mode)
- To take the drive in the Operation enable state
- At this point it is possible to command the drive

7-5 Homing Mode

The Homing Mode is used to bring the motor on a known position, using some external references as the Positive limit switch (FC +), the Negative limit switch (FC -), the mechanical stop, the Home switch and the index pulse of the feedback sensor. This operating mode can be also used to run the preset of **PositionActualValue [6064.00]** without running any motion. The Homing Mode meets the specifications of the CiA402.

Note Regardless of which feedback sensor type is on the Integrated Servo Motor, the homing procedures are always the same, it only change the position reference subsistence conditions.

Note To configure the digital inputs like Positive limit switch (FC +), Negative limit switch (FC -) or Home, see **Section 8-1-1 Digital I/O's**.

Note If the Polarity is of Reverse type, the roles of Positive limit switch (FC +) and Negative limit switch (FC -) are reversed: Positive limit switch (FC +) behaves like Negative limit switch (FC -) and Negative limit switch (FC -) behaves like Positive limit switch (FC +).

Note If you change the Polarity it will be necessary to re-execute the homing procedure.

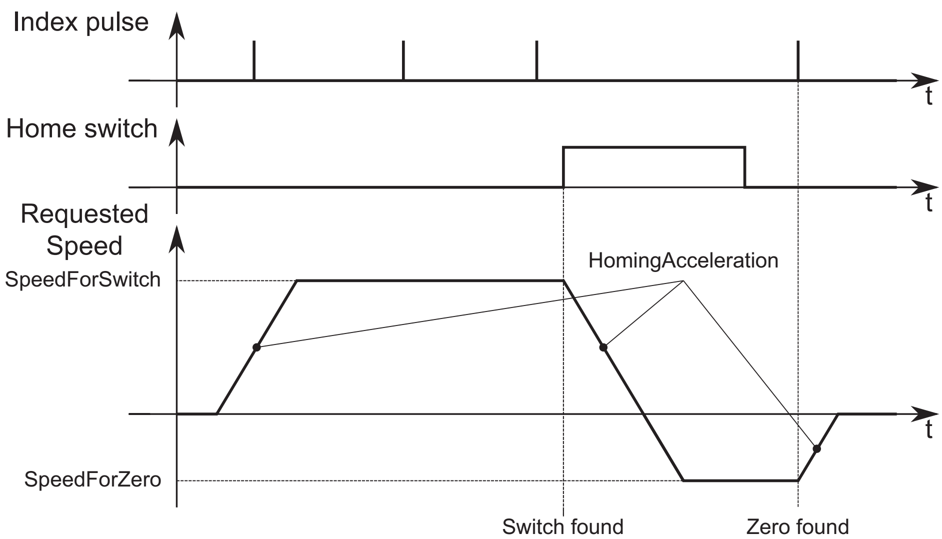
Note If a **HomingMethod [6098.00]** with mechanical stop is selected (eg. mode -1), remember to set the torque limit (see **Section 8-4 Torque Limits**).

The following positions related to the Homing Mode are defined:

- **End position:** physical position of the motor at the end of the homing procedure, when the motor is stopped after the deceleration ramp
- **Home position:** physical position of the motor where the final phase of the homing procedure is noticed
- **Zero position:** physical position of the motor where **PositionActualValue [6064.00]** is equal to 0 inc
- **HomeOffset [607C.00]:** difference between Zero position and Home position

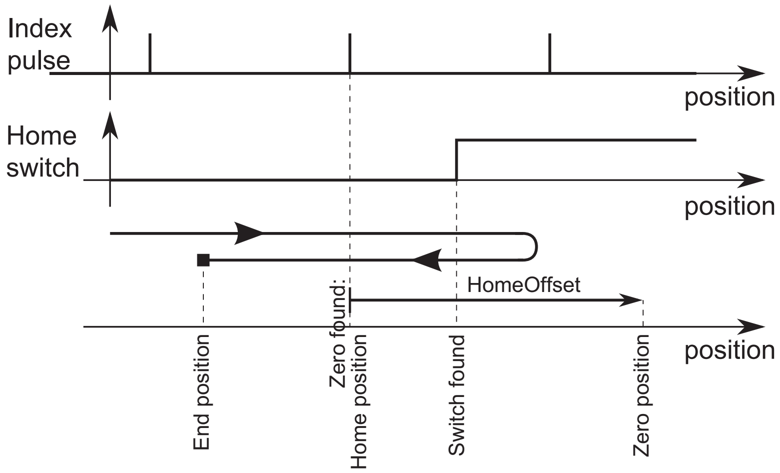
In the following picture you can find an example of homing motion searching for the Home switch and the index pulse of the feedback sensor. When the motion starts, Home switch is not engaged and the motor is moved in the positive direction at the speed **SpeedForSwitch [6099.01]**.

With the engagement of the Home switch, the motion is reversed and taken to the speed **SpeedForZero [6099.02]**. After the disengagement of the switch, the motor is stopped on the first index pulse found on the feedback sensor.



At the end of the homing procedure, a preset of the position is carried out. **PositionActualValue [6064.00]** gets the value according to the following formula:

PositionActualValue [6064.00] = **End position** - **Home position** - **HomeOffset**



To use this operating mode, you must set the **ModesOfOperation [6060.00]** with the value 6 (Homing Mode). Then you proceed writing the parameters that define how the profile and the homing procedure must be executed:

- HomingMethod [6098.00]; see the following table
- HomeOffset [607C.00]
- SpeedForSwitch [6099.01]
- SpeedForZero [6099.02]
- StartVelocity [4244.00]
- EndVelocity [6082.00]
- HomingAcceleration [609A.00]
- IndexPulseDeadZone [4285.02]
- HomingAbsRangeMode [4285.04]

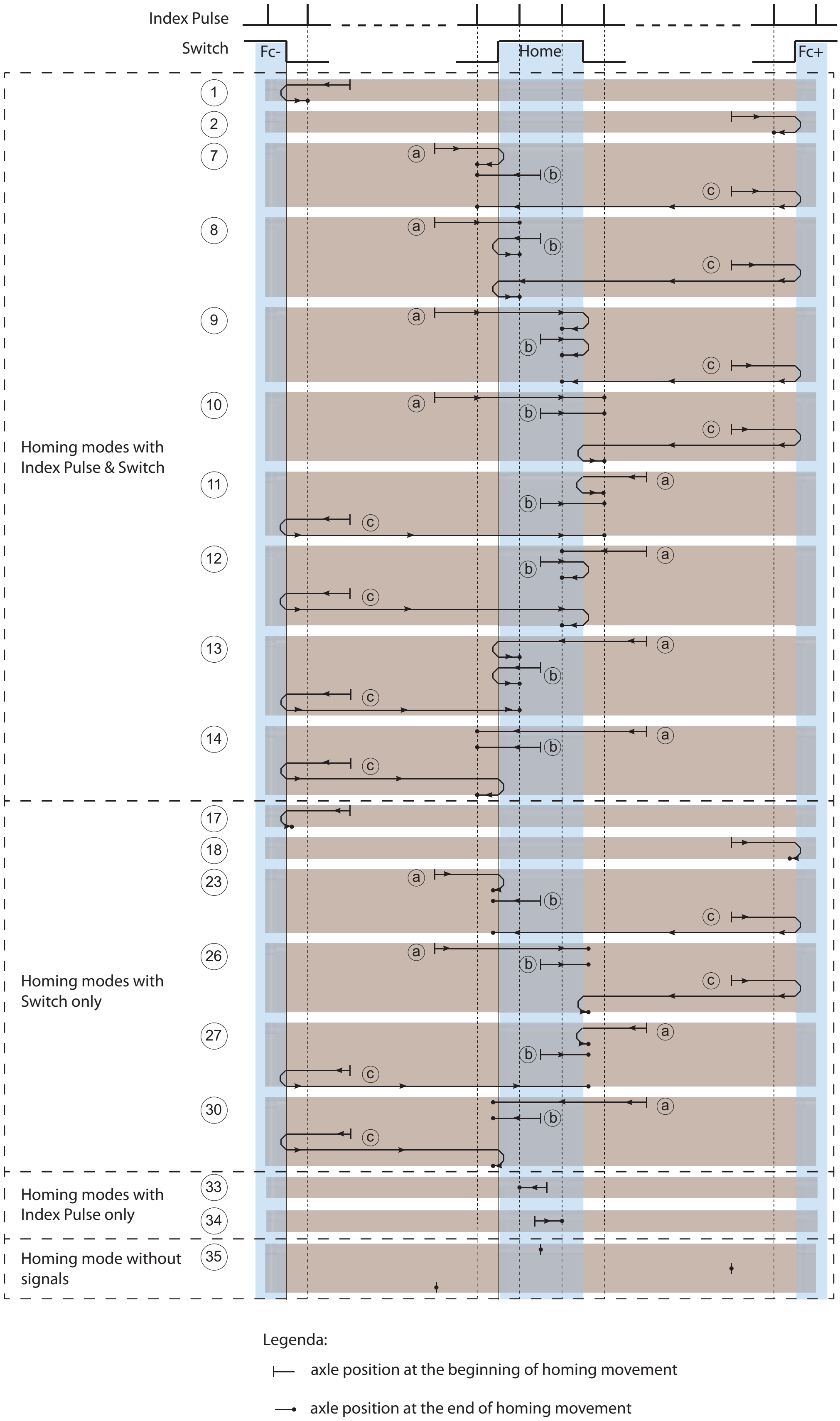
Val	Procedure description
1	The motor is moved in the negative direction with **SpeedForSwitch [6099.01]** velocity. With the engagement of the Negative limit switch (FC -), the motion is reversed and taken to the speed **SpeedForZero [6099.02]**. After the disengagement of the limit switch, the motor is stopped on the first index pulse noticed
2	The motor is moved in the positive direction with **SpeedForSwitch [6099.01]** velocity. With the engagement of the Positive limit switch (FC +), the motion is reversed and taken to the speed **SpeedForZero [6099.02]**. After the disengagement of the limit switch, the motor is stopped on the first index pulse noticed
7	You can find the following sub-cases: (a) At the start of the motion Home switch is not engaged, the motor is moved in the positive direction with **SpeedForSwitch [6099.01]** velocity. With the engagement of the Home switch, the motion is reversed and taken to the speed **SpeedForZero [6099.02]**. After the disengagement of the switch, the motor is stopped on the first index pulse noticed (b) At the start of the motion Home switch is engaged, the motor is moved in the negative direction with **SpeedForZero [6099.02]** velocity. After the disengagement of the Home switch, the motor is stopped on the first index pulse noticed (c) At the start of the motion Home switch is not engaged, the motor is moved in the positive direction with **SpeedForSwitch [6099.01]** velocity. With the engagement of the Positive limit switch (FC +), the motor motion is reversed. With the engagement of the Home switch, the motion is taken to the speed **SpeedForZero [6099.02]**. After the disengagement of the switch, the motor is stopped on the first index pulse noticed

Val	Procedure description
8	You can find the following sub-cases: (a) At the start of the motion Home switch is not engaged, the motor is moved in the positive direction with **SpeedForSwitch [6099.01]** velocity. After the engagement of the Home switch, the motion is taken to the speed **SpeedForZero [6099.02]**. The motion is stopped on the first index pulse noticed (b) At the start of the motion Home switch is engaged, the motor is moved in the negative direction with **SpeedForZero [6099.02]** velocity. After the disengagement of the Home switch, the motion is reversed. After a new engagement of the switch, the motor is stopped on the first index pulse noticed (c) At the start of the motion Home switch is not engaged, the motor is moved in the positive direction with **SpeedForSwitch [6099.01]** velocity. With the engagement of the Positive limit switch (FC +), the motor motion is reversed. With the engagement of the Home switch, the motion is taken to the speed **SpeedForZero [6099.02]**. With the disengagement of the switch, the motion is reversed again. After a new engagement of the Home switch, the motor is stopped on the first index pulse noticed
9	You can find the following sub-cases: (a) At the start of the motion Home switch is not engaged, the motor is moved in the positive direction with **SpeedForSwitch [6099.01]** velocity. With the engagement of the Home switch, the motion is taken to the speed **SpeedForZero [6099.02]**, with the disengagement of the switch the motion is reversed. After a new engagement of the Home switch, the motor is stopped on the first index pulse noticed (b) At the start of the motion Home switch is engaged, the motor is moved in the positive direction with **SpeedForZero [6099.02]** velocity. With the disengagement of the Home switch, the motion is reversed. After a new engagement of the switch, the motor is stopped on the first index pulse noticed (c) At the start of the motion Home switch is not engaged, the motor is moved in the positive direction with **SpeedForSwitch [6099.01]** velocity. With the engagement of the Positive limit switch (FC +), the motor motion is reversed. With the engagement of the Home switch, the motion is taken to the speed **SpeedForZero [6099.02]**. The motion is stopped on the first index pulse noticed
10	You can find the following sub-cases: (a) At the start of the motion Home switch is not engaged, the motor is moved in the positive direction with **SpeedForSwitch [6099.01]** velocity. With the engagement of the Home switch, the motion is taken to the speed **SpeedForZero [6099.02]**. After the disengagement of the switch, the motor is stopped on the first index pulse noticed (b) At the start of the motion Home switch is engaged, the motor is moved in the positive direction with **SpeedForZero [6099.02]** velocity. After the disengagement of the Home switch, the motor is stopped on the first index pulse noticed (c) At the start of the motion Home switch is not engaged, the motor is moved in the positive direction with **SpeedForSwitch [6099.01]** velocity. With the engagement of the Positive limit switch (FC +), the motor motion is reversed. With the engagement of the Home switch, the motion is reversed and taken to the speed **SpeedForZero [6099.02]**. After the disengagement of the switch, the motor is stopped on the first index pulse noticed
11	Symmetrical to the 7. Differences: reversed speed signs; in the sub-case c) reversed motion on the Negative limit switch (FC -)
12	Symmetrical to the 8. Differences: reversed speed signs; in the sub-case c) reversed motion on the Negative limit switch (FC -).
13	Symmetrical to the 9. Differences: reversed speed signs; in the sub-case c) reversed motion on the Negative limit switch (FC -).
14	Symmetrical to the 10. Differences: reversed speed signs; in the sub-case c) reversed motion on the Negative limit switch (FC -)
17	Same as 1. Differences: without search for index pulse, motion stopped on the correct edge of the limit switch.
18	Same as 2. Differences: without search for index pulse, motion stopped on the correct edge of the limit switch
23	Same as 7. Differences: without search for index pulse, motion stopped on the correct edge of the Home switch
26	Same as 10. Differences: without search for index pulse, motion stopped on the correct edge of the Home switch
27	Symmetrical to the 7. Differences: reversed speed signs; in the sub-case c) reversed motion on the Negative limit switch (FC -); without search for index pulse, motion stopped on the correct edge of the Home switch

Val	Procedure description
30	Symmetrical to the 10. Differences: reversed speed signs; in the sub-case c) reversed motion on the Negative limit switch (FC -); without search for index pulse, motion stopped on the correct edge of the Home switch
33	The motor is moved in the negative direction with **SpeedForZero [6099.02]** velocity. The motor is stopped on the first detected Index pulse
34	The motor is moved in the positive direction with **SpeedForZero [6099.02]** velocity. The motor is stopped on the first detected Index pulse
35	The motor does not move and the drive takes the current position as Home position
-1	The motor is moved in the negative direction with **SpeedForSwitch [6099.01]** velocity. When the mechanical stop is reached, the movement is inverted and taken to the **SpeedForZero [6099.02]** velocity. The motion is stopped on the first index pulse noticed
-2	The motor is moved in the positive direction with **SpeedForSwitch [6099.01]** velocity. When the mechanical stop is reached, the movement is inverted and taken to the **SpeedForZero [6099.02]** velocity. The motion is stopped on the first index pulse noticed
-7	Same as 7. Differences: with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-8	Same as 8. Differences: with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-9	Same as 9. Differences: with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-10	Same as 10. Differences: with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-11	Symmetrical to the 7. Differences: reversed speed signs; with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-12	Symmetrical to the 8. Differences: reversed speed signs; with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-13	Symmetrical to the 9. Differences: reversed speed signs; with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-14	Symmetrical to the 10. Differences: reversed speed signs; with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-17	Same as -1. Differences: after the mechanical stop is reached and the direction is inverted, the motor is distanced from the mechanical stop with a minimum pulse number set on **HomingPosDisengagement [4285.03]** (minimum disengagement position)
-18	Same as -2. Differences: after the mechanical stop is reached and the direction is inverted, the motor is distanced from the mechanical stop with a minimum pulse number set on **HomingPosDisengagement [4285.03]** (minimum disengagement position)
-23	Same as 7. Differences: without search for index pulse, motion stopped on the correct edge of the Home switch; with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-26	Same as 10. Differences: without search for index pulse, motion stopped on the correct edge of the Home switch; with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-27	Symmetrical to the 7. Differences: reversed speed signs; without search for index pulse, motion stopped on the correct edge of the Home switch; with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-30	Symmetrical to the 10. Differences: reversed speed signs; without search for index pulse, motion stopped on the correct edge of the Home switch; with the engagement of a limit switch the procedure is stopped and you get an error message (bit Homing error = 1)
-35	Same as 35. Differences> the drive takes RequestedPosition as Home position

Note If the Polarity is of Reverse type, the roles of Positive limit switch (FC +) and Negative limit switch (FC -) are reversed: Positive limit switch (FC +) behaves like Negative limit switch (FC -) and Negative limit switch (FC -) behaves like Positive limit switch (FC +).

Note If a **HomingMethod [6098.00]** with mechanical stop is selected (eg. mode -1), remember to set the torque limit (see **Section 8-4 Torque Limits**).



Note On the digital input with functionalities of Home a filtering at 10ms is run: the input status is considered as valid if it remains unchanged for at least 10 ms.

Note When you select a homing method which uses the index pulse, you cannot use the capture peripheral A to execute other captures and in the capture peripheral B it is not possible to configure the index pulse as trigger source.

After having parametrized the drive and taken it to the status Operation enable, you can start the homing procedure by setting the bit Homing operation start of the **Controlword [6040.00]**. On the **Statusword [6041.00]** you can see the status of the bits procedure.

- Bit Target reached: it shows if the procedure is ended
- Bit Homing attained: it shows if the homing procedure was correctly concluded
- Bit Homing error: it shows that there has been an error during the procedure running

8

Applied Functions

This section outlines the applied functions and explains the settings.

8-1 Sequence I/O Signals

You can set sequences in various operating conditions.

8-1-1 Digital I/O's

In the Integrated Servo Motors are provided the following optoisolated digital inputs and outputs:

On the CN4 connector (M23 male, 19 poles) there are:
- 5 PNP digital inputs (24 VDC)
- 3 PNP digital outputs (24 VDC, max 300 mA)
- 1 PNP bidirectional digital (with configurable direction)
- 3 differential digital IN/OUT (type +5 V/line driver), isolated from the power section (usable for example as master encoder input or step-dir input)

On the supply CN5 connector (M23 male, 8 poles) there is:
- 1 PNP digital input (24 VDC)

It's therefore possible to have up to 7 inputs (in this case the PNP digital outputs number is 3) and up to 4 PNP digital outputs 24 VDC (in this case the PNP digital inputs number is 6).

Name	Resource/logic type	Details	Default
I/O 0	Bidirectional, differential, line driver	Configurable functionality, connections: pin 13 (I/O+) and pin 12 (I/O-) of CN4	GPIN
I/O 1	Bidirectional, differential, line driver	Configurable functionality, connections: pin 14 (I/O+) and pin 1 (I/O-) of CN4	GPIN
I/O 2	Bidirectional, differential, line driver	Configurable functionality, connections: pin 5 (I/O+) and pin 2 (I/O-) of CN4	GPIN
I/O 3	Bidirectional, PNP, 24V	Configurable functionality, connection: pin 10 of CN4	GPIN
In 4	Input, PNP, 24V	Configurable functionality, connection: pin 15 of CN4	GPIN
In 5	Input, PNP, 24V	Configurable functionality, connection: pin 19 of CN4	GPIN
In 6	Input, PNP, 24V	Configurable functionality, connection: pin 18 of CN4	GPIN
In 7	Input, PNP, 24V	Configurable functionality, connection: pin 17 of CN4	GPIN
In 8	Input, PNP, 24V	Configurable functionality, connection: pin 8 of CN4	GPIN
In 9	Input, PNP, 24V	Configurable functionality, connection: pin C of CN5	GPIN
Out 4	Output, PNP, 24V	Configurable functionality, connection: pin 16 of CN4	GPOUT
Out 5	Output, PNP, 24V	Configurable functionality, connection: pin 9 of CN4	GPOUT
Out 6	Output, PNP, 24V	Configurable functionality, connection: pin 17 of CN4	GPOUT
/STOP	Input, PNP, 24V	Not configurable, connection pin A of CN5	/STOP

Bidirectional: The resource can be configured to work as an input or output.

Input: The resource works as input but not as output.

Output: The resource works as output but not as input.

Differential: The status of the resource is linked to the difference of potential between two pins.

PNP: The status of the resource is linked to the current voltage value as to the common mass.

Configurable mass: The resource can be configured to work as "Generic Input" or "Generic Output", so the status of the resource can be read or written by the user through the parameters **DigitalInputs [60FD.00]** and **PhysicalOutputs [60FE.01]**, or it can be configured to run some special functions, so its status is managed directly by the drive.

/STOP: See **Section 9 /STOP Function**.

24V PNP digital inputs specifications	
Maximum number of inputs	7
Galvanic isolation	Yes, through optoisolators
In/Out 3, In 4, In 5, In 6, In 7, In 8, In 9	
Input type	PNP
Input voltage	Nominal: 24 VDC Low signal (physical status 0): -30 to 3 VDC High signal (physical status 1): 15 to 30 VDC
Input current (typical) with Vin = 24 VDC	3.3 mA (In 8 and In 9 excluded) 5 mA (In 8 and In 9)
Maximum allowed current on IN5 if configured as SGND	2 A
HW propagation delay	max 20 µs (for In 8 and In 9 inputs if used for the capture function)
Jitter on the capture inputs SW detection	Max. 1 µs
Propagation delay (HW + SW)	Max. 1 µs (for all inputs if not used for the capture function)

Digital IN/OUT specifications (differential line drive type)	
Type	Differential IN-OUT (line driver/line receiver)
Galvanic isolation	Yes, towards the power section
Maximum number of inputs	3
Maximum number of outputs	3
In/Out 0, In/Out 1, In/Out 2	
Output specifications*1	
Differential output voltage	Min. 2 V Max. 3.3 V (with a 50 Ω load)
Input specifications*2	
Differential input voltage	Max. -5 to 5 V (with enabled termination)
Common mode voltage	-7 V to 12 V
Typical input resistance	125 KΩ (when the termination resistance is disabled)
Typical input current	110 µA
Differential threshold voltage V_{thd} (input)	0.2 V
Integrated termination resistance*3	Typical: 120 Ω
Input maximum frequency (duty cycle: 40% to 60%)	300 KHz

*1. If they are configured as outputs.

*2. If they are configured as inputs.

*3. Can be activated by software command.

Note The In/Out0, In/Out1, In/Out2 inputs are differential and must NOT be connected with “24V” level signals. Please see the applicative diagrams of the CN4 connector. It's recommended to respect the maximum differential voltage and to report this voltage to the “GND_5V” ground [pin 6 of CN4].

Note When the voltage applied to the differential input is greater than the differential threshold voltage V_{thd}, then related physical status in the Integrated Servo Motor is 1. When instead the voltage that's applied to the differential input is minor than $-V_{thd}$, then the related physical status in the Integrated Servo Motor is 0. For values included in the $\pm V_{thd}$ range the physical status of the input is not guaranteed.

Digital OUTPUTS specifications	
In/Out 3[*1], Out 4, Out 5, Out 6	
Output type	PNP
Maximum number of outputs	4
Galvanic isolation	Yes, through optoisolators
Supply voltage	24 V (internally obtained from the 24V that are presents on CN5)
Maximum output current (for each output)[*1]	300 mA
Voltage with OFF output	< 1 V

*1. If configured as output.

*2. That limit is true even if the output is configured as S24V (simulated 24V).

Note The maximum output current declared on the above table is referred to each output, therefore it's possible to have an maximum overall absorption of about 24V (with all 4 outputs enabled and with the maximum connected load) equal to 1200 mA. Inside the system a protection useful in case of the overcoming of this absorption limit is implemented. This protection disable all the outputs (even if the greater part of the absorption is due to only one of these). Therefore please pay particular attention because the overcurrent on a single output may cause a fault that provokes the switch off of even the others outputs.

Configuring the I/O using the parameters

To configure the Digital I/O by writing directly the related parameters, follow these instructions:

(a) Run the command of the System Manager 6200 to start the configuration procedure

(b) Select the functionalities through the parameters listed in the below table; the codes of the functionalities are listed in the description of the parameters

(c) Configuring the polarity (**PolarityInputValue [405A.00]**)

(d) Run the command of the System Manager 620 to end the configuration procedure

(e) Check any possible error

Resource	Parameter
I/O 0	IO_0_Function
I/O 1	IO_1_Function
I/O 2	IO_2_Function
I/O 3	IO_3_Function
In 4	In_4_Function
In 5	In_5_Function
In 6	In_6_Function
In 7	In_7_Function
In 8	In_8_Function
In 9	In_9_Function
Out 4	Out_4_Function
Out 5	Out_5_Function
Out 6	Out_6_Function

The running of the settings related to the filtering and the termination resistance do not require any particular modes or commands of the System Manager.

Functionalities

Here you can find the functionalities given to the resources of I/O of the drive of Integrated Servo Motor. Some functionalities can be given to more I/O at the same time, others can be given to only one resource per time.

Functionalities		Given to...
Input function	Generic Input (I/O X - In X)	I/O 0, I/O 1, I/O 2, I/O 3, In 4, In 5, In 6, In 7, In 8, In 9
	Home	I/O 0, I/O 1, I/O 2, I/O 3, In 4, In 5, In 6, In 7, In 8, In 9
	Step	I/O 0
	Dir	I/O 1
	Positive limit switch (FC +)	I/O 0, I/O 1, I/O 2, I/O 3, In 4, In 5, In 6, In 7, In 8, In 9
	Negative limit switch (FC -)	I/O 0, I/O 1, I/O 2, I/O 3, In 4, In 5, In 6, In 7, In 8, In 9
	Enable	I/O 3, In 4, In 5, In 6, In 7, In 8, In 9
	Quadrature Input ChA (Ch A)	I/O 0
	Quadrature Input ChB (Ch B)	I/O 1
	Quadrature Input Index (Idx)	I/O 2
	Simulated GND (SGND)	In 5
Output function	Generic Output (I/O X - Out X)	I/O 0, I/O 1, I/O 2, I/O 3, Out 4, Out 5, Out 6
	Fault	I/O 0, I/O 1, I/O 2, I/O 3, Out 4, Out 5, Out 6
	Pwm out (Pwm O)	I/O 0, I/O 1, I/O 2
	Motor Fan (M. Fan)	I/O 0, I/O 1, I/O 2, I/O 3, Out 4, Out 5, Out 6
	Drive Fan (D. Fan)	I/O 0, I/O 1, I/O 2, I/O 3, Out 4, Out 5, Out 6
	Drive Ok (Drv OK)	I/O 0, I/O 1, I/O 2, I/O 3, Out 4, Out 5, Out 6
	Simulated 24V Out (S24V)	I/O 3, Out 4, Out 5, Out 6

Note Each functionality has a code that can be assigned to the inputs and outputs. These codes are listed in **Section 10-3-17 Digital Inputs and Outputs**.

Note Simulated GND (SGND) input is not protected against overcurrent.

Generic Input (I/O X - In X)

The resource works as input for general use. The physical status of the input can be read through the parameter **DigitalInputs [60FD.00]**. The parameter **LogicalDigitalInputStatus [4051.01]** shows the input status after the application of the polarity.

Home

Input used to carry out the homing of the shaft. (See **Section 7-5 Homing Mode**). Through the parameter **HomeStatus [4054.02]** it is possible to read the status of the limit switch, irrespective of the resource used for such functionality.

Note If the Integrated Servo Motor is controlled as a servo axis in the Sysmac controller, do not use this setting.

Step

The functionality Step is used to get information on position and speed, gaining them from the frequency of the applied signal. This functionality can be used with the functionality Dir. In this way it is possible to link the drive to third part controllers.

Dir

The functionality Dir is used to get the direction of the reference gained through the functionality Step. This functionality can be used with the functionality Step. In this way it is possible to link the drive to third part controllers.

Positive limit switch (FC +)

Input of positive limit switch. The sensors used as limit switches must work when the contact is normally closed. The drive, for safety reasons, automatically selects the polarity of the input configured as limit switch, so that it can correctly work with this kind of sensor. Through the parameter **FcStatus [4054.01]** it is possible to read the status of the limit switch, irrespective of the resource used for such functionality.

Note If the Integrated Servo Motor is controlled as a servo axis in the Sysmac controller, do not use this setting.

Negative limit switch (FC -)

Input of negative limit switch. The sensors used as limit switches must work when the contact is normally closed. The drive, for safety reasons, automatically selects the polarity of the input configured as limit switch, so that it can correctly work with this kind of sensor. Through the parameter **FcStatus [4054.01]** it is possible to read the status of the limit switch, irrespective of the resource used for such functionality.

Note If the Integrated Servo Motor is controlled as a servo axis in the Sysmac controller, do not use this setting.

Enable

The functionality Enable is a consent to enable the drive. When the functionality Enable is associated to one of the digital inputs, such input must be at the logical status '1' in order to take the drive to the status Operation enable. The consent to enable the drive can be read through the parameter **EnableInputStatus [4054.03]** irrespective of which input has been used for the Enable function. When **EnableInputStatus [4054.03]** is equal to 0, the CiA402-StateMachine cannot be taken to the statuses Switched On e Operation enable (see **Section 5-5-1 CiA402 State Machine**).

If the drive is in the Operation enable status and the Enable input is disabled then the following sequence takes place:

(a) Deceleration of the motor according to the settings of the parameter **DisableOption [406E.00]**
(b) Waiting for the motor stopping and enabling of the brake, if present
(c) The CiA402StateMachine enters the status Switch On Disabled
(d) Enabling of the warning Drive disable by digital enable input error

Note For some operating modes, when the Enable input is enabled, the drive goes automatically to the status Operation enable, unless the drive is in Fault. This function is called Automatic Enable.

Note If the Integrated Servo Motor is controlled as a servo axis in the Sysmac controller, do not use this setting.

Quadrature Input ChA (Ch A)

The functionality Quadrature Input ChA is used, with Quadrature Input ChB (Ch B), to get a quadrature signal, typically used by the incremental encoders. To reverse the sense of positive rotation of the auxiliary encoder without modifying the electrical connections you can work on the parameter **RealAuxEncoderPolarity [36C9.02]**. If you select this functionality the parameter **PolarityInputValue [405A.00]** does not have any effect.

Note To read the auxiliary encoder position or to capture its position it's necessary to program in the digital inputs this functionality (together with Quadrature Input ChB (Ch B)).

Quadrature Input ChB (Ch B)

Through the functionality Quadrature Input ChB it is possible, together with Quadrature Input ChA (Ch A), to get a quadrature signal, typically used on the incremental encoders. To reverse the sense of positive rotation of the auxiliary encoder without modifying the electrical connections you can work on the parameter **RealAuxEncoderPolarity [36C9.02]**. If you select this functionality the parameter **PolarityInputValue [405A.00]** does not have any effect.

Note To read the auxiliary encoder position or to capture its position it's necessary to program in the digital inputs this functionality (together with Quadrature Input ChA (Ch A)).

Quadrature Input Index (Idx)

The functionality Quadrature Input Index is used to get the index pulse of an incremental encoder. It must be used together with Quadrature Input ChA (Ch A) and Quadrature Input ChB (Ch B). To reverse the sense of positive rotation of the auxiliary encoder without modifying the electrical connections you can work on the parameter **RealAuxEncoderPolarity [36C9.02]**. If you select this functionality the parameter **PolarityInputValue [405A.00]** does not have any effect.

Note To use the zero mark as the capture event to capture the auxiliary encoder position it's necessary to program this functionality in the digital input 2.

Simulated GND (SGND)

The functionality Simulated GND transforms the selected resource into a ground terminal. It is useful to close the circuit of the digital outputs. If used together with Simulated 24V Out (S24V), it can also be used to supply external devices.

Generic Output (I/O X - Out X)

The resource works as output for general use. The output status can be read and written through the parameter **PhysicalOutputs [60FE.01]**. To prevent the accidental modification of one or more bits of the parameter **PhysicalOutputs [60FE.01]** it is possible to block the writing, every bit through the parameter **DigitalOutputsBitMask [60FE.02]**.

Fault

The functionality Fault enables the output when a retention fault is active. When the fault is reset, the status of the digital output is reset to zero. See **Section 13-2 Fault and Warning (Integrated Servo Motor)**.

Pwm out (Pwm O)

The functionality Pwm out runs the output by creating a frequency square wave and duty cycles to be set. The configuration parameters depend on which resource is used to run this functionality; you can find a list on the following chart:

Resource	Parameter for frequency setting	Parameter for Duty Cycle setting
I/O 0	PwmHwFrequencyIO0 [403F.01]	PwmHwDutyCycleIO0 [403F.02]
I/O 1	PwmHwFrequencyIO1 [403F.03]	PwmHwDutyCycleIO1 [403F.04]
I/O 2	PwmHwFrequencyIO2 [403F.05]	PwmHwDutyCycleIO2 [403F.06]

Motor Fan (M. Fan)

The functionality Motor Fan is used to run an external fan to cool the motor. The output is enabled when the motor temperature exceeds the warning threshold. When the temperature of the motor is lower than this threshold, the output remains enabled for one minute and then it switches off.

Drive Fan (D. Fan)

The functionality Drive Fan is used to run an external fan to cool the drive. The output is automatically enabled when the temperature of the logical section or the one of the power section exceeds the warning threshold. When both temperatures are lower than this threshold, the output remains enabled for one minute and then it switches off.

Note In the Integrated Servo Motor that have the 142 flange size, 3 fans are mounted. The functioning of these fans is alternated, in other words every 5 minutes the functioning of the central fan is switched with the functioning of the two lateral fans, in order to optimize the electrical consumption and the fans wear. These fans are used both to the motor and the drive ventilation.

Drive Ok (Drv OK)

The functionality Drive Ok enables the output when the drive has finished the startup phase and it is ready to get any command. The output is switched off because of the presence of faults, since the drive is no longer operative. The faults switching this output off can be selected through the parameter **DisableOkOutput [406F.00]**.

Simulated 24V Out (S24V)

The Simulated 24V Out functionality transforms the selected resource in a 24V supply output. If used together with Simulated GND (SGND), it can be used to supply external devices.

Filters, polarities and terminations

Filtering of the digital inputs

The status of the digital inputs is updated every 250 μs.

If it is necessary to filter the digital inputs, it is possible to set a time interval, every 250 μs, during which the input status must remain stable to be validated (debounce time).

For example if, due to noises, on the inputs some unwanted status changing happens for a shorter time than the debounce time, these noises are filtered and the input status is unaltered.

After this debounce time the image stored in the digital inputs is updated with the new status. The highest filter value is 65 ms.

The debounce configuration takes place through two parameters:

- **DebounceTime [405F.00]:** time during which the input status must be stable to be validated. It can be set every 250 μs
- **EnableDebounce [405E.00]:** mask used to select on which digital inputs you can apply the filtering

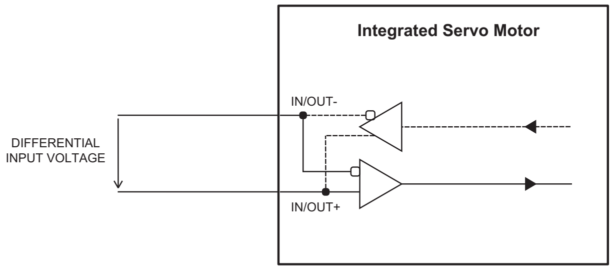
The possibility to enable the debounce depends on the functionality given to the digital input; the functionalities used to enable the filtering are:

- Generic Input (I/O X - In X)
- Positive limit switch (FC +)
- Negative limit switch (FC -)
- Home

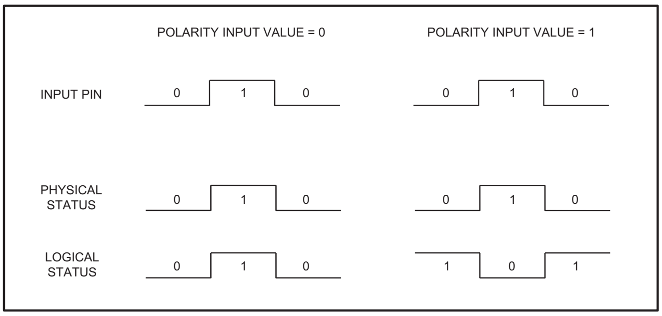
Selection of the polarity of the digital inputs

For the inputs of PNP type the enabled physical status is reached when the applied voltage (referred to the ground signal) surpasses the activation threshold. For the line-driver differential ones the enabled status is reached when the voltage difference between the positive and negative inputs is greater than $+V_{thd}$ and the not enabled status when the voltage difference is lower than $-V_{thd}$.

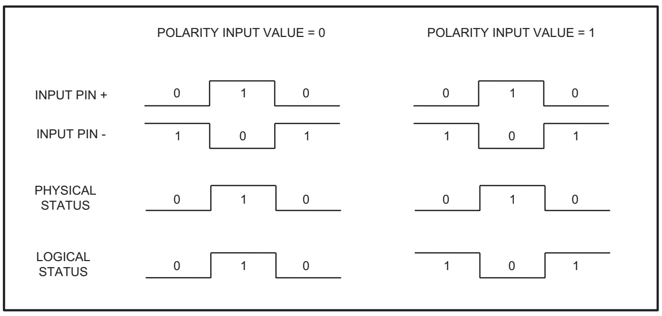
The inputs logical status (1 or 0 in the inputs image) depends on both their physical status and the polarity that's set through the **PolarityInputValue [405A.00]** parameter. If the polarity value is 0 then the logical status coincides with the physical one, otherwise if the polarity value is 1 then the logical status is inverted respect to the physical one. The **PolarityInputValue [405A.00]** parameter must be written during the Digital I/O configuration procedure.



PNP INPUT



DIFFERENTIAL INPUT



The functionalities Positive limit switch (FC +) and Negative limit switch (FC -) force to zero the bits corresponding to the parameter **PolarityInputValue [405A.00]**.

Termination resistance

For the resources with logic of differential kind it is possible to enable the termination resistance through the parameter **TerminationResistance [405B.00]**.

8-1-2 Auxiliary Encoder

The drive can acquire an external physical encoder that can be used for example to control the position of another axis or in relation to the motion function. The incremental encoder is the only auxiliary position sensor type managed by the Integrated Servo Motor firmware.

The drive provides even a virtual (or simulated) encoder that generates a position that varies with a constant velocity that can be configured by the user.

If you want to use a physical encoder, this must be connected as follows:

Encoder signal	HW input	Notes
Phase A	I/O 0	Compulsory
Phase B	I/O 2	Compulsory
Index pulse	I/O 3	Optional

To acquire the physical auxiliary position sensor, the digital input must be configured as described in the above **Section 8-1-1 Digital I/O’s**.

Here follows the list of the parameters that are provided to manage the auxiliary encoder functionalities:

Physical auxiliary encoder

- RealAuxEncoderPosition [36C9.01]
- RealAuxEncoderPolarity [36C9.02]
- RealAuxEncoderVelocity [36C9.03]

Virtual auxiliary encoder

- VirtualAuxEncoderPosition [36C8.01]
- VirtualAuxEncoderRunStop [36C8.02]
- VirtualAuxEncoderVelocity [36C8.03]

Selected auxiliary encoder

- AuxiliaryEncoderPosition [36CA.01]
- AuxiliaryEncoderSelector [36CA.02]
- AuxiliaryEncoderVelocity [36CA.03]

8-1-3 Analogue Input

The features of the analogue input are described in the following table:

Analogue input 0	Details
Electric features	Range ±10 V; Precision ±10 mV
Connection	Pin 3 and 4 of CN4
Updating time AI0Value	CurrentLoopPeriod [3521.05]
Updating time AI0FilteredValue	MotionLoopPeriod [3521.04]

The features of the analog input, related to the CN4 connector, are summarized in the following table:

Analogue input specifications	
Maximum operating differential voltage	±10 V
Maximum absolute differential voltage	±15 V
Maximum common mode voltage*1	With Vin = +10 V • -18.9 V < Vcm < +7.7 V With Vin = -10 V • -2.3 V < Vcm < +27.7 V
Input detection delay	max. 300 μs
Resolution	±50 mV
Differential input resistance	> 150 kΩ

*1. Relative to the system power ground.

The parameters of the analog input are summarized in the following table:

Analog input 0	Parameter	Description
Capture	AI0Voltage [3330.01]	Not filtered value
	AI0FilteredVoltage [3330.02]	Filtered value
Calibration	AI0CalibrationStatus [4100.01]	Calibration status
	AI0CalibrationOffset [4100.02]	Calibration offset
	AI0CalibrationGain [4100.03]	Calibration gain
	AI0CalibrationVoltage [4100.04]	Calibration voltage
Filter	AI0FilterFrequency [4110.01]	Filter frequency
	AI0FilterType [4110.02]	Filter type
	AI0FilterQFactor [4110.03]	Filter Q factor
Conversion	AI0VSettings [4120.01]	Set-up of the voltage for the conversion
	AI0RSettings [4120.02]	Set-up of the conversion reference
	AI0VPolarity [4120.03]	Polarity of the voltage for conversion
	AI0RPolarity [4120.04]	Polarity of the conversion reference
	AI0VZone [4120.05]	Half amplitude of the dead zone in the conversion
	AI0VRefLevel [4120.06]	Voltage value to define the conversion
	AI0TRefValue [4120.07]	Torque value to define the conversion
	AI0WRefValue [4120.08]	Speed value to define the conversion

Capture

The analog input is sampled every **CurrentLoopPeriod [3521.05]** and can be read in the parameter **AI0Voltage [3330.01]**. The filtered value of **AI0Voltage [3330.01]** is updated every **MotionLoopPeriod [3521.04]** and can be read in the parameter **AI0FilteredVoltage [3330.02]**.

Calibration

The analog input calibration is made on every single drive by OMRON.

Note Carry out the analog input calibration only after having precisely checked that the drive does not have a correct voltage value. It is possible to carry out the calibration to adapt the values of the analog input to the voltage generated by a generic source.

To carry out the calibration of the analog input follow these instructions:

- **Step 1: Analysis**
  - Switch off all circuits that can influence the reading accuracy of the analog input
  - Apply a direct constant voltage to the analog input
  - Make use of a voltmeter previously calibrated and precise enough
  - Check the reading accuracy of the analog input by making reference to the electric features in the table at the beginning of this Section. If accuracy is observed, it is not necessary to carry out the calibration; if accuracy is not observed and you think you shall carry out the calibration, go to step 2
- **Step 2: Offset calibration**
  - Apply a voltage 0V to the analog input (or firmly short-circuit the analog input)
  - Run the command of System Manager 7200
  - Check if the value of **AI0CalibrationOffset [4100.02]** is between -10 and +10; if the value of **AI0CalibrationOffset [4100.02]** is in the specified interval then go to step 3, otherwise repeat more precisely the step 2 or contact to your OMRON representative
- **Step 3: Gain calibration**
  - Apply a direct voltage between +4 and +10V to the analog input
  - Measure the applied voltage through a voltmeter previously calibrated and enough precise and write its value in the parameter **AI0CalibrationVoltage [4100.04]**
  - Run the command of System Manager 7201
  - Check if the value of **AI0CalibrationGain [4100.03]** is between 4950 and 5050; if the value of **AI0CalibrationGain [4100.03]** is in the specified interval then go to step 4, otherwise repeat more precisely the step 3 or contact to your OMRON representative
- **Step 4: Checking**
  - Apply different voltage values to the analog input and check if the voltmeter and the parameter **AI0Voltage [3330.01]** give the same results according to the accuracy specified in the table at the beginning of this Section; if all the comparisons give a positive result, go to step 5, otherwise repeat the calibration from the beginning or contact to your OMRON representative
- **Step 5: Data storage**
  - The calibration parameters of the analog input are of ES-type and they can be saved in the permanent memory by running the command of System Manager 2001

Note By restoring the default values of the parameters, the calibration data of the analog input are overwritten with their related default values.

Conversion

The value of the filtered analog input (**AI0FilteredVoltage [3330.02]**) can be used as torque limit or torque or speed reference depending on the value of **TorqueLimitSelector [4202.00]** and of **ModesOfOperation [6060.00]**. To convert the voltage values in torque or speed values, the parameters **AI0ConversionParameters [4120.xx]** are used. To define the different conversion options you must use IM-TOOL.

8-2 Position Limits

8-2-1 Hardware Limits

To enable the limits of hardware position you need to set the functionalities Positive limit switch (FC +) and Negative limit switch (FC -) on two digital inputs of the drive (see **Section 8-1-1 Digital I/O's**).

Note If the Polarity is of Reverse type, the roles of Positive limit switch (FC +) and Negative limit switch (FC -) are reversed: Positive limit switch (FC +) behaves like Negative limit switch (FC -) and Negative limit switch (FC -) behaves like Positive limit switch (FC +).

When the drive is in Operation enable, RequestedSpeed (**TargetTorque [6071.00]** for torque modes) is higher than 0 and the input Positive limit switch (FC +) enables, or RequestedSpeed (**TargetTorque [6071.00]** for torque modes) is lower than 0 and the input Negative limit switch (FC -) is enabled, the motor stops with a deceleration ramp equal to **QuickStopDeceleration [6085.00]**.

During the deceleration ramp, the CiA402StateMachine goes to the status Quick Stop Active and, once the motor has stopped, it goes back to the state Operation enable (see **Section 5-5-1 CiA402 State Machine**). When one limit of hardware position is enabled, the warning Limit reached error enables with the related detail (Positive hardware position limit reached or Negative hardware position limit reached), and it is enabled until the limitation stops.

Note When the drive is in Operation enable, RequestedSpeed (**TargetTorque [6071.00]** for torque modes) is higher than 0 and the input Negative limit switch (FC -) enables, or RequestedSpeed (**TargetTorque [6071.00]** for torque modes) is lower than 0 and the input Positive limit switch (FC +) enables, the motor does not stop and there are no further signals.

Note When the motor is used as servo axis by Sysmac NJ or NX controller, the hardware limits are controlled by Sysmac so, do not use this feature in the drive.

8-2-2 Software Limits

To enable the limits of software position you need to write 1 in the parameter **PositionLimitEnable [4280.01]** and write the two limits, the positive and the negative one, in the group **SoftwarePositionLimit [607D.xx]**.

When the drive is in Operation enable, RequestedSpeed (**TargetTorque [6071.00]** for torque modes) is higher than 0 and **PositionActualValue [6064.00]** is higher than **PositionLimitPositive [607D.02]**, the motor stops with a deceleration ramp equal to **QuickStopDeceleration [6085.00]**. When the drive is in Operation enable, RequestedSpeed (**TargetTorque [6071.00]** for torque modes) is lower than 0 and **PositionActualValue [6064.00]** is lower than **PositionLimitNegative [607D.01]**, the motor stops with a deceleration ramp equal to **QuickStopDeceleration [6085.00]**.

During the deceleration ramp, the **CiA402StateMachine** goes to the status Quick Stop Active and, once the motor has stopped, it goes back to the state Operation enable (see **Section 5-5-1 CiA402 State Machine**). When one limit of software position is enabled, the warning Limit reached error enables with the related detail (Positive software position limit reached o Negative software position limit reached), and it is enabled until the limitation stops.

Note If you set **PositionLimitPositive [607D.02]** lower than **PositionLimitNegative [607D.01]** the error Parameters soft error enables with detail Software position limits incompatibility.

Note When the motor is used as servo axis by Sysmac NX/NY/NJ controller, the software limits are controlled by Sysmac so, do not use this feature in the drive.

8-2-3 Profile Limits

The speed and acceleration parameters of the operating modes, aiming at running a profile to run a motion, are limited by the following parameters:

- **MaxProfileVelocity [607F.00]** and **MaxMotorSpeed [6080.00]**: the lowest value between these two parameters, it reduces all speed parameters of the profilers
- **MaxAcceleration [60C5.00]:** limit of all acceleration parameters of the profilers
- **MaxDeceleration [60C6.00]:** limit of all the deceleration parameters of the profilers

When you have a limitation on at least one parameter of the profilers the warning Motion parameter limited error enables.

Note The **MaxMotorSpeed [6080.00]** sets also the speed limit for all drive motions in the operating modes speed or position (see the below **Section 8-3 Speed Limits**).

8-3 Speed Limits

To set the speed limit you need to write the parameter **MaxMotorSpeed [6080.00]**. The speed limit is an absolute value and it works in a symmetric way on the speed request of the drive. It works only with the operative modes speed or position. When you have a speed limit, you enable the warning Limit reached error with the detail Max motor speed limit reached.

If during torque control the motor exceeds **MaxMotorSpeed [6080.00]**, overspeed error will occur.

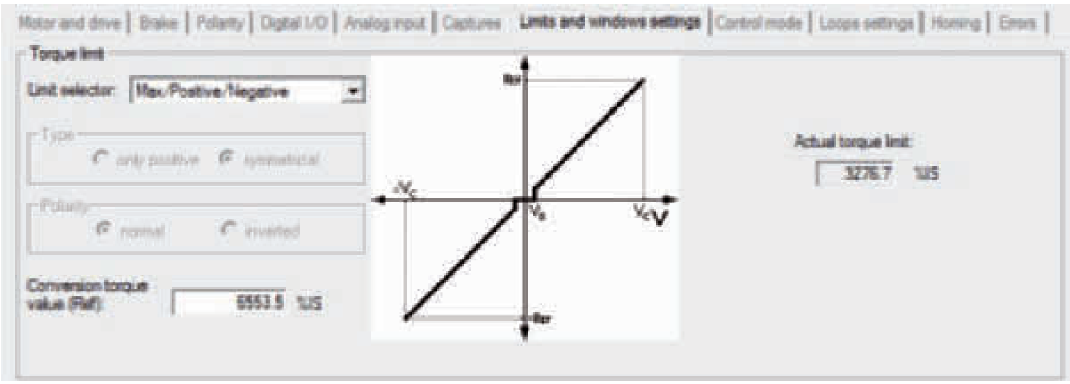
8-4 Torque Limits

8-4-1 Torque and Current Limits

To reduce the highest supplied torque write the parameter **TorqueLimitSelector [4202.00]** so that you can select the source where the torque limit can be obtained. The torque limit can have a fixed value, equal to the value of the parameter **MaxTorque [6072.00]**, or depending on the voltage of the analog input. In any case, in the parameters **ActualTorqueLimitP [420F.00]** and **ActualTorqueLimitN [4211.00]** you can read the torque value limit really applied to the motor. The torque limit is an absolute value and it works in a symmetric way on the torque request of the drive. It works only with the operative modes speed or position. When you have a torque limit, you enable the warning Limit reached error with the detail Torque limit reached.

Example of torque limit use

If you want to execute a homing with mechanical stop, (by setting for example the mode -1 in the **HomingMethod [6098.00]** parameter) it's necessary to limit the torque by selecting first the torque reference through the **Torque-LimitSelector [4202.00]** parameter and then, depending on the selection, set the desired value in the **MaxTorque [6072.00]** parameter (that, if it has been selected Fixed value in the Limit selector field, is equal to the value in the Conversion torque value (Ref) field).



Procedure to calculate MaxTorque

Supposing that you want to limit the torque to the value T_{Lim}, proceed as follows:

- Read the torque constant K_T **TorqueConstant [6410.08]**
- Read the stall current I_S **MotorStallCurrent [6410.01]**
- Calculate the stall torque T_S [Nm] as K_T [Nm/A] * I_S [A]
- Calculate the torque limit T_{Lim} expressed in [%I_S] as (T_{Lim}[Nm] / T_S) * 100
- Multiply the obtained value per 10 to obtain the torque limit T_{Lim} expressed in [% I_S10] and insert this value in the parameter **MaxTorque [6072.00]**

Calculation example of MaxTorque

In a specific case we could want to limit to 1 Nm the torque of a Integrated Servo Motor that has a 2.8 Nm stall torque motor, by following the above described procedure we obtain:

K_T = 1.6 Nm/A

I_S = 1.75 A

T_S = K_T [Nm/A] * I_S [A] = 1.6 Nm/A * 1.75 A = 2.8 Nm

T_{Lim} [%I_S] = (T_{Lim} [Nm] / T_S [Nm]) * 100 = (1 Nm / 2.8 Nm) * 100 = 35.7%I_S

MaxTorque [6072.00] = T_{Lim} [%I_S] * 10 = 35.7%I_S * 10 = 357%I_S10

8-4-2 I2T Limits

The I2T limit reduces the electric power which is transferred to the motor during the oversupply periods.

For a limited time period, the current supplied to the motor can be more than NominalCurrent (overcharge). To protect the drive motor and power section during the oversupply period, the drive controls the energy transferred to the motor and can limit the current. The parameter **I2TValue [3405.05]** shows the level of the energy transfer according to the following table:

I2TValue	Drive energy status
0	The drive is not oversupplied
> 0 and < 100	The drive is oversupplied
> 50	The drive is oversupplied and too much exploited: application in case of working critical conditions
100	The drive reached the highest level of oversupplying and the current falls at the value NominalCurrent (only if the limitation does not provoke any fault)

The maximum energy that the drive can supply in oversupplying condition can be found in the parameter **UserMaxI2T [3405.02]**. The value is limited by the parameter **DriveMaxI2T [3405.03]**.

The value **UserMaxI2T [3405.02]** is directly connected to the product between **UserPeakCurrent [3405.06]** and **I2TTime [3405.01]**. So for example it is possible to oversupply a motor with 20A for 1s or with 10A for 4s, by keeping limited the value of **UserMaxI2T [3405.02]**.

To set correctly the parameters of the I2T follow these instructions:

- Choose the value of **UserPeakCurrent [3405.06]** as current limit used to oversupply the motor and the drive
- Choose the value of **I2TTime [3405.01]** as maximum current oversupplying time PeakCurrent
- Check that **UserMaxI2T [3405.02]** is lower than **DriveMaxI2T [3405.03]**; if it is not so decrease **UserPeakCurrent [3405.06]** and/or **I2TTime [3405.01]**
- Choose **I2TWarningThreshold [3405.04]** equal to the level of **I2TValue [3405.05]** in which you wish to be warned through the I2T warning threshold reached error warning
- Consider if enabling the fault I2T limit reached error when **I2TValue [3405.05]** reaches the 100%

Active errors	LED 4	I2TValue	ActualMotorCurrent
-	GREEN, 1 FLASH	0	0
	GREEN, ON		> 0 and ≤ NominalCurrent
	ORANGE, ON	> 0 and < I2TWarningThreshold	≤ PeakCurrent
I2T warning threshold reached error	ORANGE, BLINKING	≥ I2TWarningThreshold and < 100	
I2T limit reached error	RED, ON	≥ 90	≤ NominalCurrent

Note If the fault for I2T limit reached error, is enabled, the current is limited but the motor motion stops and the drive enters the Fault status.

Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
0x3405.00	Number of entries	6	6	U8	-	CST	-	-
0x3405.01	I2TTime [3405.01]	-	-	U16	ms	RW	-	ES
0x3405.02	UserMaxI2T [3405.02]	-	-	U32	A^2s	RO	-	-
0x3405.03	DriveMaxI2T [3405.03]	-	-	U32	A^2ms	RO	-	-
0x3405.04	I2TWarningThreshold [3405.04]	0-100	80	U16	%	RW	-	ES
0x3405.05	I2TValue [3405.05]	-	-	U16	%	RO	Yes	ES
0x3405.06	UserPeakCurrent [3405.06]	-	-	U16	100 = 1A	RW	Yes	ES

8-5 Motor Direction and Position Resolution

8-5-1 Revolution Resolution

The revolution resolution shows the exact position count number for every revolution of the motor shaft. The revolution resolution defines the resolution describing the position, speed and accelerations, expressed respectively in inc, inc/s and inc/s^2. To modify the revolution resolution modify the parameter **PositionResolution [608F.xx]**. The modification of the parameter **PositionResolution [608F.xx]** does not imply the change of the drive performance but only the meaning of the values in which the above-mentioned variables are expressed.

Note If the **PositionResolution [608F.xx]** is changed it's necessary to execute a new homing procedure and set again the **SoftwarePositionLimit [607D.xx]**.

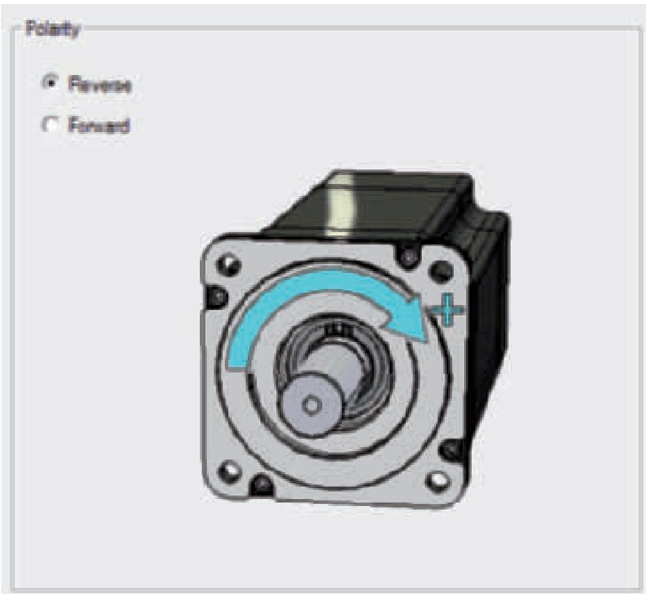
Note If using a motor with absolute encoder as Sysmac rotary axis, leave the position resolution at its default value of 2^{20}, otherwise, the absolute position may be wrong.

8-5-2 Polarity

The polarity shows the direction of the motor shaft rotation in which the values increase. The signs of the speed, acceleration and torque values show if the related parameter is concordant or not with the polarity value. To modify the polarity, modify the parameter Polarity. Changing the parameter Polarity, the value of **PositionActualValue [6064.00]** does not change.

Note If the Polarity is of Reverse type, the roles of Positive limit switch (FC +) and Negative limit switch (FC -) are reversed: Positive limit switch (FC +) behaves like Negative limit switch (FC -) and Negative limit switch (FC -) behaves like Positive limit switch (FC +).

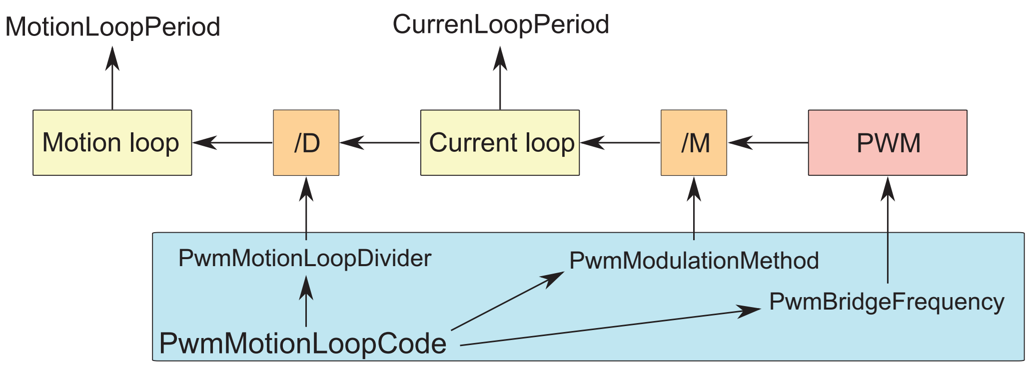
Note If the Polarity it will be necessary to re-execute the homing procedure. By selecting the reverse mode, the limits are inverted, and **PositionActualValue [6064.00]** is consequently modified.



8-6 Power PWM

In the Integrated Servo Motors it is possible to modify the sampling frequency of the three-phase bridge steering the motor currents and the loops sampling period. Increasing the sampling frequency of the three-phase bridge can increase the drive dynamic performances as well as the losses in the power section and the power section heating. Vice versa, decreasing the sampling frequency of the three-phase bridge can damage the drive dynamic performances but decreases the power section heating. In order to modify these variables, use the parameters in the following table:

Parameter	Description
PwmMotionLoopCode [3521.07]	Unique code to set the three-phase bridge frequency and the loops period (it automatically sets the **PwmBridgeFrequency [3521.01]**, **PwmModulationMethod [3521.02]** and **PwmMotionLoopDivider [3521.03]** parameters values)
MotionLoopPeriod [3521.04]	Motion loop period
CurrentLoopPeriod [3521.05]	Current loop period



The current loop period can be obtained through the following expression:

$$\text{CurrentLoopPeriod [s]} = \frac{1}{\text{PwmBridgeFrequency x PwmModulationMethod}}$$

While the motion period can be obtained with the following expression:

$$\text{MotionLoopPeriod [s]} = \text{CurrentLoopPeriod [s] x PwmMotionLoopDivider}$$

Note Modify these parameters only if strictly needed. Do not go below 100 µs with **MotionLoopPeriod [3521.04]**. After the modification of these parameters it is necessary to tare the loops again.

8-7 Drive Currents

The Integrated Servo Motor regulate the motor current depending on the torque requests and speed. The parameters related to the drive currents can be found in the following table:

Parameter	Description
MotorStallCurrent [6410.01]	Motor stall current
MotorPeakCurrent [6410.02]	Motor peak current
MaxRatedCurrent [6510.01]	Drive nominal current, power section
MaxPeakCurrent [6510.02]	Drive peak current, power section
UserPeakCurrent [3405.06]	Peak current set by the user to limit the current supply to the motor
NominalCurrent	Real nominal current: lower value between **MotorStallCurrent [6410.01]** and **MaxRatedCurrent [6510.01]**
PeakCurrent	Real peak current: lower value than **MotorPeakCurrent [6410.02]**, **MaxPeakCurrent [6510.02]** and **UserPeakCurrent [3405.06]**
ActualMotorCurrent [3320.01]	Actual motor current
ActualFieldCurrent [3320.02]	Actual motor current, field component
ActualTorqueCurrent [3320.03]	Actual motor current, torque component
OverCurrentAValue [3320.05]	Current of the motor A phase in condition of Power or motor over current error
OverCurrentBValue [3320.06]	Current of the motor B phase in condition of Power or motor over current error
OverCurrentCValue [3320.07]	Current of the motor C phase in condition of Power or motor over current error
RMSMotorCurrent [3320.08]	Motor RMS current
RMSMotorCurrentFilter [3320.09]	Filtering time to get the motor RMS current

The only writable parameter of the previous chart (after **RMSMotorCurrentFilter [3320.09]**) is **UserPeakCurrent [3405.06]** and it is used to limit the current supplied to the motor.

8-8 Absolute Feedback Position Sensor

The absolute encoder details are listed in the following table:

Description	Functioning range	Repeatability of the positioning	Precision of the reconstruction of the initial position
Model: Absolute encoder hiperface multi-turn SKM36 128sin/rev	4096 rev	2^{18} bit	2^{20} bit

The absolute position sensors keep the position value consistent even if the drive is turned off. The maintenance of the position at the turn on of the drive is guaranteed only within the operating range of the sensor.

To align the absolute sensor position with a specific mechanical position it's necessary to execute a homing procedure (see **Section 7-5 Homing Mode**).

Note If the **PositionResolution [608F.xx]** is changed it's necessary to execute a new homing procedure and set again the **SoftwarePositionLimit [607D.xx]**.

Note If the Polarity it will be necessary to re-execute the homing procedure. By selecting the reverse mode, the limits are inverted, and **PositionActualValue [6064.00]** is consequently modified.

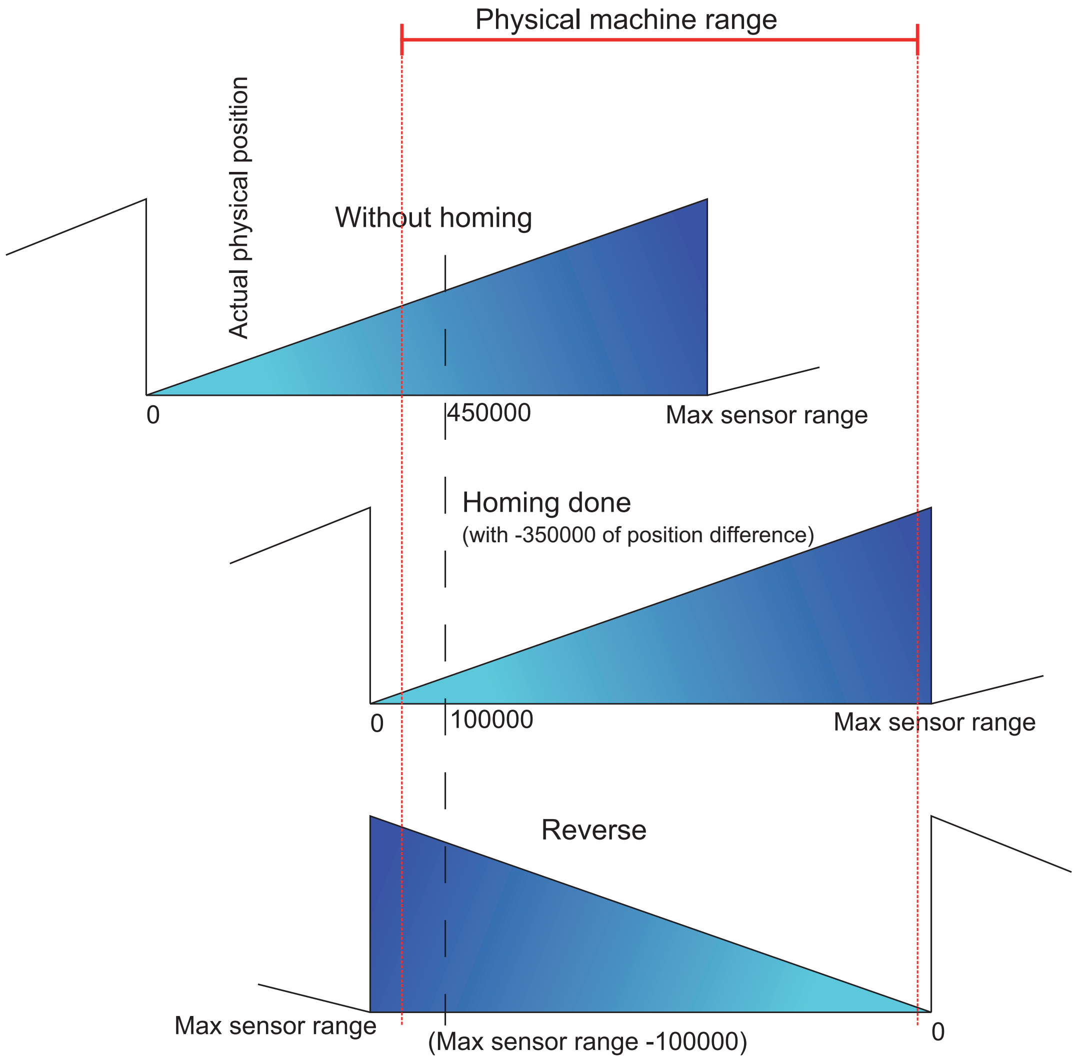
Note If using a motor with absolute encoder as Sysmac rotary axis, leave the position resolution at its default value of 2^{20}, otherwise, the absolute position may be wrong.

Example:

The following figure shows how the homing procedure works on the absolute feedback sensor by setting an offset between the physical sensor position and the position that's read by the drive.

- On the top the physical range of the machine related to the position sensor range is shown
- In the first image the read position coincides with the sensor physical position. In this condition the machine physical range is not completely included in the sensor range, therefore the absolute position is not guaranteed
- In the second image it's shown how the sensor range is shifted after the homing procedure, of 350000[inc] in the specific case (this offset is saved in the drive permanent memory and it will no longer be necessary to execute the homing procedure). Through this operation the machine physical range is completely included in the sensor range, therefore the absolute position is always guaranteed
- In the third image it's shown how the Reverse function (see Polarity) reverses the position reference between the 0 and the sensor range maximum allowed value

Note If during the functioning the motor exceeds, in positive or negative direction, the sensor range, the drive is able to correctly reconstruct the position, but if the drive is turned off while the position read by the sensor is out of its range, the position that has been read on the turn on of the drive will not be related to the executed homing and it will be necessary to re-execute the homing procedure.


Physical machine range
Actual physical position
Without homing
0
450000
Max sensor range
Homing done
(with -350000 of position difference)
0
100000
Max sensor range
Reverse
Max sensor range
(Max sensor range -100000)
0

8-9 Digital Filters

The Integrated Servo Motor provide a library of programmable digital filters. The available filters are:
- All-pass filter
- Low-pass filter of the first order
- Low-pass filter of the second order
- Band-eliminating filter
- All-stop filter

The parameters of every filter can be modified in any moment, even during the working of the filter. The output of the filter adjusts in real time to the new settings.

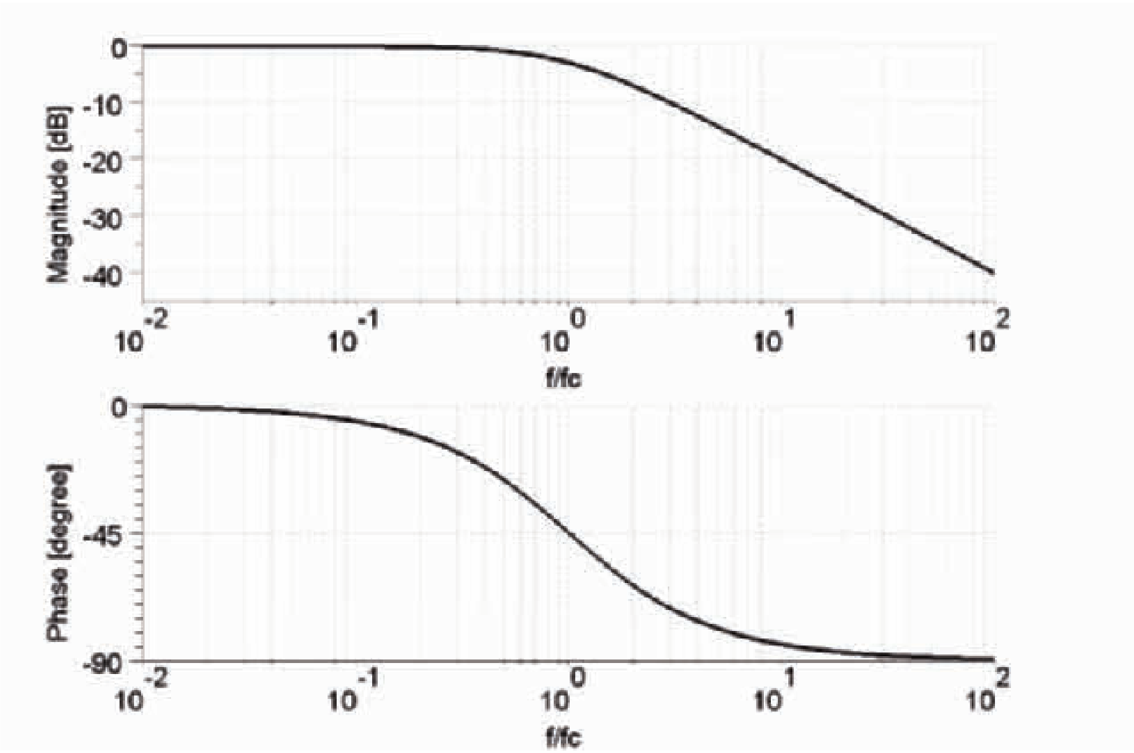
Note Do not set the frequencies of the filters at 0 Hz or at values which are one third higher than the frequency of the filter sampling.

All-pass filter

The all-pass filter or transparent filter does not apply any filtering action. The input signal of the filter is brought back to the output with unity gain and without phase delay.

Low-pass filter of the first order

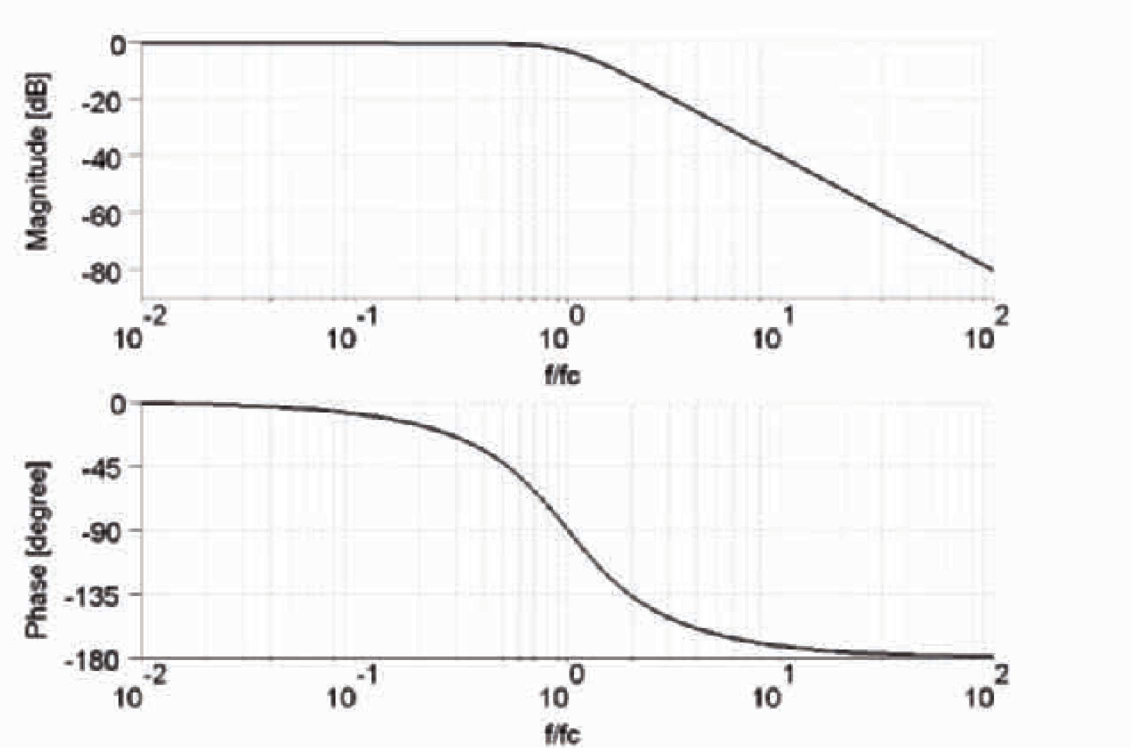
The low-pass filter of the first order is implemented in the Integrated Servo Motors as a Butterworth low-pass digital filter of the first order with pre-warping compensation. Here you can find the Bode diagrams of the function of filter transfer as the frequency changes, normalized at the value of the critical frequency. You can notice that for frequencies higher than the critical frequency, the module slope is -20dB/decade and the maximum phase delay is 90°.



Note Setting the frequency at 0 means having a filter with an infinite attenuation band. This condition cannot be accepted because the filter loses its low-pass property. It is not recommended to use the filter under these conditions.

Low-pass filter of the second order

The low-pass filter of the second order is implemented in the Integrated Servo Motors as a Butterworth low-pass digital filter of the second order with pre-warping compensation. Here you can find the Bode diagrams of the function of filter transfer as the frequency changes, normalized at the value of the critical frequency. You can notice that for frequencies higher than the critical frequency, the module slope is -40dB/decade and the maximum phase delay is 180°.

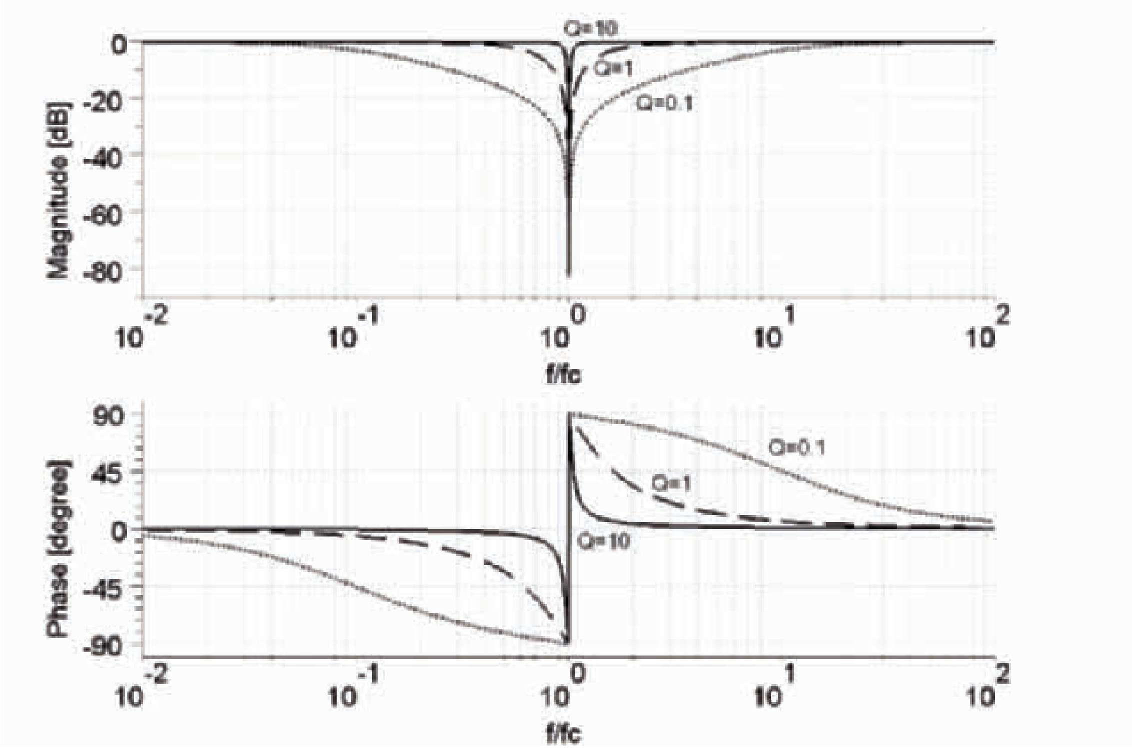


All-stop filter

The all-stop filter stops the passing of every signal by resetting at zero its output.

Band-eliminating filter

The band-eliminating filter is implemented in the Integrated Servo Motors as a Notch filter of the second order with pre-warping compensation. Here you can find the Bode diagrams of the function of filter transfer as the frequency changes, normalized at the value of the central frequency, for different values of the Q quality factor.



Note Setting a Q quality factor at 0 means having a filter with an infinite attenuation band. This condition cannot be accepted because the filter loses its band-eliminating property. Furthermore when the Q quality factor increases and the central frequency decreases, the filter convergence time increases. It is not recommended to use the filter under these conditions.

Usage

Those filters can be applied to:

- Analogue input
- Rms torque calculation
- Speed and torque regulation loops
- Encoder feedback

8-10 Capture Peripherals (Touch Probe Function)

The Integrated Servo Motors are equipped with two capture peripherals which allow to capture a maximum of 3 quantities each and which are driven by a trigger signal that provokes the capture. This signal can be linked to a digital input or can be controlled by the user, through a parameter, to force the capture via software.

Furthermore the drive provides some particular filters and algorithms to detect and validate the capture events. In this way, through the capture peripherals, it is possible to carry out some complex functionalities or avoid undesired captures.

The currently available algorithms are:

- Filter on **CaptureSource0_A [4003.01]** and **CaptureSource0_B [4013.01]** (typically the position)

From now onwards we are going to call the two capture peripherals **Capture A** e **Capture B**.

Note If the desired capture is the one with the auxiliary encoder zero mark, remember to program the digital input 2 (see **IO_2_Function [4072.01]**) with the Quadrature Input Index (Idx) functionality.

8-10-1 Configuration Interface Selection

In the Integrated Servo Motors, 2 configuration interfaces have been integrated: CUSTOM interface and CiA402 interface, that can be selected through the **CaptureInterfaceMode [402F.00]** parameter.

Note These two interfaces cannot be contemporary used because the contained informations are not consistent.

In fact these two capture interfaces differ in some details. Here follow the list of the main limits and differences:

- If case of access to the not selected interface, in reading operation the answer is 0, while in writing operation an ABORT is reported. More than this, the “Capture setup setting by using disabled parameters interface (look at parameter '**CaptureInterfaceMode [402F.00]**')” warning bit is set, in the **ParamSoftError [301A.00]** parameter. This warning cannot auto-reset, but must be reset by the user
- When the interface is changed, the new one is re-initialized with the values that are memorized in the EEprom, if are compatibles with the selected interface, or with the default values
- The filter in space (**CaptureSource0_A [4003.01]** and **CaptureSource0_B [4013.01]**) is only available for the CUSTOM interface and cannot be used with the double side capture
- In both the interfaces, the settings of the repetitive mode and of the trigger cannot be made with the capture enabled. If these actions are made, then the “Filter or trigger on both edges not allowed on selected trigger input” warning bit is set in the **ParamSoftError [301A.00]** parameter. In the CUSTOM mode the enable operation is not allowed, in the CiA402, considering that the setting and the enable operations are contemporary (because them are done through the same parameter), the parameter reports an Abort

8-10-2 Configure the Capture by Using the DS402 Interface Parameters

The Touch Probe Function latches the position actual value of the motor when an external latch input or the encoder's simulated phase-Z signal. The Integrated Servo Motor can latch two positions.

Name	Description
TouchProbeFunction [60B8.00]	Controls the latch function
TouchProbeStatus [60B9.00]	Gives the state of latches 1 and 2
TouchProbePosition1PosValue [60BA.00]	Latch position of latch 1
TouchProbePosition2PosValue [60BC.00]	Latch position of latch 2
CaptureInterfaceMode [402F.00]	Select between the standard DS402 latch function and the vendor specific one

Note Object 402F.00 must be set to 1 (default setting).

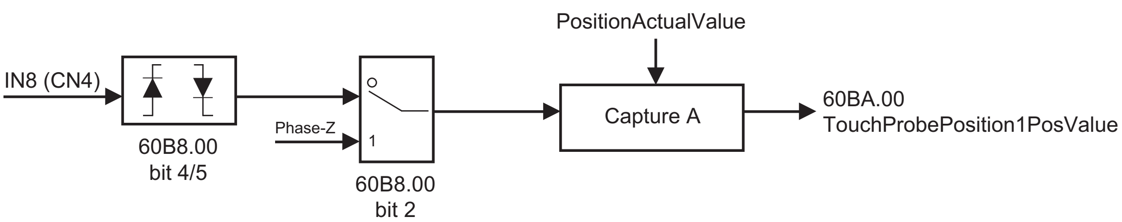
Trigger connection signals

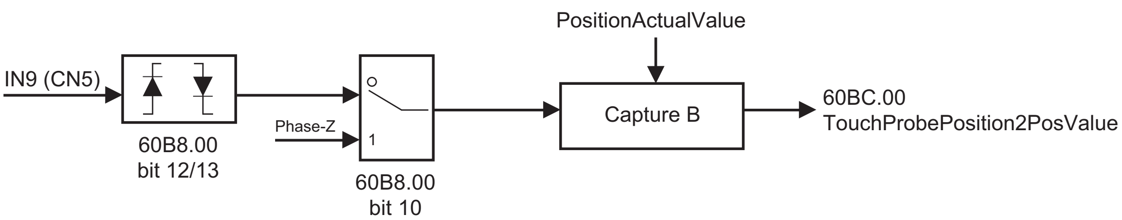
The Capture peripheral can be triggered by signal IN8 in CN4 Connector or IN9 in CN5 Connector or from the Motor simulated Z signal.

There are no settings necessary for configuring the inputs.

Bits 2 and 10 of the **TouchProbeFunction [60B8.00]** are used to specify weather to latch with an external signal or the phase-Z signal.

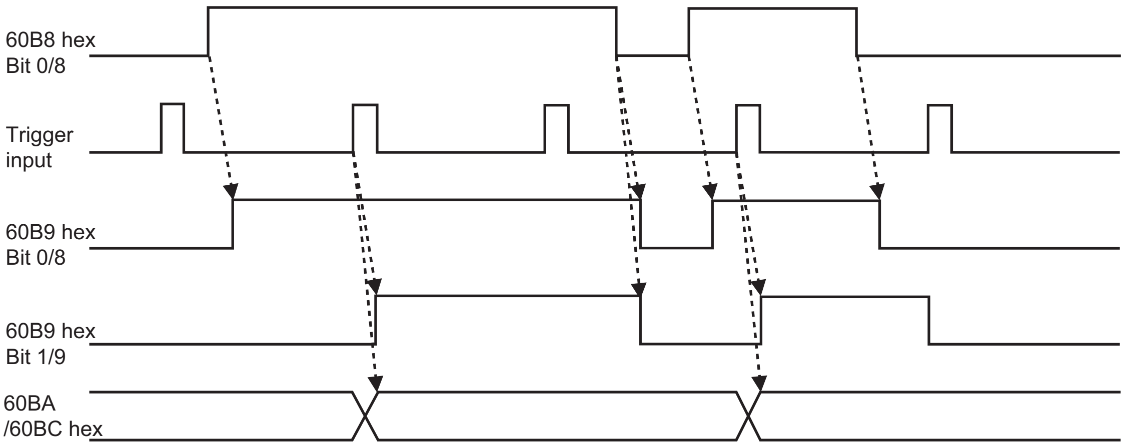
Bits 4/5 (CaptureA) and 12/13 (CaptureB) of the **TouchProbeFunction [60B8.00]** are used to select the rising edge for the trigger.



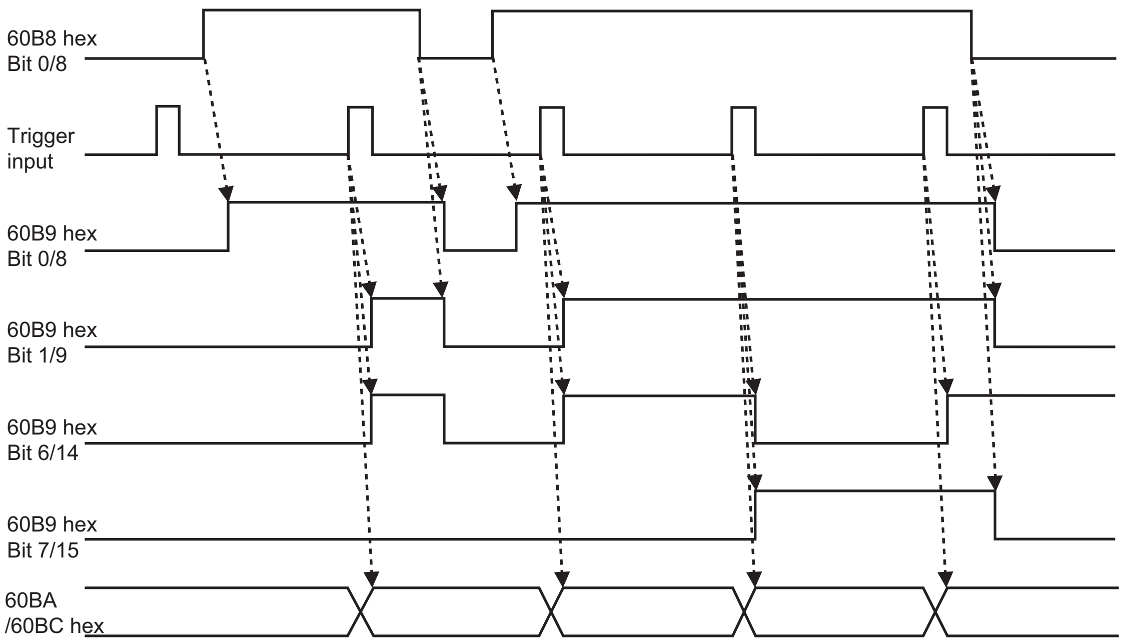


Operation sequences

Trigger first event (60B8 hex bit 1/9 = 0: Trigger first event)



Continuous (60B8 hex bit 1/9 = 1: Continuous)



8-10-3 Configure the Capture by Using the CUSTOM Interface Parameters

The configuration of the capture peripheral must be carried out when the peripheral is disabled, otherwise the configuration parameters will not be writable.

The two capture peripherals available on the Integrated Servo Motors are identical. Here you can find the configuration parameters for each peripheral:

Configuration	Capture A	Capture B
Trigger signal	CaptureTriggerInput_A [4000.02]	CaptureTriggerInput_B [4010.02]
First quantity to capture	CaptureSource0_A [4003.01]	CaptureSource0_B [4013.01]
Second quantity to capture	CaptureSource1_A [4003.02]	CaptureSource1_B [4013.02]
Third quantity to capture	CaptureSource2_A [4003.03]	CaptureSource2_B [4013.03]
Capture edge	CaptureTriggerEdge_A [4000.03]	CaptureTriggerEdge_B [4010.03]
Inhibit time	CaptureInhibitTime_A [4000.04]	CaptureInhibitTime_B [4010.04]
State of the capture peripheral	CaptureUnitState_A [4001.01]	CaptureUnitState_B [4011.01]
Capture peripheral control	CaptureUnitCommand_A [4000.01]	CaptureUnitCommand_B [4010.01]
Captured value, first quantity	CapturedValue0_A [4004.01]	CapturedValue0_B [4014.01]
Captured value, second quantity	CapturedValue1_A [4004.02]	CapturedValue1_B [4014.02]
Captured value, third quantity	CapturedValue2_A [4004.03]	CapturedValue2_B [4014.03]

Once trigger (**CaptureTriggerInput_A [4000.02]**), values to capture (**CaptureSource0_A [4003.01], CaptureSource1_A [4003.02], CaptureSource2_A [4003.03]**), capture edge (**CaptureTriggerEdge_A [4000.03]**) and inhibit time (**CaptureInhibitTime_A [4000.04]**) are configured, you can start the capture peripheral by properly writing the **CaptureUnitCommand_A [4000.01]** parameter.

Now, the capture state has to be verified through the **CaptureUnitState_A [4001.01]** parameter, and when it indicates that the capture has happened, the results can be read through the **CapturedValue0_A [4004.01]**, **CapturedValue1_A [4004.02]** and **CapturedValue2_A [4004.03]** parameters.

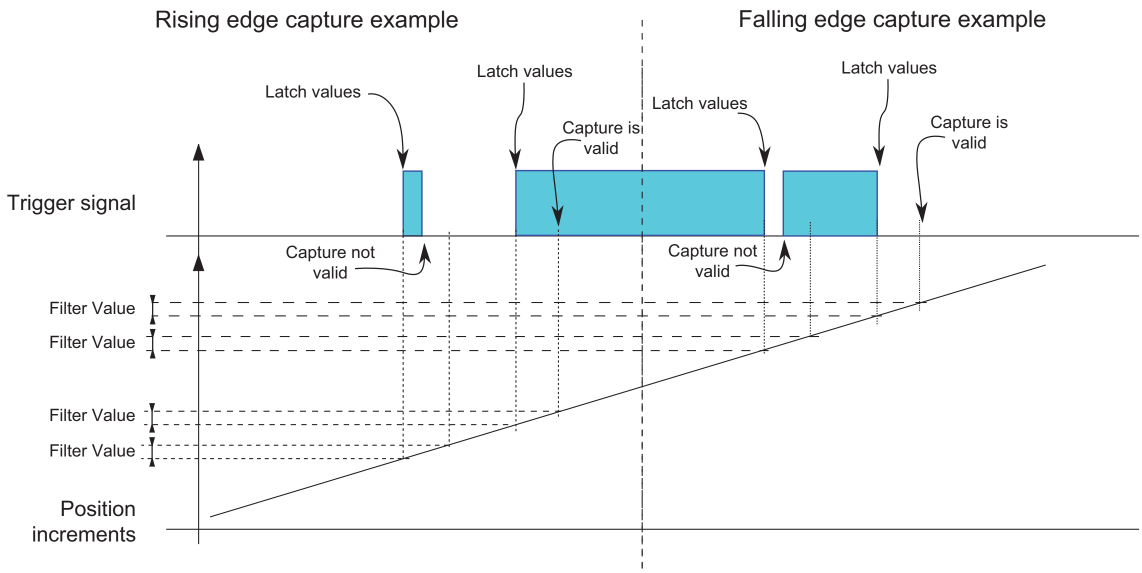
To optimize the space, if the capture results are mapped on PDO, you can use some parameters having a different length, that you can use depending on the needs. In the following chart you can find the table:

Configuration	Capture A (word)	Capture A (byte)	Capture B (word)	Capture B (byte)
Captured value, first quantity	CptVal0_Word_A [4005.01]	CptVal0_Byte_A [4006.01]	CptVal0_Word_B [4015.01]	CptVal0_Byte_B [4016.01]
Captured value, second quantity	CptVal1_Word_A [4005.02]	CptVal1_Byte_A [4006.02]	CptVal1_Word_B [4015.02]	CptVal1_Byte_B [4016.02]
Captured value, third quantity	CptVal2_Word_A [4005.03]	CptVal2_Byte_A [4006.03]	CptVal2_Word_B [4015.03]	CptVal2_Byte_B [4016.03]

This kind of filter validates the capture if the trigger signal is enabled, until the value of the first quantity to capture evolves into a quantity set by the user. The capture is carried out on the edge of the trigger signal which has been programmed (**CaptureTriggerInput_A [4000.02]**, **CaptureTriggerInput_B [4010.02]**), but the capture peripheral reports that the capture has been carried out and shows the results only after the validation.

At this point the trigger signal is on the active state. To go back to the “inactive” state and to carry out a new capture, the trigger signal undergoes the same validation. The filtering values for the enabled capture edge and for the restore edge can be different.

This kind of filter is normally used by selecting **PositionActualValue [6064.00]** on the first quantity to capture; in this way it is possible to apply a proportional filtering to the motor speed, in this case the capture is validated only if the trigger signal is enabled for a certain position range. The functioning of the filter is shown in the following picture:



Configuration of the filtering

The configuration of this function is very easy, since it is just necessary to specify the value of the filtering (parameters **CaptureRestoreSlopeValidationFilter_A [4000.09]** and **CaptureActiveSlopeValidationFilter_A [4000.08]** for Capture A, and parameters **CaptureRestoreSlopeValidationFilter_B [4000.09]** and **CaptureActiveSlopeValidationFilter_B [4010.08]** for Capture B), and the mode of the symmetric/asymmetric filtering (parameters **CaptureValidationFilterMode_A [4000.0A]** for Capture A, and **CaptureValidationFilterMode_B [4010.0A]** for Capture B).

The value according to which the parameters are set is related to the first quantity to capture, so it has the same unit of measurement.

8-10-4 Timings

The delay in the capture of the signal, including delay in photocoupler and the dedicated electronics is for a 24V pulse input.

- Rising edge: 6.8 µs
- Falling (lowering) edge: 1 µs
- Jitter on captures: < 1 µs

8-11 Brake Interlock

The brake installed in the Integrated Servo Motor is a holding brake. Do not use as a stopping device. The brake is an optional functionality. When the brake is installed, it’s automatically managed by the drive, contemporary to the enable/disable operation.

The managing of the brake is done internally in the Integrated Servo Motor. No external hardware or wiring is required.

The brake is a normally closed type so, it is braking if not supplied.

The manual control for enabling and disabling the brake is available only if the motor is disabled. If the motor is enabled it is not possible to manually enable the brake. Those commands can be used through the parameter **BrakeStatus [36D0.03]**.

8-11-1 Objects Requiring Settings

Group of parameter to manage the brake.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36D0.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

BrakeReleaseTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36D0.01	-	Desc	U16	ms	RW	-	EM

The parameter **BrakeRelaseTime** shows the time elapsed between the command to delay (disabling) the brake, occurring together with the motor enabling, and the moment when the drive accepts any motion commands. During this time, the brake is exercising its brake power and the shaft motion could damage the brake.

BrakeCloseTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36D0.02	-	Desc	U16	ms	RW	-	EM

The **BrakeCloseTime** parameter shows the time between the brake blocking command (activation), that happens after the motor disabling command, and the moment in which the drive cuts off the current to the drive. During this time, the brake is not exercising its brake power, if during this time the motor runs out of power the position could not be granted.

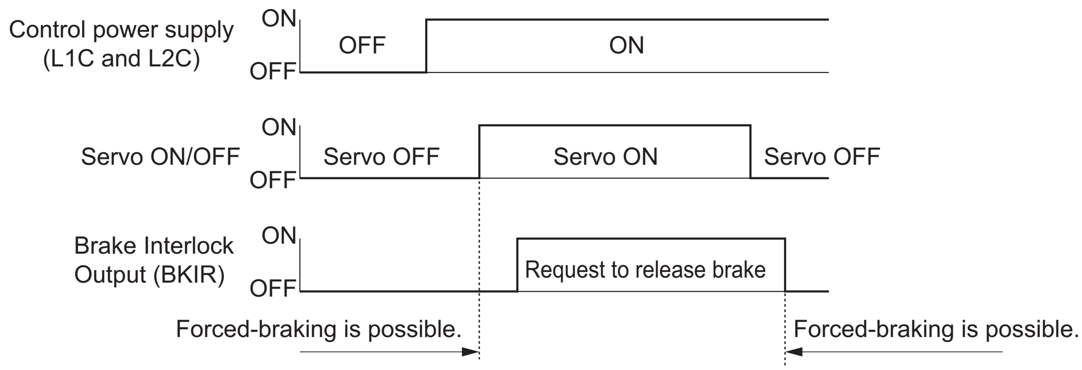
BrakeStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36D0.03	-	Desc	U16	-	RW	-	-

Brake status: 0 = disabling, 1 = enabling.

8-11-2 Operation Timing

Basic Timing



9

/STOP Function

This section gives an outline of application functions and explains the settings.

9-1 /STOP Input

When the voltage in the /STOP digital input in CN4 is cut the motor is disabled.

Note If the digital input with /STOP function is disabled, the drive power section is disabled without cutting the DC bus voltage and it is not possible to control the motor motion anymore. Always stop the motor before disabling the /STOP input. In case of suspended loads, you can use some other measures in order to reduce the risk of load falling, such using motor with brake.

Note The STOP function has a maximum enabling time of 45 ms. This time is referred to the STOP maximum supply voltage (30 V). The /STOP input is compatible with the self-diagnosing outputs, as the ones presents in some PLC, in which the test pulse duration is a maximum of 1 ms. The drive doesn't disable if the /STOP input has a low logic level pulse, shorter than 1 ms.

/STOP input electric features

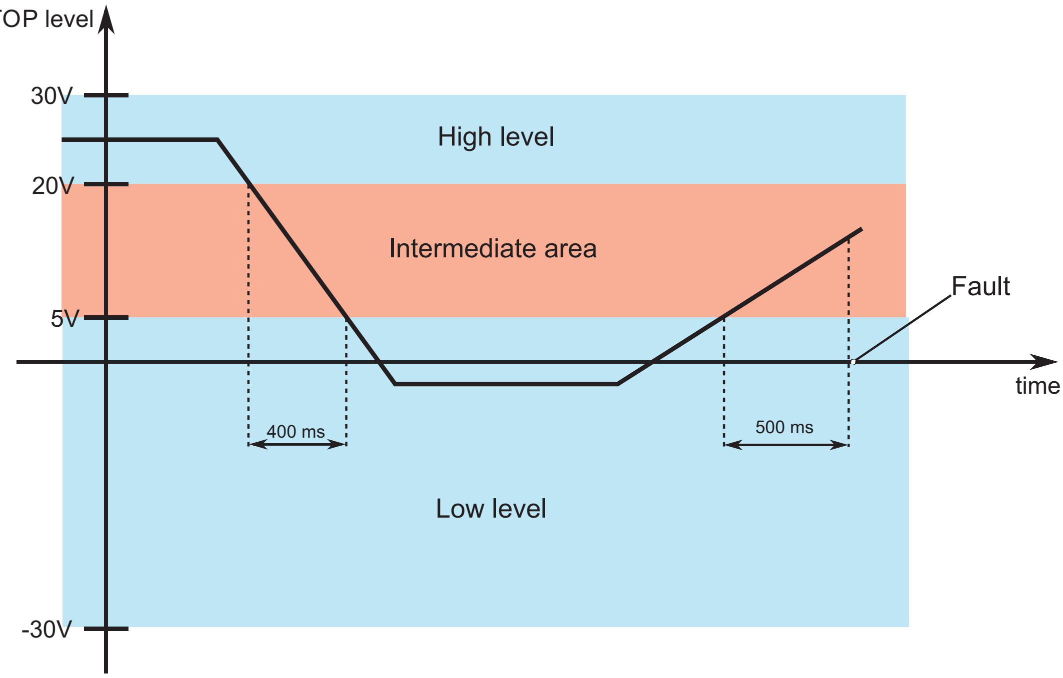
/STOP INPUT	
Input type	PNP
Input current (typical) with Vin = 24 VDC	10.5 mA
Input voltage	
Nominal	+24 VDC
For low signals	-30 V ÷ +5 VDC
For high signals	+20 V ÷ +30 VDC

LED 6 diagnostics

/STOP status	LED 6
With voltage	ON
Without voltage	OFF

Continuous /STOP input validation

The /STOP input validation is a function that continuously monitors the voltage level that's applied to the input. If this level remains for more than 500 ms in an intermediate value between the reference thresholds (+20 V for the high level and +5 V for the low level, see **/STOP input electric features**), the error is notified through the **MainError** (see bit 14 in the **Section 13-2 Fault and Warning (Integrated Servo Motor)**).

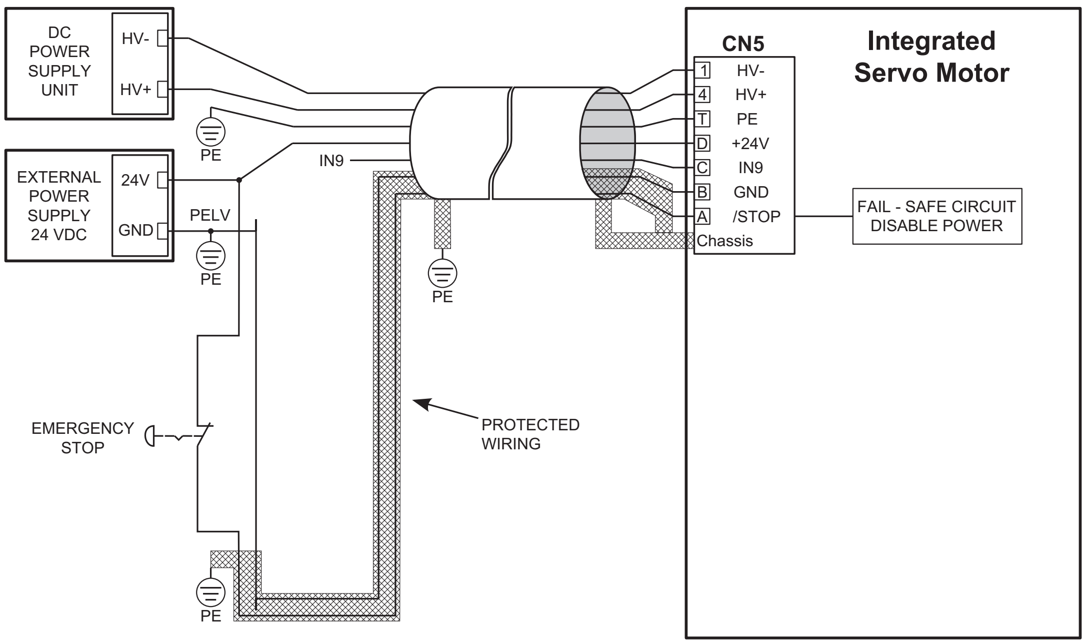


9-2 Connection Example

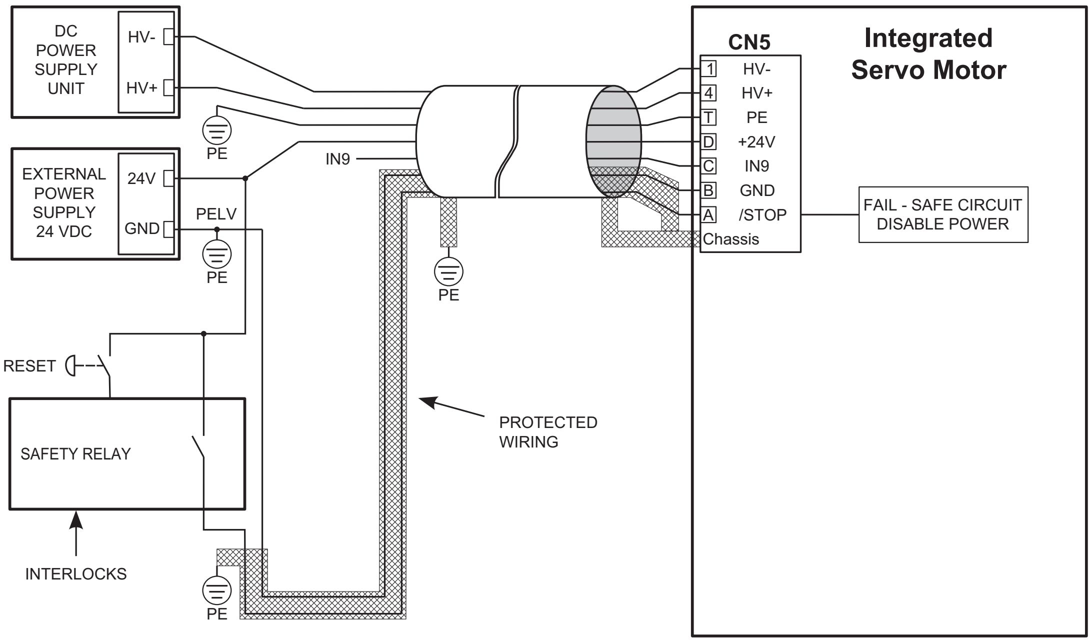
9-2-1 Examples of Connection of the /STOP Input

The external connection of the /STOP input must be protected and this can be obtained by isolating the connection or by using more simply a screened connection with the screen connected to PE. Alternatively the /STOP input can be driven by an output of a safe PLC with a test of maximum 1 ms length.

Example for stop without module fuse relay: stop not controlled



Example for stop with fuse relay and interlock at the reboot: stop not controlled



To get a controlled stop connect the input /STOP as shown in the following picture. The request for emergency stop provokes initially the disabling of the digital input of Enable. This provokes a motor stop according to the settings in the parameter **DisableOption [406E.00]**. After having programmed a delay on the fuse relay, the voltage is cut on the input /STOP and the power section is stopped. The programmed delay must be enough to stop the motor, otherwise the final part of the motion becomes uncontrolled.

Note The digital inputs to which it is possible to associate the functionality of Enable, are not safe inputs and consequently the deceleration is not safe.

10

Details of Objects

This section explains the set values and contents of each object.

10-1 Agreements on the Parameters Description

Every drive parameter is described in this chapter by the fields in the following table:

Field	Description
-	Desc means that the field information can be found in the following description
Index	This field refers to the address of the parameter in the vocabulary accessible through the protocol CANopen over EtherCAT (CoE) • YYYY: Parameter index • ZZ: Parameter subindex (the number is provided on an hexadecimal basis)
Modbus	Parameter address which is accessible through protocol Modbus (DC Power Supply Unit parameters). The number is expressed on a decimal basis.
Range	Range of values accepted for the parameter. If it is not specified it means that all values represented by the type of datum associated to the parameter are considered as valid
Default	Parameter default value.
Type	Type of datum associated to the parameter: • U8: 8 bits without sign • U16: 16 bits without sign • U32: 32 bits without sign • S8: 8 bits with sign • S16: 16 bits with sign • S32: 32 bits with sign • STR: string • IQN: notation at fixed point at 32 bits with sign and N bits after the point • FLT: floating point single precision
Units	Unit of measurement of the parameter
Acc	Type of access to the parameter: • RW (read/write): reading and writing • WO (write only): only writing • RO (read only): only reading • CST (constant): only reading (constant parameter)
PDO	Parameter mapping in a PDO: • YES: mappable parameter • -: not mappable parameter
Mem	Type of parameter saving in the permanent memory: • -: parameters non savable in the permanent memory • ES: parameters savable in the permanent memory that can be restored on command with the default values • EM: parameters savable in the permanent memory that are not restored on command with default values

10-2 Uploading/Downloading

To upload/download the parameters in the Integrated Servo Motor you can do via EtherCAT, use the SDOs normal (**Section 5-3-2 Protocol CANopen over EtherCAT (CoE)**), or via serial using Modbus protocol and the dedicated software tool IM-TOOL.

To upload/download the parameters in the DC Power Supply Unit you can use the serial port using Modbus protocol and the dedicated software tool IM-TOOL.

10-3 Object Details (Integrated Servo Motor)

10-3-1 Initial Configuration, Update and Board Identity

ProductionDate

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5F7F.00	-	-	U32	-	CST	-	-

Production date of the Integrated Servo Motor.

Format: 0000 YYMM (where YY is the last 2 digits of the year in hexadecimal and MM is the month in hexadecimal)

DriveInformation

Information related to the drive.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFD.00	15	15	U8	-	CST	-	-

Number of parameters in this group.

HardwareRevision

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFD.01	-	-	S16	-	RO	-	-

Drive hardware revision.

BootRevision

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFD.04	-	-	S16	-	RO	-	-

Boot hardware revision.

FirmwareRevision

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFD.07	-	-	S16	-	RO	-	-

Firmware revision. If -1 is valid, only the boot firmware is present.

HardwareProductCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFD.0A	-	-	U32	-	RO	-	-

Drive hardware code.

OemCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFD.0E	6868	6868	U16	-	CST	-	-

Code that identifies the manufacturer.

SoftwareProductCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFD.0F	-	-	U16	-	RO	-	-

Product software code.

FirmwareStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFE.01	-	-	U8	-	RO	-	-

Status of the firmware.

Status	Message	Solution
0	CRC has not been checked yet	Wait the end of the download procedure
1	Do not launch firmware	
10	Run	Firmware is executing
11	Permanent memory error	Error in the permanent memory, turn off and on again the drive. If the problem persists, please contact your OMRON representative
12	Reserved	-
13	CRC error	The firmware is corrupted, try again the download procedure. If the problem persists, please contact your OMRON representative
14	Hardware is not compatible with the firmware	The hardware is not compatible with firmware
15	Boot is not compatible with the firmware	The boot is not compatible with the firmware
16	Firmware is not compatible with hardware	The firmware is not compatible with the hardware
17	Firmware is not compatible with boot	Firmware non compatible with the boot
18	Reserved	-
19	CPLD error	Error during the internal memory programming
20	Firmware exception error	Due to an error that cannot be reset, the firmware start has been blocked
21	Hardware is not compatible with boot	The hardware is not compatible with the boot
100	Download error	Error during the firmware download procedure
101	Download: unrecognized command	Error during the firmware download procedure. If the problem persists, please contact your OMRON representative
106	Download: generic time out	Firmware download procedure interrupted. Check the wirings and the parameters of the connection
113	Download: memory is busy	The memory of the drive is busy because other procedures are executing on another communication channel
151	Download: file corrupted (code 5101)	The firmware file is corrupted
153	Download: file requires unsupported features (code 5103)	The firmware download requires some functionalities that are not supported by the boot
154	Download: file requires unsupported features (code 5104)	
155	Download: file requires unsupported features (code 5105)	
156	Download: file requires unsupported features (code 5106)	
157	Download: file requires unsupported features (code 5107)	
158	Download: file requires unsupported features (code 5108)	

Status	Message	Solution
161	Download: file corrupted (code 5111)	The firmware file is corrupted
162	Download: file corrupted (code 5112)	
163	Download: file corrupted (code 5113)	
164	Download: file corrupted (code 5114)	
165	Download: file corrupted (code 5115)	
166	Download: file requires unsupported features (code 5116)	The firmware download requires some functionalities that are not supported by the boot
167	Download: file requires unsupported features (code 5117)	
168	Download: file requires unsupported features (code 5118)	
169	Download: file requires unsupported features (code 5119)	
170	Download: file requires unsupported features (code 5120)	
171	Download: file requires unsupported features (code 5121)	
172	Download: memory error (code 5122)	Error during the memory programming. If the problem persists, please contact your OMRON representative
173	Download: file corrupted (code 5123)	The firmware file is corrupted
174	Download: file corrupted (code 5124)	
175	Download: memory error (code 5125)	Error during the memory programming. If the problem persists, please contact your OMRON representative
200	Download: memory error (code 5150)	
201	Download: memory error (code 5151)	
202	Download: memory error (code 5152)	
203	Download: memory error (code 5153)	
204	Download: memory error (code 5154)	
210	Download: memory error (code 5160)	
211	Download: memory error (code 5161)	
212	Download: memory error (code 5162)	
213	Download: memory error (code 5163)	
214	Download: memory error (code 5164)	
220	Download: memory error (code 5170)	
221	Download: memory error (code 5171)	
230	Download: memory error (code 5180)	

ManufacturerDeviceName

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1008.00	-	-	STR	-	CST	-	-

Reading of the ManufacturerDeviceName.

Example: R88E-AECT0230E-S2

DeviceType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1000.00	0x00020192	0x00020192	U32	-	CST	-	-

Code of the type of device and of its functionalities:

- The value in the two less significative bytes (0x0192) shows that the device is a drive in compliance with the specification CiA402 EtherCAT.
- The value in the two most significative bytes (0x0002) shows that the drive can control the motor in closed loop.

ErrorRegister

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1001.00	Desc	-	U8	-	RO	Yes	-

Concisely indicates the status of the drive alarms. If a particular type of alarm is present the corresponding bit value is 1, otherwise its value is 0:

Bit	Description	Related alarms
0	Generic alarm (the value of this bit is 1 if at least one of the following bits value is 1, in other words if it has been detected at least one alarm. Otherwise it's equal to 0).	-
1	Current fault	Power or motor short circuit error, Power or motor over current error
2	Voltage fault	Over voltage power section error, Under voltage power section error, Logic voltage error
3	Temperature fault	Thermal management error
4	Communication warning or fault	Main port communication error (ECT)
5	Fault of the Device Profile (related to the CiA402 regulations)	Parameters serious error, Position following error, I2T limit reached error, Digital IO configuration error
6	Reserved	-
7	Fault Manufacturer	Real time mode error, Last command requested failed, /STOP Management Error, User fault error, Feedback-SensorError

The value of this parameter is sent with the emergency messages (see **Section 5-7 Emergency Objects**).

ManufacturerHwVersion

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1009.00	-	-	STR	-	CST	-	-

String in ASCII characters showing the hardware version of the drive.

ManufacturerSwVersion

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x100A.00	-	-	STR	-	CST	-	-

String in ASCII characters showing the software version of the drive.

Identity

Drive identity.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1018.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

VendorID

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1018.01	-	0x83	U32	-	RO	-	-

Number code given to OMRON as manufacturer of EtherCAT devices.

ProductCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1018.02	-	0xBB	U32	-	RO	-	-

Drive software code.

RevisionNumber

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1018.03	-	0x 00190000	U32	-	RO	-	-

Product revision.

SerialNumber

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1018.04	-	-	U32	-	RO	-	-

Drive serial number.

CpuInfo

Information of the CPU.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFA.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

SwResetCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFA.03	-	0	U16	-	RO	-	-

Software reset: reset code. Please contact your OMRON representative if it is different from 0.

SwResetInfo

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFA.04	-	-	U32	-	RO	-	-

Software reset: RPC register value. It identifies a firmware internal problem.

CPUSiliconRevision

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFA.01	-	-	U16	-	RO	-	-

CPU revision.

ResetCause

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FFA.02	-	-	U32	-	RW	-	-

Code of the cause that provoked the firmware reset.

ResetCause	Description
1	Generic reset (cause not found)
2	Power-up reset (switching on the drive, command 5000 of **SysMngCommand [5FF7.01]**, firmware download)
3	Reset from line of hardware reset
4	Reset from watchdog
5	Reserved
6	Reset from any other communication channel (command 5001 of **SysMngCommand [5FF7.01]**)

10-3-2 EtherCAT Communication Port

EtherCAT_PortActual

Current configuration of the EtherCAT communication port.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5108.00	1	1	U8	-	CST	-	-

Number of parameters in this group.

EtherCAT_PortActualNodeID

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5108.01	-	-	U16	-	RO	-	-

Current node number of the EtherCAT communication port.

CommunicCyclePeriod

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1006.00	0-32000	0	U32	μs	RW	-	-

Synchronization time of the PDOs with the synchronization method **Soft sync**.

Note In case of interpolated mode use, pay attention to **Section 7-2-2 Interpolated Position Mode**.

EtherCAT_Diagnostics

Specific details of the Main port communication error (ECT).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.00	15	15	U8	-	CST	-	-

Number of parameters in this group.

EtcErrorRetentCommMsg

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.01	Desc	-	U32	-	RO	-	-

Details of the errors of the Main port communication error (ECT).

Bit	Description	Alarm
0	Sync Manager watchdog expired. The Sync manager (SM) watchdog of the PDO RX has expired; the PDO RX has not been received; correctly manage the PDO RX sending operation from the master or correct the watchdog times in the ESC registers	Fault
1	Sync 0 watchdog expired. The SyncSignal 0 watchdog has expired; correctly set and activate the SyncSignal 0 signal and the watchdog times in the ESC registers.	Fault
2	PLL Error (PDO and SyncSignal 0 are not synchronized). PDO and SyncSignal 0 are not synchronized; manage correctly in the master the sending of the PDO before the synchronization	Fault
3	Synchronization sync error. The PDOs RX don't arrive or however not in correspondence to the set synchronization reference, within a tolerance from [Sync/2] to [Sync + Sync/2] with a maximum value of [Sync + 1ms]; verify that the PDOs RX are sent by the master in correspondence to the synchronization reference	Fault
4-7	Reserved	
8	Hardware error (Hardware failure)	Warning
9-31	Reserved	

Note The faults can be generated only if the drive is in the Operation enable (CiA-402) status. In any case it is possible to analyze the causes of an unexpected EtherCAT status change, by reading the **EtcRegAlStatusCode [5FF6.0A]** parameter.

EtcPdoRxMissingTolerance

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.02	0-128	1	U16	-	RW	-	-

Tolerance on the number of PDO RX that can be consecutively lost before the drive generates an error.

Note We suggest to set a greater than 4 tolerance because each not received and not interpreted PDO RX implies that the movement is not controlled by the Master (see **Section 5-4-2 Missing or Corrupted PDO RX Management**).

EtcPdoRxLostConsecutive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.03	-	0	U16	-	RW	-	-

Counter of the maximum number of consecutively lost PDOs RX (only updated on the OPERATIONAL status).

EtcPdoRxLostTotal

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.04	-	0	U32	-	RW	-	-

Counter of the total number of consecutively lost PDOs RX (only updated on the OPERATIONAL status).

EtcPdoRxLostTotalReset

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.05	-	0	S32	-	RW	-	-

Counter of the total number of lost PDOs RX. It’s automatically reset on the transition from SAFE-OPERATIONAL status to the OPERATIONAL status and it works only in the OPERATIONAL status.

EtcDcPllResetOnOpe

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.06	Desc	-	S32	-	RW	-	-

Difference between the detected SyncSignal number and the correctly received PDO RX messages number (the value is updated only if the drive is on OPERATIONAL status and if the synchronization mode is HardSync, see **Section 5-6 Synchronization**).

EtcPdoRxTotal

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.07	Desc	0	U32	-	RW	-	-

Number of total frames that have been correctly received. The counter doesn't overflow, when the 32 bit maximum value is reached the counting stops until its value is modified by a writing operation. It is possible to write any value, it will be reset on the SAFEOPERATIONAL -> OPERATIONAL transition.

EtcRegDllStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.08	Desc	-	U16	-	RO	-	-

Register 0x110:0x111 of the ESC.

EtcRegAlStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.09	Desc	-	U16	-	RO	-	-

Register 0x130:0x131 of the ESC.

EtcRegAlStatusCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.0A	Desc	-	U16	-	RO	-	-

Register 0x134:0x135 of the ESC.

EtcRegEEpromConfiguration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.0B	Desc	-	U16	-	RO	-	-

Register 0x500:0x501 of the ESC.

EtcRegSyncOutUnit

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.0C	Desc	-	U16	-	RO	-	-

Register 0x980:0x981 of the ESC.

EtcRegSyncPulseLength

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.0D	Desc	-	U16	-	RO	-	-

Register 0x982:0x983 of the ESC.

EtcRegSyncActivationStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.0E	Desc	-	U16	-	RO	-	-

Register 0x984 of the ESC.

EtcRegSync0CycleTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.0F	Desc	-	U32	-	RO	-	-

Register 0x9A0:0x9A3 of the ESC.

EtcResetPdoRxLostMaxConsecReset

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF6.10	-	0	U16	-	RW	-	-

Counter of the total number of consecutively lost PDOs RX. It’s automatically reset on the transition from SAFE-OPERATIONAL state to the OPERATIONAL state and it works only in the OPERATIONAL state.

10-3-3 Auxiliary Communication Port

AuxiliaryPortSetup

Parameters used to configure the auxiliary communication port.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5120.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

AuxiliaryPortSetupWordOrder

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5120.01	0-1	0	U16	-	RW	-	ES

Order of the words used by the drive, through the auxiliary port, to receive or send the parameters of 32 bits.

Auxiliary Port Setup Word Order	Description	Example
0	Word sent in little-endian format	The value 0x12345678 is sent in the order 0x5678 0x1234.
1	Word sent in big-endian format	The value 0x12345678 is sent in the order 0x1234 0x5678.

AuxiliaryPortSetupTimeOut

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5120.02	20-65000	50	U16	ms	RW	-	ES

Timeout of the auxiliary port. If the distance between two consecutive characters overcomes this value, the interface cancels the ongoing receiving of the whole frame and it prepares to receive a new frame.

AuxiliaryPortSetupBaudRateImmediate

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5120.03	19200 or 57600	57600	U32	bit/s	RW	-	-

Parameters used for the immediate exchange of the baud rate of the auxiliary port. Once received the request to change the baud rate, the drive sends the answer with the precedent baud rate and only after it configures the communication interface with the new baud rate.

AuxiliaryPortSetupBaudRate

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5120.04	19200 or 57600	57600	U32	bit/s	RW	-	ES

Baud rate of the auxiliary port. This parameter is part of the group Enabled parameters after reset.

AuxiliaryPortError

Parameters to read the last error condition in writing or reading carried out with the auxiliary communication port.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5124.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

AuxiliaryPortErrorParam

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5124.01	-	0	U16	-	RW	-	-

An access in writing provokes the resetting of this parameter and of the parameter **AuxiliaryPortErrorCode [5124.02]**.

AuxiliaryPortErrorCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5124.02	Desc	0	U16	-	RW	-	-

Error code of the last error condition found during the writing/reading phase with the auxiliary communication port.
An access in writing provokes the resetting of this parameter and of the parameter **AuxiliaryPortErrorParam [5124.01]**.

10-3-4 Motor, Drive and I2T

MotorParameters

Motor Parameters.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.00	15	15	U8	-	CST	-	-

Number of parameters in this group.

MotorStallCurrent

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.01	-	-	U16	100 = 1A	RW	-	EM

It is the motor stall current, that corresponds to the current of the maximum motor torque, with a close to 0 velocity without its thermal limits are exceeded.

MotorPeakCurrent

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.02	-	-	U16	100 = 1A	RW	-	EM

Motor peak current.

CoggingTorque

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.03	-	-	U16	Desc	RW	-	EM

Motor cogging torque. The unit of measurement depends on the motor type: rotary motor [mN*m], linear motor [daN/A].

MotorInductance

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.04	-	-	U16	100 = 1mH	RW	-	EM

Phase-phase motor inductance.

MotorResistance

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.05	-	-	U16	mΩ	RW	-	EM

Phase-phase resistance.

MotorInertia

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.06	-	-	U16	Desc	RW	-	EM

Inertia moment of the motor. The unit of measurement depends on the motor type: rotary motor [1 = 10g cm^2], linear motor [1 = 10g].

MotorGuid

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.07	-	-	STR	-	RW	-	EM

Reserved.

TorqueConstant

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.08	-	-	U16	Desc	RW	-	EM

Motor torque constant. The unit of measurement depends on the motor type: rotary motor [1000 = 1Nm/A].

MotorRatedSpeed

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.09	-	-	U32	Desc	RW	-	EM

Motor nominal velocity. The unit of measurement depends on the motor type: rotary motor [rpm].

MotorPoles

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.0A	-	-	U16	-	RW	-	EM

Number of motor poles.

FaultTemperatureThrs

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.0B	-	-	U16	-	RW	-	EM

Motor temperature fault threshold.

MotorType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.0C	0 ÷ 1	-	U16	-	RW	-	EM

Motor type: 0 = rotary, 1 = linear. Reserved for the future.

PolePitch

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.0D	-	-	U16	mm	RW	-	EM

Linear motor pole pitch. Reserved for the future.

MotorFaultTemperatureThrsOhm

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.0E	-	-	U32	Ω	RW	-	EM

Resistance value that causes the motor temperature fault, if the motor temperature sensor is PTC.

MotorTemperatureSensorType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6410.0F	0-5	-	U16	-	RW	-	EM

Temperature sensor type built on the motor: 0 = no sensor (the temperature measurement is disabled), 1 = KTY84 sensor, 2 = PTC SWITCH sensor, 5 = PT1000 sensor. For the temperature value reading, if this parameter value is 1, please refer to **MotorTemperature [3300.03]**, if it is 2 refer to **MotorTemperaturePTC [3300.05]**.

DriveParameters

Drive parameters.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6510.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

MaxRatedCurrent

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6510.01	-	-	U16	100 = 1A	RO	-	-

Drive nominal current, power section.

MaxPeakCurrent

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6510.02	-	-	U16	100 = 1A	RO	-	-

Drive peak current, power section.

MaxSupplyVoltage

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6510.03	-	-	U16	V	RO	-	-

Maximum supply voltage, power section.

UserDriveName

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6510.04	-	-	-	-	RW	-	EM

Drive name, given by the user. For an easier drive identification, it's possible to insert an alphanumeric string of up to 16 characters. The UserDriveName parameter must be considered as any other parameter: it's saved in the permanent memory and it's managed by the parameters file as the others parameters. UserDriveName is showed on the connection status and in the main page heading.

I2TParameters

Parameters of the I2T limitation.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3405.00	6	6	U8	-	CST	-	-

Number of parameters in this group. For further details see **Section 8-4-2 I2T Limits**.

I2TTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3405.01	-	Desc	U16	ms	RW	-	ES

Maximum time the drive can keep the motor current at the value of PeakCurrent. It contributes to determine **UserMaxI2T [3405.02]**. Its default value is so that **UserMaxI2T [3405.02]** is lower than **DriveMaxI2T [3405.03]**, with a maximum value of 5s.

UserMaxI2T

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3405.02	-	-	U32	A^2s	RO	-	-

Maximum value of I2T calculated depending on PeakCurrent and **I2TTime [3405.01]**. Its value must be lower than **DriveMaxI2T [3405.03]**.

DriveMaxI2T

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3405.03	-	-	U32	A^2ms	RO	-	-

Maximum value of the drive I2T.

I2TWarningThreshold

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3405.04	0-100	80	U16	%	RW	-	ES

Warning threshold enabling the error I2T warning threshold reached error.

UserPeakCurrent

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3405.06	-	Desc	U16	100 = 1A	RW	Yes	ES

Peak current that can be set by the user to limit the current supply to the motor. It contributes to determine **User-MaxI2T [3405.02]**. UserPeakCurrent must be different from zero and lower or equal to **MotorPeakCurrent [6410.02]** and **MaxPeakCurrent [6510.02]**. Its default value is the lowest value between **MotorPeakCurrent [6410.02]** and **MaxPeakCurrent [6510.02]**.

10-3-5 Tuning

ResetWatchdogTimeout

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3500.00	-	-	U16	-	WO	-	-

Write in this parameter the **SysMngCommand [5FF7.01]** value to execute the Reset of the Watchdog of the System manager.

Tuning Configurations

Tuning configurations.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3502.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

DynamicResponse

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3502.01	-	150	U16	-	RW	Yes	ES

Tuning configuration used to select the dynamic response of the motor.

DynamicResponse	Description
120	Lowest
130	Very low
140	Low
150	Medium
160	High
170	Very high
180	Highest

Stiffness

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3502.02	-	150	U16	-	RW	Yes	ES

Tuning configuration used to select the motor stiffness at low velocities. Low speeds are 30% lower than **High-Speed [60F9.08]** parameter.

Stiffness	Description
130	Very low
140	Low
150	Medium
160	High
170	Very high

VelocityLoopFilter1

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3502.03	-	2	U16	-	RW	Yes	ES

Tuning configuration that defines the filtering action of the velocity loop. For further details please see “4. Modification of the Tuning configurations” in the **Section 12-3 Fast Tuning Guide**.

VelocityLoopFilter1	Description
1	User
2	Noise filter
3	Disable
51	Soft filter

VelocityLoopFilter2

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3502.04	-	3	U16	-	RW	Yes	ES

Tuning configuration selecting the second filter of the speed loop. For further details please see “4. Modification of the Tuning configurations” in the **Section 12-3 Fast Tuning Guide**.

VelocityLoopFilter2	Description
1	User
2	Resonance filter
3	Disable
50	Debounce filter

EstimatedLoopsBandwidth

Loops estimated bandwidths.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3501.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CurrentLoopEstimatedBandwidth

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3501.01	-	-	U16	Hz	RO	-	-

CurrentLoop estimated bandwidth.

VelocityLoopEstimatedBandwidth

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3501.02	-	-	U16	Hz	RO	-	-

VelocityLoop estimated bandwidth.

PositionLoopEstimatedBandwidth

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3501.03	-	-	U16	Hz	RO	-	-

PositionLoop estimated bandwidth.

TuningEndOption

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3515.08	-	22	S16	-	RW	-	-

Operation run when you press the End button in IM-TOOL (command 100 of the System Manager).

TuningEndOption	Description
0	Immediately disable, the motor is stopped with maximum deceleration resetting RequestedSpeed at zero and then the drive has the status Switch On Disabled
10	Zero speed and disable, the motor is stopped with maximum deceleration resetting RequestedSpeed at zero and then the drive has the status Switch On Disabled
11	Zero speed and enable, the motor is stopped with maximum deceleration resetting RequestedSpeed at zero and then the drive has the status Switched On
12	Zero speed and state, the motor is stopped with maximum deceleration resetting RequestedSpeed at zero and then the drive has the same status before the requested tuning command
20	Deceleration ramp and disable, the motor is stopped with a deceleration equal to **TuningEndDeceleration [3515.09]** and then the drive has the status Switch On Disabled
21	Deceleration ramp and enable, the motor is stopped with a deceleration equal to **TuningEndDeceleration [3515.09]** and then the drive has the status Switched On
22	Deceleration ramp and state, the motor is stopped with a deceleration equal to **TuningEndDeceleration [3515.09]** and then the drive has the same status before the requested tuning command

TuningEndDeceleration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3515.09	1 to 2^{32} *1	166886054*2	U32	inc/s^2	RW	-	-

*1. Minimum value is the equivalent in inc/s^2 to 0.32 rad/s^2 and maximum value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s^2 to 1000.0 rad/s^2, that is: **1000*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 166886054 inc/s^2 for the 20-bit encoder and 5215189 inc/s^2 for the 15-bit encoder.

InertiaEstimator

Parameters for the inertia estimation.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3503.00	6	6	U8	-	CST	-	-

Number of parameters in this group.

InertiaEstimatorDirection

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3503.01	-	192	U16	-	RW	-	-

Rotation direction of the drive shaft using the inertia estimator (0 = negative, 192 = positive).

InertiaEstimatorTorque

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3503.02	0 ÷ 32767	1000	U16	10 = 1%IS	RW	-	-

Torque requested to the motor using the inertia estimator.

InertiaEstimatorVelocity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3503.03	-	16688605*1	U32	inc/s	RW	-	-

*1. The default value is the equivalent in inc/s to 100.0 rad/s, that is: **100*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 16688605 inc/s for the 20-bit encoder and 521519 inc/s for the 15-bit encoder.

Velocity requested to the motor using the inertia estimator.

EstimatedInertia

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3503.05	-	10	U16	10 = 1Jm	RW	-	EM

Total inertia moment, calculated compared to the motor shaft. EstimatedInertia must take into consideration the moments of motor inertia, brake mechanical transmission and load.

InertiaReductionFactor

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3503.06	0-1000	1000	U16	Desc	RW	-	EM

Reduction factor of **EstimatedInertia [3503.05]** (0 = maximum reduction, 1000 = no reduction). The result of the reduction is used to calculate the regulation loops gains.

RLEstimator

Parameters for the phase resistance and the motor inductance.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.00	12	12	U8	-	CST	-	-

Number of parameters in this group.

EstimatedPhaseResistance

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.01	-	-	U16	mΩ	RO	-	EM

Phase resistance estimated with RLEstimator.

MotorPhaseResistance

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.02	-	-	U16	mΩ	RO	-	EM

Theoretical phase resistance obtained with the motor nameplate data (**MotorResistance [6410.05]**).

MotorSynchronousInductance

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.04	-	-	U16	100 = 1mH	RO	-	EM

Theoretical synchronous inductance obtained with the motor nameplate data (**MotorInductance [6410.04]**).

EstimatedLDNominalP

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.05	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and positive **ActualFieldCurrent [3320.02]** equal to NominalCurrent.

EstimatedLDNominalN

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.06	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and negative **ActualFieldCurrent [3320.02]** equal to NominalCurrent.

EstimatedLDPeakP

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.07	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and positive **ActualFieldCurrent [3320.02]** equal to PeakCurrent.

EstimatedLDPeakN

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.08	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and negative **ActualFieldCurrent [3320.02]** equal to PeakCurrent.

EstimatedLQNominalP

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.09	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and positive **ActualTorqueCurrent [3320.03]** equal to NominalCurrent.

EstimatedLQNominalN

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.0A	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and negative **ActualTorqueCurrent [3320.03]** equal to NominalCurrent.

EstimatedLQPeakP

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.0B	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and positive **ActualTorqueCurrent [3320.03]** equal to PeakCurrent.

EstimatedLQPeakN

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3504.0C	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and negative **ActualTorqueCurrent [3320.03]** equal to PeakCurrent.

VelocityStandStill

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3523.00	-	-	U16	-	RW	-	ES

Regulation of the gains of the speed regulator for low speeds (it modifies both **KVp_LS [60F9.04]** and **KVi_LS [60F9.05]**).

10-3-6 Loop

ResetSpeedIntegrator

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.22	-	-	U16	-	WO	-	ES

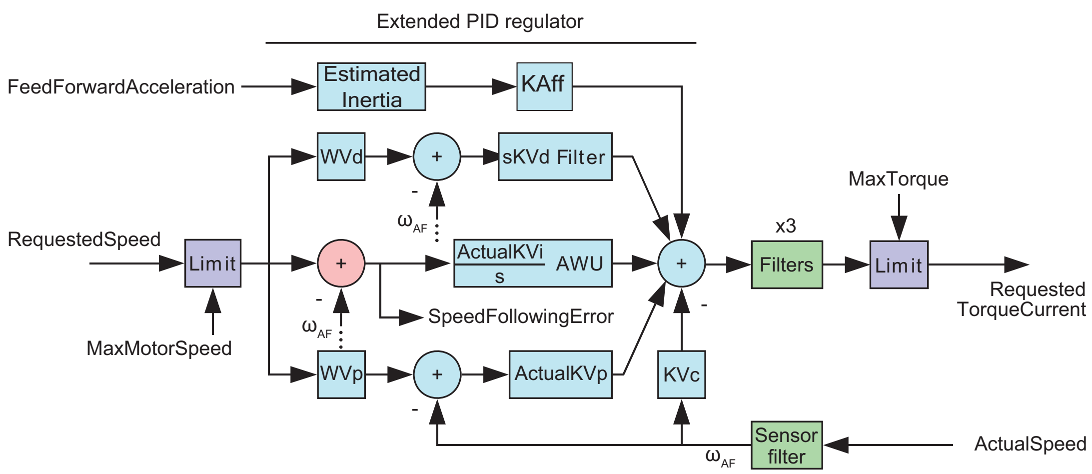
By writing any value in this parameter, the integrative memory of the velocity regulator is reset to 0.

LoopConfiguration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3522.00	0 ÷ 2	2	U16	-	RW	-	ES

Reserved. Do not change this setting.

VelocityLoop



Velocity loop.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.00	34	34	U8	-	CST	-	-

Number of parameters in this group. The VelocityLoop is composed by the following blocks:
- Input speed limiter
- PID regulator with more degrees of freedom made up by five components: acceleration feed forward, derivative with weight and filter, integral with persistence limit (AWU), proportional with weight, damping
- Three filters in the regulator output
- One filter on the sensor of the feedback position
- Limiter of the output torque

EnableVelocityStandStill

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.17	-	-	U16	-	RW	Yes	ES

Enabling of the **VelocityStandStill [3523.00]**: (0 = disabled, 1 = enabled).

LowSpeed

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.09	-	-	U32	inc/s	RW	Yes	ES

Speed threshold to use only the Stand still parameters.

HighSpeed

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.08	-	-	U32	inc/s	RW	Yes	ES

Out of this speed threshold the Stand still parameters do not have any effect.

KVp_LS

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.04	-	-	U16	-	RW	Yes	ES

Proportional gain of the speed regulator for low speeds.

KVi_LS

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.05	-	-	U16	-	RW	Yes	ES

Integral gain of the speed regulator for low speeds.

ActualKVp

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.0C	-	-	U16	-	RO	Yes	-

Proportional gain currently used by the speed regulator.

ActualKVi

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.0D	-	-	U16	-	RO	Yes	-

Integral gain currently used by the speed regulator.

KVp

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.01	-	-	U16	-	RW	Yes	ES

Proportional gain of the speed regulator.

KVi

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.03	-	-	U16	-	RW	Yes	ES

Integral gain of the speed regulator.

KVdFilterFrequency

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.10	-	-	U16	-	RW	Yes	ES

Typical filter frequency on the derivative component of the speed regulator. By increasing this parameter, the filtering action decreases.

KVd

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.11	-	-	U16	-	RW	Yes	ES

Derivative gain of the speed regulator.

WVd

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.12	-	-	U16	1000 = 1	RW	Yes	ES

Weighting coefficient of the speed reference in the calculation of the derivative component.

WVp

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.13	-	-	U16	1000 = 1	RW	Yes	ES

Weighting coefficient of the speed reference in the calculation of the proportional component.

KVc

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.14	-	-	U16	-	RW	Yes	ES

Damping gain of the speed regulator.

VFilter1Frequency

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.0E	-	-	U16	Hz	RW	Yes	ES

Typical frequency of the first filter on the output of the speed regulator.

VFilter1Type

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.0F	-	-	U16	-	RW	Yes	ES

Type of the first filter on the output of the speed regulator.

VFilter1Type	Description
0	All-stop filter
1	Low-pass filter of the first order
2	Low-pass filter of the second order
3	Band-eliminating filter
65535	All-pass filter

VFilter1QFactor

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.18	-	-	U16	10 = 1	RW	Yes	ES

Quality Q factor of the first filter on the output of the speed regulator.

VFilter2Frequency

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.19	-	-	U16	Hz	RW	Yes	ES

Typical frequency of the second filter on the output of the speed regulator.

VFilter2Type

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.1A	-	-	U16	-	RW	Yes	ES

Type of the second filter on the output of the speed regulator.

VFilter2Type	Description
0	All-stop filter
1	Low-pass filter of the first order
2	Low-pass filter of the second order
3	Band-eliminating filter
65535	All-pass filter

VFilter2QFactor

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.1B	-	-	U16	10 = 1	RW	Yes	ES

Quality Q factor of the second filter on the output of the speed regulator.

VFilter3Frequency

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.1C	-	-	U16	Hz	RW	Yes	ES

Typical frequency of the third filter on the output of the speed regulator.

VFilter3Type

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.1D	-	-	U16	-	RW	Yes	ES

Type of the third filter on the output of the speed regulator.

VFilter3Type	Description
0	All-stop filter
1	Low-pass filter of the first order
2	Low-pass filter of the second order
3	Band-eliminating filter
65535	All-pass filter

VFilter3QFactor

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.1E	-	-	U16	10 = 1	RW	Yes	ES

Quality Q factor of the third filter on the output of the speed regulator.

FieldWeakeningFilterType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3520.06	Desc	2	U16	-	RW	-	ES

Selector that allows to activate/deactivate the field weakening functionality, by acting on the filter type on the homonyms regulator output. The values that can be inserted are listed in the following table:

FieldWeakeningFilterType	Description
0	Disable weakening: All-stop filter
1	Enable weakening: Low-pass filter of the first order
2	Enable weakening: Low-pass filter of the second order
3	Enable weakening: Band-eliminating filter
65535	Enable weakening: All-pass filter (none filter)

VFilterSensorFrequency

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.1F	-	-	U16	Hz	RW	Yes	ES

Typical frequency of the filter on the feedback position sensor.

VFilterSensorType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.20	-	-	U16	-	RW	Yes	ES

Filter type on the sensor of the feedback position.

VFilterSensorType	Description
0	All-stop filter
1	Low-pass filter of the first order
2	Low-pass filter of the second order
3	Band-eliminating filter
65535	All-pass filter

VFilterSensorQFactor

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.21	-	-	U16	10 = 1	RW	Yes	ES

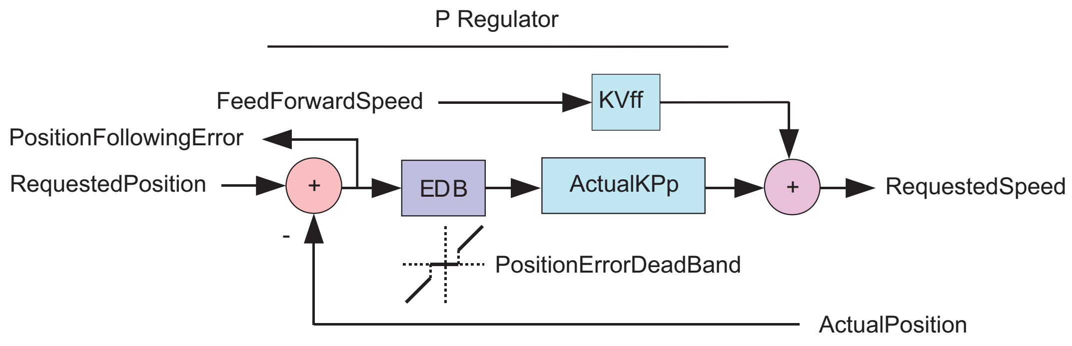
Quality Q factor of the third filter on the feedback position sensor.

KAff

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F9.16	-	-	U16	1000 = 1	RW	Yes	ES

Acceleration feed forward gain.

PositionLoop



Position loop.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FB.00	6	6	U8	-	CST	-	-

Number of parameters in this group. The position regulator is of P type, made up of two components, proportional and speed feed forward. Just at its input there is the resetting block of the **PositionFollowingError [60F4.00]** when it is included in the **PositionErrorDeadBand [4281.01]** (EDB) located near the zero.

KPp

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FB.01	-	-	U16	-	RW	Yes	ES

Proportional gain of the position regulator.

KVff

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FB.02	-	-	U16	1000 = 1	RW	Yes	ES

Velocity feed forward gain.

PositionStandStill

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FB.03	-	-	U16	-	RW	Yes	ES

Proportional gain of the position regulator for low speeds.

EnablePositionStandStill

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FB.04	-	-	U16	-	RW	Yes	ES

Enabling the **PositionStandStill [60FB.03]**: (0 = disabled, 1 = enabled).

ActualKPp

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FB.05	-	-	U16	-	RO	Yes	-

Proportional gain currently used by the position regulator.

ClosePositionLoop

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FB.06	-	1	U16	-	RW	Yes	ES

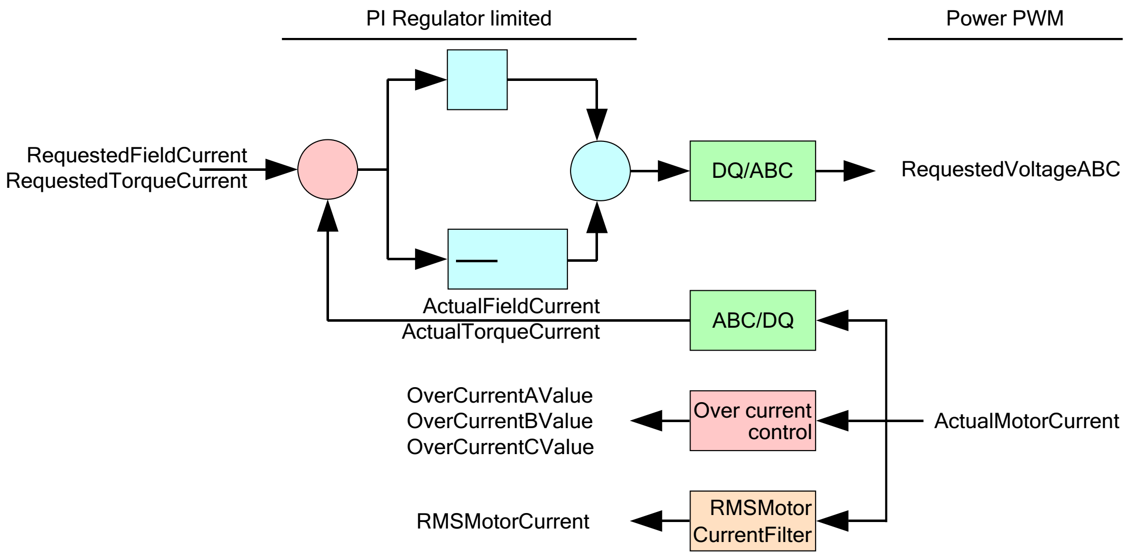
It enables the internal closure of the drive of the position loop.

PositionErrorDeadBand

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4281.01	-	0	U16	inc	RW	-	ES

Half width of the dead band of the **PositionFollowingError [60F4.00]**.

CurrentLoop



Current loop.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.00	10	10	U8	-	CST	-	-

Number of parameters in this group. The current regulator is of PI type, made up of the two components, proportional and integral with persistence limit of the integral part (Anti Wind Up). For the regulator you can use two different gain torques: one for the torque component and one for the field component.

KCp_Q

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.01	-	-	U16	-	RW	Yes	ES

Proportional gain of the torque current regulator.

KCi_Q

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.02	-	-	U16	-	RW	Yes	ES

Integral gain of the torque current regulator.

KCp_D

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.03	-	-	U16	-	RW	Yes	ES

Proportional gain of the field current regulator.

KCi_D

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.04	-	-	U16	-	RW	Yes	ES

Integral gain of the field current regulator.

KC_FilterFrequency

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.06	-	-	U16	Hz	RW	Yes	ES

Typical frequency of the filter on the output of the speed regulators.

KC_FilterType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.07	-	-	U16	-	RW	Yes	ES

Type of the filter on the output of the current regulator.

KC_FilterType	Description
0	All-stop filter
1	Low-pass filter of the first order
2	Low-pass filter of the second order
3	Band-eliminating filter
65535	All-pass filter

KC_FilterQFactor

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.08	-	-	U16	10 = 1	RW	Yes	ES

Quality factor of the filter on the current regulators output.

KC_QReduction

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.09	-	-	U16	Desc	RW	Yes	ES

Gains reduction factor to compensate the Lq saturation (0 = no reduction, 1000 = maximum reduction).

EnableLoopCompensation

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.05	-	-	U16	-	RW	Yes	ES

Each bit of this parameter enables the related functionality. The functionalities are listed in the following table:

Bit	Name	Description
0	EMF compensation	Enable the counterelectromotive force compensation
1	CrossDQ	Cross coupling contributions compensation of the current regulators
2	Reserved	-
3	Predictive current measurement	Enable the predictive current measurement
4	KC_QReduction	Enable the gains reduction to compensate the Lq saturation

AngleObserverBandwidth

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F6.0A	-	-	U16	Hz	RW	Yes	ES

Natural frequency of the observer that estimates the rotor position.

LoopType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3080.00	0 - 1	0	U16	-	RW	-	-

Reserved. Do not change this setting.

10-3-7 Power Pwm

PowerPwmParameters

Power pwm parameters.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3521.00	7	7	U8	-	CST	-	-

Number of parameters in this group.

PwmBridgeFrequency

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3521.01	1500-30000	5000	U16	Hz	RO	-	ES

Three-phase bridge modulation frequency.

PwmModulationMethod

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3521.02	2	2	U16	-	RO	-	ES

Modulation type of the three-phase bridge, 2 = asymmetrical.

PwmMotionLoopDivider

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3521.03	-	1	U16	-	RO	-	ES

Reduction factor of the loop motion period compared to the current loop period.

PwmMotionLoopCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3521.07	-	0	U16	-	WO	-	-

Unique code to set the frequency of the three-phase bridge and of the loop period. Writable only when the motor is disabled.

PwmMotion-LoopCode	PwmBridgeFre-quency	PwmModulation-Method	PwmMotion-LoopDivider	MotionLoopPe-riod	CurrentLoopPe-riod
0	5000	2	1	100	100

MotionLoopPeriod

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3521.04	-	100	U16	μs	RO	-	-

Motion loop period.

CurrentLoopPeriod

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3521.05	-	100	U16	μs	RO	-	-

Current loop period.

10-3-8 Drive Status

TemperatureStatus

Temperature status.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3300.00	5	5	U8	-	CST	-	-

Number of parameters in this group.

PowerTemperature

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3300.01	-	-	S16	10 = 1ºC	RO	Yes	-

Power section actual temperature.

LogicTemperature

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3300.02	-	-	S16	10 = 1ºC	RO	Yes	-

Logic section actual temperature.

MotorTemperature

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3300.03	-	-	S16	10 = 1ºC	RO	Yes	-

Actual motor temperature.

FeedbackSensorTemperature

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3300.04	-	-	S16	10 = 1ºC	RO	Yes	-

Feedback sensor temperature. If the value of the **SensorFaultTemperatureThrs [36C0.05]** parameter is 65535 (thermal sensor not present), **FeedbackSensorTemperature [3300.04]** coincides with **MotorTemperature [3300.03]**.

MotorTemperaturePTC

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3300.05	-	-	S32	Ω	RO	Yes	-

Motor temperature reference (if the selected sensor is PTC, see **MotorTemperatureSensorType [6410.0F]**).

DCBusVoltage

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3310.01	-	-	U16	10 = 1V	RO	Yes	-

DC bus voltage feeding the drive power section.

I2TValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3405.05	-	-	U16	%	RO	Yes	ES

Current value of I2T.

CurrentStatus

Current status.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3320.00	9	9	U8	-	CST	-	-

Number of parameters in this group.

ActualMotorCurrent

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3320.01	-	-	U16	100 = 1A	RO	Yes	-

Motor actual current.

ActualFieldCurrent

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3320.02	-	-	U16	100 = 1A	RO	Yes	-

Motor actual field current (Id).

ActualTorqueCurrent

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3320.03	-	-	U16	100 = 1A	RO	Yes	-

Motor actual torque current (Iq).

OverCurrentAValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3320.05	-	-	U16	100 = 1A	RO	Yes	-

Motor A phase current in Power or motor over current error conditions Power or motor over current error.

OverCurrentBValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3320.06	-	-	U16	100 = 1A	RO	Yes	-

Motor B phase current in Power or motor over current error conditions Power or motor over current error.

OverCurrentCValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3320.07	-	-	U16	100 = 1A	RO	Yes	-

Motor C phase current in Power or motor over current error conditions.

RMSMotorCurrent

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3320.08	-	-	U16	100 = 1A	RO	Yes	-

Motor RMS current.

RMSMotorCurrentFilter

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3320.09	-	100	U16	100 = 1s	RW	-	ES

Filtering time to get the **RMSMotorCurrent [3320.08]**. RMSMotorCurrentFilter must be different from 0. Too low values of RMSMotorCurrentFilter can generate swinging in **RMSMotorCurrent [3320.08]**. Too high values of RMSMotorCurrentFilter slow down the convergence of **RMSMotorCurrent [3320.08]**. Writing in the parameter RMSMotorCurrentFilter, the time value of machine cycle the drive belongs to, it is possible to get a stable and convergent **RMSMotorCurrent [3320.08]** in ten machine cycles.

AI0AcquiringStatus

Acquiring through the analog input 0.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3330.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

AI0Voltage

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3330.01	-	-	S16	mV	RO	Yes	-

Not filtered current value of the analog input 0. The updating time of this parameter is **CurrentLoopPeriod [3521.05]**.

AI0FilteredVoltage

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3330.02	-	-	S16	mV	RO	Yes	-

Current value of the filtered analog input 0. The updating time of this parameter is **MotionLoopPeriod [3521.04]**.

10-3-9 Fault and Warning

FaultMask

Masks having the faults features.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3000.00	3	3	U8	-	CST	-	-

Number of parameters in this group. For further details see **Section 13-2-3 Reaction to the Faults**.

FaultMaskAutoErase

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3000.01	Desc	0	U32	-	RW	-	ES

Auto-restoring fault mask the Fault Reset command is automatically run for. The Fault Reset runs when the fault cause has been removed and there are no more retentive faults. In **Section 13-2 Fault and Warning (Integrated Servo Motor)** you can find the errors that can become auto-restoring through this parameter.

FaultMaskEnable

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3000.02	Desc	Desc	U32	-	RW	-	ES

Error mask the fault warning has been enabled for. In **Section 13-2 Fault and Warning (Integrated Servo Motor)** you can find the faults that can be enabled/disabled through this parameter. All Fatal faults are enabled by default, all bits for future uses and the faults Real time mode error, Main port communication error (ECT), Position following error, User fault error, I2T limit reached error and Logic voltage error.

Note If the fault warning is disabled, the related bits in the fault registers will always be 0 and the drive will consequently not reach the status of Fault because of that error cause.

FaultMaskSafetyPrfExecute

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3000.03	Desc	0x180	U32	-	RW	-	ES

Fault mask generating the Safety profile. In **Section 13-2 Fault and Warning (Integrated Servo Motor)** you can find the faults that can generate the Safety profile.

FaultReactionOptionCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x605E.00	Desc	-1	S16	-	RW	-	ES

Action run in case of Non fatal fault and with disabled Safety profile. For further information see **Section 13-2-3 Reaction to the Faults**.

FaultReaction-OptionCode	Action
-1	The motor is stopped with maximum deceleration by resetting RequestedSpeed and then the drive reaches the status Fault
1	The motor is stopped with deceleration equal to **ProfileDeceleration [6084.00]** and then the drive reaches the status Fault
2	The motor is stopped with deceleration equal to **QuickStopDeceleration [6085.00]** and then the drive reaches the status Fault

SafetyPrfConfiguration

Parameters to configure the Safety profile.
The Safety profile is a motion of the motor carried out in the reaction to the faults to take the motor to a safe position. As a fault is detected, check if the drive is the Operation enable state, if the profile is enabled (see **SafetyPrf-Command [3010.01]**) and if the detected fault allows its running (see **FaultMaskSafetyPrfExecute [3000.03]**). If all the conditions are respected the operation shown in **SafetyPrfCommand [3010.01]** is run.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x300C.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

SafetyPrfTargetPosition

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x300C.01	-	0	S32	inc	RW	-	ES

Absolute position target to reach when the safety profile is run.

SafetyPrfVelocity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x300C.02	1 to 2^{32} *1	500658*2	U32	inc/s	RW	-	ES

*1. Minimum value is the equivalent in inc/s to 3.0 rad/s and maximum value is the equivalent in inc/s to 3216.9 rad/s. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s to 3.0 rad/s, that is: **3*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 500658 inc/s for the 20-bit encoder and 15645 inc/s for the 15-bit encoder.

SafetyPrfAcceleration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x300C.03	1 to 2^{32} *1	20860757*2	U32	inc/s^2	RW	-	ES

*1. Minimum value is the equivalent in inc/s^2 to 0.32 rad/s^2 and maximum value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s^2 to 125.0 rad/s^2, that is: **125*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 20860757 inc/s^2 for the 20-bit encoder and 651899 inc/s^2 for the 15-bit encoder.

SafetyPrfDeceleration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x300C.04	1 to 2^{32} *1	20860757*2	U32	inc/s^2	RW	-	ES

*1. Minimum value is the equivalent in inc/s^2 to 0.32 rad/s^2 and maximum value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s^2 to 125.0 rad/s^2, that is: **125*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 20860757 inc/s^2 for the 20-bit encoder and 651899 inc/s^2 for the 15-bit encoder.

SafetyPrfCommand

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3010.01	Desc	0	U16	-	RW	-	-

Command to enable/disable the safety profile. For further information see **Section 13-2-3 Reaction to the Faults**.

SafetyPrfCommand	Description
0	Safety profile not enabled
1	Safety profile enabled and configured with the same parameters of the Profile Position Mode
2	Safety profile enabled and configured with the parameters defined in **SafetyPrfConfiguration [300C.xx]**. The speed of the profile beginning and end are not valid.

Note It is advisable to choose 2 for SafetyPrfCommand to have more flexibility and less restrictions.

MainError

Drive main errors. The bit encoding is shown in **Section 13-2 Fault and Warning (Integrated Servo Motor)**.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3014.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

WarnRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3014.01	Desc	0	U32	-	RW	-	-

Main retentive warnings.

WarnDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3014.02	Desc	0	U32	-	RW	-	-

Main dynamic warnings.

FaultRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3014.03	Desc	0	U32	-	RW	Yes	-

Main retentive faults.

FaultDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3014.04	Desc	0	U32	-	RO	Yes	-

Main dynamic faults.

RealTimeModeError

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3018.00	Desc	0	U16	-	RO	-	-

Specific details of the Real time mode error.

LimitReachedError

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3019.00	Desc	0	U16	-	RO	-	-

Specific details of the Limit reached error.

ParamSoftError

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x301A.00	Desc	0	U16	-	RO	-	-

Specific details of the Parameters soft error.

MotionParamLimitedError

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x301B.00	Desc	0	U16	-	RO	-	-

Specific details of the Motion parameter limited error.

ThermalManageError

Specific details of the Thermal management error.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302C.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

ThermalManageWarnRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302C.01	Desc	0	U16	-	RO	-	-

Details of the retentive warnings of the Thermal management error.

ThermalManageWarnDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302C.02	Desc	0	U16	-	RO	-	-

Details of the dynamic warnings of the Thermal management error.

ThermalManageFaultRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302C.03	Desc	0	U16	-	RO	-	-

Details of the retentive faults of the Thermal management error.

ThermalManageFaultDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302C.04	Desc	0	U16	-	RO	-	-

Details of the dynamic faults of the Thermal management error.

ParamSeriousError

Specific details of the Parameters serious error.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302D.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

ParamSeriousWarnDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302D.02	Desc	0	U16	-	RO	-	-

Details of the dynamic warnings of the Parameters serious error.

ParamSeriousFaultRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302D.03	Desc	0	U16	-	RO	-	-

Details of the retentive faults of the Parameters serious error.

ParamSeriousFaultDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302D.04	Desc	0	U16	-	RO	-	-

Details of the dynamic faults of the Parameters serious error.

DigitalIoConfigError

Specific details of the Digital IO configuration error.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302E.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

DigitalIoConfigWarnRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302E.01	Desc	0	U16	-	RO	-	-

Details of the retentive warnings of the Digital IO configuration error.

DigitalIoConfigFaultRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302E.03	Desc	0	U16	-	RO	-	-

Details of the retentive faults of the Digital IO configuration error.

DigitalIoConfigFaultDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302E.04	Desc	0	U16	-	RO	-	-

Details of the dynamic faults of the Digital IO configuration error.

UserError

Specific details of the User fault error.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302F.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

UserFaultDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x302F.04	Desc	0	U16	-	RW	-	-

Details of the dynamic faults of the User fault error.

LogicVoltageError

Specific details of the Logic voltage error.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3030.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

LogicVoltageWarnRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3030.01	Desc	0	U16	-	RO	-	-

Details of the retentive warnings of the Logic voltage error.

LogicVoltageWarnDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3030.02	Desc	0	U16	-	RO	-	-

Details of the dynamic warnings of the Logic voltage error.

LogicVoltageFaultRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3030.03	Desc	0	U16	-	RO	-	-

Details of the retentive faults of the Logic voltage error.

LogicVoltageFaultDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3030.04	Desc	0	U16	-	RO	-	-

Details of the dynamic faults of the Logic voltage error.

FeedbackSensorError

Specific details of the FeedbackSensorError.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3031.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

FeedbackSensorWarnRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3031.01	Desc	0	U16	-	RO	-	-

Details of the retentive warnings of the FeedbackSensorError.

FeedbackSensorWarnDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3031.02	Desc	0	U16	-	RO	-	-

Details of the dynamic warnings of the FeedbackSensorError.

FeedbackSensorFaultRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3031.03	Desc	0	U16	-	RO	-	-

Details of the retentive faults of the FeedbackSensorError.

FeedbackSensorFaultDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3031.04	Desc	0	U16	-	RO	-	-

Details of the dynamic faults of the FeedbackSensorError.

STOPError

Specific details of /STOP management error.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3032.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

STOPFaultRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3032.03	Desc	0	U16	-	RO	-	-

Alarm register of the STOP status monitoring: retentive faults.

STOPFaultDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3032.04	Desc	0	U16	-	RO	-	-

Alarm register of the STOP status monitoring: dynamic faults.

InternalError

Specific details of Internal error.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x303F.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

InternalErrorFaultRetentive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x303F.03	Desc	0	U16	-	RO	-	-

Details of the retentive faults of the Internal error.

InternalErrorFaultDynamic

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x303F.04	Desc	0	U16	-	RO	-	-

Details of the dynamic faults of the Internal error.

ErrorCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x603F.00	-32768 to 32767	0	S16	-	RO	Yes	-

Captures the code of the last error that occurred in the drive.

EEC	Description
0x0000	Reset error or no error
0x2250	Power or motor short circuit error
0x2310	Power or motor over current error
0x2350	I2T limit reached error
0x3210	Over voltage power section error
0x3220	Under voltage power section error
0x4210	Thermal management error: Over temperature of logic section
	Thermal management error: Over temperature of motor
0x4310	Thermal management error: Over temperature of power section
0x5114	Logic voltage error: Logic voltage too low for brake
0x6320	Parameters serious error
	Digital IO configuration error
0x7200	Thermal management error: Power Temp Sensor hardware failure
	Thermal management error: Logic Temp Sensor hardware failure
	Thermal management error: Motor Temp Sensor hardware failure
0x7300	Unable to align due to Hardware problems - please contact your OMRON representative
0x8611	Following position error
0x8700	Sync controller error
0xFF00	Real time mode error
0xFF01	User fault error
0xFF04	/STOP = 0V with drive enabled error
0xFF05	Last command requested failed

10-3-10 CiA402 State Machine

Controlword

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6040.00	Desc	-	U16	-	RW	Yes	-

Parameter to manage the CiA402StateMachine and the specific commands offered by the operating modes. For further details see what is reported in **Section 5-5-1 CiA402 State Machine**. The bits are divided in this way:

- Bit 0 - 3 and 7: bits to command every Transition of the CiA402StateMachine.
- Bit 8: bits to manage the command of Halt.
- Bit 4 - 6: bits to request specific commands that can vary depending on the value of **ModesOfOperationDisplay [6061.00]**.
- Bit 9 - 12: bits not used.
- Bit 13 - 15: bits for the Gear Mode operation.

Statusword

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6041.00	Desc	-	U16	-	RO	Yes	-

Status of the CiA402StateMachine and of the specific commands of the operative modes. For further details see what is reported in **Section 5-5-1 CiA402 State Machine**. In the following chart you can find the encoding of the status of the Statusword . The bits shown with 'x' are not important to determine the status.

Statusword	Name	Description
xxxx xxxx x0xx 0000	Not ready to switch on	Initializing
xxxx xxxx x1xx 0000	Switch on disabled	Idle
xxxx xxxx x01x 0001	Ready to switch on	Preparation to enabling
xxxx xxxx x01x 0011	Switched on	Drive enabled without commanding the motor motion
xxxx xxxx x01x 0111	Operation enable	Drive enabled and possibility to command the motor motion
xxxx xxxx x00x 0111	Quick stop active	Running a command of Quick stop
xxxx xxxx x0xx 1111	Fault reaction active	Reaction to a fault situation. The drive can be enabled or not, depending on the situation before the error occurred
xxxx xxxx x0xx 1000	Fault	Fault state, finished reaction

QuickStopConfiguration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x605A.00	Desc	6	S16	-	RW	-	-

Action run when a command of Quick stop is run.

QuickStopConfigura-tion	Action
-6	The motor is stopped with deceleration equal to **QuickStopDeceleration [6085.00]** and, at the end of the braking ramp, the velocity integral part (**ResetSpeedIntegrator [60F9.22]**) reset is executed.
-5	The motor is stopped with deceleration equal to **ProfileDeceleration [6084.00]** and, at the end of the braking ramp, the velocity integral part (**ResetSpeedIntegrator [60F9.22]**) reset is executed.
-1	The motor is stopped with maximum deceleration by resetting to a zero Requested-Speed and later the drive enters the status Switch On Disabled
1	The motor is stopped with deceleration equal to **ProfileDeceleration [6084.00]** and later the drive enters the status Switch On Disabled

QuickStopConfiguration	Action
2	The motor is stopped with deceleration equal to **QuickStopDeceleration [6085.00]** and later the drive enters the status Switch On Disabled
5	The motor is stopped with deceleration equal to **ProfileDeceleration [6084.00]** and the drive remains in the status Quick Stop Active
6	The motor is stopped with deceleration equal to **QuickStopDeceleration [6085.00]** and the drive remains in the status Quick Stop Active

Note If **FirmwareRevision [5FFD.07]** is lower than 5, the code -1 is substituted by the code 0. If **FirmwareRevision [5FFD.07]** is lower than 5, it is not advisable to use the code 0, since it is not available in the next firmware versions.

SwitchedOnOptionCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x42E0.00	Desc	0	S16	-	RW	-	ES

Value that determines the CiA402 state machine behavior when it’s in the Switched On state (see **Section 5-5-1 CiA402 State Machine**).

SwitchedOnOptionCode	Action
0	Torque not present in the motor if the drive is in the Switched On state
1	Torque present in the motor if the drive is in the Switched On state

10-3-11 System Manager

System Manager command is used internally by the software tool to execute different operations.
Once the requested operation is executed, the value returns to zero.
If one error occur during the execution, it is reported in the System Manager error object.

SysMngCommand

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF7.01	Desc	0	U16	-	RW	-	-

Command of the System Manager requested to the drive.

SysMngCommand	Description
0	No command
100	End tuning command
600	End download parameters file
601	End export parameters file
620	End digital I/O setup
1001	Tuning: extended inertia estimator (requires the writing of **ResetWatchdogTimeout [3500.00]**)
1002	Tuning: inertia estimator (requires the writing of **ResetWatchdogTimeout [3500.00]**)
1003	Tuning: RL estimator (requires the writing of **ResetWatchdogTimeout [3500.00]**)
1010	Function Generator current D (requires the writing of **ResetWatchdogTimeout [3500.00]**)
1015	Function Generator current Q (requires the writing of **ResetWatchdogTimeout [3500.00]**)
1020	Function Generator velocity (requires the writing of **ResetWatchdogTimeout [3500.00]**)

SysMngCommand	Description
1030	Function Generator position (requires the writing of **ResetWatchdogTimeout [3500.00]**)
1040	Function Generator profile velocity (requires the writing of **ResetWatchdogTimeout [3500.00]**)
1050	Function Generator profile position (requires the writing of **ResetWatchdogTimeout [3500.00]**)
1101	Set all loops, tuning and estimated parameters at default
1102	Parameter recalculation of all loops
1103	Parameter recalculation of motion loop
1110	Parameter recalculation of **CurrentLoop [60F6.xx]**
1120	Parameter recalculation of speed loop
1130	Parameter recalculation of position loop
1140	Parameter recalculation of flux weakening loop
2001	Permanent memory: save all parameters
2200	Permanent memory: restore to default of all parameters (permanent)
2201	Reset to default of all parameters (temporary)
2250	Permanent memory: delete motor ad sensor data
2300	Permanent memory: reload value of all parameters
2301	Permanent memory: reload value of loops parameters and tuning configuration
5000	Hard firmware reset
5001	Soft firmware reset
5100	Request download firmware
5301	Phasing of feedback position sensor with index pulse pre-phased
5310	Test phasing of feedback position sensor
5400	Update ESI eeprom
6000	Downloading parameters file
6001	Export parameters file
6200	Setup digital I/O
7200	Start Analog input 0 offset calibration
7201	Start Analog input 0 gain calibration

SysMngStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF7.02	Desc	-	U16	-	RO	-	-

Status of the System Manager.

SysMngStatus	Description
5400	Comparing of the EEPROM data with the expected ones
5401	EEPROM data writing in progress
5402	EEPROM data verification in progress
5403	Procedure closing phase
5404	The procedure is finished with an error
5405	The procedure is correctly finished (EEPROM updated with new values)
5406	The procedure is correctly finished (EEPROM verified, no data updated)

SysMngError

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF7.03	Desc	0	U16	-	RO	-	-

Error of the last command of the System Manager, requested to the drive.

SysMngError	Message	Solution
0	No error	-
1	Unrecognized command	Check that the value that's written in the **SysMng-Command [5FF7.01]** parameter is present in the table that describes it. If the value is present and the error remains, update the firmware to the latest available version.
2	Test function is active	Please contact your OMRON representative
3	Test enabling key is required	The command cannot be executed by the user
4	Enabling key is required	The command cannot be executed by the user
5	Safety condition not satisfied: drive is enabled	Disable the drive before to give the command
6	Generic time out	The command has taken more than the expected time. Repeat the command and check that's correctly executed
7	No active command to stop	There are not active commands to stop. it requires the command interruption only if it is in progress
9	Safety condition not satisfied: one or more digital outputs are active	Disable the digital outputs and try again
10	Safety condition not satisfied: one or more digital outputs are not configured as Generic Output	Configure all the digital outputs as Generic Output (I/O X - Out X)
11	Safety condition not satisfied: capture units are active	Stop the capture peripherals
12	Generic error during upload/download	Check the connection status and repeat the command
13	Dynamic memory is busy	Stop the oscilloscope and try again
1000	User has stopped the command	It has been required the interruption of the last command in progress. If the end of the command is not desired, check that the drive is not commanded by other master devices
1001	Command watchdog is expired	Check if the connection is active and the **Reset-WatchdogTimeout [3500.00]** parameter writing timing requiring
1002	Switched on state has been required	If the Transition of the CiA402StateMachine is not desired, check that the drive is not commanded by other master devices (see **Section 5-5-1 CiA402 State Machine**)
1003	Position limits are reached	Disengage the limit switch and repeat the command. Be sure that the required mechanical movement doesn't engage the limit switch
1004	Quick stop has been required	If the Transition of the CiA402StateMachine is not desired, check that the drive is not commanded by other master devices (see **Section 5-5-1 CiA402 State Machine**)
1005	Halt has been required	If the Transition of the CiA402StateMachine is not desired, check that the drive is not commanded by other master devices (see **Section 5-5-1 CiA402 State Machine**)

SysMngError	Message	Solution
1006	Disable has been required	If the Transition of the CiA402StateMachine is not desired, check that the drive is not commanded by other master devices (see **Section 5-5-1 CiA402 State Machine**)
1007	Drive is in fault state	Verify the cause that has generated the fault and, once it's solved, give a Reset command
1008	Unknown transition has been required	If the Transition of the CiA402StateMachine is not desired, check that the drive is not commanded by other master devices (see **Section 5-5-1 CiA402 State Machine**)
1009	Estimator torque is out of range	**InertiaEstimatorTorque [3503.02]** must be lower than ActualTorqueLimit
1010	Estimator speed is out of range	**InertiaEstimatorVelocity [3503.03]** must be lower than ActualTorqueLimit
1011	Motor shaft is blocked	The applied load blocks the motor movement; check the mechanical
1012	Servo mode is not active	Internal error, repeat the command or reset the drive (Hard reset)
1013	Tuning mode is not achievable	Internal error, repeat the command or reset the drive (Hard reset). Check if the drive is not piloted by other master devices
1014	Motion is enable	The drive is in Operation enable; take the drive to the Switched On status
1015	Motor and feedback sensor are not aligned	With incremental encoder, turn the motor for at least a half mechanical revolution
1016	Estimated inertia is lower than motor inertia	Load with low inertia moment; try again to confirm the estimation
1017	Estimated inertia is too high: bandwidth is limited	The inertia moment of the mechanical load doesn't allow to obtain a high **VelocityLoopEstimatedBandwidth [3501.02]**; try again to confirm the estimation
1018	Estimated inertia limit reached	Inertia moment too large to be estimated. Retry to confirm the estimation; if the estimation is reliable, verify the good functioning of the mechanical. If the performances are not satisfactory, it's necessary to increase the motor size
1019	Motor parameters are not correctly set	Check the warning
1020	Feedback position sensor is not set	Check the warning
1021	Estimator security position limit reached	Retry to confirm the estimation; if the estimation is reliable, verify the good functioning of the mechanical. Try to execute a not extended estimation of the inertia moment; (command 1002 in the place of command 1001 of the **SysMngCommand [5FF7.01]**). If the problem persists the estimator cannot be used
1022	Estimator torque greater than nominal current	Reduce **InertiaEstimatorTorque [3503.02]**
1023	Estimator speed is too low: **InertiaEstimatorVelocity [3503.03]** is lower than 15rad/s	Increase the value of **InertiaEstimatorVelocity [3503.03]**
1024	Requested estimator speed is not reached	Retry the estimation; Try to execute a not extended estimation of the inertia moment (command 1002 in the place of command 1001 of the **SysMngCommand [5FF7.01]**)
1025	I2T warning threshold reached	Increase **I2TWarningThreshold [3405.04]**
1026	DC bus voltage (+HV) is too low	Increase the supply voltage **DCBusVoltage [3310.01]** and retry

SysMngError	Message	Solution
2000	Permanent memory address is out of range	Restore the permanent memory through the command 2200 (**SysMngCommand [5FF7.01]**). Reset the drive through the command 5000
2001	Permanent memory data length is not valid	Restore the permanent memory through the command 2200 (**SysMngCommand [5FF7.01]**). Reset the drive through the command 5000
2002	Message: “Dati non salvabili perché ADC di corrente non sono calibrati”	Please contact your OMRON representative
2003	Message: “Dati non salvabili perché ADC di tensioni non sono calibrati”	Please contact your OMRON representative
2004	Last permanent memory writing was not completed correctly. Permanent memory data may be corrupted	Restore the permanent memory through the command 2200 (**SysMngCommand [5FF7.01]**). Reset the drive through the command 5000
2005	Message: “Dati non salvabili perche' la calibrazione dell'Analog Input 0 non e' completa”	Completely execute the analog input calibration
2100	No error for file system	-
2101	File system ID not exist	Restore the permanent memory through the command 2200 (**SysMngCommand [5FF7.01]**). Reset the drive through the command 5000. If the problem persists, please contact your OMRON representative
2102	File system ID not present in permanent memory	
2103	File system data length mismatch	
2104	File system CRC is invalid	
2105	File system command is refused by I2C driver	
2106	File system dynamic memory is busy	
2107	File system dimension limit reached	
2108	File system ID is zero	
2109	File system data length is zero	
2110	File system operation not exist	
2200	No error for I2C driver	
2201	I2C driver is busy	
2202	I2C time out in reading	
2203	I2C time out in writing	
2204	I2C driver bus error	
2205	I2C driver has detected an odd permanent memory address	
2300	Hyperface internal memory: no error	-
2301	Hyperface internal memory: driver is busy	Turn the drive off and then on again. If the problem persists, please contact your OMRON representative
2302	Hyperface internal memory: operation not exist	Turn the drive off and then on again. If the problem persists, please contact your OMRON representative
2303	Hyperface internal memory: data size is too large	Turn the drive off and then on again. If the problem persists, please contact your OMRON representative
2304	Hyperface internal memory: for details, see Feedback sensor error	Check Feedback sensor error from **Section 13-2-5 Errors Description**
2305	Hyperface internal memory: dynamic memory is busy	Stop the oscilloscope and try again. Turn the drive off and then on again. If the problem persists, please contact your OMRON representative
2306	Hyperface internal memory: CRC is invalid	Check the wirings of the feedback sensor and that the **FeedbackSensorTemperature [3300.04]** is correctly read. Turn the drive off and then on again. Repeat the phasing and the saving

SysMngError	Message	Solution
5000	Module ID is not present in ID table	Turn the drive off and then on again. If the problem persists, please contact your OMRON representative
5101	Download: file corrupted	See the solution in **FirmwareStatus [5FFE.01]** (value 151)
5103	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 153)
5104	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 154)
5105	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 155)
5106	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 156)
5107	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 157)
5108	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 158)
5111	Download: file corrupted	See the solution in **FirmwareStatus [5FFE.01]** (value 161)
5112	Download: file corrupted	See the solution in **FirmwareStatus [5FFE.01]** (value 162)
5113	Download: file corrupted	See the solution in **FirmwareStatus [5FFE.01]** (value 163)
5114	Download: file corrupted	See the solution in **FirmwareStatus [5FFE.01]** (value 164)
5115	Download: file corrupted	See the solution in **FirmwareStatus [5FFE.01]** (value 165)
5116	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 166)
5117	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 167)
5118	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 168)
5119	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 169)
5120	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 170)
5121	Download: file requires unsupported features	See the solution in **FirmwareStatus [5FFE.01]** (value 171)
5122	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 172)
5123	Download: file corrupted	See the solution in **FirmwareStatus [5FFE.01]** (value 173)
5124	Download: file corrupted	See the solution in **FirmwareStatus [5FFE.01]** (value 174)
5125	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 175)
5150	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 200)
5151	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 201)
5152	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 202)
5153	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 203)

SysMngError	Message	Solution
5154	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 204)
5160	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 210)
5161	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 211)
5162	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 212)
5163	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 213)
5164	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 214)
5170	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 220)
5171	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 221)
5180	Download: memory error	See the solution in **FirmwareStatus [5FFE.01]** (value 230)
5300	Feedback position sensor is not compatible with command required	It’s not necessary to execute the required command.
5301	Feedback position sensor is not phased: angle error is out of range	Reboot the drive
5302	Feedback position error is not phased: index pulse not found	Check the wirings of the feedback sensor and that the **FeedbackSensorTemperature [3300.04]** is correctly read
5400	Update ESI eeprom: the EtherCAT master does not allow access to the ESI eeprom	Check that the master is connected to the EtherCAT port, repeat the procedure according to the operation sequence. If the problem persists, please contact your OMRON representative
5401	Update ESI eeprom: procedure internal error	Turn the drive off and then on again, repeat the procedure according to the operation sequence. If the problem persists, please contact your OMRON representative
5402	Update ESI eeprom: procedure in timeout	Turn the drive off and then on again, repeat the procedure according to the operation sequence. If the problem persists, please contact your OMRON representative
5403	Update ESI eeprom: error reading data	Turn the drive off and then on again, repeat the procedure according to the operation sequence. If the problem persists, please contact your OMRON representative
5404	Update ESI eeprom: error writing data	Turn the drive off and then on again, repeat the procedure according to the operation sequence. If the problem persists, please contact your OMRON representative
6200	Impossible to change the IO configuration because an IO overload warning is active (Digital output overtemperature or overload)	Reset the warning and try again
7100	Message: “VGATE not present (missing /STOP or enabling software)”	Please contact your OMRON representative

SysMngEnForcing

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF7.06	0 ÷ 1	0	U16	-	RW	-	-

It enables to force the System manager safety conditions, for the next command of the System Manager requested to the drive (0 = disabled forcing, 1 = enabled forcing).

SysMngMicroStepCurrent

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x5FF7.0A	≤ Peak Current	Nominal-Current	U16	100 = 1 A	RW	-	-

Motor current used for the System Manager commands that use the microstep mode.

10-3-12 Capture Peripherals

CaptureParam_A

Parameters of capture peripheral (A).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4000.00	10	10	U8	-	CST	-	-

Number of parameters in this group.

CaptureUnitCommand_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4000.01	0 ÷ 3	0	U16	-	RW	-	-

Commands for the capture peripheral A.

CaptureUnit-Command	Description
0	Stop Disabling the capture peripheral
1	Single Run Enabling the single capture. When the selected trigger event takes place (**CaptureTriggerInput_A [4000.02]**), the selected values of the quantities to capture (**CaptureSource0_A [4003.01], CaptureSource1_A [4003.02], CaptureSource2_A [4003.03]**) are copied in the parameters **CapturedValue0_A [4004.01], CapturedValue1_A [4004.02], CapturedValue2_A [4004.03]**. After the capture, **CaptureUnitState_A [4001.01]** goes from Single armed to Single stop. Any further trigger events will be ignored by the capture peripheral
2	Repetitive Run It enables the repeating capture. When the selected trigger event takes place (**CaptureTriggerInput_A [4000.02]**), the selected values of the quantities to capture (**CaptureSource0_A [4003.01], CaptureSource1_A [4003.02], CaptureSource2_A [4003.03]**) are copied in the parameters **CapturedValue0_A [4004.01], CapturedValue1_A [4004.02], CapturedValue2_A [4004.03]**. After the capture, **CaptureUnitState_A [4001.01]** goes from Repeated armed to Repeated captured. A further trigger event will provoke a new capture by overwriting the capture values of the event. When at least one of the parameters of the results are read, **CaptureUnitState_A [4001.01]** goes to Repeated armed
3	Capture now Enable the single capture and force the trigger. This mode is useful in debug phase to check that the configurations of the capture peripheral are correct, even if the physical source of the trigger is not available. The behavior of the capture peripheral, in this case, is equal to that of the mode Single Run, with the only difference that the trigger event is simulated

CaptureTriggerInput_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4000.02	Desc	0	U16	-	RW	-	ES

Trigger signal provoking the capture of the peripheral A.

CaptureTriggerInput	Description
0	Digital input In9
1	Digital input In8
3	Index pulse of the feedback encoder
4	Auxiliary encoder index pulse

CaptureTriggerEdge_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4000.03	0-2	0	U16	-	RW	-	ES

Trigger edge provoking the capture of the peripheral A.

CaptureTriggerEdge	Description
0	Falling edge
1	Rising edge
2	Both the edges

CaptureInhibitTime_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4000.04	0-65500	0	U16	ms	RW	-	ES

Inhibition time of the capture for the peripheral A, after the trigger event, to avoid repeated captures, in case of not clean triggers. When the trigger event takes place, the peripheral carries out the capture and later it ignores the trigger signal for the specified time. In case of capture on both edges (**CaptureTriggerEdge_A [4000.03]** = 2), CaptureInhibitTime_A is applied “for edge”. In case of repetitive capture (**CaptureUnitCommand_A [4000.01]** = 2), when a capture event happens, the capture is inhibited for the time that has been set in this parameter in relation to the specific capture edge. The other capture edge is not inhibited until it will not happen at least one time.

CaptureValidationFilterMode_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4000.0A	0-1	0	U16	-	RW	-	ES

Filtering mode of the first quantity to capture for the peripheral A (0=symmetric, 1=asymmetric). In the symmetric mode the filtering value is expressed by the parameter **CaptureActiveSlopeValidationFilter_A [4000.08]** and it is the same for the edge carrying out the capture and for the restore edge. In the asymmetric mode, the filtering value applied to the capture edge is expressed by the parameter **CaptureActiveSlopeValidationFilter_A [4000.08]**, while the filtering value applied to the restore edge is expressed by the parameter **CaptureRestoreSlopeValidationFilter_A [4000.09]**.

CaptureRestoreSlopeValidationFilter_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4000.09	-	0	U32	Desc	RW	-	ES

Enabling the filter on the value of the first quantity of the peripheral A for the capture edge not enabled (restoring). This parameter is valid only if **CaptureValidationFilterMode_A [4000.0A]** is equal to 1 (asymmetric mode). When different, it is ignored. The value shows the filtering entity and the unit of measurement is the same of the first quantity of the peripheral A.

CaptureActiveSlopeValidationFilter_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4000.08	-	0	U32	Desc	RW	-	ES

Enabling the filter on the value of the first quantity of the peripheral A for the capture edge. If **CaptureValidationFilterMode_A [4000.0A]** is equal to 0 (symmetric mode), the filtering expressed in this parameter is applied on the capture edge and on the restore edge, on the contrary the filtering expressed by this parameter is applied only to the capture edge; the filtering set by **CaptureRestoreSlopeValidationFilter_A [4000.09]** is applied to the restore edge.

CaptureState_A

Status of the capture peripheral (A).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4001.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

CaptureUnitState_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4001.01	-	-	U16	-	RO	Yes	-

Status of the capture peripheral A.

CaptureUnitState	Description
0	*Capture stop* Capture peripheral in stop. The trigger source is ignored
1	*Single capture armed* The capture peripheral is waiting for the trigger event to carry out the capture of type Single Run. When the trigger event takes place, the requested data will be stored and the capture peripheral will enter the *Single stop* state
2	*Repetitive capture armed* The capture peripheral is waiting for the trigger event to carry out a capture of repetitive type. When the trigger event takes place, the requested data will be stored and the capture peripheral will enter the *Repetitive capture done* state
3	*Single stop* The capture peripheral captured the selected data after the trigger event. After the captured data have been read, the peripheral can be disabled. The trigger source is ignored
4	*Repetitive capture done* The peripheral captured the selected data after the trigger event, every new trigger event provokes a new capture of the selected data and the overwriting of the values. This possibility is not notified in any way by the drive. When at least one of the results of the capture is read, the peripheral enters the status *Repetitive capture armed*
19	*Single capture done on falling edge* The capture peripheral has captured the selected data after the trigger event. After the captured data have been read, the peripheral can be disabled. The trigger source is ignored
35	*Single capture done on rising edge* The capture peripheral has captured the selected data after the trigger event. After the captured data have been read, the peripheral can be disabled. The trigger source is ignored
51	*Single capture done on both edges* The capture peripheral has captured the selected data after the trigger event. After the captured data have been read, the peripheral can be disabled. The trigger source is ignored

CaptureUnitState	Description
20	*Repetitive capture done on falling edge* The peripheral captured the selected data after the trigger event, every new trigger event provokes a new capture of the selected data and the overwriting of the previous values. This possibility is not notified in any way by the drive. When at least one of the results of the capture is read, the peripheral enters the status *Repetitive capture armed*
36	*Repetitive capture done on rising edge* The peripheral captured the selected data after the trigger event, every new trigger event provokes a new capture of the selected data and the overwriting of the previous values. This possibility is not notified in any way by the drive. When at least one of the results of the capture is read, the peripheral enters the status *Repetitive capture armed*

NumberCapturesRecorded_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4001.02	-	-	U16	-	RO	Yes	-

Counter of the capture number of the capture peripheral A.

NumberCapturesRecordedRising_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4001.03	-	-	U16	-	RO	Yes	-

Counter of the events that have been captured on the rising edge of the capture peripheral A.

NumberCapturesRecordedFalling_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4001.04	-	-	U16	-	RO	Yes	-

Counter of the events that have been captured on the falling edge of the capture peripheral A.

CapturedValuesRising_A

Captured value on the rising edge of the capture peripheral (A).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4007.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValueRising0_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4007.01	-	-	S32	-	RO	Yes	ES

32 bit value of the first variable of the capture peripheral A, captured on the rising edge.

CapturedValueRising1_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4007.02	-	-	S32	-	RO	Yes	ES

32 bit value of the second variable of the capture peripheral A, captured on the rising edge.

CapturedValueRising2_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4007.03	-	-	S32	-	RO	Yes	ES

32 bit value of the third variable of the capture peripheral A, captured on the rising edge.

CapturedValuesFalling_A

Captured value on the falling edge of the capture peripheral (A).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4008.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValueFalling0_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4008.01	-	-	S32	-	RO	Yes	ES

32 bit value of the first variable of the capture peripheral A, captured on the falling edge.

CapturedValueFalling1_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4008.02	-	-	S32	-	RO	Yes	ES

32 bit value of the second variable of the capture peripheral A, captured on the falling edge.

CapturedValueFalling2_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4008.03	-	-	S32	-	RO	Yes	ES

32 bit value of the third variable of the capture peripheral A, captured on the falling edge.

CaptureSources_A

Selection of the quantity to capture with the capture peripheral (A).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4003.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CaptureSource0_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4003.01	Desc	2	U16	-	RW	-	ES

Code of the first quantity to capture for the peripheral A.

CaptureSourceX	Description
0	No quantity
1	AuxiliaryEncoderPosition
2	PositionActualValue
4	PositionFollowingError

CaptureSource1_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4003.02	Desc	1	U16	-	RW	-	ES

Code of the second quantity to capture for the peripheral A. See **CaptureSource0_A [4003.01]** description for the available codes.

CaptureSource2_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4003.03	Desc	0	U16	-	RW	-	ES

Code of the third quantity to capture for the peripheral A. See **CaptureSource0_A [4003.01]** description for the available codes.

CapturedValues_A

Capture peripheral (A) captured values, saved in memory locations of 1 long size.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4004.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValue0_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4004.01	-	-	U32	-	RO	Yes	-

Captured value of the first quantity for the peripheral A (4 bytes).

CapturedValue1_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4004.02	-	-	U32	-	RO	Yes	-

Captured value of the second quantity for the peripheral A (4 bytes).

CapturedValue2_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4004.03	-	-	U32	-	RO	Yes	-

Captured value of the third quantity for the peripheral A (4 bytes).

CapturedValues_Word_A

Capture peripheral (A) captured values, saved in memory locations of 1 Word size.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4005.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CptVal0_Word_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4005.01	-	-	S16	-	RO	Yes	-

Captured value of the first quantity for the peripheral A (2 bytes).

CptVal1_Word_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4005.02	-	-	S16	-	RO	Yes	-

Captured value of the second quantity for the peripheral A (2 bytes).

CptVal2_Word_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4005.03	-	-	S16	-	RO	Yes	-

Captured value of the third quantity for the peripheral A (2 bytes).

CapturedValues_Byte_A

Capture peripheral (A) captured values, saved in memory locations of 1 Byte size.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4006.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CptVal0_Byte_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4006.01	-	-	S8	-	RO	Yes	-

Captured value of the first quantity for the peripheral A (1 byte).

CptVal1_Byte_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4006.02	-	-	S8	-	RO	Yes	-

Captured value of the second quantity for the peripheral A (1 byte).

CptVal2_Byte_A

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4006.03	-	-	S8	-	RO	Yes	-

Captured value of the third quantity for the peripheral A (1 byte).

CaptureState_B

Status of the capture peripheral (B).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4011.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

CaptureUnitState_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4011.01	-	0	U16	-	RO	Yes	-

Status of the capture peripheral B.

NumberCapturesRecorded_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4011.02	-	-	U16	-	RO	Yes	-

Counter of the capture number of the capture peripheral B.

NumberCapturesRecordedRising_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4011.03	-	-	U16	-	RO	Yes	-

Counter of the events that have been captured on the rising edge of the capture peripheral B.

NumberCapturesRecordedFalling_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4011.04	-	-	U16	-	RO	Yes	-

Counter of the events that have been captured on the falling edge of the capture peripheral B.

CaptureParam_B

Parameters of capture peripheral (B).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4010.00	10	10	U8	-	CST	-	-

Number of parameters in this group.

CaptureUnitCommand_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4010.01	0 ÷ 3	0	U16	-	RW	-	-

Commands for the capture peripheral B.

CaptureTriggerInput_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4010.02	Desc	0	U16	-	RW	-	ES

Trigger signal provoking the capture for the peripheral B.

CaptureTriggerEdge_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4010.03	0-2	0	U16	-	RW	-	ES

Trigger edge provoking the capture for the peripheral B.

CaptureInhibitTime_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4010.04	0-65500	0	U16	ms	RW	-	ES

Inhibition time of the capture for the peripheral B, after the trigger event, to avoid repeated captures, in case of not clean triggers. When the trigger event takes place, the peripheral carries out the capture and later it ignores the trigger signal for the specified time. In case of capture on both edges (**CaptureTriggerEdge_B [4010.03]** = 2), CaptureInhibitTime_B is applied “for edge”. In case of repetitive capture (**CaptureUnitCommand_B [4010.01]** = 2), when a capture event happens, the capture is inhibited for the time that has been set in this parameter in relation to the specific capture edge. The other capture edge is not inhibited until it will not happen at least one time.

CaptureValidationFilterMode_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4010.0A	0-1	0	U16	-	RW	-	ES

Filtering mode of the first quantity to capture for the peripheral B (0=symmetric, 1=asymmetric). In the symmetric mode the filtering value is expressed by the parameter **CaptureActiveSlopeValidationFilter_B [4010.08]** and it is the same for the edge carrying out the capture and for the restore edge. In the asymmetric mode, the filtering value applied to the capture edge is expressed by the parameter **CaptureActiveSlopeValidationFilter_B [4010.08]**, while the filtering value applied to the restore edge is expressed by the parameter **CaptureRestoreSlopeValidationFilter_B [4010.09]**.

CaptureRestoreSlopeValidationFilter_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4010.09	-	0	U32	Desc	RW	-	ES

Enabling the filter on the value of the first quantity of the peripheral B for the capture edge not enabled (restoring). This parameter is valid only if CaptureValidationFilterMode_B is equal to 1 (asymmetric mode). When different, it is ignored. The value shows the filtering entity and the unit of measurement is the same of the first quantity of the peripheral B.

CaptureActiveSlopeValidationFilter_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4010.08	-	0	U32	Desc	RW	-	ES

Enabling the filter on the value of the first quantity of the peripheral B for the capture edge. If CaptureValidationFilterMode_B is equal to 0 (symmetric mode), the filtering expressed in this parameter is applied on the capture edge and on the restore edge, on the contrary the filtering expressed by this parameter is applied only to the capture edge; the filtering set by **CaptureRestoreSlopeValidationFilter_B [4010.09]** is applied to the restore edge.

CapturedValuesRising_B

Captured value on the rising edge of the capture peripheral (B).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4017.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValueRising0_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4017.01	-	-	S32	-	RO	Yes	ES

32 bit value of the variable 0 that have been captured on the rising edge of the capture peripheral B.

CapturedValueRising1_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4017.02	-	-	S32	-	RO	Yes	ES

32 bit value of the variable 1 that have been captured on the rising edge of the capture peripheral B.

CapturedValueRising2_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4017.03	-	-	S32	-	RO	Yes	ES

32 bit value of the variable 2 that have been captured on the rising edge of the capture peripheral B.

CapturedValuesFalling_B

Captured value on the falling edge of the capture peripheral (B).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4018.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValueFalling0_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4018.01	-	-	S32	-	RO	Yes	ES

32 bit value of the variable 0 that have been captured on the falling edge of the capture peripheral B.

CapturedValueFalling1_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4018.02	-	-	S32	-	RO	Yes	ES

32 bit value of the variable 1 that have been captured on the falling edge of the capture peripheral B.

CapturedValueFalling2_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4018.03	-	-	S32	-	RO	Yes	ES

32 bit value of the variable 3 that have been captured on the falling edge of the capture peripheral B.

CaptureSources_B

Selection of the quantity to capture with the capture peripheral (B).

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4013.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CaptureSource0_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4013.01	Desc	2	U16	-	RW	-	ES

Code of the first quantity to capture for the peripheral B.

CaptureSourceX	Description
0	No quantity
1	AuxiliaryEncoderPosition
2	PositionActualValue
4	PositionFollowingError

CaptureSource1_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4013.02	Desc	1	U16	-	RW	-	ES

Code of the second quantity to capture for the peripheral B. See **CaptureSource0_B [4013.01]** description for the available codes.

CaptureSource2_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4013.03	Desc	0	U16	-	RW	-	ES

Code of the third quantity to capture for the peripheral B. See **CaptureSource0_B [4013.01]** description for the available codes.

CapturedValues_B

Capture peripheral (B) captured values, saved in memory locations of 1 long size.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4014.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValue0_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4014.01	-	-	U32	-	RO	Yes	-

Captured value of the first quantity for the peripheral B (4 bytes).

CapturedValue1_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4014.02	-	-	U32	-	RO	Yes	-

Captured value of the second quantity for the peripheral B (4 bytes).

CapturedValue2_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4014.03	-	-	U32	-	RO	Yes	-

Captured value of the third quantity for the peripheral B (4 bytes).

CapturedValues_Word_B

Capture peripheral (B) captured values, saved in memory locations of 1 Word size.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4015.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CptVal0_Word_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4015.01	-	-	S16	-	RO	Yes	-

Captured value of the first quantity for the peripheral B (2 bytes).

CptVal1_Word_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4015.02	-	-	S16	-	RO	Yes	-

Captured value of the second quantity for the peripheral B (2 bytes).

CptVal2_Word_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4015.03	-	-	S16	-	RO	Yes	-

Captured value of the third quantity for the peripheral B (2 bytes).

CapturedValues_Byte_B

Capture peripheral (B) captured values, saved in memory locations of 1 Byte size.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4016.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CptVal0_Byte_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4016.01	-	-	S8	-	RO	Yes	-

Captured value of the first quantity for the peripheral B (1 byte).

CptVal1_Byte_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4016.02	-	-	S8	-	RO	Yes	-

Captured value of the second quantity for the peripheral B (1 byte).

CptVal2_Byte_B

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4016.03	-	-	S8	-	RO	Yes	-

Captured value of the third quantity for the peripheral B (1 byte).

CaptureInterfaceMode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x402F.00	-	-	U16	-	RW	Yes	-

Switch to select the interface to be used to manage the capture peripherals A and B (0 = custom mode, 1 = Cia402 mode).

TouchProbeFunction

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60B8.00	-	-	U16	-	RW	Yes	-

Settings of the capture peripherals A and B.

Bit	Description
0	0: Capture peripheral A disable 1: Capture peripheral A enable
1	0: Single capture 1: Repetitive capture
2	0: Trigger on digital input A 1: Trigger on encoder zero mark (feedback encoder Index pulse) or **PositionActual-Value [6064.00]**

Bit	Description
3	Reserved
4	0: Capture on rising edge of the capture peripheral A disable 1: Capture on rising edge of the capture peripheral A enable
5	0: Capture on falling edge of the capture peripheral A disable 1: Capture on falling edge of the capture peripheral A enable
6, 7	At disposal for the user (e.g. for test)
8	0: Capture peripheral B disable 1: Capture peripheral B enable
9	0: Single capture 1: Repetitive capture
10	0: Trigger on digital input B 1: Trigger on encoder zero mark (feedback encoder Index pulse) or **PositionActual-Value [6064.00]**
11	Reserved
12	0: Capture on rising edge of the capture peripheral B disable 1: Capture on rising edge of the capture peripheral B enable
13	0: Capture on falling edge of the capture peripheral B disable 1: Capture on falling edge of the capture peripheral B enable
14, 15	At disposal for the user (e.g. for test)

TouchProbeStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60B9.00	-	-	U16	-	RO	Yes	-

Status of the capture peripherals A and B.

Bit	Description
0	0: Capture peripheral A disabled 1: Capture peripheral A enabled
1	0: No value captured on rising edge of the capture peripheral A 1: Value captured on falling edge of the capture peripheral A
2	0: No value captured on falling edge of the capture peripheral A 1: Value captured on rising edge of the capture peripheral A
3-5	Reserved
6, 7	At disposal for the user (e.g. for test)
8	0: Capture peripheral B disabled 1: Capture peripheral B enabled
9	0: No value captured on rising edge of the capture peripheral B 1: Value captured on falling edge of the capture peripheral B
10	0: No value captured on falling edge of the capture peripheral B 1: Value captured on rising edge of the capture peripheral B
11-13	Reserved
14, 15	At disposal for the user (e.g. for test)

TouchProbeSource

Selection of the capture source of the capture peripheral.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60D0.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

TouchProbe1Source

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60D0.01	-	-	S16	-	RW	Yes	-

Capture source of the capture peripheral A.

Value	Trigger event
-1	Auxiliary encoder index
1	Touch probe input 1 (digital input In8)
2	Touch probe input 2 (digital input In9)
5	Feedback encoder index

TouchProbe2Source

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60D0.02	-	-	S16	-	RW	Yes	-

Capture source of the capture peripheral B. The values that this parameter can take are reported in the above **TouchProbe1Source [60D0.01]** parameter.

TouchProbePosition1PosValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60BA.00	-	-	S32	-	RO	Yes	-

32 bit value captured on the rising edge of the capture peripheral A.

TouchProbePosition1NegValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60BB.00	-	-	S32	-	RO	Yes	-

32 bit value captured on the falling edge of the capture peripheral A.

TouchProbePosition2PosValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60BC.00	-	-	S32	-	RO	Yes	-

32 bit value captured on the rising edge of the capture peripheral B.

TouchProbePosition2NegValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60BD.00	-	-	S32	-	RO	Yes	-

32 bit value captured on the falling edge of the capture peripheral B.

TouchProbe1PosEdgeCounter

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60D5.00	-	-	U16	-	RO	Yes	-

Counter of the number of values that have been captured on the rising edge of the capture peripheral A.

TouchProbe1NegEdgeCounter

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60D6.00	-	-	U16	-	RO	Yes	-

Counter of the number of values that have been captured on the falling edge of the capture peripheral A.

TouchProbe2PosEdgeCounter

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60D7.00	-	-	U16	-	RO	Yes	-

Counter of the number of values that have been captured on the rising edge of the capture peripheral B.

TouchProbe2NegEdgeCounter

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60D8.00	-	-	U16	-	RO	Yes	-

Counter of the number of values that have been captured on the falling edge of the capture peripheral B.

10-3-13 Feedback Sensor

FeedbackSensor

Feedback sensor related values.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C0.00	8	8	U8	-	CST	-	-

Number of parameters in this group.

FeedbackSensorResolution

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C0.02	-	-	U32	count/rev	RO	-	-

Feedback sensor resolution, valid only for the sensors that declare it.

FeedbackSensorCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C0.04	-	-	U16	-	Desc	-	EM

Code of the feedback sensor.

FeedbackSensorCode	Description
0	No sensor
3	Reserved
4	Reserved
5	Reserved
100	Reserved
101	Absolute encoder Hiperface multiturn SKM36 128sin/rev, 4096rev (ABS encoder motors)
150	Absolute encoder Hiperface singleturn SEK37 16sin/rev (INC encoder motors)
151	Reserved

Note In the drives of the Integrated Servo Motor series with Hiperface encoders, the zero mark is simulated.

SensorFaultTemperatureThrs

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C0.05	-	110	U16	ºC	RO	-	EM

Feedback sensor temperature fault threshold. If the SensorFaultTemperatureThrs value is 65535 it means that the thermal sensor is not present and the sensor thermal protection is referred to **MotorTemperature [3300.03]**.

FeedbackSensorAbsMode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C0.08	-	-	S16	ºC	RW	-	EM

Absolute sensor functioning mode (0 = incremental, 1 = absolute). This parameter only makes sense if the physical sensor installed on the system is an absolute sensor. Since this parameter determines the mode to reconstruct the position, when it is written through the dictionary, it will even be immediately and automatically saved in the permanent memory, so that even in case of SOFT reset there will be no undesired changes on the functioning mode.

Note As for the **FeedbackSensorCode [36C0.04]** parameter, the default value, once it has been modified, is no more restorable.

FeedbackSensorPhasing

Feedback sensor phasing parameters related values.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C2.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

FeedbackSensorPhasingStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C2.01	-	-	U16	-	RO	-	-

Feedback sensor phasing status: 0 = not phased, 1 = phasing in progress, 2 = phased, 3 = phasing error.

FeedbackSensorPhasingAngleTest

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C2.02	0-3600	-	S16	10 = 1 deg	RW	-	-

Value of the electric angle used to execute the phasing test through the command 5300 of the **SysMngCommand [5FF7.01]**.

FeedbackSensorPhasingAngleError

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C2.03	-	-	S16	10 = 1 deg	RW	-	-

Error of the electric angle used to execute the phasing test through the command 5300 of the **SysMngCommand [5FF7.01]**.

10-3-14 Motion

PositionResolution

Number of increments related to a motor axis revolution. This parameter is calculated as EncoderIncrements / MotorRevolutions. The unit of measurement depends on the motor type: rotary motor [inc/rev], linear motor [inc/PolePitch].

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x608F.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

EncoderIncrements

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x608F.01	256 - 1048576	$2^{15}/2^{20}$*1	U32	Desc	RW	-	ES

Note 15-bit for incremental encoder or 20-bit for absolute multiturn encoder (18-bit real accuracy).

Number of increments of the feedback position sensor, used to calculate the **PositionResolution**.

MotorRevolutions

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x608F.02	1	1	U32	Desc	RW	-	-

Necessary parameter to calculate the **PositionResolution**. For rotative motors, it indicates the motor revolutions number. For linear motors, it indicates the motor polar steps number. Actually, this parameter is set to 1, so the **PositionResolution** coincides with the value of **EncoderIncrements [608F.01]**.

Polarity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x607E.00	0 or 192	192	U16	-	RW	Yes	ES

Direction of rotation of the motor shaft, in which the values increase. For further details see **Section 8-5-2 Polarity**.

Polarity	Name	Description
0	Reverse	With rotary motor: positive direction clockwise towards the motor flange
192	Forward	With rotary motor: positive direction counterclockwise towards the motor flange

ModesOfOperation

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6060.00	Desc	3	S8	-	RW	Yes	ES

Selection of the operating mode of drive functioning. The accepted value are shown in the next table.

Value	Name	Description
1	Profile position mode	The drive runs positionings with profile and set points configured by the user
3	Profile velocity mode (CiA402)	The drive runs speed motions with profile and set point configured by the user
4	Torque mode	The drive runs a motion by following a torque reference configured by the user. Only the current regulation loop is used
6	Homing mode	The drive runs a homing procedure (zero searching) with profile configured by the user.
7	Interpolated position mode	The drive runs a motion by following a position set point periodically set by the user (positionings in Real-time)
8	Cyclic synchronous position mode	The drive runs a motion by following a position set point periodically set by the user (positionings in Real-time).
9	Cyclic synchronous velocity mode	The drive runs a motion by following a velocity set point periodically set by the user (positionings in Real-time).
10	Cyclic synchronous torque mode	The drive runs a motion by following a torque set point periodically set by the user (positionings in Real-time).
-113	Profile velocity mode (CUSTOM)	The drive runs a parametrized motion as speed profile but internally checked by the drive even in its position
-111	Profile velocity AI mode	The drive runs speed motions with profile configured by the user and set point set through the analog input
-101	Torque AI mode	The drive executes a movement because it's following a torque reference that's related to the analog input value. Only the current regulation loop is used
-126	Gear mode	The drive follows the master axis position according to a following ratio configured by the user.

Note It is possible to change ModesOfOperation only if the drive is not in the status Operation enable, Quick Stop Active or Fault Reaction Active.

ModesOfOperationDisplay

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6061.00	Desc	3	S8	-	RO	Yes	-

Operating mode enabled in the drive. The values that can be read are the same of the parameter **ModesOfOperation [6060.00]** parameter (see **ModesOfOperation** table) with the addition of the Tuning Mode (-127) used for some tuning and configuration commands.

ApplyModeOperation

Group of parameter to manage the on-the-fly change of the operating mode.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x42C0.00	9	9	U8	-	CST	-	-

Number of parameters in this group.

ApplyModeOperationCommand

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x42C0.01	Desc	-	S8	-	RW	Yes	-

Selection of the operating mode for the functionality of on-the-fly mode change.

ApplyModeOpera-tionCommand	Name
1	Profile position mode
6	Homing mode
7	Interpolated position mode
-113	Profile velocity mode (CUSTOM)

Note It is possible to change **ModesOfOperation [6060.00]** through this parameter only when the drive is in the status Operation enable.

ApplyModeOperationStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x42C0.02	-	-	S8	-	RO	Yes	-

Status of the on-the-fly mode change. The parameter shows if the change was carried out or not and it shows any possible error code.

ApplyModeOpera-tionStatus	Name
0	No error, change **ApplyModeOperationCommand [42C0.01]** correctly run
1	Error: parameter **ApplyModeOperationCommand [42C0.01]** not correct
2	Error: parameter 1 of **ApplyModeOperationParameters [42C0.03]** not correct
3	Error: parameter 2 of **ApplyModeOperationParameters [42C0.04]** not correct
4	Error: parameter 3 of **ApplyModeOperationParameters [42C0.05]** not correct
5	Error: parameter 4 of **ApplyModeOperationParameters [42C0.06]** not correct
6	Error: parameter 5 of **ApplyModeOperationParameters [42C0.07]** not correct
7	Error: parameter 6 of **ApplyModeOperationParameters [42C0.08]** not correct
8	Error: parameter 7 of **ApplyModeOperationParameters [42C0.09]** not correct

ApplyModeOperationParameters

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x42C0.03 - 0x42C0.09	-	-	U32	-	RW	Yes	-

Group of 7 parameters through which it is possible to set the on-the-fly operating mode change. The meaning of every parameter changes when **ApplyModeOperationCommand [42C0.01]** changes.

PositionValidationStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x42BF.00	-	-	U32	-	RW	-	-

System encoder position validation: it indicates if the position of the sensor, here after listed, is valid for the application. Each bit is related to an Encoder type and must be set (logic state 1) from the user if the procedures that are necessaries to validate the position have been executed. With “validate” we mean that the position can be considered “aligned” with the value that is reported by the sensor (homing, position, ...) If for any motive (reset, turn off, polarity inversion, ...) the position is no more coherent, the corresponding bits automatically reset. The causes that reset the bit are:

Bit	Encoder	Cause
0	Feedback encoder	Turn off, **PositionResolution [608F.xx]** or Polarity parameters value change
3	Selected auxiliary encoder	Turn off, HardReset and SoftReset commands to the SystemManager (see **SysMngCommand [5FF7.01]**)

Bit	Encoder	Cause
4	Real auxiliary encoder	Turn off, HardReset and SoftReset commands to the SystemManager (see **SysMngCommand [5FF7.01]**)
5	Virtual auxiliary encoder	Turn off, HardReset and SoftReset commands to the SystemManager (see **SysMngCommand [5FF7.01]**)

PositionActualValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6064.00	-	-	S32	inc	RO	Yes	-

Current drive position.

Note If a firmware reset happens, and the feedback sensor is not absolute, the actual position, read by the PositionActualValue parameter, is maintained only if the read code in the **ResetCause [5FFA.02]** parameter is 5 or 6. If the feedback sensor is absolute the actual position is kept even if the drive is turned off (within the sensor functioning range).

FollowingErrorWindow

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6065.00	-	Desc	U32	inc	RW	Yes	ES

Positioning window (fault threshold) to check the Error of position tracking (setting used only in the position modes). If **PositionFollowingError [60F4.00]** remains over this threshold longer than **FollowingErrorTimeOut [6066.00]**, the system signals the fault of following error if disabled. The default value is equal to 64 motor revolutions.

FollowingErrorWindowWarn

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4282.01	-	Desc	U32	inc	RW	-	ES

Position window (warning threshold) to check the Error of position tracking (setting used only in the position modes). If **PositionFollowingError [60F4.00]** remains above this threshold longer than **FollowingErrorTimeOut [6066.00]**, the system signals the warning of following error. The default value is equal to 64 motor revolutions.

PositionFollowingError

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F4.00	-	-	S32	inc	RO	Yes	-

Current value of the error of positioning following.

FollowingErrorTimeOut

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6066.00	-	0	U16	ms	RW	Yes	ES

Maximum time period during which the absolute value of **PositionFollowingError [60F4.00]** can get over the error windows (**FollowingErrorWindow [6065.00]** and **FollowingErrorWindowWarn [4282.01]**) before respectively a fault or a warning is notified. Setting used only in the position modes.

PositionWindow

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6067.00	-	0	U32	inc	RW	Yes	ES

Tolerance window on the Position reached target (setting used only in the position modes). Once the **PositionActualValue [6064.00]** reached the window and remains inside it for a time period equal to at least **PositionWindowTime [6068.00]**, the bit Target reached of the **Statusword [6041.00]** is set. Vice versa the same bit is immediately reset as soon as the difference between the two positions (target and current) gets over the window. If this parameter is set to 0, the position target is reached only if the theoretical value of the position (set point of the position loop) is equal to the position target for a time period at least equal to **PositionWindowTime [6068.00]**.

PositionWindowTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6068.00	-	10	U16	ms	RW	Yes	ES

Minimum time period to check the reaching of the final position. Setting used only in the position modes.

VelocityActualValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x606C.00	-	-	S32	inc/s	RW	Yes	ES

Current drive speed.

VelocityWindow

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x606D.00	-	0	U16	inc/s	RW	Yes	ES

Tolerance window on the Speed target reached (setting used only in the speed modes). Once the **VelocityActualValue [606C.00]** reached the window and remains inside it for a time period equal to at least **VelocityWindowTime [606E.00]**, the bit Target reached of the **Statusword [6041.00]** is set. Vice versa the same bit is immediately reset as soon as the difference between the two speeds (target and current) gets over the window. If this parameter is set to 0, the speed target is reached only if the theoretical value of the speed (set point of the speed loop) is equal to the speed target for a time period at least equal to **VelocityWindowTime [606E.00]**.

VelocityThreshold

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x606F.00	-	0	U16	inc/s	RW	Yes	ES

Speed threshold to recognize Stopped motor (setting used only in the speed modes). Once the **VelocityActualValue [606C.00]** is decreased with a lower value than the threshold and it stays in this for a time period at least equal to **VelocityThresholdTime [6070.00]**, the bit Speed of the **Statusword [6041.00]** is set. Vice versa the same bit is immediately reset as soon as the current speed gets over the threshold. If this parameter is set to 0, the motor is considered as stopped only if the theoretical value of the speed (set point of the speed loop) is equal to 0 for a time period at least equal to **VelocityThresholdTime [6070.00]**.

VelocityWindowTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x606E.00	-	0	U16	ms	RW	Yes	ES

Minimum time period to check the reaching of the final speed. Setting used only in the speed modes.

VelocityThresholdTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6070.00	-	0	U16	ms	RW	Yes	ES

Minimum time period to check the condition of the stopped motor. Setting used only in the speed modes.

TargetTorque

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6071.00	-	-	S16	10 = 1%IS	RW	Yes	-

Target torque the motor has to reach in Torque mode.

MaxTorque

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6072.00	0 ÷ 32767	1000	U16	10 = 1%IS	RW	Yes	ES

Fixed value of the torque limit set by the user. This value is taken as reference in case the **TorqueLimitSelector [4202.00]** parameter is set to 1 (default value).

ActualTorqueLimitP

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x420F.00	-	-	U16	10 = 1%IS	RO	Yes	-

Actual torque positive limit [1000 = Rated current].

ActualTorque

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6077.00	-	-	S16	10 = 1%IS	RW	Yes	-

Applied torque value.

TorqueFilterFrequency

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x3321.01	-	80	U16	Hz	RW	-	ES

Typical filter frequency to obtain the **ActualFilteredTorque [4210.00]** parameter.

ActualFilteredTorque

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4210.00	-	-	S16	10 = 1%IS	RO	Yes	-

Filtered value of **ActualTorque [6077.00]**. The filter is a The low-pass filter of the first order with typical frequency equal to **TorqueFilterFrequency [3321.01]**.

RequestedTorque

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6074.00	-	-	S16	10 = 1%IS	RO	Yes	-

Value of the torque that’s required to the motor.

ActualTorqueLimitN

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4211.00	-	-	U16	10 = 1%IS	RO	Yes	-

Actual torque negative limit [1000 = Rated current].

PositiveTorqueLimitValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60E0.00	-	-	U16	10 = 1%IS	RW	Yes	-

Torque reference positive limit [1000 = Rated current].

NegativeTorqueLimitValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60E1.00	-	-	U16	10 = 1%IS	RW	Yes	-

Torque reference negative limit [1000 = Rated current].

TorqueLimitSelector

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4202.00	-	1	U16	-	RW	Yes	ES

Selector that allows to select the source to obtain the torque limit.

TorqueLimitSelector	Description
0	Peak current (the torque limit is always active and is equal to **UserPeakCurrent [3405.06]**)
1	Max/Positive/Negative
2	Torque limit enabled through analog input

TorqueSlope

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6087.00	Desc	0xFFFFFFFF	U32	-	RW	Yes	-

Torque increment per second in the torque profile ramps. This parameter is not used.

TorqueProfileType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6088.00	Desc	-1	S16	-	RO	Yes	-

Torque profile type: -1 = Torque step.

PositioningOptionCode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60F2.00	Desc	0	U16	-	RW	Yes	ES

Necessary options to define the behavior of the position operating modes. Only the bits related to the behavior of the Profile Position Mode have been currently implemented:

- **Relative option (bit 0 - 1):** Group of bits used to check the positioning behavior when it is of relative type (the bit Absolute / Relative of the **Controlword [6040.00]** is equal to 1). The accepted values are: 0: the positioning is run in relation to the last position target (absolute internal). 1: the positioning is carried out in relation to the set-point of the position loop. 2: the positioning is carried out in relation to the **PositionActualValue [6064.00]**.
- **Change immediately option (bit 2 - 3):** Group of bits used to check the positioning behavior when the bit Change set immediately of the **Controlword [6040.00]** is set as equal to 1. The only accepted value is 0 showing that the positioning carried out in this mode immediately readjusts the current motion to the new parameters of the position profile.
- **Request-response option (bit 4 - 5):** Group of bits used to check the handshake between the drive and the master to start the positionings. The only accepted value is 0 showing that the supported handshake is the standard one, described in **Section 7-2-1 Profile Position Mode**.

ProfilePositionStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x42A0.00	0-6	-	U16	-	RO	Yes	-

Status of the position trajectory generator.

ProfilePositionStatus	Description
0	The trajectory generator is disabled: **ModesOfOperationDisplay [6061.00]** is not Profile Position Mode or the drive is disabled
1	The position profile is in the stationary phase: steady references. From this status on **ModesOfOperationDisplay [6061.00]** is always equal to Profile Position Mode, the drive is always in the status Operation enable and the trajectory generator is always enabled
2	The position profile is in the Deceleration phase for direction reversal. This is the first phase carried out when the motor, already moving, has to reverse the motion. In this phase the deceleration used is always equal to **ProfileDeceleration [6084.00]**
3	The position profile is in the Acceleration phase. This is the phase carried out when the trajectory generator must accelerate the motor (or decelerate depending on the set parameters) to reach the cruise speed **ProfileVelocity [6081.00]**
4	The position profile is in the Cruise phase. This phase is carried out at a constant speed equal to **ProfileVelocity [6081.00]**

ProfilePositionStatus	Description
5	The position profile is in the Deceleration phase. This phase is carried out when the trajectory generator must decelerate the motor in order to reach the speed **EndVelocity [6082.00]**
6	The position profile is in the Phase of profile end. This phase is carried out at a constant speed equal to **EndVelocity [6082.00]** before stopping the positioning. When this phase is over the trajectory generator enters the status 1, Stationary phase

TargetPosition

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x607A.00	-	0	S32	inc	RW	Yes	-

Target position that must be reached at the end of a positioning carried out in Profile Position Mode. The value is understood as absolute or relative depending on the bit Absolute / Relative of the **Controlword [6040.00]**. If the positioning is of absolute type the TargetPosition is understood as a position related to the Zero position, vice versa if the positioning is of relative type the TargetPosition is understood as shown in the bits Relative option of the parameter **PositioningOptionCode [60F2.00]**.

Note During the parametrization of a positioning, the value of TargetPosition also includes the space to be covered with speed equal to **EndVelocity [6082.00]** at the end of the profile, that is **EndIncrements [4284.01]**. However if this last value is higher than TargetPosition the motion is carried out with speed equal to **EndVelocity [6082.00]** and the content of the parameter **EndIncrements [4284.01]** is ignored. It is possible to write this parameter only if **ModesOfOperationDisplay [6061.00]** is equal to 1.

Target instantaneous profile that is updated every comms cycle by the master controller in Cyclic Synchronous Position mode.

EndIncrements

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4284.01	-	0	U32	inc	RW	Yes	ES

Space to cover with speed equal to **EndVelocity [6082.00]** at the end of the deceleration ramp of a position profile. If the value of **EndVelocity [6082.00]** is 0 the value of **EndIncrements [4284.01]** is ignored and the positioning ends after the deceleration ramp.

HomeOffset

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x607C.00	-	0	S32	inc	RW	Yes	ES

Difference between Zero position and Home position. Please see **Section 7-5 Homing Mode**.

Note If the sensor is absolute then the value of HomeOffset must be between 0 and the negative full scale value (for example in a drive that has a single turn absolute encoder of 4096 imp/rev, HomeOffset must be between 0 and -(1*4096).

PositionLimitEnable

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4280.01	0 - 1	0	U16	-	RW	-	ES

Parameter used to enable/disable the software position limits. See **Section 8-2-2 Software Limits**.

SoftwarePositionLimit

Software position limits, for details see **Section 8-2-2 Software Limits**.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x607D.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

PositionLimitNegative

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x607D.01	-	-2147483648	S32	inc	RW	Yes	ES

Negative software position limit.

PositionLimitPositive

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x607D.02	-	2147483647	S32	inc	RW	Yes	ES

Positive software position limit.

MaxProfileVelocity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x607F.00	1 to 2^{32} *1	*2	U32	inc/s	RW	Yes	ES

*1. Maximum value is the equivalent in inc/s to 3216.9 rad/s. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s to 100% **MotorRatedSpeed [6410.09]** parameter.

MaxMotorSpeed

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6080.00	-	Desc	U32	Desc	RW	Yes	ES

Motor velocity limit value. The default value is equal to the 120% of **MotorRatedSpeed [6410.09]**. The units of measurement are rpm.

ProfileVelocity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6081.00	1 to 2^{32} *1	500658*2	U32	inc/s	RW	Yes	ES

*1. Minimum value is the equivalent in inc/s to 3.0 rad/s and maximum value is the equivalent in inc/s to 3216.9 rad/s. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s to 3.0 rad/s, that is: **3*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 500658 inc/s for the 20-bit encoder and 15645 inc/s for the 15-bit encoder.

Running speed of the position profile. At the end of the acceleration ramp the motor reaches this speed which is kept until the beginning of the deceleration ramp. If the value of ProfileVelocity is lower than **StartVelocity [4244.00]** or **EndVelocity [6082.00],** its value is internally set with the higher between the two.

EndVelocity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6082.00	1 to 2^{32} *1	0	U32	inc/s	RW	Yes	ES

*1. Maximum value is the equivalent in inc/s to 3216.9 rad/s. So, the numerical value depends on the type of encoder selected.

Speed which the motor has to reach at the end of the profile deceleration ramp.

ProfileAcceleration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6083.00	1 to 2^{32} *1	20860757*2	U32	inc/s^2	RW	Yes	ES

*1. Minimum value is the equivalent in inc/s^2 to 0.32 rad/s^2 and maximum value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s^2 to 125.0 rad/s^2, that is: **125*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 20860757 inc/s^2 for the 20-bit encoder and 651899 inc/s^2 for the 15-bit encoder.

Acceleration to be used in Profile Position mode.

ProfileDeceleration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6084.00	1 to 2^{32} *1	20860757*2	U32	inc/s^2	RW	Yes	ES

*1. Minimum value is the equivalent in inc/s^2 to 0.32 rad/s^2 and maximum value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s^2 to 125.0 rad/s^2, that is: **125*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 20860757 inc/s^2 for the 20-bit encoder and 651899 inc/s^2 for the 15-bit encoder.

Deceleration to be used in Profile Position Mode.

QuickStopDeceleration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6085.00	1 to 2^{32} *1	*2	U32	inc/s^2	RW	Yes	ES

*1. Minimum value is the equivalent in inc/s^2 to 0.32 rad/s^2 and maximum value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s^2 to **MaxDeceleration [60C6.00]** parameter. So, the numerical value depends on the type of encoder selected.

Quick stop ramp deceleration value. This deceleration is used in the following cases:

- The drive is in the status Operation enable with parameter **QuickStopConfiguration [605A.00]** equal to 2 or 6 and gets a command of Quick Stop.
- The drive is in the status Operation enable, is carrying out a motion and it reaches or gets over a position limit (hardware or software).

MotionProfileType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6086.00	0	0	U16	-	RW	Yes	ES

Type of acceleration and deceleration ramps used to create the profile. It is currently possible to use only linear ramps (trapeze profile).

StartVelocity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4244.00	1 to 2^{32} *1	0	U32	inc/s	RW	Yes	ES

*1. Maximum value is the equivalent in inc/s to 3216.9 rad/s. So, the numerical value depends on the type of encoder selected.

Motor speed at the beginning of the profile.

HomingMethod

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6098.00	Desc	35	S8	-	RW	Yes	ES

Method used to start the homing procedure. Fur further details please see **Section 7-5 Homing Mode**.

Note If the Polarity is of Reverse type, the roles of Positive limit switch (FC+) and Negative limit switch (FC-) are reversed: Positive limit switch (FC+) behaves like Negative limit switch (FC -) and Negative limit switch (FC-) behaves like Positive limit switch (FC+).

Note If a HomingMethod with mechanical stop is selected (eg. mode -1), remember to set the torque limit (see **Section 8-4 Torque Limits**).

Value	Procedure description
1	FC -sw, index pulse
2	FC +sw, index pulse
7	Home sw, dir +, index before rise edge, Fc+ reverse
8	Home sw, dir +, index after rise edge, Fc+ reverse
9	Home sw, dir +, index before fall edge, Fc+ reverse
10	Home sw, dir +, index after fall edge, Fc+ reverse
11	Home sw, dir -, index before rise edge, Fc+ reverse
12	Home sw, dir -, index after rise edge, Fc+ reverse
13	Home sw, dir -, index before fall edge, Fc+ reverse
14	Home sw, dir -, index after fall edge, Fc+ reverse
17	FC -sw, no index
18	FC +sw, no index
23	Home sw, dir +, rise edge, no index, Fc+ reverse
26	Home sw, dir +, fall edge, no index, Fc+ reverse
27	Home sw, dir -, rise edge, no index, Fc+ reverse
30	Home sw, dir -, fall edge, no index, Fc+ reverse
33	Dir -, index pulse
34	Dir +, index pulse
35	Current position
-1	Mechanical stop, dir-, index pulse
-2	Mechanical stop, dir+, index pulse
-7	Home sw, dir +, index before rise edge, Fc+ stop
-8	Home sw, dir +, index after rise edge, Fc+ stop
-9	Home sw, dir +, index before fall edge, Fc+ stop
-10	Home sw, dir +, index after fall edge, Fc+ stop

Value	Procedure description
-11	Home sw, dir -, index before rise edge, Fc- stop
-12	Home sw, dir -, index after rise edge, Fc- stop
-13	Home sw, dir -, index before fall edge, Fc- stop
-14	Home sw, dir -, index after fall edge, Fc- stop
-17	Mechanical stop, dir-, no index
-18	Mechanical stop, dir+, no index
-23	Home sw, dir +, rise edge, no index, Fc+ stop
-26	Home sw, dir +, fall edge, no index, Fc+ stop
-27	Home sw, dir -, rise edge, no index, Fc- stop
-30	Home sw, dir -, fall edge, no index, Fc- stop
-35	Current **RequestedPosition**

IndexPulseDeadZone

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4285.02	Desc	Desc	U32	inc	RW	-	ES

Position offset where the drive, after detecting the disengagement of the Home switch or of the limit switch (depending on the chosen method), does not control the index pulse of the feedback sensor. It represents the measurement of the dead zone after which the drive starts looking for the index pulse. The resolution of IndexPulseDeadZone is 1° rounded off, the range goes from 0° to 180° and the default value is 1°.

HomingSpeeds

Speeds used in Homing mode.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6099.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

SpeedForSwitch

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6099.01	1 to 2^{32} *1	250329*2	U32	inc/s	RW	Yes	ES

*1. Minimum value is the equivalent in inc/s to 1.5 rad/s and maximum value is the equivalent in inc/s to 3216.9 rad/s. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s to 1.5 rad/s, that is: **1.5*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 250329 inc/s for the 20-bit encoder and 7823 inc/s for the 15-bit encoder.

Speed used during the search phase of the Home switch or of the limit switch (depending on the chosen method) in the homing procedure.

SpeedForZero

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6099.02	1 to 2^{32} *1	66754*2	U32	inc/s	RW	Yes	ES

*1. Minimum value is the equivalent in inc/s to 0.4 rad/s and maximum value is the equivalent in inc/s to 3216.9 rad/s. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s to 0.4 rad/s, that is: **0.4*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 66754 inc/s for the 20-bit encoder and 2086 inc/s for the 15-bit encoder.

Speed used during the search phase of the Home position.

HomingAcceleration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x609A.00	1 to 2^{32} *1	2503291*2	U32	inc/s^2	RW	Yes	ES

*1. Minimum value is the equivalent in inc/s^2 to 0.32 rad/s^2 and maximum value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s^2 to 15.0 rad/s^2, that is: **15*[(EncoderResolution)/(2*Pi)]**. So, the numerical value depends on the type of encoder selected and is 2503291 inc/s^2 for the 20-bit encoder and 78228 inc/s^2 for the 15-bit encoder.

Acceleration to be used during Homing mode.

HomingPosDisengagement

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4285.03	Desc	Desc	U32	inc	RW	-	ES

Minimum disengagement space used in the mechanical stop **HomingMethod [6098.00]** without the index pulse searching (after the reaching of the mechanical stop, the drive reverses its direction and distances the motor from the mechanical stop of at least of the number of pulses that are written in this parameter). The value of this parameter depends on the feedback sensor resolution and can take the values from 0 to a maximum of 2048*resolution/revolution and by default it's 1/8 of the feedback sensor resolution. For example, if the feedback sensor is 8000 pul/rev then HomingPosDisengagement=2048*8000=16384000 with default=1/8*8000=1000.

HomingAbsRangeMode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4285.04	Desc	Desc	U16	inc	RW	-	ES

Selector of the allowed positions range, with absolute encoder (0 = from 0 to encoder range, 1 = from -1/2 range to +1/2 range). It has to be defined if the homing has to be executed with “zero at centre” or “zero at side”. At the end of the homing procedure the drive, that has an absolute encoder (**FeedbackSensorAbsMode [36C0.08]** = 1), will save the data so that the position can be reconstructed even if the drive is turned off and on again (provided that the axis position is within the range that has been defined for the homing, range that has been defined with this parameter).

HomingStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x42A1.00	-	-	S16	-	RO	Yes	-

Status of the Homing mode:

Value	Description
-2	Homing running
-1	The drive is saving the data in the permanent memory
0	The homing has been disabled and/or interrupted (aborted) by another command (eg. bit Halt, bit Homing operation start reset,...)
1	Homing correctly executed
17	Error: it has not been found the Home switch between 2 limit switch (it regards the **HomingMethod [6098.00]** with limit switch management) and the axis is on moving
18	Error: it has been reached a limit switch before the Home switch has been found (it regards the **HomingMethod [6098.00]** without limit switch management) and the axis is on moving
20	Error: The index pulse has already been programmed as capture trigger in the Capture B peripheral and the axis is on moving (see IndexPulseNote)

Value	Description
21	Error: during the homing procedure when it has been selected a mode with the mechanical stop management, the axis is on moving and it has not been activated the torque limit (see **Section 8-4 Torque Limits**)
22	Error: a new homing procedure is starting while the current one is still executing. At its procedure startup, the homing is not ready to be started again (the previous procedure is still finishing)
23	Error: the data saving in the permanent memory is failed, data not saved
49	Same as 17. Differences: the axis is stationary
50	Same as 18. Differences: the axis is stationary
52	Same as 20. Differences: the axis is stationary
53	Same as 21. Differences: the axis is stationary
54	Same as 22. Differences: the axis is stationary
55	Same as 23. Differences: the axis is stationary

CyclicSynchronousSubMode

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x42D0.00	Desc	-136	S16	-	RW	Yes	-

Selector of the interpolation type that the drive has to execute when one of the synchronous cyclic modes is active.

ModesOfOperationDisplay	CyclicSynchronousSubMode	Interpolation type	Auto KVff*1	Auto KAff*2
8 (CSP)	-136	none	0	0
	-135		0	1
	-132		1	0
	-131		1	1
	-144	linear	0	0
	-143		0	1
	-140		1	0
	-139		1	1
	-148	cubic	-	0
	-147		-	1
9 (CSV)	-136, -132	none	-	0
	-135, -131		-	1
	-144, -140	linear	-	0
	-143, -139		-	1
10 (CST)	-136, -135, -132, -131	none	-	-
	-144, -143, -140, -139	linear	-	-

***1.** 0 = The velocity offset is directly taken from the **VelocityOffset [60B1.00]** parameter, 1 = The velocity offset calculation is automatically executed internally of the drive.

***2.** 0 = The acceleration offset is directly taken from the **TorqueOffset [60B2.00]** parameter, 1 = The acceleration offset calculation is automatically executed internally of the drive.

PositionOffset

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60B0.00	Desc	0	S16	-	RW	Yes	-

Position offset that will be added to the **TargetPosition [607A.00]** if the Cyclic Synchronous Position Mode is active.

VelocityOffset

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60B1.00	Desc	0	S16	-	RW	Yes	-

Velocity offset that will be added to the **TargetVelocity [60FF.00]** if the Cyclic Synchronous Velocity Mode is active. Instead, in case of Cyclic Synchronous Position Mode, it can be used as velocity feed forward or velocity reference, depending on the interpolation mode (see **CyclicSynchronousSubMode [42D0.00]**).

TorqueOffset

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60B2.00	Desc	0	S16	-	RW	Yes	-

Torque offset that will be added to the **TargetTorque [6071.00]** if the Cyclic Synchronous Torque Mode is active. Instead, in case of Cyclic Synchronous Position Mode or Cyclic Synchronous Velocity Mode it can be used as acceleration feed forward (see **CyclicSynchronousSubMode [42D0.00]**).

IpPosSubModeSelect

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C0.00	Desc	0	S16	-	RW	Yes	-

Selector of the interpolation type the drive must run when the Interpolated Position Mode is enabled (see **Section 7-2-2 Interpolated Position Mode**).

IpPosSubModeSelect	Description
0	Linear interpolation
-1	Cubic interpolation
-10	Linear interpolation with speed feed forward

IpTimePeriod

Time gap in which the interpolation data must be transmitted. The final value must be calculated with the following formula: **IpTimePeriodValue** * $10^{\mathbf{IpTimeIndex}}$ [s]. This parameter can be used alternatively to the **CommunicCyclePeriod [1006.00]** (ETC) parameter. If these parameters are used at the same time, they must express the same value.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C2.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

IpTimePeriodValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C2.01	0-255	1	U8	s	RW	-	-

First multiplication factor to calculate IpTimePeriod.

IpTimePeriodIndex

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C2.02	-6 ÷ -2	-3	S8	-	RW	-	ES

Exponent (base 10) for the calculation of IpTimePeriod.

IpPosDataRecord

Group of parameters defining the set-point in the Interpolated position mode.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C1.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

IpPosFirstParameter

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C1.01	-	0	S32	inc	RW	Yes	-

This parameter is the first of a data group that are used all together to define the set-point the interpolator must reach. It contains the position value which must be reached. The parameter is valid only for Interpolated Position Mode.

IpPosSecondParameter

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C1.02	-	0	S32	Desc	RW	Yes	-

This parameter is the second of a data group that are used all together to define the set-point the interpolator must reach. It contains the speed which must be reached. The parameter is valid only for Interpolated Position Mode and is expressed in [65536 = 1inc/T_{SYNC}].

IpPosDataConfig

Group of parameters that define the IpPosDataRecord configuration.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C4.00	6	6	U8	-	CST	-	-

Number of parameters in this group.

IpPosDataConfigMaxBufferSize

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C4.01	1	1	U32	-	RW	-	-

IpPosDataRecord configuration: maximum number of buffer points.

IpPosDataConfigActualBufferSize

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C4.02	1	1	U32	-	RW	-	-

IpPosDataRecord configuration: actual number of buffer points.

IpPosDataConfigBufferOrganization

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C4.03	-	0	U8	-	RW	-	-

IpPosDataRecord configuration: it specifies the buffer organization (FIFO type buffer).

IpPosDataConfigBufferPosition

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C4.04	-	0	U16	-	RW	-	-

IpPosDataRecord configuration: index of IpPosDataRecord used for the interpolation (index of the first available point).

IpPosDataConfigSizeDataRecord

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C4.05	Desc	-	U8	-	WO	-	-

IpPosDataRecord configuration: it expresses the dimension in bytes of IpPosDataRecord (dimension in byte of the single point). It can take the values 4 or 8, depending on the **IpPosSubModeSelect [60C0.00]** parameter; if **IpPos-SubModeSelect [60C0.00]** = 0 then IpPosDataConfigSizeDataRecord = 4, else IpPosDataConfigSizeDataRecord = 8.

IpPosDataConfigBufferClear

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C4.06	1	1	U8	-	RW	-	-

IpPosDataRecord configuration: it specifies that the IpPosDataRecord is enabled (it can’t be disabled).

MaxAcceleration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C5.00	1 to 2^{32} *1	*2	U32	inc/s^2	RW	Yes	ES

*1. Minimum value is the equivalent in inc/s^2 to 0.32 rad/s^2 and maximum value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

Maximum allowed acceleration in any Position mode.

MaxDeceleration

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60C6.00	1 to 2^{32} *1	*2	U32	inc/s^2	RW	Yes	ES

*1. Minimum value is the equivalent in inc/s^2 to 0.32 rad/s^2 and maximum value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

*2. The default value is the equivalent in inc/s^2 to 205887.3 rad/s^2. So, the numerical value depends on the type of encoder selected.

Maximum allowed deceleration in any Position mode.

TargetVelocity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FF.00	-2^{32} to 2^{32}*1	0	S32	inc/s	RW	Yes	-

*1. Minimum value is the equivalent in inc/s to -3216.9 rad/s and maximum value is the equivalent in inc/s to 3216.9 rad/s. So, the numerical value depends on the type of encoder selected.

Target speed the motor has to reach in Profile Velocity Mode (CiA402) or in Profile Velocity Mode (CUSTOM). With the drive in Operation enable, the writing of a speed in an absolute value higher than **EndVelocity [6082.00]** and **StartVelocity [4244.00]** starts the motion while the writing of a speed in an absolute value lower or equal provokes the stop. The sign of the speed written in this parameter defines the motion direction.

SupportedDriveModes

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x6502.00	0x3ED	0x3ED	U32	-	RO	-	ES

Standard CiA402 supported operational modes: csp (Cyclic Synchronous Position Mode), csv (Cyclic Synchronous Velocity Mode), cst (Cyclic Synchronous Torque Mode), ip (Interpolated Position Mode), hm (Homing Mode), tq (Torque Mode), pv (Profile Velocity Mode (CiA402)), pp (Profile Position Mode).

MasterPositionSettings

Group of parameters that allows to configure the drive axis behaviour in relation to the master axis, about the adjustment ramp.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4288.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

GearMasterTriggerDirection

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4288.01	0-1	0	U16	-	RW	Yes	-

This parameter sets the direction in with the master axis position is deemed to have been overreached: correspondingly an adjustment ramp is initiated. The meaning of possible values are indicated in the table below:

Value	Description
0	The adjustment ramp is launched when the position of the master axis (**AuxiliaryEncoderPosition [36CA.01]**) is increasing and becomes greater or equal to the trigger position (**GearMasterTriggerPosition [4288.02]**).
1	The adjustment ramp is launched when the position of the master axis (**AuxiliaryEncoderPosition [36CA.01]**) is decreasing and becomes less or equal to the trigger position (**GearMasterTriggerPosition [4288.02]**).

GearMasterTriggerPosition

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4288.02	-	0	S32	inc	RW	Yes	-

Reference Master position at which, if exceeded, the adjustment ramp between two following ratios is started, once the adjustment procedure is started too. The **GearMasterTriggerPosition** is considered valid only for an adjustment procedure: this means that if two Start gear commands are sent (start procedure command) and this parameter is not updated, its value will be completely ignored and the second adjustment ramp will begin from the actual position. Another case in which the **GearMasterTriggerPosition** parameter is ignored and the adjustment ramp is initiated as soon as the Start gear command is given, is when the Start gear command is given by setting Reset trigger to 1.

GearMasterRampPosition

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4288.03	0x1 - 0x7FFFFFFF	1000	U32	inc	RW	Yes	-

Value of the master space during which the drive executes the following ratio adjustment ramp to the **TargetGearRatio [4289.00]**.

GearSlaveTriggerPosition

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4288.04	-	0	S32	inc	RO	Yes	-

Reading of the axis slave (drive axis) position when the master axis position (**AuxiliaryEncoderPosition [36CA.01]**) is equal to the trigger position (**GearMasterTriggerPosition [4288.02]**). This value is internally calculated when the adjustment ramp is started for a new following ratio.

GearStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x42A2.00	0-4	0	S16	-	RO	Yes	-

Gear Mode status. The states that may takes the Gear Mode are described in the following table:

GearStatus	Description
0	The axis is not in Gear Mode due to one of the following reasons: •The Gear Mode has not been set (**ModesOfOperationDisplay [6061.00]** different from -126) •The drive is not in the Operation enable status •The Halt or Quick stop command is in progress or is finished
1	The Gear Mode is enabled, the drive is waiting for the first Start gear command.
2	The drive has received the Start gear command and is waiting for the exceeding of the trigger master position (**GearMasterTriggerPosition [4288.02]**) to start the new adjustment ramp. When it is in this status, the axis could already be moving, either already synchronized or within an adjustment ramp, as a result of a preceding Start gear command.
3	The drive is executing an adjustment ramp between two different following ratios.
4	The drive has completed the adjustment ramp and has reached the following ratio set (**TargetGearRatio [4289.00]**).

TargetGearRatio

These parameters pair are the numerator and denominator of a fraction that represents the following ratio that the slave axis must reach at the end of the adjustment ramp:
TargetGearRatio = TargetGearRatioNumerator / TargetGearRatioDivisor

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4289.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

TargetGearRatioNumerator

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4289.01	-	0	S16	inc	RW	Yes	-

Numerator of the **TargetGearRatio** following ratio to be reached after a Start gear command. It can be interpreted as the space in which the position of the slave axis changes depending on the master axis movement in an area equal to **TargetGearRatioDivisor [4289.02]**.

TargetGearRatioDivisor

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4289.02	Desc	1000	S16	inc	RW	Yes	-

Denominator of the **TargetGearRatio** following ratio to be reached after a Start gear command. It can be interpreted as the space in which the position of the master axis must change so that the slave axis position varies of an area equal to **TargetGearRatioNumerator [4289.01]**. The admitted range is between -32768 and 32767 where only the value 0 is excluded.

StartGearRatio

These parameters pair are the numerator and denominator of a fraction that represents the following ratio that is used at the beginning of an adjustment ramp when a Start gear command is received through the Start gear ratio disable bit set to 0:
StartGearRatio = StartGearRatioNumerator / StartGearRatioDivisor

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x428A.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

StartGearRatioNumerator

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x428A.01	-	0	S16	inc	RW	Yes	-

Numerator of the **StartGearRatio** following ratio to be used at the beginning of the adjustment ramp after a Start gear command with the Start gear ratio disable set to 0. It can be interpreted as the space in which the position of the slave axis changes depending on the master axis movement in an area equal to **StartGearRatioDivisor [428A.02]**.

StartGearRatioDivisor

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x428A.02	Desc	1000	S16	inc	RW	Yes	-

Denominator of the **StartGearRatio** following ratio to be used at the beginning of the adjustment ramp after a Start gear command with the Start gear ratio disable set to 0. It can be interpreted as the space in which the position of the master axis must change so that the slave axis position varies of an area equal to **StartGearRatioNumerator [428A.01]**. The admitted range is between -32768 and 32767 where only the value 0 is excluded.

10-3-15 Brake

Brake

Group of parameter to manage the brake.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36D0.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

BrakeReleaseTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36D0.01	-	Desc	U16	ms	RW	-	EM

Brake delay time.

BrakeCloseTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36D0.02	-	Desc	U16	ms	RW	-	EM

Brake response time.

BrakeStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36D0.03	-	Desc	U16	-	RW	-	-

Brake status: 0 = disabling, 1 = enabling.

For more details, see **Section 8-11 Brake Interlock**.

10-3-16 Auxiliary Position Sensor

RealAuxEncParam

Group of parameters for the real master sensor functionalities configuration.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C9.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

RealAuxEncoderPosition

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C9.01	-	0	S32	cnt	RW	Yes	-

Position reached by the physical auxiliary position sensor. Through a writing operation it's possible to modify this value.

RealAuxEncoderVelocity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C9.03	-	0	S32	cnt/s	RO	Yes	-

Velocity reached by the physical auxiliary position sensor.

RealAuxEncoderPolarity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C9.02	-	0	U16	-	RW	-	-

Polarity of the physical sensor: Rotation direction where the position value increases: 0=Forward, 1=Reverse.

VirtualAuxEncParam

Group of parameters for the virtual master sensor functionalities configuration.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C8.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

VirtualAuxEncoderPosition

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C8.01	-	0	S32	cnt	RW	Yes	-

Position reached by the virtual auxiliary position sensor.

VirtualAuxEncoderVelocity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C8.03	-	0	S32	cnt/s	RW	Yes	-

Velocity of virtual auxiliary sensor expressed in [65536 = 10000cnt/s] (eg. to obtain 2500 cnt/s the value to be inserted is 16384).

VirtualAuxEncoderRunStop

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36C8.02	0 - 1	0	U8	-	RW	-	-

Run/stop command of the virtual sensor (0 = stop, 1 = run).

AuxiliaryEncParam

Group of parameters for the selected auxiliary master sensor functionalities configuration.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36CA.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

AuxiliaryEncoderPosition

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36CA.01	-	-	S32	cnt	RO	Yes	-

Position reached by the selected auxiliary position sensor.

AuxiliaryEncoderVelocity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36CA.03	-	-	S32	cnt/s	RO	Yes	-

Velocity reached by the selected auxiliary position sensor.

AuxiliaryEncoderSelector

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x36CA.02	0 - 1	0	U16	-	RW	-	-

Auxiliary sensor selection command: 0 = real encoder, 1 = virtual encoder.

10-3-17 Digital Inputs and Outputs

DigitalInputFuncStatus

Status of the digital inputs if programmed as FC, Home, Enable.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4054.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

FcStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4054.01	-	-	U16	-	RO	-	-

Status of the programmed inputs with the function of positive and negative limit switch.

Note If the Polarity is of Reverse type, the roles of Positive limit switch (FC+) and Negative limit switch (FC-) are reversed: Positive limit switch (FC+) behaves like Negative limit switch (FC-) and Negative limit switch (FC-) behaves like Positive limit switch (FC+).

FCStatus	Description
Bit 0	Status of the programmed input with the functionality Negative limit switch (FC-)
Bit 1	Status of the programmed input with the functionality Positive limit switch (FC+)

HomeStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4054.02	-	-	U16	-	RO	-	-

Status of the programmes input with the function of Home.

EnableInputStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4054.03	-	-	U16	-	RO	-	-

Status of the programmed input with the function of Enable. If no input is associated to the function Enable, EnableInputStatus is always equal to 1.

DisableOption

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x406E.00	-	2	S16	-	RW	-	ES

Disabling options through the digital input configured as Enable.

DisableOp-tion	Description
-1	The motor is stopped with maximum deceleration by resetting to zero RequestedSpeed
2	The motor is stopped with deceleration equal to **QuickStopDeceleration [6085.00]**

DisableOkOutput

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x406F.00	-	1401	U32	-	RW	-	ES

Mask used to select the faults disabling the digital output Drive Ok (Drv OK): 0 = the fault disables the output, 1 = the fault, even if present, does not disable the output.

PwmHwParam

Group of parameters for the PWM output configuration.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x403F.00	6	6	U8	-	CST	-	-

Number of parameters in this group.

PwmHwFrequencyIO0

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x403F.01	1-50000	1000	U16	Hz	RW	-	-

Frequency of the signal generated by the I/O 0 when programmed as output pwm.

PwmHwDutyCycleIO0

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x403F.02	0-100	0	U16	%	RW	-	-

Duty Cycle of the signal generated by the I/O 0 when programmed as output pwm. The value 0 means the output is disabled while the value 100 means the output is enabled.

PwmHwFrequencyIO1

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x403F.03	1-50000	1000	U16	Hz	RW	-	-

Frequency of the signal generated by the I/O 1 when programmed as output pwm.

PwmHwDutyCycleIO1

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x403F.04	0-100	0	U16	%	RW	-	-

Duty Cycle of the signal generated by the I/O 1 when programmed as output pwm. The value 0 means the output is disabled while the value 100 means the output is enabled.

PwmHwFrequencyIO2

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x403F.05	1-50000	1000	U16	Hz	RW	-	-

Frequency of the signal generated by the I/O 2 when programmed as output pwm.

PwmHwDutyCycleIO2

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x403F.06	0-100	0	U16	%	RW	-	-

Duty Cycle of the signal generated by the I/O 2 when programmed as output pwm. The value 0 means the output is disabled while the value 100 means the output is enabled.

LogicalDigitalInputStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4051.01	-	-	U32	-	RO	Yes	-

Logical status of the digital inputs, after having applied **PolarityInputValue [405A.00]**.

Bit	Resource
0-15	Reserved
16	IN/OUT 0
17	IN/OUT 1
18	IN/OUT 2
19	IN/OUT 3
20	IN 4
21	IN 5
22	IN 6
23	IN 7
24	IN 8
25	IN 9
26	/STOP
27-31	Reserved

DigitalInputs

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FD.00	-	-	U32	-	RO	Yes	-

Physical status of the digital inputs.

PhysicalOutputs

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FE.01	-	Desc	U32	-	RW	Yes	-

Status of the digital outputs. The default value of the digital outputs which have the Generic Output (I/O X - Out X) functionality is 0 (output off).

Bit	Resource
0-15	Reserved
16	IN/OUT0
17	IN/OUT1
18	IN/OUT2
19	IN/OUT3
20	OUT 4
21	OUT 5
22	OUT 6
23-31	Reserved

DigitalOutputsBitMask

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x60FE.02	-	0XFFFFFFFF	U32	-	RW	Yes	-

Enabling mask of the writing of the parameter **PhysicalOutputs [60FE.01]**: 1=writing enabled, 0=writing not enabled.

DebounceTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x405F.00	250 - 65000	250	U16	μs	RW	-	ES

Filtering time of the digital inputs.

EnableDebounce

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x405E.00	-	0	U16	-	RW	-	ES

Enabling mask of the filtering on the selected inputs.

PolarityInputValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x405A.00	-	0	U16	-	RW	Yes	-

This parameter is used to define which inputs must work by reversed logics. As default the input is on the logical status 1 when there is power on that. This setting has no effect if the input is programmed as limit switch. See **Selection of the polarity of the digital inputs** for further details.

Bit	Resource
0	IN/OUT 0
1	IN/OUT 1
2	IN/OUT 2
3	IN/OUT 3
4	IN 4
5	IN 5
6	IN 6
7	IN 7
8	IN 8
9	IN 9
7-15	Reserved

0 = Not reserved / 1 = Reserved

TerminationResistance

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x405B.00	-	0	U16	-	RW	Yes	ES

This parameter is used to enable the termination resistances for the resources at differential logics. See **Termination resistances** for further details.

Bit	Resource
0	IN/OUT0
1	IN/OUT1
2	IN/OUT2
3-15	Reserved

0 = Terminator resistor not connected / 1 = Terminator resistor connected

IO_0_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4070.01	-	1	U16	-	RW	-	ES

Functionality given to the I/O 0.

Functionalities	Code
General input (I/O X - In X)	1
General output (I/O X - Out X)	2
Fault (fault)	3
Home	7
Step	8
Dir	9
Positive limit switch (FC+)	10
Negative limit switch (FC-)	11
Enable	13
Quadrature input ChA (ChA)	14
Quadrature input ChB (ChB)	15

Functionalities	Code
Quadrature input Index (Idx)	16
Pwm out (Pwm O)	17
Motor fan (M. fan)	19
Drive fan (D. fan)	20
Drive Ok (D. OK)	22
Simulated 24V Out (S24V)	23
Simulated GND (SGND)	24

Note Simulated GND (SGND) input is not protected against overcurrent.

IO_1_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4071.01	-	1	U16	-	RW	-	ES

Functionality given to the I/O 1. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

IO_2_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4072.01	-	1	U16	-	RW	-	ES

Functionality given to the I/O 2. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

IO_3_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4073.01	-	1	U16	-	RW	-	ES

Functionality given to the I/O 3. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

In_4_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4084.01	-	1	U16	-	RW	-	ES

Functionality given to the In 4. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

In_5_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4085.01	-	1	U16	-	RW	-	ES

Functionality given to the In 5. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

In_6_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4086.01	-	1	U16	-	RW	-	ES

Functionality given to the In 6. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

In_7_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4087.01	-	1	U16	-	RW	-	ES

Functionality given to the In 7. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

In_8_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4088.01	-	1	U16	-	RW	-	ES

Functionality given to the In 8. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

In_9_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4089.01	-	1	U16	-	RW	-	ES

Functionality given to the In 9. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

Out_4_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x40C4.01	-	2	U16	-	RW	-	ES

Functionality given to the Out 4. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

Out_5_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x40C5.01	-	2	U16	-	RW	-	ES

Functionality given to the Out 5. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

Out_6_Function

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x40C6.01	-	2	U16	-	RW	-	ES

Functionality given to the Out 6. The codes functionalities are listed in the **IO_0_Function [4070.01]** section.

Functions

Index	Name	Default	Definition
0x4070.01	IO_0_Function	1	Define the function of this digital input
0x4071.01	IO_1_Function	1	Define the function of this digital input
0x4072.01	IO_2_Function	1	Define the function of this digital input
0x4073.01	IO_3_Function	1	Define the function of this digital input
0x4084.01	In_4_Function	1	Define the function of this digital input
0x4085.01	In_5_Function	1	Define the function of this digital input
0x4086.01	In_6_Function	1	Define the function of this digital input
0x4087.01	In_7_Function	1	Define the function of this digital input
0x4088.01	In_8_Function	1	Define the function of this digital input
0x4089.01	In_9_Function	1	Define the function of this digital input
0x40C4.01	Out_4_Function	2	Define the function of this digital output
0x40C5.01	Out_5_Function	2	Define the function of this digital output
0x40C6.01	Out_6_Function	2	Define the function of this digital output

10-3-18 Analog Input

AI0CalibrationParameters

Calibration of the analog input 0.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4100.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

AI0CalibrationStatus

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4100.01	-	4	U16	-	RO	-	ES

Status calibration of the analog input 0.

AI0CalibrationStatus	Description
0	No calibration run; the voltage values may not respect the specified tolerance
1	Calibration not completed (only offset); complete the calibration
2	Calibration not completed (only gain); complete the calibration
3	Calibration completed
4	Default calibration

AI0CalibrationOffset

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4100.02	-	Desc	S16	-	RO	-	ES

Calibration offset of the analog input 0. The default value is calculated with the calibration run by OMRON.

AI0CalibrationGain

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4100.03	-	Desc	U16	-	RO	-	ES

Calibration gain of the analog input 0.

AI0CalibrationVoltage

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4100.04	4000 - 10000	-	U16	mV	RW	-	-

Calibration voltage of the analog input 0. The default value is calculated with the calibration run by OMRON.

AI0FilterParameters

Filter of the analog input 0.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4110.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

AI0FilterFrequency

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4110.01	-	100	U16	Hz	RW	-	ES

Typical frequency of the filter on the analog input 0.

AI0FilterType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4110.02	Desc	2	U16	-	RW	-	ES

Filter type on the analog input 0.

AI0FilterType	Description
0	All-stop filter
1	Low-pass filter of the first order
2	Low-pass filter of the second order
3	Band-eliminating filter
65535	All-pass filter

AI0FilterQFactor

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4110.03	-	100	U16	10 = 1	RW	-	ES

Quality Q factor of the filter on the analog input 0.

AI0ConversionParameters

Settings for the conversions with the analog input 0.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4120.00	8	8	U8	-	CST	-	-

Number of parameters in this group.

AI0VSettings

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4120.01	-	1	U16	-	RW	-	ES

Setting the voltage for the conversion with the analog input 0 (0 = only positive, 1 = symmetric).

AI0RSettings

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4120.02	-	1	U16	-	RW	-	ES

Setting the reference for the conversion with the analog input 0 (0 = only positive, 1 = symmetric).

AI0VPolarity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4120.03	-	0	U16	-	RW	-	ES

Voltage polarity for the conversion with the analog input 0 (0 = normal, 1 = reversed).

AI0RPolarity

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4120.04	-	0	U16	-	RW	-	ES

Reference polarity for the conversion with the analog input 0 (0 = normal, 1 = reversed).

AI0VZone

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4120.05	-	10	U16	mV	RW	-	ES

Half amplitude of the dead zone of the analog input 0.

AI0VRefLevel

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4120.06	-	10000	U16	mV	RW	-	ES

Voltage value to define the conversion.

AI0TRefValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4120.07	0 ÷ 32767	1200	U16	10 = 1%IS	RW	-	ES

Torque value to define the conversion.

AI0WRefValue

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x4120.08	-	Motor-Rated-Speed	U32	inc/s	RW	-	ES

Speed value to define the conversion.

10-3-19 Sync Manager and PDOs managed by the EtherCAT Port

1st receive PDO Mapping

Mapping parameters of the PDO RX 1.

Number of mapped objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1600.00	0-8	1	U8	-	RW	-	-

Number of mapped objects.

PdoRx1_Objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Index	Name	Default
0x1600.01	PdoRx1_Object1	0x60B80010 (**TouchProbeFunction**)
0x1600.02	PdoRx1_Object2	0
0x1600.03	PdoRx1_Object3	0
0x1600.04	PdoRx1_Object4	0
0x1600.05	PdoRx1_Object5	0
0x1600.06	PdoRx1_Object6	0
0x1600.07	PdoRx1_Object7	0
0x1600.08	PdoRx1_Object8	0

2nd receive PDO Mapping

Mapping parameters of the PDO RX 2.

Number of mapped objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1601.00	0-8	8	U8	-	RW	-	-

Number of mapped objects.

PdoRx2_Objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Index	Name	Default
0x1601.01	PdoRx2_Object1	0x60400010 (**Controlword**)
0x1601.02	PdoRx2_Object2	0x607A0020 (**TargetPosition**)
0x1601.03	PdoRx2_Object3	0x60FF0020 (**TargetVelocity**)
0x1601.04	PdoRx2_Object4	0x60710010 (**TargetTorque**)
0x1601.05	PdoRx2_Object5	0x60600008 (**ModesOfOperation**)
0x1601.06	PdoRx2_Object6	0x607F0020 (**MaxProfileVelocity**)
0x1601.07	PdoRx2_Object7	0x60E00010 (**PositiveTorqueLimitValue**)
0x1601.08	PdoRx2_Object8	0x60E10010 (**NegativeTorqueLimitValue**)

3rd receive PDO Mapping

Mapping parameters of the PDO RX 3.

Number of mapped objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1602.00	0-8	2	U8	-	RW	-	-

Number of mapped objects.

PdoRx3_Objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Index	Name	Default
0x1602.01	PdoRx3_Object1	0x60400010 (**Controlword**)
0x1602.02	PdoRx3_Object2	0x607A0020 (**TargetPosition**)
0x1602.03	PdoRx3_Object3	0
0x1602.04	PdoRx3_Object4	0
0x1602.05	PdoRx3_Object5	0
0x1602.06	PdoRx3_Object6	0
0x1602.07	PdoRx3_Object7	0
0x1602.08	PdoRx3_Object8	0

4th receive PDO Mapping

Mapping parameters of the PDO RX 4.

Number of mapped objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1603.00	0-8	7	U8	-	RW	-	-

Number of mapped objects.

PdoRx4_Objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Index	Name	Default
0x1603.01	PdoRx4_Object1	0x60400010 (**Controlword**)
0x1603.02	PdoRx4_Object2	0x607A0020 (**TargetPosition**)
0x1603.03	PdoRx4_Object3	0x60FF0020 (**TargetVelocity**)
0x1603.04	PdoRx4_Object4	0x60710010 (**TargetTorque**)
0x1603.05	PdoRx4_Object5	0x60720010 (**MaxTorque**)
0x1603.06	PdoRx4_Object6	0x60600008 (**ModesOfOperation**)
0x1603.07	PdoRx4_Object7	0x60B80010 (**TouchProbeFunction**)
0x1603.08	PdoRx4_Object8	0

1st transmit PDO Mapping

Mapping parameters of the PDO TX 1.

Number of mapped objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1A00.00	0-8	3	U8	-	RW	-	-

Number of mapped objects.

PdoTx1_Objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Index	Name	Default
0x1A00.01	PdoTx1_Object1	0x60B90010 (**TouchProbeStatus**)
0x1A00.02	PdoTx1_Object2	0x60BA0020 (**TouchProbePosi-tion1PosValue**)
0x1A00.03	PdoTx1_Object3	0x60BC0020 (**TouchProbePosi-tion2PosValue**)
0x1A00.04	PdoTx1_Object4	0
0x1A00.05	PdoTx1_Object5	0
0x1A00.06	PdoTx1_Object6	0
0x1A00.07	PdoTx1_Object7	0
0x1A00.08	PdoTx1_Object8	0

2nd transmit PDO Mapping

Mapping parameters of the PDO TX 2.

Number of mapped objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1A01.00	0-8	6	U8	-	RW	-	-

Number of mapped objects.

PdoTx2_Objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Index	Name	Default
0x1A01.01	PdoTx2_Object1	0x603F0010 (**ErrorCode**)
0x1A01.02	PdoTx2_Object2	0x60410010 (**Statusword**)
0x1A01.03	PdoTx2_Object3	0x60640020 (**PositionActualValue**)
0x1A01.04	PdoTx2_Object4	0x60770010 (**ActualTorque**)
0x1A01.05	PdoTx2_Object5	0x60610008 (**ModesOfOperationDisplay**)
0x1A01.06	PdoTx2_Object6	0x60FD0020 (**DigitalInputs**)
0x1A01.07	PdoTx2_Object7	0
0x1A01.08	PdoTx2_Object8	0

3rd transmit PDO Mapping

Mapping parameters of the PDO TX 3.

Number of mapped objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1A02.00	0-8	2	U8	-	RW	-	-

Number of mapped objects.

PdoTx3_Objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Index	Name	Default
0x1A02.01	PdoTx3_Object1	0x60410010 (**Statusword**)
0x1A02.02	PdoTx3_Object2	0x60640020 (**PositionActualValue**)
0x1A02.03	PdoTx3_Object3	0
0x1A02.04	PdoTx3_Object4	0
0x1A02.05	PdoTx3_Object5	0
0x1A02.06	PdoTx3_Object6	0
0x1A02.07	PdoTx3_Object7	0
0x1A02.08	PdoTx3_Object8	0

4th transmit PDO Mapping

Mapping parameters of the PDO TX 4.

Number of mapped objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1A03.00	0-8	8	U8	-	RW	-	-

Number of mapped objects.

PdoTx4_Objects

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Index	Name	Default
0x1A03.01	PdoTx4_Object1	0x60410010 (**Statusword**)
0x1A03.02	PdoTx4_Object2	0x60640020 (**PositionActualValue**)
0x1A03.03	PdoTx4_Object3	0x60770010 (**ActualTorque**)
0x1A03.04	PdoTx4_Object4	0x60F40020 (**PositionFollowingError**)
0x1A03.05	PdoTx4_Object5	0x60610008 (**ModesOfOperationDisplay**)
0x1A03.06	PdoTx4_Object6	0x60B90010 (**TouchProbeStatus**)
0x1A03.07	PdoTx4_Object7	0x60BA0020 (**TouchProbePosition1PosValue**)
0x1A03.08	PdoTx4_Object8	0x60BC0020 (**TouchProbePosition2PosValue**)

SM_CommunicationType

Communication type set in Sync Manager.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C00.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

SM0_CommunicationType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C00.01	1-4	1	U8	-	RO	-	ES

Communication type of the Sync manager 0.

Value	Communication type of the Sync Manager
1	Mailbox RX
2	Mailbox TX
3	Process data RX
4	Process data TX

SM1_CommunicationType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C00.02	1-4	2	U8	-	RO	-	ES

Communication type of the Sync manager 1. You can find the accepted values in the **SM0_CommunicationType [1C00.01]** section.

SM2_CommunicationType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C00.03	1-4	3	U8	-	RO	-	ES

Communication type of the Sync manager 2. You can find the accepted values in the **SM0_CommunicationType [1C00.01]** section.

SM3_CommunicationType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C00.04	1-4	4	U8	-	RO	-	ES

Communication type of the Sync manager 3. You can find the accepted values in the **SM0_CommunicationType [1C00.01]** section.

SM0_PdoAssignment

Parameters for the assignment of the PDOs to the Sync Manager 0.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C10.00	0	0	U8	-	RO	-	-

Number of PDOs given to the Sync Manager 0. For this Sync Manager it is not possible to assign any PDO.

SM0_PdoMapping

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U16	-	RO	-	-

Parameters for the assignment of the PDOs to the Sync Manager 0. For this Sync Manager it is not possible to assign any PDO.

Index	Name	Default
0x1C10.01	SM0_PdoMapping0	0
0x1C10.02	SM0_PdoMapping1	0
0x1C10.03	SM0_PdoMapping2	0
0x1C10.04	SM0_PdoMapping3	0

SM1_PdoAssignment

Parameters for the assignment of the PDOs to the Sync Manager 1.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C11.00	0	0	U8	-	RO	-	-

Number of PDOs given to the Sync Manager 1. For this Sync Manager it is not possible to assign any PDO.

SM1_PdoMapping

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U16	-	RO	-	-

Parameters for the assignment of the PDOs to the Sync Manager 1. For this Sync Manager it is not possible to assign any PDO.

Index	Name	Default
0x1C11.01	SM1_PdoMapping0	0
0x1C11.02	SM1_PdoMapping1	0
0x1C11.03	SM1_PdoMapping2	0
0x1C11.04	SM1_PdoMapping3	0

SM2_PdoAssignment

Parameters for the assignment of the PDOs to the Sync Manager 2.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C12.00	2	2	U8	-	RO	-	-

Number of PDOs given to the Sync Manager 2. For this Sync Manager it is not possible to assign any PDO.

SM2_PdoMapping

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U16	-	RO	-	-

Parameters for the assignment of the PDOs to the Sync Manager 2, for this Sync Manager it is possible to assign only PDO RX. The assignment takes place by writing the index CoE (without subindex) of the PDO RX Mapping parameters that you want to assign.

Index	Name	Default
0x1C12.01	SM2_PdoMapping0	0x1600 (**PdoRx1_MappingParameters**)
0x1C12.02	SM2_PdoMapping1	0x1601 (**PdoRx2_MappingParameters**)
0x1C12.03	SM2_PdoMapping2	0
0x1C12.04	SM2_PdoMapping3	0

SM3_PdoAssignment

Parameters for the assignment of the PDOs to the Sync Manager 3.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C13.00	2	2	U8	-	RO	-	-

Number of PDOs given to the Sync Manager 3.

SM3_PdoMapping

Index	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	U16	-	RO	-	-

Parameters for the assignment of the PDOs to the Sync Manager 3, for this Sync Manager it is possible to assign only PDO RX. The assignment takes place by writing the index CoE (without subindex) of the PDO TX Mapping parameters that you want to assign.

Index	Name	Default
0x1C13.01	SM3_PdoMapping0	0x1A00 (**PdoTx1_MappingParameters**)
0x1C13.02	SM3_PdoMapping1	0x1A01 (**PdoTx2_MappingParameters**)
0x1C13.03	SM3_PdoMapping2	0
0x1C13.04	SM3_PdoMapping3	0

SM0_Synchronization

Parameters used for the management of the messages synchronization of the sync 0.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C30.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

SM0_SynchronizationType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C30.01	0	0	U16	-	RO	-	-

Synchronization type of the messages managed by the Sync Manager 0.

SM0_CycleTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C30.02	0	0	U32	ns	RO	-	-

Time period of the messages managed by the Sync Manager 0.

SM0_ShiftTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C30.03	0	0	U32	ns	RO	-	-

Time interval between the receiving/sending of the messages managed by the Sync Manager 0 and their application.

SM1_Synchronization

Parameters used for the management of the messages synchronization of the sync 1.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C31.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

SM1_SynchronizationType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C31.01	0	0	U16	-	RO	-	-

Synchronization type of the messages managed by the Sync Manager 1.

SM1_CycleTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C31.02	0	0	U32	ns	RO	-	-

Time period of the messages managed by the Sync Manager 1.

SM1_ShiftTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C31.03	0	0	U32	ns	RO	-	-

Time interval between the receiving/sending of the messages managed by the Sync Manager 1 and their application.

SM2_Synchronization

Parameters used for the management of the messages synchronization of the sync 2.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C32.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

SM2_SynchronizationType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C32.01	0-2; 34	1	U16	-	RW	-	-

Synchronization type of the messages managed by the Sync Manager 2.

Value	Synchronization type of the Sync Manager
0	Free run. No synchronization
1	Synchronized on this Sync Manager. Synchronization of the event started by the Sync Manager on which this setting is applied
2	Synchronized on SyncSignal 0. Synchronization on the signal Sync 0 managed by the Distributed clocks
34	Synchronized on SM 2. Synchronization of the event started by the Sync Manager 2

SM2_CycleTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C32.02	0	0	U32	ns	RW	-	-

Time period of the messages managed by the Sync Manager 2. Only times that are multiples of 1 μs are admitted.

SM2_ShiftTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C32.03	0	0	U32	ns	RO	-	-

Time interval between the receiving/sending of the messages managed by the Sync Manager 2 and their application.

SM3_Synchronization

Parameters used for the management of the messages synchronization of the sync 3.

Number of entries

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C33.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

SM3_SynchronizationType

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C33.01	0-2; 34	34	U16	-	RW	-	-

Synchronization type of the messages managed by the Sync Manager 3. You can find the meaning of the values in the **SM2_SynchronizationType [1C32.01]** section.

SM3_CycleTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C33.02	0	0	U32	ns	RW	-	-

Time period of the messages managed by the Sync Manager 3. Only times that are multiples of 1 μs are admitted.

SM3_ShiftTime

Index	Range	Default	Type	Units	Acc	PDO	Mem
0x1C33.03	0	0	U32	ns	RO	-	-

Time interval between the receiving/sending of the messages managed by the Sync Manager 3 and their application.

10-4 Object Details (DC Power Supply Unit)

10-4-1 Initial Configuration, Update and Board Identity

DeviceInformation

Information related to the device.

HardwareRevision

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
12	-	-	S16	-	RO	-	-

Device hardware revision.

BootRevision

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
15	-	-	S16	-	RO	-	-

Boot firmware revision.

FirmwareRevision

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
18	-	-	S16	-	RO	-	-

Firmware revision. If the value is -1, only the boot firmware is present.

HardwareProductCode

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
21	-	-	U32	-	RO	-	-

Device hardware code.

OemCode

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
33	-	-	U16	-	CST	-	-

Code that identifies the manufacturer.

SoftwareProductCode

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
34	-	-	U16	-	RO	-	-

Device software code.

FirmwareStatus

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
40	-	-	U8	-	RO	-	-

Firmware status.

FirmwareStatus	Description
0	CRC has not been checked
1	Do not launch firmware
10	Run
11	Permanent memory error
12	Reserved
13	CRC error
14	Hardware is not compatible with firmware
15	Boot is not compatible with firmware
16	Firmware is not compatible with hardware
17	Firmware is not compatible with boot

ManufacturerDeviceName

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
80	-	-	STR	-	CST	-	-

String in ASCII characters showing the name of the device.

R88S-EAD20R or R88S-EAD40R

ManufacturerHwVersion

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
110	-	-	STR	-	CST	-	-

String in ASCII characters showing the hardware version of the device.

ManufacturerSwVersion

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
114	-	-	STR	-	CST	-	-

String in ASCII characters showing the software version of the device.

Identity

Device identity.

ProductCode

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
122	-	-	U32	-	RO	-	-

Identification code of the device.

RevisionNumber

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
124	-	-	U32	-	RO	-	-

Device revision.

SerialNumber

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
126	-	-	U32	-	RO	-	-

Device serial number.

CpuInfo

Information of the CPU.

CPUSiliconRevision

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
580	-	-	U16	-	RO	-	-

CPU revision.

ResetCause

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
581	1 - 4	2	U32	-	RW	-	-

Code of the cause that has provoked the firmware reset.

ResetCause	Description
1	Generic reset (cause not found)
2	Reset from power-up (device turn-on)
3	Reset from line of hardware reset
4	Reset from watchdog

10-4-2 Auxiliary Communication Port

AuxiliaryPortSetup

Parameters used to configure the auxiliary communication port.

AuxiliaryPortSetupWordOrder

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
1100	0 - 1	0	U16	-	RW	-	-

Order of the words used by the device, through the auxiliary port, to receive or send the parameters of 32 bits (the byte order of the words is big-endian, as defined by the specification of the Modbus protocol, implemented in the auxiliary port).

AuxiliaryPortSet-upWordOrder	Description	Example
0	Word sent in little-endian format	The value 0x12345678 is sent in the order 0x5678 0x1234
1	Word sent in big-endian format	The value 0x12345678 is sent in the order 0x1234 0x5678

AuxiliaryPortSetupTimeOut

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
1101	20 - 65000	50	U16	ms	RW	-	EM

Timeout of the auxiliary port. If the time between two consecutive characters overcomes this value, the interface cancels the ongoing receiving of the whole frame and it prepares to receive a new frame.

AuxiliaryPortSetupBaudRateImmediate

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
1110	19200 or 57600	57600	U32	bit/s	RW	-	-

Parameters used for the immediate exchange of the baud rate of the auxiliary port. Once received the request to change the baud rate, the device sends the answer with the precedent baud rate and only after it configures the communication interface with the new baud rate.

AuxiliaryPortSetupBaudRate

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
1112	19200 or 57600	57600	U32	bit/s	RW	-	EM

Auxiliary port baud rate. This parameter, once written and saved in the permanent memory, take effect only after the device switching off and on again.

AuxiliaryPortError

Parameters to read the last error condition in writing or reading carried out with the auxiliary communication port.

AuxiliaryPortErrorParam

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
1120	-	0	U16	-	RW	-	-

Modbus address of the parameter that generated the last error condition during the writing/reading phase with the auxiliary communication port. An access in writing provokes the resetting of this parameter and of the **Auxiliary-PortErrorCode [Modbus 1121]** parameter.

AuxiliaryPortErrorCode

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
1121	Desc	0	U16	-	RW	-	-

Code of the last error condition found during the writing/reading phase with the auxiliary communication port. An access in writing provokes the resetting of this parameter and of the **AuxiliaryPortErrorParam [Modbus 1120]** parameter.

10-4-3 Monitor and Diagnostic of the Power Supply Unit

HVDC_OutputVoltage

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2001	-	0	U16	0.1 V	RO	-	-

RMS value of the HVDC output voltage.

PowerSupplyType

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2002	0 - 2	0	U16	-	RO	-	-

Power supply type (alternate voltage) on input section.

PowerSupplyType	Description
0	Not powered
1	Single-phase
2	Three-phase

CPUTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2010	-3276.8 to 3276.7	-	S16	0.1 ºC	RO	-	-

Instantaneous CPU temperature.

ControlSectionTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2011	-250 to 1200	-	S16	0.1 ºC	RO	-	-

Logic section instantaneous temperature.

PowerSectionTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2012	-250 to 1200	-	S16	0.1 ºC	RO	-	-

Power section instantaneous temperature.

ActualCurrent

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2013	-	0	S16	0.1 A	RO	-	-

Power supply output instantaneous current. This parameter represents the sum of the currents of the two channels (see **ActualCurrentCH1 (Modbus 2513)** and **ActualCurrentCH2 (Modbus 2613)**).

ActualCurrentLimit

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2014	-	-	U16	0.1 A	RO	-	-

Power supply output current limit, conditioned by **HVDC_OutputVoltage [Modbus 2001]**.

AverageCurrent

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2015	-	-	S16	0.1 A	RO	-	-

Power supply average current. This parameter represents the sum of the average currents of the two channels (see **AverageCurrentCH1 [Modbus 2515]** and **AverageCurrentCH2 [Modbus 2615]**).

ActualPower

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2016	-	-	S32	0.01 W	RO	-	-

Power supply output actual power. This parameter represents the sum of the average currents of the two channels (see **AverageCurrentCH1 [Modbus 2515]** and **AverageCurrentCH2 [Modbus 2615]**).

EnergyValues

Values of the energy that’s absorbed and provided by the power supply.

ActualDeviceEnergyOverload

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2020	-	-	U32	A^2s	RO	-	-

Actual value of overload energy provided by the power supply (I^2t).

BrakeEnergy

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2026	-	0	U32	0.001 J	RO	-	EM

Energy absorbed by the braking circuit. This circuit intervenes in case of overvoltage, caused for example by the energy that's regenerated by the motors.

ChargeCircuitEnergy

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2028	-	-	U32	0.001 J	RO	-	EM

Energy absorbed by the capacitors charging circuit at the power supplier start-up.

DeviceEnergyOverloadPercentage

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2030	0 - 32767	0	U16	%	RO	-	-

Percentage value of the overload energy provided to the power supply (related to **ActualDeviceEnergyOverload [Modbus 2020]**).

BrakeEnergyOverloadPercentage

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2031	0 - 32767	0	U16	%	RO	-	-

Percentage value of the braking circuit overload (see **BrakeEnergy [Modbus 2026]**).

ChargeCircuitEnergyOverloadPercentage

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2032	0 - 32767	0	U16	%	RO	-	-

Percentage value of the overload energy absorbed by the capacitors charging circuit.

CableEnergyOverloadPercentage

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2034	0 - 32767	0	U16	%	RO	-	EM

Percentage value of the overload energy absorbed by the cables that are connected to the outputs, referred to the **CableCurrentLimit(CH1) [Modbus 2142]** and **CableCurrentLimit(CH2) [Modbus 2145]** current limits.

BackfeedEnergy

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2058	-	0	S32	J	RO	-	-

Energy poured from the loads that are connected on the outputs (drives, motors, etc) to the power supply.

DeviceStatus

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2024	-	-	U16	-	RO	-	-

Power supply actual logic status.

Status	Description
Power OFF	Logic section 24 V supply missing, through the hardware circuit the RTO contact is kept disabled.
Boot startup	24 V supply present, boot start-up to fill a firmware anomaly (corrupted firmware or hardware and boot incompatibility).
FW install	Updating the firmware through the debug serial port.
FW startup (0, 1, 2)	24 V supply present, correct firmware start-up.
VAC in WAIT (3)	The RTO contact is closed and the VAC input voltage is controlled, the next status is reached only if an input voltage included in the functioning limits is detected, otherwise the VAC in WAIT status remains.
HVDC CHECK (4, 5)	The output voltage trend is analyzed: within the capacitors charging time the voltage must grow until a value within VOUT_MIN and VOUT_MAX and the ripple must be lower than a safety threshold. At the end of this phase, if all the parameters are within the limits, the system is in normal functioning conditions and the device switches to the Operative status, otherwise it switches to the Fault status.
Operational (6, 7)	The power supply works normally, no warnings or faults are detected.
Warning (8)	The power supply works normally, but some parameter has exceed the warning threshold (voltage/current/temperature).
Fault (9, 10)	The power supply is in this status when one of the type of the monitored faults happens, so the RTO contact is opened and the timer of Fault restore waiting starts. When the restore waiting time is elapsed it is verified if the fault is solved, and in this case the power supply returns in the VAC in WAIT status, according to available restore sources (In 0 input, automatic restore, restore via software with IM-TOOL); otherwise the Fault status remains.
Power down	The power supply is in this status when the 24 VDC voltage fall down below 18 VDC, in this case the RTO contact is opened. If the voltage supply restores, the power supply switches to the “NO 24V IN” status and returns the Input voltage missing on control section status.

LastFaultCause

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2025	-	0	U16	-	RO	-	-

Last detected fault code.

Fault type	FaultLockTime (s)	Fault code	WD	WR	FD	FR
Under voltage of power section	5	1	-	-	●	●
Over voltage of power section	5	2	-	-	●	●
Voltage ripple exceeds the limit on power section	10	3	-	-	●	●
Over temperature of logic section	10	4	●	●	●	●
Over temperature of power section	10	5	●	●	●	●
Over current of power section	10	6	-	-	●	●
Device energy overload exceeds the limit	10	7	●	●	●	●
Braking circuit energy overload exceeds the limit	10	8	●	●	●	●

Fault type	FaultLockTime (s)	Fault code	WD	WR	FD	FR
Over voltage of HVDC output during braking	-	-	●	●	-	-
Input voltage missing on power section	-	9	-	-	●	●
Short circuit on braking circuit	10	10	-	-	●	●
Input voltage missing on logic section	0.1	11	-	-	●	●
Charge circuit energy overload	100	12	-	-	●	●
Configuration parameters missing	-	13	-	-	●	●
Device energy overload exceeds the limit on channel 1	10	16	●	●	●	●
Device energy overload exceeds the limit on channel 2	10	17	●	●	●	●
Input circuit ripple exceeds the limit on power section	10	18	-	-	●	●
Input voltage falling on power section	5	19	-	-	●	●
Cable energy overload exceeds the limit on channel 1	100	21	●	●	●	●
Cable energy overload exceeds the limit on channel 2	100	22	●	●	●	●
Hardware configuration not valid	10	20	-	-	●	●

BrakeDutyCycle

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2033	-	0	U16	‰	RO	-	-

Duty cycle of the braking circuit, expressed in ‰.

CurrentRMSValues

RMS current values.
RMS = root-mean-square value of the current signals.

Note The calculation period of the RMS value can be set through the **RMS_Average_CalculationPeriod [Modbus 2112]** parameter.

RMS_Current

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2048	-	0	S32	0.1 A	RO	-	-

Total root-mean-square value calculated with the contribution of the **RMS_OutputCurrent [Modbus 2052]** and **RMS_BackfeedingCurrent [Modbus 2054]**.

RMS_OutputCurrent

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2052	-	0	S32	0.1 A	RO	-	-

Root-mean-square current provided by the power supply.

RMS_BackfeedingCurrent

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2054	-	0	S32	0.1 A	RO	-	-

Root-mean-square current absorbed by the power supply.

AveragePower

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2056	-	0	S32	0.01 W	RO	-	-

Average power provided by the power supply.

TemperatureLimits

Temperature Limit.

ControlSideFaultTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2060	-	85.0 ºC	S16	0.1 ºC	RO	-	ES

Temperature fault threshold of the Logic section.

ControlSideWarningTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2061	-	700	S16	0.1 ºC	RO	-	ES

Temperature warning threshold of the Logic section.

PowerSideFaultTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2064	-	900	S16	0.1 ºC	RO	-	ES

Temperature fault threshold of the Power section.

PowerSideWarningTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2065	-	800	S16	0.1 ºC	RO	-	ES

Temperature warning threshold of the Power section.

FaultLockTime

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2068	-	Desc	S32	ms	RO	-	-

Power supply lock time in case of fault (permanent fault status and output voltage not present) before the system can be restored and returns operative. To every fault a restore time is related.
For more details, see Section **13-3-1 Reaction to the Faults**.

10-4-4 Power Supply Unit Configuration

DeviceModel

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2100	1 - 2	Desc	U16	-	RO	-	ES

DC Power Supply model: 1 = R88S-EAD20R, 2 = R88S-EAD40R.

AutomaticRestartFunction

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2101	0 - 1	0	U16	-	RO	-	ES

Automatic restart function: 0 = Disabled, 1 = Enabled.

VoltageValues

Voltage values.

MinVoutFaultThreshold

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2102	-	1000	U16	0.1 V	RO	-	ES

Minimum output voltage value, under which the power supply enters in fault status.

MaxVoutFaultThreshold

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2103	-	8300	U16	0.1 V	RO	-	ES

Maximum output voltage value, over which the power supply enters in fault status.

BrakeCircuitParameters

Values related to the internal braking circuit resistor.

IntBrakeResistorValue

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2107	-	33	U16	Ω	RO	-	ES

Internal brake resistor value.

IntBrakeResistorNominalEnergy

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2108	-	6000	U32	J	RO	-	ES

Nominal energy that can be absorbed by the brake resistor.

IntBrakeResistorNominalPower

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2110	-	120	U16	W	RO	-	ES

Nominal power that can be absorbed by the brake resistor.

CapacitorDischargeTimeout

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2114	-	4000	U16	ms	RO	-	ES

Waiting time, in case of fault, before to start the capacitors discharge and to reset the output voltage.
Don't touch the HVDC output connectors (x7 and x8 Power output until the capacitors are not totally discharged (**HVDC_OutputVoltage [Modbus 2001]** = 0 VDC).

UserParameters

Parameters that can be set by the user.

RMS_Average_CalculationPeriod

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2112	-	1000	U16	ms	RW	-	ES

RMS and average current signals value calculation period.

OutputCurrentLimit

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2134	Desc	Desc	U16	0.1 A	RW	-	ES

Output current limit (it’s the sum of the CH1 + CH2 currents).

R88S-EAD20R		R88S-EAD40R	
Range	Default	Range	Default
10 - 200	200	10 - 400	400

OutputVoltageLimit

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2135	1000 - 8300	8300	U16	0.1 V	RW	-	ES

Output voltage limit.

BrakingCircuitActivationVoltage

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2136	1000 - 7850	7850	U16	0.1 V	RW	-	ES

Braking circuit activation voltage.

CableCurrentLimit(CH1)

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2142	Desc	Desc	U16	0.1 A	RW	-	ES

Output current limit on channel 1.

R88S-EAD20R		R88S-EAD40R	
Range	Default	Range	Default
10 - 250	100	10 - 250	200

CableCurrentLimit(CH2)

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2145	Desc	Desc	U16	0.1 A	RW	-	ES

Output current limit on channel 2.

R88S-EAD20R		R88S-EAD40R	
Range	Default	Range	Default
10 - 250	100	10 - 250	200

ExternalBrakeSettings

Braking circuit configuration parameters.

BrakeCircuitSelector

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2137	0 - 2	0	U16	-	RW	-	ES

Configuration of the active braking circuit: 0 = internal, 1 = external, 2 = internal + external.

ExtBrakeResistorNominalEnergy

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2138	100 - 2000000	6000	U32	J	RW	-	ES

Nominal energy that can be absorbed by the brake resistor.

ExtBrakeResistorNominalPower

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2140	100 - 40000	120	U16	W	RW	-	ES

Nominal power that can be absorbed by the brake resistor.

ExtBrakeResistorValue

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2141	16 - 1000	33	U16	Ω	RW	-	ES

External brake resistor value.

10-4-5 Fault and Warning

RetentiveWarning

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2400	-	0	U32	-	RW	-	-

Retentive warnings mask. By writing 0 in this parameter, all the active warnings reset.

DynamicWarning

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2402	-	0	U32	-	RO	-	-

Dynamic warnings mask.

RetentiveFault

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2404	-	0	U32	-	RW	-	-

Retentive fault mask. By writing 0 in this parameter, all the active faults reset.

DynamicFault

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2406	-	0	U32	-	RO	-	-

Dynamic fault mask.

10-4-6 Output Channels Monitor

Channel1CurrentValues

Current values of the channel 1.

Legend for the RMS parameter reading:
- P = Current provided by the power supply
- N = Current absorbed by the power supply
- RMS = Root-mean-square value of the current signals

Note The calculation period of the RMS value can be set through the **RMS_Average_CalculationPeriod [Modbus 2112]** parameter.

RMS_CurrentCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2548	-	0	S32	0.1 A	RO	-	-

Total root-mean-square value calculated with the contribution of **RMS_OutputCurrentCH1 [Modbus 2552]** and **RMS_BackfeedingCurrentCH1 [Modbus 2554]**.

RMS_OutputCurrentCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2552	-	0	S32	0.1 A	RO	-	-

Root-mean-square current provided by the power supply on the channel 1.

RMS_BackfeedingCurrentCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2554	-	0	S32	0.1 A	RO	-	-

Root-mean-square current absorbed by the power supply on the channel 1.

ActualCurrentCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2513	-	0	S16	0.1 A	RO	-	-

Power supply output instantaneous current for channel 1.

AverageCurrentCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2515	-	0	S16	0.1 A	RO	-	-

Power supply output average current for channel 1.

Channel1PowerValues

Power values of the channel 1.

ActualPowerCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2516	-	0	S32	0.01 W	RO	-	-

Power supply output actual power value for the channel 1.

AveragePowerCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2556	-	0	S32	0.01 W	RO	-	-

The time is shown on variable **RMS_Average_CalculationPeriod [Modbus 2112]**. Is used to calculate the average power.

Channel1EnergyValues

Values of the energy that's absorbed and provided by the power supply from the channel 1.

ActualDeviceEnergyOverloadCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2520	-	-	U32	A^2s	RO	-	-

Actual value of overload energy provided by the power supply (I^2t) on the channel 1.

DeviceEnergyOverloadPercentageCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2530	-	0	U16	%	RO	-	-

Percentage value of the overload energy provided to the power supply on the channel 1 (related to **ActualDeviceEnergyOverloadCH1 [Modbus 2520]** parameter).

CableEnergyOverloadPercentageCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2534	-	0	U16	%	RO	-	EM

Percentage value of the overload energy absorbed by the cables that are connected to the channel 1.

Channel2CurrentValues

Current values of the channel 2.

Legend for the RMS parameter reading:
- P = Current provided by the power supply
- N = Current absorbed by the power supply
- RMS = Root-mean-square value of the current signals

Note The calculation period of the RMS value can be set through the **RMS_Average_CalculationPeriod [Modbus 2112]** parameter.

RMS_CurrentCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2648	-	0	S32	0.1 A	RO	-	-

Total root-mean-square value calculated with the contribution of **RMS_OutputCurrentCH2 [Modbus 2652]** and **RMS_BackfeedingCurrentCH2 [Modbus 2654]**.

RMS_OutputCurrentCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2652	-	0	S32	0.1 A	RO	-	-

Root-mean-square current provided by the power supply on the channel 2.

RMS_BackfeedingCurrentCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2654	-	0	S32	0.1 A	RO	-	-

Root-mean-square current absorbed by the power supply on the channel 2.

ActualCurrentCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2613	-	0	S16	0.1 A	RO	-	-

Power supply output instantaneous current for channel 2.

AverageCurrentCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2615	-	0	S16	0.1 A	RO	-	-

Power supply output average current for channel 2.

Channel2PowerValues

Power values of the channel 2.

ActualPowerCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2616	-	0	S32	0.01 W	RO	-	-

Power supply output actual power value for the channel 2.

AveragePowerCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2656	-	0	S32	0.01 W	RO	-	-

The time is shown on variable **RMS_Average_CalculationPeriod [Modbus 2112]**. Is used to calculate the average power.

Channel2EnergyValues

Values of the energy that's absorbed and provided by the power supply from the channel 2.

ActualDeviceEnergyOverloadCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2620	-	-	U32	A^2s	RO	-	-

Actual value of overload energy provided by the power supply (I^2t) on the channel 2.

DeviceEnergyOverloadPercentageCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2630	-	0	U16	%	RO	-	-

Percentage value of the overload energy provided to the power supply on the channel 2 (related to **ActualDeviceEnergyOverloadCH2 [Modbus 2620]** parameter).

CableEnergyOverloadPercentageCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2634	-	0	U16	%	RO	-	EM

Percentage value of the overload energy absorbed by the cables that are connected to the channel 2.

10-4-7 Internal Diagnostic

RectifierBridgeVoltageSignal

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2824	-	-	S16	0.1 VDC	RO	-	-

Measured voltage signal of the diode-rectifier bridge.

Note The following parameters report the minimum and maximum values that have been reached by the physical quantities. The measurements start at the conclusion of the start-up (power supply on the OPERATIONAL status).

VoltageMin/MaxValues

Minimum and maximum HVDC voltage values.

MinHVDC_OutputVoltage

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2900	-	0	U16	0.1 V	RO	-	-

Minimum value reached by **HVDC_OutputVoltage [Modbus 2001]**.

MaxHVDC_OutputVoltage

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2901	-	0	U16	0.1 V	RO	-	-

Maximum value reached by **HVDC_OutputVoltage [Modbus 2001]**.

CurrentMin/MaxValues

Minimum and maximum current values.

MinRMS_Current

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2905	-	0	S16	0.1 A	RO	-	-

Minimum value reached by **RMS_Current [Modbus 2048]**.

MaxRMS_Current

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2906	-	0	S16	0.1 A	RO	-	-

Maximum value reached by **RMS_Current [Modbus 2048]**.

MinActualCurrent

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2911	-	0	S16	0.1 A	RO	-	-

Minimum value reached by **ActualCurrent [Modbus 2013]**.

MaxActualCurrent

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2912	-	0	S16	0.1 A	RO	-	-

Maximum value reached by **ActualCurrent [Modbus 2013]**.

MinActualCurrentCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2926	-	0	S16	0.1 A	RO	-	-

Minimum value reached by **ActualCurrentCH1 [Modbus 2513]**.

MaxActualCurrentCH1

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2927	-	0	S16	0.1 A	RO	-	-

Maximum value reached by **ActualCurrentCH1 [Modbus 2513]**.

MinActualCurrentCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2928	-	0	S16	0.1 A	RO	-	-

Minimum value reached by **ActualCurrentCH2 [Modbus 2613]**.

MaxActualCurrentCH2

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2929	-	0	S16	0.1 A	RO	-	-

Maximum value reached by **ActualCurrentCH2 [Modbus 2613]**.

Max_AveragePower

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2920	-	0	S32	0.01 W	RO	-	-

Maximum value reached by **AveragePower [Modbus 2056]**.

EnergyMaxValues

Energy maximum values.

MaxDeviceEnergyOverloadPercentage

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2913	-	0	U16	%	RO	-	-

Maximum value reached by **DeviceEnergyOverloadPercentage [Modbus 2030]**.

MaxActualDeviceEnergyOverload

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2914	-	0	U32	0.001 J	RO	-	-

Maximum value reached by **ActualDeviceEnergyOverload [Modbus 2020]**.

MaxBrakeEnergy

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2916	-	0	U32	0.001 J	RO	-	-

Maximum value reached by **BrakeEnergy [Modbus 2026]**.

MaxChargeCircuitEnergy

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2918	-	0	U32	0.001 J	RO	-	-

Maximum value reached by **ChargeCircuitEnergy [Modbus 2028]**.

MaxBackfeedEnergy

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2922	-	0	U32	0.001 J	RO	-	-

Maximum value reached by **BackfeedEnergy [Modbus 2058]**.

TemperatureMin/MaxValues

Minimum and maximum temperature values.

MinControlSectionTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2907	-	0	S16	0.1 ºC	RO	-	-

Minimum value reached by **ControlSectionTemperature [Modbus 2011]**.

MaxControlSectionTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2908	-	0	S16	0.1 ºC	RO	-	-

Maximum value reached by **ControlSectionTemperature [Modbus 2011]**.

MinPowerSectionTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2909	-	0	S16	0.1 ºC	RO	-	-

Minimum value reached by **PowerSectionTemperature [Modbus 2012]**.

MaxPowerSectionTemperature

Modbus	Range	Default	Type	Units	Acc	PDO	Mem
2910	-	0	S16	0.1 ºC	RO	-	-

Maximum value reached by **PowerSectionTemperature [Modbus 2012]**.

10-5 System Manager (Integrated Servo Motor)

To run some operations or commands different from those offered by the CiA402 it is necessary to use the System manager. To run a command you must respect the following rules:

- Write the code of the desired command of the parameter **SysMngCommand [5FF7.01]**:
  - If during the writing of the parameter **SysMngCommand [5FF7.01]** you get the error code **Attempt to write a read only object**, it means that the command cannot be run since you are already running another command
  - If during the writing of the parameter **SysMngCommand [5FF7.01]** you get the error code **Generic error**, it means that the command cannot be run; the reason of this is specified by the parameter **SysMngError [5FF7.03]**
  - If during the writing of the parameter **SysMngCommand [5FF7.01]** you get the error code **No error**, the command is accepted and immediately run
- Wait for the end of the command, that is that the parameter **SysMngCommand [5FF7.01]** is equal to 0
- Check if the command was correctly run by reading the possible cause of the error in the parameter **SysMngError [5FF7.03]**
- When a command is running (parameter **SysMngCommand [5FF7.01]** different from 0), the drive cannot be taken to the Operation enable state
- When an axis motion command is active it's not possible to write in the **ModesOfOperation [6060.00]** parameter, and the **ModesOfOperationDisplay [6061.00]** parameter assumes the value -127 (Tuning Mode)

System manager safety conditions

The following safety conditions are needed to run some commands:

- Disabled drive
- Setting the functionality Generic Output (I/O X - Out X) for the digital outputs and for the digital I/O (bidirectional peripheral) programmed as outputs
- Digital outputs and digital I/O (bidirectional peripheral) programmed as outputs, switched off
- Capture unit in stop

System manager command forcing

To ask the drive to go automatically in the System manager safety conditions, write the value 1 in the parameter **SysMngEnForcing [5FF7.06]** before writing the command. The safety conditions are forced solo only for those commands of the System manager requesting it.

SysMngCommand	Description
2200	Permanent memory: restore to default of all parameters (permanent)
2201	Reset to default all parameters (temporary)
2250	Permanent memory: delete motor and sensor data
2300	Permanent memory: reload value of all parameters
5000	Hard firmware reset
5001	Soft firmware reset
5100	Request download firmware
6000	Downloading parameters file

Note You may force the commands only after having seen the System manager safety conditions.

Reset of the Watchdog of the System manager

Some System manager commands need a cyclic writing in the **ResetWatchdogTimeout [3500.00]** parameter to inform the drive that the connection with the interlocutor that has been required by the command is still active and it's working. If the time between two writing operations is longer than 2 seconds, the current command is terminated and **SysMngError [5FF7.03]** assumes the value 1001. The commands which need the writing of **ResetWatchdogTimeout [3500.00]** are listed in the below table. In the **ResetWatchdogTimeout [3500.00]** parameter it has to be written the value of **SysMngCommand [5FF7.01]** to reset the timeout.

SysMngCommand	Description
1001	Tuning: extended inertia estimator
1002	Tuning: inertia estimator
1003	Tuning: RL estimator
1010	Function generator current D
1015	Function generator current Q
1020	Function generator velocity
1030	Function generator position
1040	Function generator profile velocity
1050	Function generator profile position

11

Operation

This section gives the operating procedures and explains how to operate in each mode.

11-1 Electrical Connections

Note The Integrated Servo Motor systems must be installed by specialized personnel only that must have an in-depth knowledge about the safety requirements and the electromagnetic compatibility (EMC). The planner has the responsibility to guarantee that the product or the final system comply to the pertinent regulations that are in force in the country in which the product (or the entire system) is used.

Note The producer must analyze the risks and apply the correct measures to avoid damages to people or things that may be caused by unexpected movements (due for example to a drive or its command system anomaly).

Note The Integrated Servo Motor system must be installed in an environment that guarantees the conditions that this manual prescribes, in particular it must be protected from excessive humidity and/or condensation. Furthermore it must be respected the maximum environment temperature (see **Section 3 Specifications**), considering that the heat that's produced by the system must be adequately dissipated in order to not exceed the maximum working temperature. To ensure the maximum reliability of the system and of the related installation, the regular controls for the maintenance of the overwritten conditions must be done.

Note Before to make any intervention (as for example the transparent cover removal for the settings of the communication bus) always disconnect the voltage supply through an approved isolation device and wait at least 1 minute to be sure that the residual voltages will revert to the security levels. Please consider also that the permanent magnets motors generate electric power if they are rotated, even when the system supply is disconnected. Therefore pay attention if the load connected to the motor may rotate it when the drive is not powered.

The section about the electrical connection includes both the connectors pinout and the characteristics description of the different parts which the system is made of; in particular the supply section, with the related limits, and the interface section (communication bus, digital inputs and outputs, analog input, debug serial port).

Note A correct cable, ground and shield wiring is essential for the drive safety and correct functioning. It's better if the cables are not interrupted; if it is not possible, be sure that the interruptions are reduced to the shortest possible length. It's recommended to always wire the cables without voltage presence.

11-1-1 System Supply

For the Integrated Servo Motor supply one voltage for the logic section and another one, separated from the first one, for the power section are necessary. Both these voltages must be of DC type (direct voltage) The connector for the voltage supply is CN5.

Note Use the R88S-EAD Power Supply or equivalent one to provide the adequate DC power supply to one or several Integrated Servo Motors.

There are no restrictions about the supply sequence: it can be provided the logical voltage supply first and then the power one, and vice versa. But without the logical voltage the system doesn't turn on, therefore in this situation the LEDs don't light and it's not possible any communication (even if the power voltage is present).

To connect the voltage supply use a shielded cable with an adequate section. The cable shield must be connected to the ground on the power pack side.

In order to the safety, to a well functioning of the drive and to a better behaviour against the noises, it's necessary to make the ground connection through a low impedance conductor (with a not lower than 4 mm^2 section). This conductor must be referred to the grounded equipotential collector of the machine. Even the motor must be connected to the ground independently from the drive. Usually this is made by a secure and conductive coupling of the motor flange on the support metallic structure that must be connected to the ground. In any case it must be made even the connection of the protection earth (PE) on the supply connector CN5.

Note NEVER apply neither an AC type voltage (alternating voltage), nor a DC type voltage (direct voltage) out of the described limits range or with a reverse polarity than the one described in the manual: this may cause the damage of the power and/or control sections of the drive, and imply electrical arcs or fire risk.

Note The drive is provided of a control in case of overvoltage or undervoltage, so that the drive is disabled if there are some supply problem, but this doesn't exclude to maintain the voltage between the limits, in particular in case of overvoltage. No “dump” supply circuit is in fact present in the Integrated Servo Motor.

Note The unit is NOT protected against the +HV supply polarity reverse: pay attention during the connector wiring.

Note The logic voltage supply must be guarantee “on the system connector level”. Be sure that this range is respected in particular if a long cable is used (eventually compensate the voltage drop in the cable by giving a higher voltage upstream).

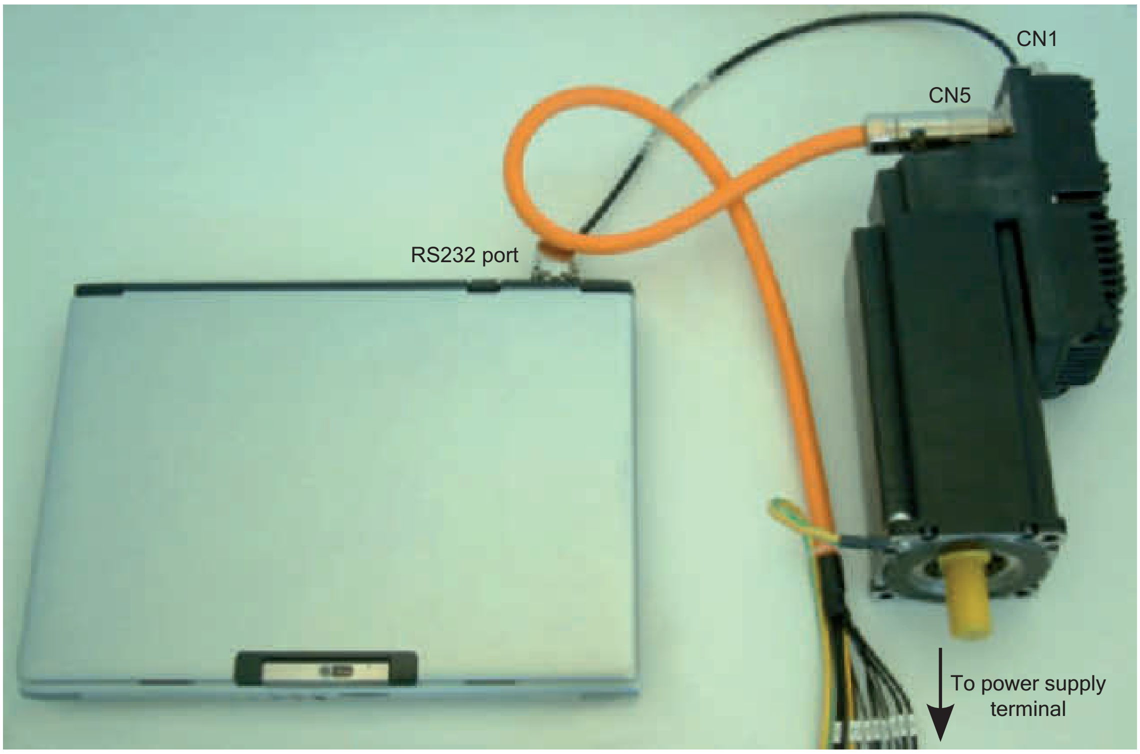
11-2 Preparing for Operation

For a quick test installation of the Integrated Servo Motor, follow what is reported in this subchapter.

Before starting

Requested instruments, materials and equipment

- Supply system to supply the logical and power section
- Supplying cable to connect to the CN5 connector
- Serial cable to connect to the CN1 connector
- Screwdrivers to tighten the supply conductor according to the suitable wiring
- PC with serial port RS232



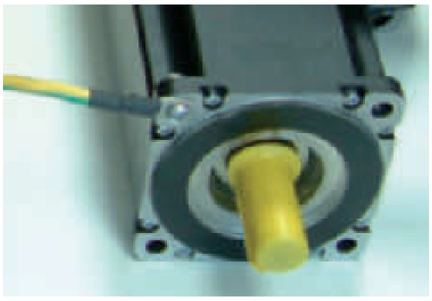
Hardware installation

1. Mechanical installation

For the system installation use the 4 holes on the motor anterior flange. The dimensions are reported in the **Section 2-4-1 Integrated Servo Motor Dimensions**. Be sure that the drive and the motor ventilation is free, respecting however the maximum admitted environment temperature (see **Section 3-1-1 General Specifications** for more details).

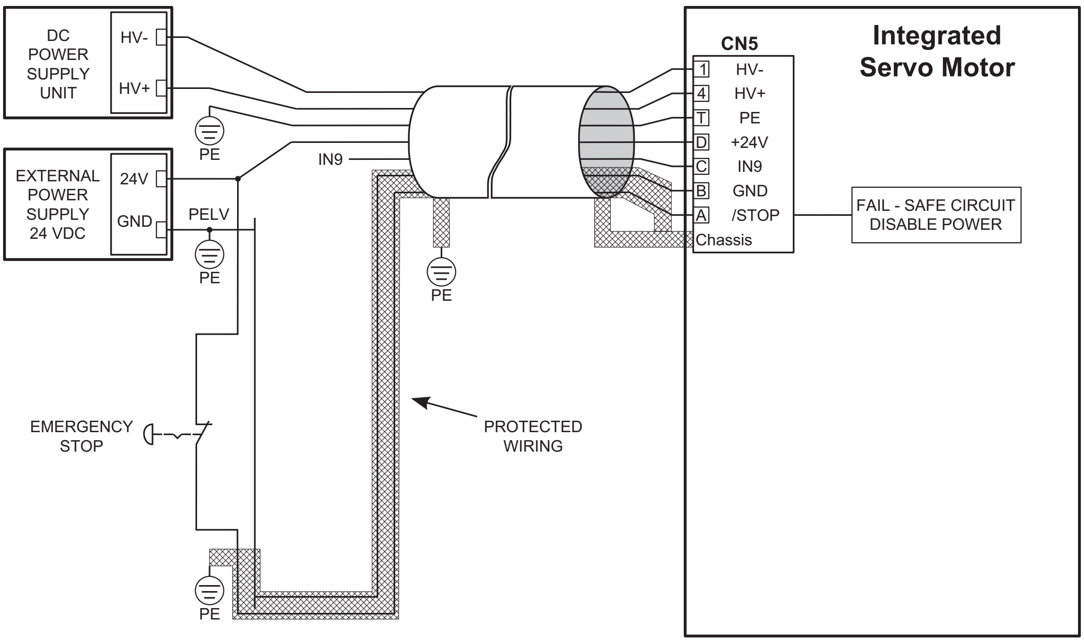
2. Connection of the protection conductors

Connect the protection conductor PE to the motor flange as shown in the following picture:



3. Connection of the supplies and /STOP

Connect the supplies and the /STOP input to the power supplies as shown in the following scheme:



Note Before proceeding, check if the power supplies are switched off and there is no more voltage in the connection terminal boards.

To connect the pins of CN5, please pay attention to what is shown in the following table:

PIN	Signal	Description
1	HV-	DC power supply (negative pole)
3	-	Not used. Do not connect
4	HV+	DC power supply (positive pole)
⏚	PE	Protection earth
A	/STOP	Safety loop (the signal is at reversed logic)
B	GND	Ground logic supply
C	IN9	Digital input 9
D	+24 V	+24 VDC logic supply
Chassis	PE	Protection earth

Note When the voltage of the digital input associated to the /STOP function is cut off, the motor torque is disabled in a safe way, the drive power section is disabled without cutting the voltage to the DC bus and it is not possible to control the motor motion. It is advisable to always stop the motor before disabling the input /STOP.

4. Connection of the serial port

Connect the serial port RS232 to the CN1 connector of the Integrated Servo Motor.

Note Connect and disconnect the communication connectors only when the drive is switched off. Check if the pin ground logic supply of CN5, the drive and the PC are correctly connected to the protection conductor.

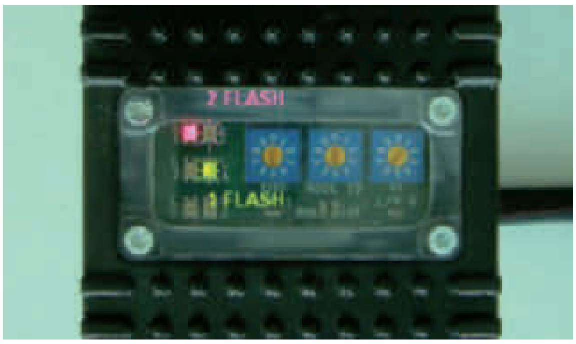
To connect the pins of CN1, please pay attention to what is shown in the following table:

PIN	Signal	Description
1	TX232	Transmit data RS232
2	RX232	Receive data RS232
3	NC	Not used. Do not connect
4	GND_COM	Ground RS232
Chassis	PE	Protection earth

5. Confirmation of the connections

After having completed the connections, check if they are correctly connected and switch on the power supply of the logical section (24 VDC). The LEDs of the transparent window should have the following configuration:

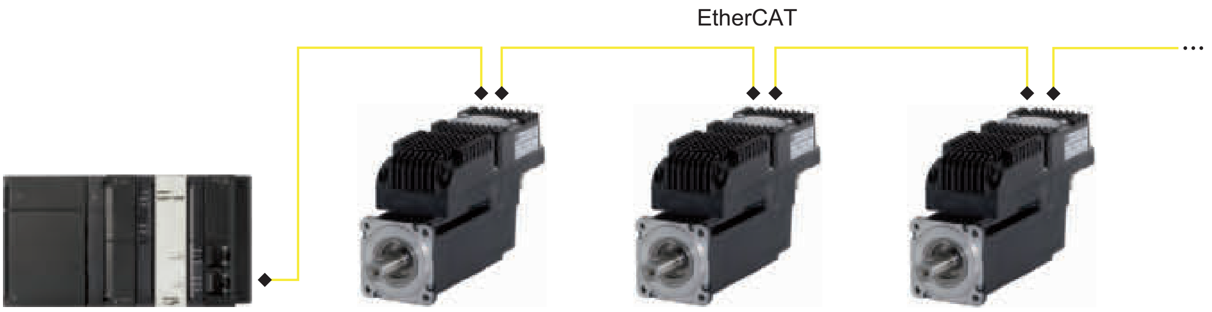
- L1 RED ON, L2 RED 2 FLASH, drive in fault for Under voltage power section error
- L4 GREEN, 1 FLASH, Actual motor current at 0
- L3 and L5 OFF
- L6 OFF, no voltage on the /STOP input



11-3 Communicating with EtherCAT Master

Note The details on the protocol implementation are described in **Section 5 EtherCAT Communications**.

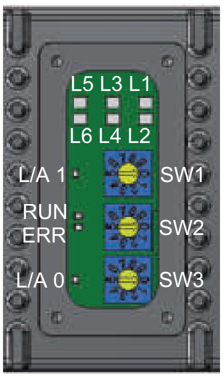
Connect the cables of the EtherCAT network to CN2 and CN3: with CN2 connect the output cable and on CN3 the input cable.



Configure the communication EtherCAT port, by defining the node number. The baud rate (communication speed), according to its technical feature, is set to 100Mbit/s. To define the node number, the master can choose one of the following modes:

- **Positional:** method generally used by the masters for the automatic detection of the drives in the EtherCAT network; the master gives every node an address which is coherent with the physical position owned by the drive in the network. In this case, set the rotary switches to zero.
- **Configured station alias:** the node number is calculated on the basis of the drive rotary switch setting; when the drive is reset (see Enabled parameters after reset), the calculated node number is written in the register Configured station alias of the ET1100.

Node number = DP3 + DP2 x 10 + DP1 x 100



Status of the L/A 0, L/A 1, ERR and RUN LEDs

Interpretation of the LEDs status:

- **L/A 0 and L/A 1:** link status and possible ongoing activity in the two physical ports; L/A 0 takes the status of the accessible input port from the connector CN3, L/A 1 takes the status of the accessible output port from the connector CN2
- **ERR:** error status found by the EtherCAT port
- **RUN:** status of the EtherCAT state machine

Link of the physical port	Activity of the physical port	L/A 0 and L/A 1
No connection	-	OFF
Connected	No message	ON
Connected	Communication enabled	FLK

EtherCAT port errors	Description	ERR
No error	The EtherCAT port is working correctly	OFF
Configuration not valid	Wrong settings of the communication EtherCAT port: the change of the status of the EtherCAT state machine requested by the master is not possible	BLK
Change of status not requested	The drive has automatically changed the status of the EtherCAT state machine without any command by the master. This solution is generally chosen when there is an error in the synchronization	1 FL
Sync Manager watchdog expired	The watchdog of the Sync manager (SM) of the PDO RX has expired	2 FL
Hardware failure	Serious error in the ET1100; please contact your OMRON representative	ON

EtherCAT state machine status	RUN
INIT	OFF
PRE-OPERATIONAL	BLK
SAFE-OPERATIONAL	1 FL
OPERATIONAL	ON
BOOTSTRAP	FLK

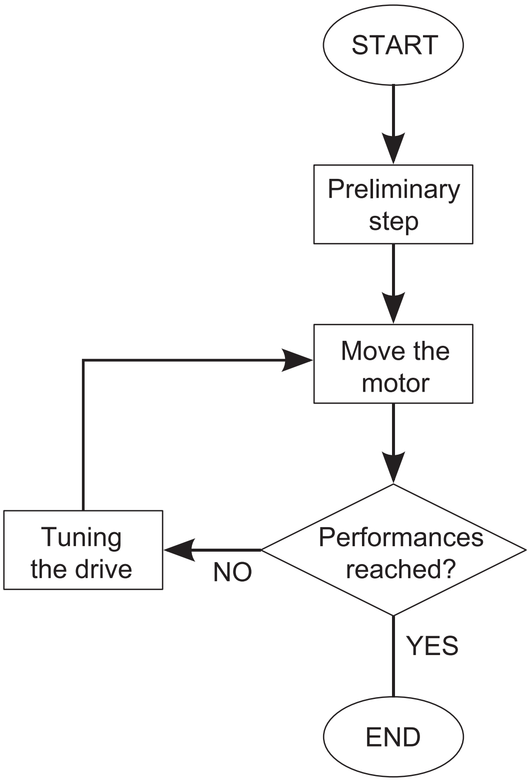
12

Adjustment Functions

This section explains the functions, setting methods, and items to note regarding various gain adjustment.

12-1 How to Determine the Tuning Criterion

To tune the Integrated Servo Motors follow the instructions in this and in the next paragraphs. The operations for adjusting the drive are summarized in the next flow chart.



1. Preliminary step A: System data

Before starting the tuning process it is necessary to gather all the data of the mechanical load; in particular you need to analyse the transmission typology and quality, the stiffness of the machine structure and size of the inertia moments, frictions, elasticity and plays.

The more information you have, the easier the next tuning phases will be. Check if the requested performances are compatible with the system mechatronic features. Check if the electric connections are correctly connected and the mechanical transmission is perfectly working.

2. Preliminary step B: Requested performances

Define the motion performances to be reached. Without these data, the tuning has no sense.

Defining precisely the requested performances by including all evaluation criteria may simplify the tuning validation. You can include in the technical specifications also the nonscientific criteria as for example getting a visibly fluid motion with no bothering noise.

Every parameter can be analysed for the tuning validation.

3. Move the motor

To check the basic performances it is necessary to move the motor with realistic motions in the foreseen load conditions. You can start with some easy and slow motions and then move to the motions the machine is designed for. The motion must be carried out by starting from low working speeds till over the requested limit in order to check the system solidity.

In presence of variable load the motion must be tested in the different configurations and in particular in the extreme and more demanding ones. To move the motor you can start with the internal references generator (**Section 12-6 Function Generator**) and then use the motion controller which produces the working cycle the machine is designed for.

Note Before moving the motor check if you can stop it in safety. If some errors or anomalies happen during the tuning, the motor can quickly reach a non-controlled speed, reaching quickly the position limit and hitting violently some other mechanical parts. To avoid such inconveniences enable all the necessary precautions and configure precisely all drive limits.

4. Performance reached?

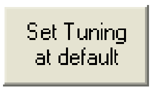
To answer to this question you need to get the specifications about the requested motion performances; it is easier to understand when one motion is not acceptable than trying to understand the exact point where one acceptable motion becomes unacceptable. Most of the objective criteria are based on the numerical analysis of parameters as **PositionFollowingError [60F4.00]** and SpeedFollowingError in some particular points of the working cycle. For example: **PositionFollowingError [60F4.00]** lower than X increment after Y milliseconds at the end of the acceleration ramp; SpeedFollowingError limited in % during a motion at constant speed; **ActualTorque [6077.00]** never higher than X % as to the selected limit. It is important to concentrate on those criteria that can guarantee the system reliable performances.

5. Tuning the drive

The tuning of the drives of the Integrated Servo Motor series must be done by using IM-TOOL. Access:

Main menu > Drive > Loop settings and tunning... > Tab Tuning configuration
or
Toolbar >  > Tuning configuration Tab.

The first operation to do is setting the drive in the default configuration: press the button



or run the command 1101 of the **SysMngCommand [5FF7.01]**. In this configuration the motor can move with lowest dynamic performances; if the motion satisfies the requested performances, it is not necessary to run further tuning operations. To tune the loops use one of the following criteria:

- **Section 12-3 Fast Tuning Guide**
- **Section 12-4 Detailed Tuning Guide**
- **Section 12-5 Interactive Tuning Guide**

The loops that have to be tuned depending on the operative modes are listed in the following table:

Mode operation	CurrentLoop	VelocityLoop	PositionLoop
Torque (Torque mode, Torque AI mode, Cyclic Synchronous Torque mode)	●	●	-
Speed (Profile Velocity mode (CiA402), Profile Velocity mode (CUSTOM), Profile Velocity AI mode, Cyclic Synchronous Velocity mode)	●	●	-
Position (Profile Position mode, Interpolated Position mode, Cyclic Synchronous Position mode)	●	●	●
Homing (Homing mode)	●	●	●

Note If the motor is controlled in one of the torque modes, it's necessary to tune the velocity loops, because the “halt” and “quick stop” commands and the non fatal fault execute a deceleration ramp, controlled in velocity, to stop the motor.

Note Whatever is the selected **ModesOfOperation [6060.00]**, the Safety profile executes a movement that's controlled in position. To use the security profile it's necessary to tune the position loop.

Note In the Cyclic Synchronous modes, the way that the drive calculates the velocity feedforward and acceleration feedforward depends on the setting of the interpolation mode. See **CyclicSynchronousSubMode [42D0.00]**.

12-2 Reset the Tuning

To take the tuning configuration back to a known condition, choose among the System Manager commands that are listed in the following table:

Name	SysMng-Command	Button	Description
Set all loops, tuning and estimated parameters at default	1101	Set all loops, tuning and estimated parameters at default	Set the loop parameters (**CurrentLoop [60F6.xx]**, **VelocityLoop [60F9.xx]**, **PositionLoop [60FB.xx]**) of the **TuningConfigurations [3502.xx]** and of the estimated parameters (**InertiaEstimator [3503.xx]** and **RLEstimator [3504.xx]**) to the default values
Parameter recalculation of all loops	1102	Recalculate all loops	Recalculation of the loop parameters in relation to the **TuningConfigurations [3502.xx]** and to the estimated parameters
Parameter recalculation of motion loops	1103	-	Recalculation of the motion loop parameters in relation to the **TuningConfigurations [3502.xx]**, to the estimated parameters and to the **CurrentLoopEstimatedBandwidth [3501.01]**
Parameter recalculation of current loop	1110	Recalculate	Recalculation of the **CurrentLoop [60F6.xx]** parameters in relation to the **TuningConfigurations [3502.xx]** and to the estimated parameters
Parameter recalculation of speed loop	1120		Recalculation of the **VelocityLoop [60F9.xx]** parameters in relation to the **TuningConfigurations [3502.xx]**, to the estimated parameters and to **CurrentLoopEstimatedBandwidth [3501.01]**
Parameter recalculation of position loop	1130		Recalculation of the **PositionLoop [60FB.xx]** parameters in relation to the **TuningConfigurations [3502.xx]**, to the estimated parameters and to **VelocityLoopEstimatedBandwidth [3501.02]**
Permanent memory: reload value of loops parameters and tuning configuration	2301	Load loops parameters from permanent memory	Updating the loops parameters and the **TuningConfigurations [3502.xx]** with the values in the permanent memory

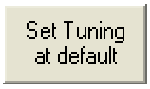
If using the configuration tool, those commands are executed by the tool in a transparent way for the user.

12-3 Fast Tuning Guide

This guide contains the quick criterion in 4 points to tune the drives of the Integrated Servo Motor series. The tuning must be carried out together with IM-TOOL according to the instructions in the **Section 12-1 How to Determine the Tuning Criterion**: each tuning operation must be carried out together with the check of the performances through the motor motion.

1. Setting the default configuration

The first operation to do is to set the drive on the default tuning configuration: press the



button in the Configuration Tuning tab. If the performances were not satisfactory, continue with the following points.

2. RL estimation

To optimize the **CurrentLoop [60F6.xx]** performances it's necessary to estimate the effective value of the phase resistance and of the synchronous motor inductance, by using the RL estimator (see **Section 12-9 RL estimator**). To estimate RL follow the instructions reported in the RL estimator area in the Tuning current Tab.

3. Estimating the inertia moment

Get the total inertia moment as to the shaft with the Inertia Estimator in the Tuning motion Tab (**Section 12-8 Inertia estimator**). If it is not possible to move the motor with the estimator or if it does not provide any reliable estimate, it is necessary to value the total inertia moment and calculating the parameters (**Section 12-7 Gains calculation**).

4. Modification of the tuning configurations

If necessary modify the TuningConfigurations considering the following.

- The option **DynamicResponse [3502.01]** acts on the motor dynamic performances. When the requested dynamic response increases, the motor reaction times and the following errors are reduced. But in contrast, when the dynamic response increases, the stability margins are reduced and any possible electrical and mechanical resonances amplified. These resonances are not always eliminated by using the filters but you have to accept a more limited dynamic response.

- The option **Stiffness** modifies the motor stiffness when it is stopped in torque. When the stiffness increases, the motor is more able to stay steady; on the contrary the stability margins are reduced and any possible electrical and mechanical resonances amplified as happening for the option **DynamicResponse [3502.01]**.

- The **VelocityLoopFilter1 [3502.03]** option works on the first filter of **VelocityLoop [60F9.xx]** and on the sensor filter and can take the following values:
  - User: the recalculation commands don't modify the filter parameters.
  - Soft filter: the filters are modified to make a heavy filtering action of the noise that's present in the loop.
  - Disable: the filtering action for the noise that's present in the **VelocityLoop [60F9.xx]** is deleted. But in this case it's possible to obtain a faster dynamic response.
  - Noise filter: the filters are modified to make a sweet filtering action of the noise that's present in the loop.

- The **VelocityLoopFilter2 [3502.04]** option works on the second **VelocityLoop [60F9.xx]** filter and can take the following values:
  - User: the filter parameters are not modified.
  - Resonance filter: a **Band-eliminating** filter is inserted to remove the mechanical resonances.
  - Disable: the filtering action is deleted.
  - Debounce filter: a The low-pass filter of the first order is inserted to remove the mechanical elasticity.

Note As default third velocity loop filter a **All-pass filter** is inserted.

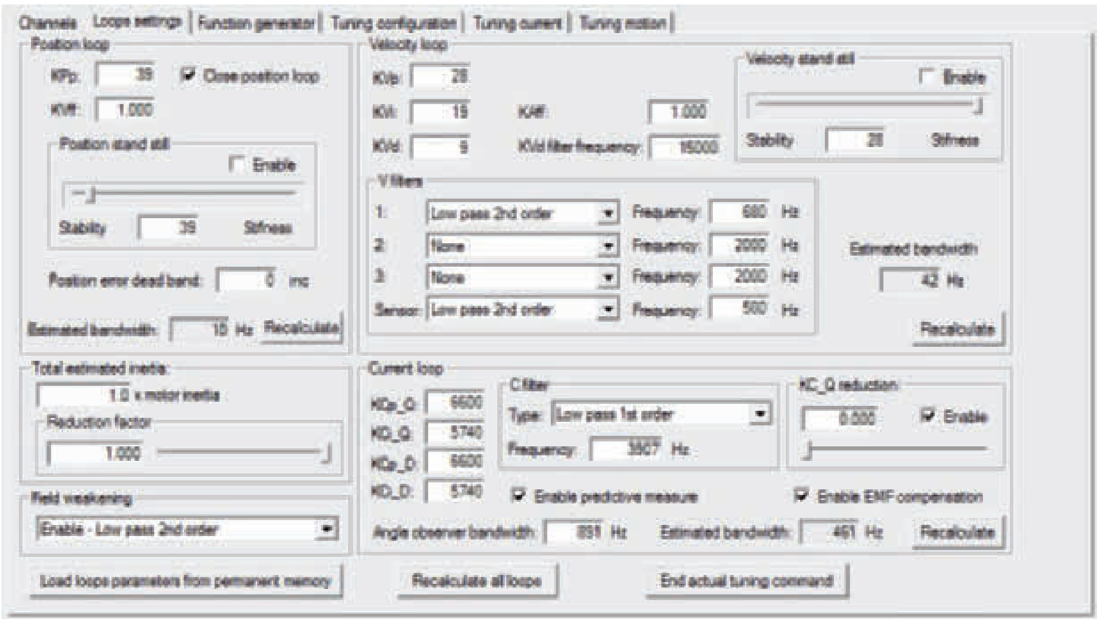
If the performances were not satisfactory use the criterion described in **Section 12-4 Detailed Tuning Guide**.

12-4 Detailed Tuning Guide

This guide contains the criterion described in 11 points about the drive tuning of the Integrated Servo Motor series. The tuning must be carried out together with IM-TOOL according to the instructions in the **Section 12-1 How to determine the tuning criterion**: each tuning operation must be carried out together with the check of the performances through the motor motion.

Unless differently specified the operations can be run from the tab Loops settings of IM-TOOL. Access:

Main menu > Drive > Loop settings and tunning... > Tab Loop settings
or
Toolbar > > Tuning Loops setting.



If you cannot find a parameter in the page, use the parameters vocabulary (**Section 10-3-6 Loop**).

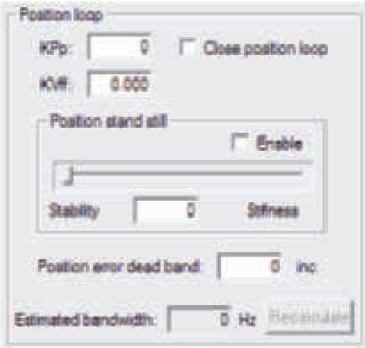
1. Fast tuning

The first operation to run is running the 4 points shown in **Section 12-3 Fast Tuning Guide** the main aim of which is defining the total inertia moment as to the shaft.

2. PositionLoop inhibition

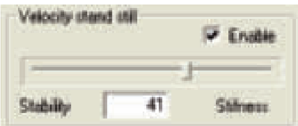
In this first phase concentrate on the tuning of the **VelocityLoop [60F9.xx]**. The **PositionLoop [60FB.xx]** must be strongly inhibited so that it cannot influence the dynamics of the **VelocityLoop [60F9.xx]**. In this phase it is accepted that **PositionFollowingError [60F4.00]** is slowly controlled. Proceed in this way:

- Disable the **EnablePositionStandStill [60FB.03]** option.
- Set **KPp [60FB.01]** equal to 4÷5 units when you have **EstimatedInertia [3503.05]** lower than 8 Jm.
- Set **KPp [60FB.01]** equal to 2÷3 units when you have **EstimatedInertia [3503.05]** higher than 8 Jm.
- Prefer lower values than **KPp [60FB.01]** in case of increase of **EstimatedInertia [3503.05]**.
- **KPp [60FB.01]** can be reset, if it is not important to hold the position or you are going to control the motor only in the speed modes.



3. Velocity stand still (only if the feedback sensor is an incremental encoder)

Regulate the bar **VelocityStandStill [3523.00]** by moving the motor at low speed. Low speeds are meant as those 30% of the parameter **HighSpeed [60F9.08]**. Move the bar towards Stability to attenuate any possible noise or resonances and towards Stiffness to increase the motor promptitude and stiffness. Do not take the bar to values of few units-; values lower than 20 units can damage the motor stiffness.



If the only way to attenuate the resonances is to seriously compromise the motor stiffness, it could be necessary to modify the filters configuration as shown in the next point.

4. Inertia moment reduction

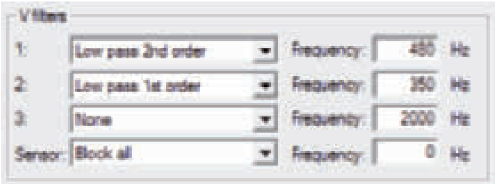
It occurs in the following cases:

- Load with inertia moment greater than 5Jm without moving
- Not rigid mechanical transmission
- Consistent plays and tolerance in the mechanical transmission

It's necessary to tune the motor as the whole inertia moment is lower than the estimated value. To do this it's necessary to decrease the value of the **InertiaReductionFactor [3503.06]** parameter that's present on the point 3 in the Gains calculation area in the Tuning motion Tab (try with 0.8, 0.5, 0.3). Too low values of **InertiaReductionFactor [3503.06]** cut down the motor dynamic performances. In this case it's advisable to even consider the following point.

5. Filters

The filters tuning of the **VelocityLoop [60F9.xx]** is useful to eliminate eventual resonances and regulation noises. The solutions closely depend on the load and transmission mechanical characteristics. There is no systematic regulation method, but it is advisable to act on the three regulator filters and then on the feedback sensor filter.



Proceed with some trials and progressively define the strategy to improve the performances. Test the following strategies (some may not be effective):

- Eliminate the Band-eliminating filter; choose as Type None, instead of Band stop.
- Insert a Low-pass filter of the second order as first filter and increase or decrease the frequency with steps of 50-100-200 Hz; if you get an improvement with frequencies higher than 1800 Hz, it is maybe possible to eliminate the filter by selecting Type None.
- Insert a low-pass filter of the first order instead of Low-pass filter of the second order as first filter; look again for an optimal filter frequency.
- Enable the other two filters to increase and modify the filtering action.
- Increase or decrease the sensor filter frequency with steps of 10-20-50 Hz.
- Insert a low-pass filter of the first order in place of Low-pass filter of the second order as feedback sensor filter.
- Search again for the filter frequency on the feedback sensor.
- Insert a Band-eliminating filter in the regulator to eliminate specific resonance frequencies. If the second filter is used, increase the **VFilter2QFactor [60F9.1B]** parameter to increase the selectivity of the filter.

If the feedback sensor is an incremental encoder and if the filters have improved the drive performances in low velocities, try to increase the system quickness by increasing **VelocityStandStill [3523.00]**, otherwise consider the following point.

6. Special parameters

If the resonances persist, try to modify the following parameters (not all of them are reported in the Loop settings Tab), while testing the motor with low velocities:

- Modify **KVd [60F9.11]**, even reset it. Also try to modify only the filtering action through the **KVdFilterFrequency [60F9.10]** parameter.
- Decrease **WVd [60F9.12]** and **WVp [60F9.13]** until they are reset.
- Increase **KVc [60F9.14]** progressively to increase the damping effect; try with steps of 20-50-100 units.

7. Stopped motor

Run some stability tests when the motor is stopped in torque. If possible, disturb the mechanical load from outside with the motor stopped in torque to test the motor ability to absorb and dampen the resonances. In case of unwanted effects, try to modify the filters or the **VelocityStandStill [3523.00]** parameter (verify that the **EnableVelocityStandStill [60F9.17]** option is enabled).

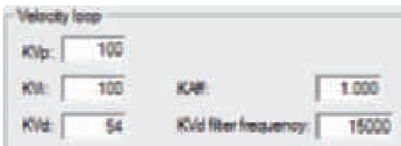
8. Quick decelerations

When the deceleration increases, the possibility to get resonances increases when the motor ends the deceleration ramp. Run some tests with the requested decelerations, in case of unwanted effects readjust the filters or the parameter **VelocityStandStill [3523.00]**. If the resonances persist, it's necessary to limit the required working decelerations.

9. Working speed

Proceed with tests with greater velocities, but never greater than the limits; start with a velocity equal to 50% of the **HighSpeed [60F9.08]** parameter and increase the velocity over the required working velocity. The speed profile to generate can be the one the machine is designed for. In these tests modify the parameters **KVp** and **KVi**, with the following criteria:

- Increase **KVp [60F9.01]** and **KVi [60F9.03]** to make the system more quick, try with steps of 20% till the system becames unstable. These parameters have greater effect for speeds higher than **HighSpeed [60F9.08]** if the **EnableVelocityStandStill [60F9.17]** option is enabled.
- Decrease **KVp [60F9.01]** and **KVi [60F9.03]** to make the system more stable and eliminate the resonances, proceed with decreases of 20% until the system becomes stable. If the option **EnableVelocityStandStill [60F9.17]** is enabled, these parameters have less effect for speeds lower than **HighSpeed [60F9.08]**. If there are some resonances for speeds much lower than **HighSpeed [60F9.08]**, readjust **VelocityStandStill [3523.00]** and the filters.



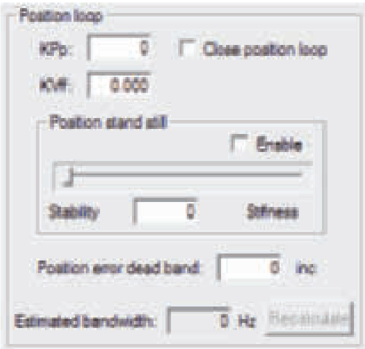
10. Feed forward acceleration

To adjust the parameter **KAff [60F9.16]** move the motor by commanding accelerations and decelerations similar to the machine working ones. Increase or decrease **KAff [60F9.16]** in order to minimize SpeedFollowingError during the acceleration and deceleration ramps. Try with steps of 100-500-1000 units. If FeedForwardAcceleration is noisy, it may be useful to reset to zero **KAff [60F9.16]** in order to reduce the noise that enters in the loop.

11. PositionLoop

When the **VelocityLoop [60F9.xx]** is adjusted in the best possible way, the **PositionLoop [60FB.xx]** adjustment becomes very easy. Follow these rules:

- Push the Recalculate button in the **PositionLoop [60FB.xx]** area.
- Increase **KPp [60FB.01]** till the appearance of some not damped resonances or oscillations of the **PositionFollowingError [60F4.00]**. Try with steps of 5-10 units.
- Enable the **EnablePositionStandStill [60FB.04]** option and set the value of **PositionStandStill [60FB.03]** equal to **KPp [60FB.01]**.
- Modify **PositionStandStill [60FB.03]** by valuing the effects on the **PositionFollowingError [60F4.00]**. This parameter has a greater effect for speeds lower than **HighSpeed [60F9.08]** and with stopped motor in torque. Increase its value to increase the resetting speed of the **PositionFollowingError [60F4.00]**; decrease its value to eliminate not damped oscillations at low speeds. With the bar at 0, **PositionFollowingError [60F4.00]** is not controlled.
- Check if **PositionLoopEstimatedBandwidth [3501.03]** is lower at least 0.7 times **VelocityLoopEstimated-Bandwidth [3501.02]**.



12-5 Interactive Tuning Guide

This guide contains the interactive criterion in 10 points to tune the drives of the Integrated Servo Motor series.

The tuning must be run together with IM-TOOL by following step by step the next instructions. For some aspects it may be similar to the criterion in **Section 12-4 Detailed Tuning Guide** even if a different approach is used. Unless differently specified the operations can be run from the tab Loops settings of IM-TOOL. Access:

Main menu > Drive > Loop settings and tunning... > Tab Loop settings
or
Toolbar > > Tab Loops settings.

If you cannot find a parameter in the page, use the parameters dictionary (**Section 10-3-6 Loop**).

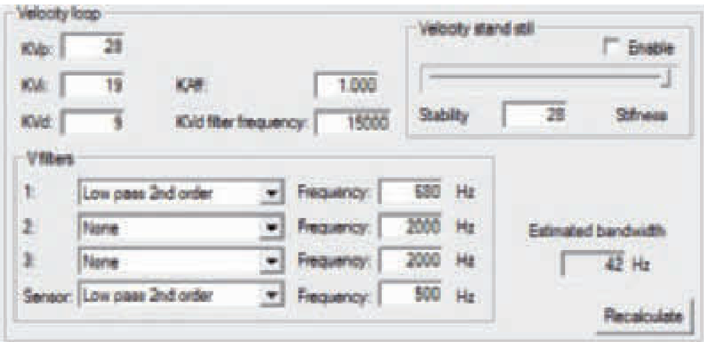
Note This tuning criterion is used to run speed motions with non limited accelerations. To protect the load and the mechanical transmission set a torque limit. In any case in order to avoid unwanted motions or collisions take all the necessary precautions and precisely configure the drive limits.

1. Fast tuning

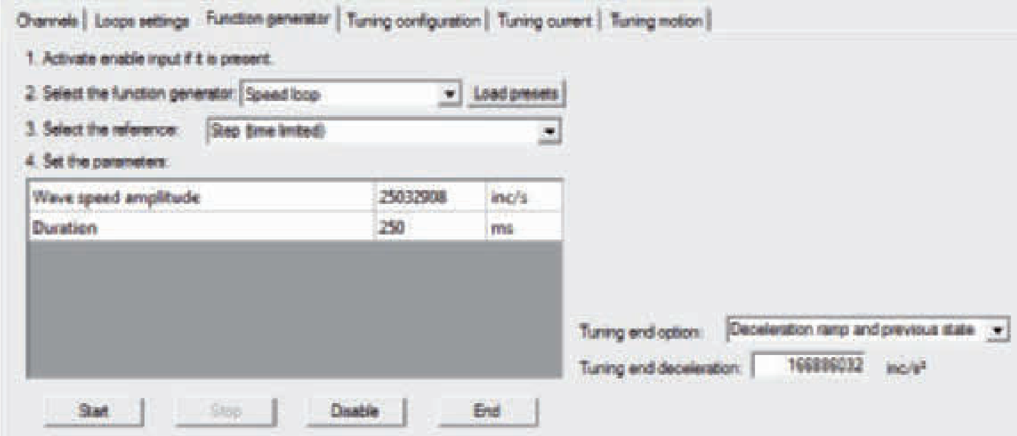
The first operation to run is running the 4 points shown in **Section 12-3 Fast Tuning Guide** the main aim of which is defining the total inertia moment as to the shaft.

2. Tuning of KVp

(a) Set to 0 **KVi [60F9.03]**, **KVd [60F9.11]** and **KAff [60F9.16]** and disable the **EnableVelocityStandStill [60F9.17]** option (unselect the Enable of the Velocity stand still) and disable the four filters by selecting None.

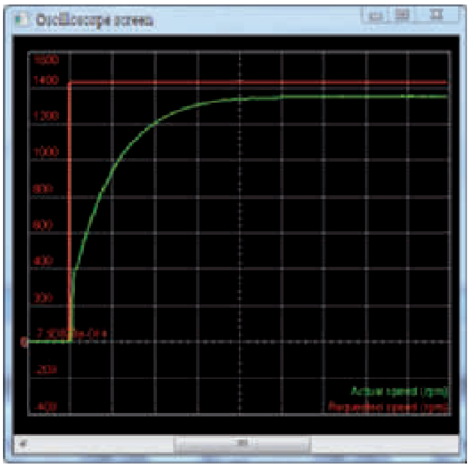


(b) Open the tab Function generator, choose Speed loop and press Load preset. Press Start to generate a step speed reference. If the response to the step has some resonances, particularly at low speeds, it is necessary to eliminate them.

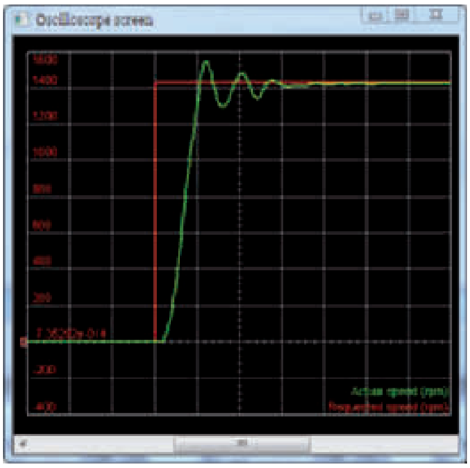


(c) Modify progressively the value of **KVp [60F9.01]** to improve the speed response and apply again the previous Function generator to check the result. In modifying **KVp [60F9.01]** bear in mind the following considerations:

- Modify **KVp [60F9.01]** approximately with steps of 50-100 units.
- For low **KVp [60F9.01]** values, the response to the step is lower and it has a non null speed error running regularly, since the integral contribution is not enabled. By decreasing the **KVp [60F9.01]** value the error increases and the step reaction is less prompt.



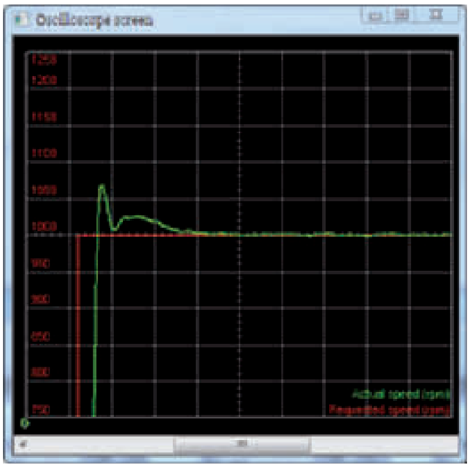
- Increasing **KVp [60F9.01]** value until some resonances or overshoots appear. At that point, decrease **KVp [60F9.01]** by 20% as stability margin.



3. Tuning of KVi

Apply the same Function generator of the previous point and progressively increase the value of **KVi [60F9.03]** to improve the response. In modifying **KVi [60F9.03]** bear in mind the following considerations:

- Modify **KVi [60F9.03]** approximately with steps of 50-100 units.
- You can increase the **KVi [60F9.03]** value until some resonances or overshoots higher than 5-10% appear. At that point, decrease **KVi [60F9.03]** by 10% as stability margin.



4. Tuning of VelocityStandStill

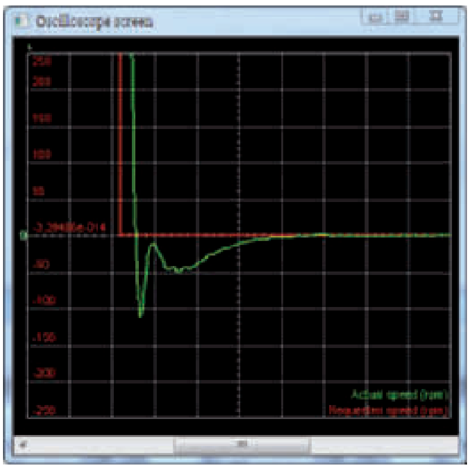
Apply the same function generator of the previous points and trigger the oscilloscope on the falling edge of RequestedSpeed to evaluate the motor stopping. If the feedback sensor is not an incremental encoder, the motor stopping should have a symmetrical response (graphically mirrored) respect to the stimulated velocity step. In any case it's possible to improve the motor stopping by activating and modifying the **VelocityStandStill [3523.00]** bar and keeping in mind the following considerations:

(a) Modify the bar approximately with steps of 20-50 units.

(b) Moving the bar towards stability:
- You can increase the stability margin eliminating any possible resonances.
- The system becomes less prompt but more stable.
- Do not take the bar at values of some units; values lower than 20 units can damage the motor promptitude.

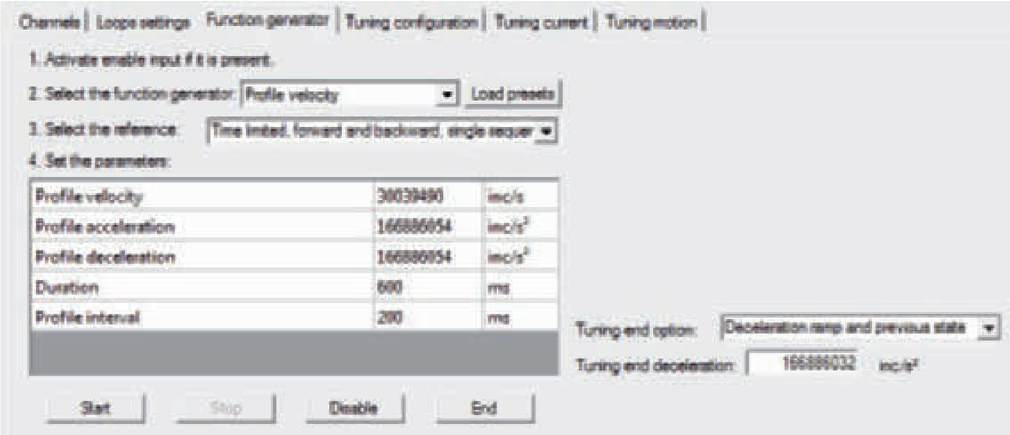
(c) Moving the bar towards stiffness:
- The stability margins decreases.
- The system becomes more prompt but more stable.
- Resonances may appear.

(d) Increase the bar value until some resonances appear at the end of the braking ramp or with stopped motor in torque. At that point decrease the bar by 20% as stability margin.

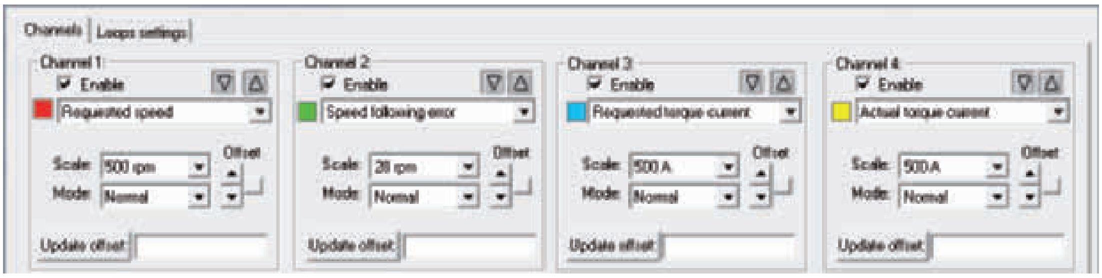


5. Tuning of KAff

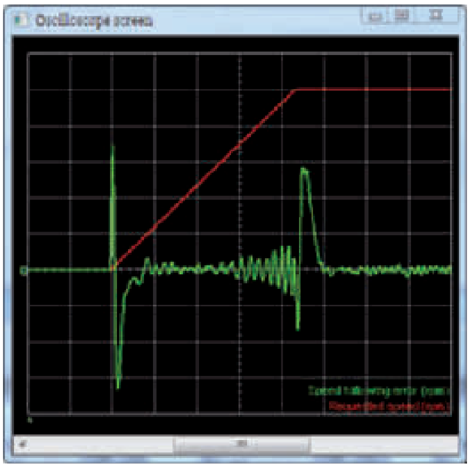
(a) Open the tab Function generator, choose Profile velocity and press Load preset. Modify at pleasure the reference parameters in order to generate some trapezoidal speed profiles.



(b) Open the tab Channels, choose the channel 2 of the oscilloscope SpeedFollowingError and disable the channels 3 and 4. Go back to the tab Function generator and press Start to start the reference.

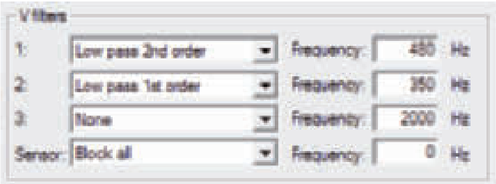


(c) Modify progressively the value of **KAff [60F9.16]** to reduce SpeedFollowingError during the motor acceleration/deceleration phases. Increase **KAff [60F9.16]** until SpeedFollowingError changes its sign at the beginning of the acceleration.



6. Filters

The filters tuning of the **VelocityLoop [60F9.xx]** is useful to eliminate eventual resonances and regulation noises. The solutions closely depend on the load and transmission mechanical characteristics. There is no systematic regulation method, but it is advisable to act on the three regulator filters and then on the feedback sensor filter. Use the Function generator to test the tuning.



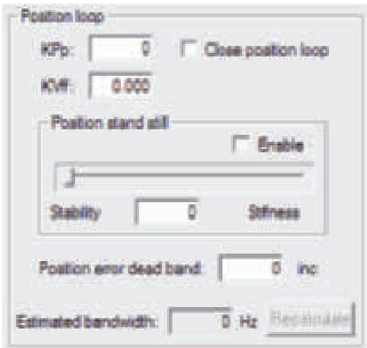
Proceed with some trials and progressively define the strategy to improve the performances. Test the following strategies (some may not be effective):

- Eliminate the Band-eliminating filter; choose as Type None, instead of Band stop.
- Insert a Low-pass filter of the second order as first filter and increase or decrease the frequency with steps of 50-100-200 Hz; if you get an improvement with frequencies higher than 1800 Hz, it is maybe possible to eliminate the filter by selecting Type None.
- Insert a low-pass filter of the first order instead of Low-pass filter of the second order as first filter; look again for an optimal filter frequency.
- Enable the other two filters to increase and modify the filtering action.
- Increase or decrease the sensor filter frequency with steps of 10-20-50 Hz.
- Insert a low-pass filter of the first order in place of Low-pass filter of the second order as feedback sensor filter.
- Search again for the filter frequency on the feedback sensor.
- Insert a Band-eliminating filter in the regulator to eliminate specific resonance frequencies. If the second filter is used, increase the **VFilter2QFactor [60F9.1B]** parameter to increase the selectivity of the filter.

If the feedback sensor is an incremental encoder and if the filters have improved the drive performances in low velocities, try to increase the system quickness by increasing **VelocityStandStill [3523.00]**.

7. Tuning of KPp

(a) Disable the option **EnablePositionStandStill [60FB.04]**, set at 5 units **KPp [60FB.01]** and at 1000 **KVff [60FB.02]**.

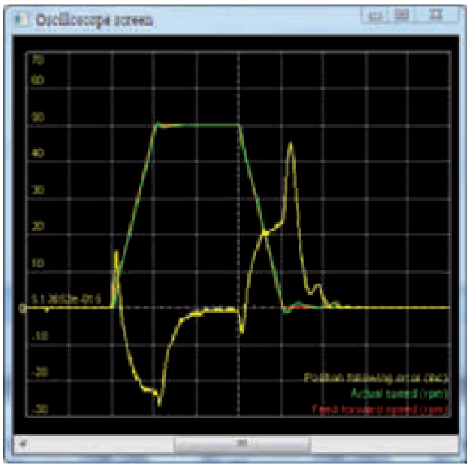


(b) Open the tab Function generator, choose Profile position and press Load preset. Modify at pleasure the reference parameters and consequently the oscilloscope trigger settings.

(c) Increase progressively the value of **KPp [60FB.01]** to reduce the **PositionFollowingError [60F4.00]** and apply the Function generator again to check the result. In modifying **KPp [60FB.01]** bear in mind the following considerations:

- Modify **KPp [60FB.01]** approximately with steps of 10-20 units.
- For **KPp [60FB.01]** low values, **PositionFollowingError [60F4.00]** takes a zero value more slowly, while increasing the **KPp [60FB.01]** value, **PositionFollowingError [60F4.00]** takes a zero value more quickly.

- Increase the **KPp [60FB.01]** value until some resonances or overshoots appear; in these cases reduce the **KPp [60FB.01]** value with a security margin.



(d) Enable the option **EnablePositionStandStill [60FB.04]** and set the value of **PositionStandStill [60FB.03]** equal to the found value of **KPp [60FB.01]**. Try to increase **KPp [60FB.01]** again.

8. Tuning of PositionStandStill

In modifying the bar **PositionStandStill [60FB.03]** bear in mind the following considerations:

(a) The bar has more influence for speeds lower than **HighSpeed [60F9.08]** and with stopped motor in torque.
(b) Modify the bar approximately with steps of 5-10 units.
(c) Moving the bar towards stability:
- You can increase the stability margin eliminating any possible resonances.
- The system becomes less prompt but more stable.
- With the bar at 0, **PositionFollowingError [60F4.00]** is not controlled.

(d) Moving the bar towards stiffness:
- The stability margin decreases.
- The system becomes more prompt but less stable.
- Resonances may appear.

(e) Increase the bar value until some resonances appear with stopped motor in torque. At that point decrease the bar by 20% as stability margin.

9. Tuning of KVff

(a) To improve the motor capacity to track a variable position request (tracking), by keeping **PositionFollowingError [60F4.00]** limited, it's advisable to set the **KVff [60FB.02]** at 1.
(b) If you do not need a very high precision in the position tracking, **KVff [60FB.02]** can be taken to low values at around 500 units, till 0. In this way you can reduce the overshoots at the positioning end.
(c) Apply again the Function generator used for the tuning of **KPp [60FB.01]** to check the result.

10. Tuning of PositionErrorDeadBand

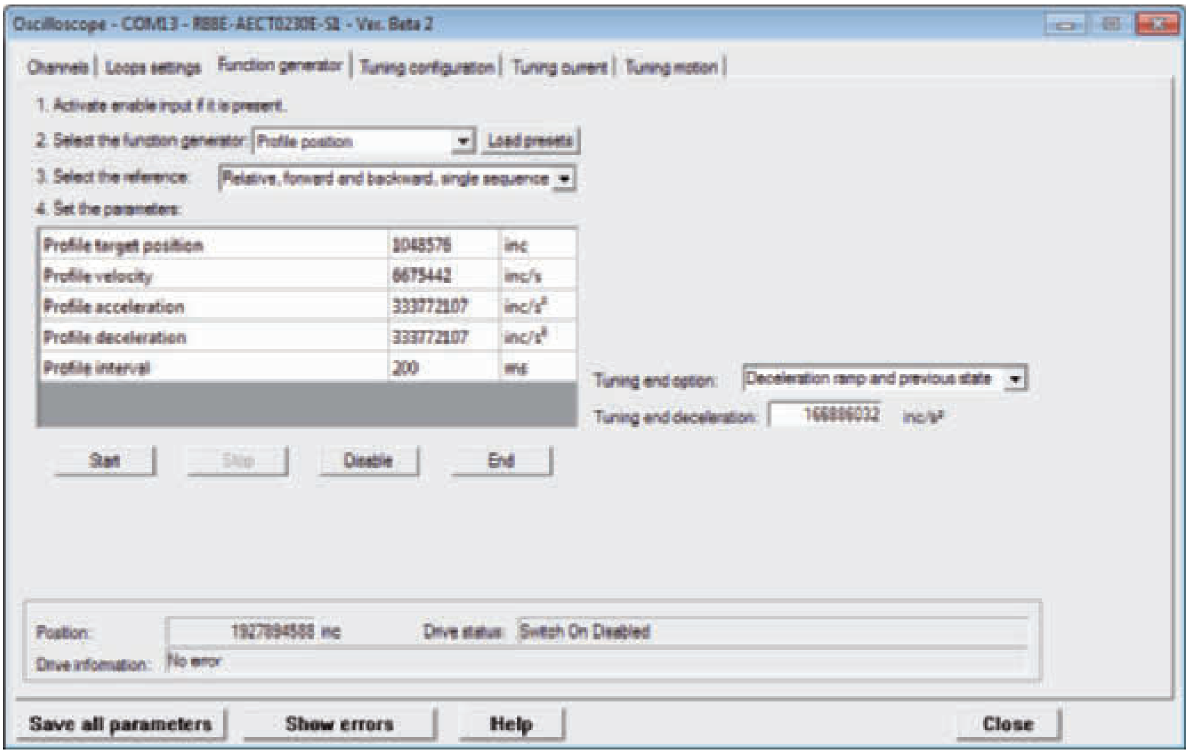
If the kind of mechanical transmission or the load cannot keep the **PositionFollowingError [60F4.00]** at zero, increase the value of **PositionErrorDeadBand [4281.01]**. In this way you create a tolerance zone where the **PositionLoop [60FB.xx]** does not react to compensate **PositionFollowingError [60F4.00]** different from zero. While inserting the dead zone, a corresponding tolerance in the positioning precision must be accepted.

12-6 Function Generator

Note Before enabling the Function generator when the drive is not adjusted yet, check if it is possible to stop the motor in safety. To avoid unwanted motions or collisions, take all the necessary precautions and configure precisely the drive limits.

The Function generator is an integrated functionality of the IM-TOOL oscilloscope applying some particular references to the control loops. When a Function generator command is requested, the oscilloscope capture is enabled to value the drive performances through the analysis of the progress of some particular parameters. Access:

Main menu > Drive > Loop settings and tunning... > Tab Function generator
or
Toolbar >  > Tab Function generator.



In the following table you can find the Function generator functionalities:

Functionalities	Description	
Select the function generator	Choose the function generator type	CurrentLoop D applies to RequestedField the generated reference
		CurrentLoop Q applies to RequestedTorqueCurrent the generated reference
		Speed loop applies to RequestedSpeed the generated reference
		Profile velocity generates a speed motion with linear acceleration ramps
		Profile position runs some positionings with linear acceleration ramps
Load preset	Set some default values for the selected reference and the oscilloscope	

Functionalities	Description	
Select the reference	Select the reference type	Stop
		Step
		Step (time limited)
		Square wave
		Square wave (time limited)
		Sinusoidal wave
		Sinusoidal wave (time limited)
		Profile velocity unlimited standard
		Profile velocity time limited
		Profile velocity time limited, forward and backward, single sequence
		Profile velocity time limited, forward, multiple sequence
		Profile velocity time limited, forward and backward, multiple sequence
		Profile position, absolute target position
		Profile position, relative, single target position
		Profile position, relative, forward and backward, single sequence
		Profile position, relative, forward, multiple sequence
		Profile position, relative, forward and backward, multiple sequence
Start	Start the reference	
Stop	Stop the reference and keep the drive enabled	
Disable	End the Function generator by stopping the motor with maximum deceleration and resetting RequestedSpeed and then the drive enters the status Switch On Disabled	
End	End the Function generator following tuning end option	
TuningEndOption	Options for the command Function generator end	Immediately disable, the motor is stopped with maximum deceleration resetting RequestedSpeed at zero and then the drive has the status Switch On Disabled
		Decelaration ramp, the motor is stopped with deceleration equal to Tuning end deceleration
		Zero speed, the motor is stopped with maximum deceleration by resetting RequestedSpeed
TuningEndDeceleration	Deceleration for the command of Function generator end	
Drive status	Drive status (**Statusword [6041.00]**)	
Drive information	Function generator status (**SysMngError [5FF7.03]**)	

In using the Function generator, bear in mind as follows:

(a) It is not possible to change Function generator without using the End command.

(b) To modify the reference type or the reference parameters, when a reference is started, you have to use a command of Stop, End or Disable.

(c) Before starting a reference, set its parameters and Tuning end option and Tuning end deceleration.

(d) At the references end, that end after a given period, the drive is always enabled.

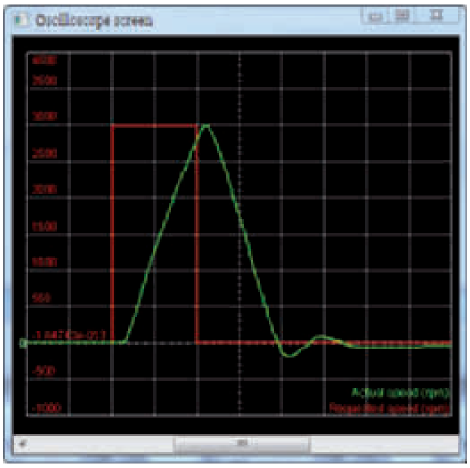
(e) The references of time limited type end after a time period equal to the parameter Duration.

(f) The references of sequence type generate some profiles which are separated among them by a time period equal to the parameter Profile interval.

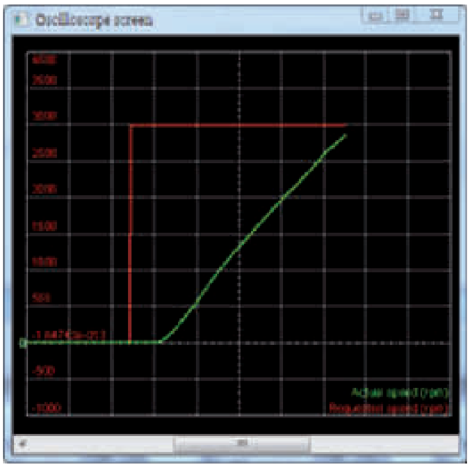
(g) When a reference is started and you close the window Oscilloscope, the End command is run.

(h) If the motor can run motions only in one direction, set properly the reference parameters.

(i) If the requested reference ends before the end of the response transient, increase properly the reference parameters to increase its duration.



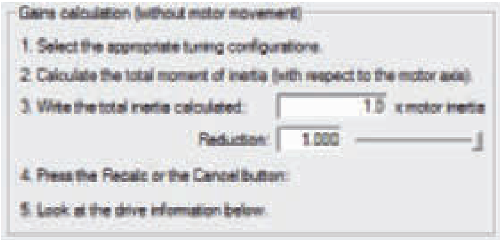
(j) If the oscilloscope capture ends before the Function generator has finished and it does not show all the reference and response progress, increase the oscilloscope sampling time.



12-7 Gains Calculation

This functionality is used to calculate the loops parameters according to the **EstimatedInertia [3503.05]** parameter and the **TuningConfigurations [3502.xx]**. Follow the instructions in the Gains calculation area in the Tuning motion Tab. Access with IM-TOOL:

Main menu > Drive > Loop settings and tunning... > Tab Tuning motion
or
Toolbar > > Tab Tuning motion.



EstimatedInertia [3503.05] must be calculated as to the motor shaft and must be written in the field number 3 of the box Gains calculation. **EstimatedInertia [3503.05]** is the total inertia moment and it includes motor, brake, mechanical transmission and load. A precise analytical estimate of the inertia moment is often very complex: you can accept even a gross estimate but probable. Bear in mind the rules of the inertia moment calculation, in particular the conversions to do between linear motion and rotatory motion, the conversions in presence of reducers and mechanical connections in general and the formulae to calculate the inertia moment of the more common solid objects.

It occurs in the following cases:

- Load with inertia moment greater than 5Jm without moving.
- Not rigid mechanical transmission.
- Consistent plays and tolerance in the mechanical transmission.

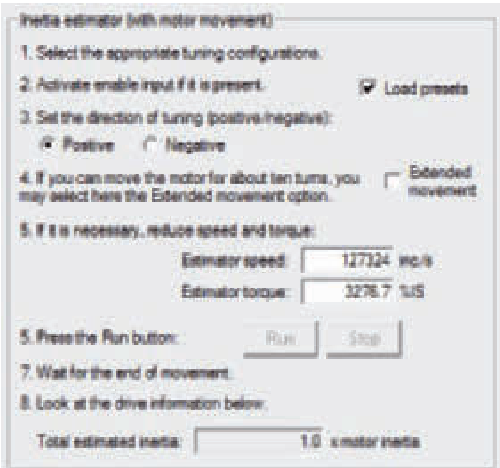
It's necessary to tune the motor as the whole inertia moment is lower than the estimated value. To do this it's necessary to decrease the value of the **InertiaReductionFactor [3503.06]** parameter (try with 0.8, 0.5, 0.3). Too low values of **InertiaReductionFactor [3503.06]** cut down the motor dynamic performances.

12-8 Inertia Estimator

Note Before enabling the Inertia estimator, check if you can stop the motor in safety. To avoid unwanted motions or collisions, take all the necessary precautions and configure precisely the drive limits.

The Inertia estimator runs a controlled motor motion to estimate the total inertia moment, calculating it as compared to the motor shaft. According to the estimated inertia moment (Total **EstimatedInertia [3503.05]**) and of the **TuningConfigurations [3502.xx]**, the parameters of the speed and position loops are calculated again. Follow the instructions in the Inertia estimator area of the Tuning motion Tab. Access with IM-TOOL:

Main menu > Drive > Loop settings and tunning... > Tab Tuning motion
or
Toolbar > > Tab Tuning motion.



Advised procedure to estimate the inertia moment

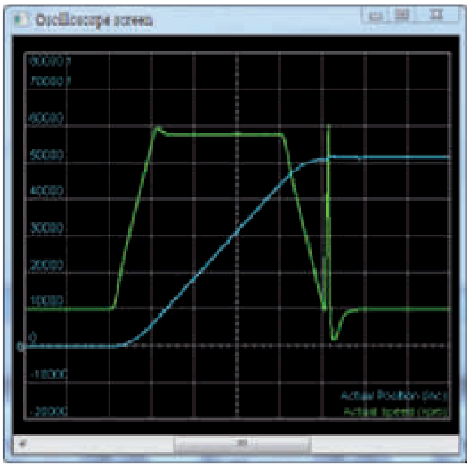
(a) Choose the following **TuningConfigurations [3502.xx]**: Medium, Noise filter and Resonance filter.

(b) Set the motor in order to run the requested motion. Take all the necessary precautions and configure precisely the drive limits.

(c) Select the wanted direction and the option Load preset, which sets a series of oscilloscope parameters.

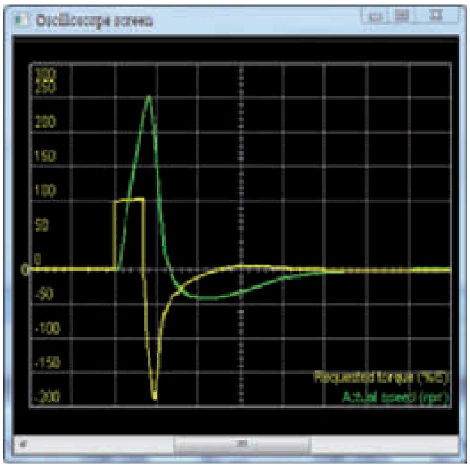
(d) Only if the shaft cannot run about ten revolutions go to the point g, otherwise select the option Extended movement.

Note If you do not select the option Extended movement, a torque impulse is applied to the motor and the motor runs a fourth of a revolution maximum. If you select the option Extended movement, a more complex motion is run and the motor runs ten revolutions maximum. If the shaft can run only a limited revolution number, it is better to position it so that during the tuning it does not overcome its race limits. In any case it is advisable to enable the position limits.



(e) Press Start.
(f) When the motion is concluded, check the information in the field Drive information.
(g) Deselect the option Extended movement.
(h) Position the shaft so that it is possible to run the requested motion and check if the shaft reaches the machine position limits.
(i) Press Start.
(j) When the motion is concluded, check the information in the field Drive information.

Note The better is the estimate, the more linear is the speed ramp obtained during the estimate without the option Extended movement. To check the estimate correctness, the oscilloscope is always enabled during the estimate for a further analysis of the speed ramp. If the option Load preset is selected, the oscilloscope is automatically set for this aim.



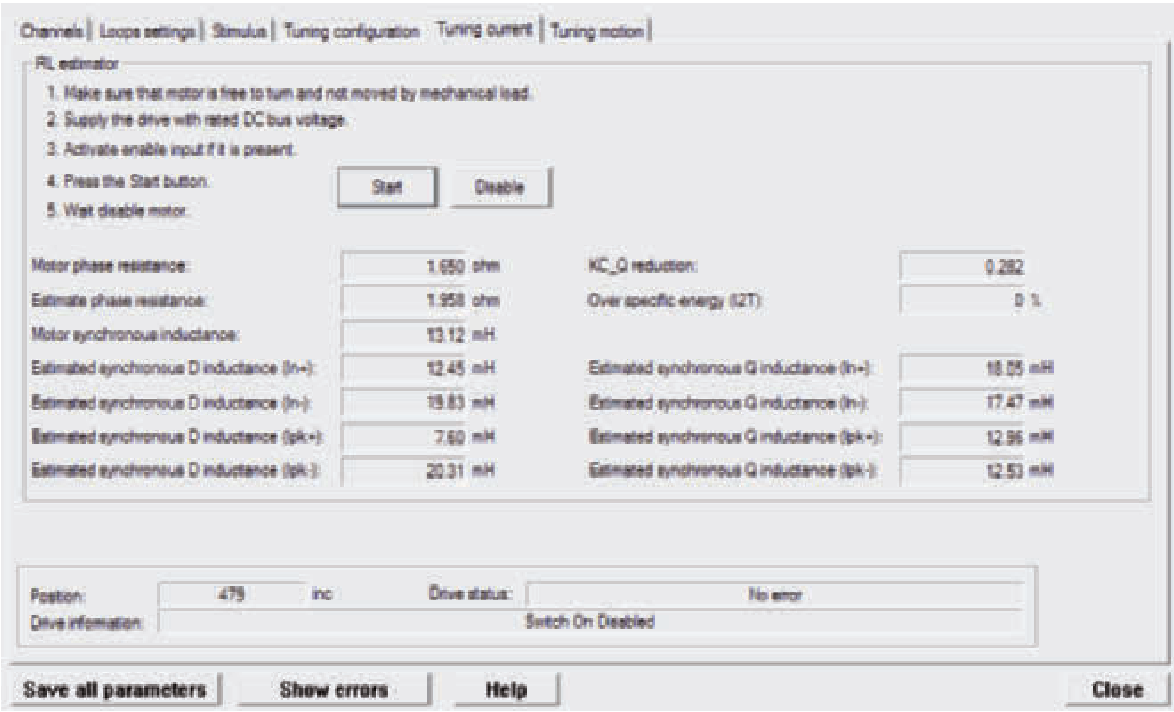
(k) Check if the result of the estimate Total **EstimatedInertia [3503.05]**, is approximately coherent with the applied load.
(l) Run for some times the tuning command by starting from the point h and check if the estimate does not sensibly change. You can tolerate changes by 10-20%.

12-9 RL Estimator

To optimize the current loop performances it's necessary to estimate the effective value of the phase resistance and of the synchronous motor inductance. RL Estimator executes an off line estimation of this parameters through the application of some ramps and pulses of current to the motor phases. During the RL estimation command the drive may move the motor shaft up to 1 polar step. According to the estimated inductance (see **RLEstimator [3504.xx]** group parameters), the parameters of the speed and position loops are calculated again.

To estimate RL follow the instructions reported in the RL estimator area in the Tuning current Tab. Access with IM-TOOL:

Main menu > Drive > Loop settings and tunning... > Tab Tuning current
or
Toolbar >  > Tab Tuning current.



Note During the RL estimation the **I2TValue [3405.05]** value, that can be read in the “Over specific energy (I2T)” box of the same page, increases. Always wait that it takes the 0 value. The end of the RL estimation command, coincides with the automatic disabling of the motor. Always wait its disable.

Note Considering that the current pulses reach **MotorPeakCurrent [6410.02]**, be sure that the voltage supply **DCBusVoltage [3310.01]** remains stable during the command.

Note To correctly estimate RL follow the instruction list in the Tuning current Tab.

Note The oscilloscope is not activated because a video diagnostics is not necessary. The results are reported in the Tuning current Tab.

13

Troubleshooting and Maintenance

This section explains the items to check when problems occur, error diagnosis using the error display and measures, error diagnosis based on the operating conditions and measures, and periodic maintenance.

13-1 Troubleshooting

13-1-1 Generic Problems

Problem	Solution
The LEDs are switched OFF	• Be sure that the drive is correctly supplied, in particular the logical section, see what is reported in **Section 3-1-3 Supply Voltages** • Check the wiring
The LEDs are ON but the drive does not communicate	• See what reported in **Section 13-1-5 Communication Problems**
Interpreting the drive status on the basis of the LEDs status	• See what reported in **Section 5-1-1 LEDs**
Find the status of the digital I/O	• Read the parameters DigitalInputs and PhysicalOutputs and see what is reported in **Section 8-1-1 Digital I/O's**
Monitor some drive parameters (temperature, currents, speed, etc...)	• See what reported in **Section 10-3-8 Drive Status**
Load braking	• Do not use the internal brake of the Integrated Servo Motors • Consider what is reported in **Section 4-7 Regenerative Energy Absorption**
Delay the brake	• The brake is managed automatically by the drive and it cannot be enabled with Drive enable • With Drive disable the brake can be delayed. Pay attention, in this case the load can move in an unforeseen way
The internal brake does not keep the motor steady	• If the load applies a higher torque on the brake torque, it is necessary to apply more efficient braking systems • The internal brake is damaged; it could be necessary to repeat the brake run-in. Please contact your OMRON representative

13-1-2 Electric and Connection Problems

Problem	Solution
Which is the reference voltage (0V) of the digital inputs and outputs	• The voltages of the digital inputs and outputs, refer to ground logic supply of CN5 (PIN B)

13-1-3 Problems with Faults and Warnings

Problem	Solution
The drive is in fault: how to proceed	• Interpret the present fault precisely (**FaultDynamic**, **Section 13-2-1 Monitoring the Errors on the Status LEDs**) • Analyse the fault type and its possible causes (**Section 13-2-5 Errors Description**) • Eliminate the causes that provoked the fault and run the reset (**13-2-4 Resetting the Errors**)
It is not possible to eliminate the faults	• Ready carefully what is reported in Section **13-2-4 Resetting the Errors**

Problem	Solution
How to remove the fault causes	• Analyse the occurred faults by using what is reported in **Section 13-2-5 Errors Description**
How to stop the motor in case of fault	• In case of fault, the drive runs what is reported in **Section 13-2-3 Reaction to the Faults**. In some cases it is not possible to check the motor stop or to run a Safety profile
Difference between a dynamic and a retention fault	• Dynamic error: The error condition is still in the drive • Retention error: The error is memorized by the drive, until it is reset
The drive goes in fault when it is enabled	• Analyse the fault after the enabling
Enabling the drive with enabled warnings	• In general the drive can be enabled also with enabled warnings • Pay attention: some warnings become faults if you try to enable the drive • It is advisable to eliminate any warning
Difference between Parameters serious error and Parameters soft error	• The serious error is a more serious warning and it becomes a fault if you try to enable the drive. The soft error does not compromise the drive integrity, that is the drive protects itself. In any case you need to analyse the error type accurately

13-1-4 Problems with Parameters and Configuration

Problem	Solution
How parametrizing the drive	• Use the parameters dictionary
Restoring a known configuration	• Run the command Restore default parameters (command of the System Manager 2200): updating the current configuration and the permanent memory with the default values • Run the command Reset to default (command of the System Manager 2201): updating the current configuration with the default values • Run the command Reload all parameters (command of the System Manager 2300): updating the current configuration with the data in the permanent memory • Run the command Hard reset (command of the System Manager 5000): it means, for all parameters, to switch on and off the drive • Run the command Soft reset (command of the System Manager 5001): it means, for all parameters, except from the position ones, to switch on and off the drive
The parameters are not kept	• Run the command Save all parameters (command of the System Manager 2001): saving the current configuration in the drive permanent memory • Check if the parameters are not written by the network master; disconnect the field buses • Check if there are no parametrization or System Manager errors at the firmware start
The parameters to configure the capture units are not writable	• The configuration parameters are not writable if the capture units are enabled. Check the status of the capture units through the parameter **CaptureUnitCommand_A [4000.01]** (**CaptureUnitCommand_B [4010.01]**)

13-1-5 Communication Problems

Problem	Solution
The drive does not communicate via Modbus	• Connect the drive and see the connection settings • Check if the drive is on: the L1 and L2 LEDs must not be off
The drive does not communicate via EtherCAT	• Connect the drive and see the connection settings according to what reported in **Section 11-3 Communicating with EtherCAT Master** • Check if the drive is on: the L1 and L2 LEDs must not be off • Check the presence of the link in the communication ports connected to the EtherCAT network: the related LEDs L/A 0 and L/A 1 must not be off • Check if the ERR LED is not on and the Main port communication error (ECT) is not enabled; if necessary remove the error
Reading/writing parameters	• See **Section 13-2-6 Errors in Reading/Writing Parameters**

13-1-6 Motion Problems

Problem	Solution
How to enable the drive	• See what reported in Section **5-5-1 CiA402 State Machine**
How to stop the load in safety	• See what reported in Section **5-5-1 CiA402 State Machine**
How to measure the drive load level	• Monitoring the regular drive temperatures with the parameters of the group **TemperatureStatus [3300.xx]** • Monitoring the working of **TargetTorque [6071.00]** • Monitoring the working of **RMSMotorCurrent [3320.08]**, after having set **RMSMotorCurrentFilter [3320.09]** equal to the value of the drive working time cycle
The motor does not run the requested motion and the drive signals I2T limit reached error or I2T warning threshold reached error	• Check the working of **I2TValue [3405.05]** and check the problem in the following line
The drive signals I2T limit reached error or I2T warning threshold error	• Monitoring the value of **I2TValue [3405.05]** and **ActualMotorCurrent [3320.01]** to find any anomalies • Check the mechanics working to avoid any anomalous absorptions of **ActualTorque [6077.00]** • Decrease the requested performances and increase the dwell times during which the motor works at low current in order to download **I2TValue [3405.05]** • Decrease the acceleration ramps and the requested speeds to decrease the **TargetTorque [6071.00]** • Increase **UserMaxI2T [3405.02]** till the value of **DriveMaxI2T [3405.03]** (**Sec 8-4-2 I2T Limits**)

Problem	Solution
The motor does not run the requested motion or the requested motion has been interrupted	• Check for any possible stop command • Check if the drive is in fault (see **Section 13-2 Fault and Warning (Integrated Servo Motor)**) • Check for any possible disabling command • Check if the Limit reached error is not enabled • Check if the drive has not run an on-the-fly mode change; in this case the drive is used to insert the new set points according to the new selected operating mode • If you work in Interpolated Position Mode check if the bit Enable ip mode of the **Controlword [6040.00]** has not been reset. If you work in Profile Velocity Mode (CiA402) or Profile Velocity Mode (CUSTOM), check if the absolute value of **TargetVelocity [60FF.00]** is higher than **EndVelocity [6082.00]** and **StartVelocity [4244.00]**

13-2 Fault and Warning (Integrated Servo Motor)

The drives of the Integrated Servo Motor, when finding some anomalies during working or some errors in the parameters setting, notify the error. Errors are divided into two categories depending on their seriousness:

- Warning, error which notifies a non-serious condition of the drive
- Fault, error preventing and stopping the motor motion; the drive is often in a serious error condition

When the drive is enabled, the faults are divided into two types:

- Fatal fault, faults immediately preventing from controlling the motor motion
- Non fatal fault: faults letting you temporarily control the motor motion

Errors can be:

- Dynamic: The error condition is still present in the drive
- Retentive: The error is stored by the drive until it is reset even if the error cause is no longer present

In the following chart you can find the features of the **MainError [3014.xx]**, the bit which any error is associated to and the features of the masks defining the behavior of the drive in case of fault. The abbreviations WD, WR, FD, FR, FA, FE and FS have the following meaning:

- WD (**WarnDynamic [3014.02]**): Main dynamic warnings
- WR (**WarnRetentive [3014.01]**): Main retentive warnings
- FD (**FaultDynamic [3014.04]**): Main dynamic faults
- FR (**FaultRetentive [3014.03]**): Main retentive faults
- FA: Faults that can be set as self-restoring (the command Fault Reset is automatically run)
- FE: Faults that can be deactivated
- FS: Faults that can generate the Safety profile
- FF: Errors of fatal fault type

Bit	Error	Main error				Fault mask			FF
		WD	WR	FD	FR	FA	FE	FS	
0	Over voltage power section error	●	●	●	●	-	-	-	●
1	Thermal management error	●	●	●	●	-	-	-	-
2	Reserved	-	-	-	-	-	-	-	-
3	Under voltage power section error	●	●	●	●	●	●	-	-
4	Power or motor short circuit error	-	-	●	●	-	-	-	●
5	Parameters soft error	●	-	-	-	-	-	-	-
6	Parameters serious error	●	-	●	●	-	-	-	-
7	Real time mode error	-	-	●	●	-	●	●	-
8	Main port communication error (ECT)	●	●	●	●	-	●	●	-
9	Reserved	-	-	-	-	-	-	-	-
10	Power or motor over current error	●	●	●	●	-	-	-	●
11	Reserved	-	-	-	-	-	-	-	-
12	Position following error	●	●	●	●	-	●	-	-
13	Last command requested failed	●	●	●	●	-	-	-	-
14	/STOP management error	-	-	●	●	-	-	-	●
15	User fault error	-	-	●	●	-	●	-	-
16	I2T limit reached error	●	●	●	●	-	●	-	-
17	I2T warning threshold reached error	●	●	-	-	-	-	-	-
18-19	Reserved	-	-	-	-	-	-	-	-
20	Limit reached error	●	-	-	-	-	-	-	-
21	Possible no tuning of regulator error	●	●	-	-	-	-	-	-

Bit	Error	Main error				Fault mask			FF
		WD	WR	FD	FR	FA	FE	FS	
22	Drive disable by digital enable input error	●	●	-	-	-	-	-	-
23	FeedbackSensorError	-	-	●	●	-	-	-	●
24	Digital IO configuration error	-	●	●	●	-	-	-	-
25	Logic voltage error	●	●	●	●	-	●	-	-
26	Motion parameter limited error	●	-	-	-	-	-	-	-
27	Digital output overtemperature or overload	●	●	-	-	-	-	-	-
28	Motor overspeed	-	-	●	●	-	-	-	●
29-30	Reserved	-	-	-	-	-	-	-	-
31	Internal error	-	-	●	●	-	-	-	-

Note To choose the self-restoring faults, use the parameter **FaultMaskAutoErase [3000.01]**. To choose the faults to enable/disable, use the parameter **FaultMaskEnable [3000.02]**. To choose the faults generating the Safety profile, use the parameter **FaultMaskSafetyPrfExecute [3000.03]**.

13-2-1 Monitoring the Errors on the Status LEDs

The Integrated Servo Motor show the status of the errors through the L1 and L2 LEDs that can take the following colours:

- **GREEN LED:** No error found, showing the enabling status of the drive.
- **ORANGE LED:** Only warnings, no faults.
- **RED LED:** Faults found.

In case of more errors, the LEDs show only the error that in the following chart has the lowest visualization order.

Error	L1	L2	Order
Main port communication error (ECT)	1 FL	ON	11
Real time mode error	1 FL	BLK	12
Position following error	1 FL	1 FL	13
Limit reached error	1 FL	2 FL	14
I2T limit reached error	1 FL	3 FL	15
I2T warning threshold reached error	1 FL	3 FL	16
Parameters soft error	2 FL	BLK	17
Possible no tuning of regulator error	2 FL	1 FL	18
Motion parameter limited error	2 FL	2 FL	19
User fault error	2 FL	ON	21
Motor overspeed	3 FL	1 FL	23
Internal error	3 FL	ON	24
/STOP management error	BLK	ON	6
FeedbackSensorError	BLK	BLK	7
Last command requested failed	BLK	1 FL	8
Parameters serious error	BLK	2 FL	9
Digital I/O configuration error	BLK	3 FL	10
Digital output overtemperature or overload	BLK	3 FL	20
Drive disable by digital enable input error	BLK	ON	22
Over voltage power section error	ON	BLK	0
Power or motor short circuit error	ON	ON	1
Power or motor over current error	ON	ON	2
Thermal management error	ON	1 FL	3
Under voltage power section error	ON	2 FL	4
Logic voltage error	ON	3 FL	5

13-2-2 Reaction to the Warnings

When an error of warning type occurs, the drive runs the following operations:

a) The bits of the parameters **WarnDynamic [3014.02]**, **WarnRetentive [3014.01]** and of any other parameter showing the details are set
b) If no faults are enabled, the LEDs show the warning according to the order in the table of **Section 13-2-1 Monitoring the Errors on the Status LEDs**
c) The status of the CiA402StateMachine is not modified

Note When the error condition that generated the warning is no longer noticed, the corresponding bits in the dynamic warning parameters are reset. In the table of **Section 13-2 Fault and Warning (Integrated Servo Motor)** you can find errors of warning type. If all the causes that have activated the bit 4 of **ErrorRegister [1001.00]** are removed, then the bit resets and, if it was the only present alarm, then even the bit 0 resets.

13-2-3 Reaction to the Faults

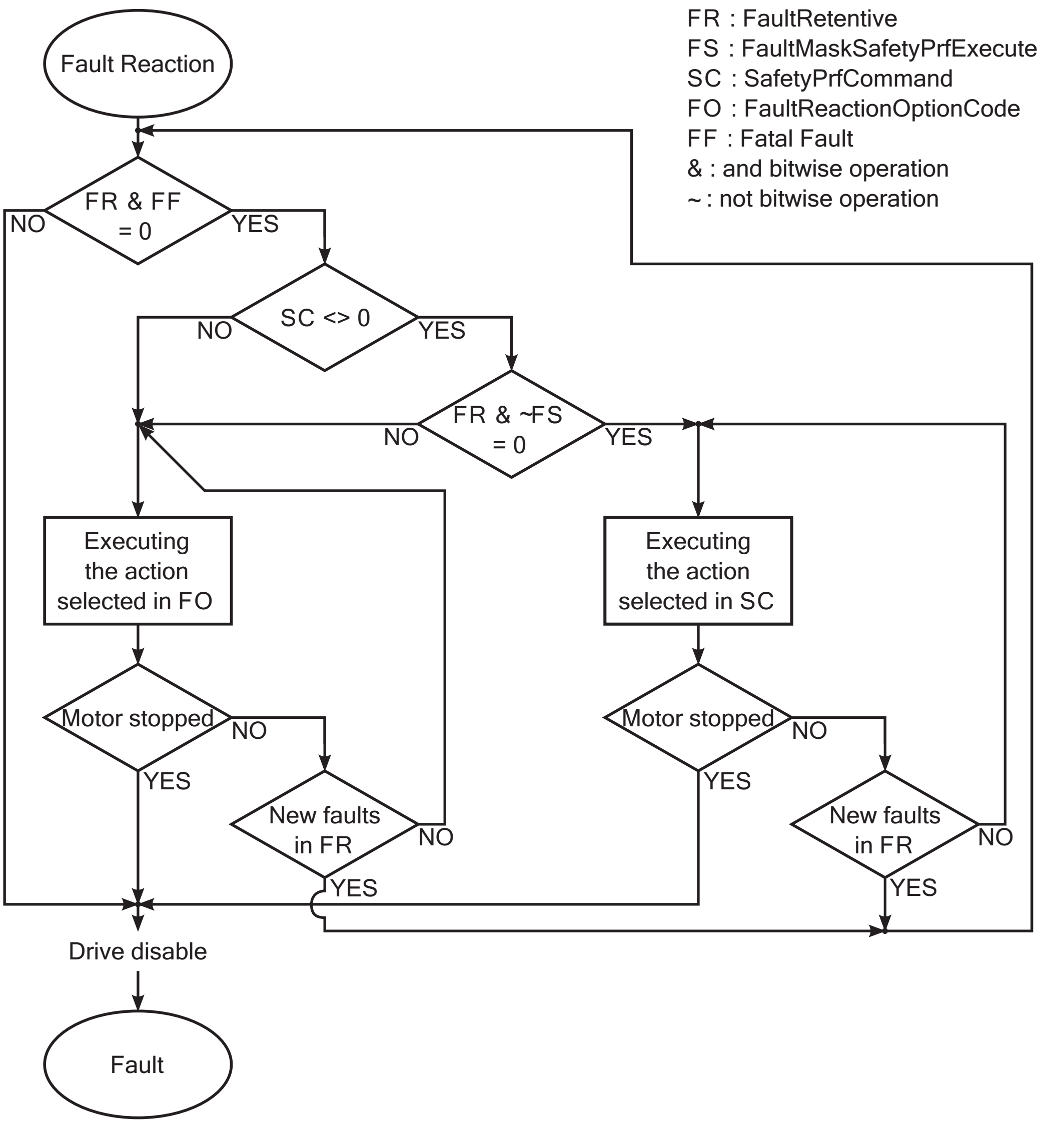
When an error of fault type occurs, the drive runs the following operations:

a) The bits of the parameters **FaultDynamic [3014.04]**, **FaultRetentive [3014.03]** and of any other parameter showing the details are set
b) The bit (or the bits) that's related to the error type and the bit 0 of the **ErrorRegister [1001.00]** are set
c) The LEDs show the fault according to the order in the table of **Section 13-2-1 Monitoring the Errors on the Status LEDs**
d) The CiA402StateMachine goes to the status of Fault Reaction Active
e) One of the following operations is executed on the motor:
   - If the fault is a Fatal Fault, then the motor is immediately disabled (see faults with FF property in the table of **Section 13-2 Fault and Warning (Integrated Servo Motor)**)
   - If the fault is NOT a Fatal Fault and has not been deactivated, even if it is self restoring, then the drive executes a ramp stop and the motor disabling according to the **FaultReactionOptionCode [605E.00]** parameter setting
   - If the fault is NOT a Fatal Fault and requires the Safety profile, that can be set through the **SafetyPrf-Command [3010.01]** and **FaultMaskSafetyPrfExecute [3000.03]** parameters, then the drive executes the positioning and the disabling of the motor

Note If contemporary more faults happen and between these there are some with different severity (and so provides a different reaction) it's important to know that the 3 different reactions (above described on point e) have a different priority: When the fault is most serious, more high is the priority. In other words the Fatal-Fault reaction has the highest priority, then follows the fault reaction that requires the ramp stop, while the reaction that requires the positioning in the security position has the lowest priority.

Note If all the causes that have activated a particular bit of **ErrorRegister [1001.00]** are removed, then that bit resets; if all the alarm causes are removed, then even the generic bit 0 is reset.

Note If the fault requires the possibility to solve with the **Safety profile** (see faults with FF property in the table of **Section 13-2 Fault and Warning (Integrated Servo Motor)**), and this profile has not been activated, the drive will execute the deceleration ramp as set on the **FaultReactionOptionCode [605E.00]** parameter.



Note When the error condition that generated the faults is no longer noticed, the corresponding bits in the dynamic fault parameters are reset. In <x0/> you can find the errors of fault type.

Safety profile

The safety profile is a motion of the motor carried out in the reaction to the faults to take the motor to a safe position. As a fault is detected, check if the drive is the status Operation enable, if the profile is enabled (see **SafetyPrfCommand [3010.01]**) and if the detected fault allows its running (see **FaultMaskSafetyPrfExecute [3000.03]**). If all the conditions are respected the operation shown in **SafetyPrfCommand [3010.01]** is run.

13-2-4 Resetting the Errors

Note It is up to the operator to find and to eliminate the causes that provoked the fault condition before running a command of Fault Reset. The continuous repetition of the command of Fault Reset without removing the causes could provoke some permanent damage to the drive.

To reset only the errors of warning retentive type, write the parameter **WarnRetentive [3014.01]**; any written value is accepted.

Note Before resetting the errors it is necessary to remove all the causes that generated them.

To reset all errors, only if the CiA402StateMachine is in the status of Fault, write the Fault reset command in the **Controlword [6040.00]**. The command consists of a transition from 0 to 1 of the bit 7 of the **Controlword [6040.00]** following these symbols: xxxx xxxx / xxx xxxx (the status of the bits shown with 'x' is not important to determine the command). This command resets the errors of retentive type, only if there are some retentive faults (**FaultRetentive [3014.03]** different 0). The CiA402StateMachine changes into the status Switch On Disabled only if there are no other faults (**FaultDynamic [3014.04]** is equal to 0).

Note Power or motor short circuit error and Power or motor over current error do not allow the running of the command Fault Reset before at least 20 seconds after the fault event.

13-2-5 Errors Description

Over voltage power section error

Overvoltage for the power supply of the power section (DC bus). Check the size of the power supply and the electrical connections. For further information, see **Section 3-1-3 Supply Voltages** and **Section 4-7 Regenerative Energy Absorption**.

Thermal management error

Error related to the drive thermal management. The details can be found in the following chart and in the parameters **ThermalManageError [302C.xx]**.

Bit	Name	Type	Description
0	Overtemperature of power section	W/F	Overtemperature of the power section (Warning level = 105°C; fault level = 110°C). Check the environment temperature and the ventilation of the power section, and reduce **PwmBridgeFrequency [3521.01]**
1	Overtemperature of logic section	W/F	Overtemperature of the logic section (Warning level = 85°C; fault level = 95°C). Check the environment temperature, the ventilation and the power consumption of the logic section with an external amperemeter. Check that the values of the current
2	Overtemperature of motor	W/F	Overtemperature of the motor (Warning level = 10°C before of the Fault threshold; fault level = it depends on which motor is used). To know the Fault threshold value: see **FaultTemperatureThrs [6410.0B]**. Verify the environment temperature, the ventilation, the dissipation, analyze the working cycle in relation to the motor performance and torque curves
6	Power temp sensor hardware failure	F	Failure of the temperature sensor of the power section. Please, contact your OMRON representative
7	Logic temp sensor hardware failure	F	Failure of the temperature sensor of the logic section. Please, contact your OMRON representative

Bit	Name	Type	Description
8	Motor temp sensor hardware failure	F	Failure of the motor temperature sensor. Please, contact your OMRON representative
9	Overtemperature of feedback sensor	W/F	Feedback sensor overtemperature. This error is present only if the position sensor is provided of the temperature sensor (and then the temperature measurement is supported by the hardware). Verify the environment temperature, the ventilation, the dissipation, analyze the working cycle in relation to the motor performance and torque curves
10-15	Reserved		

Note W = Warning, F = Fault, W/F = Both.

Under voltage power section error

Under voltage power section (DC bus). Check the output voltage of the secondary of the transformer and the input voltage of the converter (if are present), check the drive supply voltage and the wirings, use the oscilloscope to monitor the power section voltage and to check its trend and, if in some particular motion condition a voltage drop happens, decrease the velocities and the accelerations of the working cycle and/or substitute the power supply with another one more powerful. For further information, see **Section 3-1-3 Supply Voltages**.

Power or motor short circuit error

Power or motor short circuit error. Wait for 20 seconds before running the Fault Reset to allow the dissipation of the accumulated power. Check that the insulation voltage of the motor windings is compatible with the drive supply voltage. If the problem persists, please, contact your OMRON representative.

Parameters soft error

Soft error in the drive parametrization. You can find the details in the following chart and in the parameter **ParamSoftError [301A.00]** and **AI0CalibrationStatus [4100.01]**.

Bit	Name	Type	Description
0	I2T limited to max drive value	W	**UserMaxI2T [3405.02]** higher than **DriveMaxI2T [3405.03]**. Decrease **UserPeakCurrent [3405.06]** and/or **I2TTime [3405.05]**.
1	Peak current too high for motor or drive	W	**UserPeakCurrent [3405.06]** higher than **MotorPeakCurrent [6410.02]** and/or **MaxPeakCurrent [6510.02]**. Decrease **UserPeakCurrent [3405.06]**.
2-4	Reserved		
5	Loops configuration selected is not supported	W	**LoopConfiguration [3522.00]** not supported by the current firmware. Update the firmware or change configuration
6	Software position limits incompatibility	W	**PositionLimitPositive [607D.02]** lower than **PositionLimitNegative [607D.01]**. Correct the limits
7	Capture trigger source equal on both capture peripheral	W	**CaptureTriggerInput_A [4000.02]** equal to **CaptureTriggerInput_B [4010.02]**. Choose two different values.
8-9	Reserved		

Bit	Name	Type	Description
10	Capture A: Filter or trigger on both edges not allowed on selected trigger input	W	If it has been tried to contemporary set the capture on mark and the space filter (**CaptureSource0_A [4003.01]**) or the capture on both edges. Or it has been tried to set the space filter (**CaptureSource0_A [4003.01]**) with the CiA402 mode. Or it has been tried to modify the capture trigger with capture enabled.
11	Capture B: Filter or trigger on both edges not allowed on selected trigger input	W	If it has been tried to contemporary set the capture on mark and the space filter (**CaptureSource0_B [4013.01]**) or the capture on both edges. Or it has been tried to set the space filter (**CaptureSource0_B [4013.01**) with the CiA402 mode. Or it has been tried to modify the capture trigger with capture enabled.
12	Capture A: Selected trigger not available (previous value has ben kept)	W	The last value written in **CaptureTriggerInput_A [4000.02]** has been refused since it is not supported by the current firmware. Verify that the inserted data is valid, if necessary update the firmware
13	Capture B: Selected trigger not available (previous value has ben kept)	W	The last value written in **CaptureTriggerInput_B [4010.02]** has been refused since it is not supported by the current firmware. Verify that the inserted data is valid, if necessary update the firmware
14	Reserved		
15	Capture setup using disabled parameters interface (look ar parameter **CaptureInterfaceMode [402F.00]**)	W	It has been tried to access, in reading or writing, to the not selected interface (see **CaptureInterfaceMode [402F.00]** parameter). This bit cannot auto-reset, but must be reset by the user.

Note W = Warning, F = Fault, W/F = Both.

Parameters soft error is enabled even when **AI0CalibrationStatus [4100.01]** assumes the following values (W = Warning, F = Fault, W/F = Both).

Bit	Name	Type	Description
0	Analog input 0 is not calibrated	W	Analog input 0 is not correctly calibrated. Run the calibration or update the current configuration and the permanent memory with the default values
1	Analog input 0 calibration not complete (only offset)	W	
2	Analog input 0 calibration not complete (only gain)	W	

Note W = Warning, F = Fault, W/F = Both.

Parameters serious error

Serious error in the drive parametrization. The details can be found in the following chart and in the parameters **ParamSeriousError [302D.xx]**. The warning becomes a fault if you try to enable the drive.

Bit	Name	Type	Description
0	Stall current not set	W/F	**MotorStallCurrent [6410.01]** is equal to 0. Set **MotorStallCurrent [6410.01]**
1	Motor peak current not set	W/F	**MotorPeakCurrent [6410.02]** is equal to 0. Set **MotorPeakCurrent [6410.02]**
2	Motor torque constant not set	W/F	**TorqueConstant [6410.08]** is equal to 0. Set **TorqueConstant [6410.08]**
3	Motor inductance not set	W/F	**MotorInductance [6410.04]** is equal to 0. Set **MotorInductance [6410.04]**
4	Motor resistance not set	W/F	**MotorResistance [6410.05]** is equal to 0. Set **MotorResistance [6410.05]**
5	Motor inertia not set	W/F	**MotorInertia [6410.06]** is equal to 0. Set **MotorInertia [6410.06]**
6	Motor pole number not set	W/F	**MotorPoles [6410.0A]** is equal to 0. Set **MotorPoles [6410.0A]**
7	Motor rated speed not set	W/F	**MotorRatedSpeed [6410.09]** is equal to 0. Set **MotorRatedSpeed [6410.09]**
8	Sensor not set	W/F	**FeedbackSensorCode [36C0.04]** is equal to 0. Set **FeedbackSensorCode [36C0.04]**
9	Max rated current not set	W/F	**MaxRatedCurrent [6510.01]** is equal to 0. Please, contact your OMRON representative
10	Max peak current not set	W/F	**MaxPeakCurrent [6510.02]** is equal to 0. Please, contact your OMRON representative
11	Current not calibrated	W/F	Please, contact your OMRON representative
12	Voltage not calibrated	W/F	Please, contact your OMRON representative
13	Sensor not supported	W/F	**FeedbackSensorCode [36C0.04]** not supported by the current firmware. Update the firmware or change the sensor.
14	Sensor not phased	W/F	Feedback sensor phasing problems. Reset the errors and if the problem persists, please contact your OMRON representative
15	Reserved		

Note W = Warning, F = Fault, W/F = Both.

Real time mode error

Error of Interpolated Position Mode. The details can be found in the following chart and in the parameter **RealTimeModeError [3018.00]**.

Bit	Name	Type	Description
0	EtherCAT not in operational state	F	The EtherCAT state machine is not in the OPERATIONAL state. This fault is caused by: • It has been required to change the state to the EtherCAT state machine • The drive signals Main port communication error (ECT); analyse the error details
1	PDO missing	F	The parameters **IpPosFirstParameter [60C1.01]** and **IpPosSecondParameter [60C1.02]** were not received via PDO before the synchronization; manage correctly the PDOs in the master before the synchronization
2	Incompatibility of cubic interpolation parameter	F	Cubic interpolation parameters not coherent. Check that the data that are being sent by the master are correct.
3	Wrong cubic interpolation cycle period	F	T_{SYNC} too short. Increase **CommunicCyclePeriod [1006.00]**. For further details, please refer to **Section 7-2-2 Interpolated Position Mode**
4	Wrong interpolation cycle period	F	T_{SYNC} too short. Increase **CommunicCyclePeriod [1006.00]**. For further details, please refer to **Section 7-2-2 Interpolated Position Mode**
5	Interpolation parameters out of range	F	Interpolation parameters out of allowed ranges. Check that the data that are being sent to the master are correct and respect the limits set in the drive
6-15	Reserved		

Note W = Warning, F = Fault, W/F = Both.

Main port communication error (ECT)

Main port communication error EtherCAT. The details can be found in the following chart and in the parameters **EtherCAT_Diagnostics [5FF6.xx]**.

Bit	Name	Type	Description
0	Sync manager watchdog expired	F	The watchdog of the Sync manager (SM) of the PDO RX expired; the PDO RX has not been received; manage correctly in the master the sending of the PDO RX or read the watchdog times in the registers of the ET1100
1	Sync 0 watchdog expired	F	The watchdog of the SyncSignal 0 expired; set and enable correctly the signal SyncSignal 0 and the watchdog times in the registers of the ET1100
2	PLL error	F	PDO and SyncSignal 0 are not synchronized; manage correctly in the master the sending of the PDO before the synchronization
3	Synchronization error	F	The PDOs RX don't arrive or however not in correspondence to the set synchronization reference, within a tolerance from [Sync/2] to [Sync + Sync/2] with a maximum value of [Sync + 1ms]; verify that the PDOs RX are sent by the master in correspondence to the synchronization reference
4-7	Reserved		
8	Hardware failure	W	Serious error in ET1100; please contact your OMRON representative
9-31	Reserved		

Note W = Warning, F = Fault, W/F = Both.

Power or motor over current error

Too high and anomalous current in the power section or in the motor phases. The overcurrent values can be found in **OverCurrentAValue [3320.05]**, **OverCurrentBValue [3320.06]** and **OverCurrentCValue [3320.07]**. If the alarm stands for a short time period and it's a Warning, it means that the overcurrent has lasted for a short time, not dangerous for the drive; if the alarm is a Fault it means that the overcurrent has a value and a duration such that the drive might damage.

Wait for 20 seconds before running the Fault Reset to allow the dissipation of the accumulated power. Check the current loop tuning and decrease its dynamic response. Decrease the value of **UserPeakCurrent [3405.06]**. Check that the insulation voltage of the motor windings is compatible with the drive supply voltage. If the problem persists, please contact your OMRON representative.

Position following error

The **PositionFollowingError [60F4.00]** exceeded the specified thresholds, according to what is reported in Error of position tracking: check if the motor motion is compatible with the settings. The fault can be disabled by writing the parameter **FaultMaskEnable [3000.02]**; the warning cannot be disabled.

Last command requested failed

The last command of the **SysMngCommand [5FF7.01]** has concluded with an error. The details and the solutions of the error can be found in the parameter **SysMngError [5FF7.03]**.

/STOP management error [3032.xx]

Bit	Name	Type	Description
0	/STOP = 0V with drive enabled error	F	It occurs in the following cases: • The drive is in Drive enable status and the voltage on the /STOP digital input fails → Disable the drive before to cut off the voltage supply to the /STOP input • It has been tried to enable the drive without the /STOP signal → Provide voltage to the /STOP input before to give the enabling command
1	/STOP input level not in valid range	F	The voltage level that's applied on the /STOP input has lasted more than 500ms in the intermediate range of values of the voltage thresholds. Be sure that the transition between the voltage levels, from the electrical point of view, takes no more than 500ms and that the voltage values are within the correct ranges (see /STOP electric features)
2-15	Reserved		

Note W = Warning, F = Fault, W/F = Both.

User fault error

Error managed directly by the user. It can be useful when, in case of dangerous situations, the user thinks it is necessary to stop the drive working and report a fault. The details can be found in the following chart and in the parameters **UserError [302F.04]**.

Bit	Name	Type	Description
0	User fault 1	F	User fault number 1
1-15	Reserved		

Note W = Warning, F = Fault, W/F = Both.

I2T limit reached error

I2TValue reached the 100%, that is the drive reached the highest level of oversupply. If the fault is enabled the drive faults, otherwise only the warning is reported and the motor current reaches the value NominalCurrent.

I2T warning threshold reached error

I2TValue reached the specified threshold in **I2TWarningThreshold [3405.04]**. The motor current is not limited.

Limit reached error

Limits reached by the motor motion. The details can be found in the following chart and in the parameter **LimitReachedError [3019.00]**.

Bit	Name	Type	Description
0	Positive software position limit reached	W	**PositionActualValue [6064.00]** higher than **PositionLimitPositive [607D.02]**
1	Negative software position limit reached	W	**PositionActualValue [6064.00]** lower than **PositionLimitNegative [607D.01]**
2	Positive hardware position limit reached	W	Positive hardware position limit reached **Positive limit switch (FC +)**. If the position limit has not been activated by the machinery that's moved by the motor, verify that the switch has not been accidentally activated, that it's correctly powered, that the cable has not been cut, that's correctly connected with the connector **CN4**'s digital inputs.
3	Negative hardware position limit reached	W	Negative hardware position limit reached **Negative limit switch (FC -)**. If the position limit has not been activated by the machinery that's moved by the motor, verify that the switch has not been accidentally activated, that it's correctly powered, that the cable has not been cut, that's correctly connected with the connector **CN4**'s digital inputs.
4-7	Reserved		
8	Max motor speed limit reached	W	**VelocityActualValue [606C.00]** limited by **MaxMotorSpeed [6080.00]**
9-11	Reserved		
12	Torque limit reached	W	**TargetTorque [6071.00]** higher or equal to **ActualTorqueLimit** in absolute value. Verify that there are not mechanical obstacles; if the limit is set through analog input (in the **TorqueLimitSelector [4202.00]** parameter has been set the value 2), verify the input value.
13	Peak current is zero	W	**UserPeakCurrent [3405.06]** is equal to 0. Set **UserPeakCurrent [3405.06]**
14	Peak current limit reached	W	**ActualMotorCurrent [3320.01]** limited by **UserPeakCurrent [3405.06]**
15	Reserved		

Note W = Warning, F = Fault, W/F = Both.

Note If the Polarity is of Reverse type, the roles of **Positive limit switch (FC +)** and **Negative limit switch (FC -)** are reversed: **Positive limit switch (FC +)** behaves like **Negative limit switch (FC -)** and **Negative limit switch (FC -)** behaves like **Positive limit switch (FC +)**.

Possible no tuning of regulator error

Because of the change of one or more motor parameters, of the sensor or of the power pwm, the regulation loops could not be correctly calibrated.

Drive disable by digital enable input error

The digital input, to which the Enable functionality is related, is set to 0 logic state and it is required the drive enabling (take it to the Drive enable state), or, while the drive is enabled, the input which is programmed with the Enable functionality is set to 0 (is deactivated). This error report is not active in the **Profile Velocity AI Mode** and **Torque AI Mode** modes.

FeedbackSensorError

An error related to a feedback position sensor malfunctioning has occurred. The details can be found in the following chart and in the parameters **FeedbackSensorError [3031.xx]**.

Code	Name	Type	Description
0x159	Phasing: Sensor code does not match	W	The phasing has been executed with a different sensor. If it's possible, repeat the phasing procedure, if not please contact your OMRON representative
0x15A	Phasing: Polarity of quadrature signals A or B is wrong	F	The encoder A and B quadrature signals polarity is not correct. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x15B	Phasing: Quadrature signals A or B are disconnected	F	The drive does not receive the encoder A and B quadrature signals. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x30A	Phasing: Hall sensors status is not valid	F	The drive does not receive the Hall sensor signals. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x30B	Phasing: Validation window not respected	F	The alignment between the encoder and the motor position has failed. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x30C	Phasing: Hall sensors sequence is wrong	F	The Hall sensor signals don't respect the right sequence. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x359	Phasing: Sensor code does not match	W	The phasing has been executed with a different sensor. If it's possible, repeat the phasing procedure, if not please contact your OMRON representative
0x35A	Phasing: Polarity of quadrature signals A or B is wrong	F	The encoder A and B quadrature signals polarity is not correct. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x35B	Phasing: Quadrature signals A or B are disconnected	F	The drive does not receive the encoder A and B quadrature signals. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x35D	Phasing: Polarity of hall sensor U is wrong	F	The drive doesn't receive the U hall sensor signal. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x35E	Phasing: Polarity of hall sensor V is wrong	F	The drive doesn't receive the V hall sensor signal. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x35F	Phasing: Polarity of hall sensor W is wrong	F	The drive doesn't receive the W hall sensor signal. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x457	Phasing: Incremental counter initialization error	F	The alignment between the encoder and the motor position has failed. Check that, during this procedure, the motor is stopped and the encoder is correctly wired. If the problem persists, please contact your OMRON representative
0x459	Phasing: Sensor code does not match	W	The phasing has been executed with a different sensor. If it's possible, repeat the phasing procedure, if not please contact your OMRON representative

Code	Name	Type	Description
0x45A	Phasing: Polarity of Sine or Cosine is wrong	F	The encoder Sine and Cosine quadrature signals polarity is not correct. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x470	Position calculation error: Mismatch between Sine/Cosine and incremental encoder	F	Electrical problems on the reconstruction of the position from the Sine/Cosine signals. Reset the errors. If the problem persists, please contact your OMRON representative
0x471	Sine or Cosine value error	W/F	Electrical problems on the reconstruction of the position from the Sine/Cosine signals. Check the encoder connections. Reset the errors. If te problem persists, please contact your OMRON representative
0x472	Phasing: Number of Sine/Cosine is incompatible with number of motor poles	F	The feedback sensor cannot be used for the feedback of the selected motor. Select another sensor so that the pole pairs of the motor is an integer multiple of the number of sensor sinusoids/revolution.
0x501	Internal sensor error	F	Sensor internal error. If the problem persists, please contact your OMRON representative
0x502			
0x503			
0x504			
0x505			
0x506			
0x507			
0x508			
0x509			
0x50A			
0x50B			
0x50C			
0x50D			
0x50E			
0x50F			
0x510			
0x511			
0x512			
0x51F			
0x520			
0x521			
0x522			
0x523			
0x51C			
0x51E			
0x530	Communication: Timeout receiving data	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact your OMRON representative
0x531	Communication: Timeout sending data	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact your OMRON representative
0x535	Communication: Out of memory	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact your OMRON representative
0x540	Communication: Checksum error	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact your OMRON representative

Code	Name	Type	Description
0x541	Communication: Parity error	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact your OMRON representative
0x542	Communication: Framing error	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact your OMRON representative
0x543	Communication: Overrun error	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact your OMRON representative
0x557	Phasing: Incremental counter initialization error	F	The alignment between the encoder and the motor position has failed. Check that, during this procedure, the motor is stopped and the encoder is correctly wired. If the problem persists, please contact your OMRON representative
0x558	Phasing: Sensor serial number does not match	W	The phasing has been executed with a different sensor. If it's possible, repeat the phasing procedure, if not please contact your OMRON representative
0x559	Phasing: Sensor code does not match	W	The phasing has been executed with a different sensor. If it's possible, repeat the phasing procedure, if not please contact your OMRON representative
0x55A	Phasing: Polarity of Sine or Cosine is wrong	F	The encoder Sine and Cosine quadrature signals polarity is not correct. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x570	Position calculation error: Mismatch between Sine/Cosine and incremental encoder	F	Electrical problems on the reconstruction of the position from the Sine/Cosine signals. Reset the errors. If the problem persists, please contact your OMRON representative
0x571	Sine or Cosine value error	W/F	Electrical problems on the reconstruction of the position from the Sine/Cosine signals. Check the encoder connections. Reset the errors. If te problem persists, please contact your OMRON representative
0x635	Resolver startup error: Out of memory	F	Resolver start-up error. If the problem persists, please contact your OMRON representative
0x659	Phasing: Sensor code does not match	W	The phasing has been executed with a different sensor. If it's possible, repeat the phasing procedure, if not please contact your OMRON representative
0x65A	Phasing: Polarity of Sine or Cosine is wrong	F	The encoder Sine and Cosine quadrature signals polarity is not correct. Check the encoder connections. If the problem persists, please contact your OMRON representative
0x671	Sine or Cosine value error	W/F	Electrical problems on the reconstruction of the position from the Sine/Cosine signals. Check the encoder connections. Reset the errors. If te problem persists, please contact your OMRON representative
0x672	Phasing: Number of resolver poles is incompatible with number of motor poles	F	The resolver cannot be used for the feedback of the selected motor. Select another resolver so that the pole pairs of the motor is an integer multiple of the pole pairs of the resolver.

Note W = Warning, F = Fault, W/F = Both.

Note Integrated Servo Motor comes only with hyperface encoder so, some of the possible errors described do not apply to actual encoders.

Digital I/O configuration error

The configuration of the functionalities associated to the digital I/O is not correct. The details can be found in the following chart and in the parameters **DigitalIoConfigError [302E.xx]**. The warning becomes a fault if you try to enable the drive.

<table>
<tr><th>Bit</th><th>Name</th><th>Type</th><th>Description</th></tr>
<tr><td>0-4</td><td>Code of the first hardware resource involved in the error</td><td>-</td><td rowspan="2">1 = I/O 0
2 = I/O 1
3 = I/O 2
4 = I/O 3
5 = In 4
6 = In 5
7 = In 6
8 = In 7
9 = In 8
10 = In 9
11 = Out 4
12 = Out 5
13 = Out 6</td></tr>
<tr><td>5-9</td><td>Code of the second hardware resource involved in the error</td><td>-</td></tr>
<tr><td>10-15</td><td>Error code</td><td>W/F</td><td>1 = Functionality to be assigned to a hardware resource, it has been assigned to two resources; reprogram the functionalities
2 = Functionality Step assigned without having assigned the functionality Dir; assign the lacking functionality
3 = Functionality Dir assigned without having assigned the functionality Step; assign the lacking functionalities
4 = Functionality Quadrature Input Index (Idx) assigned without having assigned the functionalities Quadrature Input ChA (Ch A) and Quadrature Input ChB (Ch B); assign the lacking functionalities
5 = Functionality Quadrature Input ChB (Ch B) assigned without having assigned the functionality Quadrature Input ChA (Ch A); assign the lacking functionality
6 = Functionality Quadrature Input ChA (Ch A) assigned without having assigned the functionality Quadrature Input ChB (Ch B); assign the lacking functionality</td></tr>
</table>

Note W = Warning, F = Fault, W/F = Both.

Logic voltage error

Error of the power supply voltage of the logical section. For further information, see **Section 3-1-3 Supply Voltages**. The details can be found in the following chart and in the parameters **LogicVoltageError [3030.xx].**

Bit	Name	Type	Description
0	Logic voltage too low for brake	W/F	The supply voltage of the logical section is too low to delay correctly the brake. Increase the supply voltage or stabilize it
1-15	Reserved		

Note W = Warning, F = Fault, W/F = Both.

Motion parameter limited error

One or more motion parameters are set above their own limits. The details can be found in the following chart and in the parameter **MotionParamLimitedError [301B.00]**.

Bit	Name	Type	Description
0	Target velocity limited	W	With the **Profile Velocity Mode (CiA402)** operative modes, **TargetVelocity [60FF.00]** is greater or equal to **MaxMotorSpeed [6080.00]** or to **MaxProfileVelocity [607F.00]**. Decrease **TargetVelocity [60FF.00]**. With the **Profile Velocity AI Mode**, the conversion from **AI0FilteredVoltage [3330.02]** to the required velocity, produces a velocity value tha's grater or equal to **MaxMotorSpeed [6080.00]** or to **MaxProfileVelocity [607F.00]**.
1	Profile velocity limited	W	**ProfileVelocity [6081.00]** is higher or equal to **MaxMotorSpeed [6080.00]** or to **MaxProfileVelocity [607F.00]**. Decrease **ProfileVelocity [6081.00]**
2	Start velocity limited	W	**StartVelocity [4244.00]** is higher or equal to **MaxMotorSpeed [6080.00]** or to **MaxProfileVelocity [607F.00]**. Decrease **StartVelocity [4244.00]**
3	End velocity limited	W	**EndVelocity [6082.00]** is higher or equal to **MaxMotorSpeed [6080.00]** or to **MaxProfileVelocity [607F.00]**. Decrease **EndVelocity [6082.00]**
4	Speed during search for switch limited	W	**SpeedForSwitch [6099.01]** is higher or equal to **MaxMotorSpeed [6080.00]** or to **MaxProfileVelocity [607F.00]**. Decrease **SpeedForSwitch [6099.01]**
5	Speed during search for zero limited	W	**SpeedForZero [6099.02]** is higher or equal to **MaxMotorSpeed [6080.00]** or to **MaxProfileVelocity [607F.00]**. Decrease **SpeedForZero [6099.02]**
6	Velocity of the safety profile limited	W	**SafetyPrfVelocity [300C.02]** is higher or equal to **MaxMotorSpeed [6080.00]** or to **MaxProfileVelocity [607F.00]**. Decrease **SafetyPrfVelocity [300C.02]**
7	Reserved		
8	Profile acceleration limited	W	**ProfileAcceleration [6083.00]** is higher or equal to **MaxAcceleration [60C5.00]**. Decrease **ProfileAcceleration [6083.00]**
9	Profile deceleration limited	W	**ProfileDeceleration [6084.00]** is higher or equal to **MaxDeceleration [60C6.00]**. Decrease **ProfileDeceleration [6084.00]**

Bit	Name	Type	Description
10	Homing acceleration limited	W	**HomingAcceleration [609A.00]** is higher or equal to **MaxAcceleration [60C5.00]** or to **MaxDeceleration [60C6.00]**. Decrease **HomingAcceleration [609A.00]**
11	Quick stop deceleration limited	W	**QuickStopDeceleration [6085.00]** is higher or equal to **MaxDeceleration [60C6.00]**. Decrease **QuickStopDeceleration [6085.00]**
12	Reserved		
13	Acceleration of the safety profile limited	W	**SafetyPrfAcceleration [300C.03]** is higher or equal to **MaxAcceleration [60C5.00]**. Decrease **SafetyPrfAcceleration [300C.03]**
14	Deceleration of the safety profile limited	W	**SafetyPrfDeceleration [300C.04]** is higher or equal to **MaxDeceleration [60C6.00]**. Decrease **SafetyPrfDeceleration [300C.04]**
15	Reserved		

Note W = Warning, F = Fault, W/F = Both.

Digital output overtemperature or overload

Overcharge or overtemperature have been detected on the drive internal management circuit of the digital output. All digital outputs are switched off. Check the connected wirings and loads.

Motor overspeed

Maximum velocity limit exceeded. The threshold value is **MaxMotorSpeed***1.2, therefore it's 20% over the maximum velocity that the motor can reach. If **VelocityActualValue [606C.00]** continuously remains over this threshold for 10ms, the system enters in fault state because the movement is no more under control.

Internal error

A firmware internal error has occurred. The details can be found in the following chart and in the parameters **InternalError [303F.xx]**.

Bit	Name	Type	Description
0	Internal software reset	F	A firmware internal error has occurred. Report to OMRON the codes in the **SwResetCode [5FFA.03]** and **SwResetInfo [5FFA.04]** parameters

Note W = Warning, F = Fault, W/F = Both.

/STOP error

An error on the /STOP has occurred. The details are reported in the **STOPError [3032.xx]** parameters.

13-2-6 Errors in Reading/Writing Parameters

When there is an error in the reading or writing of the parameter, in order to understand which problem occurred it is necessary to get the error code:

- Auxiliary communication port: you can find the error code of the last failed access in **AuxiliaryPortErrorCode [5124.02]**
- Main communication EtherCAT port: the error code is contained in the frame **SDO abort**

SDO abort code	Auxiliary-PortEr-rorCode	Error	Description
0x0	0x00	No error	No error
-	0x01	Modbus protocol error: illegal function	Modbus function code not supported
-	0x02	Modbus protocol error: address not existent	Address not existing: the combination of the Modbus address and the data to write/read is not valid; the addresses included in the requested range must be contained in the vocabulary of the parameters
-	0x03	Modbus protocol error: data dimension too large	Quantity of data not admitted: too large or equal to 0
-	0x10	Modbus protocol error: illegal upload/download code	Upload/download code not valid
-	0x11	Modbus protocol error: unexpected upload/download state	Upload/download status unexpected
-	0x12	Modbus protocol error initializing upload/download	Wrong initializing of the upload/download
-	0x13	Modbus protocol error during upload/download	Error during data upload/download
-	0x14	Modbus protocol error closing upload/download	Error during upload/download closing
-	0x15	Modbus protocol error: memory overflow during upload/download	Insufficient memory to complete the upload/download
0x05030000	0x16	Unexpected toggle bit	Toggle bit not alternated during upload/download
0x05040001	-	Client / server command specifier not valid or unknown	Command specifier of the frame SDO not valid
0x05040005	0x20	Memory not available	Insufficient memory to execute the required operation
0x06010000	0x21	Access denied	Access denied to the parameter
0x06010001	0x22	Attempt to read a write only object	Reading failed, parameter only for writing
0x06010002	0x23	Attempt to write a read only object	Writing failed, parameter only for reading
0x06040043	0x24	General parameter incompatibility	General data incompatibility
0x06040047	0x25	General internal incompatibility	General incompatibility of the drive
0x06060000	0x26	Hardware error	Access failed due to a hardware error
0x06070010	-	Data type does not match	Wrong data dimension
0x06090011	0x27	SubIndex not existing	EtherCAT sub-index not existing
0x06090030	0x28	Parameter out of range	Parameter value out of accepted range
0x08000000	0x29	Generic error	Generic error
0x08000021	0x2A	Internal control refuse data	Access denied because of a local control
0x08000022	0x2B	Internal state refuse data	Access denied because of the drive current status
0x06020000	0x2C	Object does not exist	EtherCAT index not existing
0x06040041	0x2D	Object not mappable on PDO	Parameter not mappable in the PDOs
0x06040042	0x2E	Length of object mapped exceed PDO length	The dimension of the mapped parameter in the PDOs is too large

13-3 Fault and Warning (DC Power Supply Unit)

The DC Power Supply Unit provides some monitor functions of it’s physical quantities (voltage, current, temperature, etc.) in order to check the correct functioning of the power supply itself and to protect the electronic devices that are connected to it. If a functioning limits exceeding is detected, the power supply switches to the Fault status and opens the RTO contact, in order to cut off the VAC IN power supply. The fault status signal is indicated by the POWER STATUS LED, when it's on and red (see Section **1-3-4 DC Power Supply Unit Functions**), through IM-TOOL it's possible to know the Fault that is occurred in order to execute the right corrective action.

The DC Power Supply Unit, when detects some malfunctioning anomalies during working or some parameters setting error, notify the error. Errors are divided into two categories depending on their seriousness:

- Warning, error which notifies a non-serious condition of the power supply
- Fault, error that prevents and interrupt the power supply on the power section opening the RTO contact

In general, when the power supply is in the Operative or Warning status, all the physical quantities are monitored (voltage, current, temperature, etc.) and if one of them exceeded the functioning limits, it switches to the Fault status.

Errors can be:

- Dynamic: The error condition is still present in the power supply unit
- Retentive: The error is stored by the power supply unit until it is reset even if the error cause is no more present

Note The default configuration about the Fault is retentive.

Note In case of maintenance, be sure that the input voltages of the power supply unit are deactivated. Then check with a multimeter that the voltage between +HVDC and -HVDC has decreased under 50 VDC.

Note The only retentive faults exception is the HVDC undervoltage with alternate voltage missing on the power supply input (VAC_IN). In this case and automatic restart is done. The HVDC voltage decreasing on the output may generate the Undervoltage of power section fault that implies the RTO contact closing and the VAC_IN input voltage check. The next status (start-up) will be reached only if an input voltage within the functioning limits is detected, otherwise it remains in the VAC IN WAIT status. Undervoltage of power section will be automatically reset when the voltage will be once again present. If the fault intervenes when the input alternate current (VAC_IN) is present it will not be possible the automatic reset.

13-3-1 Reaction to the Faults

When the DC Power Supply Unit is in the Operational, Warning and HVDC CHECK statuses, all the physical quantities are monitored, and if at least one of them exceeds the functioning limits, then the Fault status is reached. Only for the Input voltage missing on control section fault, the power supply unit enters in the Power Down status and then, eventually, switches to the Fault status if the voltage returns normal (voltage dip).

In the Fault condition, the power supply unit disables the RTO contact, continues to check all the physical quantities and extends the Fault status until at least one of the faults, that are listed below, is present. Since no one of the fault conditions is present, the restore waiting time starts (**FaultLockTime [Modbus 2068]**).

In the following table there are reported the WD, WR, FD and FR abbreviations, that assume the following meaning:

- WD: Main dynamic warnings
- WR: Main retentive warnings
- FD: Main dynamic faults
- FR: Main retentive faults

Fault type	FaultLockTime (s)	Fault code	WD	WR	FD	FR
Under voltage of power section	5	1	-	-	●	●
Over voltage of power section	5	2	-	-	●	●
Voltage ripple exceeds the limit on power section	10	3	-	-	●	●
Over temperature of logic section	10	4	●	●	●	●
Over temperature of power section	10	5	●	●	●	●
Over current of power section	10	6	-	-	●	●
Device energy overload exceeds the limit	10	7	●	●	●	●
Braking circuit energy overload exceeds the limit	10	8	●	●	●	●
Over voltage of HVDC output during braking	-	-	●	●	-	-
Input voltage missing on power section	-	9	-	-	●	●
Short circuit on braking circuit	10	10	-	-	●	●
Input voltage missing on logic section	0.1	11	-	-	●	●
Charge circuit energy overload	100	12	-	-	●	●
Configuration parameters missing	-	13	-	-	●	●
Device energy overload exceeds the limit on channel 1	10	16	●	●	●	●
Device energy overload exceeds the limit on channel 2	10	17	●	●	●	●
Input circuit ripple exceeds the limit on power section	10	18	-	-	●	●
Input voltage falling on power section	5	19	-	-	●	●
Cable energy overload exceeds the limit on channel 1	100	21	●	●	●	●
Cable energy overload exceeds the limit on channel 2	100	22	●	●	●	●
Hardware configuration not valid	10	20	-	-	●	●

13-3-2 Resetting the Errors

The restore of the DC Power Supply Unit from the Fault status can be made in 3 different ways, in any case there must be no more active faults and the longer **FaultLockTime [Modbus 2068]** between the detected faults must be elapsed.

The modes are:

- Automatic restart: if the **AutomaticRestartFunction [Modbus 2101]** parameter is set to 1, the power supply unit automatically returns in the VAC IN WAIT state
- Restore through IN0: if a positive transition is detected on the IN0 input, the power supply unit returns in the VAC IN WAIT state
- Reset via serial communication (IM-TOOL)

Note If the 24V IN control side voltage is cut off, then the fault signals are lost and the power supply unit may normally restart even before the **FaultLockTime [Modbus 2068]** time is elapsed. WE ADVISE AGAINST THIS PROCEDURE IN ORDER TO AVOID RISKS OF INTERNAL COMPONENTS DAMAGE.

Necessary conditions to execute the faults reset

In order to reset the faults, the following points must be verified:

- Restore time waiting (**FaultLockTime [Modbus 2068]**)
- Accumulated over energy discharge waiting (only for the faults that are reported in the below table)

In the first case if the control section turns off the restore time is immediately reset, so at the next power on and without faults it's possible a new immediate start-up of the power supply. Wait in any case the restoring time in order to avoid risk of internal components irreparable damages.

Instead, in the second case, if the control section is turned off the energy that has been accumulated until that moment, is memorized so, at the following turn on, the previous energy is returned and a warning (50% < overload < 100%) or a fault (overload ≥ 100%) is reported.

Even after a fault, keep on the control section in order to allow the accumulated energy discharge and so maintain the alignment between the theoretical energy and the real one, related to the circuit that has to be protected.

Fault type	1% discharge time	100% discharge time	Energy memorization on the 24V turn off
Braking circuit energy overload exceeds the limit	0.5 s	50 s	Yes
Charge circuit energy overload	0.5 s	50 s	Yes
Cable energy overload exceeds the limit on channel 1	24.8 s	2480 s	Yes
Cable energy overload exceeds the limit on channel 2	24.8 s	2480 s	Yes
Device energy overload exceeds the limit	0.15 s	15 s	-
Device energy overload exceeds the limit on channel 1	0.18 s	18 s	-
Device energy overload exceeds the limit on channel 2	0.18 s	18 s	-

13-3-3 Errors Description

Under voltage of power section

HVDC effective voltage lower than the minimum limit. Check that the input voltage (VAC_IN) is within the expected functioning range, that there is no voltage difference between the phases and there are no voltage dips.

Over voltage of power section

HVDC effective voltage higher than the maximum limit. Check that the input voltage (VAC_IN) is within the expected functioning range, and check if the overvoltage is due to the regeneration current of the connected drives.

Voltage ripple exceeds the limit on power section

Voltage ripple higher than the 25% of the nominal voltage for 700 ms. Check that the input voltage (VAC_IN) is within the expected functioning range and there are no voltage dips; check if there are overload conditions on the output line (HVDC).

Over temperature of logic section

Temperature of the logic section higher than the maximum limit. Check the power supply environment temperature and its correct positioning and ventilation inside the electrical panel.

Over temperature of power section

Temperature of the power section higher than the maximum limit. Check the power supply environment temperature and its correct positioning and ventilation inside the electrical panel. Furthermore, check the Brake circuit intervention frequency if it has been configured the internal brake resistor use (Internal brake circuit).

Over current of power section

Instantaneous current higher than the maximum limit. Check the output current and the eventual peaks.

Device energy overload exceeds the limit

Energy provided by the power supply higher than the maximum value. Check that the **RMS_OutputCurrent [Modbus 2052]** is not higher than the **OutputCurrentLimit [Modbus 2134]**.

Braking circuit energy overload exceeds the limit

Energy absorbed by the overvoltage protection circuit higher than the maximum value. Check the Brake circuit intervention frequency, check if the Brake switch on threshold parameter has been set with a too low value (**BrakingCircuitActivationVoltage [Modbus 2136]**).

Over voltage of HVDC output during braking

The output voltage exceeds by 15V the Maximum activation threshold of the Braking Circuit. Check the braking resistor value or decrease the motors braking dynamic (deceleration ramps).

Input voltage missing on power section

Power section input voltage missing. Check the RTO contact and the power relay activation, check the upstream supply of the power relay and the status of eventual fuses, disconnecting switches.

Short circuit on braking circuit

Short circuit detected in the Brake protection section. Check the x1 Brake Resistor connector (connection of the external resistor, check even its value).

Input voltage missing on logic section

Logic section voltage supply missing (< 18 VDC). Check if the 24V supply on x3 Logic connector is within the correct range and that there are no voltage dips during the functioning.

Charge circuit energy overload

The energy absorbed by the capacitor charging current limitation circuit is higher than the maximum value. Check that at the start-up there are no loads on the output x7 and x8 Power output connectors (the output load during this operation must mainly be capacitive).

Configuration parameters missing

Missing or corrupted configuration parameters, it's not possible to use the power supply because the set of the parameters that characterize it is not valid and can't be restored by the user. Send back to repair, please contact your OMRON representative.

Device energy overload exceeds the limit on channel 1

Energy provided in the CH1 channel higher than the maximum value. Check that the **RMS_CurrentCH1 [Modbus 2548]** is within the range.

Device energy overload exceeds the limit on channel 2

Energy provided in the CH2 channel higher than the maximum value. Check that the **RMS_CurrentCH2 [Modbus 2648]** is within the range.

Internal circuit ripple exceeds the limit on power section

During the start-up, the output voltage difference (ripple) between VBRIDGE (HVDC nominal value) and the actual value of HVDC is higher than 50V. Check that at the start-up there are no excessive loads on the output x7 and x8 Power output connectors.

Input voltage falling on power section

Input voltage dip for more than 20 ms and HVDC output voltage value lower than the 65% of the nominal voltage. Check the VAC_IN input alternate voltage, the wiring and the protection upstream of the power supply.

Cable energy overload exceeds the limit on channel 1

Protection energy of the cable connected to x7 (CH1) higher than the maximum value. Check that **RMS_CurrentCH1 [Modbus 2548]** is within the limit **CableCurrentLimit(CH1) [Modbus 2142]**. Check that the value that is set on Cable current limit is not too low. If it will be necessary to increase its value, check the dimensioning of the cable (section, length, ...) to avoid the overheating.

Cable energy overload exceeds the limit on channel 2

Protection energy of the cable connected to x8 (CH2) higher than the maximum value. Check that **RMS_CurrentCH2 [Modbus 2648]** is within the limit **CableCurrentLimit(CH2) [Modbus 2145]**. Check that the value that is set on Cable current limit is not too low. If it will be necessary to increase its value, check the dimensioning of the cable (section, length, ...) to avoid the overheating.

Hardware configuration not valid

Hardware configuration not valid. Send back to repair, please contact your OMRON representative.

13-3-4 Errors in Reading/Writing Parameters

When there is an error in the reading or writing of the parameter, in order to understand which problem occurred it is necessary to get the error code:

- Auxiliary communication port: you can find the error code of the last failed access in **AuxiliaryPortErrorCode [Modbus 1121]**

AuxiliaryPort-ErrorCode	Error	Description
0x00	No error	No error
0x01	Modbus protocol error: illegal function	Modbus function code not supported
0x02	Modbus protocol error: address not existent	Address not existing: the combination of the Modbus address and the data to write/read is not valid; the addresses included in the requested range must be contained in the vocabulary of the parameters
0x03	Modbus protocol error: data dimension too large	Quantity of data not admitted: too large or equal to 0
0x10	Modbus protocol error: illegal upload/download code	Upload/download code not valid
0x11	Modbus protocol error: unexpected upload/download state	Upload/download status unexpected
0x12	Modbus protocol error initializing upload/download	Wrong initializing of the upload/download
0x13	Modbus protocol error during upload/download	Error during data upload/download
0x14	Modbus protocol error closing upload/download	Error during upload/download closing
0x15	Modbus protocol error: memory over-flow during upload/download	Insufficient memory to complete the upload/down-load
0x16	Unexpected toggle bit	Toggle bit not alternated during upload/download
0x20	Memory not available	Insufficient memory to execute the required opera-tion
0x21	Access denied	Access denied to the parameter
0x22	Attempt to read a write only object	Reading failed, parameter only for writing
0x23	Attempt to write a read only object	Writing failed, parameter only for reading
0x24	General parameter incompatibility	General data incompatibility
0x25	General internal incompatibility	General incompatibility of the power supply
0x26	Hardware error	Access failed due to a hardware error
-	Data type does not match	Wrong data dimension
0x28	Parameter out of range	Parameter value out of accepted range
0x29	Generic error	Generic error
0x2A	Internal control refuse data	Access denied because of a local control
0x2B	Internal state refuse data	Access denied because of the power supply current status

13-4 Periodic Maintenance

The periodic maintenance cycle depends on the installation environment and application conditions of the Integrated Servo Motors and DC Power Supply Unit. Recommended maintenance times are given below for Integrated Servo Motors and DC Power Supply Unit. Use these for reference in periodic maintenance.

13-4-1 Integrated Servo Motor Life Expectancy

The lifetimes for the different motor parts are listed below:

- Integrated Servo Motor bearings: 20,000 hours
- Encoder bearings (128 sin/cos - 18 bit): 3.6 x 10^9 revolutions
- Encoder bearings (16 sin/cos - 15 bit): No bearing
- Integrated Servo Motor fans: 50,000 hours

These values assume an ambient motor operating temperature of 40ºC, a shaft load within the specified value, operation within the rated values (rated torque and rated rotation speed), and proper installation as described in this manual.

The bearings and fans can be replaced for repair.

13-4-2 DC Power Supply Unit Life Expectancy

The lifetimes for the different motor parts are listed below:

- DC Power Supply Unit internal fans (only for R88S-EAD40R model): 90,000 hours (confidence level 90%)
- DC Power Supply Unit external fans (only for R88S-EAD40R model): 200,000 hours (confidence level 90%)
- DC Power Supply Unit capacitors: 50,000 hours

These values assume an ambient motor operating temperature of 40ºC and proper installation as described in this manual.

The fans and capacitors can be replaced for repair.

App

Appendices

The appendix provides the list of objects, Sysmac Studio setup and other information.

A-1 Object List (Integrated Servo Motor)

This section describes the profile that is used to control the drive of the Integrated Servo Motor.

See below for the type of access to the parameter:

- RW (read/write): reading and writing
- WO (write only): only writing
- RO (read only): only reading
- CST (constant): only reading (constant parameter)

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
	0x1000.00	DeviceType	0x0002 0192	0x0002 0192	U32	-	CST	-	-
	0x1001.00	ErrorRegister	0-7	-	U8	-	RO	Yes	-
	0x1006.00	CommunicCyclePeriod	0-32000	0	U32	μs	RW	-	-
	0x1008.00	ManufacturerDeviceName	-	-	STR	-	CST	-	-
	0x1009.00	ManufacturerHwVersion	-	-	STR	-	CST	-	-
	0x100A.00	ManufacturerSwVersion	-	-	STR	-	CST	-	-
Identity	0x1018.00	Number of entries	4	4	U8	-	CST	-	-
	0x1018.01	VendorID	-	0x83	U32	-	RO	-	-
	0x1018.02	ProductCode	-	0xBB	U32	-	RO	-	-
	0x1018.03	RevisionNumber	-	0x0019 0000	U32	-	RO	-	-
	0x1018.04	SerialNumber	-	-	U32	-	RO	-	-
	0x1600.00	PdoRx1_MappingParameters	0-8	1	U8	-	RW	-	-
	0x1601.00	PdoRx2_MappingParameters	0-8	8	U8	-	RW	-	-
	0x1602.00	PdoRx3_MappingParameters	0-8	2	U8	-	RW	-	-
	0x1603.00	PdoRx4_MappingParameters	0-8	7	U8	-	RW	-	-
	0x1A00.00	PdoTx1_MappingParameters	0-8	3	U8	-	RW	-	-
	0x1A01.00	PdoTx2_MappingParameters	0-8	6	U8	-	RW	-	-
	0x1A02.00	PdoTx3_MappingParameters	0-8	2	U8	-	RW	-	-
	0x1A03.00	PdoTx4_MappingParameters	0-8	8	U8	-	RW	-	-
SM_CommunicationType	0x1C00.00	Number of entries	4	4	U8	-	CST	-	-
	0x1C00.01	SM0_CommunicationType	1-4	1	U8	-	RO	-	ES
	0x1C00.02	SM1_CommunicationType	1-4	2	U8	-	RO	-	ES
	0x1C00.03	SM2_CommunicationType	1-4	3	U8	-	RO	-	ES
	0x1C00.04	SM3_CommunicationType	1-4	4	U8	-	RO	-	ES
SM_PdoAssignment	0x1C10.00	SM0_PdoAssignment	0	0	U8	-	RO	-	-
	0x1C11.00	SM1_PdoAssignment	0	0	U8	-	RO	-	-
	0x1C12.00	SM2_PdoAssignment	2	2	U8	-	RO	-	-
	0x1C13.00	SM3_PdoAssignment	2	2	U8	-	RO	-	-

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
SM0_Synchroni-zation	0x1C30.00	Number of entries	3	3	U8	-	CST	-	-
	0x1C30.01	SM0_Synchronization-Type	0	0	U16	-	RO	-	-
	0x1C30.02	SM0_CycleTime	0	0	U32	ns	RO	-	-
	0x1C30.03	SM0_ShiftTime	0	0	U32	ns	RO	-	-
SM1_Synchroni-zation	0x1C31.00	Number of entries	3	3	U8	-	CST	-	-
	0x1C31.01	SM1_Synchronization-Type	0	0	U16	-	RO	-	-
	0x1C31.02	SM1_CycleTime	0	0	U32	ns	RO	-	-
	0x1C31.03	SM1_ShiftTime	0	0	U32	ns	RO	-	-
SM2_Synchroni-zation	0x1C32.00	Number of entries	3	3	U8	-	CST	-	-
	0x1C32.01	SM2_Synchronization-Type	0-2; 34	1	U16	-	RW	-	-
	0x1C32.02	SM2_CycleTime	0	0	U32	ns	RW	-	-
	0x1C32.03	SM2_ShiftTime	0	0	U32	ns	RO	-	-
SM3_Synchroni-zation	0x1C33.00	Number of entries	3	3	U8	-	CST	-	-
	0x1C33.01	SM3_Synchronization-Type	0-2; 34	34	U16	-	RW	-	-
	0x1C33.02	SM3_CycleTime	0	0	U32	ns	RW	-	-
	0x1C33.03	SM3_ShiftTime	0	0	U32	ns	RO	-	-
FaultMask	0x3000.00	Number of entries	3	3	U8	-	CST	-	-
	0x3000.01	FaultMaskAutoErase	0-31	0	U32	-	RW	-	ES
	0x3000.02	FaultMaskEnable	0-31	0	U32	-	RW	-	ES
	0x3000.03	FaultMaskSafetyPrfEx-ecute	0-31	0x180	U32	-	RW	-	ES
SafetyPrfConfiguration	0x300C.00	Number of entries	4	4	U8	-	CST	-	-
	0x300C.01	SafetyPrfTargetPosition	-	0	S32	inc	RW	-	ES
	0x300C.02	SafetyPrfVelocity	1 to 2^{32}	500658	U32	inc/s	RW	-	ES
	0x300C.03	SafetyPrfAcceleration	1 to 2^{32}	20860757	U32	inc/s^2	RW	-	ES
	0x300C.04	SafetyPrfDeceleration	1 to 2^{32}	20860757	U32	inc/s^2	RW	-	ES
0x3010.01		SafetyPrfCommand	0-2	0	U16	-	RW	-	-
MainError	0x3014.00	Number of entries	4	4	U8	-	CST	-	-
	0x3014.01	WarnRetentive	-	0	U32	-	RW	-	-
	0x3014.02	WarnDynamic	-	0	U32	-	RW	-	-
	0x3014.03	FaultRetentive	-	0	U32	-	RW	Yes	-
	0x3014.04	FaultDynamic	-	0	U32	-	RO	Yes	-
0x3018.00		RealTimeModeError	0-15	0	U16	-	RO	-	-
0x3019.00		LimitReachedError	0-15	0	U16	-	RO	-	-
0x301A.00		ParamSoftError	0-15	0	U16	-	RO	-	-
0x301B.00		MotionParamLimitedEr-ror	0-15	0	U16	-	RO	-	-

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
ThermalManageError	0x302C.00	Number of entries	4	4	U8	-	CST	-	-
	0x302C.01	ThermalManageWarn-Retentive	0-15	0	U16	-	RO	-	-
	0x302C.02	ThermalManageWarn-Dynamic	0-15	0	U16	-	RO	-	-
	0x302C.03	ThermalManage-FaultRetentive	0-15	0	U16	-	RO	-	-
	0x302C.04	ThermalManageFault-Dynamic	0-15	0	U16	-	RO	-	-
ParamSeriousError	0x302D.00	Number of entries	4	4	U8	-	CST	-	-
	0x302D.02	ParamSeriousWarnDy-namic	0-15	0	U16	-	RO	-	-
	0x302D.03	ParamSeriousFaultRe-tentive	0-15	0	U16	-	RO	-	-
	0x302D.04	ParamSeriousFaultDy-namic	0-15	0	U16	-	RO	-	-
DigitalIoConfigError	0x302E.00	Number of entries	4	4	U8	-	CST	-	-
	0x302E.01	DigitalIoConfigWarnRe-tentive	0-15	0	U16	-	RO	-	-
	0x302E.03	DigitalIoConfigFaultRe-tentive	0-15	0	U16	-	RO	-	-
	0x302E.04	DigitalIoConfigFaultDy-namic	0-15	0	U16	-	RO	-	-
User-Error	0x302F.00	Number of entries	4	4	U8	-	CST	-	-
	0x302F.04	UserFaultDynamic	0-15	0	U16	-	RW	-	-
LogicVoltageError	0x3030.00	Number of entries	4	4	U8	-	CST	-	-
	0x3030.01	LogicVoltageWarnRe-tentive	0-15	0	U16	-	RO	-	-
	0x3030.02	LogicVoltageWarnDy-namic	0-15	0	U16	-	RO	-	-
	0x3030.03	LogicVoltageFaultRe-tentive	0-15	0	U16	-	RO	-	-
	0x3030.04	LogicVoltageFaultDy-namic	0-15	0	U16	-	RO	-	-
FeedbackSensorError	0x3031.00	Number of entries	4	4	U8	-	CST	-	-
	0x3031.01	FeedbackSensorWarn-Retentive	-	0	U16	-	RO	-	-
	0x3031.02	FeedbackSensorWarn-Dynamic	-	0	U16	-	RO	-	-
	0x3031.03	FeedbackSensor-FaultRetentive	-	0	U16	-	RO	-	-
	0x3031.04	FeedbackSensorFault-Dynamic	-	0	U16	-	RO	-	-
STOPError	0x3032.00	Number of entries	4	4	U8	-	CST	-	-
	0x3032.03	STOPFaultRetentive	0-15	0	U16	-	RO	-	-
	0x3032.04	STOPFaultDynamic	0-15	0	U16	-	RO	-	-
InternalError	0x303F.00	Number of entries	4	4	U8	-	CST	-	-
	0x303F.03	InternalErrorFaultRe-tentive	-	0	U16	-	RO	-	-
	0x303F.04	InternalErrorFaultDy-namic	-	0	U16	-	RO	-	-
0x3080.00		LoopType	0-1	0	U16	-	RW	-	-

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
TemperatureStatus	0x3300.00	Number of entries	5	5	U8	-	CST	-	-
	0x3300.01	PowerTemperature	-	-	S16	10 = 1ºC	RO	Yes	-
	0x3300.02	LogicTemperature	-	-	S16	10 = 1ºC	RO	Yes	-
	0x3300.03	MotorTemperature	-	-	S16	10 = 1ºC	RO	Yes	-
	0x3300.04	FeedbackSensorTem-perature	-	-	S16	10 = 1ºC	RO	Yes	-
	0x3300.05	MotorTemperaturePTC	-	-	S32	Ω	RO	Yes	-
0x3310.01		DCBusVoltage	-	-	U16	10 = 1V	RO	Yes	-
CurrentStatus	0x3320.00	Number of entries	9	9	U8	-	CST	-	-
	0x3320.01	ActualMotorCurrent	-	-	U16	100 = 1A	RO	Yes	-
	0x3320.02	ActualFieldCurrent	-	-	U16	100 = 1A	RO	Yes	-
	0x3320.03	ActualTorqueCurrent	-	-	U16	100 = 1A	RO	Yes	-
	0x3320.05	OverCurrentAValue	-	-	U16	100 = 1A	RO	Yes	-
	0x3320.06	OverCurrentBValue	-	-	U16	100 = 1A	RO	Yes	-
	0x3320.07	OverCurrentCValue	-	-	U16	100 = 1A	RO	Yes	-
	0x3320.08	RMSMotorCurrent	-	-	U16	100 = 1A	RO	Yes	-
	0x3320.09	RMSMotorCurrentFilter	-	100	U16	100 = 1s	RW	-	ES
0x3321.01		TorqueFilterFrequency	-	80	U16	Hz	RW	-	ES
AI0Ac-quir-ingStat	0x3330.00	Number of entries	2	2	U8	-	CST	-	-
	0x3330.01	AI0Voltage	-	-	S16	mV	RO	Yes	-
	0x3330.02	AI0FilteredVoltage	-	-	S16	mV	RO	Yes	-
I2TParameters	0x3405.00	Number of entries	6	6	U8	-	CST	-	-
	0x3405.01	I2TTime	-	-	U16	ms	RW	-	ES
	0x3405.02	UserMaxI2T	-	-	U32	A^2s	RO	-	-
	0x3405.03	DriveMaxI2T	-	-	U32	A^2ms	RO	-	-
	0x3405.04	I2TWarningThreshold	0-100	80	U16	%	RW	-	ES
	0x3405.05	I2TValue	-	-	U16	%	RO	Yes	ES
	0x3405.06	UserPeakCurrent	-	-	U16	100 = 1A	RW	Yes	ES
0x3500.00		ResetWatchdogTimeout	-	-	U16	-	WO	-	-
EstimatedLoops-Bandwidth	0x3501.00	Number of entries	3	3	U8	-	CST	-	-
	0x3501.01	CurrentLoopEstimated-Bandwidth	-	-	U16	Hz	RO	-	-
	0x3501.02	VelocityLoopEstimated-Bandwidth	-	-	U16	Hz	RO	-	-
	0x3501.03	PositionLoopEstimated-Bandwidth	-	-	U16	Hz	RO	-	-
Tuning Con-figurations	0x3502.00	Number of entries	4	4	U8	-	CST	-	-
	0x3502.01	DynamicResponse	120-180	150	U16	-	RW	Yes	ES
	0x3502.02	Stiffness	130-170	150	U16	-	RW	Yes	ES
	0x3502.03	VelocityLoopFilter1	1-51	2	U16	-	RW	Yes	ES
	0x3502.04	VelocityLoopFilter2	1-50	3	U16	-	RW	Yes	ES

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
InertiaEstimator	0x3503.00	Number of entries	6	6	U8	-	CST	-	-
	0x3503.01	InertiaEstimatorDirection	-	192	U16	-	RW	-	-
	0x3503.02	InertiaEstimatorTorque	0-32767	1000	U16	10 = 1%IS	RW	-	-
	0x3503.03	InertiaEstimatorVelocity	-	16688605	U32	inc/s	RW	-	-
	0x3503.05	EstimatedInertia	-	10	U16	10 = 1Jm	RW	-	EM
	0x3503.06	InertiaReductionFactor	0-1000	1000	U16	-	RW	-	EM
RLEstimator	0x3504.00	Number of entries	12	12	U8	-	CST	-	-
	0x3504.01	EstimatedPhaseResistance	-	-	U16	mΩ	RO	-	EM
	0x3504.02	MotorPhaseResistance	-	-	U16	mΩ	RO	-	EM
	0x3504.04	MotorSynchronousInductance	-	-	U16	100 = 1mH	RO	-	EM
	0x3504.05	EstimatedLDNominalP	-	-	U16	100 = 1mH	RO	-	EM
	0x3504.06	EstimatedLDNominalN	-	-	U16	100 = 1mH	RO	-	EM
	0x3504.07	EstimatedLDPeakP	-	-	U16	100 = 1mH	RO	-	EM
	0x3504.08	EstimatedLDPeakN	-	-	U16	100 = 1mH	RO	-	EM
	0x3504.09	EstimatedLQNominalP	-	-	U16	100 = 1mH	RO	-	EM
	0x3504.0A	EstimatedLQNominalN	-	-	U16	100 = 1mH	RO	-	EM
	0x3504.0B	EstimatedLQPeakP	-	-	U16	100 = 1mH	RO	-	EM
	0x3504.0C	EstimatedLQPeakN	-	-	U16	100 = 1mH	RO	-	EM
0x3515.08		TuningEndOption	0-22	22	S16	-	RW	-	-
0x3515.09		TuningEndDeceleration	1 to 2^{32}	166886054	U32	inc/s^2	RW	-	-
0x3520.06		FieldWeakeningFilterType	0-65535	2	U16	-	RW	-	ES
PowerPwmParameters	0x3521.00	Number of entries	7	7	U8	-	CST	-	-
	0x3521.01	PwmBridgeFrequency	1500-30000	5000	U16	Hz	RO	-	ES
	0x3521.02	PwmModulationMethod	2	2	U16	-	RO	-	ES
	0x3521.03	PwmMotionLoopDivider	-	1	U16	-	RO	-	ES
	0x3521.04	MotionLoopPeriod	-	100	U16	μs	RO	-	-
	0x3521.05	CurrentLoopPeriod	-	100	U16	μs	RO	-	-
	0x3521.07	PwmMotionLoopCode	-	0	U16	-	WO	-	-
0x3522.00		LoopConfiguration	0-2	2	U16	-	RW	-	ES
0x3523.00		VelocityStandStill	-	-	U16	-	RW	-	ES
Feedback-Sensor	0x36C0.00	Number of entries	8	8	U8	-	CST	-	-
	0x36C0.02	FeedbackSensorResolution	-	-	U32	count/rev	RO	-	-
	0x36C0.04	FeedbackSensorCode	0-151	-	U16	-	-	-	EM
	0x36C0.05	SensorFaultTemperatureThrs	-	110	U16	ºC	RO	-	EM
	0x36C0.08	FeedbackSensorAbsMode	-	-	S16	ºC	RW	-	EM

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
FeedbackSensor-Phasing	0x36C2.00	Number of entries	3	3	U8	-	CST	-	-
	0x36C2.01	FeedbackSensorPhas-ingStatus	-	-	U16	-	RO	-	-
	0x36C2.02	FeedbackSensorPhas-ingAngleTest	0-3600	-	S16	10 = 1deg	RW	-	-
	0x36C2.03	FeedbackSensorPhas-ingAngleError	-	-	S16	10 = 1deg	RW	-	-
VirtualAuxEnc-Param	0x36C8.00	Number of entries	3	3	U8	-	CST	-	-
	0x36C8.01	VirtualAuxEncoderPosi-tion	-	0	S32	cnt	RW	Yes	-
	0x36C8.02	VirtualAuxEncoderRun-Stop	0-1	0	U8	-	RW	-	-
	0x36C8.03	VirtualAuxEncoderVel-ocity	-	0	S32	cnt/s	RW	Yes	-
RealAuxEncParam	0x36C9.00	Number of entries	3	3	U8	-	CST	-	-
	0x36C9.01	RealAuxEncoderPosi-tion	-	0	S32	cnt	RW	Yes	-
	0x36C9.02	RealAuxEncoderPolar-ity	-	0	U16	-	RW	-	-
	0x36C9.03	RealAuxEncoderVeloc-ity	-	0	S32	cnt/s	RO	Yes	-
AuxiliaryEncParam	0x36CA.00	Number of entries	3	3	U8	-	CST	-	-
	0x36CA.01	AuxiliaryEncoderPosi-tion	-	-	S32	cnt	RO	Yes	-
	0x36CA.02	AuxiliaryEncoderSelec-tor	0-1	0	U16	-	RW	-	-
	0x36CA.03	AuxiliaryEncoderVeloc-ity	-	-	S32	cnt/s	RO	Yes	-
Brake	0x36D0.00	Number of entries	3	3	U8	-	CST	-	-
	0x36D0.01	BrakeReleaseTime	-	-	U16	ms	RW	-	EM
	0x36D0.02	BrakeCloseTime	-	-	U16	ms	RW	-	EM
	0x36D0.03	BrakeStatus	-	-	U16	-	RW	-	-
CaptureParam_A	0x4000.00	Number of entries	10	10	U8	-	CST	-	-
	0x4000.01	CaptureUnitCom-mand_A	0-3	0	U16	-	RW	-	-
	0x4000.02	CaptureTriggerInput_A	0-4	0	U16	-	RW	-	ES
	0x4000.03	CaptureTriggerEdge_A	0-2	0	U16	-	RW	-	ES
	0x4000.04	CaptureInhibitTime_A	0-65500	0	U16	ms	RW	-	ES
	0x4000.08	CaptureActiveSlopeVal-idationFilter_A	-	0	U32	-	RW	-	ES
	0x4000.09	CaptureRestoreSlope-ValidationFilter_A	-	0	U32	-	RW	-	ES
	0x4000.0A	CaptureValidationFilter-Mode_A	0-1	0	U16	-	RW	-	ES
CaptureState_A	0x4001.00	Number of entries	4	4	U8	-	CST	-	-
	0x4001.01	CaptureUnitState_A	0-4	-	U16	-	RO	Yes	-
	0x4001.02	NumberCapturesRe-corded_A	-	-	U16	-	RO	Yes	-
	0x4001.03	NumberCapturesRe-cordedRising_A	-	-	U16	-	RO	Yes	-
	0x4001.04	NumberCapturesRe-cordedFalling_A	-	-	U16	-	RO	Yes	-

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
Capture-Sources_A	0x4003.00	Number of entries	3	3	U8	-	CST	-	-
	0x4003.01	CaptureSource0_A	0-4	2	U16	-	RW	-	ES
	0x4003.02	CaptureSource1_A	0-4	1	U16	-	RW	-	ES
	0x4003.03	CaptureSource2_A	0-4	0	U16	-	RW	-	ES
Captured-Values_A	0x4004.00	Number of entries	3	3	U8	-	CST	-	-
	0x4004.01	CapturedValue0_A	-	-	U32	-	RO	Yes	-
	0x4004.02	CapturedValue1_A	-	-	U32	-	RO	Yes	-
	0x4004.03	CapturedValue2_A	-	-	U32	-	RO	Yes	-
Captured-Values_Word_A	0x4005.00	Number of entries	3	3	U8	-	CST	-	-
	0x4005.01	CptVal0_Word_A	-	-	S16	-	RO	Yes	-
	0x4005.02	CptVal1_Word_A	-	-	S16	-	RO	Yes	-
	0x4005.03	CptVal2_Word_A	-	-	S16	-	RO	Yes	-
Captured-Values_Byte_A	0x4006.00	Number of entries	3	3	U8	-	CST	-	-
	0x4006.01	CptVal0_Byte_A	-	-	S8	-	RO	Yes	-
	0x4006.02	CptVal1_Byte_A	-	-	S8	-	RO	Yes	-
	0x4006.03	CptVal2_Byte_A	-	-	S8	-	RO	Yes	-
CapturedValues-Rising_A	0x4007.00	Number of entries	3	3	U8	-	CST	-	-
	0x4007.01	CapturedValueRising0_A	-	-	S32	-	RO	Yes	ES
	0x4007.02	CapturedValueRising1_A	-	-	S32	-	RO	Yes	ES
	0x4007.03	CapturedValueRising2_A	-	-	S32	-	RO	Yes	ES
CapturedValues-Falling_A	0x4008.00	Number of entries	3	3	U8	-	CST	-	-
	0x4008.01	CapturedValueFalling0_A	-	-	S32	-	RO	Yes	ES
	0x4008.02	CapturedValueFalling1_A	-	-	S32	-	RO	Yes	ES
	0x4008.03	CapturedValueFalling2_A	-	-	S32	-	RO	Yes	ES
CaptureParam_B	0x4010.00	Number of entries	10	10	U8	-	CST	-	-
	0x4010.01	CaptureUnitCommand_B	0-3	0	U16	-	RW	-	-
	0x4010.02	CaptureTriggerInput_B	0-4	0	U16	-	RW	-	ES
	0x4010.03	CaptureTriggerEdge_B	0-2	0	U16	-	RW	-	ES
	0x4010.04	CaptureInhibitTime_B	0-65500	0	U16	ms	RW	-	ES
	0x4010.08	CaptureActiveSlopeValidationFilter_B	-	0	U32	-	RW	-	ES
	0x4010.09	CaptureRestoreSlope-ValidationFilter_B	-	0	U32	-	RW	-	ES
	0x4010.0A	CaptureValidationFilter-Mode_B	0-1	0	U16	-	RW	-	ES
CaptureState_B	0x4011.00	Number of entries	4	4	U8	-	CST	-	-
	0x4011.01	CaptureUnitState_B	-	-	U16	-	RO	Yes	-
	0x4011.02	NumberCapturesRecorded_B	-	-	U16	-	RO	Yes	-
	0x4011.03	NumberCapturesRecordedRising_B	-	-	U16	-	RO	Yes	-
	0x4011.04	NumberCapturesRecordedFalling_B	-	-	U16	-	RO	Yes	-

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
Capture-Sources_B	0x4013.00	Number of entries	3	3	U8	-	CST	-	-
	0x4013.01	CaptureSource0_B	0-4	2	U16	-	RW	-	ES
	0x4013.02	CaptureSource1_B	0-4	1	U16	-	RW	-	ES
	0x4013.03	CaptureSource2_B	0-4	0	U16	-	RW	-	ES
Captured-Values_B	0x4014.00	Number of entries	3	3	U8	-	CST	-	-
	0x4014.01	CapturedValue0_B	-	-	U32	-	RO	Yes	-
	0x4014.02	CapturedValue1_B	-	-	U32	-	RO	Yes	-
	0x4014.03	CapturedValue2_B	-	-	U32	-	RO	Yes	-
Captured-Values_Word_B	0x4015.00	Number of entries	3	3	U8	-	CST	-	-
	0x4015.01	CptVal0_Word_B	-	-	S16	-	RO	Yes	-
	0x4015.02	CptVal1_Word_B	-	-	S16	-	RO	Yes	-
	0x4015.03	CptVal2_Word_B	-	-	S16	-	RO	Yes	-
Captured-Values_Byte_B	0x4016.00	Number of entries	3	3	U8	-	CST	-	-
	0x4016.01	CptVal0_Byte_B	-	-	S8	-	RO	Yes	-
	0x4016.02	CptVal1_Byte_B	-	-	S8	-	RO	Yes	-
	0x4016.03	CptVal2_Byte_B	-	-	S8	-	RO	Yes	-
CapturedValues-Rising_B	0x4017.00	Number of entries	3	3	U8	-	CST	-	-
	0x4017.01	CapturedValueRis-ing0_B	-	-	S32	-	RO	Yes	ES
	0x4017.02	CapturedValueRis-ing1_B	-	-	S32	-	RO	Yes	ES
	0x4017.03	CapturedValueRis-ing2_B	-	-	S32	-	RO	Yes	ES
CapturedValues-Falling_B	0x4018.00	Number of entries	3	3	U8	-	CST	-	-
	0x4018.01	CapturedValueFall-ing0_B	-	-	S32	-	RO	Yes	ES
	0x4018.02	CapturedValueFall-ing1_B	-	-	S32	-	RO	Yes	ES
	0x4018.03	CapturedValueFall-ing2_B	-	-	S32	-	RO	Yes	ES
0x402F.00		CaptureInterfaceMode	-	-	U16	-	RW	Yes	-
PwmHwParam	0x403F.00	Number of entries	6	6	U8	-	CST	-	-
	0x403F.01	PwmHwFrequencyIO0	1-50000	1000	U16	Hz	RW	-	-
	0x403F.02	PwmHwDutyCycleIO0	0-100	0	U16	%	RW	-	-
	0x403F.03	PwmHwFrequencyIO1	1-50000	1000	U16	Hz	RW	-	-
	0x403F.04	PwmHwDutyCycleIO1	0-100	0	U16	%	RW	-	-
	0x403F.05	PwmHwFrequencyIO2	1-50000	1000	U16	Hz	RW	-	-
	0x403F.06	PwmHwDutyCycleIO2	0-100	0	U16	%	RW	-	-
0x4051.01		LogicalDigitalInputSta-tus	0-31	-	U32	-	RO	Yes	-
DigitalIn-putFunc-Status	0x4054.00	Number of entries	3	3	U8	-	CST	-	-
	0x4054.01	FcStatus	-	-	U16	-	RO	-	-
	0x4054.02	HomeStatus	-	-	U16	-	RO	-	-
	0x4054.03	EnableInputStatus	-	-	U16	-	RO	-	-
0x405A.00		PolarityInputValue	0-15	0	U16	-	RW	Yes	-
0x405B.00		TerminationResistance	0-15	0	U16	-	RW	Yes	ES
0x405E.00		EnableDebounce	-	0	U16	-	RW	-	ES
0x405F.00		DebounceTime	250 - 65000	250	U16	μs	RW	-	ES
0x406E.00		DisableOption	-1 or 2	2	S16	-	RW	-	ES
0x406F.00		DisableOkOutput	-	1401	U32	-	RW	-	ES
0x4070.01		Io_0_Function	1-24	1	U16	-	RW	-	ES
0x4071.01		Io_1_Function	1-24	1	U16	-	RW	-	ES

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
	0x4072.01	Io_2_Function	1-24	1	U16	-	RW	-	ES
	0x4073.01	Io_3_Function	1-24	1	U16	-	RW	-	ES
	0x4084.01	In_4_Function	1-24	1	U16	-	RW	-	ES
	0x4085.01	In_5_Function	1-24	1	U16	-	RW	-	ES
	0x4086.01	In_6_Function	1-24	1	U16	-	RW	-	ES
	0x4087.01	In_7_Function	1-24	1	U16	-	RW	-	ES
	0x4088.01	In_8_Function	1-24	1	U16	-	RW	-	ES
	0x4089.01	In_9_Function	1-24	1	U16	-	RW	-	ES
	0x40C4.01	Out_4_Function	-	2	U16	-	RW	-	ES
	0x40C5.01	Out_5_Function	-	2	U16	-	RW	-	ES
	0x40C6.01	Out_6_Function	-	2	U16	-	RW	-	ES
AI0Calibration Parameters	0x4100.00	Number of entries	4	4	U8	-	CST	-	-
	0x4100.01	AI0CalibrationStatus	0-4	4	U16	-	RO	-	ES
	0x4100.02	AI0CalibrationOffset	-	-	S16	-	RO	-	ES
	0x4100.03	AI0CalibrationGain	-	-	U16	-	RO	-	ES
	0x4100.04	AI0CalibrationVoltage	4000 - 10000	-	U16	mV	RW	-	-
AI0Filter Parameters	0x4110.00	Numbers of entries	3	3	U8	-	CST	-	-
	0x4110.01	AI0FilterFrequency	-	100	U16	Hz	RW	-	ES
	0x4110.02	AI0FilterType	0-65535	2	U16	-	RW	-	ES
	0x4110.03	AI0FilterQFactor	-	100	U16	10 = 1	RW	-	ES
AI0ConversionParameters	0x4120.00	Numbers of entries	8	8	U8	-	CST	-	-
	0x4120.01	AI0VSettings	-	1	U16	-	RW	-	ES
	0x4120.02	AI0RSettings	-	1	U16	-	RW	-	ES
	0x4120.03	AI0VPolarity	-	0	U16	-	RW	-	ES
	0x4120.04	AI0RPolarity	-	0	U16	-	RW	-	ES
	0x4120.05	AI0VZone	-	10	U16	mV	RW	-	ES
	0x4120.06	AI0VRefLevel	-	10000	U16	mV	RW	-	ES
	0x4120.07	AI0TRefValue	0-32767	1200	U16	10 = 1%IS	RW	-	ES
	0x4120.08	AI0WRefValue	-	Motor-Rated-	U32	inc/s	RW	-	ES
	0x4202.00	TorqueLimitSelector	0-2	1	U16	-	RW	Yes	ES
	0x420F.00	ActualTorqueLimitP	-	-	U16	10 = 1%IS	RO	Yes	-
	0x4210.00	ActualFilteredTorque	-	-	S16	10 = 1%IS	RO	Yes	-
	0x4211.00	ActualTorqueLimitN	-	-	U16	10 = 1%IS	RO	Yes	-
	0x4244.00	StartVelocity	1 to 2^{32}	0	U32	inc/s	RW	Yes	ES
	0x4280.01	PositionLimitEnable	0-1	0	U16	-	RW	-	ES
	0x4281.01	PositionErrorDeadBand	-	0	U16	inc	RW	-	ES
	0x4282.01	FollowingErrorWindow-Warn	-	64	U32	inc	RW	-	ES
	0x4284.01	EndIncrements	-	0	U32	inc	RW	Yes	ES
	0x4285.02	IndexPulseDeadZone	0º to 180º	1º	U32	inc	RW	-	ES
	0x4285.03	HomingPosDisengage-ment	-	1/8 of the feedback sensor resolution	U32	inc	RW	-	ES
	0x4285.04	HomingAbsRangeMode	0-1	-	U16	inc	RW	-	ES

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
MasterPosition-Settings	0x4288.00	Number of entries	4	4	U8	-	CST	-	-
	0x4288.01	GearMasterTriggerDi-rection	0-1	0	U16	-	RW	Yes	-
	0x4288.02	GearMasterTriggerPosi-tion	-	0	S32	inc	RW	Yes	-
	0x4288.03	GearMasterRampPosi-tion	0x1 - 0x7FFFFFFF	1000	U32	inc	RW	Yes	-
	0x4288.04	GearSlaveTriggerPosi-tion	-	0	S32	inc	RO	Yes	-
TargetGear-Ratio	0x4289.00	Number of entries	2	2	U8	-	CST	-	-
	0x4289.01	TargetGearRatioNumer-ator	-	0	S16	inc	RW	Yes	-
	0x4289.02	TargetGearRatioDivisor	-32768 to 32767	1000	S16	inc	RW	Yes	-
StartGear-Ratio	0x428A.00	Number of entries	2	2	U8	-	CST	-	-
	0x428A.01	StartGearRatioNumera-tor	-	0	S16	inc	RW	Yes	-
	0x428A.02	StartGearRatioDivisor	-32768 to 32767	1000	S16	inc	RW	Yes	-
0x42A0.00		ProfilePositionStatus	0-6	-	U16	-	RO	Yes	-
0x42A1.00		HomingStatus	-2 to 55	-	S16	-	RO	Yes	-
0x42A2.00		GearStatus	0-4	0	S16	-	RO	Yes	-
0x42BF.00		PositionValidationStatus	-	-	U32	-	RW	-	-
ApplyModeOperation	0x42C0.00	Number of entries	9	9	U8	-	CST	-	-
	0x42C0.01	ApplyModeOpera-tionCommand	-113 to 7	-	S8	-	RW	Yes	-
	0x42C0.02	ApplyModeOpera-tionStatus	0-8	-	S8	-	RO	Yes	-
	0x42C0.03 - 0x42C0.09	ApplyModeOpera-tionParameters	-	-	U32	-	RW	Yes	-
0x42D0.00		CyclicSynchronousSub-Mode	-136 to -148	-136	S16	-	RW	Yes	-
0x42E0.00		SwitchedOnOption-Code	0-1	0	S16	-	RW	-	ES
Ether-CAT_-PortAct	0x5108.00	Number of entries	1	1	U8	-	CST	-	-
	0x5108.01	EtherCAT_PortActual-NodeID	-	-	U16	-	RO	-	-
AuxiliaryPortSetup	0x5120.00	Number of entries	4	4	U8	-	CST	-	-
	0x5120.01	AuxiliaryPortSetup-WordOrder	0-1	0	U16	-	RW	-	ES
	0x5120.02	AuxiliaryPortSetupTim-eOut	20-65000	50	U16	ms	RW	-	ES
	0x5120.03	AuxiliaryPortSetupBau-dRateImmediate	19200 or 57600	57600	U32	bit/s	RW	-	-
	0x5120.04	AuxiliaryPortSetupBau-dRate	19200 or 57600	57600	U32	bit/s	RW	-	ES
Auxiliary-PortError	0x5124.00	Number of entries	2	2	U8	-	CST	-	-
	0x5124.01	AuxiliaryPortError-Param	-	0	U16	-	RW	-	-
	0x5124.02	AuxiliaryPortErrorCode	0x00 to 0x2E	0	U16	-	RW	-	-
0x5F7F.00		ProductionDate	-	-	U32	-	CST	-	-

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
EtherCAT_Diagnostics	0x5FF6.00	Number of entries	15	15	U8	-	CST	-	-
	0x5FF6.01	EtcErrorRetentCom-mMsg	0-31	-	U32	-	RO	-	-
	0x5FF6.02	EtcPdoRxMissingToler-ance	0-128	1	U16	-	RW	-	-
	0x5FF6.03	EtcPdoRxLostConsecu-tive	-	0	U16	-	RW	-	-
	0x5FF6.04	EtcPdoRxLostTotal	-	0	U32	-	RW	-	-
	0x5FF6.05	EtcPdoRxLostTotalRe-set	-	0	S32	-	RW	-	-
	0x5FF6.06	EtcDcPllResetOnOpe	-	-	S32	-	RW	-	-
	0x5FF6.07	EtcPdoRxTotal	-	0	U32	-	RW	-	-
	0x5FF6.08	EtcRegDllStatus	0x110: 0x111	-	U16	-	RO	-	-
	0x5FF6.09	EtcRegAlStatus	0x130: 0x131	-	U16	-	RO	-	-
	0x5FF6.10	EtcResetPdoRxLost-MaxConsecReset	-	0	U16	-	RW	-	-
	0x5FF6.0A	EtcRegAlStatusCode	0x134: 0x135	-	U16	-	RO	-	-
	0x5FF6.0B	EtcRegEEpromConfigu-ration	0x500: 0x501	-	U16	-	RO	-	-
	0x5FF6.0C	EtcRegSyncOutUnit	0x980: 0x981	-	U16	-	RO	-	-
	0x5FF6.0D	EtcRegSync-PulseLength	0x982: 0x983	-	U16	-	RO	-	-
	0x5FF6.0E	EtcRegSyncActivation-Status	0x984	-	U16	-	RO	-	-
	0x5FF6.0F	EtcRegSync0Cycle-Time	0x9A0: 0x9A3	-	U32	-	RO	-	-
0x5FF7.01		SysMngCommand	0-8200	0	U16	-	RW	-	-
0x5FF7.02		SysMngStatus	5400- 5406	-	U16	-	RO	-	-
0x5FF7.03		SysMngError	0-7100	0	U16	-	RO	-	-
0x5FF7.06		SysMngEnForcing	0-1	0	U16	-	RW	-	-
0x5FF7.0A		SysMngMicroStepCur-rent	≤ Peak-Current	Nominal-Current	U16	100 = 1 A	RW	-	-
CpuInfo	0x5FFA.00	Number of entries	4	4	U8	-	CST	-	-
	0x5FFA.01	CPUSiliconRevision	-	-	U16	-	RO	-	-
	0x5FFA.02	ResetCause	1-6	-	U32	-	RW	-	-
	0x5FFA.03	SwResetCode	-	0	U16	-	RO	-	-
	0x5FFA.04	SwResetInfo	-	-	U32	-	RO	-	-
DriveInformation	0x5FFD.00	Number of entries	15	15	U8	-	CST	-	-
	0x5FFD.01	HardwareRevision	-	-	S16	-	RO	-	-
	0x5FFD.04	BootRevision	-	-	S16	-	RO	-	-
	0x5FFD.07	FirmwareRevision	-	-	S16	-	RO	-	-
	0x5FFD.0A	HardwareProductCode	-	-	U32	-	RO	-	-
	0x5FFD.0E	OemCode	6868	6868	U16	-	CST	-	-
	0x5FFD.0F	SoftwareProductCode	-	-	U16	-	RO	-	-
0x5FFE.01		FirmwareStatus	0-230	-	U8	-	RO	-	-
0x603F.00		ErrorCode	-32768 to 32767	0	S16	-	RO	Yes	-
0x6040.00		Controlword	0-15	-	U16	-	RW	Yes	-
0x6041.00		Statusword	-	-	U16	-	RO	Yes	-

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
	0x605A.00	QuickStopConfiguration	-6 to 6	6	S16	-	RW	-	-
	0x605E.00	FaultReactionOption-Code	-1 to 2	-1	S16	-	RW	-	ES
	0x6060.00	ModesOfOperation	-126 to 10	3	S8	-	RW	Yes	ES
	0x6061.00	ModesOfOperationDis-play	-126 to 10	3	S8	-	RO	Yes	-
	0x6064.00	PositionActualValue	-	-	S32	inc	RO	Yes	-
	0x6065.00	FollowingErrorWindow	-	64	U32	inc	RW	Yes	ES
	0x6066.00	FollowingErrorTimeOut	-	0	U16	ms	RW	Yes	ES
	0x6067.00	PositionWindow	-	0	U32	inc	RW	Yes	ES
	0x6068.00	PositionWindowTime	-	10	U16	ms	RW	Yes	ES
	0x606C.00	VelocityActualValue	-	-	S32	inc/s	RW	Yes	ES
	0x606D.00	VelocityWindow	-	0	U16	inc/s	RW	Yes	ES
	0x606E.00	VelocityWindowTime	-	0	U16	ms	RW	Yes	ES
	0x606F.00	VelocityThreshold	-	0	U16	inc/s	RW	Yes	ES
	0x6070.00	VelocityThresholdTime	-	0	U16	ms	RW	Yes	ES
	0x6071.00	TargetTorque	-	-	S16	10 = 1%IS	RW	Yes	-
	0x6072.00	MaxTorque	0-32767	1000	U16	10 = 1%IS	RW	Yes	ES
	0x6074.00	RequestedTorque	-	-	S16	10 = 1%IS	RO	Yes	-
	0x6077.00	ActualTorque	-	-	S16	10 = 1%IS	RW	Yes	-
	0x607A.00	TargetPosition	-	0	S32	inc	RW	Yes	-
	0x607C.00	HomeOffset	-	0	S32	inc	RW	Yes	ES
Software-Position-Limit	0x607D.00	Number of entries	2	2	U8	-	CST	-	-
	0x607D.01	PositionLimitNegative	-	-2147483648	S32	inc	RW	Yes	ES
	0x607D.02	PositionLimitPositive	-	2147483647	S32	inc	RW	Yes	ES
	0x607E.00	Polarity	0 or 192	192	U16	-	RW	Yes	ES
	0x607F.00	MaxProfileVelocity	1 to 2^{32}	-	U32	inc/s	RW	Yes	ES
	0x6080.00	MaxMotorSpeed	-	120% of Motor-Rated-Speed	U32	rpm	RW	Yes	ES
	0x6081.00	ProfileVelocity	1 to 2^{32}	500658	U32	inc/s	RW	Yes	ES
	0x6082.00	EndVelocity	1 to 2^{32}	0	U32	inc/s	RW	Yes	ES
	0x6083.00	ProfileAcceleration	1 to 2^{32}	20860757	U32	inc/s^2	RW	Yes	ES
	0x6084.00	ProfileDeceleration	1 to 2^{32}	20860757	U32	inc/s^2	RW	Yes	ES
	0x6085.00	QuickStopDeceleration	1 to 2^{32}	-	U32	inc/s^2	RW	Yes	ES
	0x6086.00	MotionProfileType	0	0	U16	-	RW	Yes	ES
	0x6087.00	TorqueSlope	-	0xFFFFFFFF	U32	-	RW	Yes	-
	0x6088.00	TorqueProfileType	-1	-1	S16	-	RO	Yes	-
Position-Resolution	0x608F.00	Number of entries	2	2	U8	-	CST	-	-
	0x608F.01	EncoderIncrements	256-1048576	$2^{15}/2^{20}$	U32	inc/rev	RW	-	ES
	0x608F.02	MotorRevolutions	1	1	U32	inc/rev	RW	-	-
	0x6098.00	HomingMethod	-35 to 35	35	S8	-	RW	Yes	ES

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
Homing-Speeds	0x6099.00	Number of entries	2	2	U8	-	CST	-	-
	0x6099.01	SpeedForSwitch	1 to 2^{32}	250329	U32	inc/s	RW	Yes	ES
	0x6099.02	SpeedForZero	1 to 2^{32}	66754	U32	inc/s	RW	Yes	ES
0x609A.00		HomingAcceleration	1 to 2^{32}	2503291	U32	inc/s^2	RW	Yes	ES
0x60B0.00		PositionOffset	-	0	S16	-	RW	Yes	-
0x60B1.00		VelocityOffset	-	0	S16	-	RW	Yes	-
0x60B2.00		TorqueOffset	-	0	S16	-	RW	Yes	-
0x60B8.00		TouchProbeFunction	-	-	U16	-	RW	Yes	-
0x60B9.00		TouchProbeStatus	-	-	U16	-	RO	Yes	-
0x60BA.00		TouchProbePosition1PosValue	-	-	S32	-	RO	Yes	-
0x60BB.00		TouchProbePosition1NegValue	-	-	S32	-	RO	Yes	-
0x60BC.00		TouchProbePosition2PosValue	-	-	S32	-	RO	Yes	-
0x60BD.00		TouchProbePosition2NegValue	-	-	S32	-	RO	Yes	-
0x60C0.00		IpPosSubModeSelect	0 to -10	0	S16	-	RW	Yes	-
IpPosData-Record	0x60C1.00	Number of entries	2	2	U8	-	CST	-	-
	0x60C1.01	IpPosFirstParameter	-	0	S32	inc	RW	Yes	-
	0x60C1.02	IpPosSecondParameter	-	0	S32	65536 = 1inc/ T_{SYNC}	RW	Yes	-
IpTime-Period	0x60C2.00	Number of entries	2	2	U8	-	CST	-	-
	0x60C2.01	IpTimePeriodValue	0-255	1	U8	s	RW	-	-
	0x60C2.02	IpTimePeriodIndex	-6 ÷ -2	-3	S8	-	RW	-	ES
IpPosDataConfig	0x60C4.00	Number of entries	6	6	U8	-	CST	-	-
	0x60C4.01	IpPosDataConfigMax-BufferSize	1	1	U32	-	RW	-	-
	0x60C4.02	IpPosDataConfigActual-BufferSize	1	1	U32	-	RW	-	-
	0x60C4.03	IpPosDataConfigBuffer-Organization	-	0	U8	-	RW	-	-
	0x60C4.04	IpPosDataConfigBuffer-Position	-	0	U16	-	RW	-	-
	0x60C4.05	IpPosDataConfigSize-DataRecord	4 or 8	-	U8	-	WO	-	-
	0x60C4.06	IpPosDataConfigBuffer-Clear	1	1	U8	-	RW	-	-
0x60C5.00		MaxAcceleration	1 to 2^{32}	-	U32	inc/s^2	RW	Yes	ES
0x60C6.00		MaxDeceleration	1 to 2^{32}	-	U32	inc/s^2	RW	Yes	ES
Touch-Probe-Source	0x60D0.00	Number of entries	2	2	U8	-	CST	-	-
	0x60D0.01	TouchProbe1Source	-	-	S16	-	RW	Yes	-
	0x60D0.02	TouchProbe2Source	-	-	S16	-	RW	Yes	-
0x60D5.00		TouchProbe1PosEdge-Counter	-	-	U16	-	RO	Yes	-
0x60D6.00		TouchProbe1NegEdge-Counter	-	-	U16	-	RO	Yes	-
0x60D7.00		TouchProbe2PosEdge-Counter	-	-	U16	-	RO	Yes	-
0x60D8.00		TouchProbe2NegEdge-Counter	-	-	U16	-	RO	Yes	-
0x60E0.00		PositiveTorqueLimit-Value	-	-	U16	10 = 1%IS	RW	Yes	-

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
0x60E1.00		NegativeTorqueLimit-Value	-	-	U16	10 = 1%IS	RW	Yes	-
0x60F2.00		PositioningOptionCode	0-5	0	U16	-	RW	Yes	ES
0x60F4.00		PositionFollowingError	-	-	S32	inc	RO	Yes	-
CurrentLoop	0x60F6.00	Number of entries	10	10	U8	-	CST	-	-
	0x60F6.01	KCp_Q	-	-	U16	-	RW	Yes	ES
	0x60F6.02	KCi_Q	-	-	U16	-	RW	Yes	ES
	0x60F6.03	KCp_D	-	-	U16	-	RW	Yes	ES
	0x60F6.04	KCi_D	-	-	U16	-	RW	Yes	ES
	0x60F6.05	EnableLoopCompensa-tion	-	-	U16	-	RW	Yes	ES
	0x60F6.06	KC_FilterFrequency	-	-	U16	Hz	RW	Yes	ES
	0x60F6.07	KC_FilterType	0-65535	-	U16	-	RW	Yes	ES
	0x60F6.08	KC_FilterQFactor	-	-	U16	10 = 1	RW	Yes	ES
	0x60F6.09	KC_QReduction	-	-	U16	-	RW	Yes	ES
	0x60F6.0A	AngleObserverBand-width	-	-	U16	Hz	RW	Yes	ES
VelocityLoop	0x60F9.00	Number of entries	34	34	U8	-	CST	-	-
	0x60F9.01	KVp	-	-	U16	-	RW	Yes	ES
	0x60F9.03	KVi	-	-	U16	-	RW	Yes	ES
	0x60F9.04	KVp_LS	-	-	U16	-	RW	Yes	ES
	0x60F9.05	KVi_LS	-	-	U16	-	RW	Yes	ES
	0x60F9.08	HighSpeed	-	-	U32	inc/s	RW	Yes	ES
	0x60F9.09	LowSpeed	-	-	U32	inc/s	RW	Yes	ES
	0x60F9.0C	ActualKVp	-	-	U16	-	RO	Yes	-
	0x60F9.0D	ActualKVi	-	-	U16	-	RO	Yes	-
	0x60F9.0E	VFilter1Frequency	-	-	U16	Hz	RW	Yes	ES
	0x60F9.0F	VFilter1Type	0-65535	-	U16	-	RW	Yes	ES
	0x60F9.10	KVdFilterFrequency	-	-	U16	-	RW	Yes	ES
	0x60F9.11	KVd	-	-	U16	-	RW	Yes	ES
	0x60F9.12	WVd	-	-	U16	1000 = 1	RW	Yes	ES
	0x60F9.13	WVp	-	-	U16	1000 = 1	RW	Yes	ES
	0x60F9.14	KVc	-	-	U16	-	RW	Yes	ES
	0x60F9.16	KAff	-	-	U16	1000 = 1	RW	Yes	ES
	0x60F9.17	EnableVelocityStandStill	-	-	U16	-	RW	Yes	ES
	0x60F9.18	VFilter1QFactor	-	-	U16	10 = 1	RW	Yes	ES
	0x60F9.19	VFilter2Frequency	-	-	U16	Hz	RW	Yes	ES
	0x60F9.1A	VFilter2Type	0-65535	-	U16	-	RW	Yes	ES
	0x60F9.1B	VFilter2QFactor	-	-	U16	10 = 1	RW	Yes	ES
	0x60F9.1C	VFilter3Frequency	-	-	U16	Hz	RW	Yes	ES
	0x60F9.1D	VFilter3Type	0-65535	-	U16	-	RW	Yes	ES
	0x60F9.1E	VFilter3QFactor	-	-	U16	10 = 1	RW	Yes	ES
	0x60F9.1F	VFilterSensorFre-quency	-	-	U16	Hz	RW	Yes	ES
	0x60F9.20	VFilterSensorType	0-65535	-	U16	-	RW	Yes	ES
	0x60F9.21	VFilterSensorQFactor	-	-	U16	10 = 1	RW	Yes	ES
	0x60F9.22	ResetSpeedIntegrator	-	-	U16	-	WO	-	ES

Group	Index	Name	Range	Default	Type	Units	Acc	PDO	Mem
PositionLoop	0x60FB.00	Number of entries	6	6	U8	-	CST	-	-
	0x60FB.01	KPp	-	-	U16	-	RW	Yes	ES
	0x60FB.02	KVff	-	-	U16	1000 = 1	RW	Yes	ES
	0x60FB.03	PositionStandStill	-	-	U16	-	RW	Yes	ES
	0x60FB.04	EnablePositionStand-Still	-	-	U16	-	RW	Yes	ES
	0x60FB.05	ActualKPp	-	-	U16	-	RO	Yes	-
	0x60FB.06	ClosePositionLoop	-	1	U16	-	RW	Yes	ES
0x60FD.00		DigitalInputs	-	-	U32	-	RO	Yes	-
0x60FE.01		PhysicalOutputs	0-31	0	U32	-	RW	Yes	-
0x60FE.02		DigitalOutputsBitMask	-	0XFFFF FFFF	U32	-	RW	Yes	-
0x60FF.00		TargetVelocity	-2^{32} to 2^{32}	0	S32	inc/s	RW	Yes	-
MotorParameters	0x6410.00	Number of entries	15	15	U8	-	CST	-	-
	0x6410.01	MotorStallCurrent	-	-	U16	100 = 1A	RW	-	EM
	0x6410.02	MotorPeakCurrent	-	-	U16	100 = 1A	RW	-	EM
	0x6410.03	CoggingTorque	-	-	U16	mN*m	RW	-	EM
	0x6410.04	MotorInductance	-	-	U16	100 = 1mH	RW	-	EM
	0x6410.05	MotorResistance	-	-	U16	mΩ	RW	-	EM
	0x6410.06	MotorInertia	-	-	U16	1 = $10gcm^2$	RW	-	EM
	0x6410.07	MotorGuid	-	-	STR	-	RW	-	EM
	0x6410.08	TorqueConstant	-	-	U16	1000 = 1Nm/A	RW	-	EM
	0x6410.09	MotorRatedSpeed	-	-	U32	rpm	RW	-	EM
	0x6410.0A	MotorPoles	-	-	U16	-	RW	-	EM
	0x6410.0B	FaultTemperatureThrs	-	-	U16	-	RW	-	EM
	0x6410.0C	MotorType	0-1	-	U16	-	RW	-	EM
	0x6410.0D	PolePitch	-	-	U16	mm	RW	-	EM
	0x6410.0E	MotorFaultTempera-tureThrsOhm	-	-	U32	Ω	RW	-	EM
	0x6410.0F	MotorTemperatureSen-sorType	0-5	-	U16	-	RW	-	EM
0x6502.00		SupportedDriveModes	0x3ED	0x3ED	U32	-	RO	-	ES
DriveParameters	0x6510.00	Number of entries	4	4	U8	-	CST	-	-
	0x6510.01	MaxRatedCurrent	-	-	U16	100 = 1A	RO	-	-
	0x6510.02	MaxPeakCurrent	-	-	U16	100 = 1A	RO	-	-
	0x6510.03	MaxSupplyVoltage	-	-	U16	V	RO	-	-
	0x6510.04	UserDriveName	-	-	-	-	RW	-	EM

A-2 Object List (DC Power Supply Unit)

This section describes the profile that is used to configure the DC Power Supply Unit.

See below for the type of access to the parameter:

- RW (read/write): reading and writing
- WO (write only): only writing
- RO (read only): only reading
- CST (constant): only reading (constant parameter)

Group	Modbus	Name	Range	Default	Type	Units	Acc	PDO	Mem
Device-Information	12	HardwareRevision	-	-	S16	-	RO	-	-
	15	BootRevision	-	-	S16	-	RO	-	-
	18	FirmwareRevision	-	-	S16	-	RO	-	-
	21	HardwareProductCode	-	-	U32	-	RO	-	-
	33	OemCode	-	-	U16	-	CST	-	-
	34	SoftwareProductCode	-	-	U16	-	RO	-	-
40		FirmwareStatus	-	-	U8	-	RO	-	-
80		ManufacturerDeviceName	-	-	STR	-	CST	-	-
110		ManufacturerHwVersion	-	-	STR	-	CST	-	-
114		ManufacturerSwVersion	-	-	STR	-	CST	-	-
Identity	122	ProductCode	-	-	U32	-	RO	-	-
	124	RevisionNumber	-	-	U32	-	RO	-	-
	126	SerialNumber	-	-	U32	-	RO	-	-
Cpu-Info	580	CPUSiliconRevision	-	-	U16	-	RO	-	-
	581	ResetCause	1 - 4	2	U32	-	RW	-	-
AuxiliaryPortSetup	1100	AuxiliaryPortSetup-WordOrder	0 - 1	0	U16	-	RW	-	-
	1101	AuxiliaryPortSetupTimeOut	20 - 65000	50	U16	ms	RW	-	EM
	1110	AuxiliaryPortSetupBaudRateImmediate	19200 or 57600	57600	U32	bit/s	RW	-	-
	1112	AuxiliaryPortSetupBaudRate	19200 or 57600	57600	U32	bit/s	RW	-	EM
Auxiliary-PortError	1120	AuxiliaryPortError-Param	-	0	U16	-	RW	-	-
	1121	AuxiliaryPortErrorCode	-	0	U16	-	RW	-	-
2001		HVDC_OutputVoltage	-	0	U16	0.1 V	RO	-	-
2002		PowerSupplyType	0 - 2	0	U16	-	RO	-	-
2010		CPUTemperature	-3276.8 to 3276.7	-	S16	0.1 ºC	RO	-	-
2011		ControlSectionTemperature	-250 to 1200	-	S16	0.1 ºC	RO	-	-
2012		PowerSectionTemperature	-250 to 1200	-	S16	0.1 ºC	RO	-	-
2013		ActualCurrent	-	0	S16	0.1 A	RO	-	-
2014		ActualCurrentLimit	-	-	U16	0.1 A	RO	-	-
2015		AverageCurrent	-	-	S16	0.1 A	RO	-	-

Group	Modbus	Name	Range	Default	Type	Units	Acc	PDO	Mem
2016		ActualPower	-	-	S32	0.01 W	RO	-	-
EnergyValues	2020	ActualDeviceEnergy-Overload	-	-	U32	A^2s	RO	-	-
	2026	BrakeEnergy	-	0	U32	0.001 J	RO	-	EM
	2028	ChargeCircuitEnergy	-	-	U32	0.001 J	RO	-	EM
	2030	DeviceEnergyOverload-Percentage	0 - 32767	0	U16	%	RO	-	-
	2031	BrakeEnergyOverload-Percentage	0 - 32767	0	U16	%	RO	-	-
	2032	ChargeCircuitEnergy-OverloadPercentage	0 - 32767	0	U16	%	RO	-	-
	2034	CableEnergyOverload-Percentage	0 - 32767	0	U16	%	RO	-	EM
	2058	BackfeedEnergy	-	0	S32	J	RO	-	-
2024		DeviceStatus	-	-	U16	-	RO	-	-
2025		LastFaultCause	-	0	U16	-	RO	-	-
2033		BrakeDutyCycle	-	0	U16	‰	RO	-	-
Current-RMSValues	2048	RMS_Current	-	0	S32	0.1 A	RO	-	-
	2052	RMS_OutputCurrent	-	0	S32	0.1 A	RO	-	-
	2054	RMS_BackfeedingCur-rent	-	0	S32	0.1 A	RO	-	-
2056		AveragePower	-	0	S32	0.01 W	RO	-	-
TemperatureLimits	2060	ControlSideFaultTem-perature	-	85.0 ºC	S16	0.1 ºC	RO	-	ES
	2061	ControlSideWarning-Temperature	-	700	S16	0.1 ºC	RO	-	ES
	2064	PowerSideFaultTem-perature	-	900	S16	0.1 ºC	RO	-	ES
	2065	PowerSideWarning-Temperature	-	800	S16	0.1 ºC	RO	-	ES
2068		FaultLockTime	-	-	S32	ms	RO	-	-
2100		DeviceModel	1 - 2	-	U16	-	RO	-	ES
2101		AutomaticRestartFunc-tion	0 - 1	0	U16	-	RO	-	ES
Voltage-Values	2102	MinVoutFaultThreshold	-	1000	U16	0.1 V	RO	-	ES
	2103	MaxVoutFaultThreshold	-	8300	U16	0.1 V	RO	-	ES
BrakeCircuit-Parameters	2107	IntBrakeResistorValue	-	33	U16	Ω	RO	-	ES
	2108	IntBrakeResistorNomi-nalEnergy	-	6000	U32	J	RO	-	ES
	2110	IntBrakeResistorNomi-nalPower	-	120	U16	W	RO	-	ES
2114		CapacitorDischarge-Timeout	-	4000	U16	ms	RO	-	ES

Group	Modbus	Name	Range	Default	Type	Units	Acc	PDO	Mem
UserParameters	2112	RMS_Average_CalculationPeriod	-	1000	U16	ms	RW	-	ES
	2134	OutputCurrentLimit	10 - 400	200 or 400	U16	0.1 A	RW	-	ES
	2135	OutputVoltageLimit	1000 - 8300	8300	U16	0.1 V	RW	-	ES
	2136	BrakingCircuitActivationVoltage	1000 - 7850	7850	U16	0.1 V	RW	-	ES
	2142	CableCurrentLimit(CH1)	10 - 250	100 or 200	U16	0.1 A	RW	-	ES
	2145	CableCurrentLimit(CH2)	10 - 250	100 or 200	U16	0.1 A	RW	-	ES
ExternalBrakeSettings	2137	BrakeCircuitSelector	0 - 2	0	U16	-	RW	-	ES
	2138	ExtBrakeResistorNominalEnergy	100 - 2000000	6000	U32	J	RW	-	ES
	2140	ExtBrakeResistorNominalPower	100 - 40000	120	U16	W	RW	-	ES
	2141	ExtBrakeResistorValue	16 - 1000	33	U16	Ω	RW	-	ES
2400		RetentiveWarning	-	0	U32	-	RW	-	-
2402		DynamicWarning	-	0	U32	-	RO	-	-
2404		RetentiveFault	-	0	U32	-	RW	-	-
2406		DynamicFault	-	0	U32	-	RO	-	-
Channel1CurrentValues	2513	ActualCurrentCH1	-	0	S16	0.1 A	RO	-	-
	2515	AverageCurrentCH1	-	0	S16	0.1 A	RO	-	-
	2548	RMS_CurrentCH1	-	0	S32	0.1 A	RO	-	-
	2552	RMS_OutputCurrentCH1	-	0	S32	0.1 A	RO	-	-
	2554	RMS_BackfeedingCurrentCH1	-	0	S32	0.1 A	RO	-	-
Channel1PowerValues	2516	ActualPowerCH1	-	0	S32	0.01 W	RO	-	-
	2556	AveragePowerCH1	-	0	S32	0.01 W	RO	-	-
Channel1EnergyValues	2520	ActualDeviceEnergyOverloadCH1	-	-	U32	A^2s	RO	-	-
	2530	DeviceEnergyOverloadPercentageCH1	-	0	U16	%	RO	-	-
	2534	CableEnergyOverloadPercentageCH1	-	0	U16	%	RO	-	EM
Channel2CurrentValues	2613	ActualCurrentCH2	-	0	S16	0.1 A	RO	-	-
	2615	AverageCurrentCH2	-	0	S16	0.1 A	RO	-	-
	2648	RMS_CurrentCH2	-	0	S32	0.1 A	RO	-	-
	2652	RMS_OutputCurrentCH2	-	0	S32	0.1 A	RO	-	-
	2654	RMS_BackfeedingCurrentCH2	-	0	S32	0.1 A	RO	-	-
Channel2PowerValues	2616	ActualPowerCH2	-	0	S32	0.01 W	RO	-	-
	2656	AveragePowerCH2	-	0	S32	0.01 W	RO	-	-

Group	Modbus	Name	Range	Default	Type	Units	Acc	PDO	Mem
Channel2Energy-Values	2620	ActualDeviceEnergy-OverloadCH2	-	-	U32	A^2s	RO	-	-
	2630	DeviceEnergyOverload-PercentageCH2	-	0	U16	%	RO	-	-
	2634	CableEnergyOverload-PercentageCH2	-	0	U16	%	RO	-	EM
2824		RectifierBridgeVoltage-Signal	-	-	S16	0.1 VDC	RO	-	-
VoltageMin/-MaxValues	2900	MinHVDC_OutputVolt-age	-	0	U16	0.1 V	RO	-	-
	2901	MaxHVDC_OutputVolt-age	-	0	U16	0.1 V	RO	-	-
CurrentMin/MaxValues	2905	MinRMS_Current	-	0	S16	0.1 A	RO	-	-
	2906	MaxRMS_Current	-	0	S16	0.1 A	RO	-	-
	2911	MinActualCurrent	-	0	S16	0.1 A	RO	-	-
	2912	MaxActualCurrent	-	0	S16	0.1 A	RO	-	-
	2926	MinActualCurrentCH1	-	0	S16	0.1 A	RO	-	-
	2927	MaxActualCurrentCH1	-	0	S16	0.1 A	RO	-	-
	2928	MinActualCurrentCH2	-	0	S16	0.1 A	RO	-	-
	2929	MaxActualCurrentCH2	-	0	S16	0.1 A	RO	-	-
TemperatureMin/Max-Values	2907	MinControlSectionTem-perature	-	0	S16	0.1 ºC	RO	-	-
	2908	MaxControlSectionTem-perature	-	0	S16	0.1 ºC	RO	-	-
	2909	MinPowerSectionTem-perature	-	0	S16	0.1 ºC	RO	-	-
	2910	MaxPowerSectionTem-perature	-	0	S16	0.1 ºC	RO	-	-
2920		Max_AveragePower	-	0	S32	0.01 W	RO	-	-
EnergyMaxValues	2913	MaxDeviceEnergyOver-loadPercentage	-	0	U16	%	RO	-	-
	2914	MaxActualDeviceEner-gyOverload	-	0	U32	0.001 J	RO	-	-
	2916	MaxBrakeEnergy	-	0	U32	0.001 J	RO	-	-
	2918	MaxChargeCircuitEn-ergy	-	0	U32	0.001 J	RO	-	-
	2922	MaxBackfeedEnergy	-	0	U32	0.001 J	RO	-	-

A-3 Sysmac Studio Setup

This section describes the setting and procedures to connect the Integrated Servo Motor to an Omron Sysmac NX/NY/NJ machine controller.

The Integrated Servo Motor is connected to Sysmac NX/NY/NJ controller via the EtherCAT interface. The machine automation controller sees the Integrated Servo Motor as an EtherCAT node and, normally, it is used as a Sysmac Servo Axis.

Hardware settings

Connect CN3 (ECT IN) to the Sysmac controller or to the previous EtherCAT node.

Connect CN2 (ECAT OUT) to the next node, if any.

Set the rotary switches to a suitable unique address in the EtherCAT network or, alternatively, set the rotary switches to zero if the address must be set by the master controller.

Related objects

The default object setting in the Integrated Servo Motor usually is suitable for its use with Sysmac machine controller. Nevertheless, there are some object that have a direct influence in the interfacing with Sysmac.

Name	Default	Definition
CaptureInterfaceMode [402F.00]	1	Define if DS402 capture or vendor specific capture is used
IO_0_Function [4070.01]	1	Define the function of this digital input
IO_1_Function [4071.01]	1	Define the function of this digital input
IO_2_Function [4072.01]	1	Define the function of this digital input
IO_3_Function [4073.01]	1	Define the function of this digital input
In_4_Function [4084.01]	1	Define the function of this digital input
In_5_Function [4085.01]	1	Define the function of this digital input
In_6_Function [4086.01]	1	Define the function of this digital input
In_7_Function [4087.01]	1	Define the function of this digital input
In_8_Function [4088.01]	1	Define the function of this digital input
In_9_Function [4089.01]	1	Define the function of this digital input
TorqueLimitSelector [4202.00]	1	Define the source of the torque limit value
PositionLimitEnable [4280.01]	0	Enable/disable the software limit
CyclicSynchronousSubMode [42D0.00]	0	Selects the interpolation mode in CSP, CST and CSV
HomeOffset [607C.00]	0	Selects the homing offset in the motor
EncoderIncrements [608F.01]	$2^{15}/2^{20}$	Encoder increments per machine revolution
MotorRevolutions [608F.02]	1	Motor revolution per machine revolution

Detail settings

Index	Name	Default	Definition
0x402F.00	CaptureInterfaceMode	1	Define if DS402 capture or vendor specific capture is used

Normally set this object to 1. Then, you use the MC_TouchProbe to activate the registration. If you want to use the custom Touch probe functionality, set to 0. In this case MC_TouchProbe cannot be used.

I/O function

When the Integrated Servo Motor is used as Sysmac axis, Sysmac controller assumes next functionality:

- Positive limit switch: Input 3 (Normally closed)
- Negative limit switch: Input 4 (Normally closed)
- Immediate stop: Input 6 (Normally opened)
- Home switch: Input 7 (Normally opened)
- Latch 1: Input 8 (Normally opened)
- Latch 2: Input 9 (Normally opened)

To avoid conflicts between the Sysmac functionality and the Input functionality follow next rules:

- Leave the functionality of the inputs above as “general purpose”
- Do not use the setting of positive limit, negative limit, home or enable in any digital input

Index	Name	Default	Definition
0x4202.00	TorqueLimitSelector	1	Define the source of the torque limit value

The torque limit is set via the controller to objects 60E0.00 and 60E1.00.

Index	Name	Default	Definition
0x4280.01	PositionLimitEnable	0	Enable/disable the software limit

Keep this disabled as Sysmac controller takes care of this functionality.

Index	Name	Default	Definition
0x607C.00	HomeOffset	0	Selects the homing offset in the motor

Set if required. You can also apply one offset in Sysmac so, setting this value is not normally necessary.

Index	Name	Default	Definition
0x608F.01	EncoderIncrements	$2^{15}/2^{20}$	Encoder increments per machine revolution
0x608F.02	MotorRevolutions	1	Motor revolution per machine revolution

This allows to set a gear ratio in the Motor.

Sysmac controller has its own gear ratio functionality so those values does not need to be normally changed.

The default setting for **EncoderIncrements [608F.01]** is 2^{20} for the absolute encoder and 2^{15} for the incremental encoder.

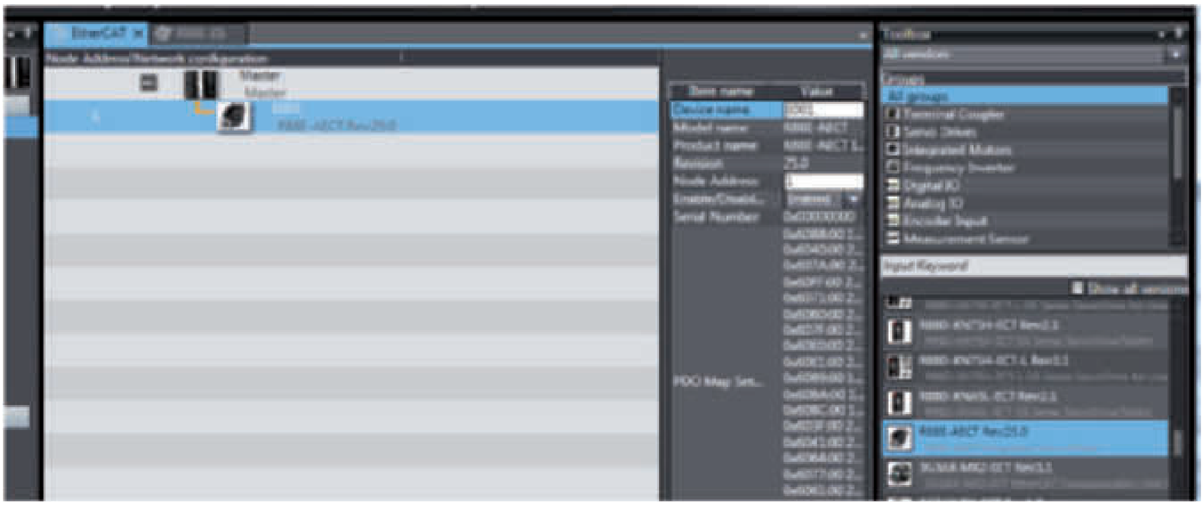
In case of absolute encoder in rotary mode, it is mandatory to leave the default value, otherwise Sysmac cannot calculate properly the position when the overflow of the counter occur.

Configuration in Sysmac Studio

Make sure that you have a version of Sysmac Studio that supports Integrated Servo Motors. If not, contact your OMRON representative to get the right version.

STEP 1

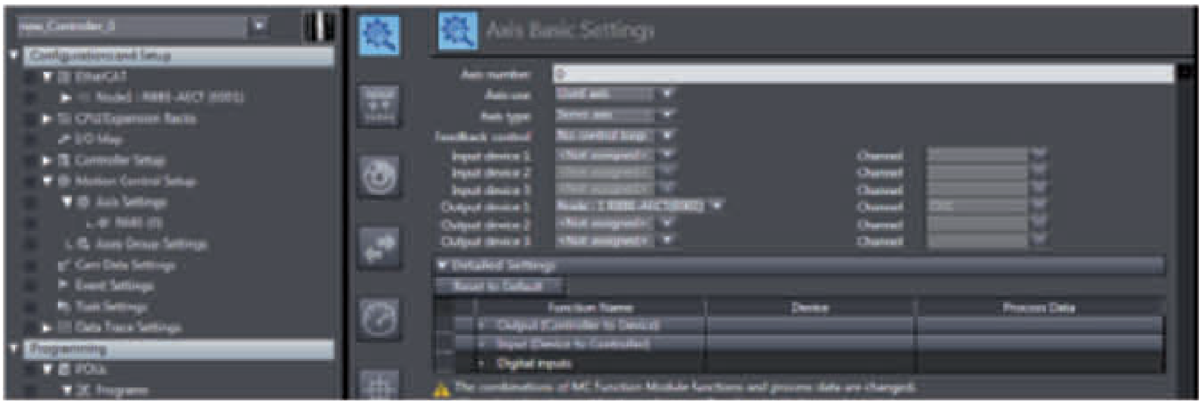
Insert the Integrated Servo Motor in the EtherCAT network.



Normally it is not necessary to change the default PDO mapping.

STEP 2

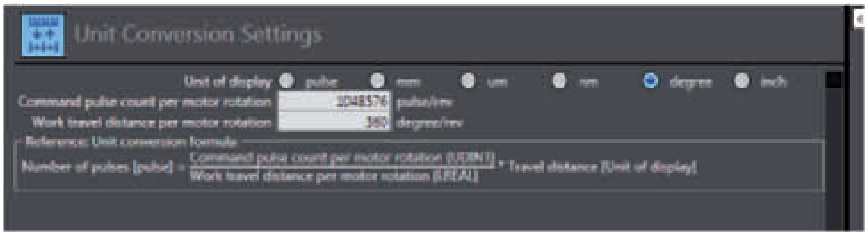
Create a Sysmac axis. Select servo axis type and assign it to R88E-AECT Integrated Servo Motor.



Normally it is not necessary to use the default detailed setting.

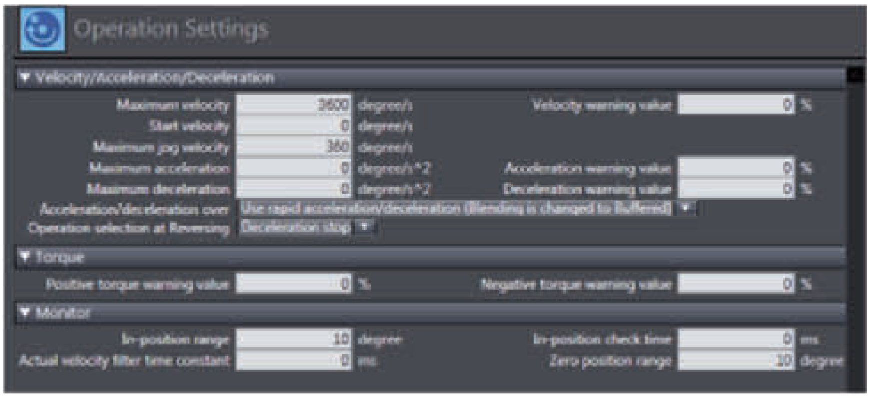
STEP 3

Set the right conversion setting in Sysmac. In this example we use an absolute encoder with 20-bit resolution and degrees as work units.



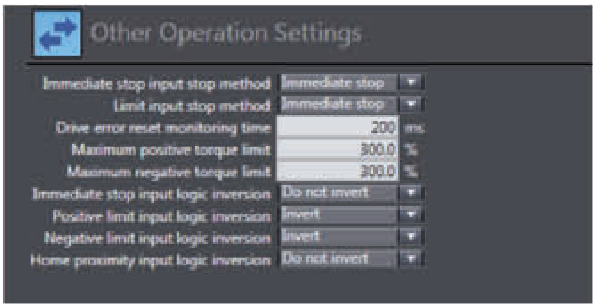
STEP 4

Set the operation settings as required by the application.



STEP 5

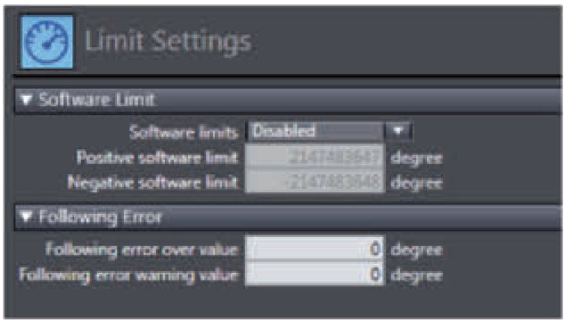
Set the “other operation settings” as required.



If limit switch is not being used, change the inversion to “Do not invert”.

STEP 6

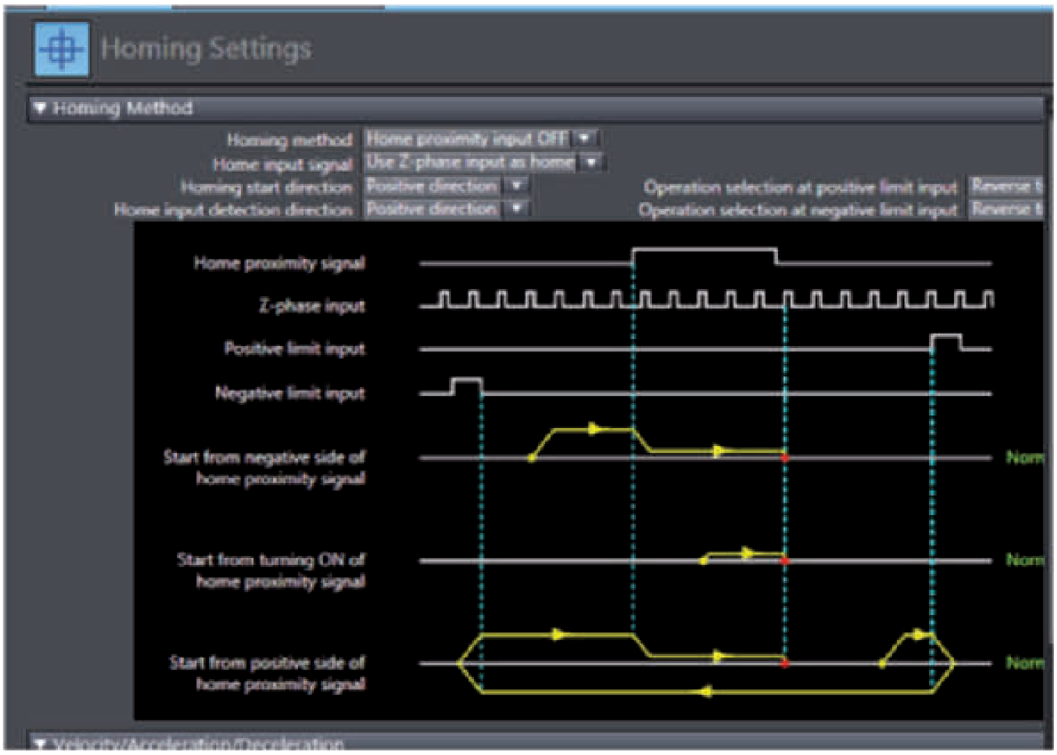
Set the limit setting as required.



If following error over value is 0 there is no following error control in Sysmac and the following error limit in the motor will apply.

STEP 7

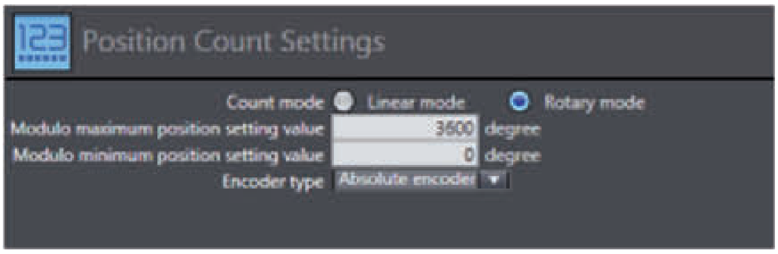
Set the homing settings as required.



Note that Sysmac controls the homing operation. Homing mode is NOT used in the motor.

STEP 8

Set the right position count settings according to the application.



In the example, the position backs to zero every 10 revolution.

A-4 EtherCAT Terminology

Use the following list of EtherCAT terms for reference.

Term	Abbrevi-ation	Description
Object	-	Abstract representation of a particular component within a device, which consists of data, parameters, and methods
Object dictionary	OD	Data structure addressed by Index and Subindex that contains description of data type objects, communication objects and application objects
Service data object	SDO	CoE asynchronous mailbox communications where all objects in the object dictionary can be read and written
Index	-	Address of an object within an application process
Subindex	-	Sub-address of an object within the object dictionary
Process data	-	Collection of application objects designated to be transferred cyclically or acyclically for the purpose of measurement and control
Process data object	PDO	Structure described by mapping parameters containing one or several process data entities
Receive PDO	TxPDO	A process data object received by an EtherCAT slave
Transmit PDO	RxPDO	A process data object sent from an EtherCAT slave
Sync manager	SM	Collection of control elements to coordinate access to concur-rently used objects
Distributed clock	DC	Method to synchronize slaves and maintain a global time base
Device profile	-	Collection of device dependent information and functionality providing consistency between similar devices of the same device type
Fieldbus memory management unit	FMMU	Single element of the Fieldbus memory management unit: one correspondence between a coherent logical address space and a coherent physical memory location
Physical device internal interface	PDI	A series of elements to access data link services from the application layer
CAN in Automation	CiA	CiA is the international users’ and manufacturers’ group that develops and supports higher-layer protocols
CAN application protocol over Eth-erCAT	CoE	A CAN application protocol service implemented on EtherCAT
EEPROM	EEPROM	Electrically erasable PROM
EtherCAT Technology Group	ETG	The ETG is a global organization in which OEM, End Users and Technology Providers join forces to support and promote the further technology development
EtherCAT slave controller	ESC	A controller for EtherCAT slave communication
EtherCAT state machine	ESM	An EtherCAT communication state machine
EtherCAT slave information	ESI	An XML file that contains setting information for an EtherCAT slave
Slave Information Interface	SII	Slave information stored in the nonvolatile memory of each slave
Power Drive System	PDS	A power drive system consisting of a Servo Drive, an inverter, and other components

Authorized Distributor:

Note: Specifications subject to change without notice.

Printed in Europe