DuetHV

Drive integrated servomotors

DuetHV

Ed. 2.4 - English - 09 Jun 2017

(Translated from the original instructions)

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Chapter 1

General informations on this manual

EtherCAT is a registered trade mark and a patented technology, the licence granted by Beckhoff Automation GmbH.

Modbus is a registered trade mark of Schneider Automation Inc.

WINDOWS is a registered trade mark of Microsoft Corporation.

1.1. Aim

This manual is a complete guide to the installation, commissioning, functioning and use of the drives of the series DuetHV. There are general purpose informations about the functionalities and about the drive structure, notices related to the safety for people and for the product; furthermore, for the technicians in-charge to installation, all the data and specifications to be observed for the wiring and the installation are described.

> **Important**
>
> What is written in this manual refers to the versions of firmware 31 et seq., except from any other different instructions.
>
> Previous firmware versions could not implement all the functionalities described in this manual.

The description of the different functionalities always refers to the whole series of the drives DuetHV unless it is specified in which versions you can find the functionalities mentioned in the description.

1.2. Recipients

Only specialized staff can modify the drives of the series DuetHV 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 ISO 12100, EN 60364 ed EN 60664;
- national safe working practices.

This manual is addressed to all users that use the DuetHV drives with or without a master controller.

Caution

The non-observance of the precautions included in this document may cause risk 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.

1.3. Responsibilities

Motor Power Company Srl can modify the described products in this manual in any time and without any notice.

This manual was written by Motor Power Company Srl 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 Motor Power Company Srl, in particolar for possible imperfections, incompleteness, and/or any other difficulties.

1.4. Abbreviations

Abbreviation	Meaning
0x	Number in hexadecimal notation
+HV	DC bus voltage, supply voltage of the power section
ABS_E	Absolute encoder
AI	Analog input

Abbreviation	Meaning
ac	Alternating current
BDM	Base drive module
CDM	Complete drive module
CE	Communité Européenne
CH A	Channel A of a torque of quadrature signals
CH B	Channel B of a torque of quadrature signals
COB-ID	Communication object identifier
CoE	*CANopen over EtherCAT*
COM	Serial communication interface for personal computer
CRC	Cyclic redundancy control
D	Phase signal with the magnetic field of the motor rotor
D. Fan	Digital output starting the drive external cooling fan
dc	Direct current
Drv OK	Digital output with drive function OK
EEPROM	Electrically erasable programmable memory (permanent memory)
EMC	Electromagnetic compatibility
EMCY	Emergency: protocol object EtherCAT to notify any errors
ESC	EtherCAT Slave Controller (ET1100 component)
INC_E	Incremental encoder
ETC	EtherCAT, Ethernet for Control Automation Technology, field bus
FA	Phase A of a torque of quadrature signals
FB	Phase B of a torque of quadrature signals
FC + / FC POS	Positive limit switch or positive limit of hardware position
FC - / FC NEG	Negative limit switch or negative hardware position
FC + sw	Positive limit position programmable via software
FC - sw	Negative limit position programmable via software
FoE	*File access over EtherCAT*
FW	Firmware
GND	Ground
HOME	Digital input of*Home*
HW	Hardware
I	Input, generally digital
I2C	Inter-Integrated Circuit, two-wire serial communication system used among integrated circuits
I2T	Passing specific over energy
DuetHV	Integrated brushless drive
ID	Identifier
LED	Light-emitting diode
LSB	Byte (or bit) less important
MB	Mega Byte

Abbreviation	Meaning
M. Fan	Digital output starting the external fan to cool down the motor
MDB	Modbus, serial communication protocol Modbus on RS232
MSB	Byte (or bit) less important
neg	Negative
NC	Not connected
O	Output, generally digital
OSC	Integrated oscilloscope
OSI	Open system interconnection
PC	Personal computer
PDO	Process data object: object of the EtherCAT protocols to read and write the cyclic data (mappable parameters on the PDOs)
PDS	Power Drive System
PE	Protection Earth, protection conductor
PLL	Phase locked loop
pos	Positive
Q	Quadrature signal with the magnetic field of the motor rotor
PWM	Pulse-width modulation
Pwm O	Output PWM
RAM	Random access memory (non permanent memory)
RES	Resolver
RMS	Root Mean Square, effective value
RTR	Remote transmission request
RX	Reception
SDO	Service data object: object of the EtherCAT protocol for the reading and writing of the drive parameters
S1	Continuous service, functioning condition used to reach the thermal value
a.s.l.	Above sea level
SM	*Sync manager (SM)*
/STO	Safe Torque Off (this is an active-low logic signal)
SW	Software
TBD	To be defined
Temp	Temperature
T_{SYNC}	Period in which the process data (PDO) are exchanged
TX	Transmission
U	Motor phase U
V	Motor phase V
W	Motor phase W

1.5. Symbols

Caution

It shows a dangerous situation, in case of failure to comply with safety rules it can lead to a serious or fatal accident or damage to the equipment.

Warning

It shows a potentially dangerous situation, in case of failure to comply with safety rules it can lead to a serious accident or damage to the equipment.

Important

It shows some important information on the mentioned topic.

Note

It shows some important information on the text about the mentioned topic.

Tip

It shows some useful information on the mentioned topic.

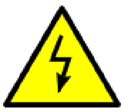
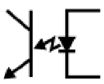
Symbol	Description
	It shows the presence of dangerous voltages that can cause electrical shocks.
	It shows the presence of surfaces and/or heat sources that can cause burns.

Table 1.1. Complementary symbols.

Symbol	Description
	Optical coupler
	Make contact

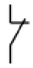
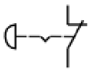
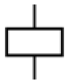
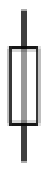
Symbol	Description
	Break contact
	Break command with emergency shutdown, started by a "mushroom-headed" button and at a certain position
	Control coil
	Lamp
	Fuse
	Ground protection
	Shield

Table 1.2. Electrical symbols.

1.6. Definitions

BDM Base drive module
Activation module made up by a conversion section and a section used to check the speed, the torque, the current or the voltage, etc. In this manual the BDW is called **power section**.

CANopen over EtherCAT
Protocol on EtherCAT bus that allows the access to the drive parameters through SDO CANopen.

CDM Complete drive module
Activation without motor and sensors mechanically coupled to the drive shaft, made up by a BDM, but not limited to it, and other devices, such as the charge section and the auxiliaries.

CiA-301
Detailed note on communication protocols and objects to manage the network CANopen (*Communication Profile* DS301).

CiA-402
Detailed note to define the rules for a standardized behaviour of the drives connected to a fieldbus. The drive management according to this specification is described in *Section 8.4, CiA402 state machine*. In case of an EtherCAT network, the specificateion refers to the *Implementation Directive for CiA-402Drive profile* ETG.6010.

Distributed clocks
Mechanism used to synchronize the Masters and the slaves in the EtherCAT network (functionality implemented in the *ET1100* chip).

Drive
See definition*PDS Power drive system*

Drive disable
States of the CiA402 State Machine (see *Section 8.4, CiA402 state machine*) in which the torque is not applied to the motor and the motor control loops aren't active.

Drive enable
States of the CiA402 State Machine (see *Section 8.4, CiA402 state machine*) in which the torque is applied to the motor and the motor control loops are active.

File access over EtherCAT
Protocol on bus EtherCAT used to update the drive directly from the files.

Index
Encoder zero mark.

Master
*Node*taking control of the communication bus and starting first to interact with the other connected nodes.

Node
Hardware device (drive, sensors, actuators) connected to the communication bus which can communicate with the other devices.

Operation disable
States of the CiA402 State Machine (see *Section 8.4, CiA402 state machine*) where it is not possible to command the motor motion. The drive can be enabled or disabled.

Operation enable
State of the CiA402 State Machine (see *Section 8.4, CiA402 state machine*) where it is possible to command the motor motion.

Integrated PDS
PDS where the motor and the CDM/BDM are mechanically integrated in a single unit.

PDS Power drive system
System used to control the speed of an electric motor, including the CDM and the motor, but not the already started equipment. In this manual the PDS is simply called **drive**.

Network protocol
All rules, mechanisms and formalities that two or more electronic devices connected one another must respect to start a communication.

Real-time
Drive command mode used to control the motor motion continuously and in pre-arranged time.

Modbus register
Memory area of 1 Word = 16 bit = 2 byte that contains a numeric value, accessible both in reading and in writing. It's identified by a number that represents its memory position and it's used to exchange data in the Modbus protocol.

Functional safety
Part of the safety of the machine and the machine control system which depends on the correct functioning of the *Safety system*, other technology safety-related systems and external risk reduction facilities.

Safety system
(Even named SRECS) Machine electrical control system whose failure can result in an immediate increase of the risk(s).

Sync manager (SM)
Functionality of the *ET1100* chip (contained in the drives version ETC) used to exchange data in a safe and consistent way between the Master and the EtherCAT drives. For any further information please look *EtherCAT Technology Group (ETG)*.

Sync Signal
Hardware signal generated by *ET1100* and managing the *Distributed clocks*.

Discrepancy time (maximum)
(Maximum) time interval during which a difference between the signal logic level is allowed.

Transition
Intermediate phase that allows the transition from a state to another one of the CiA402 State Machine (see *Section 8.4, CiA402 state machine*).

1.7. Reviews

<table>
<tr><th colspan="3">Revision History</th></tr>
<tr><td>Revision 1.0 (rev.1)</td><td>29/05/2015</td><td>Author: Motor Power Company Srl</td></tr>
<tr><td colspan="3">First manual revision.</td></tr>
<tr><td>Revision 1.1</td><td>01/07/2015</td><td>Author: Motor Power Company Srl</td></tr>
<tr><td colspan="3">Chapter 14, Configuring motor, sensors and brake: updated the paragraph related to the brake
Chapter 19, System tuning: updated the tuning procedure
Chapter 24, Troubleshooting: updated the informations related to the tuning</td></tr>
<tr><td>Revision 1.2</td><td>22/10/2015</td><td>Author: Motor Power Company Srl</td></tr>
<tr><td colspan="3">Chapter 6, STO safety function: Safe Torque Off : updated the paragraph related to the STO function
Section 2.3, Safety precautions and limits: added/updated the field safety notices</td></tr>
<tr><td>Revision 2.0</td><td>04/07/2016</td><td>Author: Motor Power Company Srl</td></tr>
</table>

<table>
<tr><td colspan="3">

- *Section 14.4, Feedback position sensor mode: incremental/absolute*: absolute feedback position sensors data updated
- *Section 23.6, Errors description*: errors diagnostic updated
Chapter 25, Software updating: Led 1-6 diagnostic during the Boot and the firmware update inserted
- *Chapter 8, Communicating with the drive*: updated the image of the DuetHVSuite Bus page, with EtherCAT drive
Chapter 26, Parameters vocabulary: updated the "Communication port EtherCAT" parameters group

</td></tr>
<tr><td>Revision 2.1</td><td>20/07/2016</td><td>Author: Motor Power Company Srl</td></tr>
<tr><td colspan="3">

- *Chapter 19, System tuning*: note about the behaviour of some parameters of the <x1/> group related to *RLEstimator* added*Section 19.7, RL estimator*
- *Chapter 20, Saving, restoring or cloning the drive configuration.*: "Cloning of the parameters with non MPC Master" operation sequence updated
- *Chapter 25, Software updating*: updated the tuning procedure
- *Chapter 26, Parameters vocabulary*: updated the thermal sensors list in*MotorTemperatureSensorType*

</td></tr>
<tr><td>Revision 2.2</td><td>14/09/2016</td><td>Author: Motor Power Company Srl</td></tr>
<tr><td colspan="3">

- *Chapter 2, Information on the drives drive DuetHV* : CE regulation updated
- *Chapter 7, Electrical connections, leds and dip switches*: added*Section 7.2.5, Cables for DuetHV*
- *Chapter 26, Parameters vocabulary*:
- some parameters of the feedback position sensor added in the *FeedbackSensor*, *FeedbackSensorPhasing*, *HallFeedbackSensor* groups; ;
- feedback position sensor codes added in *FeedbackSensorCode*;
- feedback position sensor phasing codes added in *SysMngCommand*;
- feedback position sensor phasing error codes added in *SysMngError*.

</td></tr>
<tr><td>Revision 2.3</td><td>23/03/2017</td><td>Author: Motor Power Company Srl</td></tr>
<tr><td colspan="3">

- Revision of the management of *PositionActualValue* introducing the incremental/absolute modes in relation to the homing, to the modification of some parameters and during and after the reset commands (turn-off and turn-on (reboot) procedure included).
- *Chapter 21, Creating a motion*: contents related to the *Gear Mode* added:
- *Section 21.5, On-the-fly operative mode change* contents integrated;
- *Section 21.11, Gear Mode* added;

</td></tr>
</table>

- parameters related to the *Gear Mode* added in *Section 26.17, Motion (4000-4999)*. • *Section 21.20, Homing Mode*: *Table 21.8* updated by adding modes 33 and 34. • *Chapter 26, Parameters vocabulary*: - motor sensor temperature table (*MotorTemperatureSensorType*) updated; - modes -5 and -6 added in *QuickStopConfiguration*.		
Revision 2.4	09/06/2017	Author: Motor Power Company Srl
• DuetHV flangia 60 contents introduction • *Chapter 26, Parameters vocabulary*: - error messages updated in the *FirmwareStatus*; - Values of *HomingStatus* updated; - Inserted the *BrakePresence* parameter; • *Chapter 23, Fault and Warning*: Values of */STO Management Error* and *Internal Error* updated.		

Chapter 2

Information on the drives drive DuetHV

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

The software on the drives of the series DuetHV is divided into two types:

- *Boot firmware*: it boots the drive by enabling some basic services and, after an initial phase of identification and diagnostics of the system, it runs the firmware
- *Firmware*: it manages all the drive operating functions

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 current found in the phases.

> **Note**
>
> The drive mission time is 20 years.

> **Note**
>
> For further details on the features and options of the available versions, see *Chapter 5, Technical features* and *Chapter 28, Order codes*.

2.1. Laws and standards

The products of the DuetHV series are in accordance with the following specifications:

- 2014/30/EU relating to electromagnetic compatibility;
- 2014/35/EU relating to electrical equipment designed for use within certain voltage limits;
- 2006/42/CE relating on machinery;

in conditions in which the installation may be considered as typical (then the instructions in the user manual are respected and there are not particular work environment or installation needs).

Motor Power Company Srl guarantees the conformity of the drive to the harmonized standards:

EN 61800-5-1:2007	Adjustable speed electrical power drive systems Part 5-1: Safety requirements - Electrical, thermal and energy
EN 61800-5-2:2007	Adjustable speed electrical power drive systems Part 5-2: Safety requirements - Functional safety
EN ISO 13849-1:2008	Safety of machinery - Safety-related parts of control systems Parte 1: General principles for design
EN 60204-1:2006 EN 60204-1/AC:2010	Safety of machinery - Electrical equipment of machines Part 1: General requirements
EN 61800-3:2004 EN 61800-3/A1:2012	Adjustable speed electrical power drive systems Part 3: EMC requirements and specific test methods
EN 55011:2009 EN 55011/A1:2010	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio frequency equipment
EN 61000-6-2:2005 EN 61000-6-2/ AC:2005	Electromagnetic Compatibility (EMC) Part 6-2: Generic Standards - Immunity for industrial environments

The products of the DuetHV series are commercialized as components of a Power Drive System, belong to the restricted distribution category and are intended to the installation in industrial environment. If used in domestic environment it may be necessary to take further emission measures and appropriate precautions.

The installation of these devices is intended to specialized personnel that has 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.

If the entire system is connected to a low voltage distribution public network it will be necessary to pay attention to the network harmonic and flicker inclusion effects to guarantee the overall certification.

2.2. General features of the DuetHV drives

Features	DuetHV
Motor size	See the table at the beginning of the*Chapter 5, Technical features*
Range of supply of the power section	See the table at the beginning of the*Chapter 5, Technical features*
Range of supply of the control section	See the table at the beginning of the*Chapter 5, Technical features*
Feedback sensor	Incremental encoder + sensors of Hall, Hyperface absolute Encoder
Main communication port (field bus)	EtherCAT with device profile*CiA-402*
Auxiliary communication port (debug)	Modbus on RS232
Multifunction port[a]	N. 3 differential bidirectional lines (RS485 compatible) for presettable default functions (auxiliary encoder input, others)
Rotary dip switches	Setting the node number and/or communication speed of the main bus
Leds	Information and local diagnostics through transparent window
Number of digital bidirectional I/O	4, except for DuetHV flange 60; 1 for DuetHV flange 60
Number of digital inputs	6, except for DuetHV flange 60; 3 for DuetHV flange 60
Number of digital outputs	3, except for DuetHV flange 60; 2 for DuetHV flange 60
Number of analog inputs	1, except for DuetHV flange 60
Functional safety	See *Section 6.2, DuetHV functional specifications (except for DuetHV flange 60)*[b]
Electrical insulation	Adequate distances of electric insulation both in the surface and in the air are guaranteed according to the EN61800-5-1 regulation, between the input voltage of the DC bus/motor connections and the signal and communication electronics of the control section (refer to *Chapter 5, Technical features*).
Protections	• DC bus overvoltage • short circuit and/or overcurrent on the motor phases • power section overtemperature • control section circuits overtemperature • Motor winding overtemperature • motor energy overload, through I^2T (please refer to *Chapter 23, Fault and Warning* and to *Section 13.6, I2T*).
Permanent memory	YES

[a]not present in the DuetHV flange 60.

[b]for the flange 60 see *Section 6.3, Functional specifications of DuetHV flange 60mm*.

Table 2.1. Features of the DuetHV drives

2.2.1. Drives equipment

The drive package includes:

- the DuetHV drive
- plastic cap for the M8 connector(for DuetHV except the flange 60)
- plastic cap "dust cover" for the M23 I/O connector(for DuetHV except the flange 60)
- plastic cap for the M12 connector (for DuetHV flange 60 only)
- package leaflet

Note

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

Before to begin to work with the drive, verify that there are not visible damages. Be sure that the DuetHV drive you have taken from the package is the correct model for your application, that it corresponds to what you have ordered and that you can provide a voltage supply as prescribed for the system.

2.2.2. System block diagram

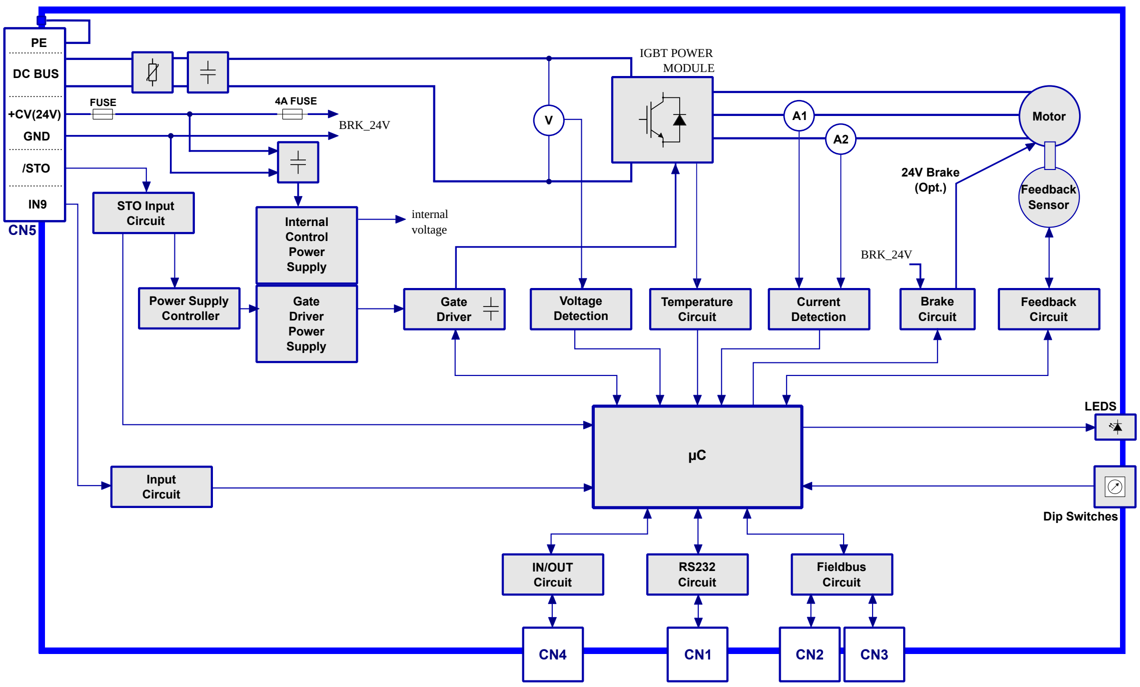


Figure 2.1. Block diagram of DuetHV drives (except for DuetHV flange 60mm)

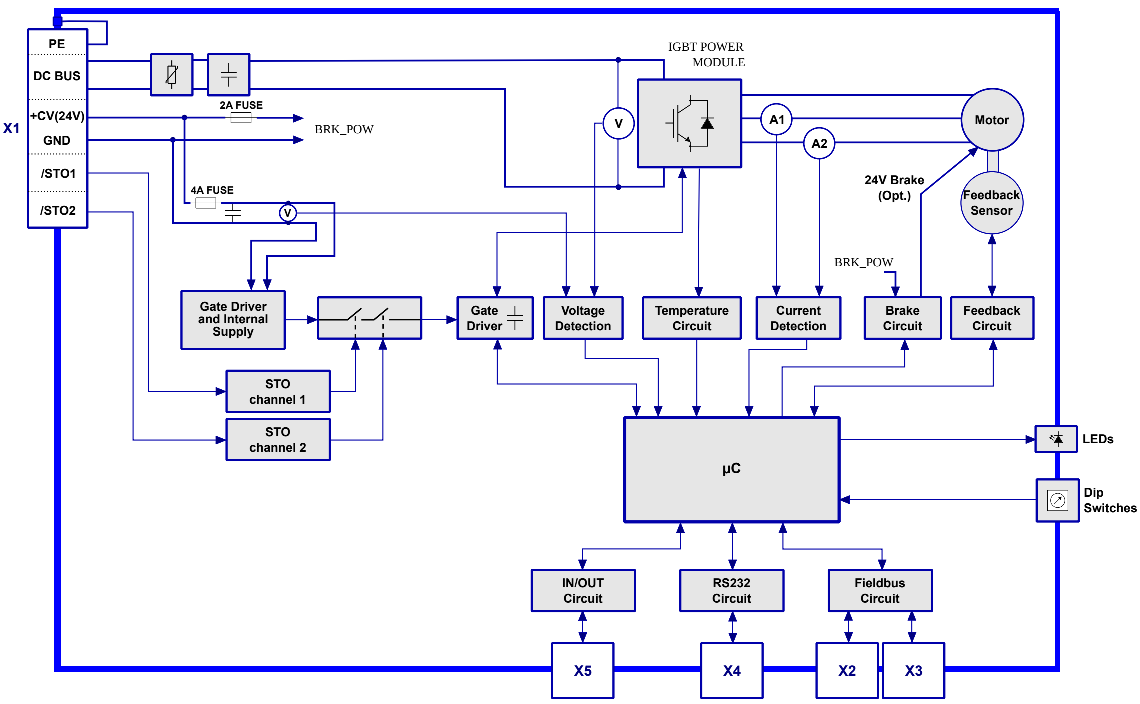


Figure 2.2. Block diagram of DuetHV flange 60mm drives

2.2.3. Identificative plate

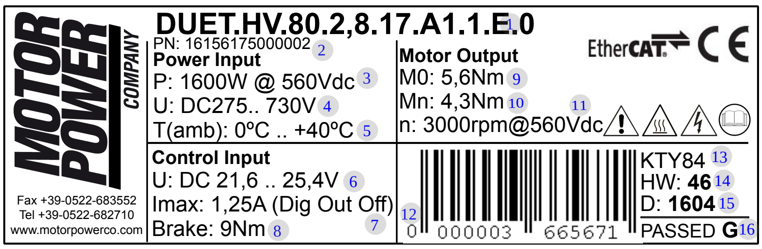


Figure 2.3. Product plate example.

Reference	Meaning
1	Product name
2	Part Number
3	Nominal power[a] of the power section input
4	Range of input voltage of the power section
5	Working environment temperature for a functioning compliant to the technical data
6	Control section voltage range
7	Maximum current of the control section
8	Brake nominal torque
9	Stall torque
10	Torque at the rated speed
11	Rated speed

Reference	Meaning
12	Serial number
13	Hardware revision
14	Conformity test results
15	CE mark
16	EtherCAT mark

[a]referring to the torque at the rated speed

Table 2.2. Plate fields

2.3. Safety precautions and limits

Caution

The precautions described in this paragraph are aimed to avoid any dangerous situation by suggesting the right use of the product. Only qualified staff who read and understood all the documents on this product can use it. The specialized staff must follow a safety training in order to know which individual protective equipments to be taken and to avoid any risks related to the product use (included any changes in the parameters) and to find a possible solution.

Caution

The drive must not be used in an explosive or corrosive environment, in the presence of inflammables, water or fuels. There can be risk of fire, electrical shock or injuries. In case of failures because of accidental circumstances or wiring errors the power section can even provoke electric arcs. The drive must be installed in an environment without any inflammables. It is particularly forbidden to use it in the presence of inflammable gases or vapours.

Warning

The drives can be used/installed outdoor, but can't be directly exposed to the sunlight (UV rays).

Caution

Do not install any connections or make inspections when the drive is charged. In such cases switch the power off, wait for some seconds until the voltage is lower than 50 volts, otherwise there can be risks of electrical shock or damaging the drive.
The connector used to connect the power supply can have a very high voltage. Do not touch these devices when the drive is supplied, even if it is disabled.

Caution

The usage of this product implies the presence of a voltage greater then 50V, therefore there is life-threatening and a risk of electric shock and serious injury. Follow the general and safety regulations when you are working on the power related installations.
Do not connect the power connector (power supply and/or motor) when the drive is powered. There can be electrical arcs that can damage the connector and the drive and provoke a fire.

Caution

The protection from surge must be delegated to a device that's external from the DuetHV drives, after an accurate risk analysis made by the integrator of the machine.

Caution

Keep the drive power supply within the specified ranges in order to avoid any risks of fire, electrical shocks and damaging the drive. In the same way connect the cables in a safe way by respecting the connections.

Caution

Do not touch the connection devices when the drive is in voltage. In case of maintenance be aware that the voltage in the power connectors is lower enough not to provoke an electrical shock.

Caution

Do not touch the drive or the motor during functioning or immediately after its disabling: the surface temperature can ne higher than 80°C.
To prevent any risks of damaging the drive do not obstruct or limit its ventilation.

Caution

Do not open and do not modify the system: for any internal checks please contact Motor Power Company Srl. In case of forcing the system the warranty expires.

Warning

Please do not short-circuit any signals from the power connector with the drive case or logic signals (for exaple coming from the connectors for the field bus).
It's recommended a control section supply wiring separated by the power supply one, in order to avoid malfunctioning and to limit the control logic signals noises. The cables section for the power stage must be adequate to the drive power.

Caution

The section of the power supply conductors must be adequate to the drive power.
Always connect the protection ground and the functional mass with two separate cables (star connection of the grounds).

Caution

In case of simultaneous failure of two power semiconductors (IGBT) of the power section, it is possible that the motor turns by 180°/number of pole pairs.

Caution

Don't apply an excessive force on the motor shaft, in order to avoid the damage of the bearings.
If the key is installed on the motor shaft, be sure that it is fixed to the machinery so that the key cannot slip off from its seat.

Warning

Insofar as their purpose allows, accessible parts of the drive have no sharp edges and no rough surfaces likely to cause injury. In case the key is removed, the sharp edges of the key seat are accessible to the user, unless the shaft plastic cover is installed: beware the injury danger in case of removing the plastic cover or the shaft key.

Warning

The drive has dip switches to set the node number and/or communication speed of the main bus. 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).

Warning

When some Fault is found, the drive automatically disables and a led signal shows the possible cause: the motor is no longer in torque and it can move to another position and to damage the devices and/or the surrounding people. It must be made a evaluation of the risk about the particular machine in which the product is used. In consequence the user must take appropriate measures to avoid risks to the safety of the person.

Warning

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.

Caution

The magnetic and electromagnetic fields, that are generated by the conductors in which the current flows or by permanent magnets inside the electric motors, represent a serious danger for the people with the pacemaker, metallic prostheses and hearing aids. Be sure that these people have no access to the areas in which these systems are presents (both during functioning and in storage). Eventually, if these persons have to enter in the described areas, consult a doctor.

Caution

The device builder using the drives DuetHV must analyse the risk for the device and implement the necessary measures to safeguard the device itself and the surrounding people from any unforeseen motions.

Warning

The drive has been designed and constructed so that risks resulting from the emission of airborne noise are reduced to the lowest level. The airborne noise emission and the related risks for the user are in any case depending on the application and must be analyzed by the machine designer.

Warning

The drive has been designed and constructed to limit the build-up of potentially dangerous electrostatic charges and is provided of a discharging system: the chassis is made of metal and polimeric material. The metallic part is protected by the grounding system. The non-metallic materials may build-up electrostatic charges in case of contact with other insulating materials.

Caution

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.
It is recommended not to use the product for any further purpose than those specified in this manual.

Chapter 3

Main features of DuetHVSuite

DuetHVSuite is a programme for *personal computer* used to control, configure and programme in a simple, quick and perceptive way the drives of the DuetHV series.

From the tab Main of DuetHVSuite it is possible to know the whole drive status. For example: the detailed description of the found errors, the status of the outputs and of the digital and analog inputs, actual position and speed, drive operative status, connection status, etc… From DuetHVSuite it is possible to export the drive parameters in a text file to clone more drives in the same mode by exporting the parameters from one drive to another.

Important

What is written in this manual refers to the DuetHVSuite 3.0.3.225 versions et seq. Previous versions of DuetHVSuite could not implement all the functionalities described here.

3.1. Requirements and compatibility

Minimum PC requirements:

- System with compatible processor Pentium 133 MHz or higher.
- Sufficient memory for the operating system, minimum 128 MB, recommended 512.
- Hard disk with minimum available space to install the programme, at least 35MB.
- Display adapter and monitor Super VGA, minimum resolution 800 x 600 px, better 1024x768 px or higher.

Compatibility with the following operating systems:

- Microsoft Windows XP
- Microsoft Windows Vista, 7, 8 or latest versions, 32bit and 64bit.

3.2. Installation

Check if all the system prerequisites are respected (*Section 3.1, Requirements and compatibility*).

Installation from file

- If the *DuetHVSuite.msi* file is already on the PC, run the file and follow the proposed procedure, otherwise contact Motor Power Company Srl in order to request the file.
- Every DuetHVSuite version is released with the most updated firmwares and motors database, in relation to the release date.

> **Tip**
>
> Please accept all the configurations proposed during the installation.

3.3. DuetHVSuite overview

All the functionalities of DuetHVSuite can be accessible through the three tabs (Bus, Main), the menus or the toolbars.

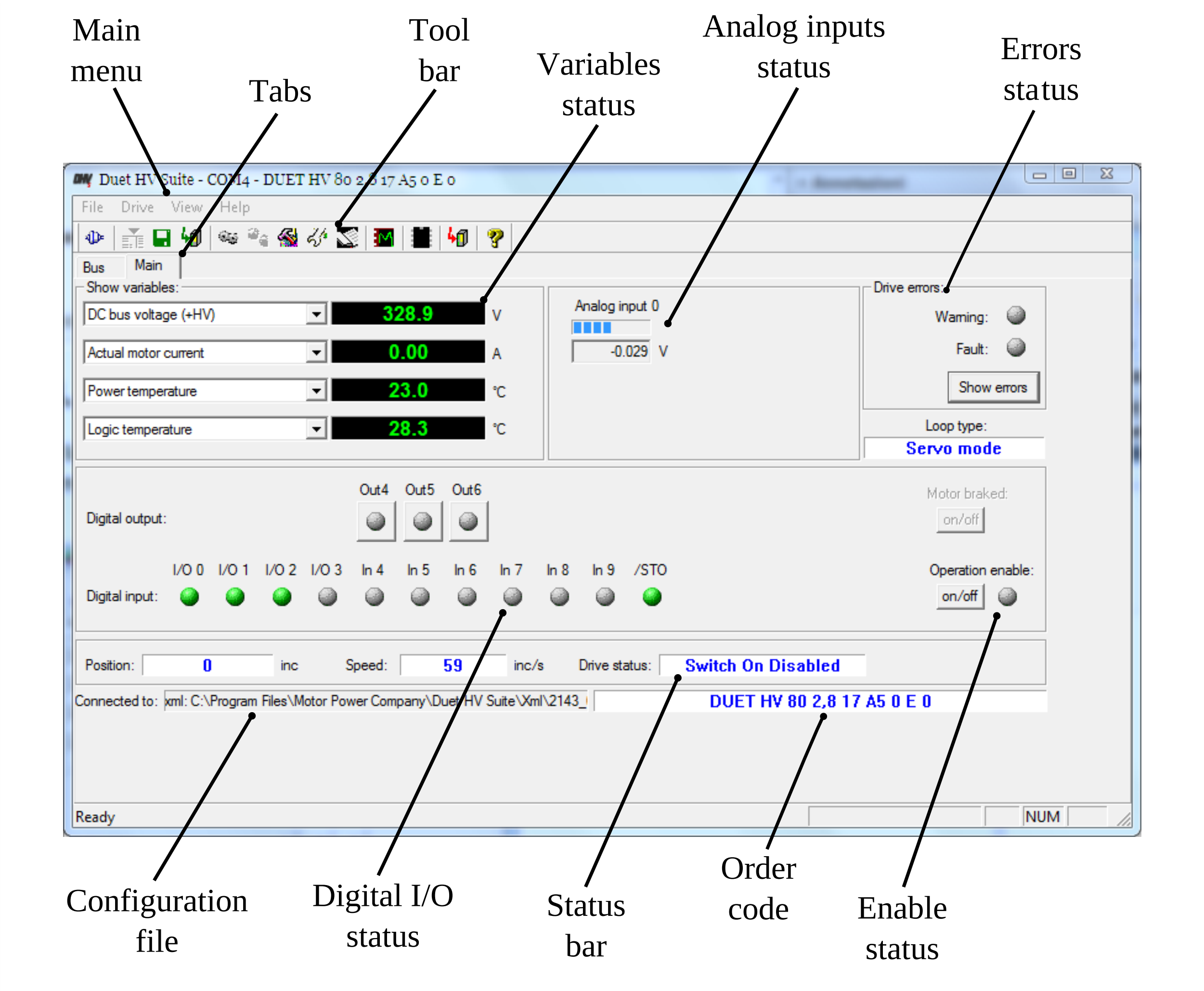


Figure 3.1. Tab Main of DuetHVSuite

Tab	Functionalities	Link
Main	Variables status	*Section 22.1, Parameters monitoring*
	Analog inputs status	*Chapter 16, Analog input*
	Errors status	*Chapter 23, Fault and Warning*
	Configuration File	*Section 25.5, Updating the Configuration File*
	Digital I/O status	*PhysicalOutputs*and*DigitalInputs*
	ManufacturerDeviceName	*Section 28.1, OrderCode*
	Enable status	*Operation enable*
Bus	Configure the Main bus	*Chapter 8, Communicating with the drive*

Table 3.1. Functionalities of the two main tabs

Chapter 4
Quick start for drives DuetHV

For a quick test installation of the drives DuetHV, follow what is reported in this chapter.

4.1. Before starting

Safety precautions

> **Caution**
>
> Before installing the drive, read the paragraph on safety *Section 2.3, Safety precautions and limits*. If you do not follow the safety instructions you may damage the equipment or be hurt.

Requested instruments, materials and equipment

- Supply system to supply the control and power section;
- Supplying cable to be wired to the connector *CN5* except for DuetHV flange 60, *X1(F60)* for DuetHV flange 60;
- Serial cable to be wired to the connector *CN1* except for DuetHV flange 60, *X4 (F60)* for DuetHV flange 60;
- Screwdrivers to tighten the supply conductor according to the suitable wiring;
- PC with serial port RS232 and with the requisites in *Section 3.1, Requirements and compatibility*.

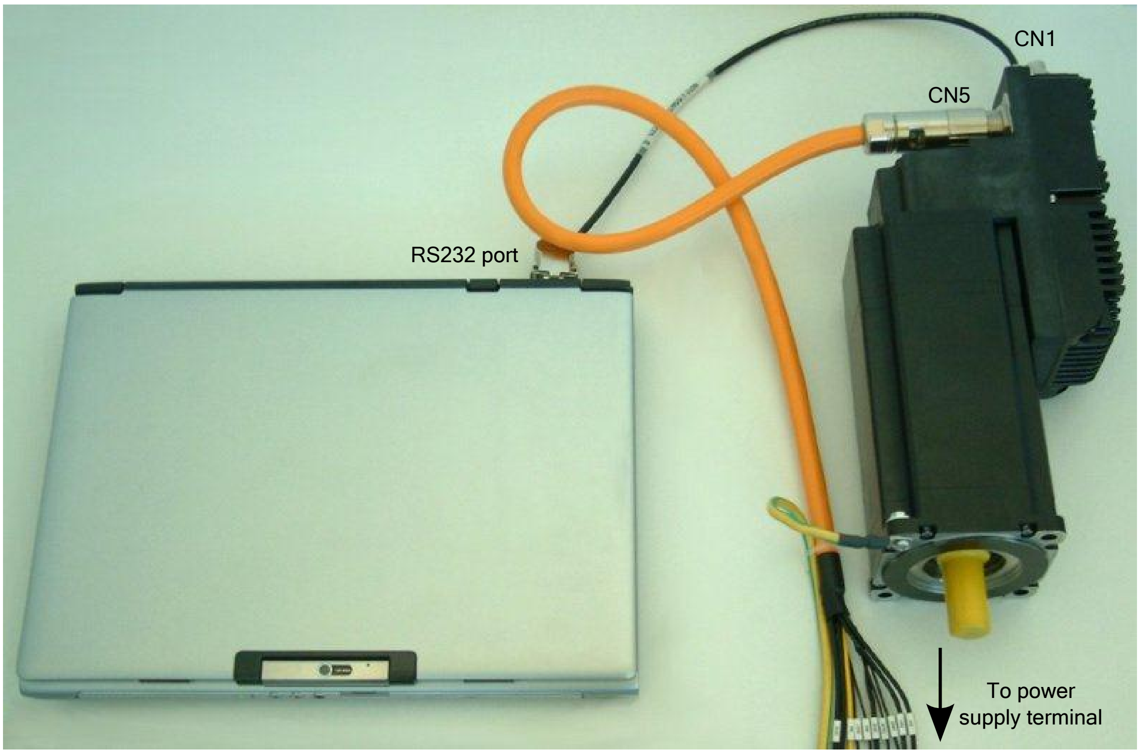


Figure 4.1. Minimum setup for the quick start.

4.2. Hardware installation

1. Mechanical installation
For the system installation use the 4 holes on the motor anterior flange. The dimensions are reported on the *Section 5.2, DuetHV dimensions and sizes*. Be sure that the drive and the motor ventilation is free, respecting however the maximum admitted environment temperature (see *Chapter 5, Technical features*).

2. Connection of the protection conductors
Connect the PE protection conductor to the motor flange as shown in the *Figure 4.2*. For detailed informations about the connection to the protection conductors see *Section 7.2.1, System Supply*.

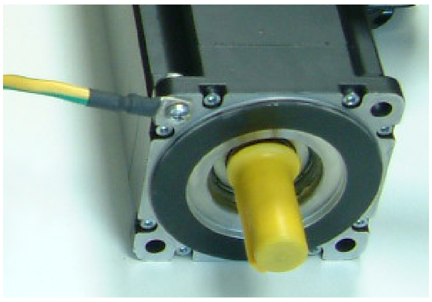


Figure 4.2. Connection of the PE protection conductor to the flange

3. Connection of supplies and /STO

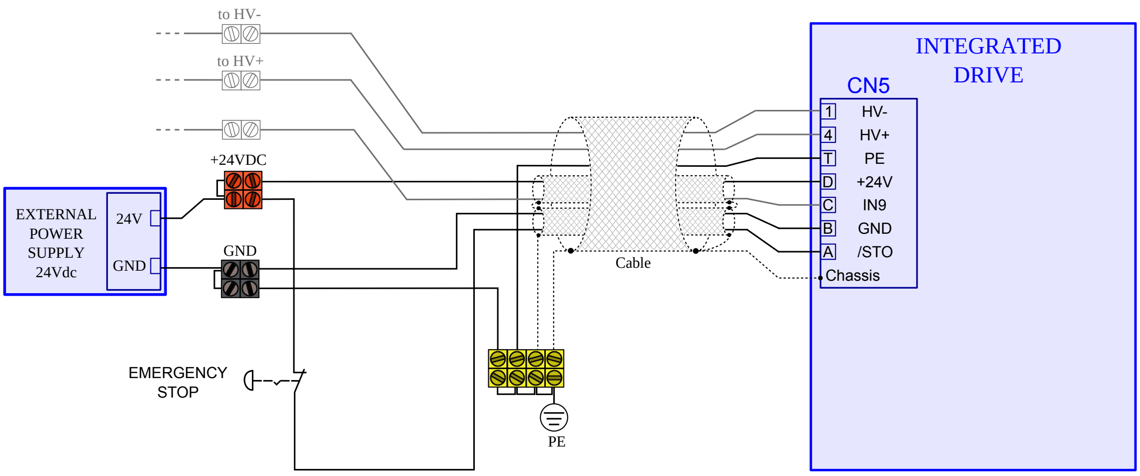
Tip

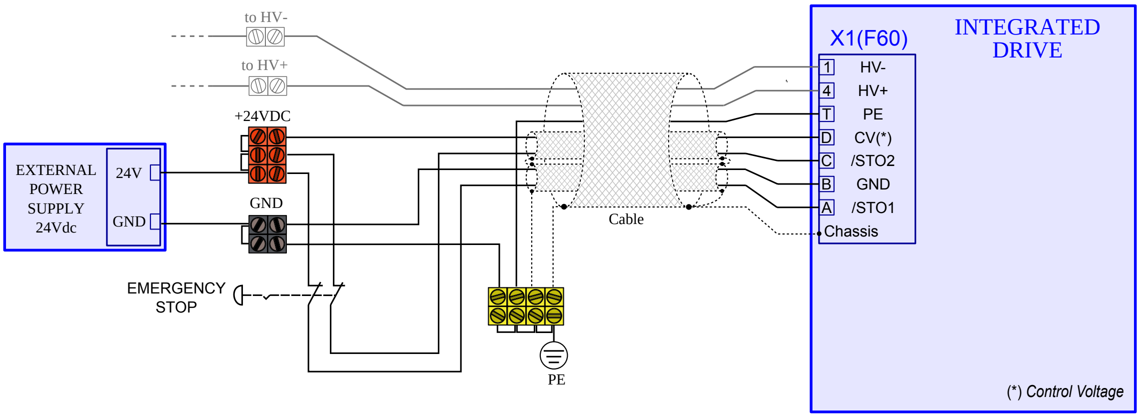
For further details please refer to *Chapter 6, STO safety function: Safe Torque Off* .

Connect the supplies and the /STO input, or the /STO1 e /STO2 inputs in case of DuetHV flange 60, according to what's reported in the following scheme.

Caution

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





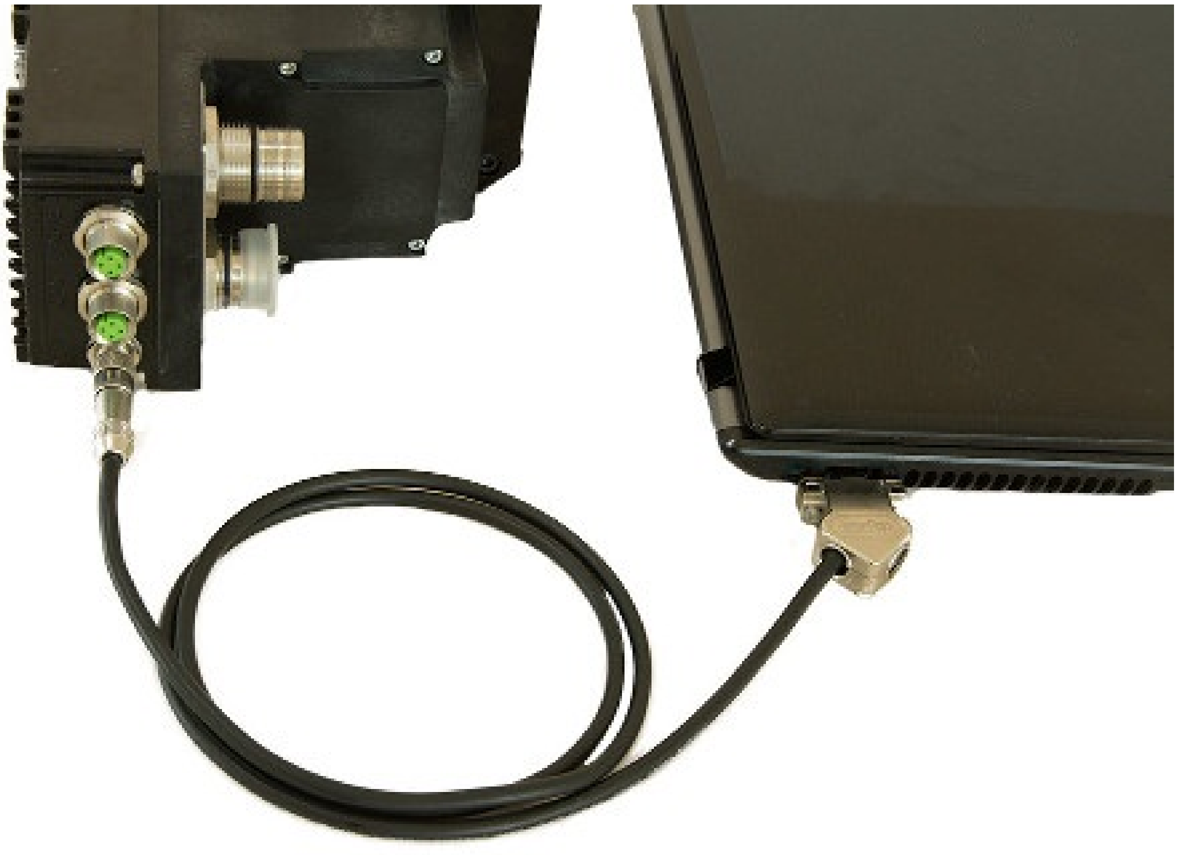
To onnect the pins of *CN5*, please pay attention to what is shown in the description table of the connector itself, except for the DuetHV flange 60.
For DuetHV flangia 60, to connect the pins of *X1(F60)* refer to what's reported in the description table of the connector itself. The STO integrated function is implemented in the drives according to the EN 61800-5-2 norms and is used to execute a stop of 0 cathegory according to the EN 60204-1 norms.

> **Caution**
>
> When the voltage of the digital input associated to the STO 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 /STO inputor the /STO1 and /STO2 inputs in case of the DuetHV flange 60.

4. Connection of the serial port

Connect the serial port RS232 to the connector *CN1* of the DuetHV drive. except for the DuetHV flange 60, *X4 (F60)* for DuetHV flange 60.

> **Caution**
>
> Connect and disconnect the communication connectors only when the drive is switched off. Check if the drive, the PC and the Ground Control Supply pin of *CN5* except for the DuetHV flange 60, of *X1(F60)* for DuetHV flange 60, are correctly connected to the protection conductor.

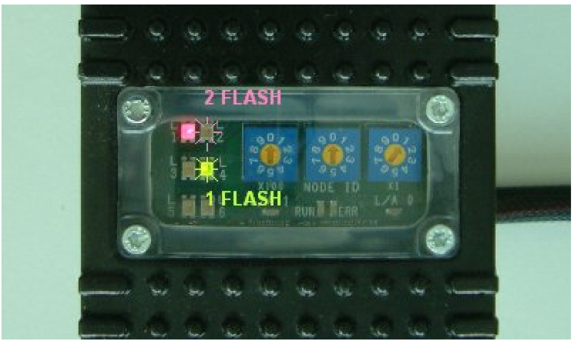


To onnect the pins of *CN1*, please pay attention to what is shown in the description table of the connector itself, except for the DuetHV flange 60.
For DuetHV flangia 60, to connect the pins of *X4 (F60)* refer to what's reported in the description table of the connector itself.

5. Confirmation of the connections

After having completed the connections, check if they are correctly connected and switch on the power supply of the control section (24 Vdc). The leds of the transparent window should have the following configuration. If it is not so, see *Table 7.11*.

- L1 RED ON; L2 RED 2 FLASH; drive in Fault for *DC bus under voltage*;
- L4 GREEN, 1 FLASH, *ActualMotorCurrent* at 0;
- L3 and L5 OFF;
- L6 OFF, No voltage on the /STO input, or /STO1 and /STO2 inputs for DuetHV flange 60.



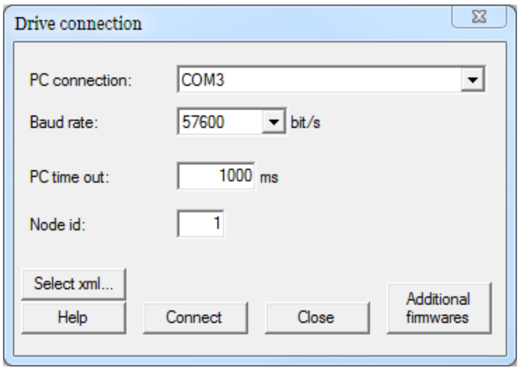
4.3. Setup software

1. DuetHVSuite installation

Install the last available version of DuetHVSuite that you can download from the http://www.motorpowerco.com website or that is provided by MPC . Accept the configurations proposed by the installation procedure. For further details see *Section 3.2, Installation*.

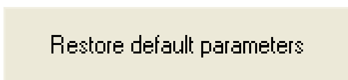
2. Starting DuetHVSuite

Start DuetHVSuite from: **Start menu** > **Programs** > **Motor Power Company** > **DuetHVSuite** and set the *Connection parameters* in the proposed window *Drive connection* .

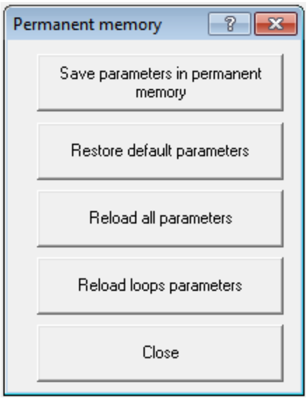


In case of problems see *Section 11.3, Communication errors with DuetHVSuite* or *Section 24.5, Communication problems*.

3. Configuration restoring

Check if you are using the default configuration, push the botton 

in the window *Permanent memory* (**Main menu** > **Drive** > **Permanent memory...**)

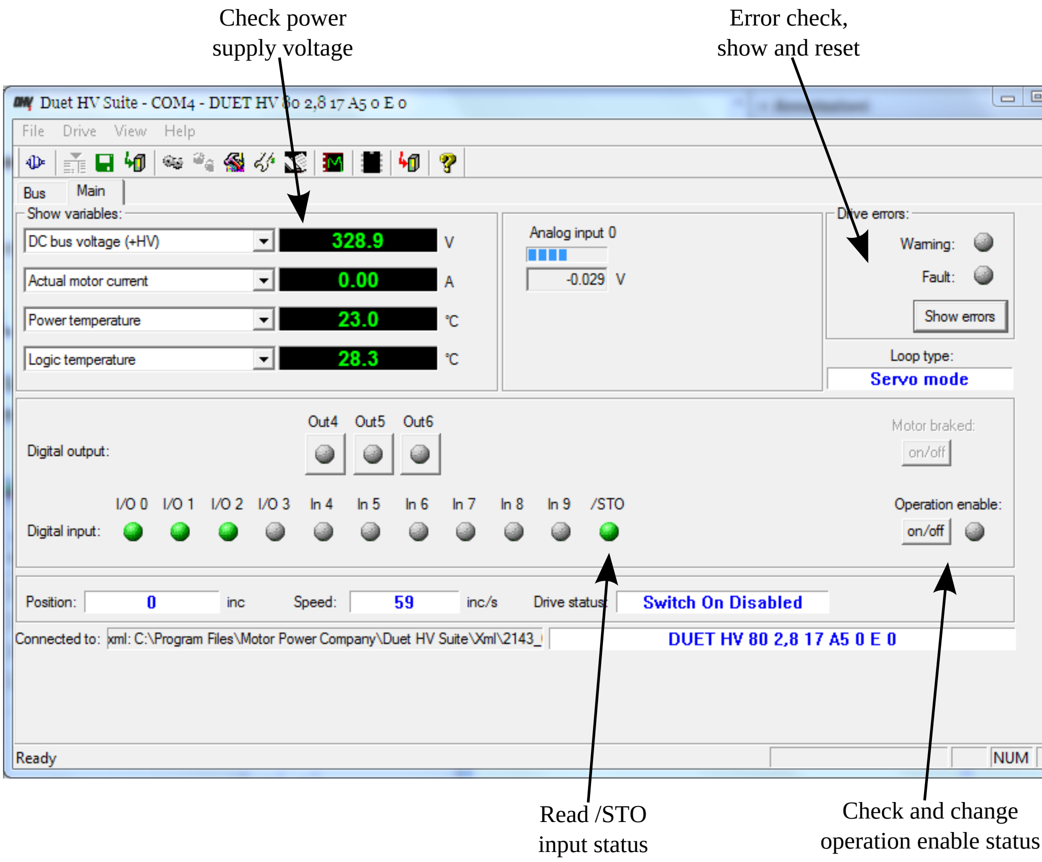


4.4. Starting the motion

> **Important**
>
> The "Quick Start" guide is designed to perform the movement command with only the DuetHVSuite tool, without the interference of the fieldbus (EtherCAT) Master. The DuetHVSuite tool is not designed to command the DuetHV drives in one of the real time modes.

1. Enabling the power

After having checked if the connections are correct and safe, switch on the power supply of the power section. Check if the voltage applied is included in the right ranges and reset any errors.



2. Enabling/disabling the drive and the motor motion.

- Apply the voltage to the /STO input, or /STO1 and /STO2 for DuetHV flange 60, and check if the led L6 is switched on (GREEN);
- enable the drive by pushing the On/Off button shown in the previous picture; the drive enters the status *Operation enable* by giving voltage to the motor phases;
- write a rotation speed:
  - Open the *Object dictionary* window; **Main menu** > **Drive** > **Object dictionary...**
  - write 4700 in the field *Address Modbus* (parameter *TargetVelocity*);
  - write 8000 in the field *Value*;
  - by pushing the *Write* button, the motor starts moving at 8000inc/s. To modify the speed, modify the value of the parameter *TargetVelocity*.

> **Important**
>
> To stop the motion, write 0 in the parameter *TargetVelocity* and only then disable the drive.

Chapter 5

Technical features

5.1. DuetHV technical features

Power section		
Supply voltage	Vdc	Nominal 560; Minimum 275; Maximum 730[a]
Internal fuse	-	-
Capacity on DC bus	µF	2.65 for motors with flange 60 mm 2.2 5.45 for motors with greater flange

[a]The DC bus must be obtained from a TT or TN network; system voltage (nominal voltage between phase and earth): MAX 300V [overvoltage category III]

Control section[a]		
Supply voltage without brake	Vdc	24 (-15% / +15%)
Supply voltage with brake	Vdc	24 (-10% / + 6%)
Threshold drive disabling	Vdc	18.3 - except for DuetHV flange 60mm 18.15 - DuetHV flange 60mm only
Error threshold for the brake	Vdc	20.9 - except for DuetHV flange 60mm 20.4 - DuetHV flange 60mm only
Absorbed current @ 24Vdc (control section only)	mA	Rated 250; Max 500; - except DuetHV flange 60mm [TBD] - DuetHV flange 60mm only
ADDITIONAL absorbed current @ 24Vdc (if brake is present)	mA	500 with brake of 2Nm 500 with brake of 4.5Nm; 750 with brake of 9Nm (except for DuetHV flange 60) [TBD] for DuetHV flange 60
ADDITIONAL absorbed current @ 24Vdc (with outputs ON)	mA	See *Table 15.5*
Internal fuse	-	4A-T not replaceable 2A-T not replacable (only for motor with flange 60mm)

[a]The voltage of the control section must be generated with a galvanically isolated supplier and with PE connected reference (grounded).

DuetHV features (flange of 60mm)		
		DuetHV60 1,3
Flange dimension	mm	60
MotorPoles	-	8
MotorRatedSpeed @ 560Vdc	rpm	5000
Stall torque (continuous supply with flanged motor on metallic heat sink 250x250x6mm)	Nm	1.3
Torque peak	Nm	3.9
Nominal torque @ 5000rpm e 560Vdc	Nm	0.9
Motor nominal power @ 5000rpm e 560Vdc	W	470
Power consumption in continuous functioning[a]	W	550
Motor inertia moment	kg cm^2	0.24
Maximum radial load @ 5000rpm (applied on the shaft centreline)	N	220
Maximum axial load (applied on the shaft centreline)	N	70
Bearings duration	h	20000 @ 5000rpm
Mechanical Shock according to the IEC 60068-2-27 standard 3 shocks per direction, on 3 axes. Pulse duration of 11ms.	g	[TBD]
Sinusoidal vibration according to the IEC 60068-2-6 standard from 5 to 500 Hz, on 3 axes.	g	[TBD]
Class of insulation	-	F
Weight without brake	kg	1.9
Additional weight in version with brake	kg	0.43
Brake static torque	Nm	2
Additional moment of inertia in version with brake	kg cm^2	0.05
Working environment temperature	°C	0 ÷ 40
Storage environment temperature	°C	-20 ÷ 70
Humidity related to storage and working (without condensation)	%	5 ÷ 95
Maximum installation altitude (without adding devices that can limit the overvoltage)[b]	m	2000 m.s.l.
Ventilation	-	Natural
Pollution degree	-	3[c]
Protection degree	-	IP65[d] with connectors inserted

[a] at 5000rpm, at the overtemperature limits and with environment temperature of 40°C

[b] for an installation altitude between 2000m and 4000m m.s.l., it's necessary to install an overvoltage limiter device on the machine to oppose the transient overvoltages, so that the power circuit overvoltages are limited to the overvoltage category II. It can be achieved with a galvanic insulation transformer.

[c] Conductive pollution or dry non conductive pollution that can became conductive in case of condensation

[d] anterior flange excluded.

DuetHV features					
		DuetHV802,8	DuetHV804	DuetHV1005,6	DuetHV1008
Flange dimension	mm	80	80	100	100
MotorPoles	-	8			
MotorRatedSpeed @ 560Vdc	rpm	3000			
Stall torque (continuous supply with flanged motor on metallic heat sink 300x300x6mm)	Nm	2.8	4	5.6	6
Torque peak	Nm	8.4	12	22	22
Nominal torque @ 3000rpm e 560Vdc	Nm	2.55	3.2	4.3	5
Motor nominal power @ 3000rpm e 560Vdc	W	800	1000	1350	1570
Power consumption in continuous functioning[a]	W	950	1200	1600	1850
Motor inertia moment	kg cm^2	1.16	1.58	2.8	4
Maximum radial load @ 3000rpm (applied on the shaft centreline)	N	350	350	626	626
Maximum axial load (applied on the shaft centreline)	N	110	110	225	225
Bearings duration	h	20000 @ 5000rpm			
Mechanical Shock according to the IEC 60068-2-27 standard 3 shocks per direction, on 3 axes. Pulse duration of 11ms.	g	14			
Sinusoidal vibration according to the IEC 60068-2-6 standard from 5 to 500 Hz, on 3 axes.	g	2			
Class of insulation	-	F			
Weight without brake	kg	4.1	5.1	6.7	8
Additional weight in version with brake	kg	0.7	0.7	1.2	1.2
Brake static torque	Nm	4.5	4.5	9	9
Additional moment of inertia in version with brake	kg cm^2	0.22	0.22	0.8	1.06
Working environment temperature	°C	0 ÷ 40			
Storage environment temperature	°C	-20 ÷ 70			
Humidity related to storage and working (without condensation)	%	5 ÷ 95			
Maximum installation altitude (without adding devices that can limit the overvoltage)[b]	m	2000 m.s.l.			
Ventilation	-	Natural			
Pollution degree	-	3[c]			
Protection degree	-	IP65[d] with connectors inserted			

[a] at 5000rpm, at the overtemperature limits and with environment temperature of 40°C

[b]for an installation altitude between 2000m and 4000m m.s.l., it's necessary to install an overvoltage limiter device on the machine to oppose the transient overvoltages, so that the power circuit overvoltages are limited to the overvoltage category II. It can be achieved with a galvanic insulation transformer.

[c]Conductive pollution or dry non conductive pollution that can became conductive in case of condensation

[d]anterior flange excluded.

> **Note**
>
> The torque values and the related power values are referred to the maximum allowed functioning environment temperature, that is 40°C.

5.2. DuetHV dimensions and sizes

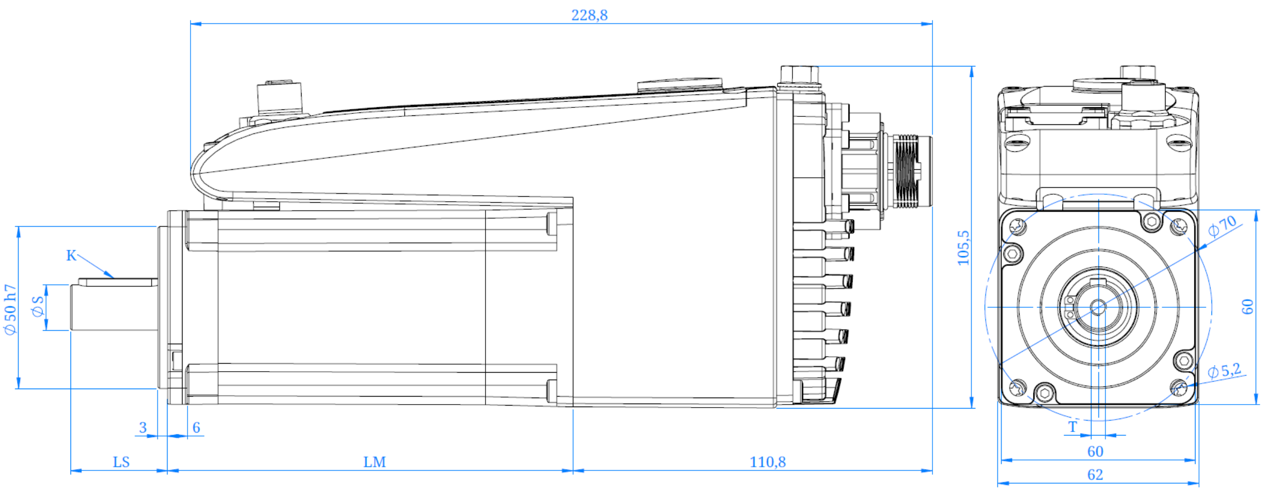


Figure 5.1. DuetHV dimensions (flange 60mm).

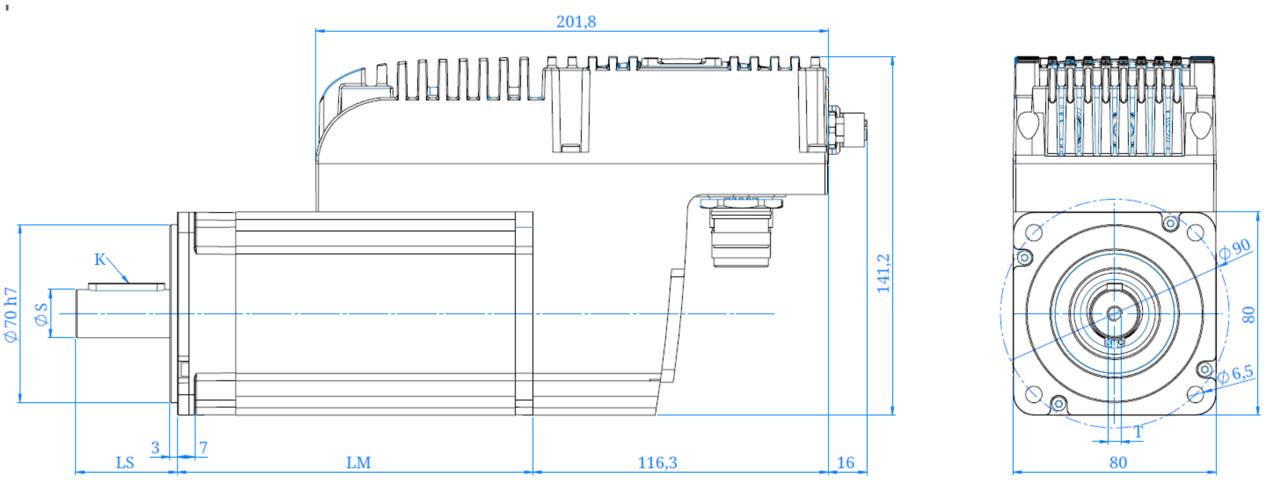


Figure 5.2. DuetHV dimensions (flange 80mm).

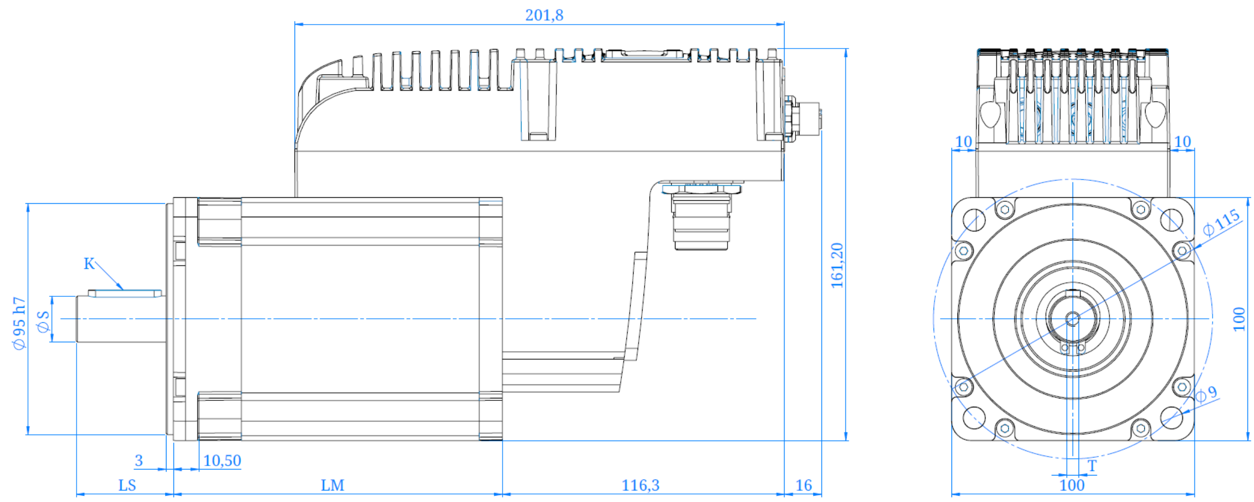


Figure 5.3. DuetHV dimensions (flange 100mm).

DuetHV dimensions (flange 60mm)		
		DuetHV60 1,3
Flange	mm	60
Length (LM) without brake	mm	125
Length (LM) with brake	mm	162
Shaft length (LS)	mm	30
Shaft Diameter (ØS)	mm	14h6
Thread (T)	-	M5
Key dimensions (K)	mm	5x5x30

Dimensions DuetHV (flange 80mm)			
		DuetHV802,8	**DuetHV804**
Flange	mm	80	80
Length (LM) without brake	mm	115	140
Length (LM) with brake	mm	157	182
Shaft length (LS)	mm	40	40
Shaft Diameter (ØS)	mm	19h6	19h6
Thread (T)	-	M6	M6
Key dimensions (K)	mm	6x6x30	6x6x30

DuetHV dimesnions (flange 100mm)			
		DuetHV1005,6	**DuetHV1008**
Flange	mm	100	100
Length (LM) without brake	mm	135.5	165.5
Length (LM) with brake	mm	186	216
Shaft length (LS)	mm	40	40
Shaft Diameter (ØS)	mm	19h6	19h6

DuetHV dimesnions (flange 100mm)			
		DuetHV1005,6	DuetHV1008
Thread (T)	-	M6	M6
Key dimensions (K)	mm	6x6x30	6x6x30

5.3. Performances derating

5.3.1. Derating with altitude

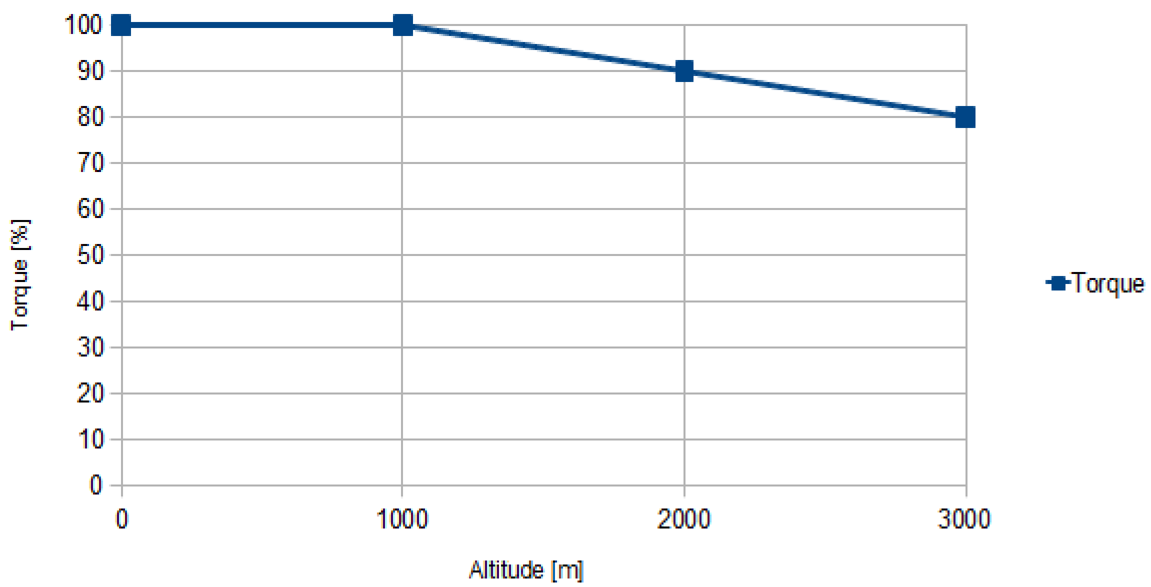


Figure 5.4. Torque and current downgrading in relation to the altitude.

Chapter 6

STO safety function: Safe Torque Off

Important

By “STO” is meant the safety function, while in order to refer to the physical input and to the external signal it is used the “/STO”. In this last definition the bar "/" represents the "NOT" logical function, to indicate that the safety function removes the motor torque if the signal voltage is at low logic level.

6.1. General informations

The STO integrated function is implemented in the drive according to the related european harmonized standards. When, the digital input the function STO is linked to is switched to the low logic level, the motor torque is disabled according to a stop of category 0, as defined in the EN 60204-1:2006/A1:2009 standards.

Caution

If the digital input with /STO 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 to reset to the low level the /STO input (for the DuetHV flange 60, one of /STO1 and /STO2 inputs).. In case of suspended loads, some other measures in order to reduce the risk of load falling must be considered, for example installing a dynamic brake.

Caution

It must be made an evaluation of the risk about the particular machine in which the product is used. In consequence the user must take appropriate measures to avoid risks to the safety of the person.
In order to guarantee the safe removal of the motor torque, it is recommended to use the Safe Torque Off function, by using only the provided input, named /STO (for the DuetHV flange 60 use the provided inputs, named /STO1 and /STO2).

The examples and the procedures described in this manual are based on the reaching of the de-energized state of the drive as safe state (e.g. in case of emergency).

In case there are external forces on the load (e.g. in case of vertical loads), some additional actions must be considered in order to prevent danger risks (e.g. by using a mechanical brake, eventually commanded by a safe output).

Caution

The Safe Torque Off function DOESN'T cut off the voltage nor in the drive power and logic circuits neither in the motor, therefore it CANNOT be considered as an insulation system of the drive from supply sources (DCbus). In order to execute the maintenance service on the drive electrical components or on the motor, it is necessary to insulate the supply system first.

Caution

The /STO input is not protected (/STO1 and /STO2 inputs for the DuetHV drive flange 60) is not protected against the overcurrents. The user, if he deems it appropriate, can provide external protections.

The STO function can be used to prevent an unintentional start of the motor: the STO function use is possible in case some quick operations have to be executed (e.g. the machine cleaning) and/or for maintenance services on NOT electrical parts of the machine, without cutting off the drive supply voltage.

Caution

It is recommended to not stop the drive and/or the motor by using the Safe Torque Off function. If the motor is stopped through the STO function, the drive cuts off the power to the motor and it stops due to the inertia. Furthermore, in the motors that are provided of the internal holding brake, the motor brake can be damaged. In order to avoid these dangerous/damaging situations, stop the drive and the motor with the provided modes before to use the STO function.

It has been provided a diagnostics system of the STO system status, that allows the anomalies report to the user.

Note

The *Safety system* has been completely hardware realized: the STO functionality is independent from the software configuration and version of the drive. The software manages only the anomalies warning signal, but doesn't prevent the system safety setting.

Environment conditions and EMI
The environment and operating conditions in which the *Safety system* functioning is provided and guaranteed, are the same ones of the entire system (see *Chapter 5, Technical features*).

Stop categories (IEC EN 60204-1)
Uncontrolled stop: the intervention of the STO function disables the drive and cuts off the torque from the motor, therefore the axis is free to move according to the uncontrolled stop of cat.0 (EN 60204-1).
Controlled stop: if the application requires a controlled stop according with the stop of cat.1 (EN 60204-1), the following actions must be executed respecting the listed order:

1. deceleration of the motor through the braking ramp, executed by the drive (see *Section 21.3, Execute a stop by using the Master*);
2. drive disable (this operation must be executed when the motor is in standstill)[1]: (see *Section 21.2, Disabling by using the Master*);
3. safe removal of the motor torque through the transition to the low level of the /STO input, while for the DuetHV flange 60 the transition must be made on one of the /STO1 and /STO2 inputs.

In the *Figure 6.1* a graphic representation of the above described phases is reported.

[1]The voltage on the /STO input must be cut off after a delay, that has to be programmed on the safety relay, that has to be sufficient to include the stop of the motor; otherwise the final part of the movement will be uncontrolled. The same applies to DuetHV flange 60, but is related to one of the /STO1 and /STO2 inputs

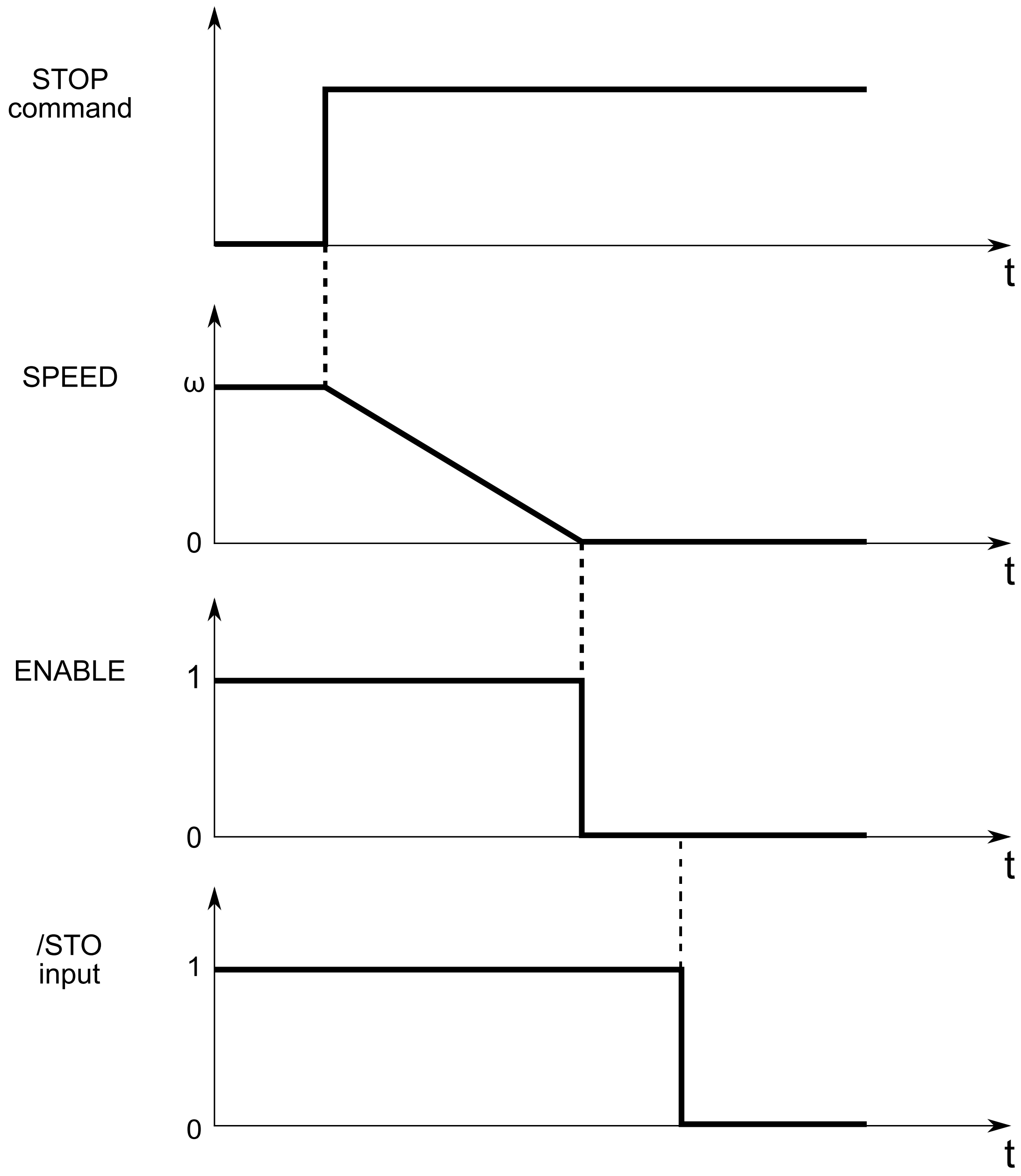


Figure 6.1. Steps of a controlled stop

An example of how to wire the drive in order to obtain a stop of cat.1 is reported in */STO input connection examples* for the DuetHV (except for the DuetHV flange 60, for which refer to */STO1 and /STO2 inputs connection example*). The emergency stop request initially causes the *Enable* digital input disable. Therefore the drive executes a motor controlled stop according to the *DisableOption* parameter settings.

Note

The digital inputs to which is possible to associate the *Enable* functionality are not part of the *Safety system* system and, consequently, the motor deceleration is not a safety function.

Residual risk
In case of fault for short circuit on one or more IGBT power semiconductors, despite the safe removal of the motor torque, there is the residual risk that the drive produces on the motor shaft a maximum rotation of 360° / (2p), where 2p is the motor poles number.

6.2. DuetHV functional specifications (except for DuetHV flange 60)

Safety system
In the picture below the bloks that are part of the *Safety system* with STO function are included in the yellow/black dotted outline, marked with the «SAFETY SYSTEM» writing. The references in the picture, represented by the yellow circled numbers, are related to the following parts of the system:

1. /STO input on *CN5* connector;
2. STO input circuit;
3. IC controller for the management of the converter that supplies the gate drivers;
4. Converter for the gate drivers voltage supply;
5. Gate driver for the IGBTs.

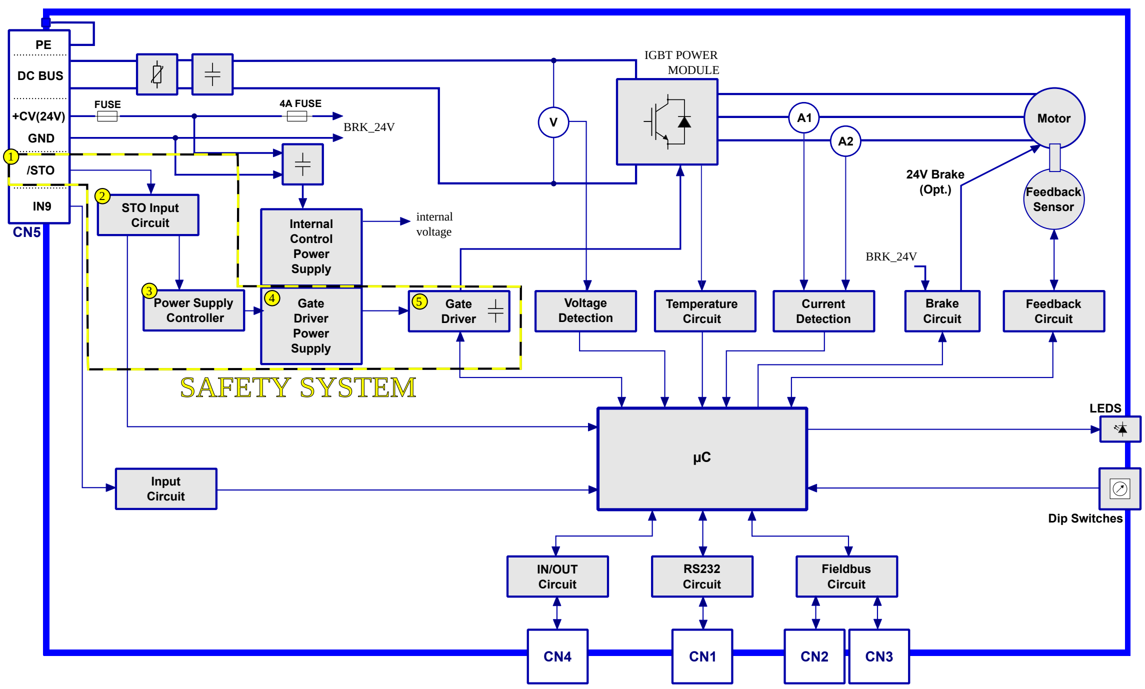


Figure 6.2. System block diagram

Mode of operation

The STO *Safety system* allows the deactivation of the control voltage of the power semiconductors (IGBT) of the drive output stage through the input /STO signal, avoiding the generation of enough voltage to provide power to the motor.

The states of the *Safety system* are the following:

- in case the voltage that's applied to the /STO input is at high logic level: the STO *Safety system* allows the drive enabling and so the torque may be present on the motor **(potentially not safe status)**;
- in case the voltage that's applied to the /STO input is at low logic level: the STO *Safety system* cuts off the voltage on the motor phases, so that there is no torque and the automatic start-up is disabled **(safe status)**;

After the disabling, the drive can be enabled after these operations have been executed:

- restore of the high logic level on the /STO external input;
- deleting of the alarms via software;
- sending of the command to switch the drive in the *Drive enable* state.

The safety function is independent of the status of the drive: it is always active and continuously executed. In fact there are no configurations able to temporary disable the safety function.

/STO input electric features

/STO INPUT	
Input type	PNP
Input current (typical) with Vin = 24Vdc	10.5 mA
Input voltage (low or high logic level)	
Nominal	+24Vdc
for low signals	-30V ÷ +5Vdc
for high signals	+20V ÷ +30Vdc

Warning

The /STO input is compatible with the auto-diagnostic digital outputs of a command device, in which the test pulse has a maximum duration of 1ms. This implies that the motor torque is not removed if the /STO input receives a low logic level pulse with a duration lower than 1ms.

Led 6 diagnostics

The STO system logic state (for the meaning see *Mode of operation*) is monitored by a microcontroller and signaled through the software (bit 24 di *LogicalDigitalInputStatus*) and the Led 6, as reported in the following table:

STO logic status	Led 6
Voltage presence on the input and Fault absence	ON
Voltage absence on the input and/or Fault presence	OFF

Important

In the boot and firmware start-up phases, the above description of the led is no more valid. Refer to *Chapter 25, Software updating*.

Continuous /STO input validation

The /STO input validation function continuously monitors the voltage level applied to the input: if this level keeps a value between the reference thresholds (+20V for the high level and +5V for the low one, see */STO input electric features*) for more than 500ms, the error is reported through the *MainError* (see the bit 14 in the *Table 23.1*).

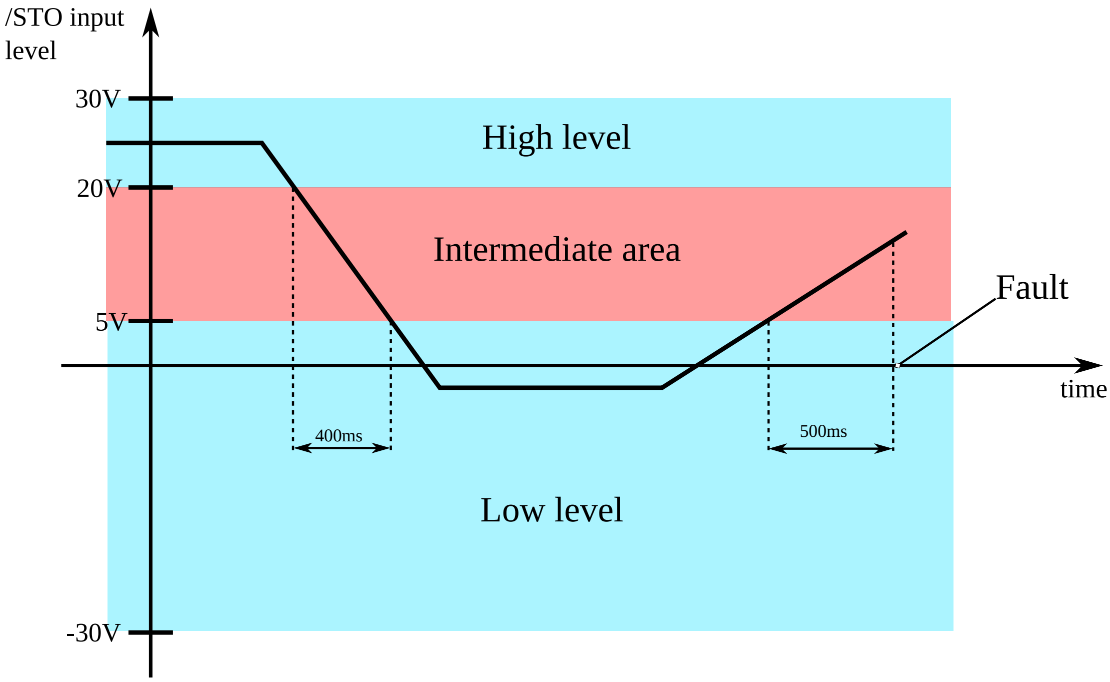


Figure 6.3. Voltage levels of the /STO input

Environment conditions and EMI

The environment and operating conditions in which the *Safety system* functioning is provided and guaranteed, are the same ones of the entire system (see *Chapter 5, Technical features*).

Safety related data

The STO function is completely implemented via hardware as safety function with single channel architecture.
It is furthermore provided a STO system status monitoring circuit that detects the presence of failures on the *Safety system*.

Functional integrity level (EN 61800-5-2)	Performance level (ISO EN 13849-1)
SIL3	PLd

According to the EN 61800-5-2 standards it is guaranteed a probability of dangerous failure PFHd = $6.27*10^{-8}$ with safe failure fraction SFF = 99%, obtaining a *Functional safety* integrity level equal to SIL3.
According to the ISO EN 13849-1 standard, the STO *Safety system* is characterized by an architecture that complies to the Cat. 2 with via software implemented diagnostics (DC=90%) reaching a performance level equal to PLd. The applied failure exclusions correspond to the ones that are reported in the Annex D of the EN 61800-5-2 standard.

Response time

> **Warning**
>
> The STO function has a maximum response time of 120ms. This time has been measured by cutting the voltage applied to the /STO input (the maximum allowed, 30V), with negligible external capacity.

The response time corresponds to the time interval between the instant of the /STO input state transition from high to low logic level and the instant in which the voltage that's present on the IGBT supply circuit is reset to zero, that coincides with the system safety state.

STO system diagnostics

The *Safety system* includes a diagnostics, that works via software, that detects the hardware faults of the STO circuit. For a description of the errors that are detected by the STO system, please refer to */STO Management Error*.

Risk mitigation

The STO function has a single channel architecture. It implies that if in the /STO external signal connection happens a single fault that provides to the input enough energy to keep it at the high logic level (e.g. a /STO signal short circuit with a voltage of 24V), and this fault is not detected, it may occur a STO function interruption: in order to reduce the risk due to any eventual failure, the external connection of the /STO signal must be protected from faults that accidentally may provide it a voltage that puts the system in a not safe condition.

It can be obtained in several modes:

a. by completely isolating the /STO signal from the output of the device that commands the drive input; or
b. by shielding the /STO signal connection cable and connecting the shield to GND (/STO signal command voltage potential reference); or
c. by monitoring the /STO signal status from the control device (e.g. by using a control device with an output, which can generate a test pulse, connected to the /STO) that allows an independent disabling of the drive.

/STO input connection examples

The connection examples in */STO input connection examples* report the general scheme for the /STO input wiring and don't have to be intended as detailed and complete pictures.
The integration of the STO function in the machine must be the result of the complete risks analysis of the machine made by the machine designer.

Test and periodic check of the STO function

The machine final assembly manager must do the test and the periodic check of the safety functions, verifying the correct functioning.
The periodic test/check procedure must be done with a frequency that respects the following situations:

- at the first safety function start-up;
- after every modification related to the safety function (wiring, settings, ecc.);
- after every system maintenance intervention;
- at least every 24 months (2 years), starting from the first put in service of the system and, in any case, after the machine has not been used for an equal or greater time period;

The test/periodic check of the safety functions must be executed only by expert and authorized personnel, that have the necessary competence related to the use of the functions and knows the risks in case the safety functions don't work as they should. The periodic test/check must be documented and undersigned by authorized personnel and the reports of the result of the test, eventual faults alarms and problems resolutions must be archived.

Test/periodic check procedure

- check that the STO circuit wirings related to the drive and the control circuit are correctly executed as reported in */STO input connection examples*;
- check that the shield of the /STO input cable is electrically connected to the GND in correspondence of the signal source and the drive connector (mandatory test in case the mode “b” has been adopted, in reference to the *Risk mitigation* paragraph);

- with /STO input at high logic level and the drive in the *Drive enable* status, check that the torque is present on the motor and that there are no safety alarms;
- disable the drive and, successively, cut off the voltage from the /STO input (through the control device/s suitable for this function). Check that the “/STO = 0V with drive enabled error” or other safety alarms are not presents (see */STO Management Error*) and that the motor is free to move (torque absence);
- when the drive is disabled and the /STO input is at low logic level, enable again the drive. Check that the alarm report related to the enable attempt with /STO input at low logic level ("/STO = 0V with drive enabled error”) is present and that the motor is still free to move (torque absence - safe status);
- in these conditions switch the /STO input to the high logic level and check that the motor is still free to move (torque absence - safe status); furthermore, check that the fault written above is present;
- reset the alarm and, with the /STO input set to the high logic level, enable the drive. In these conditions the motor must be enabled (on torque) and neither the "/STO = 0V with drive enabled error” alarm nor other safety alarms must be present.

Warning

In case some inconsistencies are detected, in relation to the overwritten expected results, the *Safety system* cannot be considered intact and the drive mustn't be used. Contact Motor Power Company Srl in order to obtain an adequate support and for the record of the fault event: in addition, it will be necessary to proceed with the repairing operation by the authorized personnel. This procedure is necessary to guarantee the safe use of the drive.

6.3. Functional specifications of DuetHV flange 60mm

Important

The system named STO is under certification. It cannot be guaranteed the conformity with EN 62061 or ISO EN 13849-1. The informations in this chapter can be subject to change.

Drive configurations

The drive integrates, in each of its configuration, a *Safety system* with STO function realized with HW components.

***Safety system*of DuetHV flange 60**

In the picture below the bloks that are part of the *Safety system* with STO function are included in the yellow/black dotted outline, marked with the “SAFETY SYSTEM” writing.

The references in the picture, represented by the yellow circled numbers, are related to the following parts of the system:

1. /STO1 and /STO2 inputs through *X1(F60)* connector;
2. STO logic circuit: executes the processing of the inputs (the *Safety system* diagnostics related block is not reported in the picture for the sake of simplicity);
3. Switch in series connection: allow the unpower of the gate driver, the consequent safe removing of the torque after the intervention of the *Safety system*;
4. Gate driver for the management of the IGBTs that provide the torque to the motor.

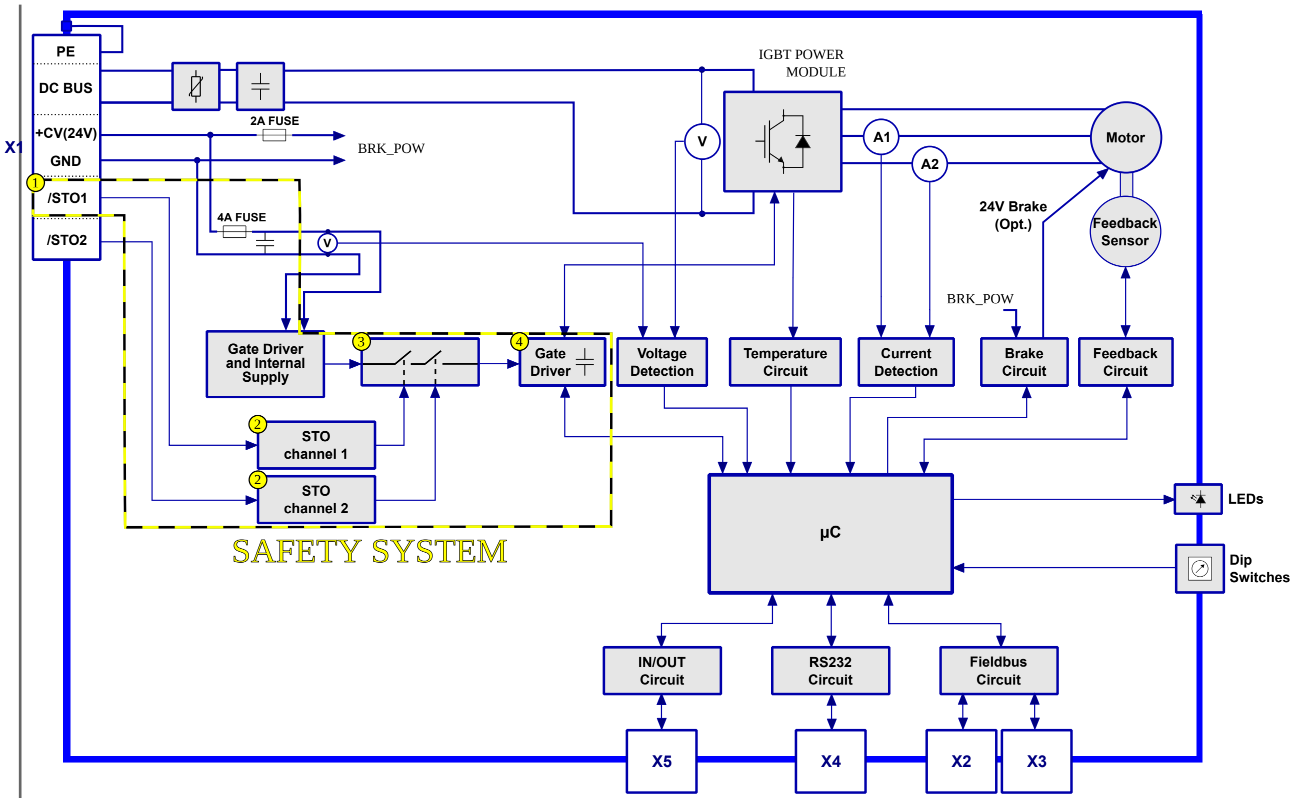


Figure 6.4. Block diagram of DuetHV flange 60

Mode of operation

The STO *Safety system* allows the deactivation of the control voltage of the power semiconductors (IGBT) of the drive output stage through 2 input signals (/STO1, /STO2), avoiding the generation of enough voltage to provide power to the motor.

The safety function of torque safe removing is always active and continuously executed.

The DuetHV flange 60 drives provide a single connector *X1(F60)* related to the functional safety signals.

> **Warning**
>
> The STO function is characterized by HW redundancy (system with 2 channels, HFT = 1); in order to obtain a redundancy of the entire system it's necessary that:
>
> - the /STO1 and /STO2 input signals are electrically insulated between the safe command device and the drive; the STO signals must be externally connected to the drive according to the */STO input connection examples* rules;
> - the /STO1 and /STO2 signals are respectively driven by an output pairs of a safety command device.

The motor torque enabling state can be:

- **Motor torque present (potentially not safe status)**: The torque is present if the drive is enabled and the diagnostic doesn't detects any Fault: for the enabling it's necessary that the voltage of both the STO inputs is at high logic level; the drive will can be disabled with the torque removing through the STO function after the transition of at least one input between /STO1 and /STO2, from hogh to low level;
- **Torque removed (safe state)**: the drive is not enabled and the voltage on the motor phases is not present, so it is the torque, and the automatic start-up is disabled.

After the disabling, the drive can be enabled after these operations have been executed:

- restore of the high logic level on the /STO1 and /STO2 inputs ;
- deleting of the alarms via software;
- sending of the command to switch the drive in the *Drive enable* state.

/STO1, /STO2 inputs electrical features

/STO1, /STO2 INPUTS	
Input type	PNP
Input current (typical) with Vin = 24Vdc	10.5 mA
Input voltage (low or high logic level)	
Nominal	+24Vdc
for low signals	-30V ÷ +5Vdc
for high signals	+20V ÷ +30Vdc

> **Warning**
>
> The /STO1 and /STO2 inputs are compatible with the auto-diagnostic digital outputs of a command device, in which the test pulse has a maximum duration of 1ms. This implies that the motor torque is not removed if the /STO1 and /STO2 inputs receive a low logic level pulse with a duration lower than 1ms.

Led 6 diagnostics

The STO system logic state (for the meaning see *Mode of operation*) is monitored by a microcontroller and signaled through the software (bit 24 di *LogicalDigitalInputStatus*) and the Led 6, as reported in the following table:

STO logic status	Led 6
Voltage presence on both inputs and Fault absence	ON
Voltage absence on at least one input and/or Fault presence	OFF

> **Important**
>
> In the boot and firmware start-up phases, the above description of the leds is no more valid. Refer to *Chapter 25, Software updating*.

Safety related data

The STO function is completely implemented via hardware as safety function on a double channel architecture.
It has been provided a diagnostics circuit of the STO system status that, in case of not desired states or anomalies, switches the drive in the safe status (see *Mode of operation*). Furthermore it is provided a warning via SW and through LEDs.

Response time

> **Warning**
>
> The maximum response time of the STO function for the DuetHV flange 60 drive is [TBD] ms. These values have been measured by cutting off the maximum applicable voltage from the /STO1, /STO2 inputs (see the range of the high signals in the */STO1, /STO2 inputs electrical features*), with negligible external capacity.

The response time of the *Safety system* corresponds to the time interval between the instant of the state transition of at least one of the inputs (STO1, STO 2) from high to low logic level and the final instant in which the voltage that's present on the IGBT supply circuit is reset to zero, that coincides with the system safety state.

STO system diagnostics

The *Safety system* includes a diagnostics that detects the eventual errors or hardware faults of the STO circuit. For a detailed description of the errors that are detected by the STO system, please refer to */STO Management Error*.

Protezione da sottotensione e sovratensione e rilevamento dei guasti HW
The STO circuit supply is protected from undervoltage and overvoltage. Furthermore, the diagnostics allows to detect some HW failures in the output section (actuators) of the *Safety system*.
The diagnosis of these anomalies includes the safe removal of the motor torque in case of damage, and the signalation of the Fault (see */STO Management Error*) through LED.

Risk mitigation
The STO function has a double channel architecture. It implies that:

- if a single Fault happens in the redundant section, the drive executes the transition to the safe state (torque removal).

  As defined by the standards according to the functional integrity level of the product, the suggested measures have been taken in order to limit the common mode failures to the 2 channels.

- If in the /STO1 and /STO2 external signal connection happens a single Fault that provides to the STO circuit enough energy to detect the high logic level (e.g. a /STO1 or /STO2 signal short circuit with a voltage of 24V), this fault cannot be detected by the drive; the risk related to this type of anomaly must be mitigated with one of the following modes:
  a. by completely isolating the /STO1 and /STO2 inputs from the output of the command device on the drive input;
  b. by shielding the /STO1 from the /STO2 signal and connecting the shield to GND (/STO1 and /STO2 signals command voltage potential reference); or
  c. by monitoring the /STO1 and /STO2 signal status (e.g. by using a control device with an output which can generate a periodic test pulse, connected to the /STO1 and /STO2) that allows an independent disabling of the drive in case of the detection af an anomaly.

/STO1 and /STO2 inputs connection example
The connection examples reported in [TBD], report the general scheme for the /STO1 and /STO2 inputs wiring and don't have to be intended as detailed and complete pictures.
The integration of the STO function in the machine must be the result of the complete risks analysis of the machine (that has to be made by the machine designer).

Test and periodic check of the STO function
The machine final assembly manager must do the starting test and the periodic check of the safety functions.
The periodic test/check procedure must be done with a frequency that respects the following situations:

- at the first safety function start-up;
- after every modification related to the safety function (wiring, settings, ecc.);
- after every system maintenance intervention;
- at least every 24 months (2 years), starting from the first put in service of the system and, in any case, after the machine has not been used for an equal or greater time period;

The test/periodic check of the safety functions must be executed only by expert and authorized personnel, that have the necessary competence related to the use of the functions and knows the risks in case the safety functions don't work as they should. The periodic test/check must be documented and undersigned by authorized personnel and the reports of the result of the test, eventual faults alarms and problems resolutions must be archived.

Test/periodic check procedure

- check that the STO circuit wirings related to the drive and the control circuit are correctly executed as reported in [TBD];
- check that the shielding of the cable that transport the /STO1 and /STO2 signals is electrically connected to GND (source voltage ref.) that corresponds to the signal on the drive connector (mandatory check when the “b” mode is choosen) in reference to the *Risk mitigation* paragraph);
- with /STO1 and /STO2 inputs at high logic level and the drive in the *Drive enable* status, check that the torque is present on the motor and that there are no safety alarms;
- disable the drive and, successively, cut off the voltage from the /STO1 and /STO2 inputs. Check that the “/STO = 0V with drive enabled” alarm or other safety alarms are not presents (see */STO Management Error*) and that the motor is free to move (torque absence - safe state);
- when the drive is disabled and the /STO1 and /STO2 inputs are at low logic level, enable again the drive. Check that the alarm report related to the enable attempt input at low logic level ("/STO = 0V with drive enabled error”) is present and that the motor is still free to move (torque absence - safe status);
- in these conditions check that the Fault written above is present and switch the /STO1 and /STO2 inputs to the high logic level; check that the motor is still free to move (torque absence - safe status);
- reset the Fault and, with the /STO1 and /STO2 inputs set to the high logic level, enable the drive. In these conditions the motor must be enabled (on torque) and neither the "/STO = 0V with drive enabled error” alarm nor other safety alarms must be present.

Warning

In case some inconsistencies are detected, in relation to the *Test/periodic check procedure* results, the *Safety system* cannot be considered intact and the drive mustn't be used. Contact Motor Power Company Srl in order to obtain an adequate support and for the record of the fault event: in addition, it will be necessary to proceed with the repairing operation by the authorized personnel. This procedure is necessary to guarantee the safe use of the drive.

Note

The test procedure must be executed by driving the *Safety system* with both the /STO1 and /STO2 signals.

Note

In case the motor is provided of the brake, it is necessary to unblock it before to check if the shaft is free to rotate.

Chapter 7

Electrical connections, leds and dip switches

7.1. Installation notes

Warning

The DuetHV systems must be installed by specialized personnel olny 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.

Important

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).

Warning

The DuetHV system must be installed in an environment that guarantees the conditions that this manual prescribes (see *Section 2.3, Safety precautions and limits*), in particular it must be protected from excessive humidity and/or condensation. Furthermore it must be respected the maximum environment temperature (see *Chapter 5, Technical features*), 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.

Important

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.

Warning

The removing of the transparent window to set the dip switches exposes the electronics to the external environment, causing the risk of an involuntary infiltration of foreign bodies that may cause damages. Limit the window opening to the strictly necessary time to set the dip switches.

7.2. Electrical connections

The section about the electrical connection includes both the connectors pins and the characteristics and the 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).

Warning

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. In order to bring back the electromagnetics phenomenons generation and the electromagnetic immunity of the product to values that comply with the current standards it's suggested to apply the measures that are reported in Art. 4.4.2 of IEC 60204-1. For example, the conducted common mode immunity can be limited, if possible, through filters on the supply line.

7.2.1. System Supply

For the system supply a voltage for the control 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 supply is *CN5*, except for DuetHV flange 60 for which is *X1(F60)*.

There are no restrictions about the supply sequence: it can be provided the control voltage supply first and then the power one, or vice versa. But without the control 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). In the technical data table in the *Chapter 5, Technical features* there are the limits of the control and power sections voltage.

Connection notes

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.

The grounding of the drive is made through the grounding wire of *CN5*, except for the DuetHV flange 60 for which it is *X1(F60)*. The grounding wire must be connected to the equipotential collector of the machine. In order to guarantee the drive electrical safety, a well functioning of the drive and a better behaviour against the noises, it's necessary to make the connection of the metallic structure, where the motor flange is fixed, to the ground equipotential network (through a low impedance conductor with a not lower than 4 mm^2 section, as showed in *Section 4.2, "Hardware installation"*).

Warning

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.

Warning

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. In fact, no "dump" circuit on the supply voltage is present.

Warning

The drive is NOT protected against the HV power supply polarity reverse: so pay attention during the connector wiring procedure.

Warning

The control section voltage supply must be guaranteed "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)

Tip

For further details see even *Chapter 13, Power configuration*.

7.2.2. Fuses

Control section

The drive is provided, internally to the control section, of a non replaceable fuse (SMT type): DO NOT SUBSTITUTE FOR ANY REASON THIS FUSE. In fact the fuse breaking probably implies a damage of the electronics: in this case please contact Motor Power Company Srl

Power section

On the power section of the drive there are no fuses, so it must be provided a protection upstream: for further informations refer to the *Chapter 13, Power configuration*.

7.2.3. DuetHV drive connectors (except for flange 60)

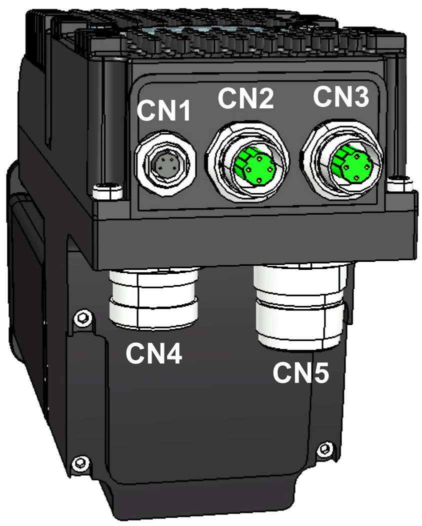
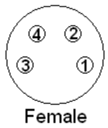


Figure 7.1. Connectors arrangement: flange rear view 80-100mm

CN1 Auxiliary bus (RS232 Serial port)

Connector for the auxiliary bus with Modbus protocol on RS232, M8 female, 4 poles (this serial port is insulated).

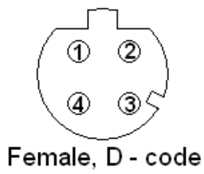
> **Important**
>
> Make the serial cable connection when the drive is not powered. The cable shield must be connected to the ground only on the host (PC) side, while on the drive side it must be maintained insulated.



PIN	Signal	Description
1	TX232	Transmit Data RS232
2	RX232	Receive Data RS232
3	NC	Reserved, not connected
4	GND_COM	Ground RS232
Chassis	PE	Ground RS232

CN2, CN3 Main bus (ETC)

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



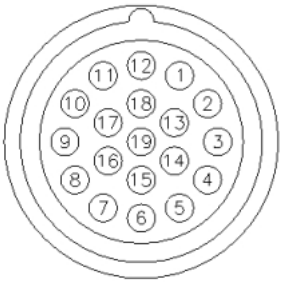
PIN	Signal	Description
1	TX Data+	Transmit Data +
2	RX Data+	Receive Data +
3	TX Data-	Transmit Data -
4	RX Data-	Receive Data -
Chassis	PE	Protection Earth

CN4 Input/Output

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

Note

The PNP digital inputs (24V) have the common ground internally connected to the system on the GND signal, that is the 24V 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.



Male, Hummel

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

Important

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 ground [pin 6 of *CN4*].

Important

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 circular connector. On the controller/PLC side follow the constructor instructions about the shield connection.

Example of PNP 24V inputs and outputs wiring

On the DuetHV 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 DuetHV system control supply is referred (pin B of *CN5*, GND signal). In fact, as can be seen on the following diagram, the inputs have a system internal common ground that's connected on the GND signal. The DuetHV system outputs are internally powered by the 24V with which the control 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 (see *Table 15.5*). The ground of the loads that are connected to the outputs must be the same one of which the DuetHV system control supply is referred to (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 connections that are external to the DuetHV.

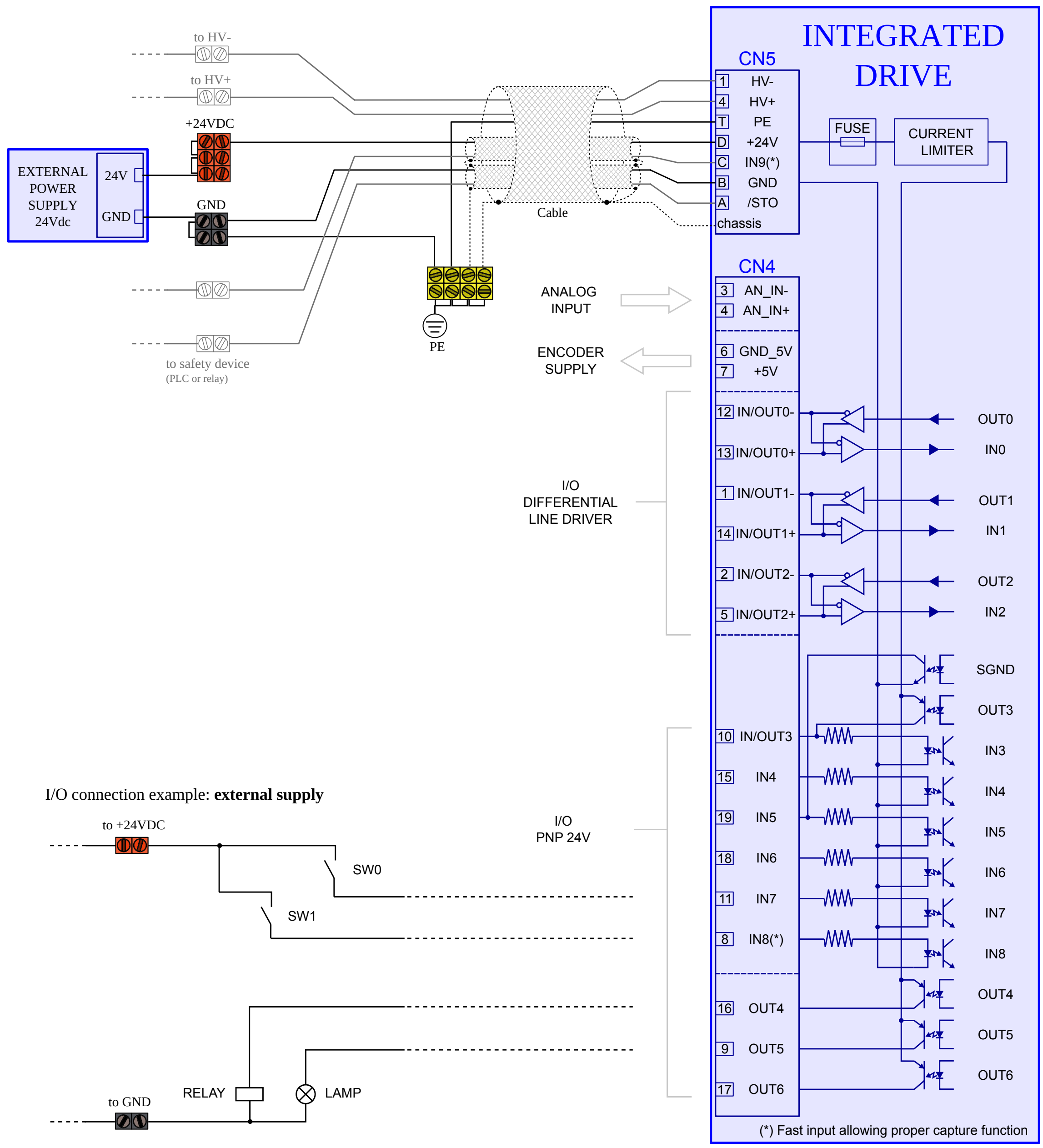


Figure 7.2. Example of inputs and outputs wiring with external supply.

It's possible to make these connections directly on the DuetHV system (as reported on the *Figure 7.3* example). 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 on 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 the 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.

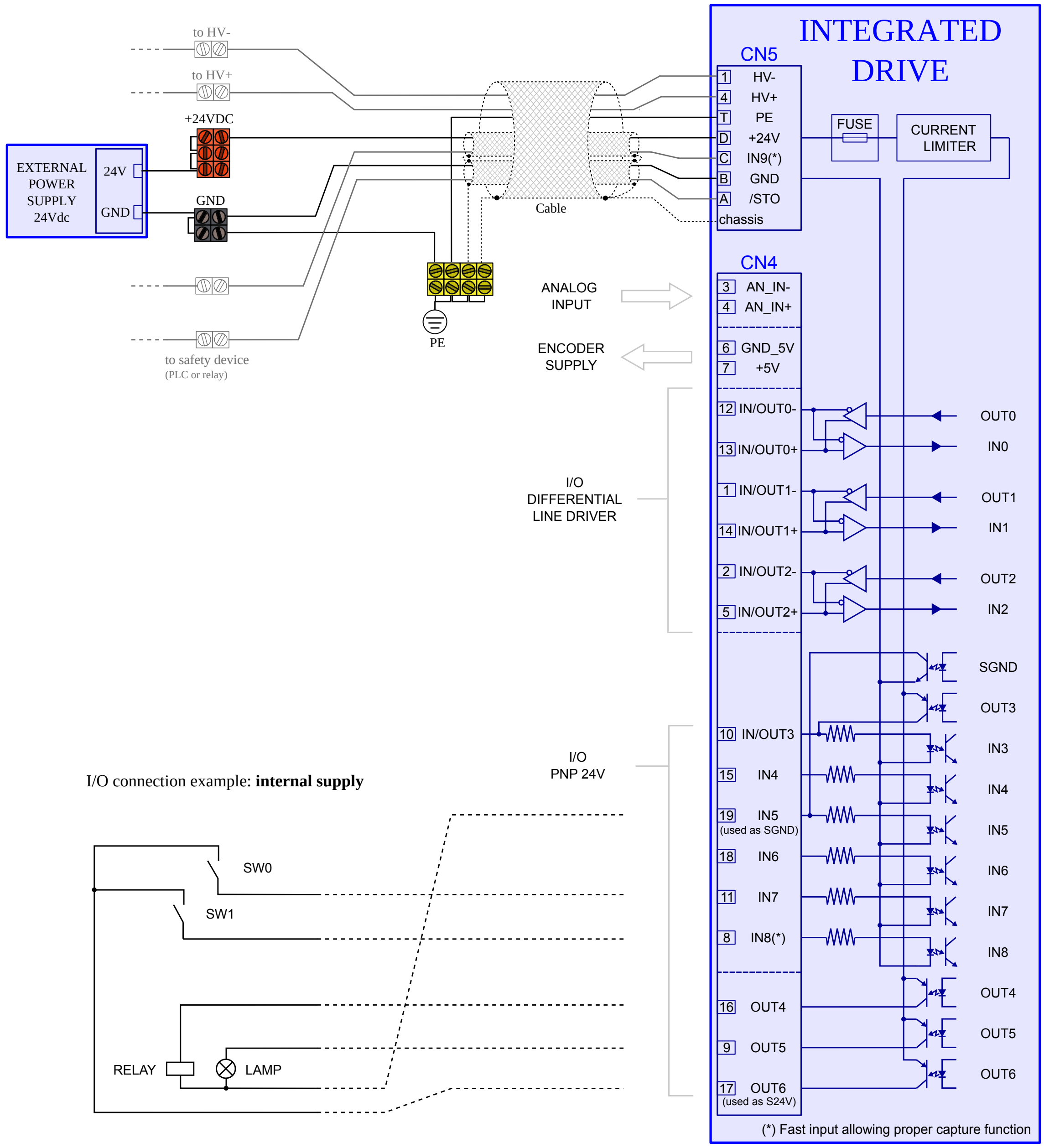


Figure 7.3. Example of inputs and outputs wiring with internal supply.

The current limits of the pins that have been used as SGND ("SIMULATED GROUND") and S24V ("SIMULATED 24V") are reported on the *Table 15.5*. On the S24V configured pins a protection for the overcurrent or short circuit 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' is necessary to connect the ground externally from the DuetHV, as showed in *Figure 7.2*.

Generic differential IN/OUT

The IN/OUT0, IN/OUT1, IN/OUT2 inputs (line-driver differentials), can be even used as normal digital inputs (generic input functionality) The voltage levels are not 24V as for the

PNP inputs, but they are referred to the line-drive specific levels that are described in the *Table 15.3*.

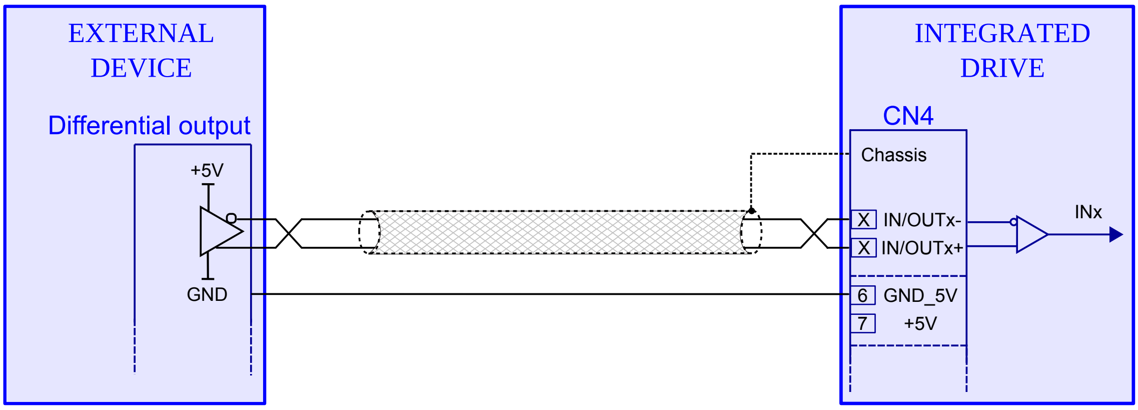


Figure 7.4. Example of IN/OUT wiring with generic input functionality.

Warning

The differential IN/OUT, even if used with generic input functionality, are differential line-drive type. Do not connect signals with 24V levels! Please refer to the electrical features described in the *Table 15.3*.

Auxiliary Encoder Input (differential IN/OUTs)

The IN/OUT0, IN/OUT1, IN/OUT2 inputs (line-driver differentials), as well as with generic input functionality, can be used as incremental encoder inputs (phase A and phase B): to select the functionality please refer to *Chapter 15, Digital inputs and outputs*. 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 *Index* 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 DuetHV is available a 5V voltage (see pin 8 in the *CN4 pin*). In case the encoder is externally powered, or a simulated encoder is used, in addition to the differential signals (phase A, phase B and eventually the *Index*) the encoder ground must be connected to the GND_5V signal of the DuetHV (pin 6 of *CN4*).

For the external encoder connection on *CN4* please refer to the *Figure 7.5* in which are showed both the wirings when the supply is provided by the DuetHV and when the supply is external.

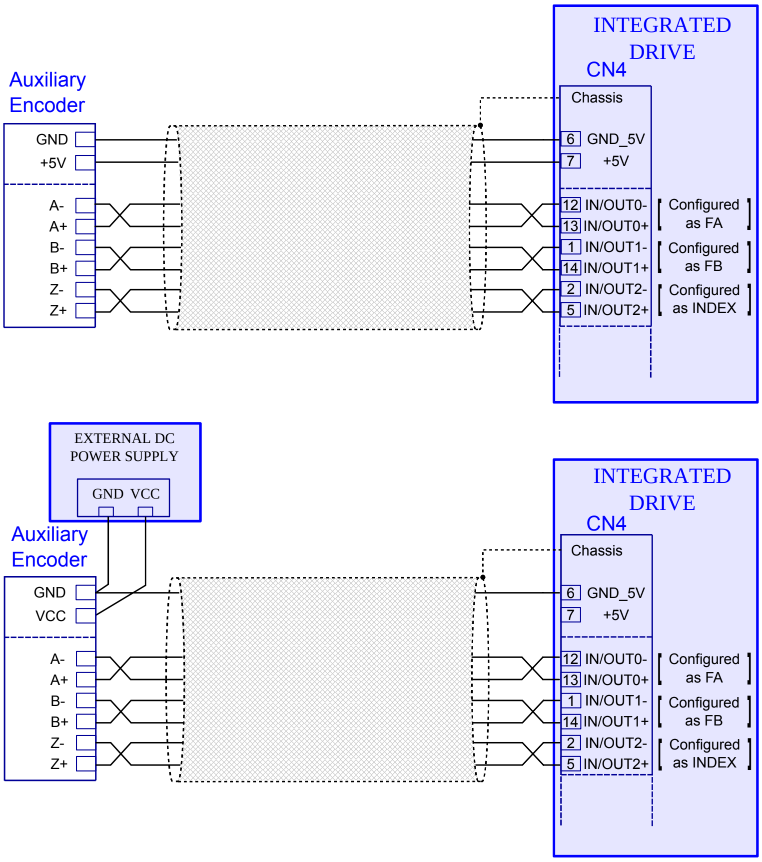


Figure 7.5. Auxiliary encoder to differential IN/OUT wiring example.

Note

In this figure only the wires related to the connection with an auxiliary encoder are showed. For informations about the cable see *Table 7.4*.

Warning

The encoder outputs must be differential line-driver, compatibles with the *Table 15.3* described characteristcs. Do not connect signals with 24V levels!

Tip

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 twisted pair plus overall cable shield). It's suggested to connect the shield to the ground (connector chassis) only on the DuetHV 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 part has the minimum possible length.

DuetHV Analog Input

The drive has a differential analog input (*CN4* connector: pin 3 and 4) to which different functionalities can be associated (see *Section 16.3, Conversion* and *Section 21.17, Profile Velocity AI Mode*).

Tip

For the analog input configuration please see the *Chapter 16, Analog input*.
For the analog input electric characteristics see the *Table 16.2*.

Warning

The maximum common-mode voltage of the differential analog input must not exceed the value that is reported in *Table 16.2*. For that reason it's reccomended to refer the analog device supply ground to the GND_5V signal [pin 6 of *CN4*], as reported in the *Figure 7.6* connection diagram.

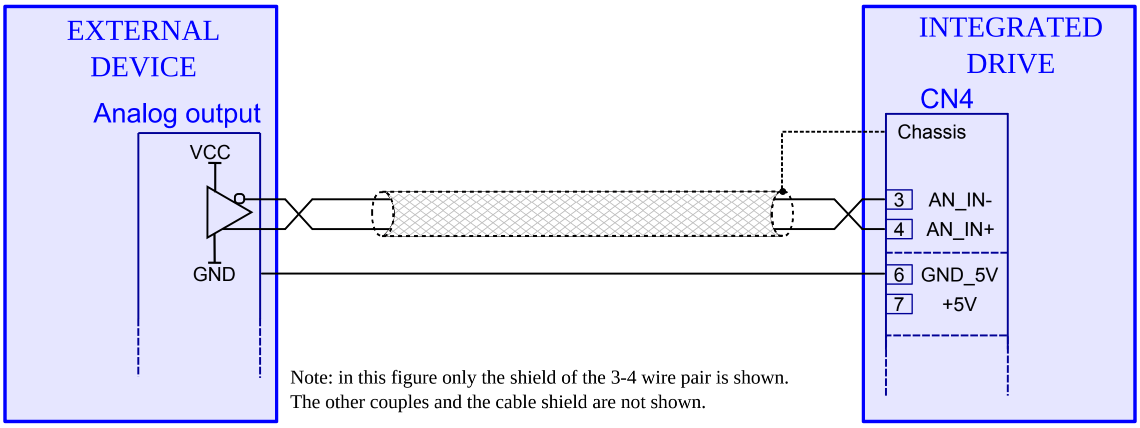


Figure 7.6. Analog input wiring example (on *CN4*).

Note

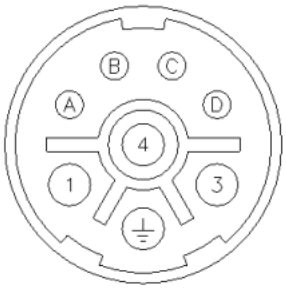
In this figure only one pair of twisted wires is showed, related to the pins 3 and 4. For informations about the cable see *Table 7.4*.

Tip

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 twisted pair plus overall cable shield). It's suggested to connect the shield to the ground (connector chassis) only on the DuetHV 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 part has the minimum possible length.

CN5 DC Power and Control supply, /STO, IN9

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



Male, Hummel

PIN	Signal	Description
1	HV -	DC Power supply (negative pole)
⏚	PE	Protection Earth
3	-	Not connected
4	HV +	DC Power supply (positive pole)
A	/STO	Safe Torque Off Input (this is an active-low logic signal)
B	GND	Ground Control supply
C	IN9	Digital Input 9
D	+24 V	+24Vdc Control supply
Chassis	PE	Protection Earth

/STO input connection examples

The external connection of the /STO input must be protected and this can be obtained by isolating the connection or by using more simply a shielded connection with the shield connected to PE. Alternatively the /STO input can be driven by an output of a safe PLC with a test pulse duration of 1 ms.

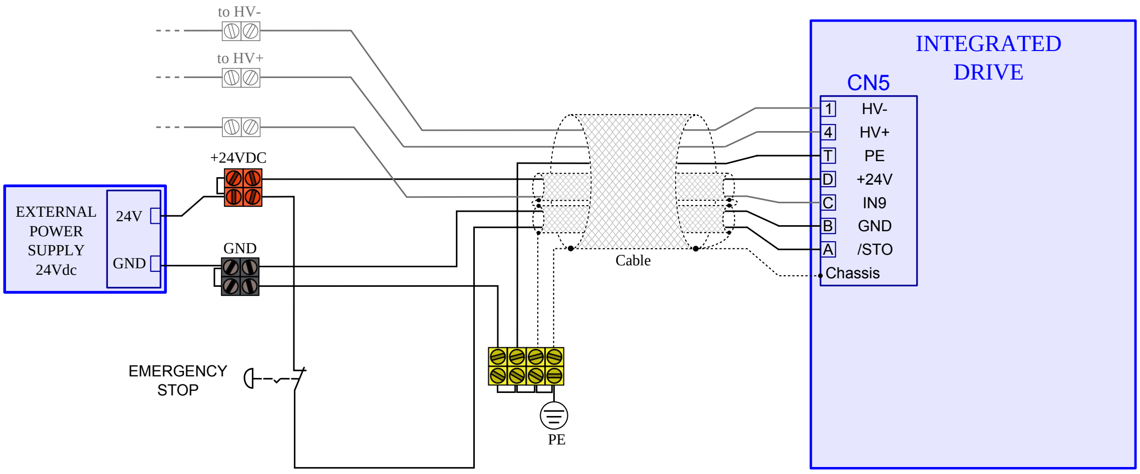


Figure 7.7. Example of connection of the /STO input for stop of category 0 without module fuse relay: stop not controlled.

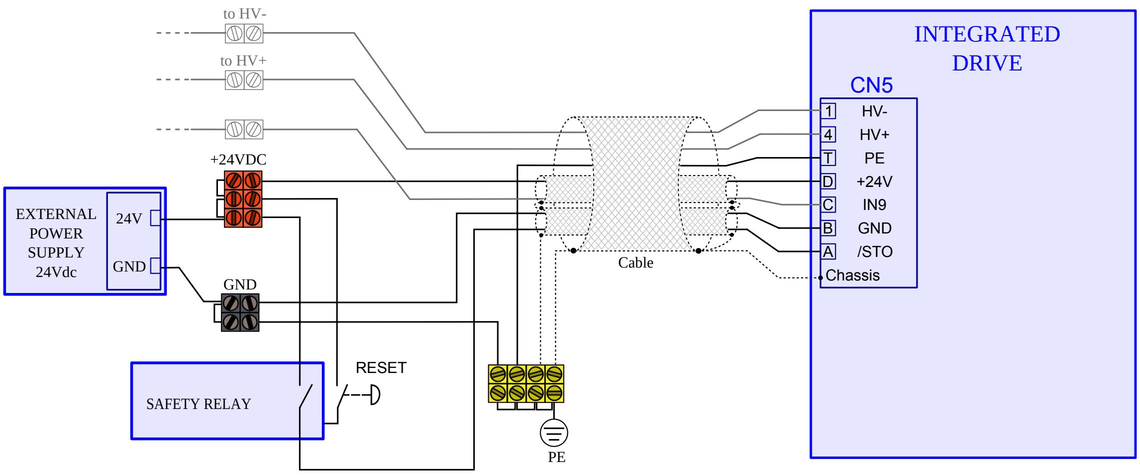


Figure 7.8. Example of connection of the /STO input for stop of category 0 with fuse relay and interlock at the reboot: stop not controlled.

To obtain a stop of category 1 connect the /STO input 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*. After having programmed a delay on the fuse relay, the voltage on the input /STO is cut off and the power section is deactivated. The programmed delay must be enough to stop the motor, otherwise the final part of the motion becomes uncontrolled.

> **Important**
>
> 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.

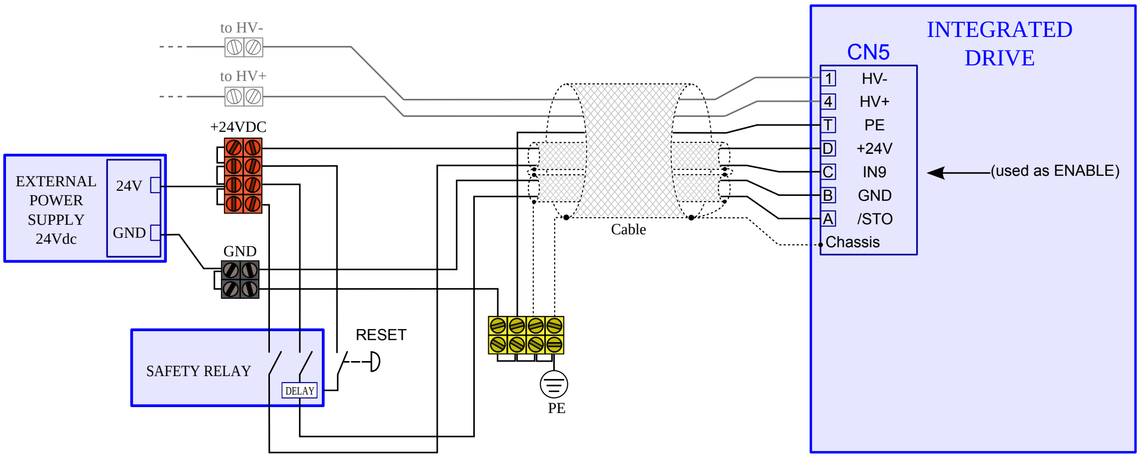


Figure 7.9. Example of connection of the /STO input for stop of category 1 with fuse relay and interlock at the reboot. The functionality of *Enable* is associated to the input N9.

7.2.4. DuetHV flange 60 drive connectors

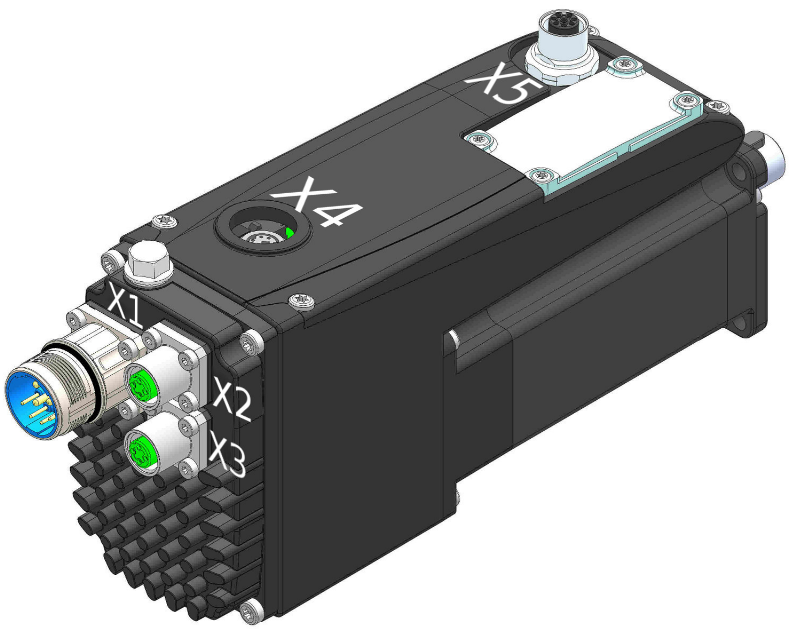


Figure 7.10. Connectors arrangement: flange rear view 60mm.

***X1(F60)* DC Power and Control supply, /STO input (2 channels)**

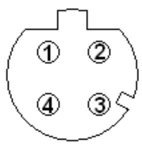
Connector for the supply of the power section and of the control section, digital inputs of the two channels /STO1 and /STO2, M23 male, 8 poles (4 + 3 + PE), Hummel.

Male, Hummel

PIN	Signal	Description
1	HV-	DC Power supply (negative pole)
⏚	PE	Protection Earth
3	-	Not connected
4	HV+	DC Power supply (positive pole)
A	/STO1	Safe Torque Off Input, Channel 1 (the signal logic is reversed)
B	GND	Ground Control supply
C	/STO2	Safe Torque Off Input, Channel 2 (the signal logic is reversed)
D	CV	Control Voltage (24 Vdc)
Chassis	PE	Protection Earth

X2 e X3 (F60) Main bus (ETC)

Connectors for the main bus with EtherCAT protocol, M12 female, 4 poles, D-code, output and input respectively on *X2 e X3 (F60)*.



Female, D - code

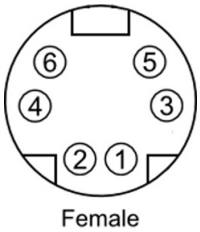
PIN	Signal	Description
1	TX Data+	Transmit Data +
2	RX Data+	Receive Data +
3	TX Data-	Transmit Data -
4	RX Data-	Receive Data -
Chassis	PE	Protection Earth

X4 (F60) Auxiliary bus (RS232 Serial port)

Connector for the auxiliary bus with Modbus protocol on RS232, Minidin female, 6 poles (this serial port is insulated).

Important

Make the serial cable connection when the drive is not powered. The cable shield must be connected to the ground both on the host (PC) side and on the Mini-din connector chassis on the drive side.



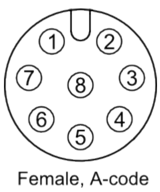
PIN	Signal	Description
1	NC	Reserved, not connected
2	TX232	Transmit Data RS232
3	GND_COM	Ground RS232
4	-	Reserved, don't use
5	NC	Reserved, not connected
6	RX232	Receive Data RS232
Chassis	GND_COM	Ground RS232

X5 (F60) Input/Output

Connector for the digital inputs and outputs, M12 female, 8 poles, A-code.

Note

The PNP digital inputs (24V) have the common ground internally connected to the system on the GND signal, that is the control section supply ground present on *X1(F60)*-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/OUT0	Digital Input/Output 0
2	IN1	Digital Input 1
3	IN2	Digital Input 2
4	IN3	Digital Input 3

PIN	Signal	Description
5	NC	Reserved, not connected
6	OUT1	Digital Output 1
7	GND	Ground of +24V
8	OUT2	Digital Output 2
Chassis	PE	Protection Earth

Example of PNP 24V inputs and outputs wiring

On the DuetHV flange 60 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 DuetHV flange 60 system control supply is referred (pin B of *X1(F60)*, 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. The DuetHV flange 60 system outputs are internally powered by the 24V obtained from the control section (pin D of *X1(F60)*). On this voltage there is a current limiter that is a protection in case of overload or short-circuit on the outputs themselves (see *Table 15.11*). The ground of the loads that are connected to the outputs must be the same one of which the DuetHV flange 60 system control supply is referred to (pin B of *X1(F60)*, 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 connections that are external to the DuetHV flange 60.

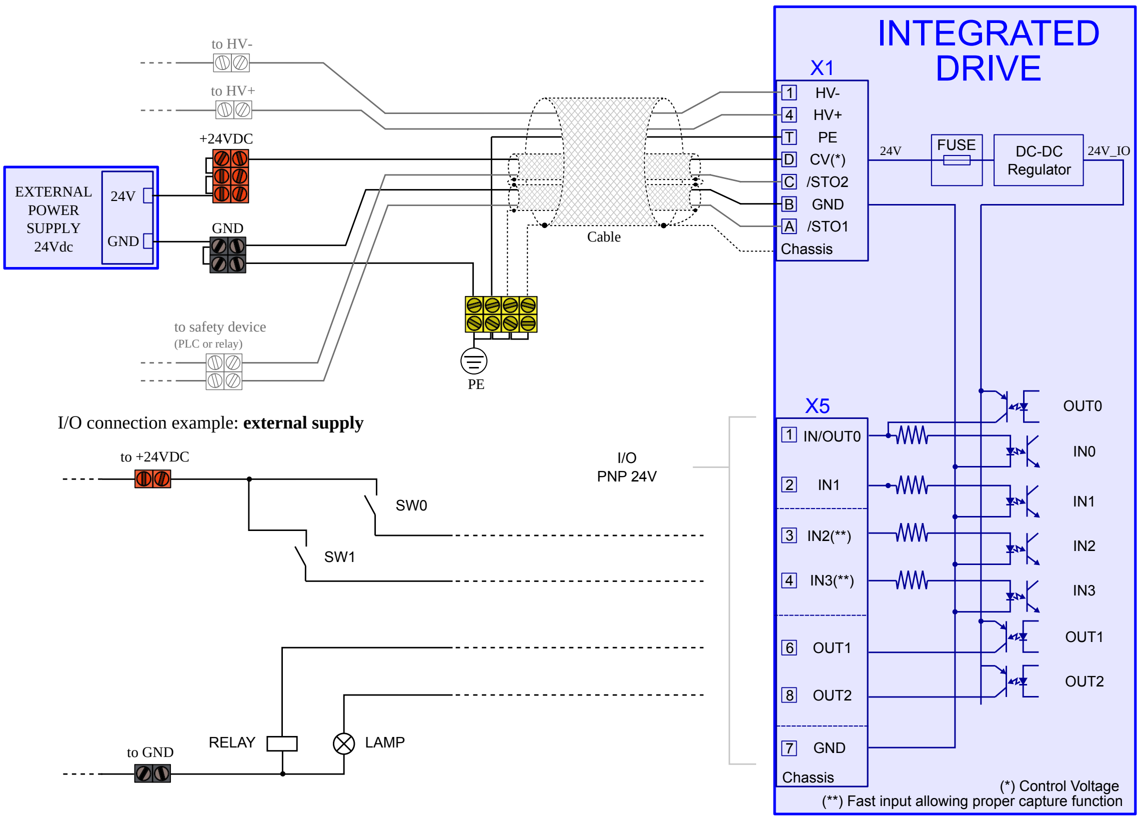


Figure 7.11. Example of inputs and outputs wiring with external supply.

> **Important**
>
> Absolutely avoid to place the I/O signals cables 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 circular connector. On the controller/PLC side follow the constructor instructions about the shield connection.

7.2.5. Cables for DuetHV

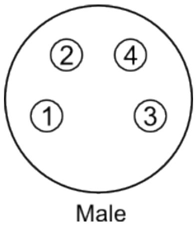
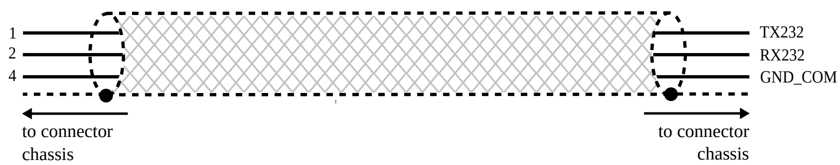
Connector	Cable
 Flying connector on DuetHV side, connection view	DuetHV side host side 
Example: *Productor*: Binder *Connector:* 9933630004	• Overall shielding • 3 or 4 wires • maximum total length 5m

Table 7.1. Specifications for the RS232 serial cable (*CN1*).

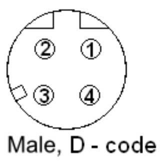
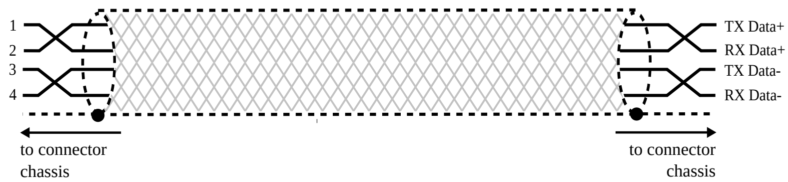
Connector	Cable	
 Flying connector on DuetHV side, connection view	DuetHV side Master side 	ETC
Example: *Connector:* M12, D-code (ETC)	• Overall shielding (mixed: film and braid) • 2 twisted pairs • maximum total length: 100m (ETC) • Conductive material: tinned copper Added requirements for the CAN cable	

Table 7.2. Specifications for the Main bus cable for the DuetHV - Master connection (*CN2, CN3*)

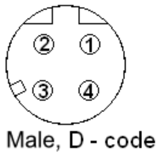
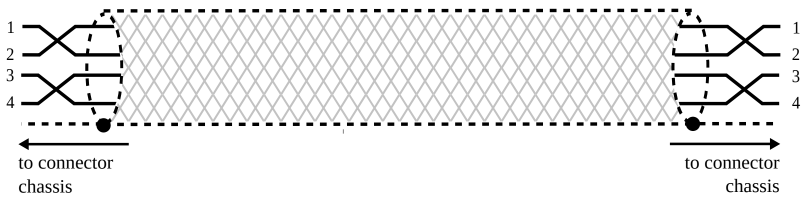
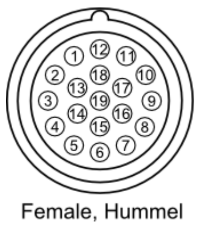
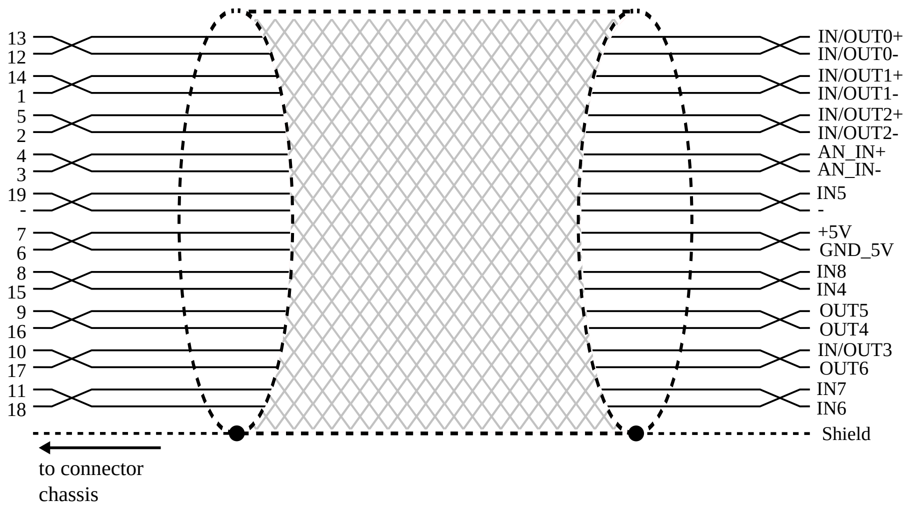
Connector	Cable	
 Flying connector on both sides, connection view	DuetHV side DuetHV side 	ETC
Example: *Connector:* M12, D-code (ETC)	• Overall shielding (mixed: film and braid) • 2 twisted pairs • maximum total length: 100m (ETC) • Conductive material: tinned copper Added requirements for the CAN cable	

Table 7.3. Specifications for the Main bus cable for the DuetHV - DuetHV (for CAN version *CN2, CN3*)

Connector	Cable
 Flying connector on DuetHV side, connection view	DuetHV side Command devices or actuators side 
Example: *Productor*: Hummel *Connector:* 7.106.500.000 *Insert*: 7.003.919.102 *Contacts*: (3x, pin 12, 19, 6) 7.010.901.512; (16x) 7.010.901.012	• Overall shielding • 10 twisted pairs (as an alternative 11 wires + 4 twisted pairs[a]) • maximum total length 30m

[a]The wires pairs that must be twisted are the ones that correspond to the differential IN/OUT and to the analog input.

Table 7.4. Specifications for the Input / Output cable (*CN4*).

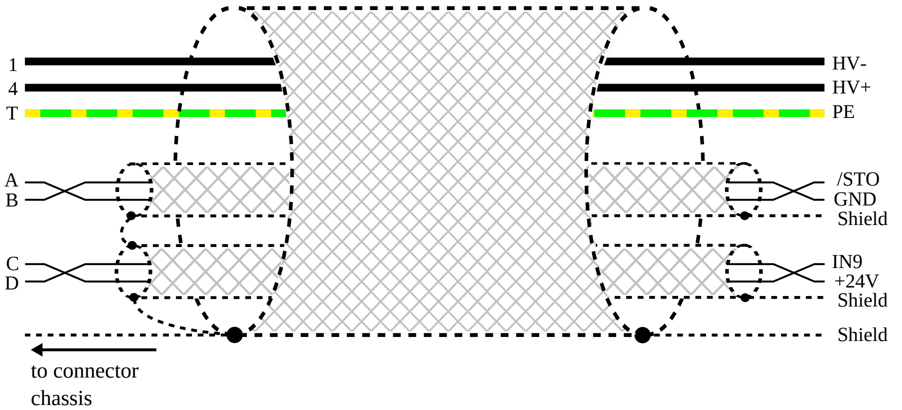
Connector	Cable
 Flying connector on DuetHV side, connection view	DuetHV side supplier side 
Example: *Productor*: Hummel *Connector:* 7.106.500.000 *Insert*: 7.084.943.102 *Contacts*: (3x, pin 1, 4, T) 7.010.942.002, (4x) 7.010.941.002	• Overall shielding • 2 wires + PE + 2 shielded and twisted pairs • low capacity (example: UNIKA UNIDRALL 5005 cod. 3J049) • maximum total length 30m

Table 7.5. Specifications for the DC bus, control, /STO and IN9 cable (*CN5*)

7.2.6. Cables for DuetHV flange 60mm

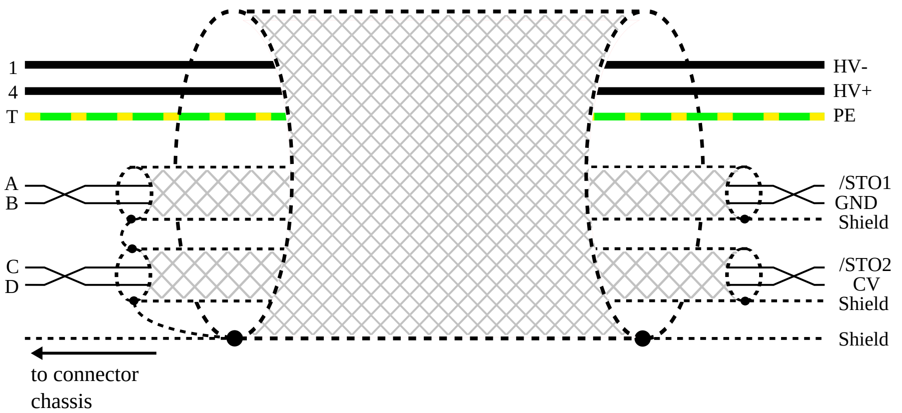
Connector	Cable
 Flying connector on DuetHV flange 60 side, connection view	DuetHV flange 60 side Master side 
Example: *Productor*: Hummel *Connector:* 7.106.500.000 *Insert*: 7.084.943.102 *Contacts*: (3x, pin 1, 4, T) 7.010.942.002, (4x) 7.010.941.002	• Overall shielding • 2 wires + PE + 2 shielded and twisted pairs • low capacity (example: Molino Movinflex 4G25-2RC/PUR or UNIKA UNI-DRALL 5005 cod. 3J049) • maximum total length 30m

Table 7.6. Specifications for the DC bus, control and /STO input (2 channels) cable through*X1(F60)*

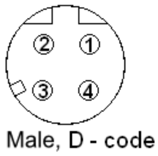
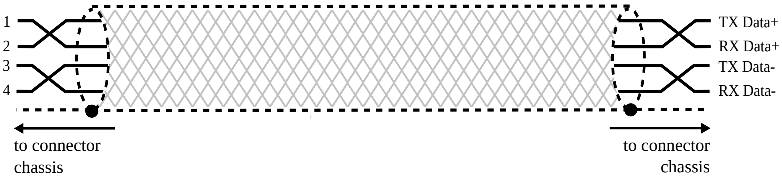
Connector	Cable	
 Flying connector on DuetHV flange 60 side, connection view	DuetHV flange 60 side Master side 	ETC
Example: *Connector:* M12, D-code (ETC)	• Overall shielding (mixed: film and braid) • 2 twisted pairs • maximum total length: 100m (ETC) • Conductive material: tinned copper Added requirements for the CAN cable	

Table 7.7. Specifications for the Main bus cable for the DuetHV flange 60 - Master connection (*X2 e X3 (F60)*)

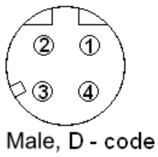
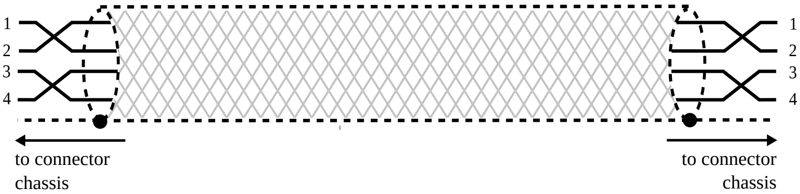
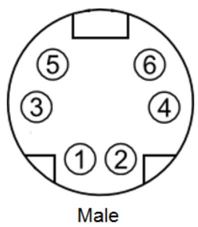
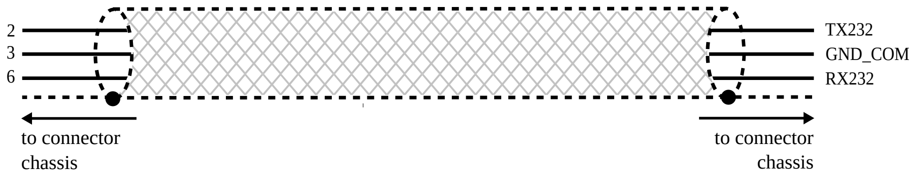
Connector	Cable	
 Flying connector on both sides, connection view	DuetHV flange 60 side DuetHV flange 60 side 	ETC
Example: *Connector:* M12, D-code (ETC)	• Overall shielding (mixed: film and braid) • 2 twisted pairs • maximum total length: 100m (ETC) • Conductive material: tinned copper	

Table 7.8. Specifications for the Main bus cable for the DuetHV flange 60 - DuetHV flange 60 (*X2 e X3 (F60)*)

Connector	Cable
 Flying connector on DuetHV flange 60 side, connection view	DuetHV flange 60 side host side 
Example: *Productor*: Binder	• Overall shielding • 3 wires

Connector	Cable
Connector: 9933630004	• maximum total length 5m

Table 7.9. Specifications for the RS232 serial cable (*X4 (F60)*).

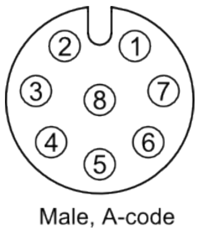
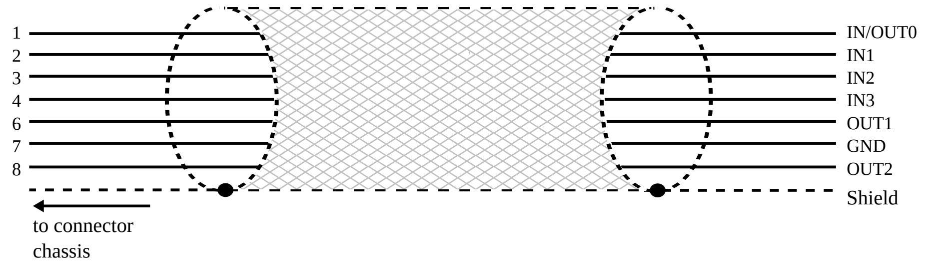
Connector	Cable
 Flying connector on DuetHV flange 60 side, connection view	DuetHV flange 60 side Command devices or actuators side 
Example: *Productor*: CONEC *Connector:* 43-00128	• Overall shielding • 7 wires • maximum total length 30m

Table 7.10. Specifications for the Input / Output cable (*X5 (F60)*).

7.3. Leds

The leds can have the following statuses:

- *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 the leds, can be found in the link in the following table:

> **Important**
>
> In the boot and firmware start-up phases of the description of the six leds L1-L6 is not the one indicated below. Refer to *Chapter 25, Software updating*.

Leds	Description	Link
L1, L2	Drive status (Fault, Warning, enabling)	*Table 8.5*
L3, L5	Reserved (led off)	-
L4	Limitation status I2T	*Table 13.2*

Leds	Description	Link
L6	STO logic status	DuetHV (except for DuetHV flange 60): *Led 6 diagnostics*
L/A 0	Status of the Physical link/activity of the EtherCAT port on the CN3 connector, except for the DuetHV flange 60, for which the connector is X3.	*Table 8.1*
L/A 1	Status of the Physical link/activity of the EtherCAT port on the CN2 connector, except for the DuetHV flange 60, for which the connector is X2.	
ERR	EtherCAT error led (ERR)	*Table 8.2*
RUN	EtherCAT run led (RUN)	*Table 8.3*

Table 7.11. Leds description.

7.3.1. Leds arrangement on the DuetHV drive except for DuetHV flange 60

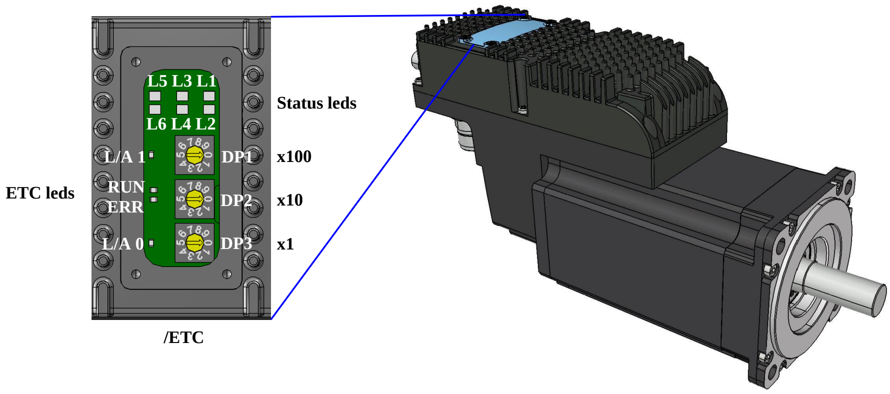


Figure 7.12. Leds and dip switches arrangement in the transparent window of the DuetHV (except for DuetHV flange 60).

7.3.2. Leds arrangement in the DuetHV flange 60

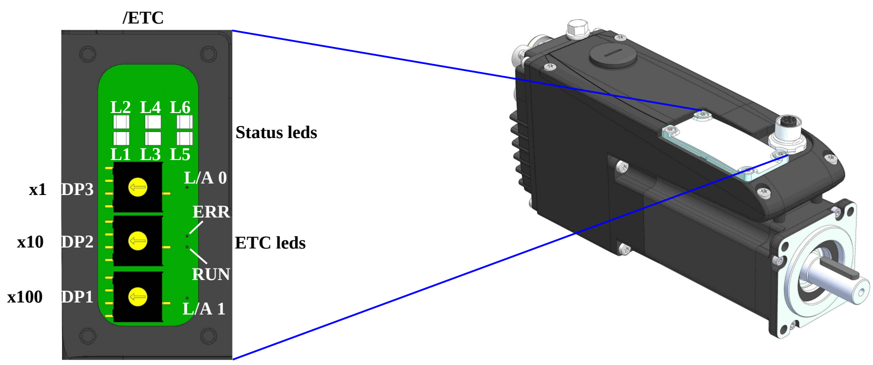


Figure 7.13. Leds and dip switches arrangement in the transparent window of the DuetHV flange 60.

7.4. Dip switches

7.4.1. Dip switches arrangement in the DuetHV (except for DuetHV flange 60)

The dip switches arrangement for the DuetHV drives is shown in *Figure 7.12* (except for DuetHV flange 60, for which the reference figure is *Figure 7.13*). The parameters defined by the dip switches can be found in the following charts.

Dip sw	Description	Link
DP1	EtherCAT user address (station alias) x100	*Configured station alias*
DP2	EtherCAT user address (station alias) x10	
DP3	EtherCAT user address (station alias) x1	

Table 7.12. Description of the dip switches for DuetHV/ETC drives (except for DuetHV flange 60).

7.4.2. Arrangement and characteristics of the dip-switches of the DuetHV flange 60.

The dip switches arrangement for the DuetHV flange 60 drives is shown in *Figure 7.13*. The parameters defined by the dip switches can be found in the following table.

Dip sw	Description	Link
DP1	EtherCAT user address (station alias) x100	*Configured station alias*
DP2	EtherCAT user address (station alias) x10	
DP3	EtherCAT user address (station alias) x1	

Table 7.13. Description of the dip switches for DuetHV/ETC flange 60 drives.

Chapter 8

Communicating with the drive

Caution

Connect and disconnect the communication connectors only when the drive is switched off. Check if the drive, the Master, the PC, all the devices and the Ground Control Supply pin of *CN5* except for the DuetHV flange 60, of *X1(F60)* for DuetHV flange 60, are correctly connected to the protection conductor.

8.1. Communicate with EtherCAT Master

Note

The information in this paragraph are valid only for the drive version ETC. The details on the protocol implementation are described in *Chapter 9, Communication port EtherCAT*.

Connect the cables of the EtherCAT network to *CN2*, *CN3* for the DuetHV except for the DuetHV flange 60, for which they have to be connected to *X2 e X3 (F60)*. Connect the output cable on the first connector and the input cable on the second one. For further information see *Section 7.2, Electrical connections*.

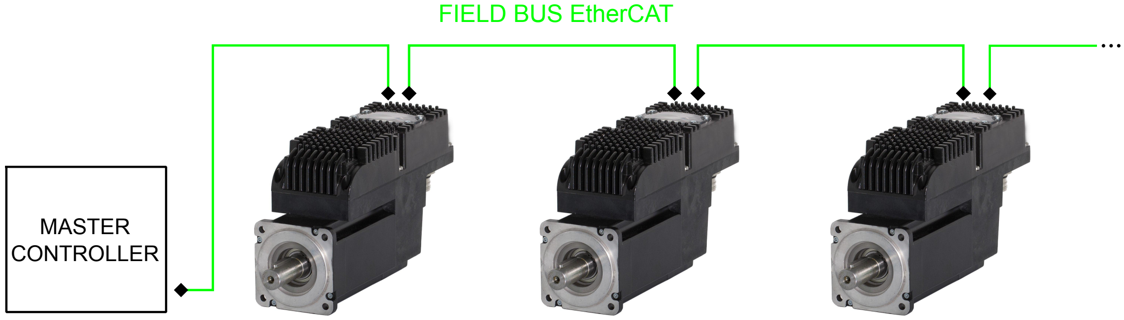


Figure 8.1. Communication scheme with EtherCAT Master.

Configure the communication port EtherCAT, 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 (Position Address)*: this method is generally used by the Masters for the automatic detection of the drives in the EtherCAT network; the Master gives to every node an address which is coherent with the physical position owned by the drive in the network;

- *Fixed (Node Address)*: For the fixed addressing it's necessary that the Master writes in the "Configured Station Address" register (address 0x0010-0x0011 of the *ET1100* memory) the address with which it wants to identify, in univocal way, the drive. This address can be set before (according to an own algorithm in the Master) or can be read from the "Configured Station Alias" register (address 0x0012-0x0013 of the *ET1100* memory).
  The "Configured Station Alias" register has the following behaviour:
  - it takes the value of the rotative dip-switches (DP1, DP2 e DP3) if their total value is different from 0
  - it takes the value that's contained in the word address 0x0004 of the ESI eeprom if the rotative dip-switches total value is 0.

  node number = DP3 + DP2 x 10 + DP1 x 100 (refer to *Figure 7.12* and to *Section 7.4, Dip switches*).

Note

Every time the dip-switches and/or the "Configured Station Alias" value is changed, it's necessary to reset the drive (or to execute a turn-off/turn onsequence).

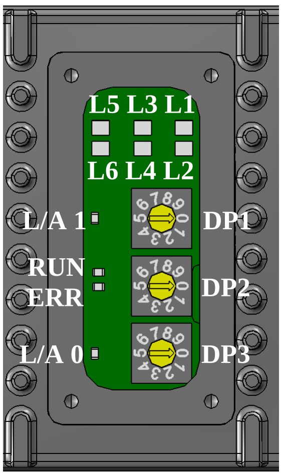


Figure 8.2. Leds and dip switches arrangement

Status of the leds *L/A 0*, *L/A 1*, *ERR* e*RUN*

Interpretation of the leds status:

*L/A 0*and *L/A 1*: link status and possible ongoing activity in the *CN2, CN3* physical ports , except for the DuetHV flange 60 drives for which the physical ports are *X2 e X3 (F60).*; L/A 0 takes the status of the accessible input port from the second connector, L/A 1 takes the status of the accessible output port from the first connector; the encoding of the two leds is taken to *Table 8.1*;
ERR: error status found by the port EtherCAT; the encoding is taken to *Table 8.2*;
RUN: status of the *EtherCAT state machine*; the encoding is taken to *Table 8.3*.

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

Table 8.1. Encoding of the leds status *L/A 0* and *L/A 1*.

Errors of the port EtherCAT	Description	ERR
No error	The port EtherCAT is working correctly.	OFF
Configuration not valid	Wrong settings of the EtherCAT communication port: the change of the state of the *EtherCAT state machine* requested by the Master is not possible.	BLK
Change of status not requested	The drive has automatically changed the state 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 Motor Power Company Srl	ON

Table 8.2. Encoding of the leds status *ERR*.

Status of the*EtherCAT state machine*	RUN
INIT	OFF
PRE-OPERATIONAL	BLK
SAFE-OPERATIONAL	1 FL
OPERATIONAL	ON
BOOTSTRAP	FLK

Table 8.3. Encoding of the leds status *RUN*.

8.1.1. File access over EtherCAT (FoE) protocol

The FoE protocol is implemented in the drive, but its use is limited only to update the firmware.

8.2. Communicate with Master Modbus RS232 (auxiliary communication port)

Connect the RS232 serial cable of the Master to *CN1* for the DuetHV except for the DuetHV flange 60, for which it has to be connected to *X4 (F60)*. For further informations see *Section 7.2, Electrical connections*.

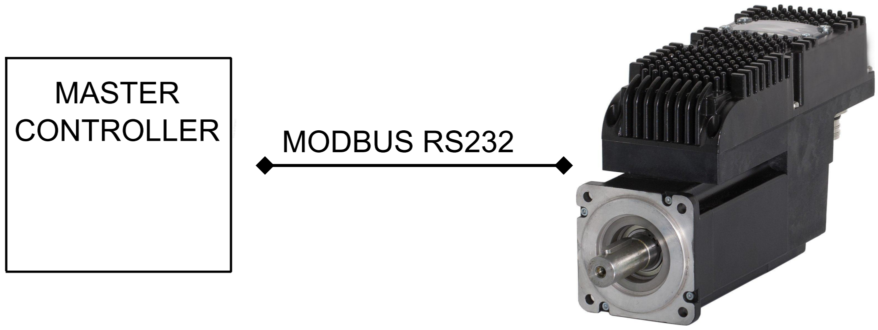


Figure 8.3. Point-to-point communication scheme with Master.

Set the features of the serial as follows:

- Character length: 8 bits
- Type of parity: even
- Number of stop bits: 1 bit.
- Default baud rate: 57600bit/s.

The drive answers on the auxiliary communication port with node-ID equal to 1. The other features of the port are configured with the parameters of the group *AuxiliaryPortSetup*. The details on the protocol implementation are described in *Chapter 10, Auxiliary communication port Modbus*.

> **Note**
>
> To analyse the latest communication error of the protocol Modbus, read the parameters of the group *AuxiliaryPortError*.

8.3. Errors in reading / writing of the 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*;

- main communication port EtherCAT: the error code is contained in the frame **SDO abort**.

SDO abort code	*AuxiliaryPortErrorCode*	Error	Description
0x0	0x00	No error	No error.
-	0x01	Modbus protocol error: illegal function	Code function Modbus not supported. In *Table 10.1* you can see the accepted codes.
-	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 initialization 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	Memory overflow to complete 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	Memory overflow to run the requested 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 incompatibility of the datum.
0x06040047	0x25	General internal incompatibility	General internal incompatibility of the drive.
0x06060000	0x26	Hardware error	Access failed because of a hardware error.
0x06070010	-	Data type does not match	Datum dimension not correct.
0x06090011	0x27	SubIndex not existing	EtherCAT sub-index not existing.
0x06090030	0x28	Parameter out of range	Parameter value out of range accepted.

SDO abort code	*Auxiliary-PortErrorCode*	Error	Description
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.

Table 8.4. Encoding the errors of reading/writing of the parameters.

8.4. CiA402 state machine

The drive of the DuetHV series, follow the *CiA-402* specification. For the drive management, the *CiA-402* specification needs the implementation of a state machine, which scheme can be found in the following picture. The drives of the DuetHV series follow the *CiA-402* specifications.

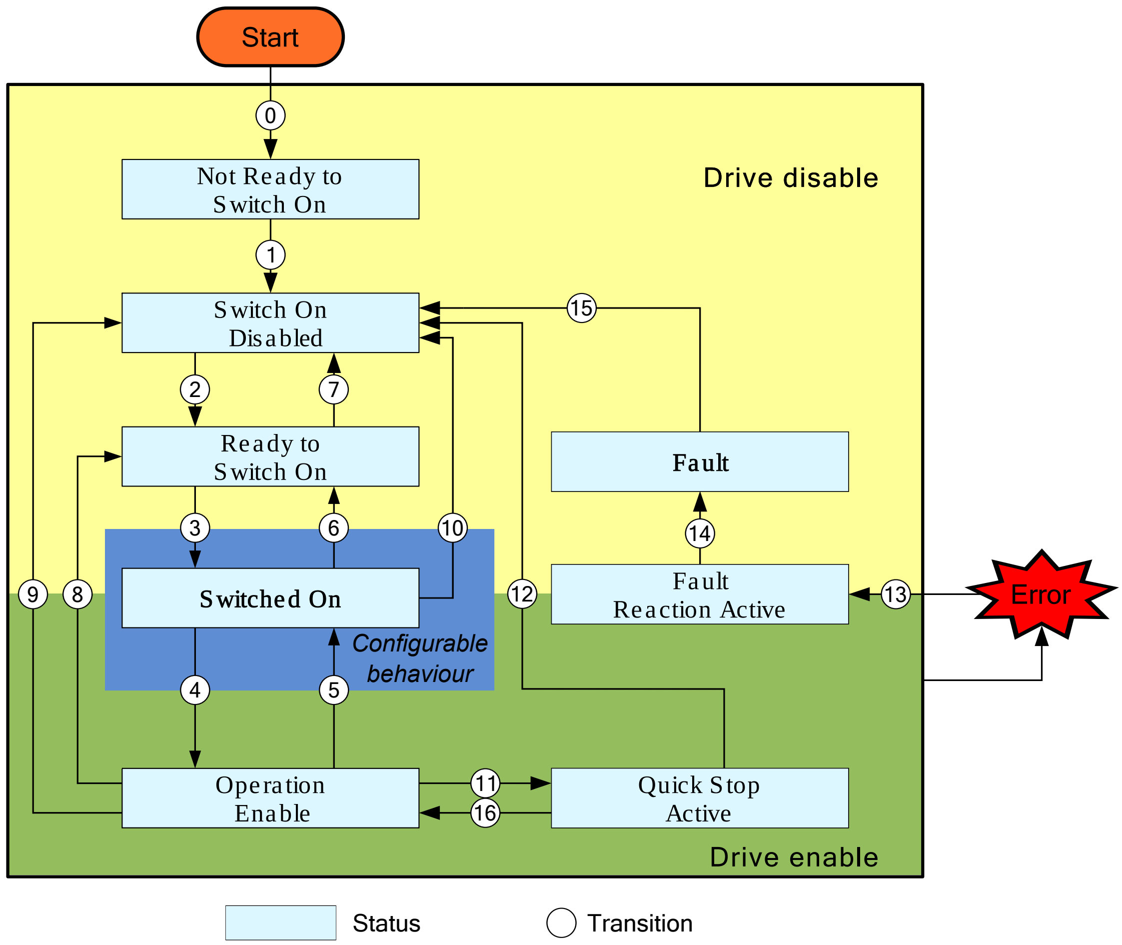
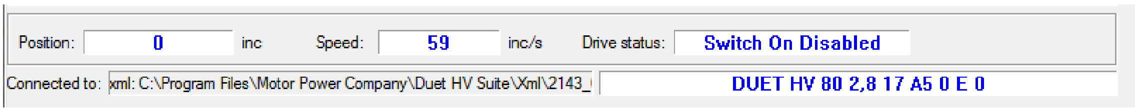


Figure 8.4. CiA402 state machine implemented in the DuetHV drives.

To enable or disable the drive and the motor motion, to stop and reset any error, it's necessary to ask for the right transitions to the CiA402 state machine so that it can reach the desired state. The *Statusword* parameter reports the CiA402 state machine status.



The CiA402 state machine status is partly also shown with the L1 and L2 leds, according to the following chart. The encoding of the errors can be found in *Section 23.2, Monitoring the errors on the status leds*.

> **Important**
>
> In the boot and firmware start up phases of the DuetHV drives, the below description of the leds is no more valid. Refer to the *Chapter 25, Software updating*.

Status of the drive	Led L1 drive DuetHV	Led L2 drive DuetHV
*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 *Table 23.2*)	
There are some errors of Fault type	RED VARIOUS STATUS (see *Table 23.2*)	

Table 8.5. Status of the CiA402 state machine visualized with the L1 and L2 leds.

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

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

<table>
<tr><th>Bit</th><th>Mode</th><th>Name</th><th>Description</th></tr>
<tr><td>0</td><td rowspan="8">All</td><td>Ready to switch on</td><td rowspan="3">Encoding the state of the CiA402 state machine (see).</td></tr>
<tr><td>1</td><td>Switched on</td></tr>
<tr><td>2</td><td>Operation enabled</td></tr>
<tr><td>3</td><td>Fault</td><td>Bit which is set when a retentive Fault is detected (FaultRetentive)</td></tr>
<tr><td>4</td><td>Voltage enabled</td><td>Bit that indicates if the HV supply voltage is applied or not on the drive power section</td></tr>
<tr><td>5</td><td>Quick stop</td><td rowspan="2">Encoding the state of the CiA402 state machine (see).</td></tr>
<tr><td>6</td><td>Switch on disabled</td></tr>
<tr><td>7</td><td>Warning</td><td>Bit which is set when a dynamic Warning is detected (WarnDynamic)</td></tr>
</table>

Bit	Mode	Name	Description
8		Reserved	
9		*Remote*	Bit which is set when the *Controlword* is processable from the CiA402 state machine. If you write the parameter *Controlword* when this bit is equal to 0, the operation does not have any effect.
10	8,9,10	Reserved	
	Others	*Target reached*	Bit which is set when the motor reaches the set-point (see *Position reached target*, *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* has a different value) or when a new procedure is started. For the *Gear Mode* see *Table 21.6*.
11	All	*Internal limit active*	Bit that must be set when at least one position limit is reached, speed or torque (see *Chapter 18, Motion limits*).
12	1	*Set-point acknowledge*	Status of capture / processing of the position set-point (see *Section 21.9, 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 21.20, 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 21.10, Interpolated Position Mode*).
	8	Target Position ignored	Bit which is set when the *TargetPosition* is used (see *Section 21.12, Cyclic Synchronous Position Mode*).
	9	Target Velocity ignored	Bit which is set when the *TargetVelocity* is used (see *Section 21.13, Cyclic Synchronous Velocity Mode*).
	10	Target Torque ignored	Bit which is set when the *TargetTorque* is used (see *Section 21.14, Cyclic Synchronous Torque Mode*).
	Others	Reserved	
13	1, 8, -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 21.20, 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	
14	All	Reserved	
15	All	Reserved	

Table 8.6. Meaning of the bits of the *Statusword*.

To run some operations with the CiA402 state machine, it's necessary to write some commands in the *Controlword* parameter (see the description of the parameter itself in ornder to learn how the command bits are divided).

In order to change the state of the CiA402 state machine, write in the parameter *Controlword* 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	Related link
Shutdown	xxxx xxxx 0xxx x110	2, 6, 8	*Section 21.2, Disabling by using the Master*
Switch On	xxxx xxxx 0xxx 0111	configurable[a]	*Section 21.1, Enabling by using the Master*
Switch On + Enable Operation	xxxx xxxx 0xxx 1111	3 + 4	
Disable Voltage	xxxx xxxx 0xxx xx0x	7, 9, 10, 12	*Section 21.2, Disabling by using the Master*
Disable Operation	xxxx xxxx 0xxx 0111	5	
Enable Operation	xxxx xxxx 0xxx 1111	4, 16	*Section 21.1, Enabling by using the Master*
Quick Stop	xxxx xxxx 0xxx x01x	7, 10	*Section 21.2, Disabling by using the Master*
		11	*Section 21.3, Execute a stop by using the Master*
Fault Reset	xxxx xxxx ↑xxx xxxx	15	*Section 23.5, Resetting the errors*

[a] See*SwitchedOnOptionCode*

Table 8.7. Commands for the state transitions of the CiA402 state machine.

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*; some of them have a different meaning depending on the value of *ModesOfOperationDisplay*: the column Mode shows the value that the parameter *ModesOfOperationDisplay* 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 state transitions of the CiA402 state machine (see *Table 8.7*).
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 21.9, Profile Position Mode*).
	6	*Homing operation start*	Bit enabling the start/stop of the homing procedure (see *Section 21.20, Homing Mode*).

Bit	Mode	Name	Description
	7	*Enable ip mode*	Bit used for the enabling/disabling of the *Interpolated Position Mode* (see *Section 21.10, 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 21.9, 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 21.9, Profile Position Mode*).
	Others	Reserved	
7	All	*Fault reset*	Bit used to encode the commands of the state transitions of the CiA402 state machine (see *Table 8.7*).
8		*Halt*	Bit used to run a stop of the motor (*Halt*, see *Section 21.3, Execute a stop by using the Master*).
9 - 12		Reserved	
13	-126	*Start gear ratio disable*	Bit used to define the starting following ratio of the adjustment ramp (see *Table 21.7*).
14		*Reset trigger*	Bit used to set the adjustment ramp starting (see *Table 21.7*).
15		*Start gear*	Bit used to start the movement in *Gear Mode* (see *Table 21.7*).

Table 8.8. Meaning of the bits of the *Controlword*.

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

> **Important**
>
> During the access in writing to the *Controlword* no bits changes are accepted during a state transition of the CiA402 state machine. This condition is reported by the *Remote* bit of the *Statusword* (see *Table 8.6*.

8.5. System manager

To run some operations or commands different from those offered by the *CiA-402* it is necessary to use the System manager. To run a command you must respect the following rules:

1. write the code of the desired command of the parameter *SysMngCommand*;
   - if during the writing of the parameter *SysMngCommand* 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* 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*
- if during the writing of the parameter *SysMngCommand* you get the error code *No error*, the command is accepted and immediately run

2. wait for the end of the command, that is when the parameter *SysMngCommand* is equal to 0
3. check if the command was correctly run by reading the possible cause of the error in the parameter*SysMngError*
4. when a command is running (parameter *SysMngCommand* different from 0), the drive cannot be taken to the status*Operation enable*
5. when an axis motion command is active it's not possible to write in the *ModesOfOperation* parameter, and the *ModesOfOperationDisplay* parameter assumes the value -127 (*Tuning Mode*).

System manager safety conditions

The following safety conditions are needed to run some commands:

1. disabled drive
2. 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
3. digital outputs and digital I/O (bidirectional peripheral) programmed as outputs, switched off
4. 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* before writing the command. The safety conditions are forced *solo* only for those commands of the System manager requesting it.

> **Caution**
>
> You can force the commands only after having seen the *System manager safety conditions*.

SysMngCommand	Description
2200	Permanent memory: restore to default of all parameters (permanent)
2201	Reset to default of all parameters (temporary)
2250	Permanent memory: delete motor and sensor data
2300	Permanent memory: reload value of all parameters
5000	Hard firmware reset

SysMngCommand	Description
5001	Soft firmware reset
5100	Request download firmware
6000	Downloading parameters file

Table 8.9. Commands of the System manager requesting the *System manager safety conditions*.

> **Note**
>
> The safety conditions can be set manually. In these cases it is not necessary to force the commands.

Reset of the Watchdog of the System manager

Some System manager commands need a cyclic writing in the *ResetWatchdogTimeout* 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* assumes the value 1001. The commands which need the writing of *ResetWatchdogTimeout* are listed in the *Table 8.10*. In the *ResetWatchdogTimeout* parameter it has to be written the value of *SysMngCommand* 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

Table 8.10. System manager commands that require the watchdog reset.

Chapter 9
Communication port EtherCAT

> **Note**
>
> About the communication settings with a EtherCAT Master, please refer to *Section 8.1, Communicate with EtherCAT Master*.

> **Note**
>
> All information in this chapter are valid for the drives of version ETC.

The communication port EtherCAT is the interface of the main bus for the drives of version ETC. The main bus must be connected to the *CN2, CN3* connectors for the DuetHV except for the flange 60, for which ti must be connected to *X2 e X3 (F60)*. The implemented EtherCAT protocol meets the specifications of the *EtherCAT Technology Group (ETG)*. In the drives of the DuetHV series, the interface towards the EtherCAT network is constituted by the ASIC *ET1100*. To communicate with the drive, refer to the data sheet of the *ET1100*.

EtherCAT state machine

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

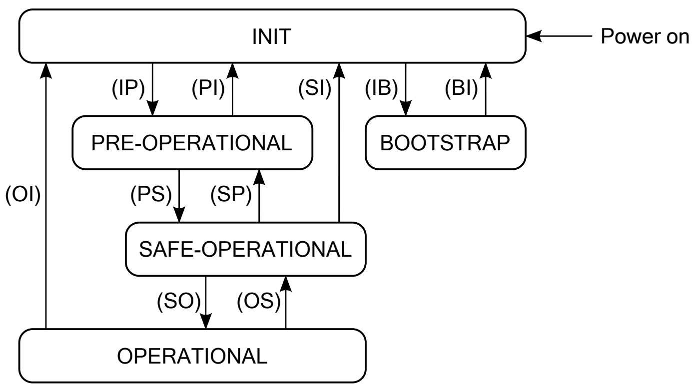


Figure 9.1. Status diagram of the EtherCAT state machine.

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 state and remains in such state waiting for the commands coming from the Master. The led *RUN* shows the state of the EtherCAT state machine, according to what is reported in *Table 8.3*.

State	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*	-	-

Table 9.1. Available services in the states of the EtherCAT state machine.

> **Note**
>
> In the data sheet of the *ET1100* you can find the available registers used to monitor the status of the communication in all its aspects.

Sync manager (SM)

The management of the messages of the communication port EtherCAT 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 drives of the series DuetHV.

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

Table 9.2. Features of the managed *Sync manager (SM)*.

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 26.22, Sync manager and PDOs managed by the port EtherCAT*.

> **Note**
>
> The following paragraphs describe how the functionalities for the communication port EtherCAT have been implemented in the drives DuetHV.

9.1. Protocol CANopen over EtherCAT (CoE)

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

The CoE provides the Service data object (SDO) to exchange data with confirmation. The SDOs are used to access all parameters of the vocabulary (*Chapter 26, Parameters vocabulary*). Their messages have the same dimension as the whole mailbox of the protocol CoE (see *Table 9.2*). The drives of the series DuetHV 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 appropriate to configure the drive and the PDOs (see *Section 9.3, Process data object (PDO)*), and in general for the low priority communication between the drive and the Master.

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

9.2. Emergency Error Code

In the drive ETC the emergency management is not implemented. Through the *ErrorCode* parameter the code of the last error is reported. The code contains all the informations that are useful to indentify the error type, and is composed by 8 bytes that are divided in three parts: *Emergency Error Code* (EEC, byte 0-1), *ErrorRegister* (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*.
0x2310	*Power or motor over current*.
0x2350	*I2T limit reached*.
0x3210	*DC bus over voltage*.
0x3220	*DC bus under voltage*.
0x4210	*Thermal management*(one of the following): - Over temperature of logic section (bit 1) - Over temperature of motor (bit 2)
0x4310	See (bit 0) of *Thermal management*.
0x5114	See (bit 0) of *Logic voltage error*.
0x6320	At least one of the following situations has occurred: - At least one of the bits of *Parameters serious error* is active; - At least one of the bits of *Digital IO configuration error* is active.
0x7200	*Thermal management*(one of the following): - Power Temp Sensor hardware failure (bit 6); - Logic Temp Sensor hardware failure (bit 7); - Motor Temp Sensor hardware failure (bit 8).
0x8611	*Position following error*.
0x8700	
0xFF00	*Real time mode error*.
0xFF01	*User Fault*.
0xFF04	See (bit 0) of */STO Management Error*.
0xFF05	*Last command requested failed*.

Table 9.3. Codes for the Emergency Error Code (EEC) part.

9.3. Process data object (PDO)

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 DuetHV drives 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 *Table 9.2*.

The PDOs must be configured and enabled in the PRE-OPERATIONAL state 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 tp 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.

9.3.1. 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 parameters that can be mapped are identified by the written *"YES"* in the *"PDO"* field of the table that describe them (see *Section 26.1, 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 (e.g. 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 26.22, Sync manager and PDOs managed by the port EtherCAT*.

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

9.3.2. 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 re-transmission. That implies that if a PDO RX is corrupted or doesn't arrive in correspondence of the synchronization reference (see *Section 9.4, Synchronization*), the drive immediately generates an alarm and disables the motor. To avoid this inconvenience MPC has implemented in the DuetHV drive series 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 *EtcPdoRxMissingTolerance*). 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 21.10, 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*) the drive goes in synchronization error (see bit 3 of *Table 23.7*).
> 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 each other, the alarm is immediately generated independently of the set tolerance (see bit 3 of *Table 23.7*).
> For a complete diagnostic see the *EtherCAT_Diagnostics* parameter group.

9.4. Synchronization

In the drives ETC 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 26.22, Sync manager and PDOs managed by the port EtherCAT*).

In the drive of the DuetHV series 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*.

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 network EtherCAT). 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 *Sync Signal* signal;
- to set the registers of the Sync managers of the PDOs in order to get the value 2 in the parameters *SM2_SynchronizationType* and *SM3_SynchronizationType*.

PDO transmission/sending/analysis sequence
The order with which the messages are transmitted/sent/analized is the following:

- the Master sends the PDO(s) RX;
- the synchronism signal is activated. This signal is the SyncSignal 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.

Chapter 10

Auxiliary communication port Modbus

Note

For the communication settings with a Modbus Master, please refer to *Section 8.2, Communicate with Master Modbus RS232 (auxiliary communication port)*.

The drives of the DuetHV series provide an auxiliary communication port on which the Modbus protocol is implemented. For further details see *Section 8.2, Communicate with Master Modbus RS232 (auxiliary communication port)*.

Note

The Modbus protocol that's implemented in the drives respects the regulations of the ***Modbus organization***: in this section are only reported the implemented functionalities indications.
In the protocol only the transmission mode of RTU type has been implemented.

Modbus frame

The protocol Modbus uses a frame composed by many fields, in *Figure 10.1* you can find the scheme.

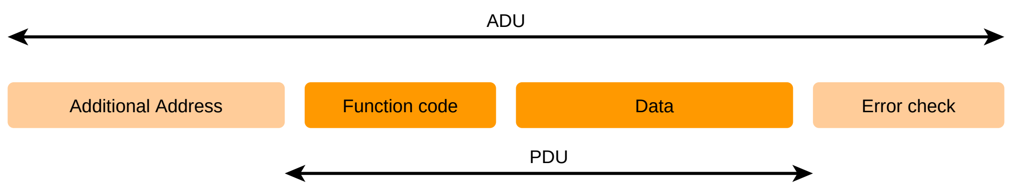


Figure 10.1. Modbus frame

The field *Function code* shows which operation the drive must run, once received and checked the whole frame, it checks it is not damaged. This information occupies 1 byte and has a range of valid values from 1 to 127; the codes between 128 and 255 are used for the *Exceptions* but the value 0 is not accepted. In *Table 10.1* you can find all the accepted codes.

Funct. Code	Name	Description
3	Read Holding Register	Reading one or more parameters (at 16/32 bits) starting from the Modbus address shown in the frame (such as *Read Input Register*).
4	Read Input Register	Reading one or more parameters (at 16/32 bits) starting from the Modbus address shown in the frame (such as Read Holding Register).
6	Write Single Register	Writing a parameter at 16 bits near the Modbus address shown in the frame. If the Modbus address refers to a parameter higher than 16 bits the operation is not run and the drive finds an exception.
7	Diagnostics	The diagnostics is only simulated and it has been implemented only to be compatible with the terminals requesting it.
16	Write Multiple Register	Writing one or more parameters (at 16/32 bits) starting from the Modbus address shown in the frame.

Table 10.1. Function Codes supported by the drives.

The function codes (3, 4, 6 and 16), described in the previous chart, give full access to all drive parameters through the vocabulary in *Chapter 26, Parameters vocabulary*.

Exceptions

If the drive receives a message without communication errors, but it cannot run the requested operation or there is an error in the protocol, the drive answers to the request with an exception frame. In *Table 10.2* you can find the implemented exception codes.

Funct. Code	Name	Description
1	Illegal function	Function code not supported.
2	Illegal data address	Modbus address not accepted. More precisely, the combination of the Modbus address and of the number of data to write / read is not valid (all addresses included in the requested range must be in the vocabulary).
3	Illegal data value	Data quantity not accepted (too high or equal to 0).
4	Slave device failure	Error in the running of the requested action.

Table 10.2. Exception codes implemented in the drive.

> **Note**
>
> The details on the error condition can be found in the group of parameters *AuxiliaryPortError*.

Chapter 11
Communicating with DuetHVSuite

11.1. DuetHVSuite via RS232 (auxiliary communication port)

Connect the PC serial port to *CN1* for the DuetHV except the flange 60, for which the *X4 (F60)* is used. For further informations see *Section 7.2, Electrical connections*.

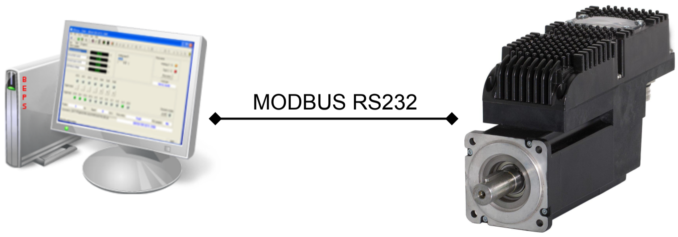
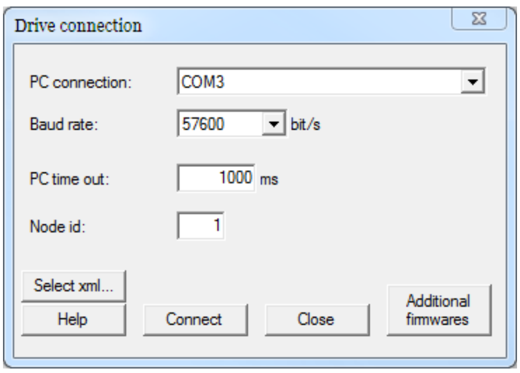


Figure 11.1. Point-point communication scheme with DuetHVSuite.

Start DuetHVSuite from: **Start menu** > **Programs** > **Motor Power Company** > **DuetHVSuite.**

Set the connection parameters in the window *Drive connection.*



If the programme has already been started, run a new connection. Access:

Main menu > **File** > **New connection ...**

Toolbar >

Connection parameters

1. *PC connection*: choosing the connection physical port (COM1, COM2...)
2. *Baud rate*: choosing the communication speed (the drive default value is 57600bit/s).
3. *PC time out*: if the drive does not answer during a longer time period than this value, the communication is interrupted and it is necessary to reconnect (the default value is 500 ms).
4. *Node id*: set the value 1.

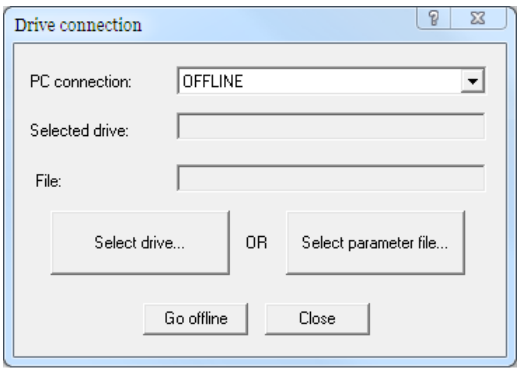
> **Tip**
>
> In case of more connection interruptions it may be necessary to increase the PC time out. It is advisable not to increase the timeout more than 5 seconds.

11.2. Offline mode

Through the Offline mode it is possible to connect to a virtual drive through DuetHVSuite. To enable this mode, start DuetHVSuite or request a new connection by pressing .

In the window *Drive connection:*

1. Choose *OFFLINE* in the pull-down menu *PC connection*
2. Select the drive type by pressing Select drive... or a parameters file previously saved by pressing Select parameter file... .
3. Start the Offline mode by pressing Go offline .



Note

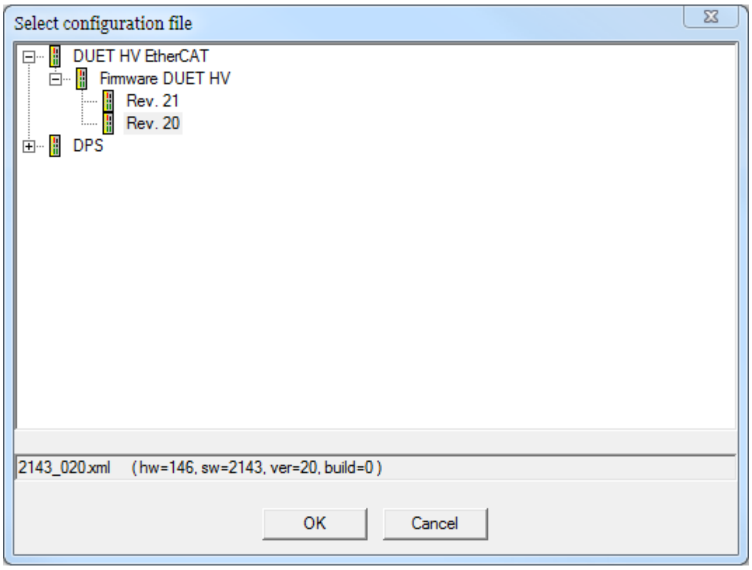
The Offline mode is the best way to debug the system remotely by analising the parameters file containing the problem.

How to choose the drive

Choose in the window *Select configuration file* the firmware Configuration file and the related version you are going to work with by exploring the stem-and-leaf diagram.

Tip

Always choose the latest avalable firmware version. After having selected the file, check that the drive data shown in the field below are the wanted ones.



What you cannot do in the Offline mode

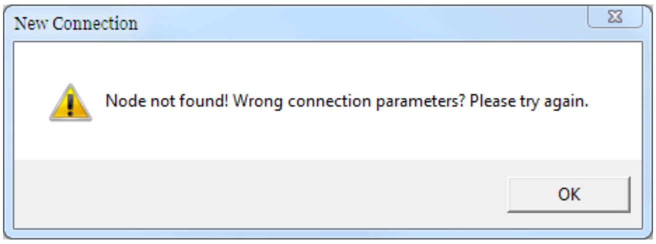
In the Offline mode you can run all the operations foreseen by DuetHVSuite, except from:

- Tab Main
  - enabling the drive
  - downloading the firmware
- Drive setup
  - enabling the capture peripherals
  - running the Tuning commands of the regulation loops
- Oscilloscope
  - enabling a data capture
  - running motions by the Function Generator
  - running Tuning commands of the regulation loops.

11.3. Communication errors with DuetHVSuite

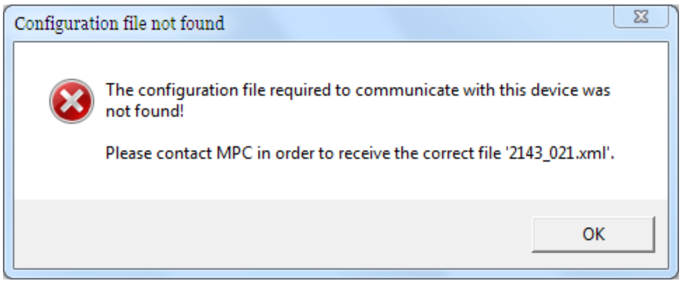
New connection

If during the connection the following window appears check carefully the electrical connections, the correctness of the *Connection parameters* and if the drive is correctly supplied; then try again.



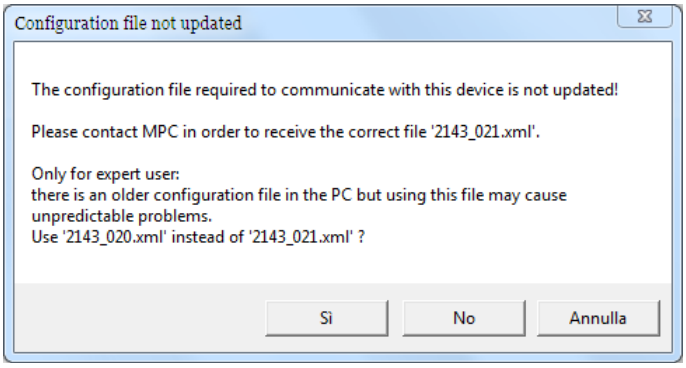
Configuration file not found

If the following window appears it is necessary to update the DuetHVSuite Configuration files according to what is reported in *Section 25.5, Updating the Configuration File*.



Configuration file not update

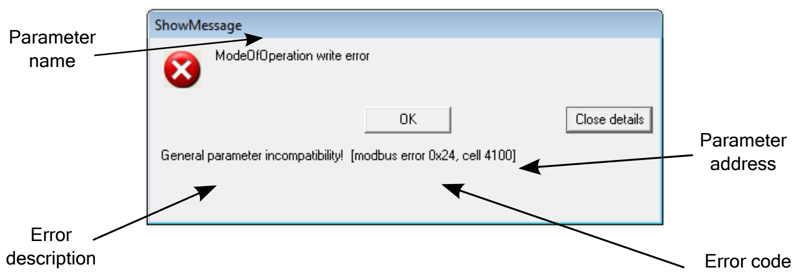
If the following window appears it is advisable to update the DuetHVSuite Configuration files according to what is reported in *Section 25.5, Updating the Configuration File*.



> **Warning**
>
> In case of urgency and if it is not possible to update the Configuration files, you can connect to the drive by using the Configuration file proposed only to expert users. By using not updated Configuration files, Motor Power Company Srl does not guarantee the correct working of DuetHVSuite.

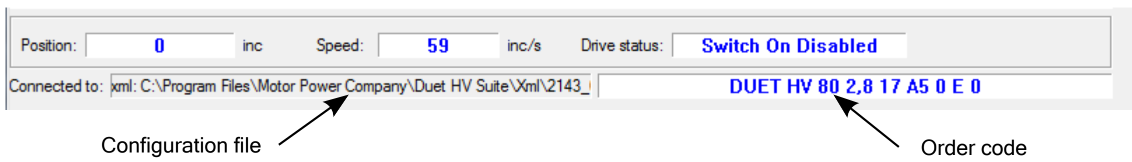
Generic errors

When you have communication errors, DuetHVSuite shows some specific messages. To understand the information in the error generic message see the following picture and the *Table 8.4*.



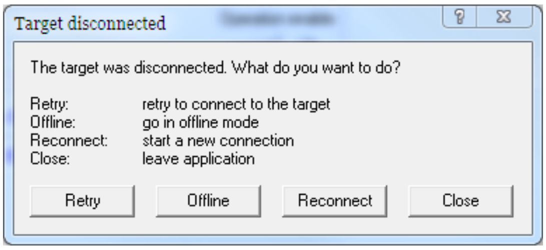
11.4. Connection status with DuetHVSuite

The connection status is made up by the Configuration File and by the *ManufacturerDeviceName* which can be found in the last line below in the tab Main. For further informations see *Section 25.5, Updating the Configuration File* and *Section 28.1, OrderCode*.



11.5. Disconnection of DuetHVSuite

When the connection between DuetHVSuite and the drive is interrupted you will see the following window.



Retry try to connect again with the last *Connection parameters* used.

Offline go to mode *Offline*.

Reconnect open a new connection.

Close close the programme.

11.6. DuetHVSuite options

The DuetHVSuite options refer to the program working mode, particularly with its messages transmission. Access:

> **Main menu** > **View** > **Options** > **General options**.

The choices done by the user by interacting with the DuetHVSuite message service are saved in this page and can be modified in any moment.

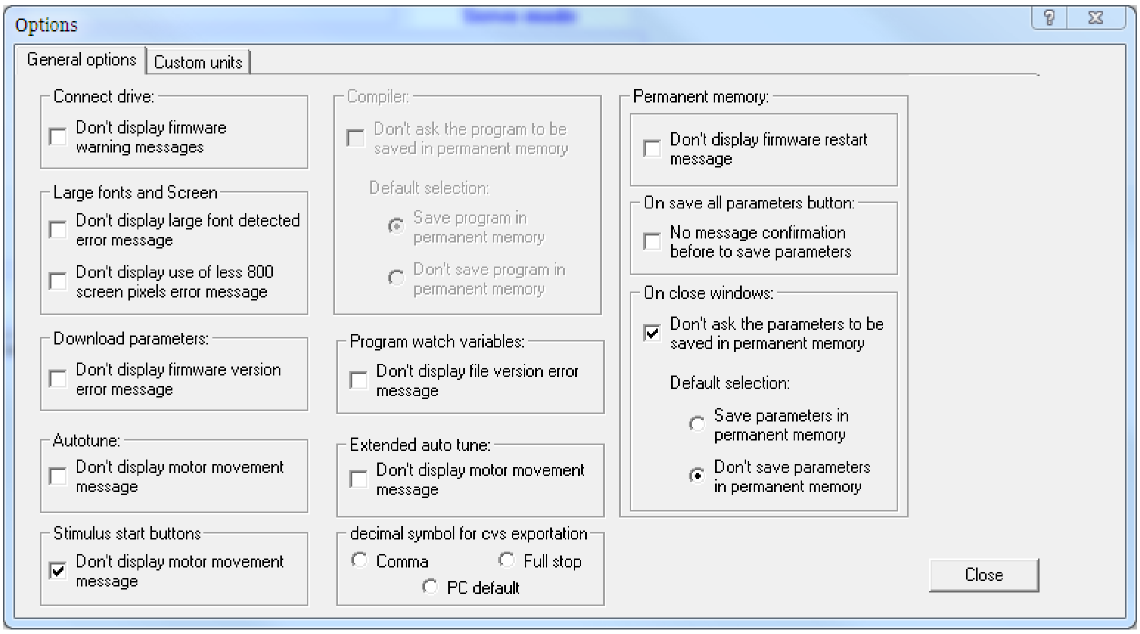


Figure 11.2. Default configuration of DuetHVSuite options

- *Connect drive:* notice of obsolete firmware connection (only for some firmwares)

- *Large fonts and Screen:* notice at the start-up in case some screen graphical options are not compatible with DuetHVSuite
- *Download parameters:* error notice during the download of the parameters file (only for some firmwares)
- *Autotune:* confirmation for the motion which will be run at the requested tuning command
- *Function Generator start button:* confirmation of the motion you are going to run by the function generator
- *Extended autotune:* confirmation for the motion which will be run by the requested tuning command
- *Decimal symbol for cvs exportation:* choice of the separating character to export the oscilloscope data to a file
- *Permanent memory:* notice of firmware reboot when the default parameters in the permanent memory are restored (only for some firmwares)
- *On save all parameters button:* saving confirmation in the permanent memory of the modifications to the parameters
- *Drive setup close window:* automatic saving of the modifications to the parameters in the permanent memory at the Drive setup closure.

Chapter 12

Units of measurement

12.1. Units of measurement of the parameters

In the drives of the series DuetHV, the parameters are expressed with the units of measurement of the following table. The first column shows the symbol, the second the name in detail, the third a short description.

Unit	Name	Description
ns	nano second	Time unit of measurement
µs	micro second	
s	second	
h	hour	
inc	increment	Position unit of measurement. A complete revolution of the motor shaft for the rotary motors, or a movement equal to *PolePitch* for the linear motors, corresponds to the number of increments that is reported in the *EncoderIncrements* parameter.
cnt	count	Unit of measurement of the position obtained by counting the number of edges of the encoder phases it is referring to.
pulse	pulse	Quadrature encoder resolution unit of measurement [1pulse = 4count].
deg	degree	Position unit of measurement in sexagesimal degrees.
inc/s	increment/second	Speed unit of measurement, calculated as incremental ratio of a position expressed in increment.
cnt/s	count/second	Velocity unit of measurement, calculated as incremental ratio of a position expressed in count.
rev/s	revolution/second	Velocity unit of measurement, expressed in revolutions per second.
rad/s	radian/second	Velocity unit of measurement, expressed in radiants per second.
rpm	revolution/minute	Velocity unit of measurement, expressed in revolutions per minute.
mm/s	millimeters/second	Linear velocity unit of measurement, expressed in millimeters per second.
inc/s^2	increment/$second^2$	Acceleration unit of measurement, calculated as incremental ratio of a speed expressed in inc/s.
rev/s^2	revolution/$second^2$	Acceleration unit of measurement, calculated as incremental ratio of a speed expressed in rev/s.
rad/s^2	radian/$second^2$	Acceleration unit of measurement, calculated as incremental ratio of a speed expressed in rad/s.

Unit	Name	Description
%IS	%I Stall	Torque unit of measurement. The 100% corresponds to the motor stall torque, considering the torque constant equal to the *TorqueConstant(ForceConstant)* parameter value. The sign shows the torque application direction in accordance with the *Polarity* parameter (it does not show if the couple is supplied or absorbed by the motor).
V	Volt	Voltage unit of measurement.
A	Ampere	Current unit of measurement, values RMS.
mH	milli Henry	Inductance unit of measurement.
Ω	Ohm	Unit of measurement of the electric resistance.
g	gram	Mass unit of measurement.
g cm^2	gram cm^2	Inertia moment unit of measurement.
Jm	J motor	Inertia moment unit of measurement. 1Jm corresponds to the motor inertia moment.
°C	degree Celsius	Temperature unit of measurement.
bit/s	bit/second	Communication speed unit of measurement.
-	-	Dimensionless unit.

Important

All the torque values are obtained from a current measure multiplied per *TorqueConstant(ForceConstant)*. If the torque constant does not correspond to the value of the *TorqueConstant(ForceConstant)* parameter, the obtained torque value is not correct.

12.2. Revolution resolution

Position resolution (*PositionResolution*):

- shows the exact inc number for every revolution of the motor shaft for rotative motors or for every polar step for linear motors (*PolePitch*).
- defines the resolution describing the position, speed and accelerations, expressed respectively in inc, inc/s and inc/s^2.
- is calculated as *EncoderIncrements* / *MotorRevolutions*.

To modify the *PositionResolution*, modify the *EncoderIncrements* parameter. The *MotorRevolutions* parameter is set to 1. Actually *PositionResolution* coincides with the value of *EncoderIncrements*. The modification of *PositionResolution* does not imply the change of the drive performances but only the meaning of the values in which the above-mentioned variables are expressed.

> **Caution**
>
> In order to know the consequences of the *PositionResolution* modification, see the *Table 14.2*. Furthermore, by modifying *PositionResolution* it's necessary to set again the *SoftwarePositionLimit*.

Access with DuetHVSuite:

Main menu > **Drive** > **Drive setup ...** > **Motor and drive**

Toolbar > > **Motor and drive**

> **Caution**
>
> In case the *HomingStatus* parameter is reset, the homing procedure losts its validity and it's necessary to repeat it and to set again the *SoftwarePositionLimit*.

12.3. Polarity

The polarity shows the direction of the motor shaft rotation in which *PositionActualValue* increases. 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 *Polarity* parameter.

> **Caution**
>
> Unit of measurement of the parameter (see *Polarity*), see the *Table 14.2*.

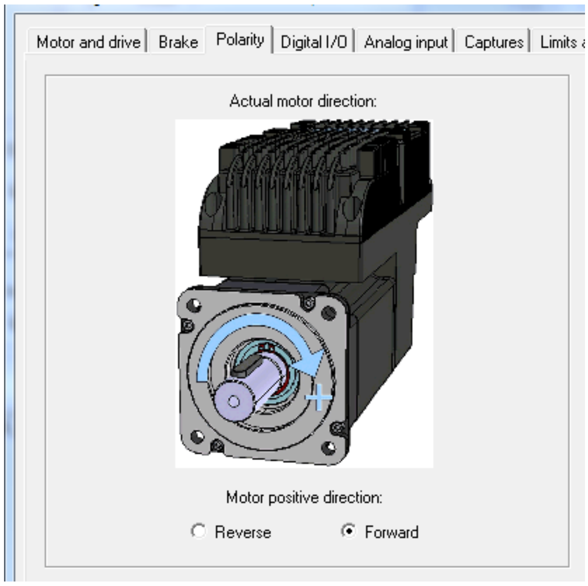
> **Caution**
>
> If the *Polarity* is of Reverse type, then the roles of *Positive limit switch (FC +)* and *Negative limit switch (FC -)* are reversed: *Positive limit switch (FC +)* behaves like *Negative limit switch (FC -)*and *Negative limit switch (FC -)* behaves like *Positive limit switch (FC +)*. This is true both in the text of this manual and in the DuetHVSuite.

> **Warning**
>
> In case the *HomingStatus* parameter is reset, the homing procedure losts its validity and it's necessary to repeat it. In case the feedback position sensor management mode is absolute (*FeedbackSensorAbsMode* = 1), then by modifing the *Polarity* the limits will invert and *PositionActualValue* will be modified accordingly (see *Figure 14.1*).

Access with DuetHVSuite:

Main menu > **Drive** > **Drive setup ...** > **Polarity**

Toolbar >  > **Polarity**

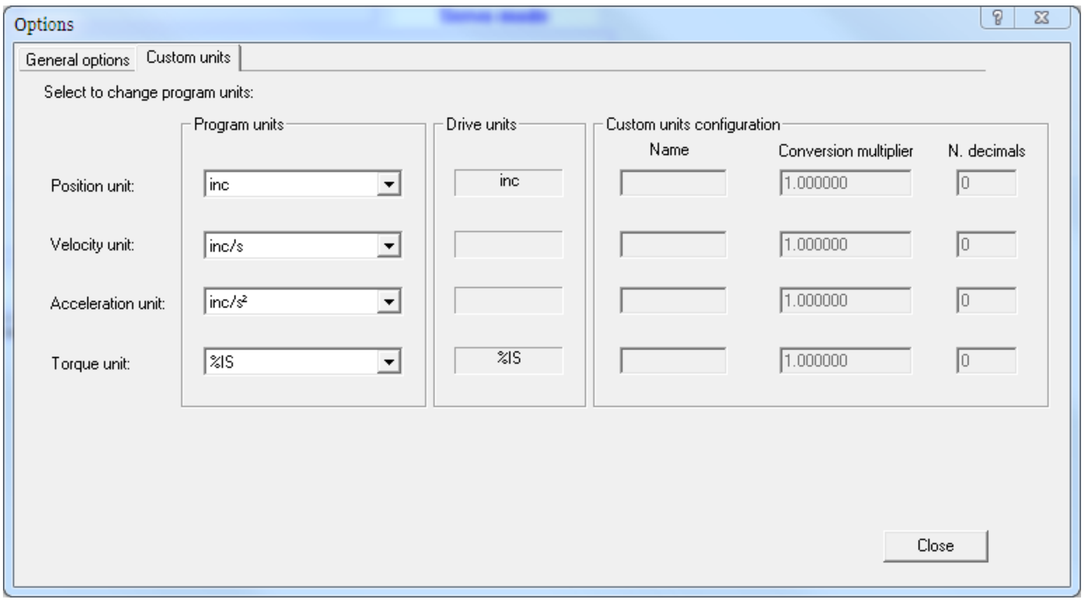


12.4. DuetHVSuite units

It is possible to select the unit of measurement with which some quantities are displayed in DuetHVSuite. To do this go to the page Custom units.

Access:

Main menu > **View** > **Options** > **Custom units**.

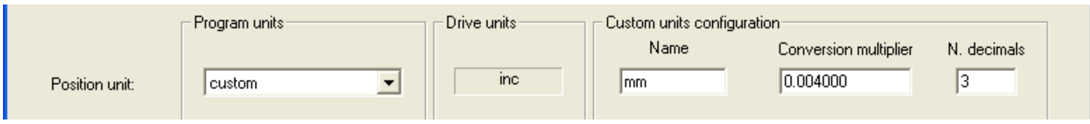


Note

The settings modified in the Custom units page are linked to the DuetHVSuite program and not to the single drive you are connected to.

To personalise the display of some DuetHVSuite variables, choose Custom in the Combo box of the Program units area and define the related fields in the box Custom units configuration. The Conversion multiplier value expresses the multiplicative factor converting the drive units in custom units.

If for example, you must match a value of 32mm to an exact revolution of the motor shaft, when the *EncoderIncrements* is equal to 8000inc/rev, the Conversion multiplier must be set at 32 / 8000 = 0.004 mm/inc.



Example 12.1. Enabling the custom units for the position: 1inc = 0.004mm.

Chapter 13
Power configuration

13.1. DuetHV series drives supply: Y topology

The power section of the DuetHV series drives has been projected in order to be supplied through a continue voltage that can be easily obtained from the network voltage through the AC/DC power supply named DPS. It is however possible to realize an installation with a different power supply that respects the *Section 13.1.2, "Supply with a generic power supply"* requirements.

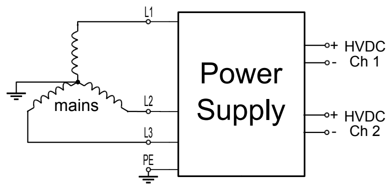


Figure 13.1. Connection scheme of the DPS to the network

Make the connections of the network and of the grounding as required by the regulations in force: on the contrary subsists the electric shock danger.

The system voltage (phase-ground voltage) mustn't exceed 300VAC: in particular it may be necessary to insert an appropriate insulation transformer upstream of the drives in case of supply with not grounded networks or with networks that are grounded asymmetrically.

13.1.1. Supply with DPS

In order to supply the DuetHV series drives it's better to use a power supply of the DPS series: for further details see the dedicated user manual.

Caution

Make the connection of the power supply only after the correct sizing of the wiring system and the related protections and after having read the user manual of the used devices.
The power supply is designed for a fixed connection on a three-phase electric network of TT and TN type. The rated current of short-circuit of the electric line must be < 5kA.
Be sure that the protection devices on the DPS input have an adequate interruption capacity.

To use this power supply has the following advantages:

- the DPS has been designed to supply the DuetHV series drives;
- the overcurrent protections are integrated;
- The DC bus voltage levelling characteristics are adequate to the DuetHV series drives;
- Protections integration:
  - Overcharge on the DC bus outputs;
  - Braking circuit short-circuit;
  - Braking energy overcharge;
  - Charging energy overcharge;
  - Undervoltage / overvoltage / DC bus excessive ripple;
  - Power and control section overtemperature;

The DPS series suppliers are provided of 2 DC bus outputs; it's possible to maintain these outputs separated by making 2 branches or by connecting them in parallel: in this last configuration it's necessary to adequate the cables flow, downstream of the union of the cables to the maximum suppliable current of the supplier.

A semplified scheme for the DuetHV connection to the DC bus generated by the DPS is reported in *Figure 13.2*: this scheme represents the DPS outputs separated connection (HVDC CH1 and HVDC CH2); the DC bus cables can therefore be connected to a terminal box, represented by the “A” and “B” details in figure.

A wiring example of HVDC CH1 to the terminal box is reported in *Figure 13.3*.

The cable that's identified by the orange colour allows to make in the same way the connection to the DC bus and to the control voltage for all the DuetHV drives; furthermore this cable allows to connect to the DuetHV drive (except for DuetHV flange 60) 1 input channel for the STO and the IN9 input.

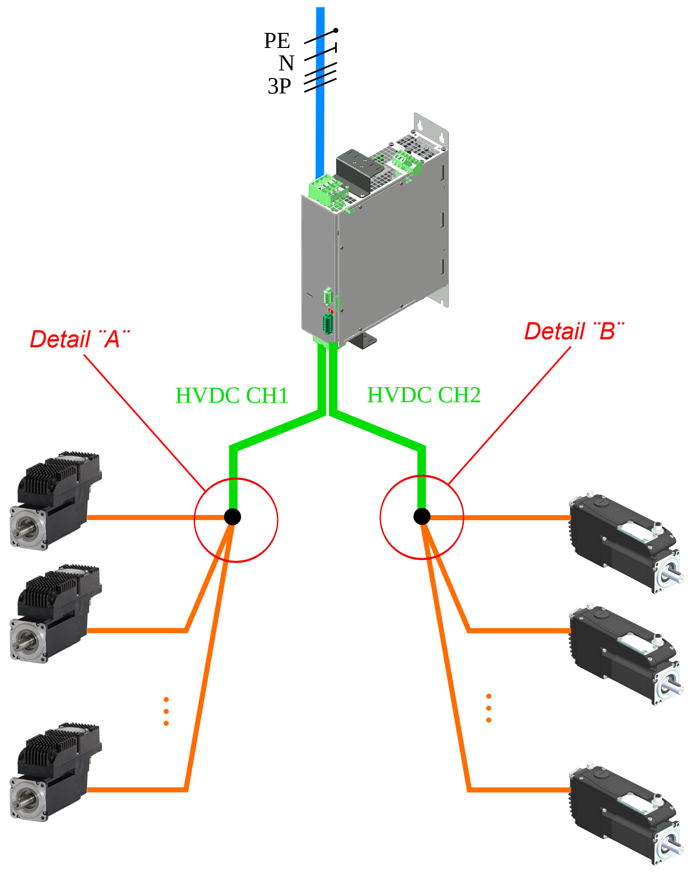


Figure 13.2. Scheme of the DPS connection to DuetHV drives

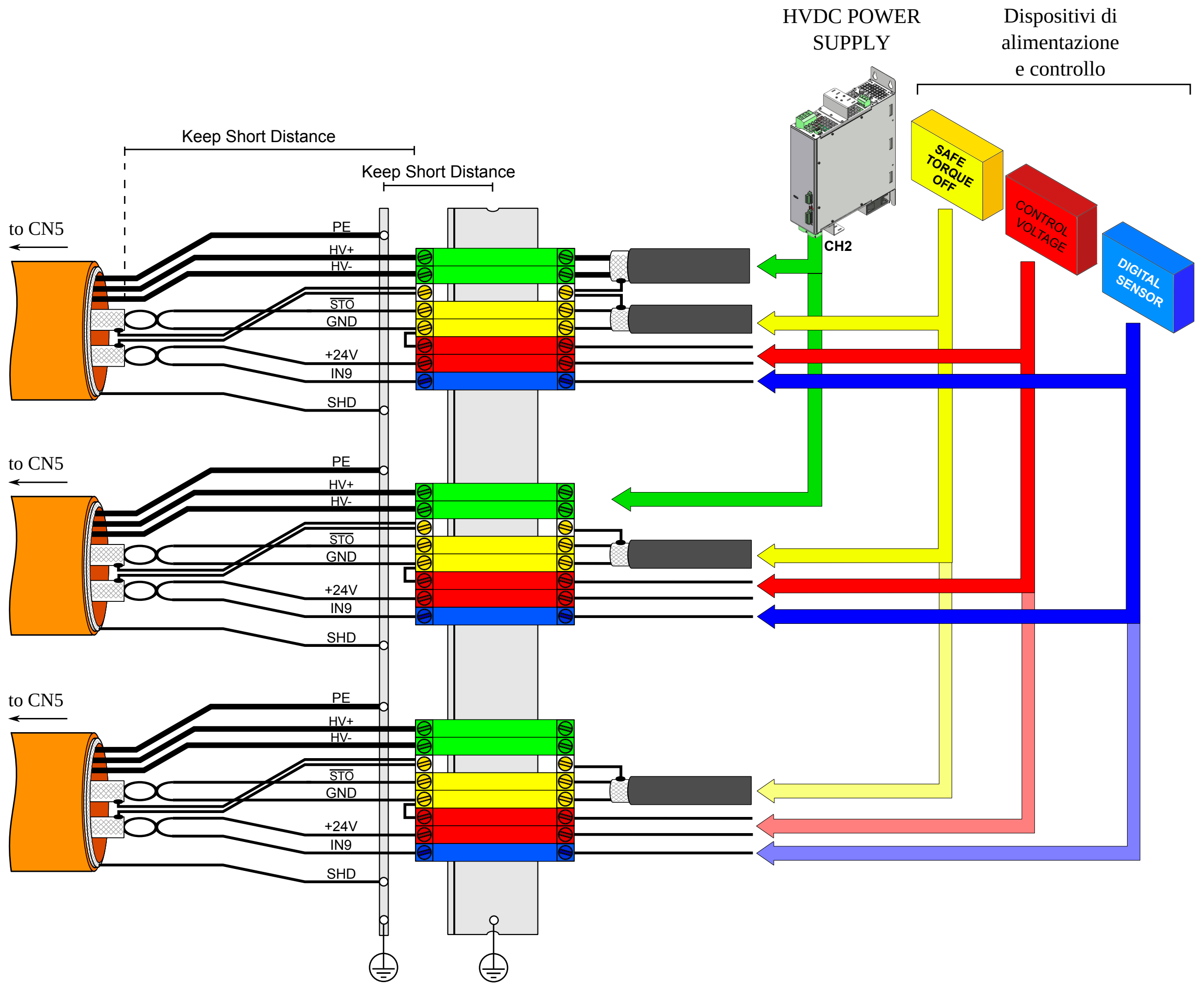


Figure 13.3. Scheme of the DPS connection to DuetHV (except for DuetHV flange 60) - particular A

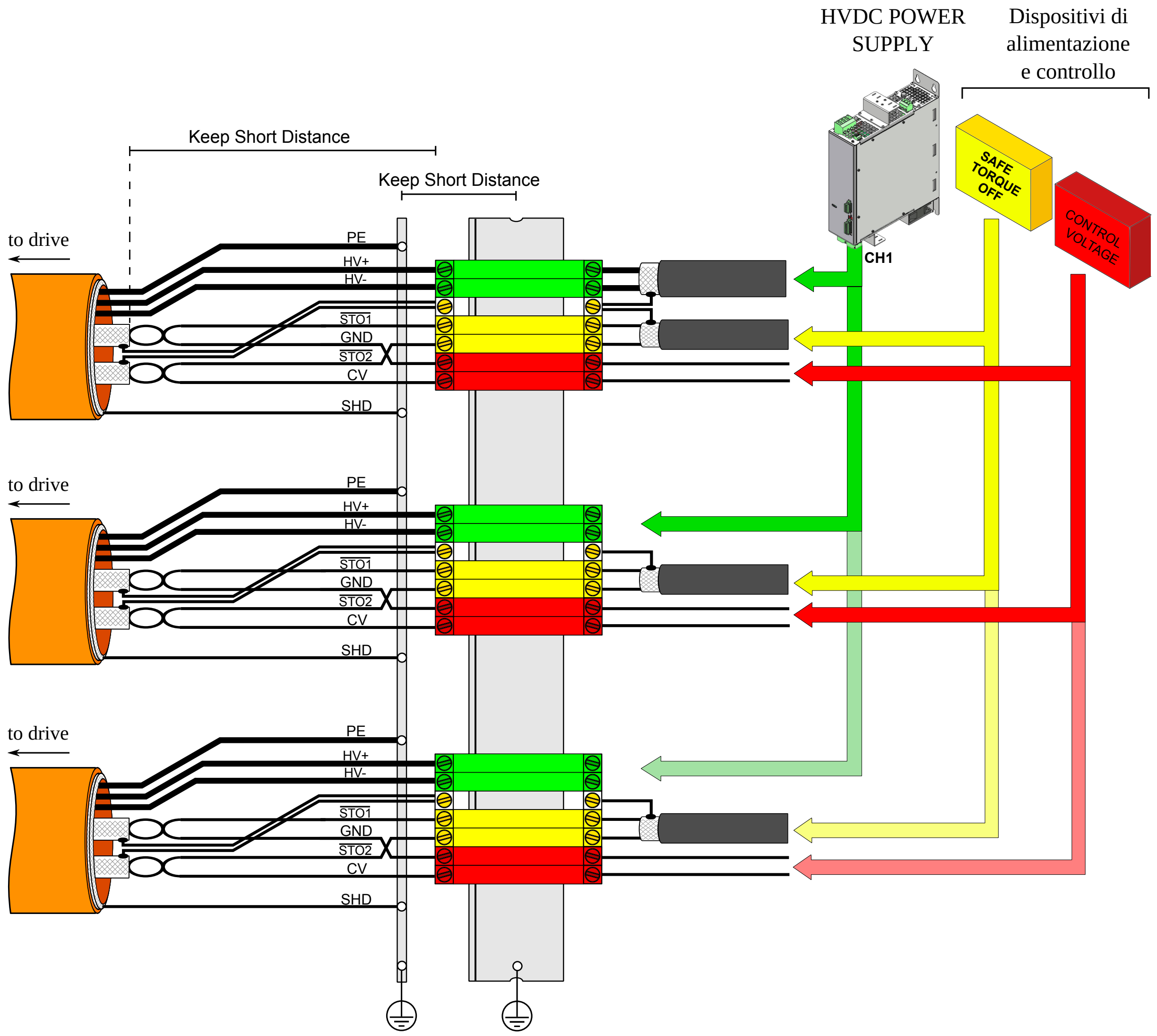


Figure 13.4. Scheme of the DPS connection to DuetHV flange 60 - particular B

The wiring system drives supply network topology design and the cables selection must be done according to the requirements contained in the DPS manual and by respecting the current regulations. In particular it's necessary the conformity to the IEC 60364-5-52 (Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems) and the IEC 60364-4-43 (Low-voltage electrical installations – Part 4-43: Protection for safety – Protection against overcurrent).

It's important that during the realization of the duct the maximum drives connection cables length is respected: for further informations see *Section 7.2.5, “Cables for DuetHV”* for DuetHV except for DuetHV flange 60, for which see *Section 7.2.6, “Cables for DuetHV flange 60mm”*.

13.1.2. Supply with a generic power supply

The drives can be supplied by a DC bus generated by a generic supplier, as indicated in *Figure 13.5*: in this case it's necessary to make the complete sizing of the ducts and of the protections.

Caution

Make the connection to the network only after the correct sizing of the electrical wiring and the related protections and after having read the user manual of the used devices.
The drive is designed to be used with a supplier connected to an TT or TN electric network of three-phase or single-phase (depending on the performances required to the motor).

In particular, to supply the drives with a generic supplier, over the requirements of *Section 13.1.1, “Supply with DPS”*, it's necessary to guarantee the conformity to the requirements reported in *Table 13.1* and to the current standards about the adjustable speed electrical power drive systems.

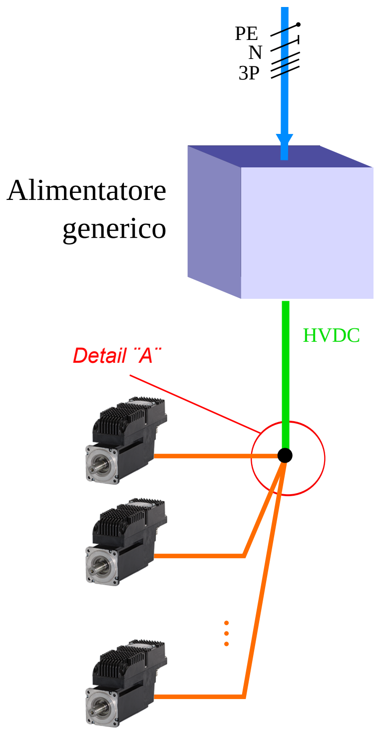


Figure 13.5. Scheme of connection to a generic supplier to DuetHV drives

Supplier electrical requirements

Supplier features	Symbol	Requirement
Output voltage range	Vdc	Minimum 275VDC; Maximum 730VDC[a]
Output voltage ripple	DVdc	The supplier must guarantee a levelling of the output voltage adequate to the performance requirements[b].

Supplier features	Symbol	Requirement
Maximum output voltage while braking	Vdc_{max}	785VDC[c]
Soft start	-	It's necessary a soft start system through which the supplier limits the capacitors charging current at the turn on so that to avoid overcurrent and overvoltage peaks on the DC bus.
Output current	Idc	The supplier must provide a rated and peak currents adequate to the type and the absorption of each single drive[d]and to the coincidence factor.
Protection from overcurrent and short-circuit of the output.	-	The supplier must be provided of internal protections, adequate to the installation, against the short-circuit and the overvoltage on the DC bus. Otherwise protect the cables of the DC bus with external devices (es. fuses) adequate to the load, to the installation electrical features and to the requirements of the current regulations.

[a]The supplier must be installed in a TT or TN system network. The system voltage must be equal or lower than 300 VAC. The output voltage of the DC bus must be adequate to the electrical features of the drives that are connected in order to guarantee to reach the required performances of velocity and torque. Tipically a decreasing of the DC bus voltage determines a proportional reduction of the motor rotation.

[b]A decreasing of the DC bus voltage determines a proportional reduction of the motor rotation velocity.

[c]The maximum voltage must be adequate to the electrical features of the drives that are connected: in particular it's necessary to guarantee a margin to avoid the DC bus overvoltage Fault.

[d]The maximum absorption of each drive is related to the I2T parameter (for further information see *Section 13.6, I2T*).

Table 13.1. Supplier electrical requirements for compatibility with DuetHV drives

13.2. Supply voltages

The drives of the DuetHV series have two separated sections, control and power, that must be separately supplied with direct voltages (galvanic isolation between that two sections). Check that the values of the voltage, that are reported in the *Chapter 5, Technical features*, are respected.

While choosing the voltage of the DC bus (power section supply) you need to consider:

1. any possible voltage changes in order to avoid any unwanted notifications of Faults or Warnings
2. the drive cannot dissipate the energy of regeneration (see *Section 13.3, Regeneration*)
3. the drop in the motor performances, decreasing the supply voltage

> **Tip**
>
> Supplying the power section with the rated voltage value.

When the supply voltage of the control section decreases below the lowest threshold, the drive is disabled. See *Chapter 5, Technical features*.

There is a threshold, on brake-equipped motors, causing the drive Fault when the supply voltage of the control section is not sufficient to ensure the safe brake release. See *Logic voltage error*.

Note

*DC bus under voltage*it can be of self-restoring type. Furthermore you can choose if enabling or not the Fault in case of *Logic voltage error*. For further details see *Chapter 23, Fault and Warning*.

13.3. Regeneration

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 cause the drive Fault. The drives DuetHV are not enabled 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.

Tip

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.

13.4. Drive currents

The drives of the series DuetHV 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	Motor stall current
MotorPeakCurrent	Motor peak current
MaxRatedCurrent	Drive nominal current, power section
MaxPeakCurrent	Drive peak current, power section
UserPeakCurrent	Peak current set by the user to limit the current supply to the motor
NominalCurrent	Real nominal current: lower value between *MotorStallCurrent* and*MaxRatedCurrent*
PeakCurrent	Real peak current: lower value than *MotorPeakCurrent*, *MaxPeakCurrent* and*UserPeakCurrent*

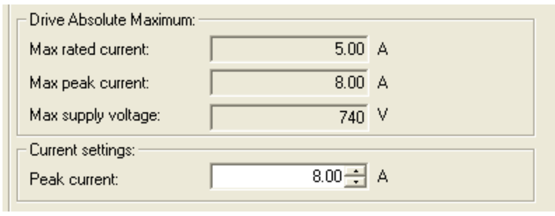
Parameter	Description
ActualMotorCurrent	Actual motor current
ActualFieldCurrent	Actual motor current, field component
ActualTorqueCurrent	Actual motor current, torque component
OverCurrentAValue	Current of the motor U phase in condition of*Power or motor over current*
OverCurrentBValue	Current of the motor V phase in condition of*Power or motor over current*
OverCurrentCValue	Current of the motor W phase in condition of*Power or motor over current*
RMSMotorCurrent	Motor RMS current
RMSMotorCurrentFilter	Filtering time to get the motor RMS current

The only writable parameter of the previous chart (after *RMSMotorCurrentFilter*) is *UserPeakCurrent* and it is used to limit the current supplied to the motor (see *Section 18.1, Electricity limit*).

Access with DuetHVSuite:

Main menu > **Drive** > **Drive setup ...** > **Motor and drive**

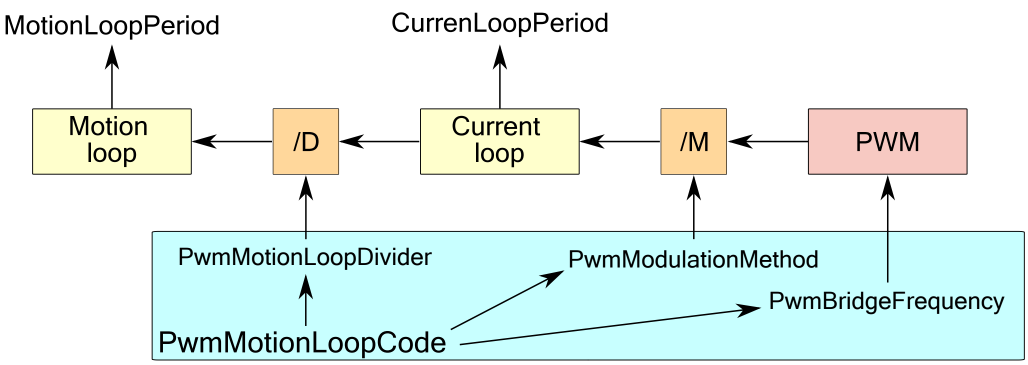
Toolbar >  > **Motor and drive**



13.5. Power PWM

In the drives of the series DuetHV 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	Unique code to set the three-phase bridge frequency and the loops period (it automatically sets the *PwmBridgeFrequency*, *PwmModulationMethod* and *PwmMotionLoopDivider* parameters values)
MotionLoopPeriod	Motion loop period
CurrentLoopPeriod	Current loop period



The current loop period can be obtained through the following expression:

$$\text{CurrentLoopPeriod [s]} = \frac{1}{\text{PwmBridgeFrequency} \times \text{PwmModulationMethod}}$$

while the motion period can be obtained with the following expression:

$$\text{MotionLoopPeriod [s]} = \text{CurrentLoopPeriod [s]} \times \text{PwmMotionLoopDivider}$$

Tip

Modify these parameters only if strictly needed. Do not go below 100µs with *MotionLoopPeriod*. After the modifcation of these parameters it is necessary to tare the loops again.

13.6. I2T

For a limited time period, the current supplied to the motor can be more than *NominalCurrent* (**overload**). To protect the drive motor and power section during the overload periods, the drive controls the energy transferred to the motor and can limit the current. The parameter *I2TValue* shows the level of the energy transfer according to the following table:

I2TValue	Drive energy status.
0	The drive is not overloaded
>0 and <100	The drive is overloaded
>50	The drive is overloaded and too much exploited: application in case of working critical conditions
100	The drive has reached the highest level of overload and the current falls at the value *NominalCurrent* (only if the limitation does not cause any Fault)

The maximum energy that the drive can supply in overload condition can be found in the parameter *UserMaxI2T*. The value is limited by the parameter *DriveMaxI2T*.

The value *UserMaxI2T* is directly connected to the product between *UserPeakCurrent* and *I2TTime*. 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* .

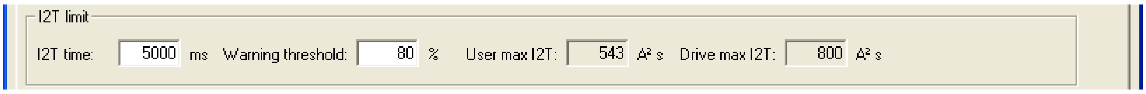
To set correctly the parameters of the I2T follow these instructions:

1. choose the value of *UserPeakCurrent* as current limit used to overload the motor and the drive (with DuetHVSuite, "Motor and drive" page of Drive Setup)
2. choose the value of *I2TTime* as maximum current overload time*PeakCurrent*
3. check that *UserMaxI2T* is lower than *DriveMaxI2T*; if it is not so decrease *UserPeakCurrent* e/o*I2TTime*
4. choose *I2TWarningThreshold* equal to the level of *I2TValue* on which the Warning occurrence is wanted*I2T Warning threshold reached*
5. consider if enable the Fault *I2T limit reached* when *I2TValue* reaches the 100% (with DuetHVSuite, Errors page of Drive Setup).

Access with DuetHVSuite:

Main menu > **Drive** > **Drive setup ...** > **Limit and windows settings**

Toolbar > > **Limit and windows settings**



Active errors	Led L4 drive	*I2TValue*	*ActualMotorCurrent*
-	GREEN, 1 FLASH	0	0
	GREEN, ON		> 0 and ≤ *NominalCurrent*
	ORANGE, ON	> 0 and <*I2TWarningThreshold*	≤ *PeakCurrent*
I2T Warning threshold reached	ORANGE, BLINKING	≥ *I2TWarningThreshold* and < 100	
I2T limit reached	RED, ON	≥ 90	≤ *NominalCurrent*

Table 13.2. Status of the I2T.

Warning

If the fault for *I2T limit reached* is enabled, the current is limited but the motor motion stops and the drive enters the Fault status.

Important

In the boot and firmware start-up phases of the DuetHV drives, the above description of the led is no more valid. Refer to the *Chapter 25, Software updating*.

Chapter 14

Configuring motor, sensors and brake

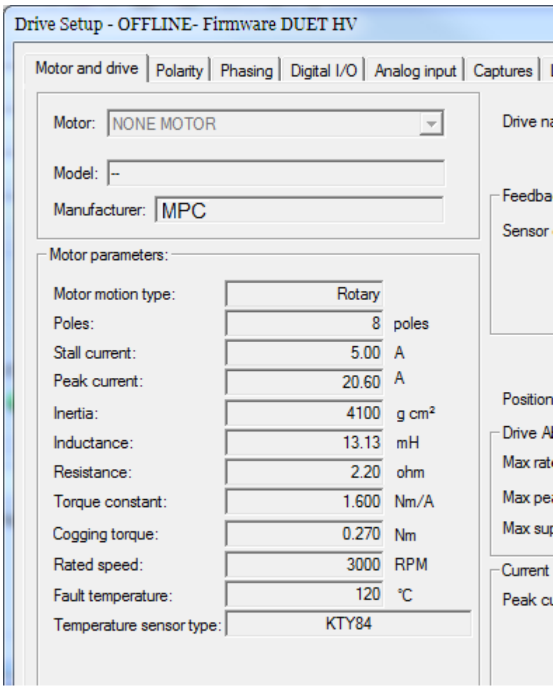
14.1. Motor parametrization

To parametrize the motor follow the order of the tabs that are presents in the *Drive Setup* window

Access with DuetHVSuite:

Main menu > **Drive** > **Drive setup ...**

Toolbar > 



> **Note**
>
> In the DuetHV drives the motor is already selected and cannot be modified.

1. if necessary, define the parameters in the *Motor and drive* page;
2. continue with the parameterisation of the drive functionalities in the other pages;
3. execute the loop tuning (see *Chapter 19, System tuning*);
4. Save the parameters in the internal memory or in a parameters file (see *Chapter 20, Saving, restoring or cloning the drive configuration.*).

14.2. Sensor of the feedback position

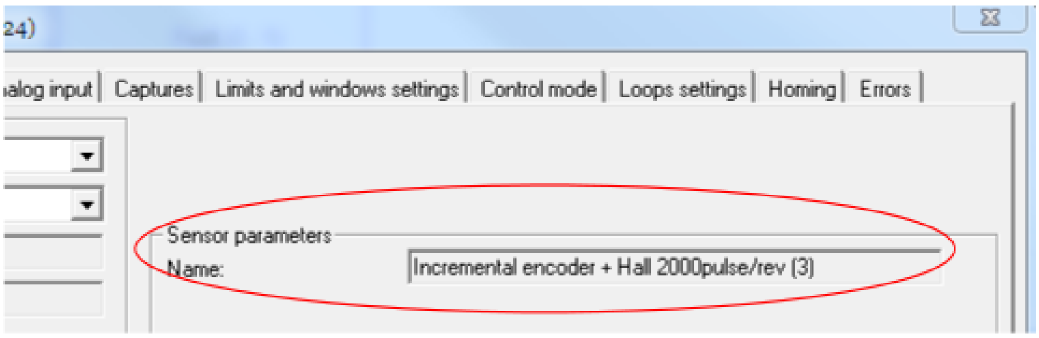
> **Note**
>
> In the DuetHV drives the feedback sensor is already selected and cannot be changed.

The code that selects the installed feedback sensor type is in the *FeedbackSensorCode* parameter. The feedback sensor type is reported in the *Motor and Drive* tab of the *Drive Setup*.

Access with DuetHVSuite:

Main menu > **Drive** > **Drive setup ...** > **Motor and drive**

Toolbar > > **Motor and drive**



> **Caution**
>
> In the drives of the DuetHV series with Hiperface encoders, the *Index* is simulated.

14.3. Feedback position sensor phasing check.

To check the feedback sensor phasing, even in case of sensor anomalies, follow the instructions contained in the *Test feedback sensor phasing* field.

Access with DuetHVSuite:

Main menu > **Drive** > **Drive setup ...** > **Phasing**

Toolbar > > **Phasing**

- through the *FeedbackSensorPhasingAngleTest* parameter the angle position on which the test will be executed is specified;
- through the Start button the test starts (to execute the test through *System Manager* use the command 5310);
- through the field on step 4 (that returns the value contained in the *FeedbackSensorPhasingAngleError* parameter) the phasing angle error is read. If the value of this parameter exceeds a drive internally defined threshold, it is signaled the error 5301 of the *SysMngError*.

> **Important**
>
> In case the value of *FeedbackSensorPhasingAngleError* is near to 120° or -120° see what's reported in *Section 24.6, "Motion problems"* "The motor is no more controllable or the I2T protection activates".

> **Tip**
>
> Repeat the operation by trying different values of *FeedbackSensorPhasingAngleTest*.

Check the phasing through*System Manager*

In order to manage the phasing test from controller through the *System Manager* commands, it is sufficient to perform the following procedure:

- Start: write the value of *FeedbackSensorPhasingAngleTest* first and then execute the command 5310 of the *SysMngCommand* (Test phasing of feedback position sensor)
- Save: execute the command 5320 of the *SysMngCommand* (Save phasing of feedback position sensor)
- Disable: as every operative mode according to the specifications*CiA-402*

> **Tip**
>
> Repeat the operation by trying different values of *FeedbackSensorPhasingAngleTest*.

14.4. Feedback position sensor mode: incremental/absolute

In order to modify the feedback sensore and position management mode, modify the *FeedbackSensorAbsMode* parameter (0=incremental, 1=absolute).

The features of the feedback sensors that support the absolute mode, are reported in the *Table 14.1*, while in the *Table 14.2* the differences between the incremental and absolute mode are reported.

Feedback-SensorCode	Description	Functioning range	Accuracy[a]	Precision (repeatability)[b]
100	Absolute encoder Hiperface multiturn SEL 16sin/rev.	4096rev	1/4000 rev	1/10000 rev
101	Absolute encoder Hiperface multiturn SKM36 128sin/rev.	4096rev	1/10000 rev	1/40000 rev
102	Absolute encoder Hiperface multiturn SRM 1024sin/rev.	4096rev	1/20000 rev	1/40000 rev
150	Absolute encoder Hiperface singleturn SEK 16sin/rev.	1rev	1/4000 rev	1/10000 rev
152	Absolute encoder Hiperface singleturn SRS 1024sin/rev.	1rev	1/20000 rev	1/40000 rev

[a] *"Accuracy"* is the proximity of measurement results to the true value.

[b] *"Precision"* is the repeatability or reproducibility of the measurement in the same conditions.

Table 14.1. Supported absoluted feedback sensors

Caution

Only in absolute mode:

- The drive retains the *PositionActualValue* even in off state, as long as it is within the range
- if the homing has been executed (*HomingStatus* = 1), the range of *PositionActualValue* is defined by*HomingAbsRangeMode*
- if the homing has NOT been executed (*HomingStatus* different from 1), the range of *PositionActualValue* goes from 0 to the value that's reported in the *Table 14.1*.

Warning

The drive can normally manage *PositionActualValue* even out of its range. But if the drive is turned off while *PositionActualValue* is out of range, on the turn on *PositionActualValue* will not be coherent with the previous value. So it will be necessary to re-execute the homing.

The *Table 14.2* describes the behaviour of *PositionActualValue*, of the bit 0 of *PositionValidationStatus* and *HomingStatus* on the occurrence of the listed actions and by distinguishing between the two feedback sensors management modes.

Action	ABSOLUTE mode			INCREMENTAL mode		
	PositionActualValue	Valid[a]	*HomingStatus*	*PositionActualValue*	Valid[a]	*HomingStatus*
Parameter modification *FeedbackSensorCode*	Recalculated within the range	0	0	0	0	0

Action	ABSOLUTE mode			INCREMENTAL mode		
	PositionActualValue	**Valid**[a]	***HomingStatus***	***PositionActualValue***	**Valid**[a]	***HomingStatus***
Parameter modification *FeedbackSensorAbsMode*	Recalculated within the range	0	0	0	0	0
Parameter modification *EncoderIncrements*	Rescaled according to the new *PositionResolution*	0	X	Rescaled according to the new *PositionResolution*	0	0
Parameter modification *Polarity*	Recalculated within the range	0	X	X	0	0
Command 2250 of *System Manager* (Permanent memory: delete motor and sensor data, see *SysMngCommand*)	0	0	0	0 at the end of the command	0	0
System startup and command 5000 of the *System Manager* (Hard firmware reset, see *SysMngCommand*)	Recalculated within the range	0	Loaded from the permanent memory	0	0	0
NMT and command 5001 of the *System Manager* (Soft firmware reset, see *SysMngCommand*)	X	X	X	X	X	X
Command 5300 of the *System Manager* (Phasing of feedback position sensor, see *SysMngCommand*)	0 during the whole command and recalculated within the range at the end of the command	0	X	0 during the whole command	0	0
Command 6000 of the *System Manager* (Download parameters file, see *SysMngCommand*)	The behaviour depends on which parameters are different after the download, according to the cases reported above					

[a] *"Valid"* is the bit 0 of *PositionValidationStatus*.

Table 14.2. Differences between the incremental and the absolute modes (0= value reset, X = no operation/retention of the value)

Example:

In the *Figure 14.1* it is shown an example about the homing procedure and the modification of the *Polarity* parameter effects on *PositionActualValue*, when *FeedbackSensorAbsMode* is 1 and *HomingAbsRangeMode* is 0. In the example an offset is set between the sensor physical position and *PositionActualValue*.

- On the top the machine physical range is represented (red reference) compared with the *PositionActualValue* sensor range (blue triangle);
- In the first image, *PositionActualValue* coincides with the sensor physical position. In this condition the machine physical range is not completely included in the *Po-*

sitionActualValue range, therefore the *PositionActualValue* value retention is NOT guaranteed between the drive turn off and turn on phases;

- In the second image it's shown how the *PositionActualValue* range is shifted after the homing procedure, of 350000inc 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. By executing the homing, the machine physical range is not completely included in the *PositionActualValue* range, therefore the *PositionActualValue* value retention is guaranteed between the drive turn off and turn on phases;
- In the third image it's shown how the modification of *Polarity* reverses the *PositionActualValue* range.

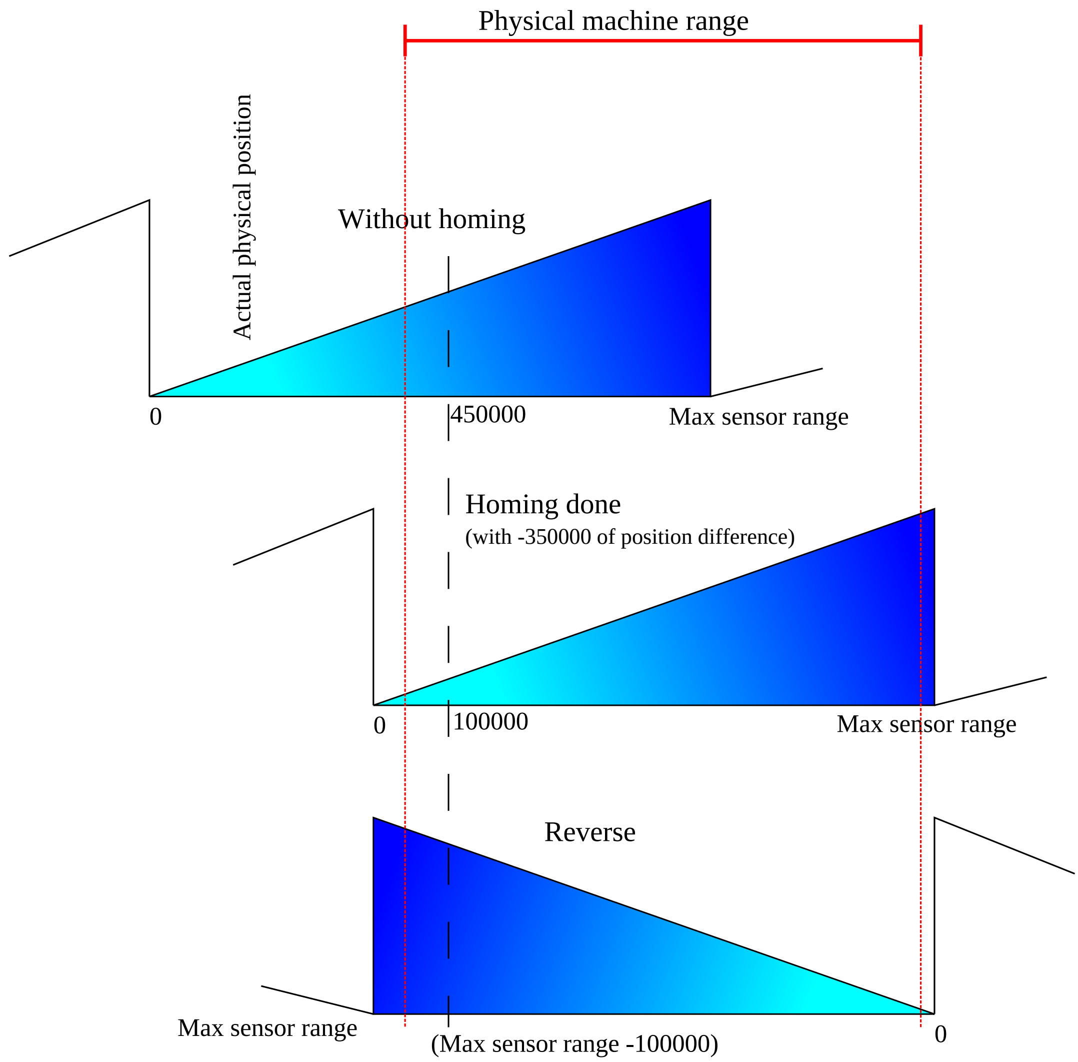


Figure 14.1. Functioning range of absolute sensors, position preset and reverse.

14.5. Auxiliary position sensor

Important

This functionality is not present in the DuetHV flange 60

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 managed auxiliary position sensor type.

The drive internally provides even a virtual (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 (for further information about wiring please see *Chapter 7, Electrical connections, leds and dip switches*):

Encoder signal	DuetHV HW input	Notes
Quadrature Input ChA (Ch A)	I/O 0 (connector *CN4*)	Compulsory
Quadrature Input ChB (Ch B)	I/O 1 (connector *CN4*)	Compulsory
Index Input (Idx)	I/O 2 (connector *CN4*)	Optional

To acquire the physical auxiliary position sensor, the digital input must be configured as described in *Chapter 15, Digital inputs and outputs*.

Here follows the list of the parameters that are provided to manage the master encoder functionalities:

Physical auxiliary encoder:

- *RealEncoderPosition*
- *RealEncoderVelocity*
- *RealEncoderPolarity*

Virtual auxiliary encoder:

- *VirtualEncoderPosition*
- *VirtualEncoderVelocity*
- *VirtualEncoderRunStop*

Selected auxiliary encoder:

- *AuxiliaryEncoderPosition*
- *AuxiliaryEncoderVelocity*
- *AuxiliaryEncoderSelector*

> **Note**
>
> If a physical auxiliary encoder is used and *RealEncoderPolarity* value is 0 (it's set on forward), *RealEncoderPosition* increments when *Quadrature Input ChA (Ch A)* anticipates *Quadrature Input ChB (Ch B)*.

14.6. Brake

The brake installed in the DuetHV drives is a holding brake. In the *BrakePresence* parameter can be verified if the brake is installed, because it is an optional functionality. Once the brake is configured, it's automatically managed by the drive, through to the enable/disable operation. The brake parameters are in *Drive setup*.

Brake output electrical features	
Rated voltage	24Vdc
Minimum supply voltage for the brake functioning	See *Chapter 5, Technical features*
Internal fuse	2A-T not replaceable
Protections	Protection from short-circuit, electronic on all the DuetHV except for the flange 60 in which the protection is made through an internal not auto-restorable fuse

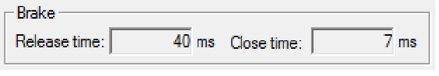
Table 14.3. Brake features

> **Note**
>
> In the DuetHV drives the brake is already configured therefore it is not required any parameterisation.

Access with DuetHVSuite:

Main menu > **Drive** > **Drive setup ...** > **Motor and drive**

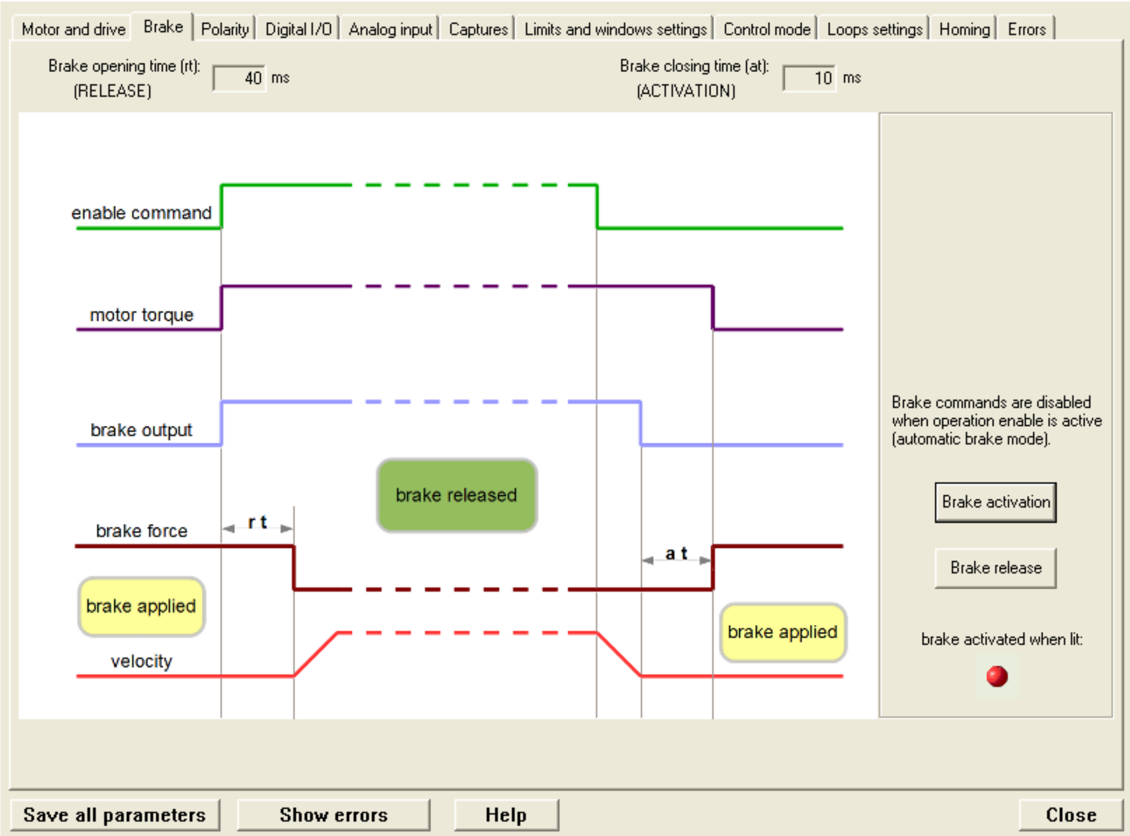
Toolbar > > **Motor and drive**



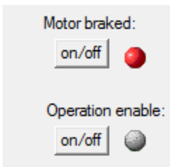
The parameter *BrakeReleaseTime* shows the time elapsed between the command to delay (disabling) the brake, occurring together with the motor enabling, and the moment when the drive accepts any motion commands. During this time interval the brake is exercising its braking power and the shaft motion could damage the brake.

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 braking power; if during this time the motor runs out of power the position could not be guaranteed.

See the timing in the following figure.



The brake can be manually commanded only when the motor is disabled. If the motor is enabled, it's not possible to activate the brake. The command can be reached through the *BrakeStatus* parameter or through the dedicated button that's present in the *Main* Tab of DuetHVSuite.



Note

The brake is active when it is not powered, so when it produces braking force (red led is on).

Chapter 15

Digital inputs and outputs

15.1. Digital inputs and outputs of the DuetHV drives(except for the DuetHV flange 60)

In the DuetHV drives (except for DuetHV flange 60) the following optoisolated digital inputs and outputs are provided:

On the *CN4* connector (M23 male 19 poles) there are:

- 5 PNP digital inputs (24Vdc)
- 3 PNP digital outputs (24Vdc)
- 1 PNP bidirectional digital [with configurable direction]

On the supply connector *CN5* (M23 male 8 poles) there is:

- 1 PNP digital input (24Vdc)

It's therefore possible to have up to 7 inputs[1]*and up to 4 PNP digital outputs*[2]*24Vdc.*

On the *CN4* connector there are also:

- 3 differential digital IN/OUT (type +5V/Line driver), isolated from the power section, [usable for example as auxiliary encoder input].

Provided digital I/Os for DuetHV drive except for DuetHV flange 60

Name	Type of resource / logic	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

[1]In this case the PNP digital outputs number is 3.
[2]In this case the PNP digital inputs number is 6.

Name	Type of resource / logic	Details	Default
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	Funzionalità configurabile, connessione: pin 17 di *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	Funzionalità configurabile, connessione: pin 17 di *CN4*;	GPOUT
/STO	Input, PNP, 24V	Not configurable. Connection: pin A of *CN5*;	/STO

Table 15.1. Description of the DuetHV drive digital I/O

Description of the terms used in the previous chart

Bidirectional: The resource cannot 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 (*Section 7.2.3, DuetHV drive connectors (except for flange 60)*).

PNP: The status of the resource is linked to the current voltage value as to the common mass (*Section 7.2.3, DuetHV drive connectors (except for flange 60)*).

Configurable functionality: The resource can be configured to work as "Generic Input" (GPIN) or "Generic Output" (GPOUT), so the status of the resource can be read or written by the user through the *DigitalInputs* and *PhysicalOutputs* parameters, or it can be configured to run some special functions (see *Section 15.4, Functionalities*), so its status is directly managed by the drive.

/STO : See *Chapter 6, STO safety function: Safe Torque Off* .

Inputs (*Table 15.2*), differential IN/OUTs (*Table 15.3*) and outputs (*Table 15.5*) electrical characteristics.

24V PNP DIGITAL INPUTS CHARACTERISTICS	
Inputs maximum n°	7
Galvanic isolation	YES, through optoisolators
In/Out3, In4, In5, In6, In7, In8, In9	
Input type	PNP

24V PNP DIGITAL INPUTS CHARACTERISTICS	
Input voltage	• Nominal : +24Vdc • LOW signal (physical status 0) : -30 ÷ +3Vdc • HIGH signal (physical status 1) : +15 ÷ +30Vdc
Input current (typical) with Vin = 24Vdc	• 3,3 mA (IN8 and IN9 excluded) • 7 mA (IN8 and IN9)
Maximum allowed current on IN5 if configured as SGND	2A
HW propagation delay (IN8 and IN9 capture inputs)[a]	• Typical : rising edge=6,8µs , falling edge=1µs • Minimum : rising edge=3,6µs , falling edge=1µs • Maximum: rising edge=12µs , falling edge=1µs
Jitter on the SW acquiring of IN8 and IN9 capture inputs	max 1µs
HW propagation delay (generic input)	Typical : rising edge=15µs , falling edge=170µs

[a]24V amplitude step signal

Table 15.2. Digital inputs electrical characteristics

DIGITAL IN/OUT CHARACTERISTICS of differential line drive type (In/Out0, In/Out1, In/Out2)	
Type	Differential IN-OUT (line driver/line receiver)
Galvanic isolation	YES, towards the power section
Maximum outputs n.	3
Maximum inputs n.	3
OUTPUT characteristics[a]	
Differential output voltage	min: 2V; max: 3,3V (with a 50Ω load)
INPUT characteristics[b]	
Differential input voltage	max: -5V ÷ +5V (with enabled termination)
Common-mode voltage	-7V ÷ +12V
Typical input resistance	125kΩ (when the termination resistance is disabled)
Typical input current	110µA
Differential threshold voltage V_{thd} (input)	0,2V
Integrated termination resistance[c]	typ: 120Ω
Input maximum frequency (duty cycle: 40%÷60%)	300KHz

[a]If they are configured as outputs.

[b]If they are configured as inputs.

[c]Can be activated by software command.

Table 15.3. Digital IN/OUT electrical characteristics

> **Warning**
>
> The In/Out0, In/Out1, In/Out2 inputs are differential and must NOT be connected with "24V" level signals. 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 that's applied to the differential input is greater than the differential threshold voltage V_{thd} (see *Table 15.3*), then the related physical status in the DuetHV 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 DuetHV is 0. For values included in the $\pm V_{thd}$ range the physical status of the input is not guaranteed.

/STO INPUT FEATURES	
/STO input	See */STO input electric features*

Table 15.4. /STO input electric features

DIGITAL OUTPUTS CHARACTERISTICS	
In/Out3[a], Out4, Out5, Out6	
Output type	PNP
Outputs maximum n°	4
Galvanic isolation	YES, through optoisolators
Supply voltage	24V (internally obtained from the 24V that are presents on *CN5*)
Maximum output current (for each output)[b]	300mA
Voltage with OFF output	<1V
Protection	Polarity inversion, overcurrent, short-circuit

[a]If configured as output.

[b]That limit is true even if the output is configured as S24V (simulated 24V)

Table 15.5. Digital outputs electrical characteristics

Note

The supply voltage of the digital inputs and outputs is internally obtained through the *CN5* connector (see *Figure 7.2* as reference).

Note

The maximum output current declared on *Table 15.5* 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 1200mA. Inside the system a protection useful in case of the overcoming of this absorption limit is implemented. This protection disables all the outputs (even if the greater part of the absorption is due to only one of these)(except for the DuetHV flange 60, in which each output is singularly protected, so that only the output which reports an excessive absorption turns off). 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 (except for the DuetHV flange 60, in which no Fault is reported).

15.1.1. Provided digital I/Os functionalities for DuetHV drive (except for DuetHV flange 60)

Here follows the functionalities that can be assigned to the I/O resources of the drive DuetHV (except for the DuetHV flange 60). 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...
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
Generic Output (I/O X - Out X)	I/O 0, I/O 1, I/O 2, I/O 3, Out 4, Out 5, Out6
Fault (Fault)	I/O 0, I/O 1, I/O 2, I/O 3, Out 4, Out 5, Out6
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
Index Input (Idx)	I/O 2
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, Out6
Drive Fan (D. Fan)	I/O 0, I/O 1, I/O 2, I/O 3, Out 4, Out 5, Out6
Drive Ok (Drv OK)	I/O 0, I/O 1, I/O 2, I/O 3, Out 4, Out 5, Out6
Simulated 24V Out (S24V)	I/O 3, Out 4, Out 5, Out6
Simulated GND (SGND)	In5

Table 15.6. Functionalities given to the resources of I/O

> **Note**
>
> Each functionality has a code that can be assigned to the inputs and outputs. These codes are listed in the *Table 26.19*

The following table lists the parameters fo the selection of the functionality related to each single I/O. The procedure for their use is described in *Section 15.3, Configuring the I/O by using the parameters*.

Resource	Parameter
I/O 0	*IO_0_Function*
I/O 1	*IO_1_Function*

Resource	Parameter
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*

Table 15.7. List of the configuration parameters of the functionalities supported by every resource in the DuetHV drives

15.2. Digital inputs and outputs of the DuetHV flange 60 drives

In the DuetHV flange 60 drives the following optoisolated digital inputs and outputs are provided:

On the *X5 (F60)* connector (M23 female, 8 poles) there are:

- 3 PNP digital inputs (24Vdc)
- 2 PNP digital outputs (24Vdc)
- 1 PNP bidirectional digital [with configurable direction]

It's therefore possible to have up to 4 inputs[3]*and up to 3 outputs*[4]*24Vdc.*

Provided digital I/Os for DuetHV flange 60 drive

Name	Type of resource / logic	Details	Default
I/O 0	Bidirectional, PNP, 24V	Configurable functionality, connection: pin 1 of *X5 (F60)*;	GPIN
In 1	Input, PNP, 24V	Configurable functionality, connection: pin 2 of *X5 (F60)*;	GPIN
In 2	Input, PNP, 24V	Configurable functionality, connection: pin 3 of *X5 (F60)*;	GPIN
In 3	Input, PNP, 24V	Configurable functionality, connection: pin 4 of *X5 (F60)*;	GPIN
Out 1	Output, PNP, 24V	Configurable functionality, connection: pin 6 of *X5 (F60)*;	GPOUT
Out 2	Output, PNP, 24V	Configurable functionality, connection: pin 8 of *X5 (F60)*;	GPOUT

[3] In this case the PNP digital outputs number is 1.
[4] In this case the PNP digital inputs number is 3.

Name	Type of resource / logic	Details	Default
/STO1	Input, PNP, 24V	Not configurable. Connection: pin A of *X1(F60)*;	/STO
/STO2	Input, PNP, 24V	Not configurable. Connection: pin C of *X1(F60)*;	/STO

Table 15.8. Description of the DuetHV flange 60 drive digital I/Os

Description of the terms used in the previous chart

Bidirectional: The resource cannot 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.

PNP: The status of the resource is linked to the current voltage value as to the common mass (*Section 7.2.3, DuetHV drive connectors (except for flange 60)*).

Configurable functionality: The resource can be configured to work as "Generic Input" (GPIN) or "Generic Output" (GPOUT), so the status of the resource can be read or written by the user through the *DigitalInputs* and *PhysicalOutputs* parameters, or it can be configured to run some special functions (see *Section 15.4, Functionalities*), so its status is directly managed by the drive.

/STO : See *Chapter 6, STO safety function: Safe Torque Off* .

Inputs (*Table 15.9*), outputs (*Table 15.11*) and /STO inputs (*Table 15.10*) electrical characteristics.

24V PNP DIGITAL INPUTS CHARACTERISTICS	
Inputs maximum n°	4
Galvanic isolation	YES, through optoisolators
Input type	PNP
Input voltage	• Nominal : +24Vdc • LOW signal (physical status 0) : -30 ÷ +3Vdc • HIGH signal (physical status 1) : +15 ÷ +30Vdc
GENERIC INPUTS (In/Out0[a], In1)	
Input current (typical) with Vin = 24Vdc	3,3 mA
HW propagation delay	Typical : rising edge=18µs, falling edge=200µs
CAPTURE INPUTS (In2, In3)	
Input current (typical) with Vin = 24Vdc	7 mA
Jitter on the SW acquiring of IN2 and IN3 capture inputs	max 1µs
HW propagation delay[b]	• Typical : rising edge=6,8µs , falling edge=1µs • Minimum : rising edge=[TBD], falling edge=[TBD] • Maximum: rising edge=[TBD], falling edge=[TBD]

[a]If configured as input

[b]24V amplitude step signal

Table 15.9. Digital inputs electrical characteristics

/STO INPUTS FEATURES	
/STO inputs	See */STO1, /STO2 inputs electrical features*

Table 15.10. /STO inputs electric features

DIGITAL OUTPUTS CHARACTERISTICS	
In/Out0[a], Out1, Out2	
Output type	PNP
Outputs maximum n°	3
Galvanic isolation	YES, through optoisolators
Supply voltage	24V (internally obtained from the 24V that are presents on *X1(F60)*)
Maximum output current (for each output)[b]	200mA
Voltage with OFF output	<1V
Protection	Polarity inversion, overcurrent, short-circuit

[a]If configured as output.

[b]That limit is true even if the output is configured as S24V (simulated 24V)

Table 15.11. Digital outputs electrical characteristics

Note

The supply voltage of the digital inputs and outputs is internally obtained through the *X1(F60)* connector (see *Figure 7.11* as reference).

Note

The maximum output current declared on *Table 15.11* is referred to each output, therefore it's possible to have a maximum overall absorption of about 24V (with all 3 outputs enabled and with the maximum connected load) equal to 600mA. Inside the system a protection useful in case of the overcoming of this absorption limit is implemented. This protection disables all the outputs (even if the greater part of the absorption is due to only one of these)(except for the DuetHV flange 60, in which each output is singularily protected, so that only the output which reports an excessive absorption turns off). 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 (except for the DuetHV flange 60, in which no Fault is reported).

15.2.1. I/O functionality for DuetHV flange 60 drive

Here follows the functionalities given to the resources of I/O of the drive DuetHV flange 60. 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...
Generic Input (I/O X - In X)	I/O 0, In 1, In 2, In 3
Generic Output (I/O X - Out X)	I/O 0, Out 1, Out 2
Fault (Fault)	I/O 0, Out 1, Out 2
Home	I/O 0, In 1, In 2, In 3
Positive limit switch (FC +)	I/O 0, In 1, In 2, In 3
Negative limit switch (FC -)	I/O 0, In 1, In 2, In 3
Enable	I/O 0, In 1, In 2, In 3
Motor Fan (M. Fan)	I/O 0, Out 1, Out 2
Drive Fan (D. Fan)	I/O 0, Out 1, Out 2
Drive Ok (Drv OK)	I/O 0, Out 1, Out 2
Simulated 24V Out (S24V)	Out 1, Out 2

Table 15.12. Functionalities given to the resources of I/O

Note

Each functionality has a code that can be assigned to the inputs and outputs. These codes are listed in the *Table 26.19*

The following table lists the parameters fo the selection of the functionality related to each single I/O. The procedure for their use is described in *Section 15.3, Configuring the I/O by using the parameters*.

Resource	Parameter
I/O 0	*IO_0_Function*
In 1	*In_1_Function*
In 2	*In_2_Function*
In 3	*In_3_Function*
Out 1	*Out_1_Function*
Out 2	*Out_2_Function*

Table 15.13. List of the configuration parameters of the functionalities supported by every resource in the DuetHV flange 60 drives

15.3. Configuring the I/O by using the parameters

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

1. Run the command of the *System Manager* 6200 to start the configuration procedure.

2. Select the functionalities through the parameters listed in *Table 15.7* except for the DuetHV flange 60 drives, in *Table 15.13* for DuetHV flange 60.; the codes of the functionalities are listed in the description of the parameters.
3. Configuring the polarity (*PolarityInputValue*).
4. Run the command of the *System Manager* 620 to end the configuration procedure.
5. Check any possible error.

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*. Refer to *Section 15.5, Filters, polarities and terminations*.

15.4. Functionalities

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*. The parameter *LogicalDigitalInputStatus* shows the input status after the application of the polarity (see *Selection of the polarity of the digital inputs*).

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*. To prevent the accidental modification of one or more bits of the parameter *PhysicalOutputs* it is possible to block the writing, every bit through the parameter *DigitalOutputsBitMask*.

Fault (Fault)
The *Fault* functionality enables the output when a retentive Fault is active. When the Fault is reset, the status of the digital output is set to zero. See *Chapter 23, Fault and Warning*.

Home
Input used to carry out the homing of the shaft. (See *Section 21.20, Homing Mode*). Through the parameter *HomeStatus* it is possible to read the status of the limit switch, irrespective of the resource used for such functionality.

STEP
The *STEP* functionality 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's possible to connect an auxiliary encoder with the STEP/DIR interface.

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's possible to connect an auxiliary encoder with the STEP/DIR interface.

> **Important**
>
> In the drives of the DuetHV series it's not provided a STEP/DIR operative mode, these inputs have the only purpose to manage an auxiliary encoder with STEP/DIR interface.

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 (see *Selection of the polarity of the digital inputs*). Through the parameter *FcStatus* it is possible to read the status of the limit switch, irrespective of the resource used for such functionality. The HW limit status is the oppostite of the input status, for example if the HW limit is engaged *FcStatus* is set to 1 while the input is set to 0.

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 (see *Selection of the polarity of the digital inputs*). Through the *FcStatus* parameter is possible to read the HW limit status, independently from the resource that has been used for this functionality. The HW limit status is the opposite of the input status, for example if the HW limit is engaged *FcStatus* is set to 1 while the input is set to 0.

> **Caution**
>
> 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 +)*.

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 *Operation enable* state. The consent to enable the drive can be read through the parameter *EnableInputStatus* irrespective of which input has been used for the Enable function. When *EnableInputStatus* value is 0, the CiA402 State Machine cannot be taken to the *Switched On* and *Operation enable* states (see *Section 8.4, CiA402 state machine*).

If the drive is in the *Operation enable* state and the Enable input is disabled then the following sequence takes place:

1. deceleration of the motor according to the settings of the parameter *DisableOption*;
2. waiting for the motor stopping and enabling of the brake, if present;
3. the CiA402 State Machine enters the *Switch On Disabled* state (see *Section 8.4, CiA402 state machine*);
4. activation of the *Drive is in disable state, since the enable input is or has been in not active state* Warning.

Important

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; the operating modes with automatic Enable are specified in .

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 *RealEncoderPolarity*.

If you select this functionality the parameter *PolarityInputValue* does not have any effect.

Warning

To read the auxiliary encoder position or to capture its position it's necessary to program this functionality (together with *Quadrature Input ChB (Ch B)*) in the digital inputs. See *Section 14.5, Auxiliary position sensor*.

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 *RealEncoderPolarity*.

If you select this functionality the parameter *PolarityInputValue* does not have any effect.

Warning

To read the auxiliary encoder position or to capture its position it's necessary to program this functionality (together with *Quadrature Input ChA (Ch A)*) in the digital inputs. See *Section 14.5, Auxiliary position sensor*.

Index Input (Idx)

The *Input Index* functionality 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 *RealEncoderPolarity*.

If you select this functionality the parameter *PolarityInputValue* does not have any effect.

> **Warning**
>
> If the *Index* is used as capture event to capture the auxiliary encoder position, it's necessary that this functionality is programmed in the digital input 2 (see *IO_2_Function*), except for the DuetHV flange 60.

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*	*PwmHwDutyCycleIO0*
I/O 1	*PwmHwFrequencyIO1*	*PwmHwDutyCycleIO1*
I/O 2	*PwmHwFrequencyIO2*	*PwmHwDutyCycleIO2*

Motor Fan (M. Fan)

The functionality *Motor Fan* is used to run a fan to cool the motor. The output is automatically enabled when the motor temperature exceeds the warning threshold (see *Table 23.3*). 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 a fan to cool the drive. The output is automatically enabled when the temperature of the control section or the one of the power section exceeds the Warning threshold (see *Table 23.3*). When both temperatures are lower than this threshold, the output remains enabled for one minute and then it switches off.

Drive Ok (Drv OK)

The functionality *Drive Ok* enables the output when the drive has finished the start-up phase and it is ready to get any command. This 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 *DisableOkOutput* parameter.

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.

> **Important**
>
> This functionality is available only in the DuetHV drives with hardware revision 17 and higher and in the DuetHV flange 60.

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.

> **Warning**
>
> *Simulated GND (SGND)* input is not protected against overcurrent.

> **Important**
>
> This functionality is available on drives with hardware revision 17 or higher.

> **Note**
>
> This functionality is available only in the DuetHV drives (except for the DuetHV flange 60).

15.5. 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*: time during which the input status must be stable to be validated. It can be set every 250 μs.
- *EnableDebounce*: 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 declared on the *Table 15.3*. 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 is reached when the voltage difference is lower than $-V_{thd}$ (see *Table 15.3*).

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* 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* parameter must be written during the Digital I/O configuration procedure (see *Section 15.3, Configuring the I/O by using the parameters*).

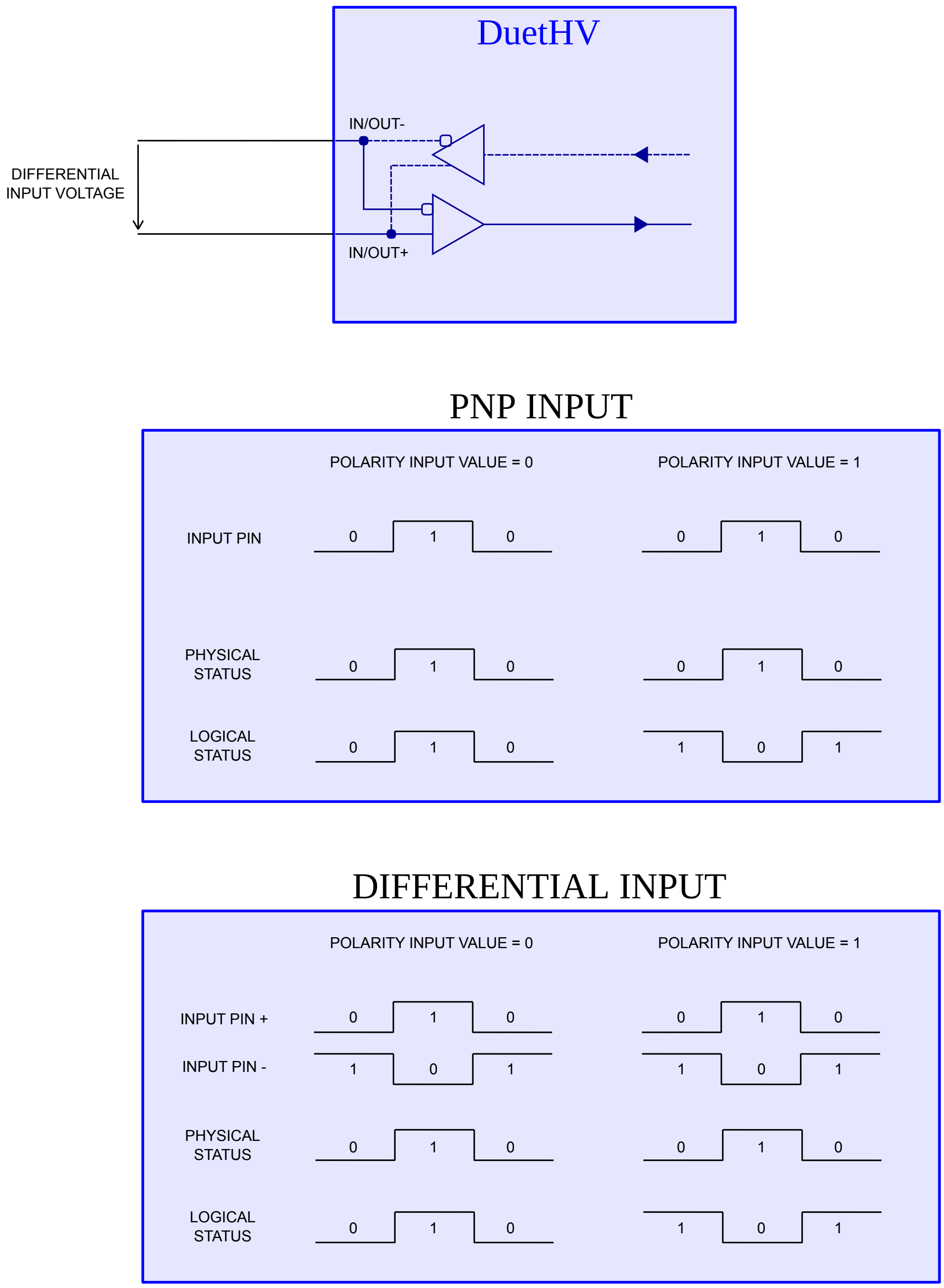


Figure 15.1. Inputs logical status in relation to the polarity.

The functionalities *Positive limit switch (FC +)* and *Negative limit switch (FC -)* force to zero the bits corresponding to the parameter *PolarityInputValue*.

Termination resistances

For the resources with logic of differential kind (*Table 15.1*) it is possible to enable the termination resistance through the parameter *TerminationResistance*.

Chapter 16
Analog input

The features of the analog input are summarized in the following table:

Analog input 0	Details
Electric features	Range ±10V; Precision ±10mV
Connections	Pins 3 and 4 of *CN4* (except for DuetHV flange 60).
Updating time *AI0Voltage*	*CurrentLoopPeriod*
Updating time *AI0FilteredVoltage*	*MotionLoopPeriod*

Table 16.1. Features of AI0

The electrical features of the analog input, related to the *CN4* connector for DuetHV (except for DuetHV flange 60) are summarized in the following table:

ANALOG INPUT FEATURES	
Maximum operating differential voltage	±10V
Maximum absolute differential voltage	±15V
Maximum common-mode voltage[a]	• with Vin=+10V → -18,9V < Vcm < +7,7V • with Vin=-10V → -2,3V < Vcm < +27,7V
Input detection delay	max 300µs
Resolution	±50mV
Differential input resistance	> 150kΩ

[a]in relation to the GND_5V signal (pin 6 of *CN4*).

Table 16.2. Analog input electrical features on *CN4*

The parameters of the analog input are summarized in the following table:

Analog input 0	Parameter	Description
Capture	*AI0Voltage*	Not filtered value
	AI0FilteredVoltage	Filtered value
Calibration	*AI0CalibrationStatus*	Calibration status
	AI0CalibrationOffset	Calibration offset
	AI0CalibrationGain	Calibration gain
	AI0CalibrationVoltage	Calibration voltage

Analog input 0	Parameter	Description
Filter	*AI0FilterFrequency*	Filter frequency
	AI0FilterType	Filter type
	AI0FilterQFactor	Filter Q factor
Conversion	*AI0VSettings*	Set-up of the voltage for the conversion
	AI0RSettings	Set-up of the conversion reference
	AI0VPolarity	Polarity of the voltage for conversion
	AI0RPolarity	Polarity of the conversion reference
	AI0V0Zone	Half amplitude of the dead zone in the conversion
	AI0VRefLevel	Voltage value to define the conversion
	AI0TRefValue	Torque value to define the conversion
	AI0WRefValue	Speed value to define the conversion

Note

About the electrical connections of the DuetHV (except for DuetHV flange 60) please see *DuetHV Analog Input*, in the related section.

16.1. Capture

The analog input is sampled every *CurrentLoopPeriod* and can be read in the parameter *AI0Voltage*. The filtered value of *AI0Voltage* is updated every *MotionLoopPeriod* and can be read in the parameter *AI0FilteredVoltage*.

16.2. Calibration

The analog input calibration is made on every single drive by MPC.

Tip

Execute 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 enough precise;
  - check the reading accuracy of the analog input by making reference to the electric features in *Table 16.1*. 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* is between -10 e +10; if the value of *AI0CalibrationOffset* is in the specified interval then go to step 3, otherwise repeat more precisely the step 2 or contact Motor Power Company;
- Step 3: Gain calibration
  - apply a direct voltage between +4 e +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* ;
  - run the command of *System Manager* 7201;
  - check if the value of *AI0CalibrationGain* is between 4950 e 5050; if the value of *AI0CalibrationGain* is in the specified interval then go to step 4, otherwise repeat more precisely the step 3 or contact Motor Power Company;
- Step 4: checking
  - apply different voltage values to the analog input and check if the voltmeter and the parameter *AI0Voltage* give the same results according to the accuracy specified in the *Table 16.1*; if all the comparisons give a positive result, go to step 5, otherwise repeat the calibration from the beginning or contact Motor Power Company;
- 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.

Important

By restoring the default values of the parameters, the calibration data of the analog input are overwritten with their related default values.

16.3. Conversion

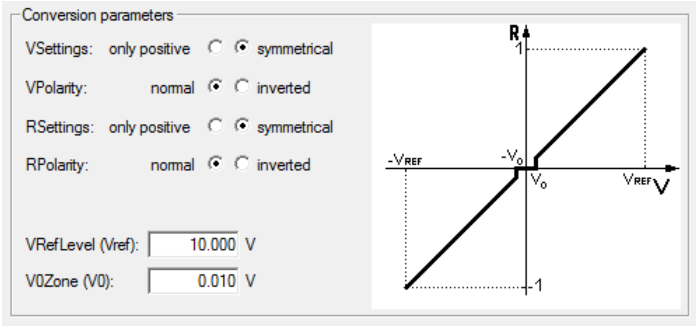
The value of the filtered analog input (*AI0FilteredVoltage*) can be used as torque limit or torque or speed reference depending on the value of *TorqueLimitSelector* and of *ModesOfOperation*. To convert the voltage values in torque or speed values, the parameters *AI0ConversionParameters* are used. In order to define the various conversion options, use DuetHVSuite, considering the reported cenversion diagrams.

Parameters to define the conversion function

In the following DuetHVSuite page, the parameters used to convert the input voltage can be set. Access:

Main menu > **Drive** > **Drive setup ...** > **Analog input**

Toolbar >  > **Analog input**

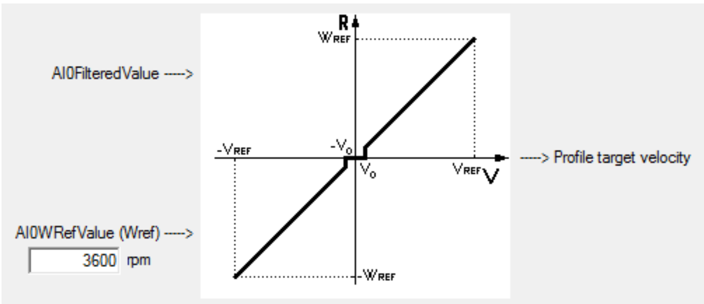


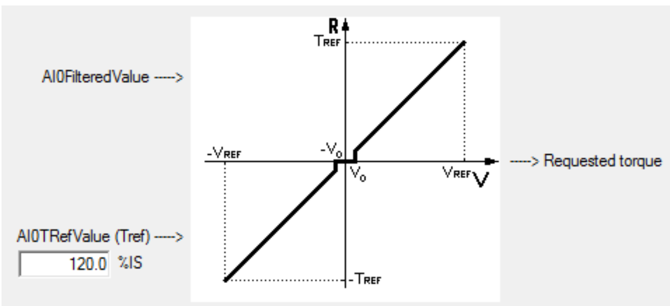
References related parameters

In the following page of DuetHVSuite it's possible to choose the parameters related to the references (the *AI0TRefValue* parameter is even used by the torque limit). Access:

Main menu > **Drive** > **Drive setup ...** > **Control mode**

Toolbar >  > **Control mode**





Chapter 17
Capture Peripherals

The drives of DuetHV series 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 causes 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* and *CaptureSource0_B* (typically the position).

From now onwards we are going to call the two capture peripherals **Capture A** e **Capture B**.

> **Warning**
>
> If the desired capture is the one with the auxiliary encoder *Index*, remember to program the I/O 2 of the DuetHV (see *IO_2_Function*) (except for DuetHV flange 60), with the *Index Input (Idx)* functionality.

17.1. Configuration interface selection

In the DuetHV series drives, 2 configuration interfaces have been integrated: CUSTOM interface and *CiA-402* interface, that can be selected through the *CaptureInterfaceMode* parameter.

Important

It's not possible to change the interface if the capture functionality is active:
- in case *CaptureInterfaceMode* value is 0 (CUSTOM interface): if at least one of the *CaptureUnitState_A* and *CaptureUnitState_B* parameters value is 1;
- in case *CaptureInterfaceMode* value is 1 (*CiA-402* interface): if both the bits 0 and/or both the bits 8 of *TouchProbeFunction* and of *TouchProbeStatus* are set to 1.

Warning

Le due interfacce non possono essere usate contemporaneamente perché le informazioni contenute non sono omogenee.

In fact these two capture interfaces differ in some details. Here follows 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')" warning bit is set, in the *ParamSoftError* parameter. This Warning doesn't automatically reset, it has to 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 they are compatibles with the selected interface, or with the default values.
- The filter in space (*CaptureSource0_A* and *CaptureSource0_B*) 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 selections are made, then the "Filter or trigger on both edges not allowed on selected trigger input" Warning bit is set in the *ParamSoftError* parameter. In the CUSTOM mode the enable operation is not allowed, in the *CiA-402* mode, considering that the setting and the enable operations are contemporary (because both are done through the same parameter), the parameter reports an Abort.

17.2. 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 drives of DuetHV series are identical. Here follow the configuration parameters for each peripheral:

Configuration	Capture A	Capture B
Trigger signal	*CaptureTriggerInput_A*	*CaptureTriggerInput_B*
First quantity to capture	*CaptureSource0_A*	*CaptureSource0_B*
Second quantity to capture	*CaptureSource1_A*	*CaptureSource1_B*
Third quantity to capture	*CaptureSource2_A*	*CaptureSource2_B*
Capture edge	*CaptureTriggerEdge_A*	*CaptureTriggerEdge_B*
Inhibit time	*CaptureInhibitTime_A*	*CaptureInhibitTime_B*
State of the capture peripheral	*CaptureUnitState_A*	*CaptureUnitState_B*
Capture peripheral control	*CaptureUnitCommand_A*	*CaptureUnitCommand_B*
Captured value, first quantity	*CapturedValue0_A*	*CapturedValue0_B*
Captured value, second quantity	*CapturedValue1_A*	*CapturedValue1_B*
Captured value, third quantity	*CapturedValue2_A*	*CapturedValue2_B*

Once trigger (*CaptureTriggerInput_A*), values to capture (*CaptureSource0_A*, *CaptureSource1_A*, *CaptureSource2_A*), capture edge (*CaptureTriggerEdge_A*) and inhibit time (*CaptureInhibitTime_A*) are configured, you can start the capture peripheral by properly writing the *CaptureUnitCommand_A* parameter.

Now, the capture state has to be verified through the *CaptureUnitState_A* parameter, and when it indicates that the capture has happened, the results can be read through the *CapturedValue0_A*, *CapturedValue1_A* and *CapturedValue2_A* 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	*CapturedValue0_ Word_A*	*CapturedValue0_ Byte_A*	*CapturedValue0_ Word_B*	*CapturedValue0_ Byte_B*
Captured value, second quantity	*CapturedValue1_ Word_A*	*CapturedValue1_ Byte_A*	*CapturedValue1_ Word_B*	*CapturedValue1_ Byte_B*
Captured value, third quantity	*CapturedValue2_ Word_A*	*CapturedValue2_ Byte_A*	*CapturedValue2_ Word_B*	*CapturedValue2_ Byte_B*

17.3. Filter on CaptureSource0_A andCaptureSource0_B

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*, *CaptureTriggerInput_B*), 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* 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 *Figure 17.1*.

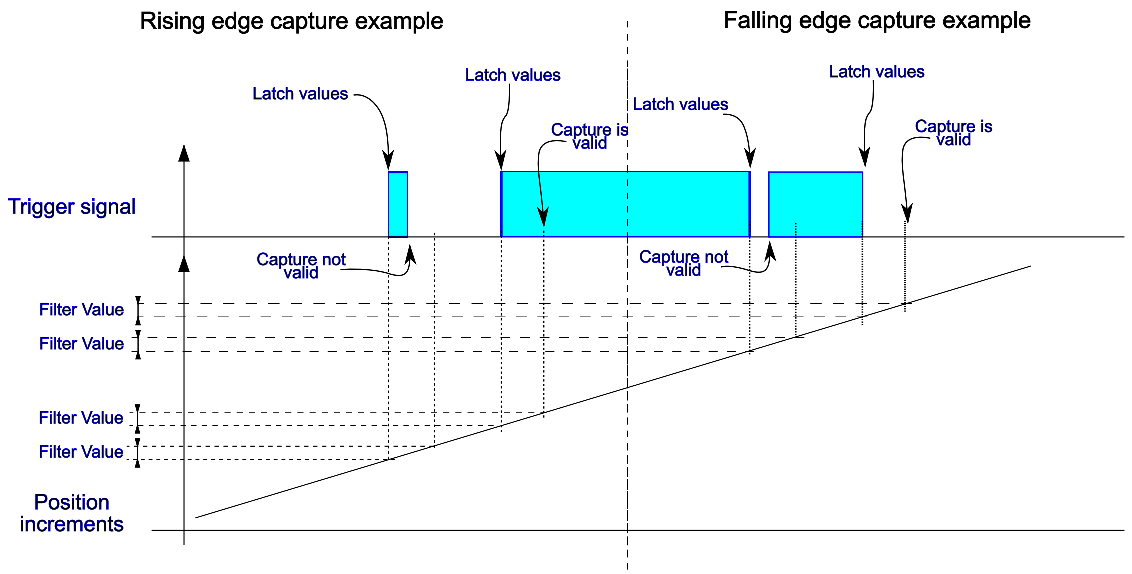


Figure 17.1. Example of filtering of the trigger signal.

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* and *CaptureActiveSlopeValidationFilter_A* for Capture A, and parameters *CaptureRestoreSlopeValidationFilter_B* and *CaptureActiveSlopeValidationFilter_B* for Capture B), and the mode of the symmetric/asymmetric filtering (parameters *CaptureValidationFilterMode_A* for Capture A, and *CaptureValidationFilterMode_B* 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.

Chapter 18

Motion limits

18.1. Electricity limit

To reduce the motor electricity you need to write the parameter *UserPeakCurrent*. Reducing the motor electricity means reducing the motion performances, so reducing the highest supplied torque (*ActualTorqueLimitP*).

18.2. Limit I2T

The I2T limit reduces the electric power which is transferred to the motor during the overload periods. For further details see *Section 13.6, I2T*.

18.3. Torque limit

To reduce the highest supplied torque write the parameter *TorqueLimitSelector* so that you can select the source where the torque limit can be obtained. The torque limit can be limited by:

- only the value of the parameter*PeakCurrent*
- the combination between the *MaxTorque*, *PositiveTorqueLimitValue*,*NegativeTorqueLimitValue*
- the value that has been obtained from the analog input voltage conversion, according to what's reported in*Section 16.3, Conversion*

In any case, in the *ActualTorqueLimitP* and *ActualTorqueLimitN* parameters you can read the value of the torque limits that are really applied to the motor. When a torque limit intervenes, the *Limit reached* Warning activates with the *Torque limit reached* detail.

Torque values calculation procedure
In order to limit the torque to the value T_{Lim}, continue as follows:

1. read the torque constant K_T *TorqueConstant(ForceConstant)*

2. read the stall current I_S *MotorStallCurrent*
3. calculate the stall torque T_S [Nm] as K_T [Nm/A] * I_S [A]
4. calculate the T_{Lim} torque limit expressed in [%I_S] as (T_{Lim}[Nm] / T_S) * 100 or as (I_{Lim}[A] / I_S) * 100
5. multiply the obtained value per 10 to obtain the T_{Lim} torque limit expressed in [%I_S10] and insert this value in the desired torque parameter

Calculation example of *PositiveTorqueLimitValue*
With a DuetHV with a 2.8 Nm motor, we want to limit the torque, in positive direction, to 1Nm and to not limit the torque in the negative direction. by following the above described procedure we obtain:

K_T = 1.6 Nm/A
I_S = 1.75 A
PeakCurrent = 5 A
T_S = K_T [Nm/A] * I_S [A] = 1.6 Nm/A * 1.75 A = 2.8 Nm
T_{LimP} [%I_S] = (T_{Lim} [Nm] / T_S [Nm]) * 100 = (1 Nm / 2.8 Nm) * 100 = 35.7 %I_S
T_{LimN} [%I_S] = (I_{Lim} [A] / I_S [A]) * 100 = (5 A / 1.75 A) * 100 = 285.7 %I_S
PositiveTorqueLimitValue = T_{LimP} [%I_S] * 10 = 35.7 %I_S * 10 = 357 %I_S10
MaxTorque = *NegativeTorqueLimitValue* = T_{LimN} [%I_S] * 10 = 285.7 %I_S * 10 = 2857 %I_S10

18.4. Speed limit

To set the speed limit you need to write the parameter *MaxMotorSpeed*. 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 a speed limit intervenes, the Warning *Limit reached* activates with the *Max motor speed limit reached* detail.

18.5. Limits of hardware position

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 *Chapter 15, Digital inputs and outputs*).

> **Caution**
>
> 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* for torque modes) is higher than 0 and the *Positive limit switch (FC +)* input enables, or *RequestedSpeed* (*Tar-*

getTorque for torque modes) is lower than 0 and the *Negative limit switch (FC -)* input is enabled, the motor stops with a deceleration ramp equal to *QuickStopDeceleration*.

During the deceleration ramp, the CiA402 State Machine goes to the *Quick Stop Active* state and, once the motor has stopped, it goes back to the *Operation enable* state (see *Section 8.4, CiA402 state machine*). When one of the hardware position limits is enabled, the *Limit reached* Warning activates with the related detail (*Positive hardware position limit reached* or *Negative hardware position limit reached*), and remains active until the limitation stops.

Warning

When the drive is in *Operation enable*, *RequestedSpeed* (*TargetTorque* for torque modes) is higher than 0 and the *Negative limit switch (FC -)* input enables, or *RequestedSpeed* (*TargetTorque* for torque modes) is lower than 0 and the *Positive limit switch (FC +)* input enables, the motor does not stop and there are no further signals.

18.6. Limits of software position

To enable the limits of software position you need to write 1 in the parameter *PositionLimitEnable* and write the two limits, the positive and the negative one, in the group *SoftwarePositionLimit*.

When the drive is in *Operation enable*, *RequestedSpeed* (*TargetTorque* for torque modes) is higher than 0 and *PositionActualValue* is greater than *PositionLimitPositive*, the motor stops with a deceleration ramp equal to *QuickStopDeceleration*. When the drive is in *Operation enable*, *RequestedSpeed* (*TargetTorque* for torque modes) is lower than 0 and *PositionActualValue* is lower than *PositionLimitNegative*, the motor stops with a deceleration ramp equal to *QuickStopDeceleration*.

During the deceleration ramp, the CiA402 State Machine goes to the *Quick Stop Active* state and, once the motor has stopped, it goes back to the *Operation enable* state (see *Section 8.4, CiA402 state machine*). When one of the software position limits is enabled, the *Limit reached* Warning activates with the related detail (*Positive software position limit reached* or *Negative software position limit reached*), and remains active until the limitation stops.

Note

If you set *PositionLimitPositive* lower than *PositionLimitNegative* the error *Parameters soft error* enables with detail*Software position limits incompatibility*.

18.7. Profiles limit

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*e *MaxMotorSpeed*: the lowest value between these two parameters, it reduces all speed parameters of the profilers.
- *MaxAcceleration*:limit of all acceleration parameters of the profilers.
- *MaxDeceleration*:limit of all the deceleration parameters of the profilers.

When you have a limitation on at least one parameter of the profilers, the *Motion parameter limited* Warning enables. In *Table 23.14* you can find the error detail with the limited parameters.

Note

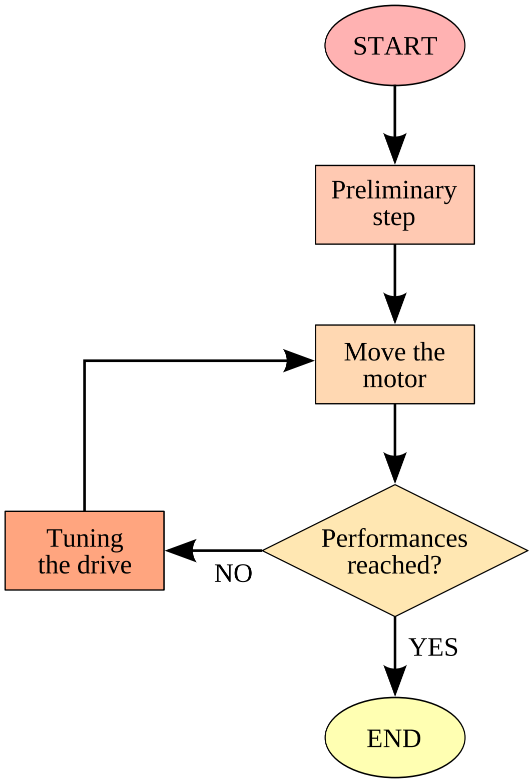
The parameter *MaxMotorSpeed* sets also the speed limit for all drive motions in the operating modes speed or position (see *Section 18.4, Speed limit*).

Chapter 19

System tuning

19.1. How to determine the tuning criterion

To tune the drives of the DuetHV series 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 backlashes. 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 non-scientific 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 19.6, Function Generator*) and then use the motion controller which produces the working cycle the machine is designed for.

> **Caution**
>
> 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 (*Chapter 18, Motion 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* and *SpeedFollowingError*, in some particular points of the working cycle. For example: *PositionFollowingError* lower than X increment after Y milliseconds at the end of the acceleration ramp; *SpeedFollowingError* limited in % during a motion at constant speed; *ActualTorque* 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 DuetHV series must be done by using DuetHVSuite. To tune the loops use one of the following criteria:

- *Section 19.3, Fast tuning guide*
- *Section 19.5, Detailed tuning guide*

ModesOfOperationDisplay	*CurrentLoop*	*VelocityLoop*	*PositionLoop*
Torque	*YES*	*YES*	-
Speed	*YES*	*YES*	-
Position	*YES*	*YES*	*YES*
Homing	*YES*	*YES*	*YES*

Table 19.1. Loop that have to be tuned depending on the operative mode.

Caution

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 (see *Section 21.3, Execute a stop by using the Master*) and the non fatal Fault execute a deceleration ramp, controlled in velocity, to stop the motor.

Warning

Whatever is the selected *ModesOfOperation*, the *Safety profile* executes a movement that's controlled in position. To use the Security profile it's always necessary to tune the position loop.

19.2. 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*, *VelocityLoop*, *PositionLoop*) of the *TuningConfigurations* and of the estimated parameters (*InertiaEstimator* and *RLEstimator*) to the default values
Parameter recalculation of all loops	1102	Recalculate all loops	Recalculation of the loop parameters in relation to the *TuningConfigurations* and to the estimated parameters
Parameter recalculation of motion loops	1103	-	Recalculation of the motion loop parameters in relation to the *TuningConfigurations*, to the estimated parameters and to the*CurrentLoopEstimatedBandwidth*
Parameter recalculation of current loop	1110	Recalculate	Recalculation of the *CurrentLoop* parameters in relation to the *TuningConfigurations* and to the estimated parameters

Name	*SysMng-Command*	Button	Description
Parameter recalculation of speed loop	1120		Recalculation of the *VelocityLoop* parameters in relation to the *TuningConfigurations*, to the estimated parameters and to*CurrentLoopEstimatedBandwidth*
Parameter recalculation of position loop	1130		Recalculation of the *PositionLoop* parameters in relation to the *TuningConfigurations*, to the estimated parameters and to*VelocityLoopEstimatedBandwidth*
Permanent memory: reload value of loops parameters and tuning configuration	2301	Load loops parameters from permanent memory	Updating the loops parameters and the *TuningConfigurations* with the values in the permanent memory

19.3. Fast tuning guide

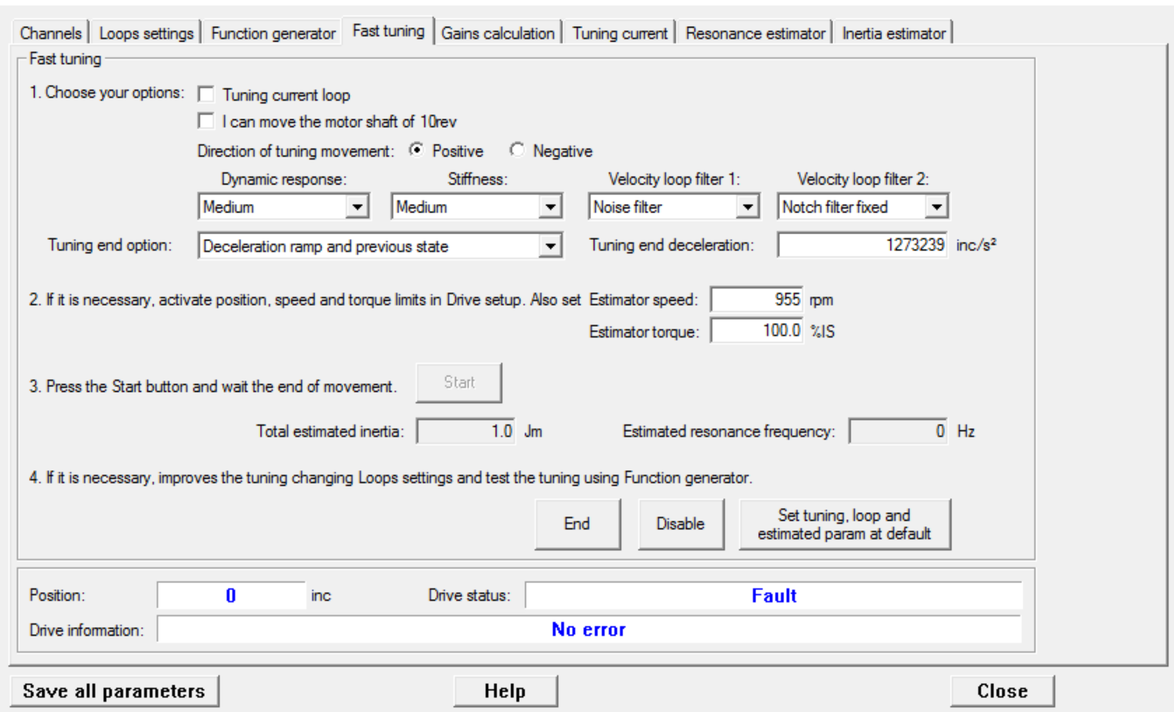
This guide contains the quick criterion to tune the drives of the DuetHV series. The tuning must be run together with DuetHVSuite from the *Fast Tuning* Tab by following step by step the instructions reported in *Section 19.1, How to determine the tuning criterion*. Access:

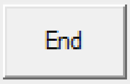
Main menu > **Drive** > **Tuning...** > **Tab Fast tuning**

Toolbar >  > **Tab Fast tuning**.

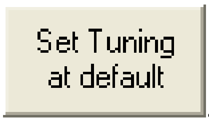
Tip

In case of problems or unexpected situations please see the *Section 24.8, Tuning problems*.



> **Note**
>
> The 
>
> button stops the tuning command according to *Tuning end option* settings.
>
> The 
>
> button ends the tuning command by stopping the motor with maximum deceleration and resetting *RequestedSpeed* and then the drive enters the *Switch On Disabled* status.

0. Setting of the default configuration

The first operation to do is taking the drive in the default tuning configuration: push the button 

. 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. If the performances were not satisfactory, continue with the following points.

1. Options selection

- *Tuning current loop* must be activated to improve the current loop performances (usually it is not necessary). For further details please see*Section 19.7, RL estimator*
- *I can move the motor shaft of 10rev* must be activated if the system mechanics allows the motor to safely move for 10 revolutions. This option requires more accurate the extimation of *EstimatedInertia*. If the motor can move for no more than 1 revolution, then it is however possible to proceed with the *Fast tuning* without selecting this option. If, on the contrary, it is not possible to move the motor, it is necessary to abort the *Fast tuning* procedure and to execute the parameters calculation as reported in *Section 19.4, Gains calculation*.
- *Direction of tuning movement* allows to select the motor movement direction during the tuning operation.
- *DynamicResponse*influences the motor dynamic performances. When the requested dynamic answer increases, the motor answering times and the following errors are reduced. As against, while the dynamic response increases, the stability margins are reduced and eventual electrical or mechanical resonances are amplified. These resonances are not always eliminated by using the filters but it has to be willing to accept a more limited dynamic answer.

- *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*.

- *VelocityLoopFilter1*works on the first filter of *VelocityLoop* and on the sensor filter and can take the following values:
  - User: the tuning commands don't modify the filter parameters
  - Soft filter: the filters are modified to make a *sweet* filtering action of the noise that's present in the loop.
  - Noise 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* is deleted. In this case it can be obtained a faster dynamic response.

- *VelocityLoopFilter2*works on the 2 and 3 filters of the *VelocityLoop* and can take the following values:
  - User: the filters parameters are not modified.
  - Resonance filter: a single filter is inserted to eliminate the constant frequency mechanical resonances
  - Double resonance filter: 2 filters are inserted to *strongly* eliminate the constant frequency mechanical resonances,
  - Debounce filter: a single *Low-pass filter of the first order* is inserted, in order to limit the unwanted effects of the mechanical transmissions if it is not stiff or if it has backlashes.
  - Notch filter fixed: a *Band-eliminating filter* is inserted and set to 350Hz.
  - Disable: the filtering action is deleted.

- *TuningEndOption*and *TuningEndDeceleration* define the operation that are executed when the *End* button (command 100 of the *System Manager*) is pressed or at the end of the tuning movement.

2. Movement limits selection

If necessary, set the movement limits according to what's reported in *Chapter 18, Motion limits* and insert the values of *InertiaEstimatorVelocity* and *EstimatorTorque* that will be used during the tuning movement. In most cases it is not necessary to modify the default values of these two parameters.

3. Tuning movement

By pressing the *Start* button the tuning procedure starts, and automatically stops when the progress bar disappears.

4. Results verification
When the tuning movement is concluded, check that there are no anomalies reported in the *Drive information* field. The oscilloscope shows the step response of the *Velocity loop*. Evaluate the response and, eventually, modify the tuning, according to what's reported in *Section 19.4, Gains calculation*.
To better calculate the total inertia moment as to the motor shaft, see what's reported in *Section 19.9, Inertia estimator*.
To better calculate the mechanical resonances as to the motor shaft, see what's reported in *Section 19.8, Resonance estimator*.

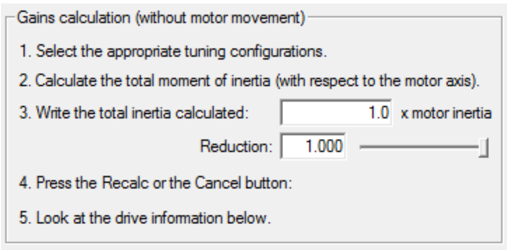
19.4. Gains calculation

This functionality allows to tune the loops parameters without to move the motor. Follow the instructions reported in the *Gains calculation* Tab.

Access with DuetHVSuite:

Main menu > **Drive** > **Tuning ...** > **Tab Gains calculation**

Toolbar >  > **Tab Gains calculation**



1. Options selection
Select the desired configuration, selecting between the available options. The option selection criteria are reported on the point 1 of the *Section 19.3, Fast tuning guide*.

2. Total inertia moment calculation

> **Note**
>
> If the "Fast Tuning" has already been executed, it's possible to directly jump to the next point.

*EstimatedInertia*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. If the mechanical allows the motor movement, it is advisable to execute the calculation of *EstimatedInertia* through the dedicated extimator (see *Section 19.9, Inertia estimator*).

3. Settings of the total inertia moment

Write the calculated inertia value in the dedicated field, and if one of the following cases happens:

- loads with inertia moment greater than 5 Jm, without friction or dumping
- Not rigid mechanical transmission
- consistent backlashes and tolerance in the mechanical transmission

that cannot be solved through the filters options, it's necessary to tune the motor as if the total inertia moment is lower than the estimated value. To do this it's necessary to decrease the value of the *InertiaReductionFactor* parameter (try with 0.8, 0.5, 0.3). Too low values of *InertiaReductionFactor* cut down the motor dynamic performances.

4. Mechanical resonance

> **Note**
>
> If the "Fast Tuning" has already been executed, it's possible to directly jump to the next point.

*EstimatedResonanceFrequency*is the mechanical resonance frequency estimated value. If there are mechanical resonances it's advisable to pay attention to the contents of *Section 19.8, Resonance estimator*.

5. Parameters calculation

Execute the parameters calculation by pressing the *Calculate* button and verify that in the *Drive information* field there are no anomalies reported. If the desired performances have not been reached, restart from the point 1 and select different options, or execute a tuning according to what's described in *Section 19.5, Detailed tuning guide*.

19.5. Detailed tuning guide

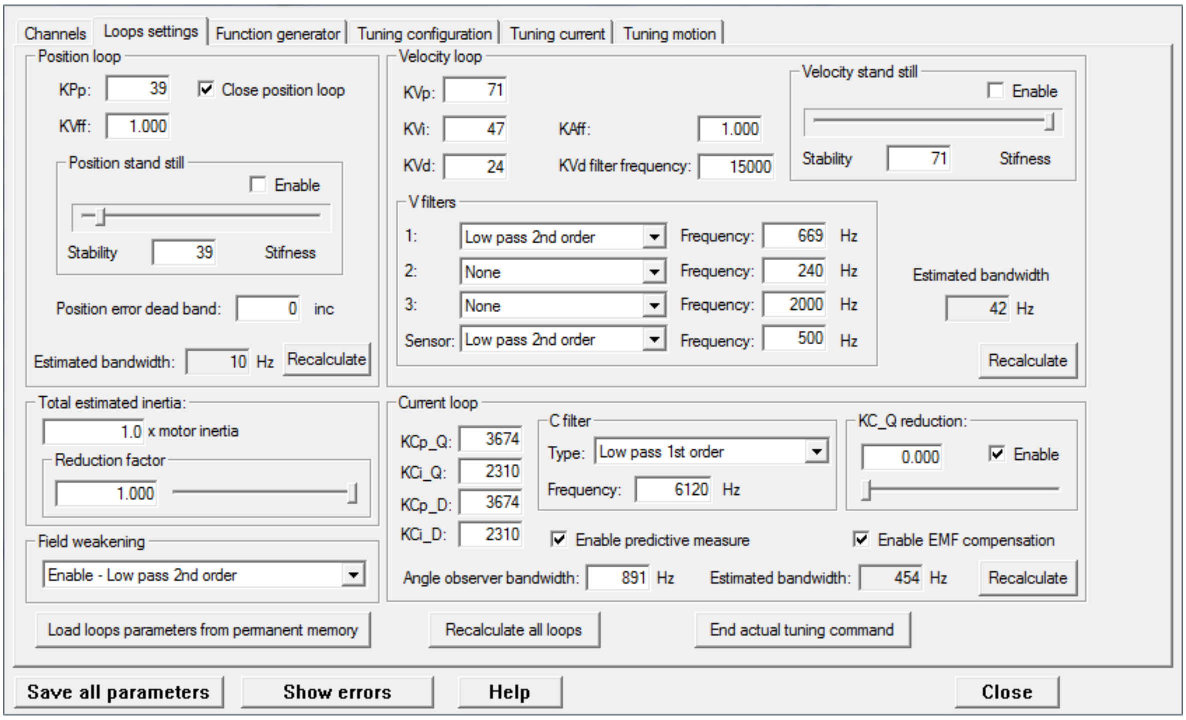
This guide contains the detailed criterion described about the drive tuning of the DuetHV series. The tuning must be carried out together with DuetHVSuite according to the instructions in the *Section 19.1, How to determine the tuning criterion*: each tuning operation must be carried out together with the check of the performances through the motor motion.

> **Tip**
>
> In case of problems or unexpected situations please see the *Section 24.8, Tuning problems*.

Unless differently specified the operations can be run from the tab Loops settings of DuetHVSuite. Access:

Main menu > **Drive** > **Tuning ...** > **Tab Loops settings**

Toolbar >  > **Tab Loops settings**



If you cannot find a parameter in the page, use the parameters vocabulary (*Section 26.9, Loop (1500-1599)*).

1. Parameters estimation

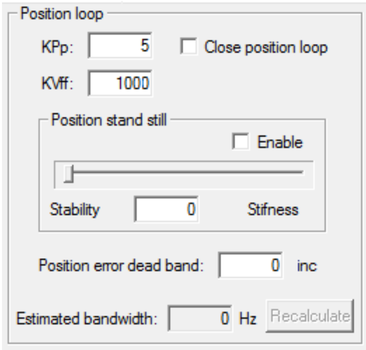
The first operation to be executed is the parameters estimation according to the procedure described in *Section 19.7, RL estimator*, *Section 19.8, Resonance estimator* and *Section 19.9, Inertia estimator*.

2. PositionLoop inhibition

During this step the focus is on the *VelocityLoop* tuning. The *PositionLoop* must be strongly inhibited so that it doesn't influence the dynamic of the *VelocityLoop*. During this step it is accepted that *PositionFollowingError* is slowly controlled. Proceed in this way.

- disable the option*EnablePositionStandStill*

- set *KPp* equal to 4÷5 units when you have *EstimatedInertia* lower than 8 Jm
- set *KPp* equal to 2÷3 units when you have *EstimatedInertia* higher than 8 Jm
- prefer lower values than *KPp* in case of increase of*EstimatedInertia*
- *KPp*can be reset, if it is not important to hold the position or you are going to control the motor only in the velocity modes.



3. System stabilisation

If, on the motor enabling or during a low velocity movement, the system is not stable, it's necessary to stabilize it before to proceed with the tuning. There may be many causes for the instability:

- Presence of a mechanical risonance with a constant frequency. In this case through the *Resonance estimator* it must be obtained the *EstimatedResonanceFrequency* and it is necessary to cut it off by using the *Resonance filter* or *Double resonance filter* options, in the *Gains calculation* Tab.

> **Important**
>
> The *Resonance filter* or *Double resonance filter* options use is useful only if the *EstimatedResonanceFrequency* is constant (see *Section 19.8, Resonance estimator*).

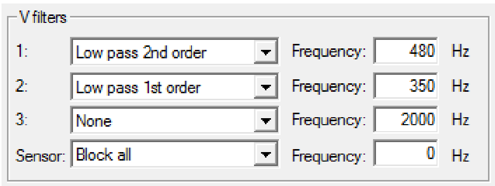
- Too high gains, compared to the load mechanical characteristics (loads with an inertia moment greater than 5 Jm without friction or damping, not rigid mechanical transmission, presence of heavy backlash or tolerance on the mechanical transmission, ...).
  In this case it's necessary to decrease the required dynamic performances by lowering the *DynamicResponse* option and/or decreasing the *InertiaReductionFactor* parameter value (try with 0.8, 0.5, 0.3; too low values of *InertiaReductionFactor* cut down the motor dynamic performances) and/or by selecting the *Debounce filter* option in the *Gains calculation* Tab.

If the operations that have been made in the *Gains calculation* Tab are not sufficient to stabilize the system, pay attention to what's reported in *4. Filters*.

> **Important**
>
> On every action performed in the *Gains calculation* Tab, repeat the point 2(*Position-Loop inhibition*).

4. Filters

The filters of the *VelocityLoop* should be used only if strictly necessary in order to cut off any eventual regulation noise or resonance. To evaluate the need of a filter, try to disable it or, in case it is a low pass filter, try to increase its cutoff frequency. The filters right configuration depends 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):

- remove the *Band-eliminating filter*; select *Type None*
- 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 there are improvements with frequencies higher than 1800 Hz, maybe it's possible to remove 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 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
- if a *Band-eliminating filter* is used, check its performance and modify its selectivity through the quality factor Q (for example, for the filter 2, by using the *VFilter2QFactor* parameter).

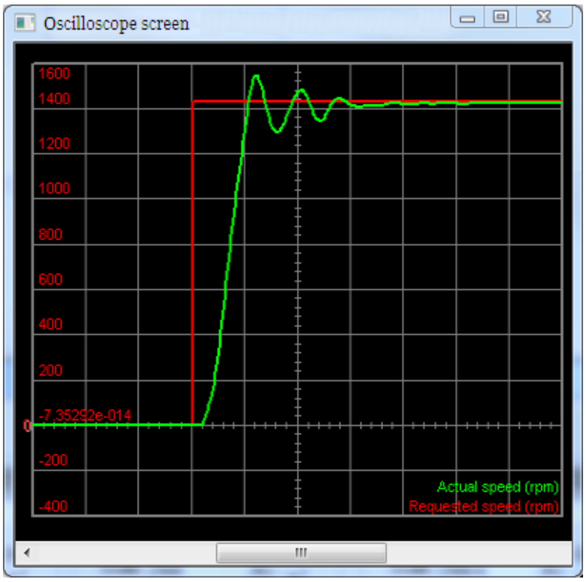
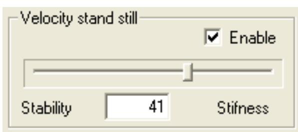


Figure 19.1. Response to the step where can be observed the start of a resonance, then damped.

> **Tip**
>
> In order to reduce the velocity ripple, in presence of sin-cos feedback sensors with a limited sinusoids per revolution number, or in presence of resolvers, it is advised to decrease the *AngleObserverBandwidth* parameter of 50-100Hz at a time even until values close 50Hz are reached, for very slow dynamics.
> If *VFilterSensorType* is a low pass filter and *AngleObserverBandwidth* is lower than *VFilterSensorFrequency*, try to disable *VFilterSensorType* because it probably hasn't any effect on the system.
> Keep in mind that decrease *AngleObserverBandwidth* causes an increasing of the velocity overshoot. Try to find a compromise between the velocity ripple limitation and the overshoots increasing.

5. Velocity stand still

Activate the *EnableVelocityStandStill* option and, by moving the motor with low velocity (with low velocity is meant velocities that are lower than the 30% of the *HighSpeed* parameter), move the *VelocityStandStill* bar as much as possible toward *Stiffness*, in order to increase the motor quickness and stiffness. Moving the bar towards *Stability* eventual noises or resonances are attenuated. Don't move the bar to values lower than 20 units, because the quickness of the motor will be deteriorated.



6. Special parameters

If the resonances persist, modify the following parameters (not all of them are reported in the *Loops settings* Tab), while continuing to test the motor with low speed. Please refer to *Figure 26.1*:

- modify *KVd*, even up to set it to 0. Also try to modify only the filtering action through the parameter*KVdFilterFrequency*
- decrease *WVd* and *WVp* even up to set them to 0
- progressively increase *KVc* in order 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* parameter (verify that the *EnableVelocityStandStill* 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*. If the resonances at the end of the ramp persist, it's necessary to limit the required working decelerations.

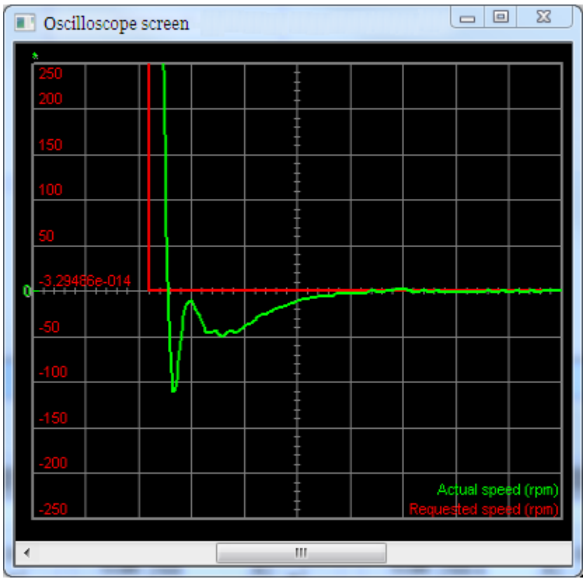
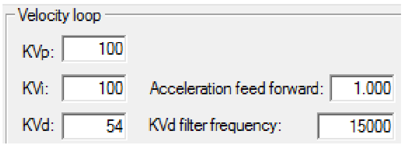


Figure 19.2. Step answer in deceleration with limited overshoot without resonances and prompt error resetting.

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* 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* and *KVi* 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* if the *EnableVelocityStandStill* option is enabled.
- decrease *KVp* and *KVi* to make the system more stable and eliminate the resonances, proceed with decreases of 20% until the system becomes stable. If the option *EnableVelocityStandStill* is enabled, these parameters have less effect for speeds lower than *HighSpeed*. If there are some resonances for speeds much lower than *HighSpeed*, readjust *VelocityStandStill* and the filters.



Note

If the movement noise level or the noise that's overlapped to *VelocityActualValue* don't have reached the desired levels, it's necessary to work again on the regulator filters and parameters. Check that the noise cause is not due to the noise present in the velocity reference (*RequestedSpeed*).

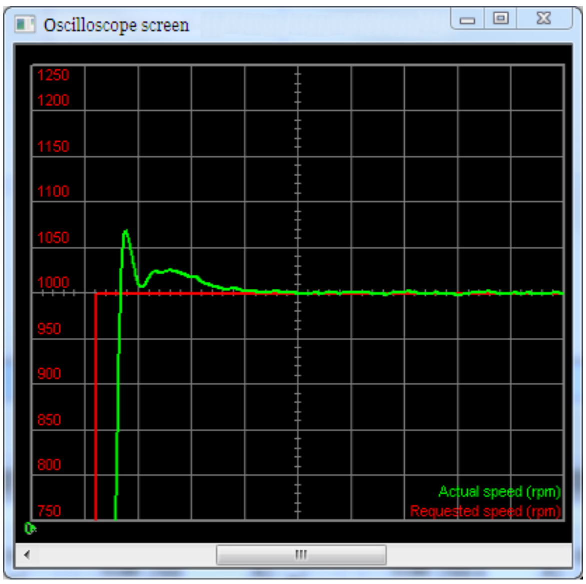


Figure 19.3. Step answer with acceptable overshoot without resonances and prompt error resetting.

10. Feed forward acceleration

To adjust the parameter *KAff* move the motor by commanding accelerations and decelerations similar to the machine working ones. Increase or decrease *KAff* in order to minimize *SpeedFollowingError* during the acceleration and deceleration ramps. If *FeedForwardAcceleration* is noisy, it may be useful to reset to zero *KAff* in order to reduce the noise that enters in the loop. If it's not necessary to tune the *PositionLoop*, then the tuning is finished.

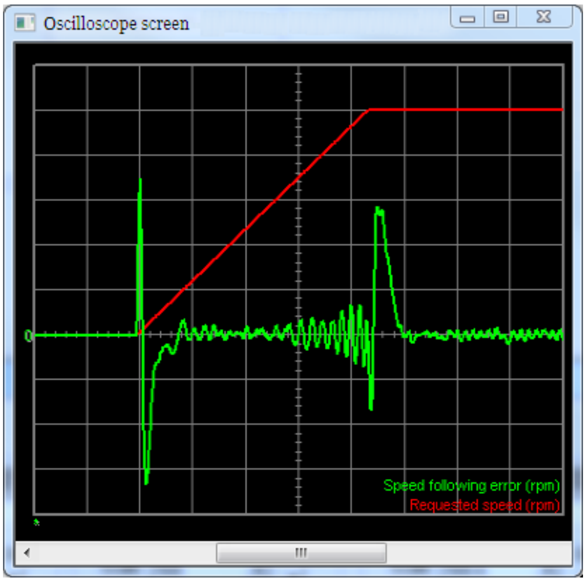
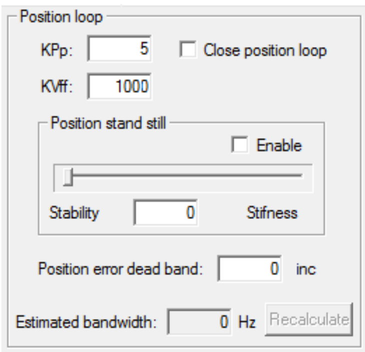


Figure 19.4. Sign change of *SpeedFollowingError* at the ramp beginning: *KAff* too high.

11. PositionLoop (low velocities)

When the *VelocityLoop* is tuned in the best possible way, the *PositionLoop* tuning becomes very easy. Execute some movement with position reference with speeds lower than *HighSpeed* and with the motor stopped in torque, in order to check the following tuning operations:

- Push the *Recalculate* button in the *PositionLoop* area
- activate the *EnablePositionStandStill* option and modify *PositionStandStill* by valuing the effects on the *PositionFollowingError*. Increase its value to increase the resetting speed of the *PositionFollowingError*; decrease its value to eliminate not damped oscillations at low speeds. With the bar at 0, *PositionFollowingError* is not controlled



12. PositionLoop (high velocities)
Proceed with tests with greater velocities, but never greater than the limits; start with a velocity equal to 50% of the *HighSpeed* parameter and increase the velocity over the required working velocity. The position profile that has to be generated should be the one the machine is made for. Check the following tuning operations:

- set the value of *KPp* equal to the value of*PositionStandStill*
- modify *KPp* by valuing the effects on the *PositionFollowingError*. The effect of this parameter is greater for velocities higher than *HighSpeed*. Increase its value in order to maintain low the *PositionFollowingError*; decrease its value if vibrations or resonances appear
- check if *PositionLoopEstimatedBandwidth* is lower at least 0.7 times *VelocityLoopEstimatedBandwidth*.

19.6. Function Generator

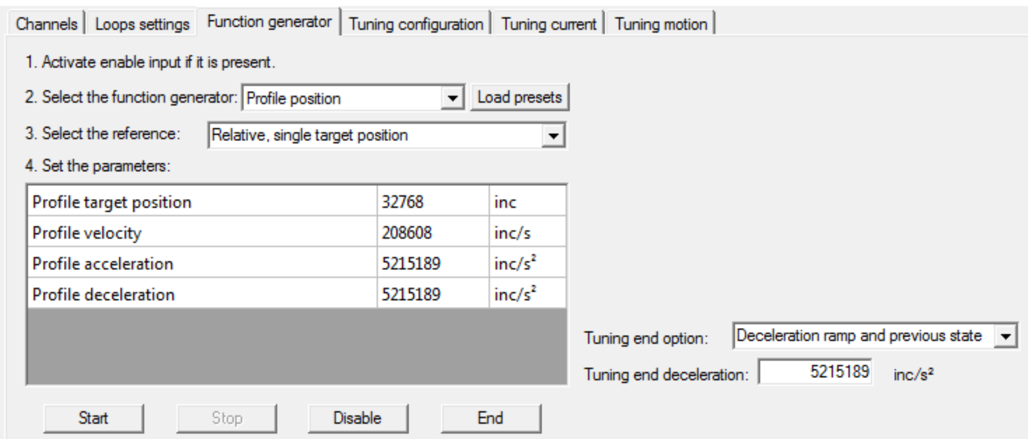
> **Caution**
>
> Before enabling the Function Generator when the drive is not adjusted yet, check if it is possible to stop the motor in safety. To avoid unwanted motions or collisions, take all the necessary precautions and configure precisely the drive limits (*Chapter 18, Motion limits*).

The Function Generator is an integrated functionality of the DuetHVSuite 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** > **Loops settings and tuning** > **Function Generator Tab**

Toolbar >  > **Tab Function Generator**



In the following table you can find the Function Generator functionalities:

<table>
<tr><th>Function-alities</th><th colspan="2">Description</th></tr>
<tr><td rowspan="5">Select the Function Generator</td><td rowspan="5">Choose the Function Generator type</td><td>CurrentLoop D applies to RequestedField the generated reference</td></tr>
<tr><td>CurrentLoop Q applies to RequestedTorqueCurrent the generated reference</td></tr>
<tr><td>Speed loop applies to RequestedSpeed the generated reference</td></tr>
<tr><td>Profile velocity generates a speed motion with linear acceleration ramps</td></tr>
<tr><td>Profile position runs some positionings with linear acceleration ramps</td></tr>
<tr><td>Load presets</td><td colspan="2">Set some default values for the selected reference and the oscilloscope</td></tr>
<tr><td rowspan="17">Select the reference</td><td rowspan="17">Select the reference type</td><td>Stop</td></tr>
<tr><td>Step</td></tr>
<tr><td>Step (time limited)</td></tr>
<tr><td>Square wave</td></tr>
<tr><td>Square wave (time limited)</td></tr>
<tr><td>Sinusoidal wave</td></tr>
<tr><td>Sinusoidal wave (time limited)</td></tr>
<tr><td>Profile velocity unlimited standard</td></tr>
<tr><td>Profile velocity time limited</td></tr>
<tr><td>Profile velocity time limited, forward and backward, single sequence</td></tr>
<tr><td>Profile velocity time limited, forward, multiple sequence</td></tr>
<tr><td>Profile velocity time limited, forward and backward, multiple sequence</td></tr>
<tr><td>Profile position, absolute target position</td></tr>
<tr><td>Profile position, relative, single target position</td></tr>
<tr><td>Profile position, relative, forward and backward, single sequence</td></tr>
<tr><td>Profile position, relative, forward, multiple sequence</td></tr>
<tr><td>Profile position, relative, forward and backward, multiple sequence</td></tr>
<tr><td>Start</td><td colspan="2">Start the reference</td></tr>
<tr><td>Stop</td><td colspan="2">Stop the reference and keep the drive enabled</td></tr>
<tr><td>Disable</td><td colspan="2">It ends the Function Generator by stopping the motor with maximum deceleration and resetting RequestedSpeed and then the drive enters the Switch On Disabled status</td></tr>
<tr><td>End</td><td colspan="2">End the Function Generator following Tuning end option</td></tr>
<tr><td rowspan="3">TuningEndOption</td><td rowspan="3">Options for the Function Generator end command</td><td>Immediately disable, the motor is stopped with maximum deceleration resetting RequestedSpeed to zero and then the drive has the Switch On Disabled state</td></tr>
<tr><td>Decelaration ramp, the motor is stopped with deceleration equal to Tuning end deceleration</td></tr>
<tr><td>Zero speed, the motor is stopped with maximum deceleration by resetting RequestedSpeed</td></tr>
<tr><td>TuningEndDeceleration</td><td colspan="2">Deceleration for the Function Generator end command</td></tr>
<tr><td>Drive status</td><td colspan="2">Drive status (Statusword)</td></tr>
<tr><td>Drive information</td><td colspan="2">Function Generator status (SysMngError)</td></tr>
</table>

When using the Function Generator, bear in mind as follows:

1. it is not possible to change Function Generator without using the End command
2. 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
3. before starting a reference, set its parameters and Tuning end option and Tuning end deceleration
4. at the references end, that end after a given period, the drive is always enabled
5. the references of time limited type end after a time period equal to the parameter Duration
6. the references of sequence type generate some profiles which are separated among them by a time period equal to the parameter Profile interval
7. when a reference is started and you close the window Oscilloscope, the End command is run
8. if the motor can run motions only in one direction, set properly the reference parameters
9. if the requested reference ends before the end of the answer transient, increase properly the reference parameters to increase its duration

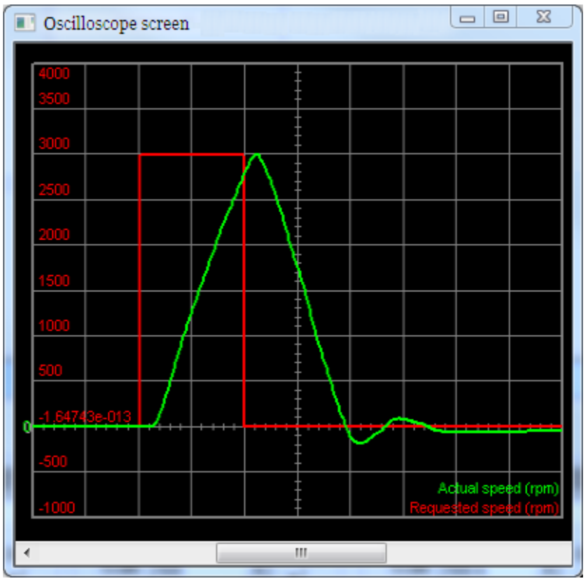


Figure 19.5. Example of reference concluding before the end of the speed transient.

10. if the oscilloscope capture ends before the Function Generator has finished and it does not show all the reference and answer progress, increase the oscilloscope sampling time.

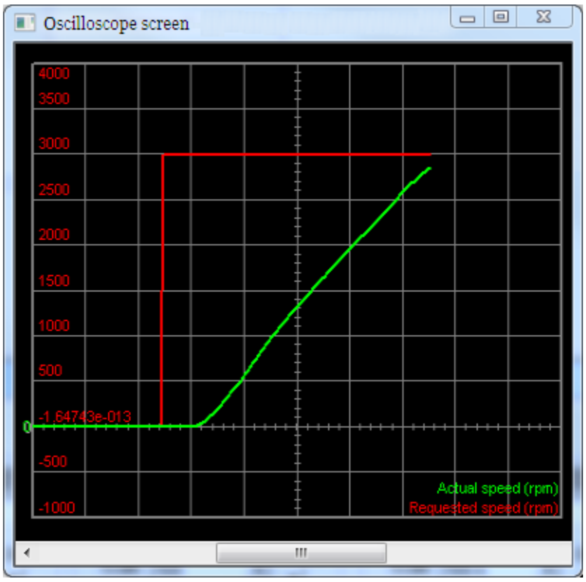


Figure 19.6. Example of too short capture ending before the Function Generator has finished.

19.7. 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 offline estimation of these 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 value (see *RLEstimator* group parameters), the parameters of the speed and position loops are calculated again.

Warning

During the RL estimation, the motor is free to move. Therefore, in case of vertical load or relevant disturbing forces on the load, the estimation should be executed unmounting the motor and without mechanics and not with the motor connected to the machine mechanics.

Important

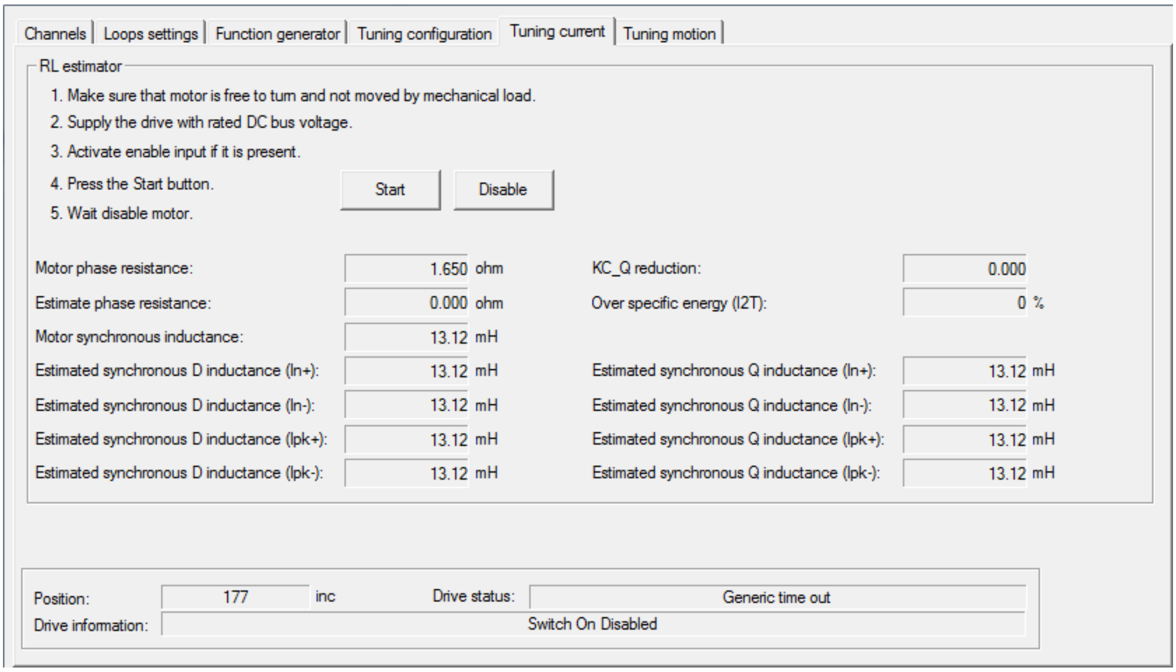
The *EstimatedPhaseResistance*, *EstimatedLDNominalP*, *EstimatedLDNominalN*, *EstimatedLDPeakP*, *EstimatedLDPeakN*, *EstimatedLQNominalP*, *EstimatedLQNominalN*, *EstimatedLQPeakP*, *EstimatedLQPeakN* parameters cannot be downloaded through the parameters file because they are specific for every axis. On the contrary, the parameters file download reset them to the default value.

To estimate RL follow the instructions reported in the *RL Estimator* area in the *Tuning current* Tab.

Access with DuetHVSuite:

Main menu > **Drive** > **Tuning ...** > **Tab Tuning current**

Toolbar >  > **Tab Tuning current**



Warning

During the RL estimation the *I2TValue* 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.

Important

Considering that the current pulses reach *MotorPeakCurrent*, be sure that the voltage supply *DCBusVoltage(+HV)* remains stable during the command.

Tip

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.

19.8. Resonance estimator

The *Resonance Estimator* serves to evaluate if some mechanical resonances with *constant frequency* are present. Through the application of a variable torque, with null average, with maximum amplitude of *EstimatorTorque*, in order to generate a controlled vibration, the drive obtains and shows the frequency response of the mechenical load and determines *EstimatedResonanceFrequency*. The main chart reading purpose is to point out the eventual resonance peaks, their frequency and their band width. The resonance peak can be eliminated by setting a band-stop filter with the peak central frequency.

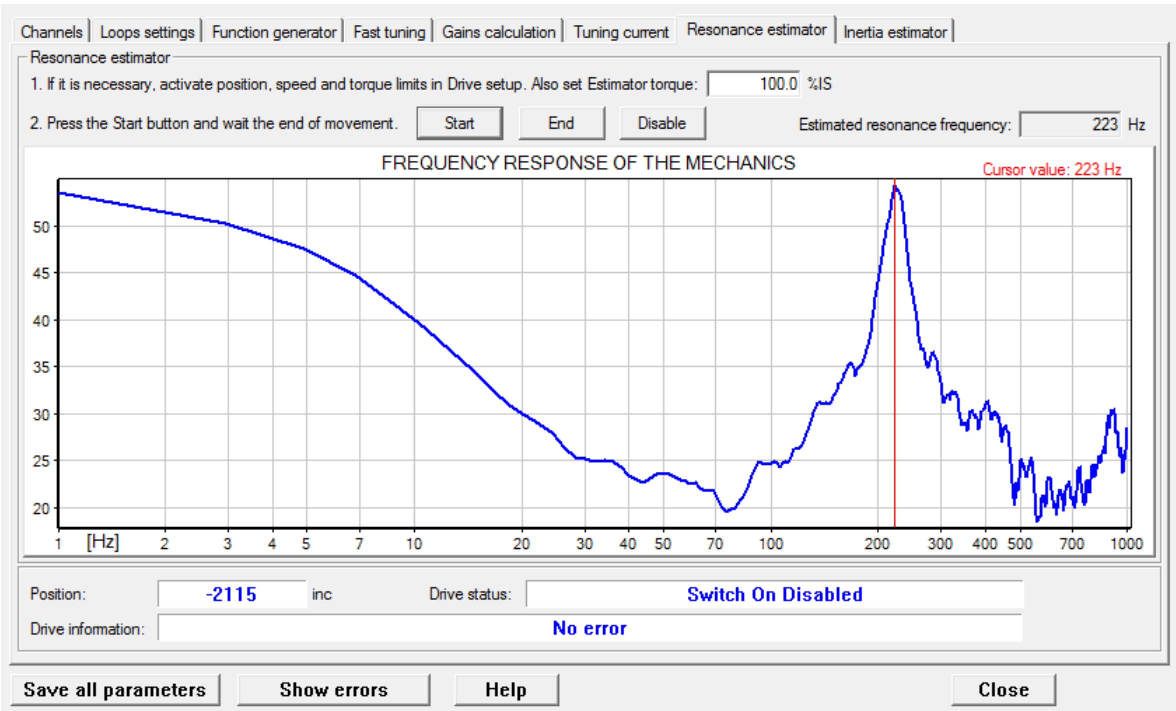
> **Important**
>
> During the mechanical resounances estimation, the motor is free to move. Therefore, in case of vertical load or relevant disturbing forces on the load, the estimation cannot be executed.

For a correct estimation of *EstimatedResonanceFrequency* follow the instructions reported in the *Resonance estimator* Tab:

Access with DuetHVSuite:

Main menu > **Drive** > **Tuning ...** > **Tab Resonance estimator**

Toolbar >  > **Tab Resonance estimator**



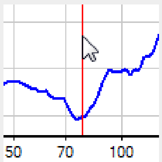
Tip

Try with different values of *EstimatorTorque*. According to the machine structure and typology, try by positioning the load that's connected to the motor, in different positions of the working cycle.

Important

If when the *EstimatorTorque* value or the axis position change, the resonance frequency peak moves in the chart for a significant quantity, don't use the *Resonance filter* or *Double resonance filter* options, in the *Gains calculation* tab, because a band-stop filter is not sufficient to cut off the resonance.

Note



The drive recognize the resonance peaks for frequences higher than 10Hz. If in the chart there are resonance peaks higher than or significant compared to the one that has been automatically found, drag the red cursor to the desired position in order to read the frequency value. Then recalculate the gains in the Gains calculation tab by setting the found resonance frequency, by selecting the Resonance filter or Double resonance filter options.

19.9. Inertia estimator

Caution

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 (*Chapter 18, Motion limits*).

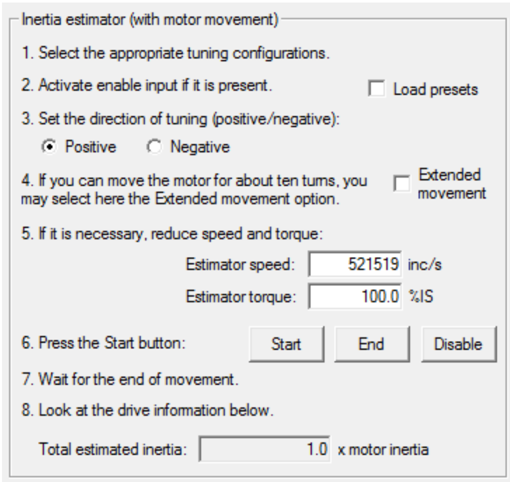
The *Inertia estimator* executes a controlled movement of the motor in order to estimate the total inertia moment, calculating according to the motor shaft. The estimated inertia moment (Total *EstimatedInertia*) is used to automatically calculate the parameters of the speed and position loops. Follow the instructions reported in the *Inertia estimator* Tab.

> **Important**
>
> In case of vertical load or relevant disturbing forces on the load, the estimator produces wrong results. Its use is not recommended.

Access with DuetHVSuite:

Main menu > **Drive** > **Tuning ...** > **Tab Inertia estimator**

Toolbar >  > **Tab Inertia estimator**



1. Options selection

- *I can move the motor shaft of 10rev* must be activated if the system mechanics allows the motor to safely move for 10 revolutions. This option requires more accurate the extimation of *EstimatedInertia*. If the motor can move for no more than a quarter of revolution, it's anyway possible to proceed with the estimation without selecting this option. If, instead, it's absolutely not possible to move the motor, the estimation can't be executed.
- *Direction of tuning movement* is used to select the direction of the movement of the motor during the estimation.
- *Load presets* automatically sets the oscilloscope for a correct estimation evaluation.
- *TuningEndOption*and *TuningEndDeceleration* define the operation that are executed when the *End* button (command 100 of the *System Manager*) is pressed or at the end of the tuning movement.

2. Movement limits selection

If necessary set the movement limits according to what's reported in *Chapter 18, Motion limits* and insert the *InertiaEstimatorVelocity* and *EstimatorTorque* values that will be used during the estimation. In most cases it is not necessary to modify the default values of these two parameters.

3. Estimation movement

By pressing the *Start* button the estimation procedure starts, and automatically stops when the progress bar disappears. Then, check that there are no anomalies reported in the *Drive information* field. If the *Load presets* button has been pressed, the oscilloscope automatically shows the trend of some variables that are important to evaluate the estimation quality.

4. Advised procedure to estimate the inertia moment

a. If possible, select the *Extended movement* option. Select the estimation direction and push *Load presets*.
b. Set the motor in order to run the requested motion. Take all the necessary precautions and configure precisely the drive limits (*Chapter 18, Motion limits*).

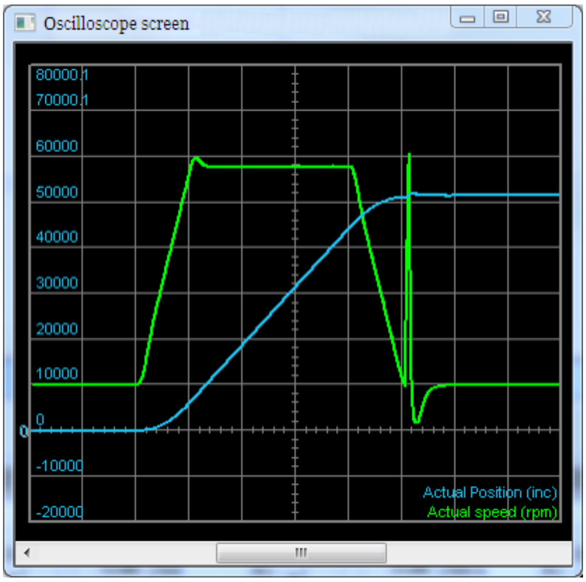


Figure 19.7. Example of speed and position progress obtained through the selected option Extended movement (*EncoderIncrements* is 8000 inc/rev).

c. Press *Start*.
d. When the movement is finished, control the informations that are reported in the *Drive information* field.
e. Unselect the *Extended movement* option.
f. Position the shaft so that it is possible to run the requested motion and check if the shaft reaches the machine position limits.
g. Press *Start*.
h. When the movement is finished, control the informations that are reported in the *Drive information* field.

i. Check if the result of the estimate Total *EstimatedInertia*, is approximately coherent with the applied load.
j. Run for some times the tuning command by starting from the point f and check if the estimation does not sensibly change. Variations of 10-20% can be tolerated.

> **Tip**
>
> In case of heavy friction, increase *EstimatorTorque* up to the nominal value.

5. Inertia moment estimation verification
To verify the estimation, use the oscilloscope. If the *Load presets* button has been pushed, the oscilloscope is automatically set for this aim.
During the first phase of the estimation, while the torque step is applied, the velocity should be a linear ramp (with the *Extended movement* option unselected).

> **Tip**
>
> In general, if there are some vibrations during ther first phase of the estimation, try to repeat decreasing the value of *EstimatorTorque*.
> In order to limit the velocity and the position reqched during the estimation, the *InertiaEstimatorVelocity* value can be decreased.
> In case of transmission with chains, backlash or plays, reduce the value of *EstimatorTorque* in order to maintain as linear as possible the velocity ramp, during the first step of the estimation.

- During the first phase of the estimation, the more the velocity ramp is linear the better the estimation is (see the following figure).

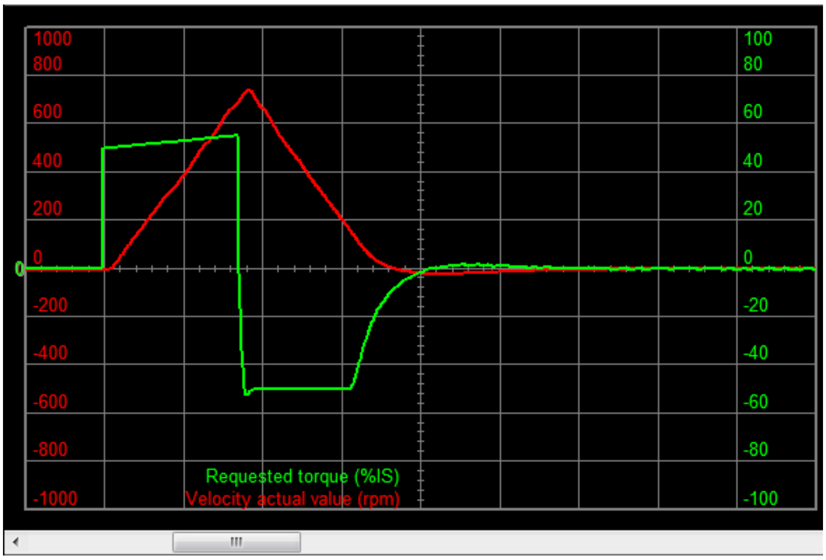


Figure 19.8. Example of a correct estimate of the inertia moment.

- If there are vibrations during the first phase of the estimation, but the velocity profile is quite a linear ramp, specially in the final part of the ramp, the estimation can be considered reliable (see the following figure). Consider however, during the tuning, a possible presence of mechanical elasticities of the load (see *Section 24.8, Tuning problems*).

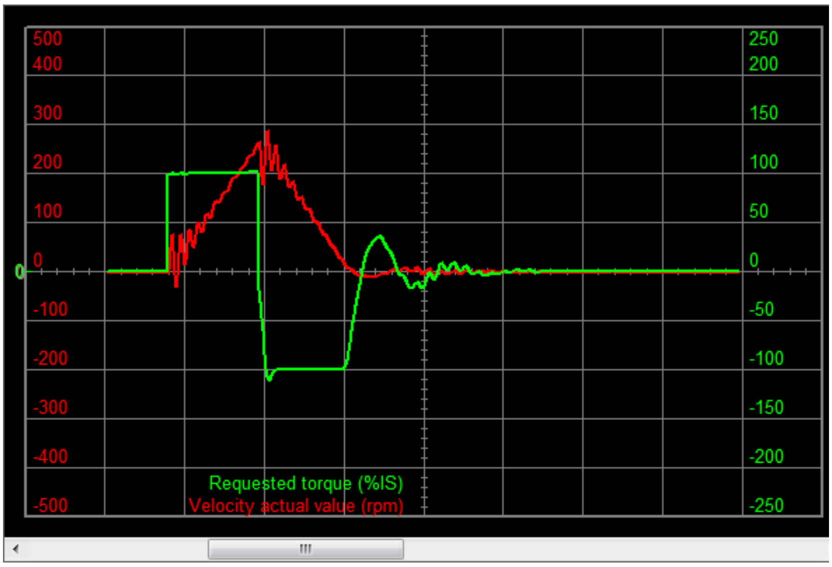


Figure 19.9. Example of a correct estimation of the inertia moment with vibrations.

- If there are some heavy vibrations during ther first phase of the estimation, it's probable that the mechanical transmission is too elastic (see the following figure). In this case the estimation is not reliable and it is necessary to make the correct operations during the tuning (see *Section 24.8, Tuning problems*).

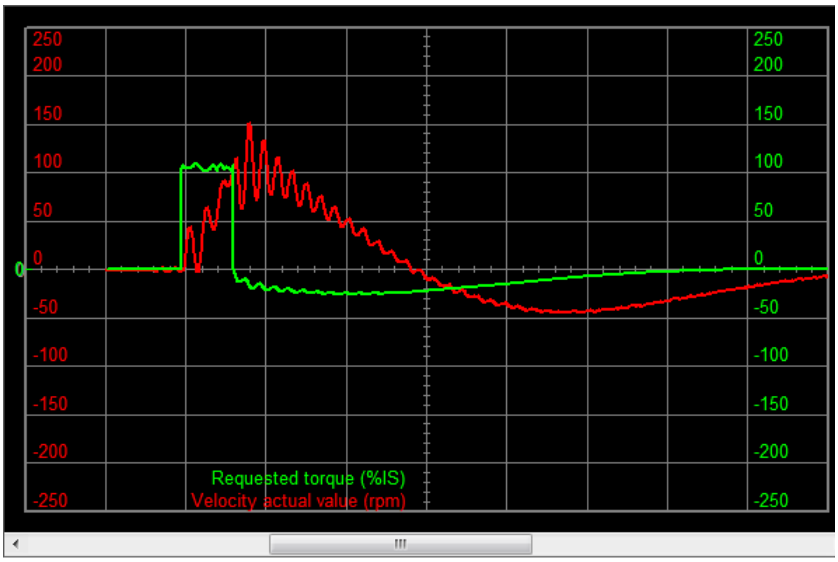


Figure 19.10. Example of a not valid estimation, with not rigid mechanical transmission.

- During the first phase of the estimation, when there is backlash in the transmission, the velocity will rise rapidly and then decrease, and may even reverse direction when the transmission engages. If this velocity "bounce" lasts for the entire first phase, then the estimation is not reliable (see the following figure). In any case it's necessary to consider the presence of this behaviour during the tuning (see *Section 24.8, Tuning problems*).

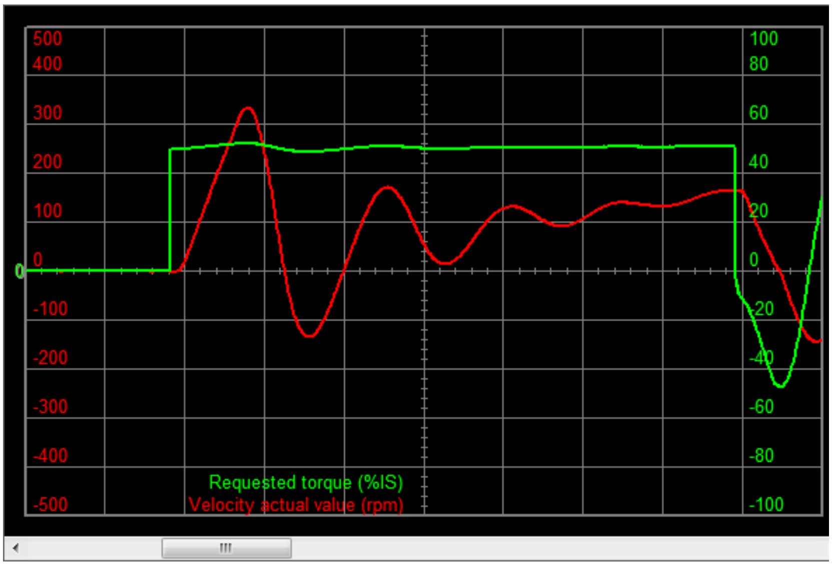


Figure 19.11. Example of a not valid estimation due to backlashes in the transmission.

6. Verification of the tuning configuration, calculated by the inertia moment estimator

The second phase of the estimation is a quick stop of the motor, that uses the loop parameters that have been recalculated according to the measured value of Total*EstimatedInertia*. evaluating this phase, we can get the following conclusions:

- If the stop has a behaviour similar to the one that's reported in *Figure 19.8*, so without vibrations, without noise and with a little and immediatly damped overshoot, then the velocity loop tuning is finished without problems.
- Otherwise, if the stop presents a behavious similar to the one that's reported in*Figure 19.9*, so with little and immediatly damped vibrations, the system is however stable and it's better to improve its stability (see the points *3. System stabilisation* and *4. Filters* of the *Detailed Tuning Guide*).
- At last, if the stop presents a behavious similar to the one that's reported in*Figure 19.10*, so with wide and persistent vibrations, the system is unstable and it has to be stabilized (see the points *3. System stabilisation* and *4. Filters* of the *Detailed Tuning Guide*).

Chapter 20

Saving, restoring or cloning the drive configuration.

20.1. Drive configuration

By *configuring the drive* it is meant to configure all the parameters of the vocabulary. The drives of the series DuetHV provide some commands to manage in an organic way (not only according to a single parameter) the current configuration. The configuration management of the drive is summarized in the following image.

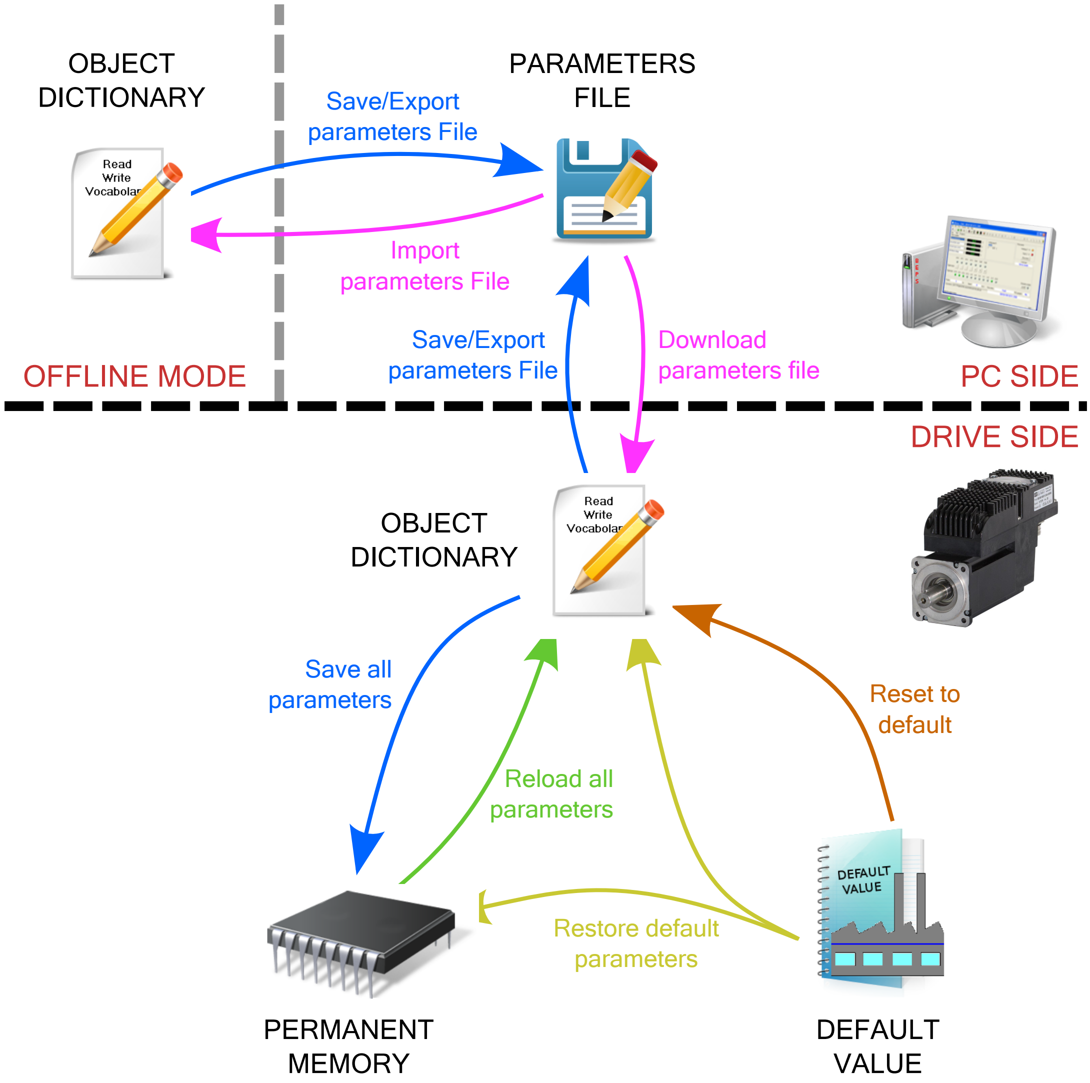


Figure 20.1. Commands for the configuration management of the drive.

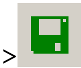
Command	*System Manager*	Description
Save/Export parameters file	DuetHVSuite reserved	Saving the current configuration on parameter files
Import parameters file	DuetHVSuite reserved	Updating the current configuration with all the data in a parameter file (mode *Offline*)
Download parameters file	DuetHVSuite reserved	Updating the current configuration with all the data contained in a parameter file (mode Online)
Save all parameters	2001	Saving the current configuration in the drive permanent memory
Restore default parameters	2200	Updating the current configuration and the permanent memory with the default values
Reset to defaults	2201	Updating the current configuration with the default values
Reload all parameters	2300	Updating the current configuration with all the data in the permanent memory

Command	*System Manager*	Description
Reload value of loops parameters and tuning configuration	2301	Updating the loops parameters and the *TuningConfigurations* with the values in the permanent memory

20.2. Saving/Exporting parameters file

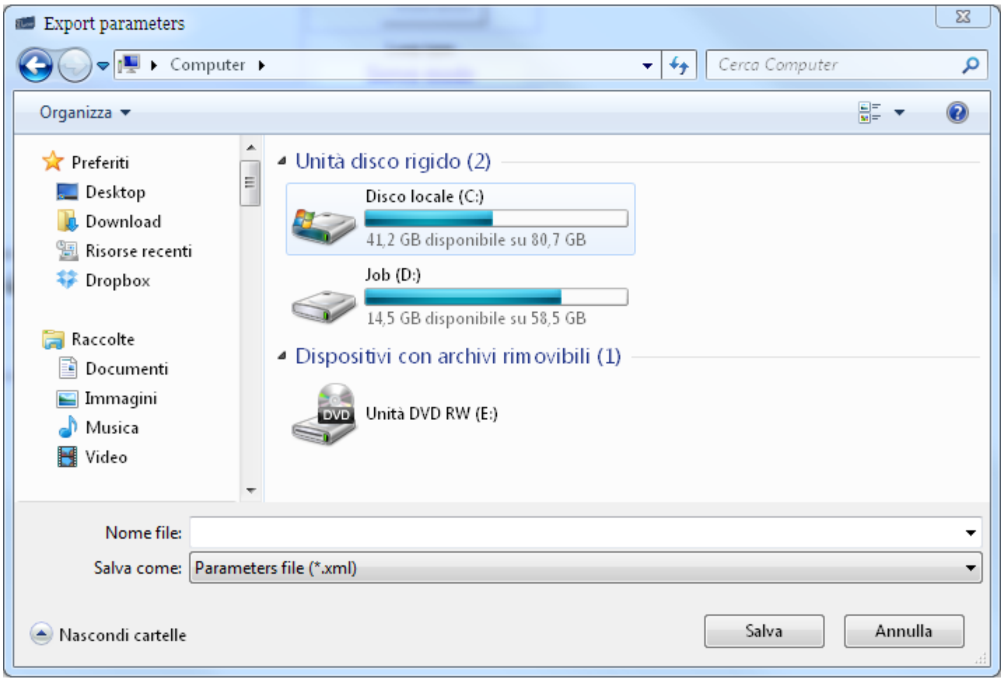
To export the drive parameters on a file, in order to save them in an archive or download them in other drives, please follow this procedure. Access with DuetHVSuite:

Main menu > **Drive** > **Save/Export parameters...**

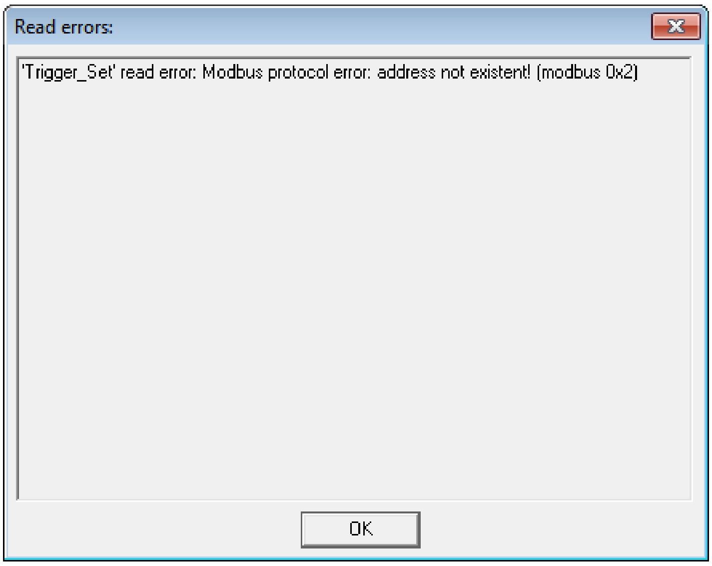
Toolbar > 

Choose the directory and the name of the destination file in the window Export parameters and press 

.



Some problems that may occur while exporting the parameters
If there is an error in reading one or more parameters, the user is informed through a notice, as the one shown in the following window, that contains the list of the errors.



In this case it's convenient:

i. to update DuetHVSuite and the configuration files (*Section 25.1, DuetHVSuite updating*)
ii. to update the firmware with the latest available version (*Section 25.3, Firmware updating*)
iii. to interpret the error details (*Section 8.3, Errors in reading / writing of the parameters*)

20.3. Downloading parameters file

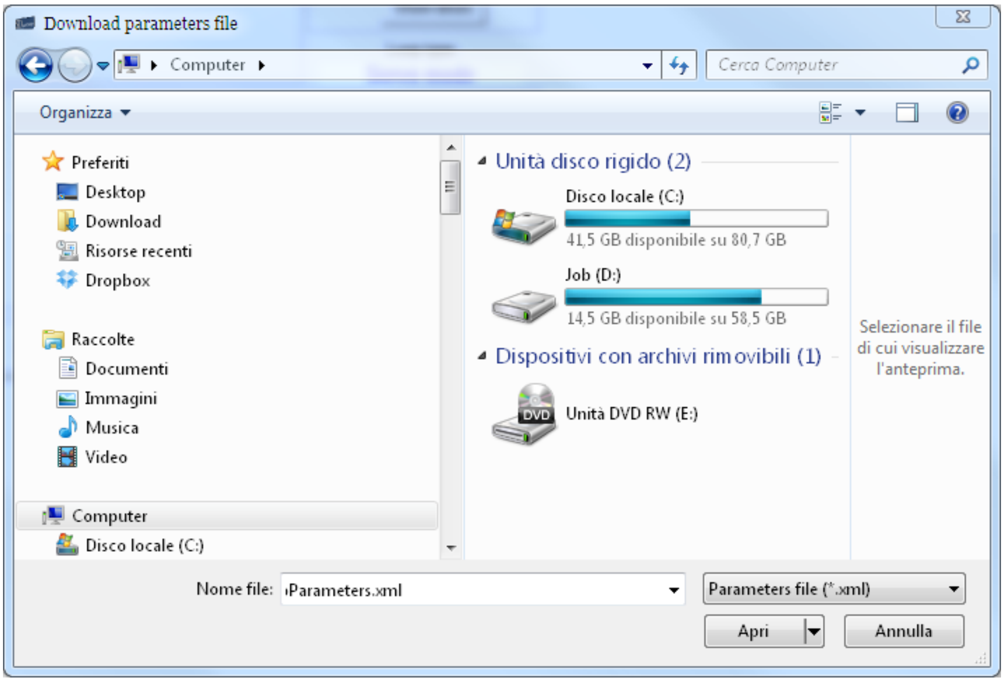
To update the drive parameters with a previously created parameters file, please use the following procedure. Access with DuetHVSuite:

Main menu > **Drive** > **Download parameters file...**

Toolbar > 

Choose in the window Download parameters file the parameters file to download in the drive and press 

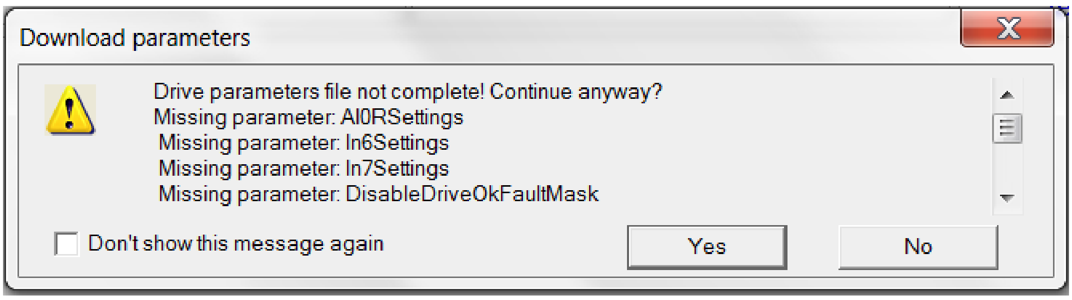
.



> **Note**
>
> The parameters downloaded in the drive are not automatically saved in the internal permanent memory.

Some problems that may occur while downloading the parameters

1. If case of downloading in a drive a parameter file generated with a firmware that's older than the actually installed one, the user is informed through a notice, as the one shown in the following window, that contains the list of the missing parameters.

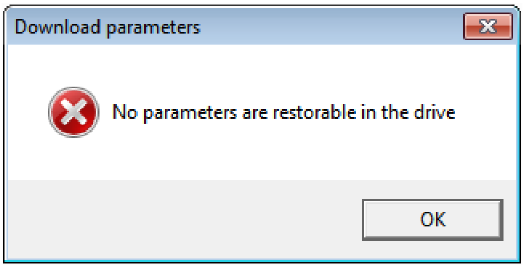


In this case it is sufficient to:

i. confirm and proceed with the downloading of the parameter file, even if it is incomplete

ii. save a new parameter file, that will be in this way generated compatible with the firmware that's actually installed and includes the parameters that have just been downloaded.

2. If the following window appears, it means that this function is not available because of the firmware version that's installed in the drive. In this case it is necessary to update the firmware (*Section 25.3, Firmware updating*).



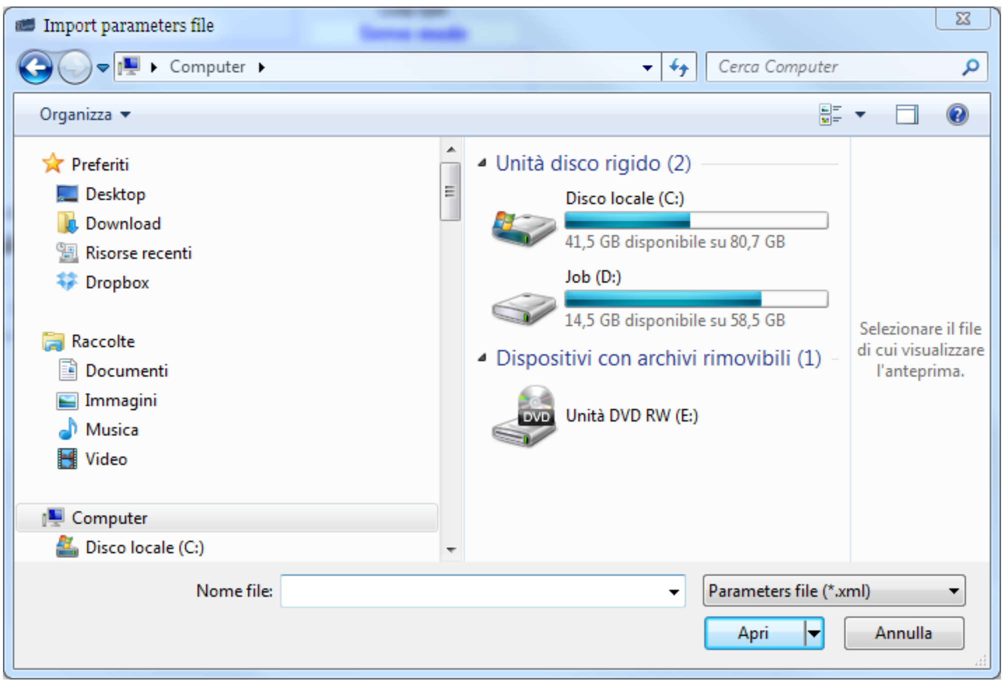
20.4. Importing parameters file

To change the parameters file during the *Offline* mode, please follow this procedure. Access with DuetHVSuite:

Main menu > **Drive** > **Import parameters file...**

Toolbar > 

Choose in the window Import parameters file, the directory and the file name to import and press .



> **Note**
>
> Any changes in the imported parameters file are not automatically saved in the file. To save changes in the parameters file in Offline mode, use the command *Save/Export parameters file*.

20.5. Compare parameters file

The DuetHVSuite environment provides an instrument to compare 2 parameters files. This method can be even used to verify the differences between the currently configured parameters and the default configuration. Access with DuetHVSuite:

Main Menu > **Drive** > **Compare parameters ...**

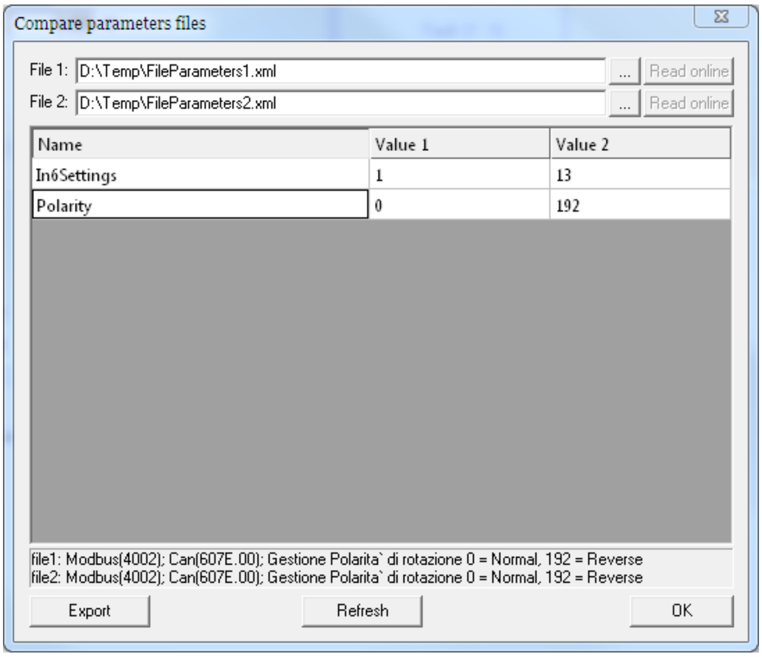
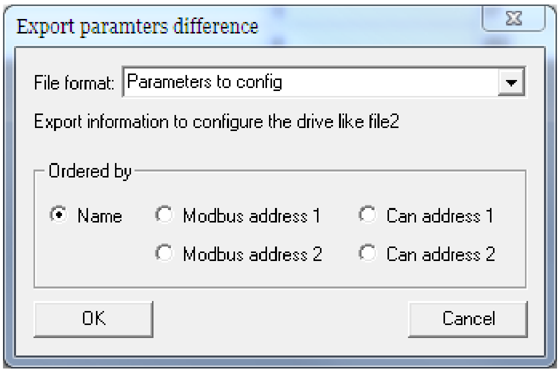


Figure 20.2. Compare of 2 parameters

Here follow the steps to execute the compare function:

1. Insert in the *File1* field the reference parameters file (.xml).
2. Insert in the *File2* field the parameters file (.xml) that you want to compare.
3. If a difference appears in the window, click on it to read its details in the text area on the bottom.
4. If you modify a file, click on the *Refresh* button to update the comparing.
5. To export the differences, click on the *Export* button and select the exportation mode:



a. *Full Text Exportation:* to export in a ".txt" file the list of data of every parameter that results different or not present (in one of the two files) after the comparing.

b. *Parameters to config:* in order to export in a ".txt" file the list of the data, referring to the file that's inserted in the *File2* field, that are necessary to write the parameters in the drive through a NON MPC Master: Modbus addresses , Parameters name and Priority[1].

> **Important**
>
> The files that have been obtained with the export operation ARE NOT PARAMETERS FILES (therefore they cannot be directly downloaded in the drive through DuetHVSuite), but only simple text files, that contain the list of the differences between the 2 parameters files. The purpose of those files is, as well as to list the differences, to provide the data that are necessary to write in the drive, through a NON MPC master, the parameters that result different after the comparing.

> **Note**
>
> If you want to compare a parameter file with the actual drive parameterization, it's sufficient to load the first one and to use the "Read Online" function for the second one. This function creates a temporary file that will be used to compare operation and that will be automatically deleted on the Compare window closing action.

[1] The priority value is used to determine the writing order of the parameters. A parameter with a lower priority value must be written before, while a parameter with a higher priority value must be written after. The parameters with the same priority value can be written in any order.

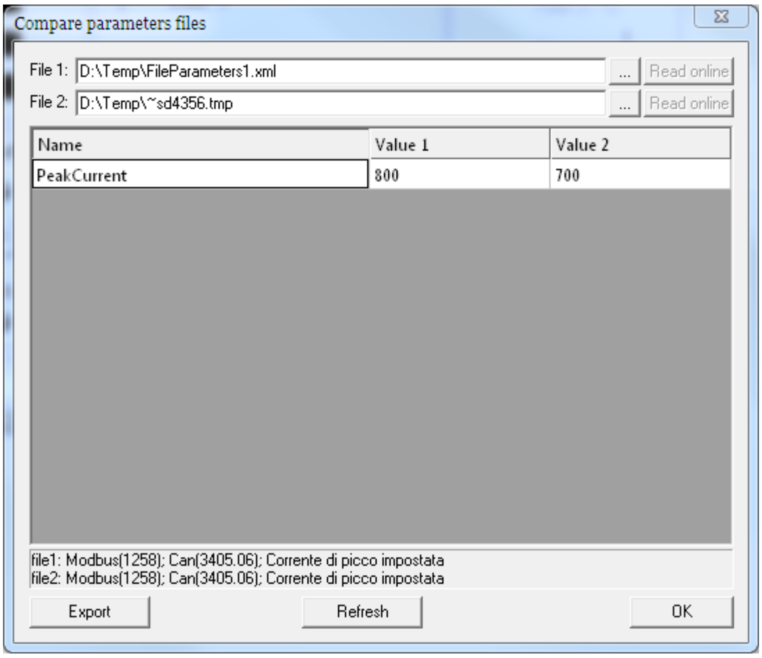


Figure 20.3. Compare of a parameter file with the current drive parameters.

20.6. Parameters cloning

For *cloning* it is meant the copy of only the configuration parameters from a drive to another one. It will be not executed any firmware update.

> **Warning**
>
> The cloning procedure is guaranteed only if the two drives have the same firmware version. If the drives are not aligned, you have to update the drives with the desired firmware version.

Parameters cloning with DuetHVSuite

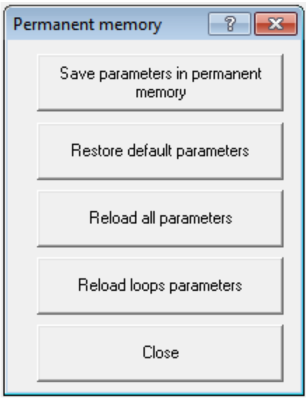
1. Connect to the drive that has to be cloned and export the parameter file (see *Section 20.2, Saving/Exporting parameters file*).
2. Connect to the drive that has to be configured and import the saved parameters file (see *Section 20.3, Downloading parameters file*).

20.7. Permanent memory

Management of the current configuration with the permanent memory. Access with DuetHVSuite:

Main menu > **Drive** > **Permanent memory...**

Toolbar >



To save the current configuration in the drive permanent memory, press Save parameters in permanent memory (available also in Drive setup) or use the command 2001 of *System Manager*.

To update the current configuration and the permanent memory with the default values, press Restore default parameters or use the command 2200 of *System Manager*.

To update the current configuration with the data in the permanent memory, press Reload all parameters or use the command 2300 of *System Manager*.

To update only the loops configuration with the data in the permanent memory, press Reload loops parameters or use the command 2301 of *System Manager*.

Important

It is not necessary to reboot the drive for the new parameters resulted from Reload and Restore commands of the permanent memory to take effect.

20.8. Resetting

The drives of the DuetHV series provide different reset levels. Access with DuetHVSuite from **Main menu** > **Drive**.

Command	*System Manager*	*Reset-Cause*	Description
Hard reset	5000	2	Firmware reset according to what's reported in the *Table 14.2*;
Soft reset	5001	6	Firmware reset according to what's reported in the *Table 14.2*;

Command	***System Manager***	***Reset-Cause***	**Description**
Reset to defaults	2201	-	Updating the current configuration with the default values. *ResetCause* does not change.

Caution

With the Hard reset command all the parameters are overwritten with their value contained in the permanent memory. To maintain coherent *PositionActualValue*, ONLY in case of NMT/Soft reset, all the parameters are overwritten with their value contained in the permanent memory, but the followings:

- *FeedbackSensorCode*
- *Polarity*
- *EncoderIncrements*
- *FeedbackSensorAbsMode*

The following parameters do NOT change:

- bit 0 of*PositionValidationStatus*
- *HomingStatus*

During the reset the feedback sensor must not move for more than a half mechanical revolution. If the feedback sensor moves for more that a half mechanical revolution during the reset, *PositionActualValue* will be no more coherent with the value that's previous to the reset, even if *PositionValidationStatus* and *HomingStatus* don't report it.

Enabled parameters after reset

The *enabled parameters after reset*, once written and saved in the drive permanent memory, take effect only after the *Hard reset*, *Soft reset*, command or after the drive switching off and restarting. They are:

- *AuxiliaryPortSetupBaudRate*;
- *Configured station alias*in the drive version ETC.

Chapter 21

Creating a motion

Using the drives of the DuetHV series, the motor motion can be commanded through:

- *Master*with EtherCAT port that supports the CoE protocol ("*CANopen over EtherCAT*)
- digital inputs and outputs + drive analog input (if present).

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*. In the following chart you can find the features of the available operating modes. To learn how to command and control the motor motion, or how to enable, disable and stop the motor, or how to change the *ModesOfOperation*, please follow the instructions in the next paragraphs of this chapter.

Type of motion	***ModesOfOperationDisplay***	**Paragraph**	**Standard *CiA-402***	***Real-time***	**Digital I/O**	**Analog input**	***Enable*automatic**
Position	*Profile Position Mode*	*Section 21.9, Profile Position Mode*	*YES*	-	-	-	-
	Interpolated Position Mode	*Section 21.10, Interpolated Position Mode*	*YES*	*YES*	-	-	-
	Cyclic Synchronous Position Mode	*Section 21.12, Cyclic Synchronous Position Mode*	*YES*	*YES*	-	-	-
Speed	*Profile Velocity Mode (CiA402)*	*Section 21.15, Profile Velocity Mode (CiA402)*	*YES*	-	-	-	-
	Profile Velocity Mode (CUSTOM)	*Section 21.16, Profile Velocity Mode (CUSTOM)*	-	-	-	-	-
	Profile Velocity AI Mode	*Section 21.17, Profile Velocity AI Mode*	-	-	-	*YES*	*YES*
	Cyclic Synchronous Velocity Mode	*Section 21.13, Cyclic Synchronous Velocity Mode*	*YES*	*YES*	-	-	-
Torque	*Torque Mode*	*Section 21.18, Torque Mode*	*YES*	-	-	-	-
	Torque AI Mode	*Section 21.19, Torque AI Mode*	-	-	-	*YES*	*YES*

Type of motion	*ModesOfOperationDisplay*	Paragraph	Standard *CiA-402*	*Real-time*	Digital I/O	Analog input	*Enableautomatic*
	Cyclic Synchronous Torque Mode	*Section 21.14, Cyclic Synchronous Torque Mode*	*YES*	*YES*	-	-	-
Other	*Homing Mode*	*Section 21.20, Homing Mode*	*YES*	-	-	-	-

Table 21.1. Features of the operating modes and modes of generation of the references.

Important

To command the drive by using any *Master*, it's necessary to know and use the CiA402 State Machine, which characteristics are reported in *Section 8.4, CiA402 state machine*.

21.1. Enabling by using the Master

To enable the drive it's necessary to set the CiA402 State Machine to one of these 2 states:

- *Operation enable*
- *Switched On* (only if *SwitchedOnOptionCode* value is 1)

To enable the motor movement, set the CiA402 State Machine to the *Operation enable* state (see *Section 8.4, CiA402 state machine*). In the *Operation enable* state the changing of the operative mode is allowed both using the on-the-fly mode change (please see *Section 21.5, On-the-fly operative mode change*) and through the parameter *ModesOfOperation*.

Important

To enable the drive, the parameter *EnableInputStatus* must be equal to 1.

21.2. Disabling by using the Master

To disable the drive it is necessary to execute one of the following two operations:

- if the *SwitchedOnOptionCode* parameter value is 0, set the CiA402 State Machine to the *Switched On* state (see *Section 8.4, CiA402 state machine*)
- set the CiA402 State Machine to the *Switch On Disabled* state (see *Section 8.4, CiA402 state machine*). Through this operation it is possible to disable also the motor motion.

To only disable the motor movement without disabling the drive is only possible if the *SwitchedOnOptionCode* parameter value is 1. In this case it's sufficient to set the CiA402 State Machine to the *Switched On* state (see *Section 8.4, CiA402 state machine*).

Warning

If the drive is in *Operation enable* and the motor is in motion, the disabling operations causes the motor stop with maximum deceleration by setting *RequestedSpeed* to zero.
Before starting a disabling operation, it is recommended to stop the motor motion by using the procedures described in *Section 21.3, Execute a stop by using the Master*.

21.3. Execute a stop by using the Master

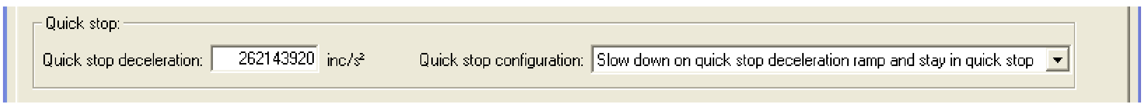
To stop the motor when the drive is in the *Operation enable* state and with any *ModesOfOperation* enabled, it is possible to run a stop command. The two stop commands implemented in the drive follow the specifications of *CiA-402* and they are:

- *Halt*: stop command which carries out a braking ramp with a *ProfileDeceleration* deceleration. The stop ramp starts from the *RequestedPosition* and *RequestedSpeed*, without nullify *PositionFollowingError* and *SpeedFollowingError*;
- *Quick stop*: stop command which carries out a braking ramp parametrized according to the *QuickStopConfiguration* parameter. The braking ramp starts from the *VelocityActualValue* value, setting to zero *SpeedFollowingError* at the beginning of the ramp.

Tip

Use the command Halt for a normal stop and the command Quick stop for an emergency stop.

The stop execution can be commanded through the *Controlword* and the state of the CiA402 State Machine can be checked with the *Statusword* (see *Section 8.4, CiA402 state machine*).

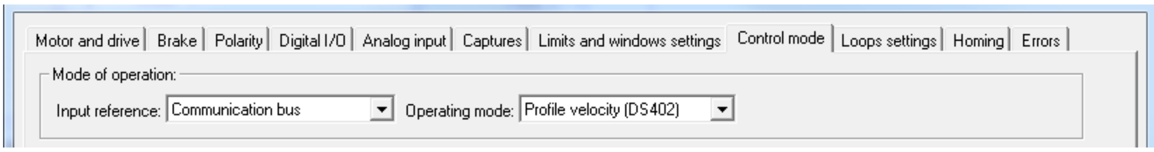


21.4. Change the operative mode with standard parametersCiA-402

This type of operative mode change follows the *CiA-402* specifications. To execute the operative mode change it's necessary to write the *ModesOfOperation* parameter; by reading the *ModesOfOperationDisplay* it's possible to check the active operative mode.

Warning

In the *Operation enable* state it's possible to change *ModesOfOperation* only if the bit 4 of the *Controlword* is set to 0 (see *Section 8.4, CiA402 state machine*). The operative mode change, with this method, must be done with the motor stopped, and it is user's responsibility to verify that the drive is in this condition.



In the frame *Mode of operation* choose the source of the reference in the pull-down menu *Input reference* and the operating mode in the pull-down menu *Operating mode*.

Note

The change of *ModesOfOperation* is not allowed in the statuses *Not Ready to Switch On, Quick Stop Active* e *Fault Reaction Active*.

21.5. On-the-fly operative mode change

Note

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

This mode change method allows to switch from an operative mode to another without having to disable the motor and maintaining the drive in *Operation enable*. To make a mode change on-the-fly it's necessary that the actual operative mode (actual value of *ModesOfOperation*) is NOT of *Real-time* type (see *Table 21.1*), barring to submit to the limitations described in the *On-the-fly mode change for Real-time modes* paragraph.

The "on-the-fly" mode change can be executed only towards the following operative modes:

- *Profile Position Mode* (*ModesOfOperation* = 1);
- *Homing Mode* (*ModesOfOperation* = 6);
- *Gear Mode* (*ModesOfOperation* = -126);
- *Profile Velocity Mode (CUSTOM)* (*ModesOfOperation* = -113).

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

Parameter	Description
ApplyModeOperationCommand	Desired operating mode

Parameter	Description
ApplyModeOperationStatus	Status of the operating mode change
ApplyModeOperationParametersand following ones	Group of 7 parameters to set the mode change. The meaning of each of these parameters changes when *ApplyModeOperationCommand* changes, as shown in *Table 21.2*.

N. par.	*Profile Position Mode*	*Homing Mode*	*Interpolated Position Mode*	*Gear Mode*	*Profile Velocity Mode (CUSTOM)*
1	*TargetPosition*	*HomingMethod*	*IpPosFirstParameter*	See*Table 21.3*	*TargetVelocity*
2	*ProfileVelocity*	*SpeedForSwitch*	*IpPosSecondParameter*	*GearMasterTriggerPosition*	-
3	*EndVelocity*	*SpeedForZero*	-	*GearMasterRampPosition*	*EndVelocity*
4	*ProfileAcceleration*	*HomingAcceleration*	*IpPosSubModeSelect*	*TargetGearRatioNumerator*	*ProfileAcceleration*
5	*ProfileDeceleration*	*IndexPulseDeadZone*	-	*TargetGearRatioDivisor*	*ProfileDeceleration*
6	*EndIncrements*	*HomeOffset*	-	*StartGearRatioNumerator*	-
7	*StartVelocity*	-	-	*StartGearRatioDivisor*	*StartVelocity*

Table 21.2. Meaning of the *ApplyModeOperationParameters* parameters.

Bit	Value	Meaning
0	0	Valid trigger position: the adjustment to the new following ratio starts when the new trigger position is exceeded (*GearMasterTriggerPosition*), 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* parameter).
1	0	The trigger position (*GearMasterTriggerPosition*) is reached if it is exceeded by the increasing position of the master.
	1	The trigger position (*GearMasterTriggerPosition*) is reached if it is exceeded by the decreasing position of the master.
2	0	On the adjustment beginning is assumed that the starting following ratio (*StartGearRatio*) is the actual one.
	1	On the adjustment beginning is assumed that the starting following ratio (*StartGearRatio*) is the one that's set in the parameters 6 and 7 of *ApplyModeOperationParameters*.

Table 21.3. Meaning of the bits of the parameter 1 for the transition to the *Gear Mode*.

> **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:

1. Configure the change of the operating mode by properly setting *ApplyModeOperationParameters*.
2. Write the code of the new operating mode in *ApplyModeOperationCommand*.
3. Verify the result of the change by reading the parameter *ApplyModeOperationStatus*.

For some values of *ApplyModeOperationCommand*, there can be some peculiarities. Here follow 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 21.9, Profile Position Mode*.

On-the-fly mode change for Real-time modes
If the operative mode actually set in the drive is of *Real-time* type (see *Table 21.1*) and so the drive is inserted in a CANopen or EtherCAT fieldbus network and is working in one of the modes 7/8/9/10 (see *ModesOfOperation*), then the on-the-fly mode change is still possible, but with some restrictions: in the process data sent by the Master (PDO RX necessary for the set-point sending, e.g. *TargetPosition*, *TargetVelocity*) there mustn't be present any parameters used even by the on-the-fly mode change (*Controlword*, *ModesOfOperation* and all the parameters related to the mode to be reached, indicated in *Table 21.2*).

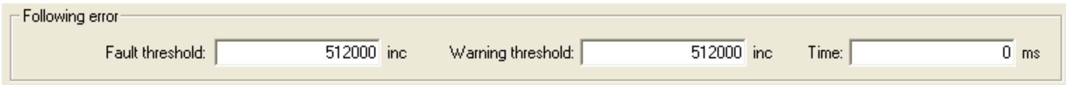
21.6. How to control a motion in position

In the drives of the series DuetHV 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*.

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

Error of position tracking
If in *ModesOfOperationDisplay* a position mode is set, it is possible to check the *PositionFollowingError* during the motor motion. Properly configuring the *FollowingErrorWindow* and *FollowingErrorWindowWarn* parameters it's possible to activate the *Position following error* (Fault and Warning respectively), if the *PositionFollowingError* exceeds the window for a time greater or equal to *FollowingErrorTimeOut*. Furthermore, in some operating modes, when *PositionFollowingError* exceeds the Fault threshold for a time at least equal to the time out, also the *Following error* bit of *Statusword* is set. The bit is reset when *PositionFollowingError* is lower, in absolute value, than the Fault window. For any further information on the error notice please see *Chapter 23, Fault and Warning*.

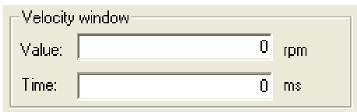


21.7. Control of a speed motion

In the DuetHV series 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*.

Speed target reached
If in the *ModesOfOperationDisplay* a speed mode is set, it is sufficient to check if the bit *Target reached* of the *Statusword* 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* for a time period at least equal to *VelocityWindowTime*. The bit is reset when the difference gets over the window.



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

21.8. Control of a torque motion

In the drives of the series DuetHV 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.

> **Warning**
>
> 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* parameter or the *ActualFilteredTorque* parameter.

Torque target reached
If in the *ModesOfOperationDisplay* 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* is equal to 1. This bit is set when the difference between RequestedTorqueCurrent and *ActualTorqueCurrent* is lower (in absolute value) than the 5% of *MotorStallCurrent* for a time period of at least 1ms. The bit is reset when the difference gets over the window.

21.9. 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 *CiA-402*.

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

TargetPosition;
EndIncrements;
ProfileVelocity;
StartVelocity;

EndVelocity;
ProfileAccceleration;
ProfileDeceleration.

Warning

If the value of *ProfileVelocity* is lower than *StartVelocity* or *EndVelocity*, its value is internally set at the highest value of the two.

*Figure 21.1*You can find an example of profile and the meaning of the parameters defining it.

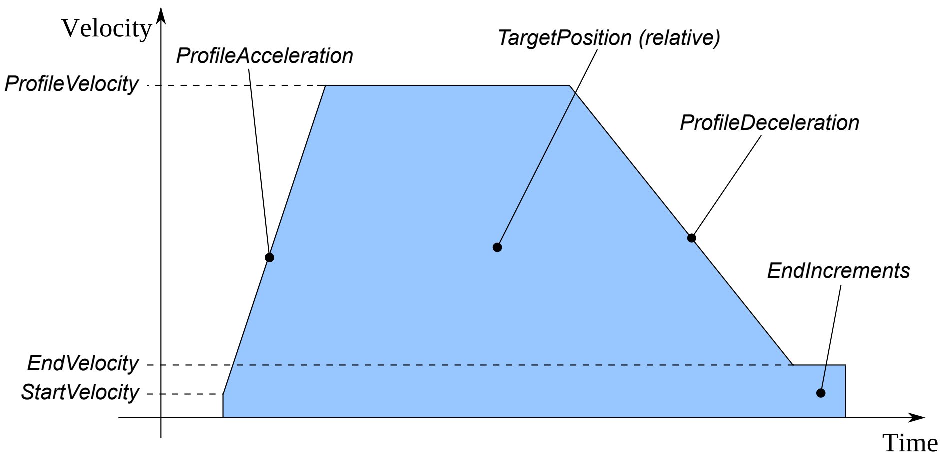


Figure 21.1. Example of position profile with linear ramps.

After having parametrized the drive and set it in the *Operation enable* state, you can run the commands to start the positionings and to check the state. To command a positioning you have to write the *Controlword* and read the *Statusword* following the procedures described in the *CiA-402*. Particularly, through this operating mode it is possible to run a positioning by commanding the following bits in the *Controlword*:

- 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;
- 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 0) and *Set of set-point* (if the bit is set to 1). In the Set of set-point mode (see *Figure 21.3*) you can find only a buffer of data, the one for the data used during the positioning. In the Single set-point mode (see *Figure 21.2*) the positioning acts as described in the bit *Change immediately option* in the parameter *PositioningOptionCode*. 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*: 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*.

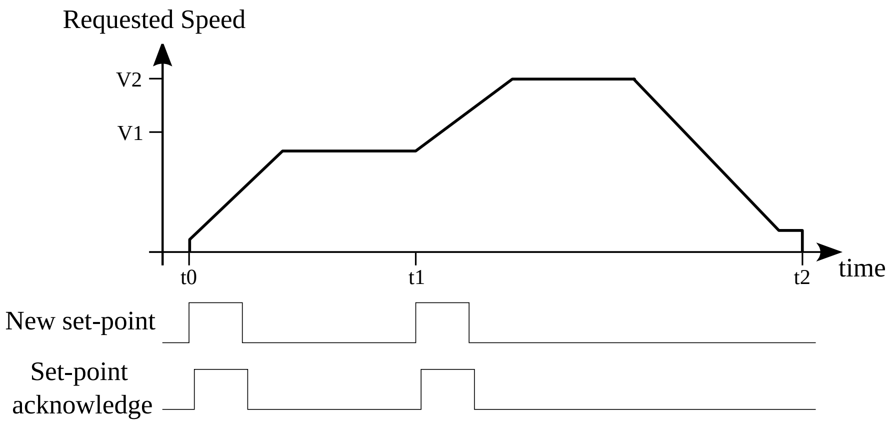


Figure 21.2. Timing chart *Profile Position Mode* in Single set point mode.

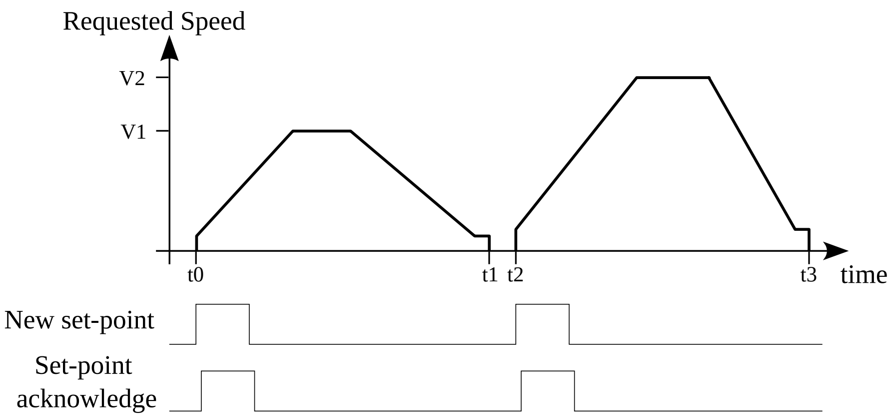


Figure 21.3. Timing chart *Profile Position Mode* in Set of set points mode.

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

In the Statusword 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.

21.10. Interpolated Position Mode

Important

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

The *Interpolated 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 *CiA-402* specifications.

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 (the synchronization techniques are described in the chapter of the communication interfaces):

- *IpPosFirstParameter*: position reached when the T_{SYNC} expires. This datum is necessary in all kinds of interpolation implemented in the drive.
- *IpPosSecondParameter*: speed reached when the T_{SYNC} expires. This datum is not used in the linear interpolation.

The writing of the *IpPosFirstParameter* and *IpPosSecondParameter* 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 *Figure 21.4* an example of linear interpolation with the *Hard sync* synchronization technique is reported. This technique is used in the EtherCAT field bus through the *Sync Signal* synchronization signal (SYNC).

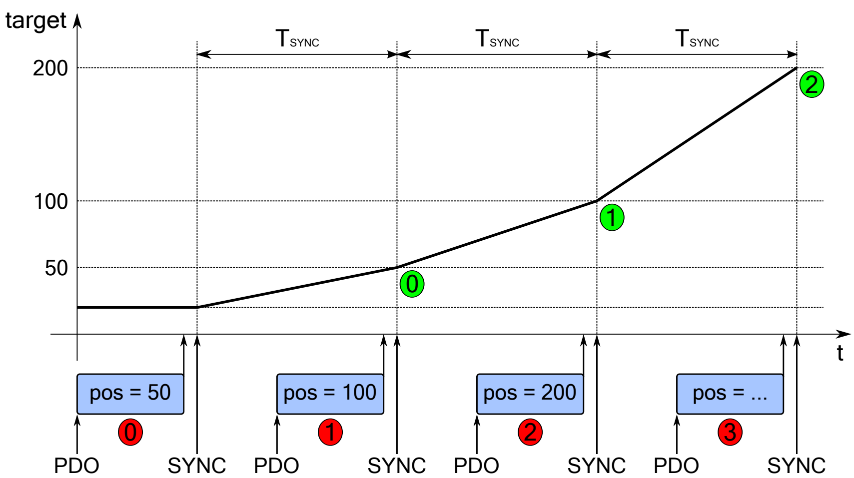


Figure 21.4. Linear interpolation with synchronization made through *Sync Signal* synchronization signal (SYNC)

Warning

The parameters are so contained in the PDO RX (see the communication interface related chapters) and determine the construction of the movement profile.
To avoid this drawback, MPC has implemented in the drives of the DuetHV series a monitoring and management functionality for the corrupted or missing PDO RX (see *Section 9.3.2, Missing or corrupted PDO RX management*).

The kind of interpolation can be set through the *IpPosSubModeSelect* parameter and the following methods are available:

- **Linear interpolation**
  The drive runs the interpolation of the position only, by linking with a straight line the set-point of the previous position, reached at the beginning of the new period of T_{SYNC}, with the position set point sent by the Master in the *IpPosFirstParameter* parameter. The FeedForwardSpeed is calculated by the drive and is constant during the whole T_{SYNC} period. In *Figure 21.5* you can find an example of linear interpolation.

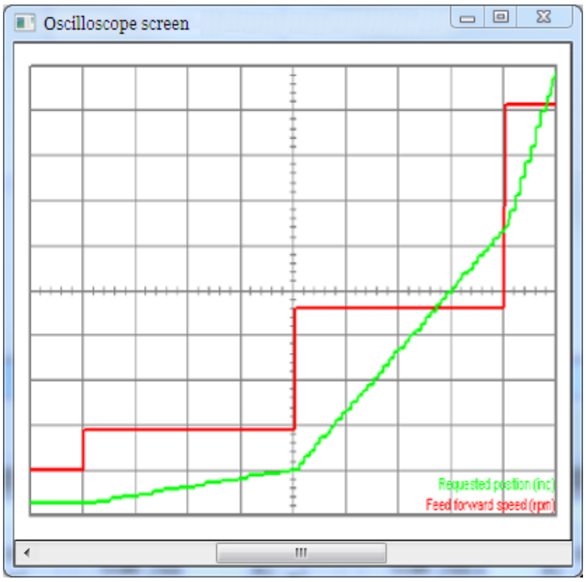


Figure 21.5. Example of linear interpolation

- **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, with the position set point sent by the Master in the *IpPosFirstParameter* 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* 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 (*IpPosFirstParameter* and *VelocityOffset* values received by the Master with the previous T_{SYNC} period) with the end values (*IpPosFirstParameter* and *VelocityOffset* values received by the Master through *IpPosFirstParameter* and *IpPosSecondParameter*). The movement fluidity of this kind of interpolation respect to the other ones is better, as you can observe by comparing *Figure 21.6* with *Figure 21.5*. In fact considering that these two pictures have been created by using the same parameters (except of course the interpolation type selector *IpPosSubModeSelect*) and with a T_{SYNC} of medium duration, it is evident how the *Figure 21.6* curves have a trend with less abrupt movements.

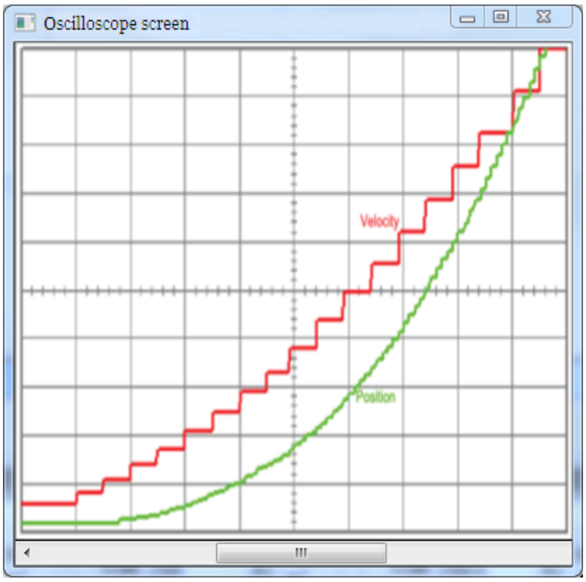


Figure 21.6. Example of cubic interpolation

Warning

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

Tip

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:

1. to set the *ModesOfOperation* with the value 7 (*Interpolated Position Mode*);

2. to configure the communication parameters of the bus field (PDO configuration and mapping, setting of the synchronization system, ...):
3. to set the *IpPosSubModeSelect*;
4. to enable in the Master the management that allows, at regular intervals, the sending of the set-points via PDO in the *IpPosDataRecord* and the synchronism management;
5. to take the drive in the *Operation enable* state;
6. enable the position interpolator by setting the *Enable ip mode* bit (see *Table 8.8* of the *Controlword* and check that the *Ip mode active* bit is set (see *Table 8.6* of the *Statusword*;
7. at this point it is possible to command the drive.

Warning

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

21.11. 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 *Figure 21.7* shows an example of how the following ratio can be changed by the user.

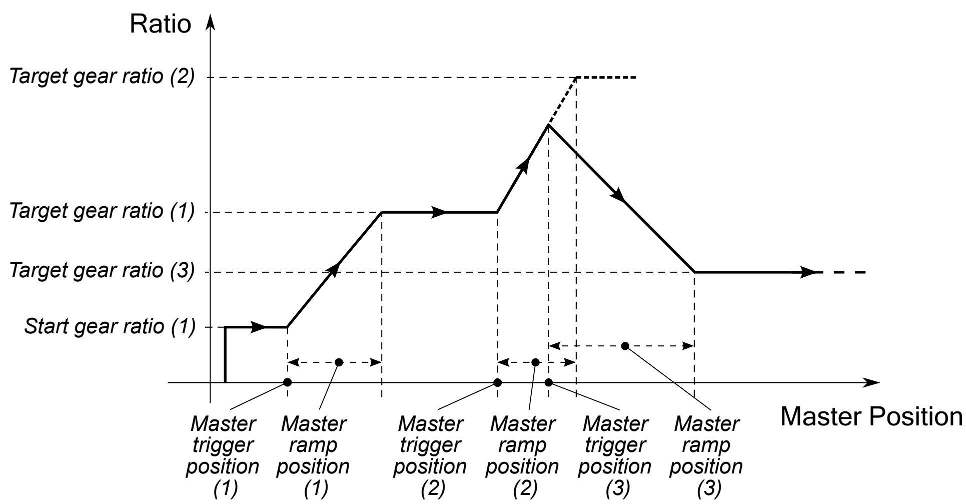


Figure 21.7. Motion profile in *Gear Mode*.

In the *Figure 21.7* example, when the master axis position exceedes the *GearMasterTriggerPosition* that has been set *Master trigger position (1)*), the drive executes an adjustment ramp in order to reach the new following ratio *TargetGearRatio* (*Target gear ratio (1)*) in an adjustment master spaceequal to *GearMasterRampPosition* (*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 progress (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* parameter configuration, can be virtual or real. For further informations please refer to *Section 14.5, Auxiliary position sensor*.

21.11.1. Gear Mode parameters configuration

The *Gear Mode* configuration includes the setting of several parameters that allows to define the initial following ratio (*StartGearRatio*), the final following ratio (*TargetGearRatio*) and how the master axis must be interpreted (*MasterPositionSettings*). In addition to these parameters it must be configured the *ProfileDeceleration*, 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 *Section 21.11.2, Start a movement in Gear Mode*.

Now consider the following initial condition as a demonstrative example:

- increasing master axis position: *AuxiliaryEncoderPosition* = 100…200…300…;
- increasing configured activation direction: *GearMasterTriggerDirection* = 0;

Consider the following command sequence:

- writing of the *TargetGearRatio*, *GearMasterRampPosition* parameters, eventually *StartGearRatio* and setting of the *Master trigger position* to 1000;
- sending of the first *Start gear* command (bit *Reset trigger* = 0);
- writing of the *TargetGearRatio*, *GearMasterRampPosition* parameters, eventually *StartGearRatio* and setting of the *Master trigger position* to 2000;
- sending of the second *Start gear* command (bit *Reset trigger* = 0);
- writing of the *TargetGearRatio*, *GearMasterRampPosition* parameters, eventually *StartGearRatio*;
- 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 anly 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* 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* 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* can happen in different ways depending on the settings of *StartGearRatio*, 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* = 100…200…300…), that the trigger position (*GearMasterTriggerPosition*) is not used and that the *Actual gear ratio* is always lower than *TargetGearRatio*.

Case 1. In this case the following condition is assumed:

- *Actual gear ratio* < *StartGearRatio* < *TargetGearRatio*;
- the *Start gear* command sending is made through the *Start gear ratio disable* bit set to 0.

The axis behaviour is showed in *Figure 21.8*: as soon as the *Start gear* command has been received by the drive, the following ratio is istantly set to the *StartGearRatio* value, then the adjustment ramp is started and when it will end the following ratio will be *TargetGearRatio*.

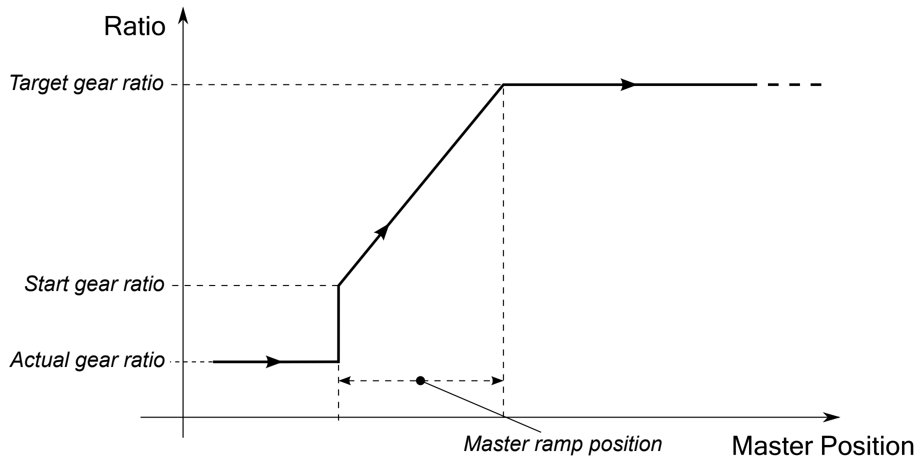


Figure 21.8. Following ratios: example 1

Case 2. This case may arise from two different conditions.

- First condition:
  - *StartGearRatio* < *Actual gear ratio* < *TargetGearRatio*;
  - 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 *Figure 21.9*: as soon as the *Start gear* command has been received by the drive, the *StartGearRatio* parameter value is disregarded at all, then the adjustment ramp is started and when it will end the following ratio will be *TargetGearRatio*.

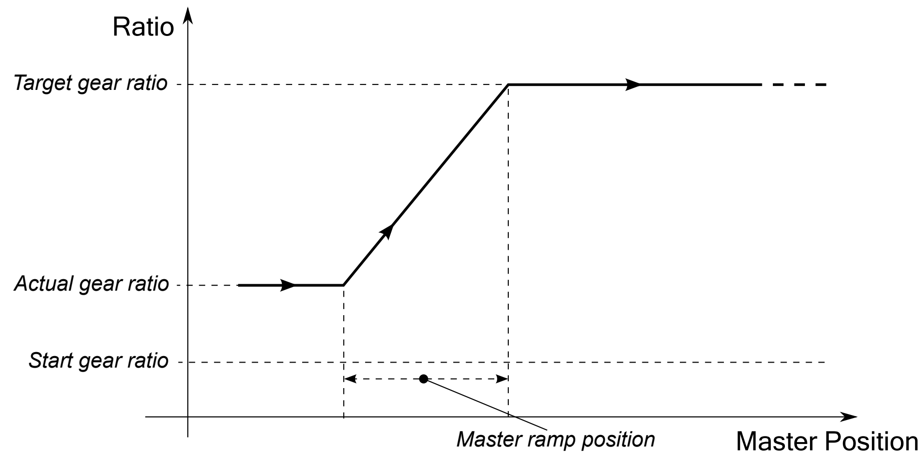


Figure 21.9. Following ratios: example 2

Case 3. In this case the following condition is assumed:

- *Actual gear ratio* < *TargetGearRatio* < *StartGearRatio*;
- the *Start gear* command sending is made through the *Start gear ratio disable* bit set to 0.

The axis behaviour is showed in *Figure 21.10*: the *Start gear* command has not been received by the drive, the following ratio is istantly set to the *TargetGearRatio* final value, without to execute the adjustment ramp.

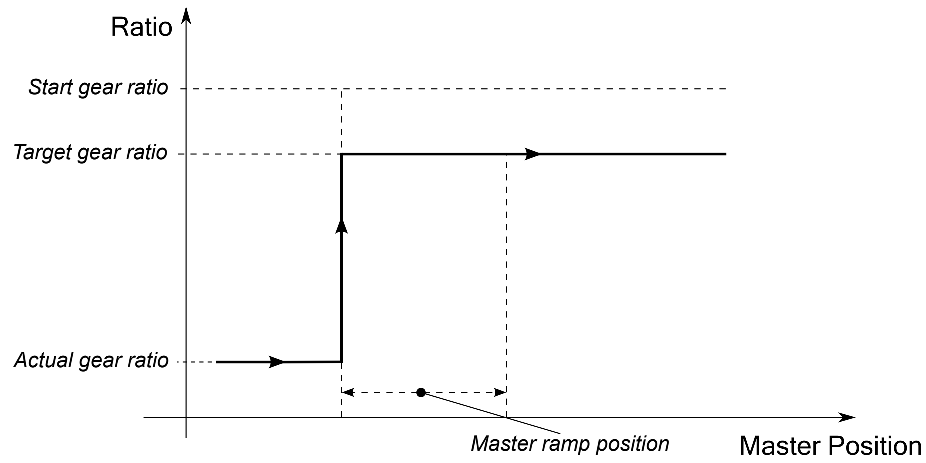


Figure 21.10. Following ratios: example 3

21.11.2. 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 *Figure 21.11* and to the *Table 21.5* that describes its transitions. The states that may take the *Gear Mode* are described in the *Table 21.4*, while the actual status can be read in the *GearStatus* parameter.

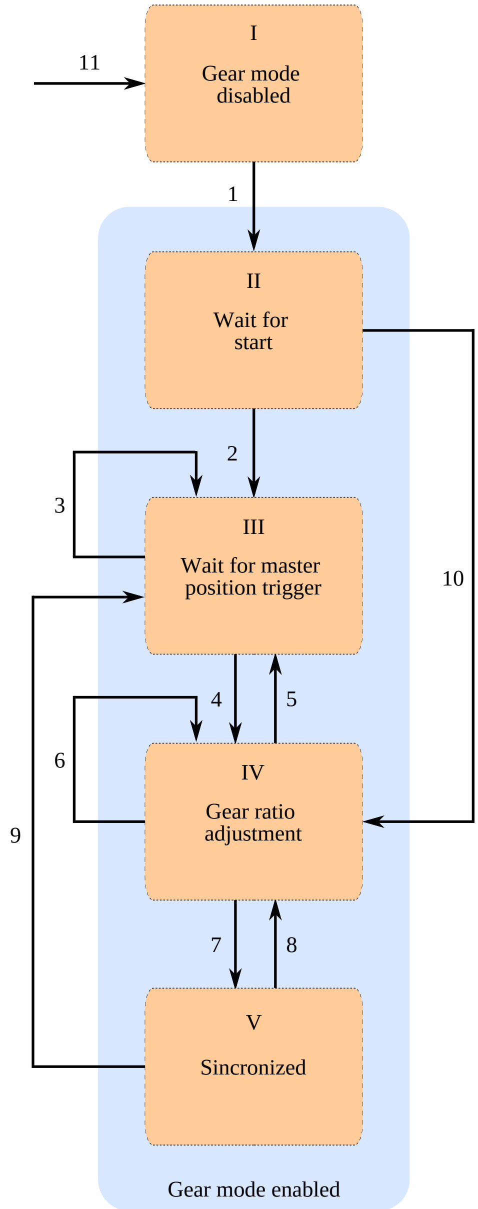


Figure 21.11. *Gear Mode* state machine

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* different from -126);	0

Status	Description	GearStatus
	- the drive is not in the *Operation enable* status; - the *Halt* or *Quick stop* command is in progress or is finished	
II	The *Gear Mode* is enebled, 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*) 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*).	4

Table 21.4. States of the *Gear Mode* state machine.

Trans.	Action	Description
1	Writing of the value -126 in the *ModesOfOperation* parameter and writing in *Controlword* of the values indicated in the *Section 8.4, CiA402 state machine* to bring the drive in the *Operation enable* status.	The *Gear Mode* is selected and the dive switches to the *Operation enable* status.
2	Wrinting of a new *GearMasterTriggerPosition* 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*).
3	Writing of a new trigger position (*GearMasterTriggerPosition*) 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 teh master axis exceeds the new trigger position (*GearMasterTriggerPosition*).
4	This transition is due to one of the following causes: - the master axis has exceeded the trigger position (*GearMasterTriggerPosition*); - a new *Start gear* command has been received without a previous writing of the triger position (*GearMasterTriggerPosition*); - a new *Start gear* command has been received with *Reset trigger* = 1.	The drive starts the adjustment ramp in otder to reach the following ratio that has been set (*TargetGearRatio*).
5	Writing of a new *GearMasterTriggerPosition* 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*).
6	This transition is due to one of the following causes: - a *Start gear* command has been received without a previous writing of the triger position (*GearMasterTriggerPosition*); - a *Start gear* command has been received with *Reset trigger* = 1.	The drive remains in the execution of the adjustment ramp and acquires as set point the new following ratio that has been set (*TargetGearRatio*).
7	The drive has completed the following ration that has been set (*TargetGearRatio*) and has not received any other *Start gear* command.	The drive moves with following ratio equal to*TargetGearRatio*
8	This transition is due to one of the following causes:	The drive starts the adjustment ramp in otder to reach the following ratio that has been set (*TargetGearRatio*).

Trans.	Action	Description
	- a *Start gear* command has been received without a previous writing of the triger position (*GearMasterTriggerPosition*); - a *Start gear* command has been received with *Reset trigger* = 1.	
9	Writing of a new *GearMasterTriggerPosition* 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*).
10	This transition is due to one of the following causes: - a *Start gear* command has been received without a previous writing of the triger position (*GearMasterTriggerPosition*); - a *Start gear* command has been received with *Reset trigger* = 1.	The drive starts the adjustment ramp in otder to reach the following ratio that has been set (*TargetGearRatio*).
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.

Table 21.5. Transitions of the state machine of *Figure 21.11*.

Here follows the procedure for starting an *Gear Mode* movement:

1. 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 8.4, CiA402 state machine*).

2. Select the *Gear Mode* by writing the value -126 in the *ModesOfOperation* parameter and set the master axis following the indications reported in *Section 14.5, Auxiliary position sensor*. Bear in mind that the master axis role is performed by the Ausiliary encoder.

3. Bring the axis in the *Operation enable* status as described in the *Section 8.4, CiA402 state machine* (transition 1, to switch from the status I to II).

4. Parametrize the *Gear Mode* by following the indications of *Section 21.11.1, Gear Mode parameters configuration*.

5. Start of the *Gear Mode* movement by sending the *Start gear* command. According to the parametrizations 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 tge *GearMasterTriggerPosition* 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 synchronisation with the master axis. The various passages are shown in the *Figure 21.11* and their description in *Table 21.5*.

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 *Table 21.7* and *Table 21.6* the *Operation mode specific* of the *Controlword* and *Statusword* parameters are described. These are necessary to control the *Gear Mode* (for the bit with general use refer to the description of the *Controlword* parameters and to the *Statusword*).

Bit	Name	Value	Description
0 - 9	See the *Statusword* 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 *Table 8.6*	
12	Reserved.		
13	*Following error*	0	There is no position following error (see *Section 21.6, How to control a motion in position*).
		1	Position following error present (see *Section 21.6, How to control a motion in position*).
14 -15	Reserved.		

Table 21.6. Meaning of the bits if the *Statusword* for the *Gear Mode*.

Bit	Name	Value	Description
0 - 3	See the *Controlword* parameter.		
4 - 6	Reserved.		
7	See parameter*Controlword*		
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*.
9 - 10	See the *Controlword* 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* parameter.
		1	The starting following ratio of the adjustment ramp is the actual one.
14	*Reset trigger*	0	The adjustment ramp starts when the master axis position exceeds the *GearMasterTriggerPosition* parameter value (if set).

Bit	Name	Value	Description
		1	The adjustment ramp starts as sono as the *Start gear* command is received.
15	*Start gear*	1	Command for the start of an *Gear Mode* movement.

Table 21.7. Meaning of the bits if the *Controlword* for the *Gear Mode*.

21.11.3. Gear Mode movement conclusion

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

> **Note**
>
> The statuses and the transitions this paragraph is referred to are related to the state machine of the *Gear Mode* (see *Section 21.11.2, "Start a movement in Gear Mode"*)

Halt command

Setting to 1 the bit 8 *Halt* of the *Controlword* a stop command is executed: the axis is stopped with the deceleration ramp that has been set in the *ProfileDeceleration* 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 mus be reset and the drive must be rebrought 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.

For the detailed description of this functionality see the *Section 21.3, Execute a stop by using the Master*. It is advisable to use this command only to quikly 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 8.4, CiA402 state machine*). 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 8.4, CiA402 state machine*), 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 18.6, Limits of software position*). 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 21.5, On-the-fly operative mode change*); The *Gear Mode* state machine switches to the status I.

21.11.4. Motion control

The functionalities implemented for controlling the *Gear Mode* movement are the same described in the *Section 21.6, How to control a motion in position*.

It is furthermore possible to read even the *Gear Mode* status through the *GearStatus* parameter.

21.12. Cyclic Synchronous Position Mode

Important

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

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 *CiA-402* 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* parameter (the synchronization techniques are described in the chapter of the communication interfaces):

In case of cubic interpolated mode use, even the *VelocityOffset* 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*: position that will be added to the *TargetPosition*.

- *VelocityOffset*:
  - 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* indicates that the *KVff* internal calculation is disabled, it will be used as *KVff*;
  - In all the other cases it is not used.

- *TorqueOffset*: it is used as *KAff* if the *CyclicSynchronousSubMode* parameter indicates that the *KAff* internal calculation is disabled, otherwise it's not used.

The writing of the *TargetPosition* 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 *Figure 21.4* it is reported an example of linear interpolation with the *Hard sync* synchronization technique, used in the EtherCAT field bus with the *Sync Signal* synchronization signal (SYNC).

Warning

The parameters are so contained in the PDO RX (see the communication interface related chapters) and determine the construction of the movement profile.
To avoid this drawback, MPC has implemented in the drives of the DuetHV series a monitoring and management functionality for the corrupted or missing PDO RX (see *Section 9.3.2, Missing or corrupted PDO RX management*).

The kind of interpolation can be set through the *CyclicSynchronousSubMode* 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 (see *Table 26.13* for the available combinations).
- **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* parameter. The FeedForwardSpeed and the FeedForwardAcceleration can be set by the Master or internally calculated by the drive (see *Table 26.13*). In *Figure 21.5* an example of linear interpolation can be found.
- **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* and *VelocityOffset* received from the Master with the previous T_{SYNC} period) with the final ones (values of *TargetPosition* and *VelocityOffset* received by the Master). This interpolation type, as you can see comparing *Figure 21.6* with *Figure 21.5*, 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* interpolation type selector, of course) and by using a T_{SYNC} with medium duration, it's evident how the curves in *Figure 21.6* have a trend with less abrupt deviations. The FeedForwardAcceleration can be set by the Master or internally calculated by the drive (see *Table 26.13*).

Warning

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

Tip

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:

1. to configure the communication parameters of the bus field (PDO configuration and mapping, setting of the synchronization system, ...):
2. 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* that has been set;
3. to set the *CyclicSynchronousSubMode*;
4. to set the *ModesOfOperation* with the value 8 (*Cyclic Synchronous Position Mode*);
5. to take the drive in the *Operation enable* state;
6. at this point it is possible to command the drive.

Warning

By selecting a value of *CyclicSynchronousSubMode* that assigns to the master the *KVff* and *KAff* 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.

21.13. Cyclic Synchronous Velocity Mode

Important

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

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 *CiA-402* 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* 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*: velocity that will be added to *TargetVelocity*.
- *TorqueOffset*: it is used as *KAff* if the *CyclicSynchronousSubMode* parameter indicates that the *KAff* internal calculation is disabled, otherwise it's not used.

The writing of the *TargetVelocity* 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 *Figure 21.4* it is reported an example of linear interpolation with the *Hard sync* synchronization technique, used in the EtherCAT field bus with the *Sync Signal* synchronization signal (SYNC).

Warning

The parameters are so contained in the PDO RX (see the communication interface related chapters) and determine the construction of the movement profile.
To avoid this drawback, MPC has implemented in the drives of the DuetHV series a monitoring and management functionality for the corrupted or missing PDO RX (see *Section 9.3.2, Missing or corrupted PDO RX management*).

The kind of interpolation can be set through the *CyclicSynchronousSubMode* 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 (see *Table 26.13* for the available combinations).
- **Linear interpolation**
  The drive executes the interpolation of the velocity, 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 parameter. The FeedForwardAcceleration can be set by the Master or internally calculated by the drive (see *Table 26.13*). In *Figure 21.5* you can find an example of linear interpolation.

> **Warning**
>
> The T_{SYNC} period that has been set must be greater than *MotionLoopPeriod*.

To command the drive with this mode it is necessary:

1. to configure the communication parameters of the bus field (PDO configuration and mapping, setting of the synchronization system, ...):
2. 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* that has been set;
3. to set the *CyclicSynchronousSubMode*;
4. to set the *ModesOfOperation* with the value 9 (*Cyclic Synchronous Velocity Mode*);
5. to take the drive in the *Operation enable* state;
6. at this point it is possible to command the drive.

> **Warning**
>
> By selecting a value of *CyclicSynchronousSubMode* that assigns to the Master the *KAff* 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.

21.14. Cyclic Synchronous Torque Mode

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

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 *CiA-402* 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* 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*: torque that will be added to the *TargetTorque*.

The writing of the *TargetTorque* 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 *Figure 21.4* it is reported an example of linear interpolation with the *Hard sync* synchronization technique, used in the EtherCAT field bus with the *Sync Signal* synchronization signal (SYNC).

Warning

The parameters are so contained in the PDO RX (see the communication interface related chapters) and determine the construction of the movement profile.
To avoid this drawback, MPC has implemented in the drives of the DuetHV series a monitoring and management functionality for the corrupted or missing PDO RX (see *Section 9.3.2, Missing or corrupted PDO RX management*).

The kind of interpolation can be set through the *CyclicSynchronousSubMode* 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 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 T_{SYNC}, with the torque set point sent to the Master in the *TargetTorque* parameter. In *Figure 21.5* you can find an example of linear interpolation.

Warning

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

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

1. to configure the communication parameters of the bus field (PDO configuration and mapping, setting of the synchronization system, ...):
2. 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* that has been set;
3. to set the *CyclicSynchronousSubMode*;
4. to set the *ModesOfOperation* with the value 10 (*Cyclic Synchronous Torque Mode*);
5. to take the drive in the *Operation enable* state;

6. at this point it is possible to command the drive.

21.15. 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 *CiA-402*.

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

- *MotionProfileType*;
- *StartVelocity*;
- *EndVelocity*;
- *ProfileAcceceleration*;
- *ProfileDeceleration*;
- *TargetVelocity*.

In *Figure 21.12* you can find an example showing how it is possible to change the *TargetVelocity* 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* and from *EndVelocity*.

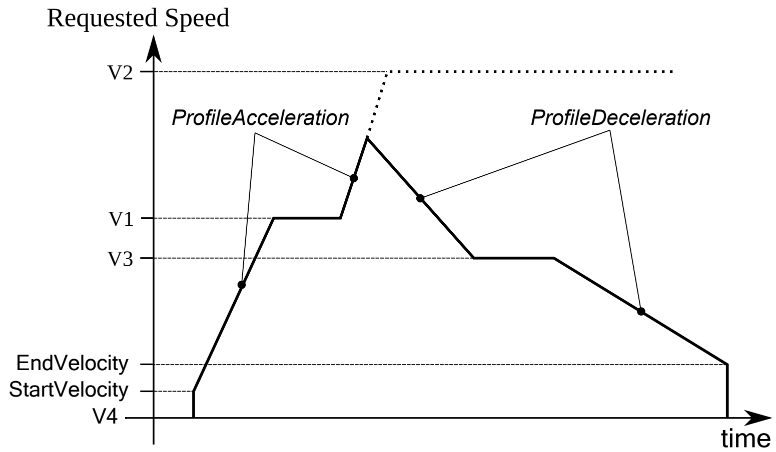


Figure 21.12. Speed profile with linear ramps.

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

In the Statusword 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*.

> **Warning**
>
> If with the motor in motion in mode *Profile Velocity Mode (CiA402)* the *TargetVelocity* is written in an absolute value which is lower than *EndVelocity* or *StartVelocity*, the motor slows down with a deceleration equal to *ProfileDeceleration* until it reaches the *EndVelocity* and then it stops.

> **Warning**
>
> If with the motor in motion in *Profile Velocity Mode (CiA402)* mode, the *EndVelocity* or the *StartVelocity* are written in an absolute value which is higher than *TargetVelocity*, the motor stops with maximum deceleration resetting *RequestedSpeed* to zero.

21.16. 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 *Figure 21.13* you can notice a difference in the behaviour of the motor speed between the two operating modes, when a brake torque is applied at the instant t_1.

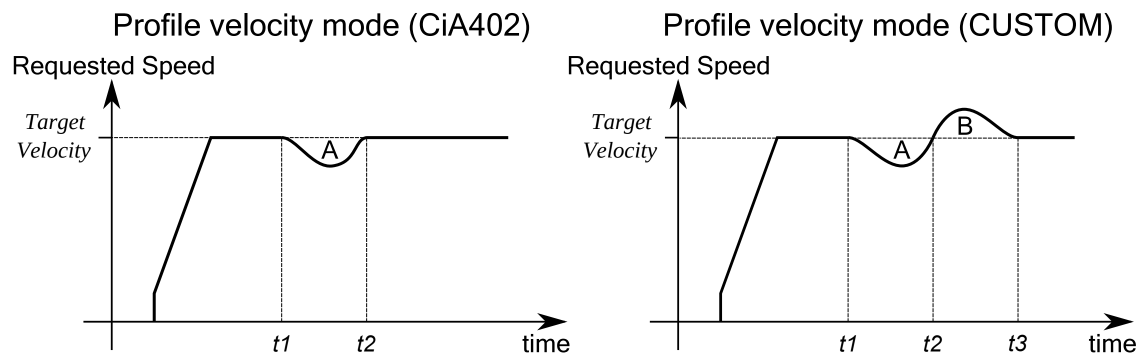


Figure 21.13. Comparison between a motion in *Profile Velocity Mode (CiA402)* and in *Profile Velocity Mode (CUSTOM)*.

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*.
- ***Profile Velocity Mode (CUSTOM)***
  The drive returns to the speed *TargetVelocity* after regaining the lost position. This means that a speed overshoot is created in the time interval t2-t3, so that the A area

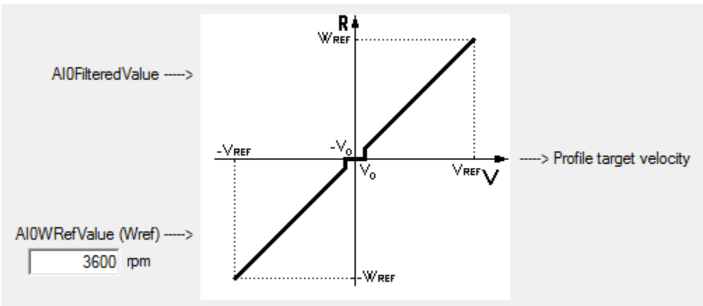
is equal to the B area (A area = lost position = regained position = B area). At the instant t3, when the lost position is fully regained, the drive returns to the speed *TargetVelocity*.

> **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 -113 in *ModesOfOperation* and, so, to follow the instructions described in *Section 21.15, Profile Velocity Mode (CiA402)*.

21.17. 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* parameter but it is obtained from *AI0FilteredVoltage*. The conversion of the values from their voltage to the requested speed occurs according to what is reported in *Section 16.3, Conversion*.



> **Important**
>
> 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 *Section 21.15, Profile Velocity Mode (CiA402)*, except from what was stated for the *TargetVelocity* parameter.

To enable the *Profile Velocity AI Mode* you must write the -111 value in the *ModesOfOperation* parameter. The *Profile Velocity AI Mode* has the automatic *Enable* functionality.

> **Tip**
>
> 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 (*ProfileAccceleration* and *ProfileDeceleration*).

21.18. 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* with the value 4 (*Torque Mode*) and then set the drive to the *Operation enable* state as described in the *Section 8.4, CiA402 state machine*. Later you can run the motion by writing the torque reference *TargetTorque*.

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

- *TargetTorque*;
- *TorqueSlope*;
- *TorqueProfileType*;

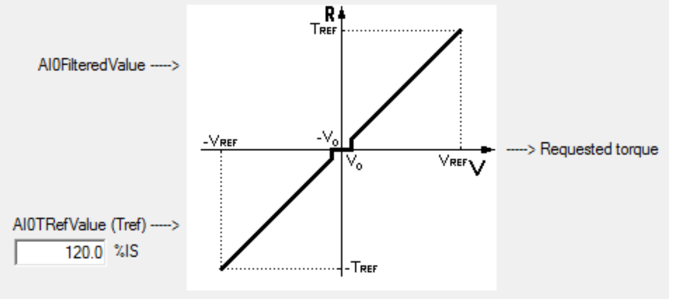
After the drive is parametrized and set to the *Operation enable* mode, a torque with module and direction consistent with the value in the *TargetTorque* parameter is applied on the motor.

In the Statusword there is a bit that shows the motion status:

- bit *Target reached*: bit showing the status of the *Torque target reached*;

21.19. 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* parameter but it is obtained from *AI0FilteredVoltage*. The conversion of the values from the voltage to the requested torque occurs according to what is reported in *Section 16.3, Conversion*.



> **Important**
>
> For the *Torque AI Mode* you can apply all the considerations related to the *Torque Mode* and its parameters, as explained in *Section 21.18, Torque Mode*, except from what was stated for the *TargetTorque* parameter.

To enable the *Torque AI Mode* you must write the -101 value in the *ModesOfOperation* parameter. The *Torque AI Mode* has the automatic *Enable* functionality.

> **Tip**
>
> 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.

21.20. 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* of the feedback sensor. This operating mode can be also used to run the preset of *PositionActualValue* without running any motion. The *Homing Mode* meets the specifications of the *CiA-402*.

> **Warning**
>
> Both in incrementalnd in absolute mode the homing procedures are always the same. Otherwise, the management and the retention of *PositionActualValue* change. For further information see the paragraph in *Section 14.4, Feedback position sensor mode: incremental/absolute*.

> **Tip**
>
> To configure the digital inputs like *Positive limit switch (FC +)*, *Negative limit switch (FC -)* or *Home*, see *Chapter 15, Digital inputs and outputs*.

> **Warning**
>
> In case the *HomingStatus* parameter is reset, the homing procedure losts its validity and it's necessary to repeat it.

> **Caution**
>
> If a *HomingMethod* (see also *Table 21.8*) with mechanical stop is selected (e.g. mode -1), remember to set the torque limit (see *Section 18.3, Torque limit*).

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* is equal to 0 inc.

- *HomeOffset*: difference between Zero position and Home position.

In the following picture can be found an example of homing motion with searching of the *Home* switch and the *Index* of the feedback sensor. When the motion starts, *Home* switch is not engaged and the motor is moved in the positive direction at the *SpeedForSwitch* speed. With the engagement of the *Home* switch, the motion is reversed and taken to the *SpeedForZero* speed. After the disengagement of the switch, the motor is stopped on the first *Index* found on the feedback sensor.

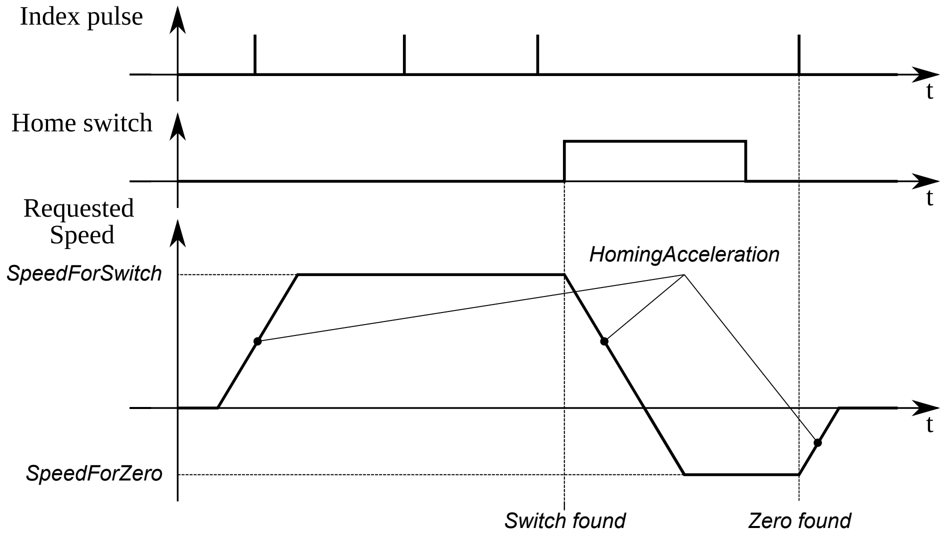


Figure 21.14. Example of timing chart of a homing profile (*HomingMethod* = 7).

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

PositionActualValue = End position - Home position - HomeOffset

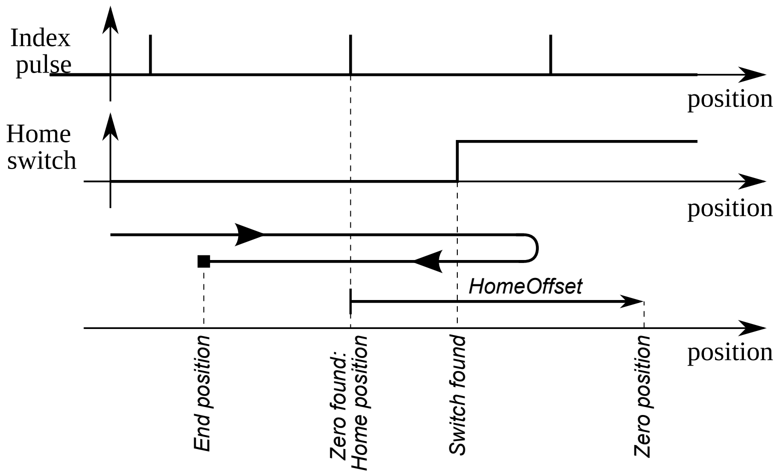


Figure 21.15. Example of position trend of a homing profile (*HomingMethod* = 7).

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

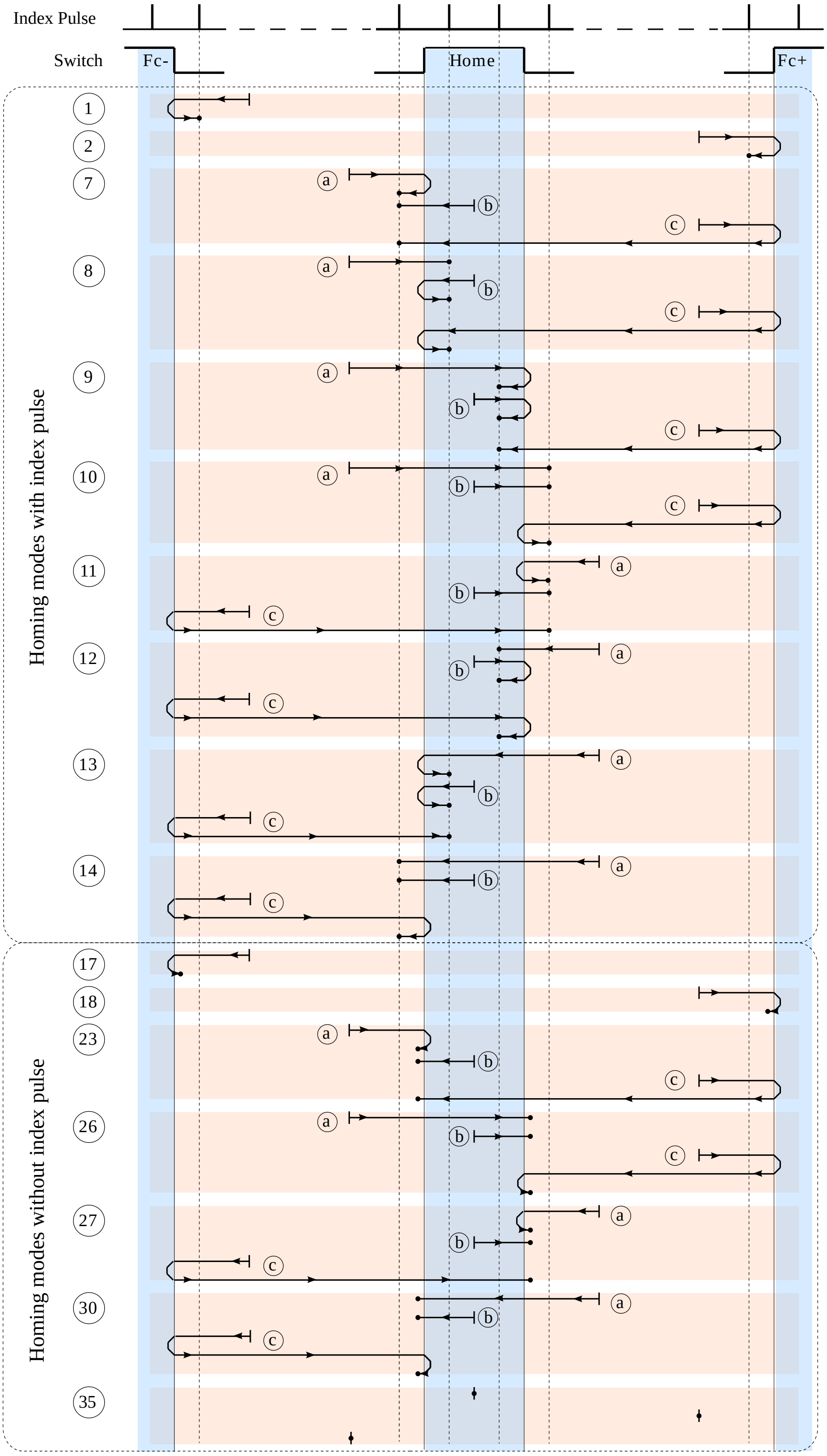
- *HomingMethod*, see the following chart;
- *HomeOffset*;
- *SpeedForSwitch*;
- *SpeedForZero*;
- *StartVelocity*;
- *EndVelocity*;
- *HomingAcceleration*;
- *IndexPulseDeadZone*.
- *HomingAbsRangeMode*.

Val.	Procedure description
1	The motor is moved in the negative direction with *SpeedForSwitch* velocity. With the engagement of the *Negative limit switch (FC -)*, the motion is reversed and taken to the speed *SpeedForZero*. After the disengagement of the limit switch, the motor is stopped on the first detected *Index* pulse.
2	The motor is moved in the positive direction with *SpeedForSwitch* velocity. With the engagement of the *Positive limit switch (FC +)*, the motion is reversed and taken to the speed *SpeedForZero*. After the disengagement of the limit switch, the motor is stopped on the first detected *Index* pulse.
7	You can find the following subcases: a. At the start of the motion *Home* switch is not engaged, the motor is moved in the positive direction with *SpeedForSwitch* velocity. With the engagement of the *Home* switch, the motion is reversed and taken to the speed *SpeedForZero*. After the disengagement of the switch, the motor is stopped on the first detected *Index* pulse. b. At the start of the motion *Home* switch is engaged, the motor is moved in the negative direction with *SpeedForZero* velocity. After the disengagement of the *Home* switch, the motor is stopped on the first detected *Index* pulse. c. At the start of the motion *Home* switch is not engaged, the motor is moved in the positive direction with *SpeedForSwitch* 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*. After the disengagement of the switch, the motor is stopped on the first detected *Index* pulse.
8	You can find the following subcases: a. At the start of the motion *Home* switch is not engaged, the motor is moved in the positive direction with *SpeedForSwitch* velocity. After the engagement of the *Home* switch, the motion is taken to the speed *SpeedForZero*. The motor is stopped on the first detected *Index* pulse. b. At the start of the motion *Home* switch is engaged, the motor is moved in the negative direction with *SpeedForZero* 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 detected *Index* pulse. c. At the start of the motion *Home* switch is not engaged, the motor is moved in the positive direction with *SpeedForSwitch* 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*. With the disengagement of the switch, the motion is reversed again. After a new engagement of the *Home*, the motor is stopped on the first detected *Index* pulse.
9	You can find the following subcases: a. At the start of the motion *Home* switch is not engaged, the motor is moved in the positive direction with *SpeedForSwitch* velocity. With the engagement of the *Home* switch, the motion is taken to the speed *SpeedForZero*, with the disengagement of the switch the motion is reversed. After a new engagement of the *Home*, the motor is stopped on the first detected *Index* pulse. b. At the start of the motion *Home* switch is engaged, the motor is moved in the positive direction with *SpeedForZero* 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 detected *Index* pulse.

Val.	Procedure description
	c. At the start of the motion *Home* switch is not engaged, the motor is moved in the positive direction with *SpeedForSwitch* 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*. The motor is stopped on the first detected *Index* pulse.
10	You can find the following subcases: a. At the start of the motion *Home* switch is not engaged, the motor is moved in the positive direction with *SpeedForSwitch* velocity. With the engagement of the *Home* switch, the motion is taken to the speed *SpeedForZero*. After the disengagement of the switch, the motor is stopped on the first detected *Index* pulse. b. At the start of the motion *Home* switch is engaged, the motor is moved in the positive direction with *SpeedForZero* velocity. After the disengagement of the *Home* switch, the motor is stopped on the first detected *Index* pulse. c. At the start of the motion *Home* switch is not engaged, the motor is moved in the positive direction with *SpeedForSwitch* 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*. After the disengagement of the switch, the motor is stopped on the first detected *Index* pulse.
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.
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* velocity. The motor is stopped on the first detected *Index* pulse.
34	The motor is moved in the positive direction with *SpeedForZero* 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* velocity. When the mechanical stop is reached, the movement is inverted and taken to the *SpeedForZero* velocity. The motor is stopped on the first detected *Index* pulse.
-2	The motor is moved in the positive direction with *SpeedForSwitch* velocity. When the mechanical stop is reached, the movement is inverted and taken to the *SpeedForZero* velocity. The motor is stopped on the first detected *Index* pulse.

Val.	Procedure description
-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* (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* (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*.

Table 21.8. Available Homing procedures (*HomingMethod*).

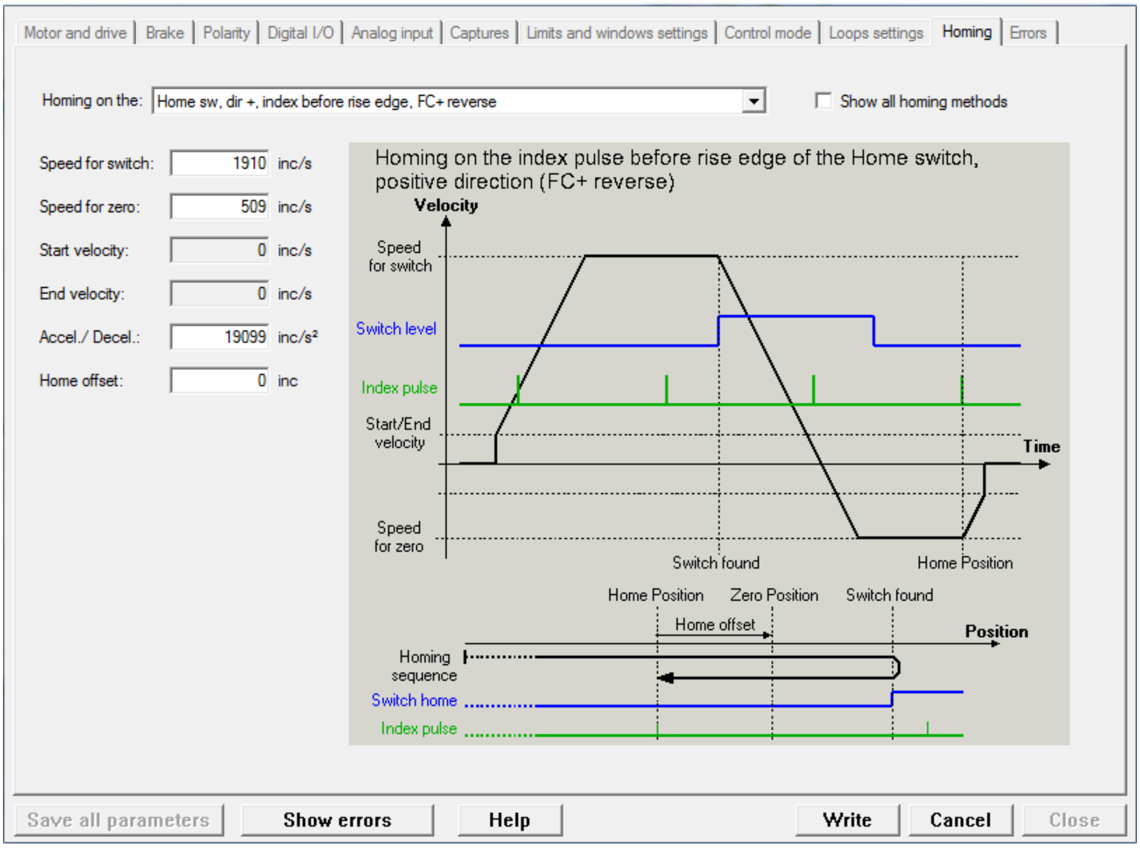


Legenda:

⊢— : axle position at the beginning of homing movement

—• : axle position at the end of homing movement

Figure 21.16. Available Homing *CiA-402* procedures.



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.

After having parametrized the drive and taken it to the *Operation enable* state, you can start the homing procedure by setting the bit *Homing operation start* of the *Controlword*. On the *Statusword* 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.

For further details on these bits, see *Table 8.6*.

21.21. Tuning Mode

This operating mode is used only for the drive configuration and calibration. It is temporary enabled by the drive when some commands of the *SysMngCommand* are requested.

Chapter 22

Oscilloscope and monitoring

22.1. Parameters monitoring

To monitor the parameters it is possible to follow three methods:

1. Object dictionary for non repetitive instant monitoring (*Section 26.2, Reading and writing a parameter*)
2. Show variables (*Figure 3.1*) for repetitive instant monitoring
3. DuetHVSuite oscilloscope for longer monitoring in precise time intervals (*Section 22.2, Monitoring by oscilloscope*).

Parameter	Show variables	Oscilloscope
PowerTemperature	*YES*	-
LogicTemperature	*YES*	-
MotorTemperature	*YES*	-
FeedbackSensorTemperature	*YES*	-
DCBusVoltage(+HV)	*YES*	*YES*
ActualMotorCurrent	*YES*	*YES*
ActualFieldCurrent	*YES*	-
ActualTorqueCurrent	*YES*	*YES*
RMSMotorCurrent	*YES*	*YES*
RequestedField	-	*YES*
ActualField	-	*YES*
RequestedTorque	*YES*	*YES*
ActualTorque	-	*YES*
ActualFilteredTorque	*YES*	-
ActualCurrentU	-	*YES*
ActualCurrentV	-	*YES*
ActualCurrentW	-	*YES*
I2TValue	*YES*	*YES*
RequestedSpeed	-	*YES*
VelocityActualValue	-	*YES*

Parameter	Show variables	Oscilloscope
SpeedFollowingError	-	*YES*
FeedForwardSpeed	-	*YES*
FeedForwardAcceleration	-	*YES*
RequestedPosition	-	*YES*
PositionActualValue	-	*YES*
PositionFollowingError	*YES*	*YES*
AI0Voltage	-	*YES*
AI0FilteredVoltage	*YES*	*YES*
AuxiliaryEncoderPosition	*YES*	-
AuxiliaryEncoderVelocity	*YES*	*YES*
Motor electric angle	-	*YES*
Feedback electric angle	-	*YES*
Feedback incremental counter[a]	-	*YES*
Feedback hall status[b]	-	*YES*
Feedback cosine	-	*YES*
Feedback sine	-	*YES*

[a]It applies to all the feedback sensors, resolver excluded.

[b]It applies to all the feedback sensors with Hall sensors (to date, all incremental sensor + Hall).

22.2. Monitoring by oscilloscope

Through the DuetHVSuite oscilloscope it is possible to acquire up to four channels at the same time. Any of the four channels, conventionally given to the vertical axis Y, and the temporal channel, conventionally given to the horizontal axis X, can be set through the related box in the tab Channels.

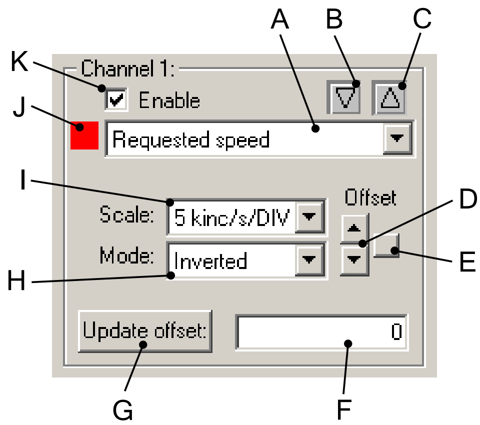
> **Note**
>
> When the Function Generator and Tuning tabs are enabled, DuetHVSuite can only run the functions that are at disposal by the windows of Oscilloscope, Oscilloscope screen and Trigger. To enable the other functionalities again it is necessary to close the oscilloscope and reopen it by using only the following paths.

Access:

Main menu > **Drive** > **Oscilloscope ...** > **Channels**

Toolbar >  > **Channels**

To start a capture see *Section 22.3, Setting the oscilloscope Trigger*, while hereafter you can find the settings related to the oscilloscope channels.



In the previous box you can find:

A. selecting the parameter to capture
B. indicator warning when the track gets over the lowest Screen limit; to let the track get back within bounds, change the scale or the offset
C. indicator warning when the channel gets over the highest Screen limit; to let the track get back within bounds, change the scale or the offset
D. buttons used to modify the offset
E. buttons used to centre the track in the Screen
F. field used to read and write the offset
G. button used to update the offset after having written it in the field F
H. selecting the display mode of the track:
   - *Disable o Hide* they hide the track
   - *Inverted* it inverts the track sign
   - *Normal* normal track display
   - *Zero* resets the track points
I. selecting the channel scale (see also the options in *Scale and autoscale options*)
J. track colour (to modify it, see *Tracks preferences*)
K. option used to enable the channel capture

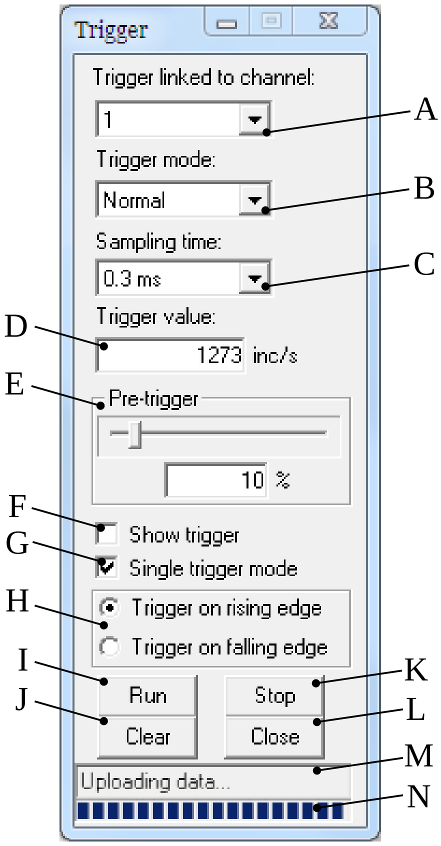
22.3. Setting the oscilloscope Trigger

Access:

Main menu > **Drive** > **Oscilloscope ...** > **Channels** > 

Toolbar >  > **Channels** > 

To set the event of *trigger*, which starts the data capture, refer to the Trigger window.



In the Trigger window you can find:

A. selecting the channel the trigger is associated to
B. mode selection:
   - *Auto*: data capture without waiting for the trigger
   - *Normal*: data capture waiting for the trigger.

> **Tip**
>
> If during the Normal mode no capture starts, enable the display of the trigger level (F), capture through the Auto mode, check on the screen the channel progress the trigger is associated to (A), set correctly the value (D) and the trigger edge (H) and try to capture again (I).

C. selecting the sampling time; if the sampling time increases, the capture interval proportionally increases
D. setting the trigger value
E. setting the points percentage you want to capture before the trigger event, as to the total number of the single track points. For example, if the Pre-trigger is equal to 50%, the trigger event will take place at half track
F. enabling the display at the trigger level
G. option used to run a single capture
H. selecting the trigger edge
I. button used to enable the data capture

J. button used to delete the captured data
K. button used to stop the capture in progress; the data will not be displayed in the Screen
L. button used to close the trigger window
M. reading the oscilloscope status; in case of error the Screen data will not be validated
N. reading the percentage of the progress of the oscilloscope status.

22.4. Saving or uploading an oscilloscope capture

Open the tab Channel. Access:

Main menu > **Drive** > **Oscilloscope ...** > **Channels**

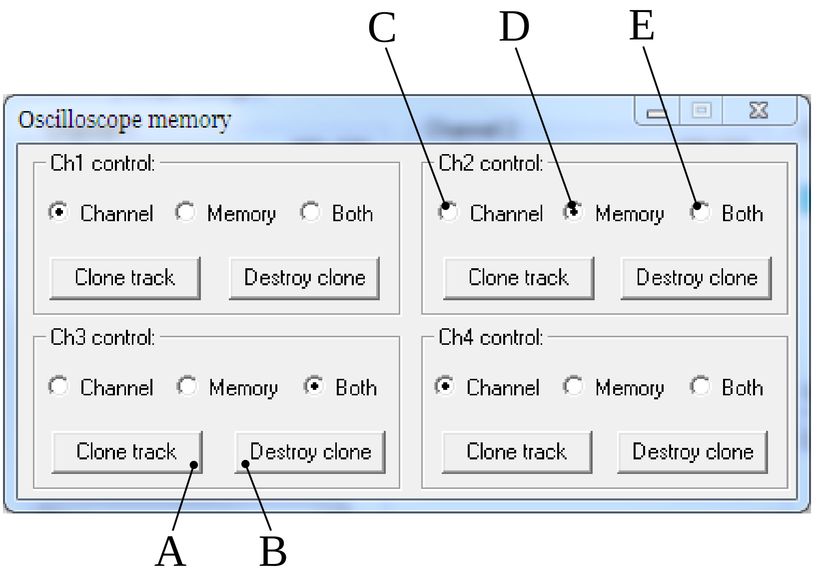
Toolbar >  > **Channels**

To upload a capture saved in a file in the oscilloscope, push the button Switch to view mode and then the button Load, then select the file to upload.

> **Important**
>
> The saved data are independent from the parameters and from the resolutions that are set in the drive. On consequence the oscilloscope will show the data in the charts according to the parameters that has been inserted (for example, a position profile will depend on the revolution resolution that has been set).

To save the capture in a file, push the button Save. Saving on file allows to add a short description of the capture to be saved.

To save the captured tracks in the Screen in order to compare them with any new captures, open the window Oscilloscope Memory by pushing the button View memory... .



In the window Oscilloscope memory you can find:

A. button used to save the track in the Screen
B. button used to delete the track saved in the Screen
C. option used to see the chart of only the captured track and modify its features
D. option used to see the chart of only the saved track and modify its features
E. option used to see the chart both of the captured track and the saved track and modify their features

22.5. Processing the captured tracks by the oscilloscope

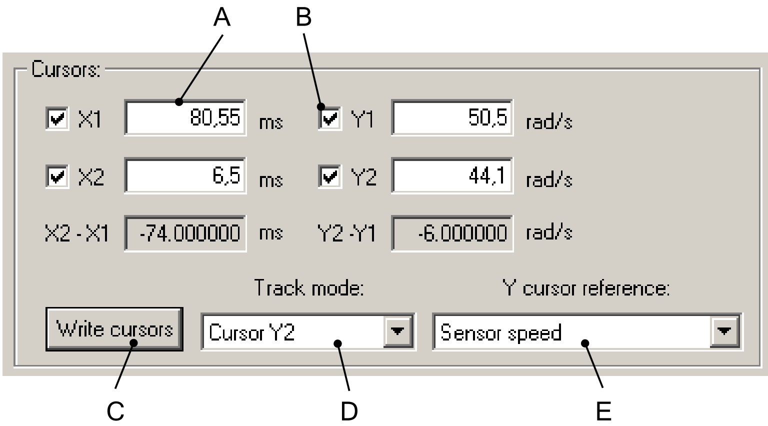
Open the tab Channel. Access:

Main menu > **Drive** > **Oscilloscope ...** > **Channels**

Toolbar >  > **Channels**

Autoscale
To set the Screen tracks automatically, according to the settings selected in *Scale and autoscale options*, push the button 
.

Measures
To measure the Screen tracks use the box Cursors.



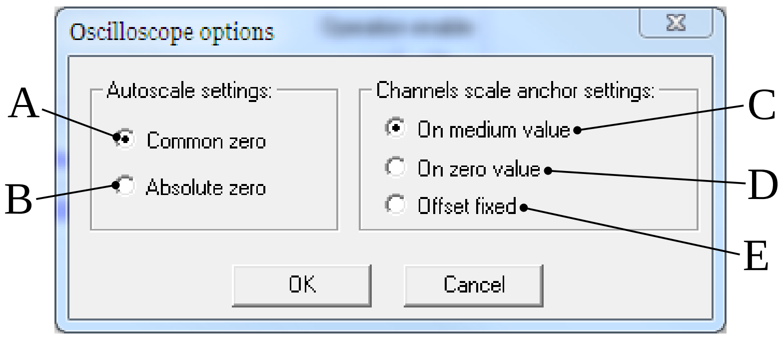
In the box Cursors you can find:

A. field used to read and write the cursors values
B. option used to enable the cursors
C. button used to confirm the digital values in the fields A
D. selecting the functionalities associated to the mouse:
   - *None*: no operation
   - *Track*: displaying the coordinates pointed with the mouse, by pushing the mouse left button in the Screen
   - *Zoom*: zooming a Screen portion
   - *Pan XY*: tracks movement along the axes X and Y by moving the mouse pointer on the screen and pushing the left button
   - *Pan X*: tracks movement along the axis X by moving the mouse pointer on the screen and pushing the left button
   - *Pan Y*: tracks movement along the axis Y by moving the mouse pointer on the screen and pushing the left button
   - *Cursor X1*: enabling and positioning the cursor X1 with the mouse on the Screen
   - *Cursor X2*: enabling and positioning the cursor X2 with the mouse on the Screen
   - *Trigger*: positioning the trigger with the mouse on the Screen, only if the option Show trigger is enabled (see the point F in *Section 22.3, Setting the oscilloscope Trigger*)
   - *Cursor Y1*: enabling and positioning the cursor Y1 with the mouse on the Screen
   - *Cursor Y2*: enabling and positioning the cursor Y2 with the mouse on the Screen
E. selecting the channel the cursors Y1 and Y2 refer to

Scale and autoscale options

To modify the features of the scale and autoscale change open the window Oscilloscope options by pushing the button 

.



In the window Oscilloscope options you can find:

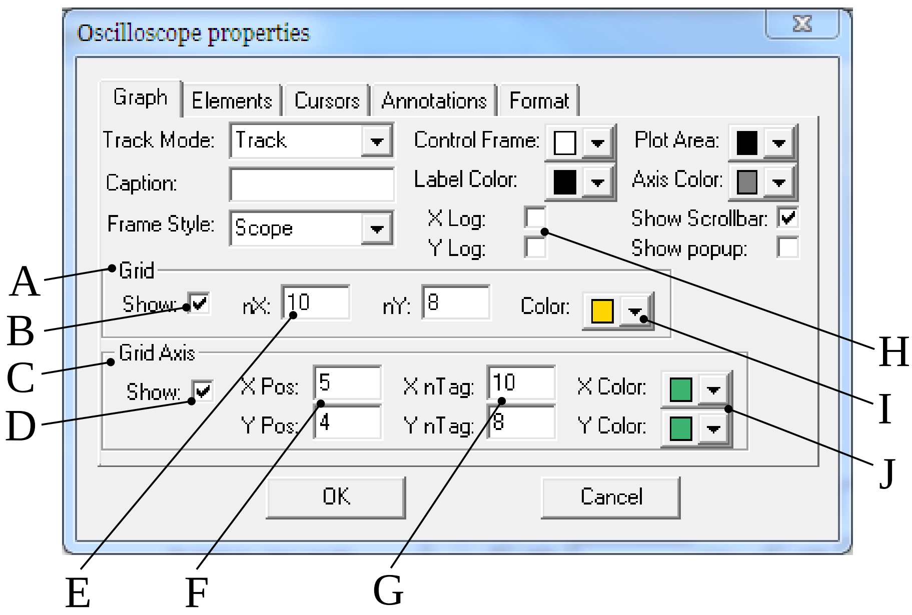
A. option of command Autoscale forcing to zero the channels offset
B. option of command Autoscale modifying the offset in order to maximize the scale
C. option of scale change setting the average tracks value on the Screen
D. option of scale change setting the tracks zero on the Screen
E. option of scale change maintaining the tracks offset

Screen dimensions

To modify the dimensions of the window Oscilloscope Screen, drag the window borders with the mouse. If the window is closed push the button View screen... .

Screen preferences

To modify the Screen preferences open the window Properties - ScopeX Control, by clicking twice with the mouse left button on the window Oscilloscope Screen.

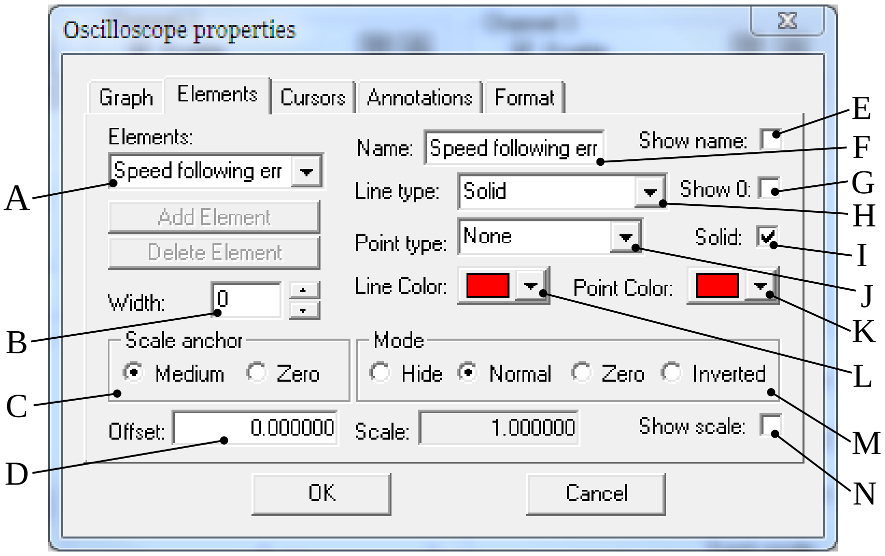


In the tab *Graph*, of the window Properties - ScopeX Control, you can find:

A. box regarding the main grid
B. option used to display the grid
C. box regarding the axes
D. option used to display the axes
E. total number of divisions of the main grid
F. position of the axes origin expressed according to the divisions number of the main grid
G. number of subdivisions reported on the axes, for each division of the main grid
H. options used to display the logarithmic scales
I. selecting the colour of the main grid
J. selecting the axes colours

Tracks preferences

To modify the tracks preferences open the window Properties - ScopeX Control, by clicking twice with the mouse left button on the window Oscilloscope Screen.



In the tab *Elements*, of the window Properties - ScopeX Control, you can find:

A. selection of the channel to modify
B. track dimension
C. track scale change (see the point I in *Section 22.2, Monitoring by oscilloscope*)
D. modification of the track offset (see the point F in *Section 22.2, Monitoring by oscilloscope*)
E. option used to display the name of the captured parameter on the Screen
F. displayed name
G. option used to display the track zero
H. selecting the track line type
I. option used to fill the track points with the same colour selected at the point K
J. selecting the track points type

K. selecting the track points colour
L. selecting the track colour
M. selecting the channel mode (see the point H in *Section 22.2, Monitoring by oscilloscope*)
N. option used to display the channel scale

Chapter 23

Fault and Warning

The drives of the series DuetHV, 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 in 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**, if the error condition is still present in the drive (otherwise the warning automatically disappear)
- **Retentive**, if the error is stored by the drive until it is reset.

In the following table you can find the features of the *MainError*, the bit which any error is associated to and the features of the masks defining the behaviour of the drive in case of Fault. The abbreviations WD, WR, FD, FR, FA, FE and FS have the following meaning:

- WD (*WarnDynamic*): main Dynamic Warnings
- WR (*WarnRetentive*): main Retentive Warnings
- FD (*FaultDynamic*): main Dynamic Faults
- FR (*FaultRetentive*): main Retentive Faults
- FA: Faults that can be set as self-restoring (the Fault Reset command 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	*MainError*				*FaultMask*			FF
		WD	WR	FD	FR	FA	FE	FS	
0	*DC bus over voltage*	*YES*	*YES*	*YES*	*YES*	-	-	-	*YES*

Bit	Error	*MainError*				*FaultMask*			FF
		WD	WR	FD	FR	FA	FE	FS	
1	*Thermal management*	*YES*	*YES*	*YES*	*YES*	-	-	-	-
2	Reserved	-	-	-	-	-	-	-	-
3	*DC bus under voltage*	*YES*	*YES*	*YES*	*YES*	*YES*	*YES*	-	*YES*
4	*Power or motor short circuit*	-	-	*YES*	*YES*	-	-	-	*YES*
5	*Parameters soft error*	*YES*	-	-	-	-	-	-	-
6	*Parameters serious error*	*YES*	-	*YES*	*YES*	-	-	*YES*	-
7	*Real time mode error*	-	-	*YES*	*YES*	-	*YES*	*YES*	-
9	Reserved	-	-	-	-	-	-	-	-
10	*Power or motor over current*	*YES*	*YES*	*YES*	*YES*	-	-	-	*YES*
11	Reserved	-	-	-	-	-	-	-	-
12	*Position following error*	*YES*	*YES*	*YES*	*YES*	-	*YES*	*YES*	-
13	*Last command requested failed*	*YES*	*YES*	*YES*	*YES*	-	-	*YES*	-
14	*/STO Management Error*	-	-	*YES*	*YES*	-	-	-	*YES*
15	*User Fault*	-	-	*YES*	*YES*	-	*YES*	*YES*	-
16	*I2T limit reached*	*YES*	*YES*	*YES*	*YES*	-	*YES*	*YES*	-
17	*I2T Warning threshold reached*	*YES*	*YES*	-	-	-	-	-	-
18 - 19	Reserved	-	-	-	-	-	-	-	-
20	*Limit reached*	*YES*	-	-	-	-	-	-	-
21	*Possible no tuning of regulator*	*YES*	*YES*	-	-	-	-	-	-
22	*Drive is in disable state, since the enable input is or has been in not active state*	*YES*	*YES*	-	-	-	-	-	-
23	*Feedback sensor error*	-	-	*YES*	*YES*	-	-	-	*YES*
24	*Digital IO configuration error*	-	*YES*	*YES*	*YES*	-	-	*YES*	-
25	*Logic voltage error*	*YES*	*YES*	*YES*	*YES*	-	*YES*	*YES*	-
26	*Motion parameter limited*	*YES*	-	-	-	-	-	-	-
27	*Digital output overtemperature or overload (DuetHV)*	*YES*	*YES*	-	-	-	-	-	-
28	*Over Speed*	-	-	*YES*	*YES*	-	*YES*	-	*YES*
29 - 30	Reserved	-	-	-	-	-	-	-	-
31	*Internal Error*	-	-	*YES*	*YES*	-	-	-	-

Table 23.1. Features of the *MainError*.

Note

To choose the self-restoring Faults, use the parameter *FaultMaskAutoErase*.
To choose the Faults to enable/disable, use the parameter *FaultMaskEnable*.
To choose the faults generating the *Safety profile*, use the parameter *FaultMaskSafetyPrfExecute*.

23.1. Management of the errors with DuetHVSuite

In the tab Main of DuetHVSuite, in the frame *Drive error* you can find two indicators showing the status of the Warnings and of the Faults. The colours have the following meaning:

(0 - 0) indicator switched off, no error
(0 - 1) orange light, Warning presence
(1 - 1) red light, Fault presence.

Next to the indicators you can find the number of the found errors. The number on the left shows the number of the errors of dynamic type, the number on the right shows the number of errors of retentive type, both for Faults and for Warnings. To see the details of the errors, open the window Show errors:

Main menu > **Drive** > **Show errors ...**

Tab Main > Show errors

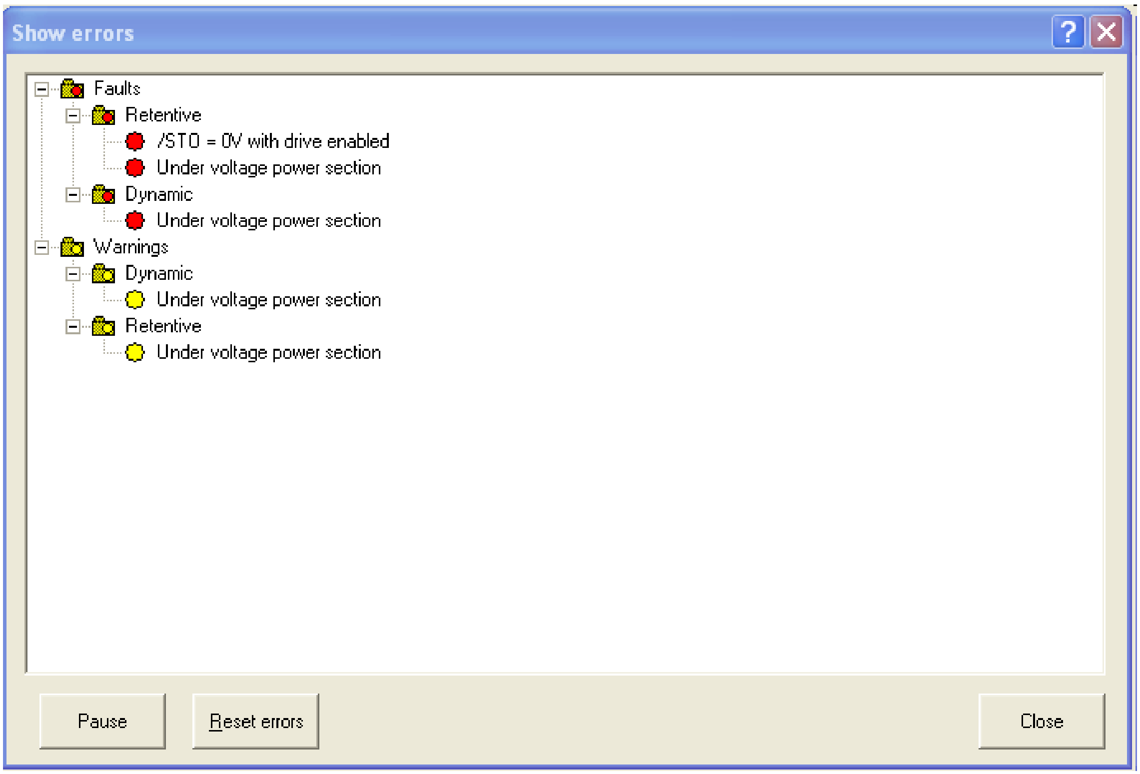


Figure 23.1. Window Show errors.

In the window Show errors, every error is placed next to an indicator, the colour of which has the following meaning:

gree indicator, no error
yellow light, Warning

orange light, Warning becoming Fault if you try to enable the drive
red light, Fault.

The errors are written in *Section 23.6, Errors description*.

Note

To reset the errors push the button Reset errors. To stop the updating of the errors shown in the page, push the button Pause.

23.2. Monitoring the errors on the status leds

The drives show the status of the errors through the L1 and L2 leds (*Section 7.3, Leds*) that can take the following colours:

- green led, no error found, showing the enabling status of the drive (see *Table 8.5*)
- orange led, only Warnings and no Faults
- red led, Faults found.

In case of more errors, the leds only show the error that in the following chart has the lowest visualization order (that corresponds to a higher priority).

Important

In the boot and firmware start up phases of the DuetHV drives, the below description of the leds is no more valid. Refer to the *Chapter 25, Software updating*.

Error	L1	L2	Order
Real time mode error	1 FL	BLK	12
Position following error	1 FL	1 FL	13
Limit reached	1 FL	2 FL	14
I2T limit reached	1 FL	3 FL	15
I2T Warning threshold reached	1 FL	3 FL	16
Parameters soft error	2 FL	BLK	17
Possible no tuning of regulator	2 FL	1 FL	18
Motion parameter limited	2 FL	2 FL	19
User Fault	2 FL	ON	21
Over Speed	3 FL	1 FL	23
Internal Error	3 FL	ON	24
/STO Management Error	BLK	ON	6

Error	L1	L2	Order
Feedback sensor error	BLK	BLK	7
Last command requested failed	BLK	1 FL	8
Parameters serious error	BLK	2 FL	9
Digital IO configuration error	BLK	3 FL	10
Digital output overtemperature or overload (DuetHV)	BLK	3 FL	20
Drive is in disable state, since the enable input is or has been in not active state	BLK	ON	22
DC bus over voltage	ON	BLK	0
Power or motor short circuit	ON	ON	1
Power or motor over current	ON	ON	2
Thermal management	ON	1 FL	3
DC bus under voltage	ON	2 FL	4
Logic voltage error	ON	3 FL	5

Table 23.2. Status of the L1 and L2 leds in case of error.

Note

The leds activation depends on the value of some parameters. The value of the *FaultRetentive* parameter, if different from 0, determines the activation of the red colour leds. If there are no Faults, but Warnings only, then the orange leds depend on the most significant bit between the ones that are different from 0 in the *WarnDynamic* and *WarnRetentive* parameters (this bit is determined by executing the OR logic operation between the two parameters).

23.3. Reaction to the Warnings

When an error of Warning type occurs, the drive runs the following operations:

1. the bits of the parameters *WarnDynamic*, *WarnRetentive* and of any other parameter showing the details are set
2. if no Faults are enabled (*FaultRetentive* is equal to 0), the leds show the Warning according to the order in*Table 23.2*
3. the state of the CiA402 State Machine is not modified (see *Section 8.4, CiA402 state machine*).

Note

When the error condition that generated the Warning is no longer noticed, the corresponding bits in the dynamic Warning parameters are reset.
In *Table 23.1* you can find the errors of Warning type.
If all the causes that have activated the bit4 of *ErrorRegister* are removed, then the bit resets and, if it was the only present alarm, then even the bit0 resets.

23.4. Reaction to the Faults

When an error of Fault type occurs, the drive executes the following operations:

1. the bits of the parameters *FaultDynamic* and *FaultRetentive* and of any other parameter showing the details are set
2. The bit (or the bits) that's related to the error type and the bit 0 of the *ErrorRegister* are set.
3. the leds show the Fault according to the order in*Table 23.2*
4. the CiA402 State Machine goes to the *Fault Reaction Active* state (see *Section 8.4, CiA402 state machine*)
5. 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 23.1*);
   - If the fault is NOT a Fatal Fault and has not been deactivated, even if it is self restoring, (see Faults with FA and FE properties in the *Table 23.1*) then the drive executes a ramp stop and the motor disabling according to the *FaultReactionOptionCode* parameter setting;
   - If the fault is NOT a Fatal Fault and requires the *Safety profile* (see Faults with FS properties in *Table 23.1*), that can be set through the *SafetyPrfCommand* and *FaultMaskSafetyPrfExecute* parameters, then the drive executes the positioning and the disabling of the motor.

Warning

If more faults contemporary happen and between these there are some with different severity (and so they provide a different reaction) it's important to know that the 3 different reactions (above described on point 6) have a different priority:
The more the Fault type is serious, the higher the priority is.
>In other words, the FatalFault 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.

Warning

If all the causes that have activated a particular bit of *ErrorRegister* are removed, then that bit resets; if all the alarm causes are removed, then even the generic bit0 is resetted.

Warning

If a FE Fault is deactivated through the *FaultMaskEnable* parameter (see *Table 23.1*), the related Warning is anyway signaled, but the Fault reaction actions will not be executed.

Note

If the fault requires the possibility to solve with the *Safety profile* (see faults with FS property on *Table 23.1*), and this profile has not been activated, the drive will execute the deceleration ramp as set on the *FaultReactionOptionCode* parameter.

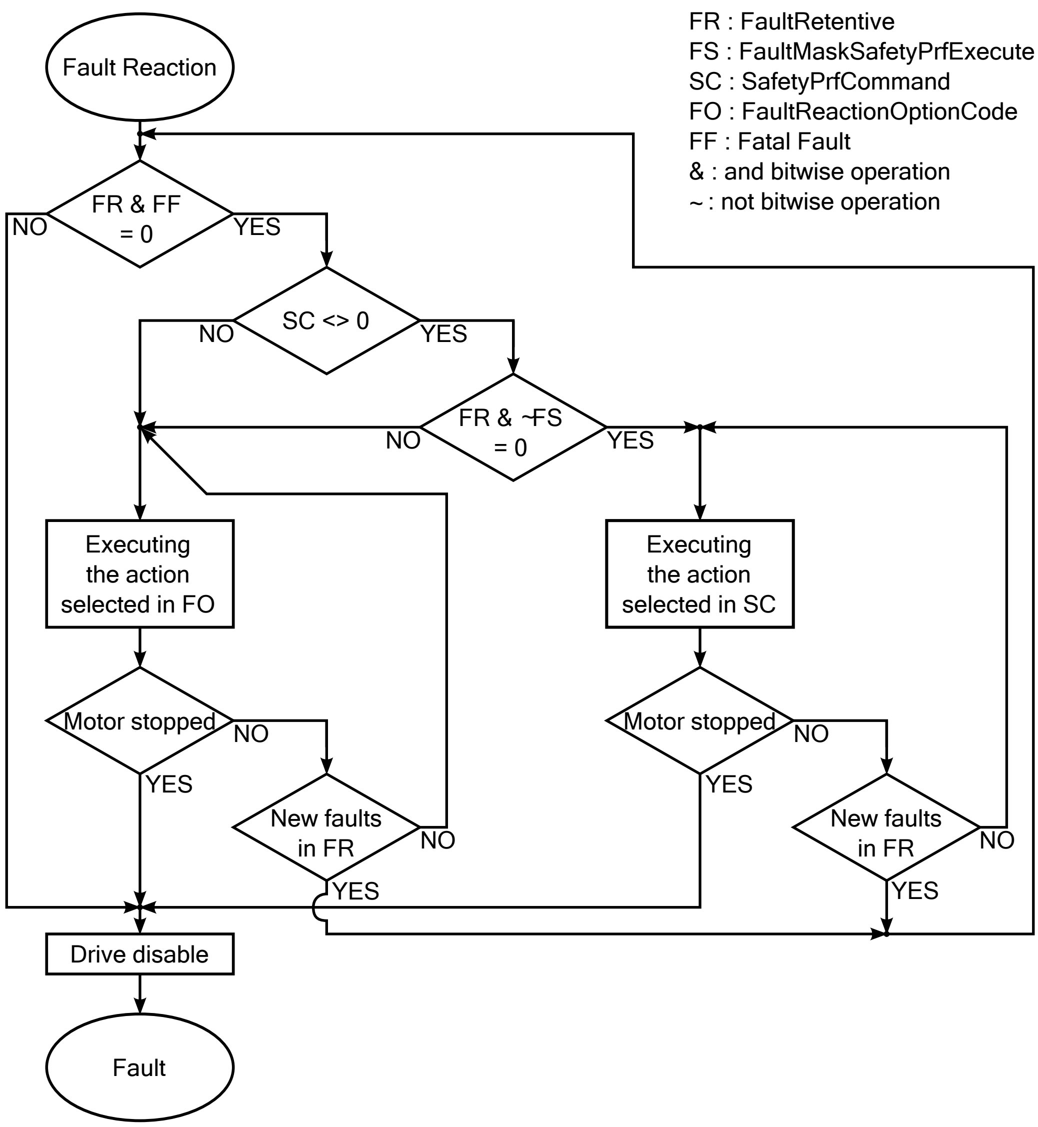


Figure 23.2. Flow diagram of the reaction to the Faults.

Note

When the error condition that has generated the Fault is no longer noticed, the corresponding bits in the dynamic Fault parameters are reset.
In *Table 23.1* 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 *Operation enable* state, if the profile is enabled (see *SafetyPrfCommand*) and if the detected Fault allows its running (see *FaultMaskSafetyPrfExecute*). If all the conditions are respected the operation shown in *SafetyPrfCommand* is run.

23.5. Resetting the errors

> **Warning**
>
> 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 retentive Warning type, write the *WarnRetentive* parameter; any written value is accepted.

> **Important**
>
> Before resetting the errors it is necessary to remove all the causes that generated them.

To reset all errors, only if the CiA402 State Machine is in the *Fault* state (see *Section 8.4, CiA402 state machine*), write the Fault reset command in the *Controlword*. The command consists of a transition from 0 to 1 of the bit 7 of the *Controlword* 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* different from 0). The CiA402 State Machine switches to the *Switch On Disabled* state (see *Section 8.4, CiA402 state machine*) only if there are no other Faults (*FaultDynamic* value is 0).

> **Note**
>
> *Power or motor short circuit*and *Power or motor over current* do not allow the running of the command Fault Reset before at least 20 seconds after the Fault event.

23.6. Errors description

DC bus over voltage
Overvoltage for the power supply of the power section (DC bus) (Warning = 800 V; Fault = 840 V). Check the size of the power supply and the electrical connections. For any further information, see *Section 13.3, Regeneration*. The DC bus voltage can be monitorized through the *DCBusVoltage(+HV)* parameter.

Thermal management
Error related to the drive thermal management. The details can be found in the following chart and in the parameters *ThermalManageError*.

Bit	Name	Type	Description
0	Power over temperature	W/F	Overtemperature of the power section (Warning = 105°C; Fault = 110°C). Check the environment temperature and the ventilation of the power section
1	Logic over temperature	W/F	Overtemperature of the power section (Warning = 85°C; Fault = 95°C). Check the environment temperature, the ventilation and the power consumption of the control section with an external amperometer. Check that the values of the current, that are reported in the *Chapter 5, Technical features*, are respected
2	Motor over temperature	W/F	Overtemperature of the motor (Warning = 10°C before of the Fault threshold; Fault = it depends on which motor is used). To know the Fault threshold value see *FaultTemperatureThrs*. Verify the environment temperature, the ventilation, the dissipation, analyze the working cycle in relation to the motor performance and torque curves
3	Fan 1 stuck	W	Fan 1 stuck. Clean the fans and try again.
4	Fan 2 stuck	W	Fan 2 stuck. Clean the fans and try again.
5	Fan 3 stuck	W	Fan 3 stuck. Clean the fans and try again.
6	Power temp. sensor hardware failure	F	Failure of the sensor or the misuration system of the power section temperature. Please contact Motor Power Company
7	Logic temp. sensor hardware failure	F	Failure of the sensor or the misuration system of the control section temperature. Please contact Motor Power Company
8	Motor temp. sensor hardware failure	F	Failure of the sensor or the misuration system of the motor temperature. Please contact Motor Power Company
9	Feedback sensor over temperature	W/F	Feedback sensor over temperature. 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 en-

Bit	Name	Type	Description
			vironment temperature, the ventilation, the dissipation, analyze the working cycle in relation to the motor performance and torque curves.
10	Motor temperature sensor unknown - selection forced to none sensor	W	Temperature sensor unknown The firmware doesn't recognize the temperature sensor code, the system will maintain as selected the sensor that has been set by the user, but will internally manage it as it had been selected "None sensor" (*MotorTemperatureSensorType* = 0), so without monitoring the motor temperature. Every time that the system is turned off and on again and finds a sensor that's not provided by the firmware, this Warning will recur unless a motor without a temperature sensor, or with a supported one, is saved in EEPROM (see *MotorTemperatureSensorType*).
11 - 15	Reserved		

Table 23.3. Details about *ThermalManageError* (W = Warning, F = Fault, W/F = both).

DC bus under voltage

Undervoltage for the power supply of the power section (DC bus) (Warning = 200 V; Fault = 150 V). 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. The DC bus voltage can be monitorized through the *DCBusVoltage(+HV)* parameter.

Power or motor short circuit

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 Motor Power Company.

Parameters soft error

Soft error in the drive parametrization. You can find the details in the following chart and in the parameter *ParamSoftError* and *AI0CalibrationStatus*.

Bit	Name	Type	Description
0	I2T Limited to max drive value	W	*UserMaxI2T*higher than *DriveMaxI2T*. Decrease *UserPeakCurrent* e/o *I2TTime*.
1	Peak current too high for motor or drive	W	*UserPeakCurrent*higher than *MotorPeakCurrent* e/o *MaxPeakCurrent*. Decrease *UserPeakCurrent*.
2 - 4	Reserved		

Bit	Name	Type	Description
5	Loops configuration selected is not supported	W	*LoopConfiguration*not supported by the current firmware. Update the firmware or change configuration.
6	Software position limits incompatibility	W	*PositionLimitPositive*lower than *PositionLimitNegative*. Correct the limits
7	Capture Trigger Source equal on both Capture peripheral	W	*CaptureTriggerInput_A*equal to *CaptureTriggerInput_B*. Choose two different values.
8 - 9	Reserved		
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 *Index* and the space filter (*CaptureSource0_A*) or the capture on both edges. Or it has been tried to set the space filter (*CaptureSource0_A*) 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 *Index* and the space filter (*CaptureSource0_B*) or the capture on both edges. Or it has been tried to set the space filter (*CaptureSource0_B*) 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 been kept)	W	The last value written in *CaptureTriggerInput_A* 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 been kept)	W	The last value written in *CaptureTriggerInput_B* 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 at parameter '*CaptureInterfaceMode*')	W	It has been tried to access, in reading or writing, to the not selected interface (see *CaptureInterfaceMode* parameter). This bit cannot auto-reset, but must be reset by the user.

Table 23.4. Details about *ParamSoftError* (W = Warning, F = Fault, W/F = both).

Parameters soft error is enabled even when *AI0CalibrationStatus* assumes the following values (W = Warning, F = Fault, W/F = both).

Value	Name	Type	Description
0	Analog input 0 is not calibrated	W	Analog input 0 is not correctly calibrated. Run the calibration according to what is reported in *Section 16.2, 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	

Parameters serious error

Serious error in the drive parametrization. The details can be found in the following chart and in the parameters *ParamSeriousError*. The Warning becomes a Fault if you try to enable the drive.

Bit	Name	Type	Description
0	Stall current not set	W/F	*MotorStallCurrent*is equal to 0. Turn off and on again the drive. If the problem persists, please contact Motor Power Company Srl.
1	Motor peak current not set	W/F	*MotorPeakCurrent*is equal to 0. Turn off and on again the drive. If the problem persists, please contact Motor Power Company Srl.
2	Motor torque constant not set	W/F	*TorqueConstant(ForceConstant)*is equal to 0. Turn off and on again the drive. If the problem persists, please contact Motor Power Company Srl.
3	Motor inductance not set	W/F	*MotorInductance*is equal to 0. Turn off and on again the drive. If the problem persists, please contact Motor Power Company Srl.
4	Motor resistance not set	W/F	*MotorResistance*is equal to 0. Turn off and on again the drive. If the problem persists, please contact Motor Power Company Srl.
5	Motor inertia not set	W/F	*MotorInertia(MotorMass)*is equal to 0. Turn off and on again the drive. If the problem persists, please contact Motor Power Company Srl.
6	Motor pole number not set	W/F	*MotorPoles*is equal to 0. Turn off and on again the drive. If the problem persists, please contact Motor Power Company Srl.
7	Motor rated speed not set	W/F	*MotorRatedSpeed*is equal to 0. Turn off and on again the drive. If the problem persists, please contact Motor Power Company Srl.
8	Sensor not set	W/F	*FeedbackSensorCode*is equal to 0. Turn off and on again the drive. If the problem persists, please contact Motor Power Company Srl.
9	Max rated current not set	W/F	*MaxRatedCurrent*is equal to 0. Please contact Motor Power Company Srl
10	Max peak current not set	W/F	*MaxPeakCurrent*is equal to 0. Please contact Motor Power Company Srl
11	Current not calibrated	W/F	Please contact Motor Power Company Srl
12	Voltage not calibrated	W/F	Please contact Motor Power Company Srl
13	Sensor not supported	W/F	*FeedbackSensorCode*not supported by the current firmware. Update the firmware or change the sensor.
14	Sensor not phased	W/F	Feedback sensor phasing problems. The cause is specified by the *Feedback sensor error*. Reset the errors, if the problem persists please contact Motor Power Company Srl.
15	Pole pitch not set	W/F	*PolePitch*is equal to 0. Turn off and on again the drive. If the problem persists, please contact Motor Power Company Srl.

Table 23.5. Details about *ParamSeriousError* (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*.

The following descriptive table refers to the parameters for the interpolation and to the synchronization methods. Their use is intended according to the following rules:

With *parameters for the interpolation* is meant:

- if *ModesOfOperationDisplay* = 7 → *IpPosFirstParameter* and *IpPosSecondParameter* (the second one is not necessary if *IpPosSubModeSelect* value is 0);
- if *ModesOfOperationDisplay* = 8 → *TargetPosition* and *VelocityOffset* (the second one is necessary only if *CyclicSynchronousSubMode* value is -147 or -148);
- if *ModesOfOperationDisplay* = 9 → *TargetVelocity*;
- if *ModesOfOperationDisplay* = 10 → *TargetTorque*;

The limits of the *parameters for the interpolation* related to alarm that corresponds to the bit5, according to the value of *ModesOfOperationDisplay*, mean that:

- in a T_{SYNC} period the resultant position difference must be lower than 16.38 rev. The position difference is calculated according to the value that's written in the *IpPosFirstParameter* parameter if *ModesOfOperationDisplay* value is 7 or according to the value of *TargetPosition* if *ModesOfOperationDisplay* value is 8;
- the velocity must be lower than ±3216 rad/s. The velocity set in *IpPosSecondParameter* if *ModesOfOperationDisplay* value is 7, in *VelocityOffset* if *ModesOfOperationDisplay* value is 8, in *TargetVelocity* if *ModesOfOperationDisplay* value is 9;

For the *synchronization method* see*Section 9.4, Synchronization*

Bit	Name	Type	Description
1	Pdo missing	F	The parameters for the interpolation were not received via PDO, before the synchronization; correctly manage the PDOs in the Master according to the synchronization method.
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 the period according to the synchronization method and to the *ModesOfOperationDisplay* (For further details see what is reported in each single operative mode in the *Chapter 21, Creating a motion*).
4	Wrong interpolation cycle period	F	
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	Incompatibility interpolation sub mode	F	The *CyclicSynchronousSubMode* is not compatible with the *ModesOfOperationDisplay*. Check the settings according to the contents of *Table 26.13*.
7 - 15	Reserved		

Table 23.6. Details about *RealTimeModeError* (W = Warning, F = Fault, W/F = both).

EtherCAT communication error

Main port communication error EtherCAT. The details can be found in the following chart and in the parameters *EtherCAT_Diagnostics*.

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 *Sync Signal* 0 expired; set and enable correctly the signal *Sync Signal* 0 and the watchdog times in the registers of the ET1100.
2	PLL Error	F	PDO and *Sync Signal* 0 are not synchronized; manage correctly in the Master the sending of the PDO before the synchronization; the synchronization methods can be found in *Section 9.4, Synchronization*.
3	Synchronization Error	F	The PDOs RX don't arrive or however not in correspondence to the set synchronization reference (see *Section 9.4, Synchronization*), 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 Motor Power Company Srl
9	ESI eeprom may not be updated	W	ESI eeprom not updated; update the ESI eeprom according to what's reported in *Section 25.6, ESI EEPROM updating procedure on ETC drive*.
10	ESI eeprom will be updated at the next power-up cycle	W	ESI eeprom not updated; in case the drive characteristics allow the ESI eeprom automatic update (if the conditions that are reported in *Section 25.6, ESI EEPROM updating procedure on ETC drive* are respected), when a firmware download ends then the drive is ready to execute it on next start-up.
11	ESI eeprom updating at the power-up failed	W	ESI eeprom not updated; the automatic procedure has failed due to a drive HW problem; execute the ESI eeprom manual update procedure according to what's reported in *Section 25.6, ESI EEPROM updating procedure on ETC drive*.
10 - 31	Reserved		

Table 23.7. Details about *EtcErrorRetentCommMsg* (W = Warning, F = Fault, W/F = both).

Power or motor over current

Too high and anomalous current in the power section or in the motor phases. The overcurrent values can be found in *OverCurrentAValue*, *OverCurrentBValue* and *OverCurrentCValue*. It generally happens when the drive is not on condition to correctly control the current due to an anomaly or a non optimal parametrisation (tuning). 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 Check the current loop tuning and decrease its dynamic response. Decrease the value of *UserPeakCurrent*. Check that the insulation voltage of the motor windings is compatible with the drive supply voltage.
This anomaly can happen even when *ActualFieldCurrent* < -50%IS and very steep decelerations are executed. In these conditions the DC bus supply voltage turns out to be not sufficient to control the current, the counter-electromotive force of the motor increases the currents to valules that are higher than the limit and the over current may be reported. If this condition continues, during the Warning presence, it can become a Fault. Decrease the deceleration ramps or the starting ramp velocity, increase the DC bus supply voltage.
Wait 20 seconds before to execute the Fault Reset, in order to allow the dissipation of the stored energy. If the problem persists, please contact Motor Power Company.

Position following error
The *PositionFollowingError* 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 *FaultMaskEnable* parameter; the Warning cannot be disabled.

Last command requested failed
The last command of the *SysMngCommand* has concluded with an error. The details and the solutions of the error can be found in the parameter *SysMngError*.

/STO Management Error
Error related to the /STO input management, while for the DuetHV flange 60 it is related to one of /STO1 and /STO2 inputs. The details are reported in this table and in the *STOError* parameters.

Bit	Name	Type	Description
0	/STO = 0V with drive enabled	F	It occurs in the following cases: • The drive is in *Drive enable* state and the voltage on the /STO digital input fails → Disable the drive before to cut off the voltage supply to the /STO input, or /STO1 and /STO2 for the DuetHV flange 60. • It has been tried to enable the drive without the /STO signal → Provide voltage to the /STO input , or /STO1 and /STO2 for the DuetHV flange 60 before to give the enabling command.
1	/STO input level not in valid range	F	The voltage level that's applied on the /STO input has lasted more than 500ms in the intermediate range of values of the voltage thresholds (see *Figure 6.3*). Be sure that the transition between the voltage levels, from the electrical point of view, takes no more than 500ms and

Bit	Name	Type	Description
			that the voltage values are within the correct ranges (see */STO input electric features*)
2 - 15	Reserved		

Table 23.8. Details about *STOError* (W = Warning, F = Fault, W/F = both).

User Fault

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*.

Bit	Name	Type	Description
0	User Fault 1	F	User fault number 1
1 - 15	Reserved		

Table 23.9. Details about *UserError* (W = Warning, F = Fault, W/F = both).

I2T limit reached

*I2TValue*has reached the 100%, that is the drive has reached the highest level of overload. If the Fault is enabled the drive Faults, otherwise only the Warning is reported and the motor current reaches the value *NominalCurrent*. See what reported in *Section 24.6, Motion problems*.

I2T Warning threshold reached

*I2TValue*reached the specified threshold in *I2TWarningThreshold*. The motor current is not limited. See what reported in *Section 24.6, Motion problems*.

Limit reached

Limits reached by the motor motion (see *Chapter 18, Motion limits*). The details can be found in the following chart and in the parameter *LimitReachedError*.

Bit	Name	Type	Description
0	Positive software position limit reached	W	*PositionActualValue*higher than *PositionLimitPositive*.
1	Negative software position limit reached	W	*PositionActualValue*lower than *PositionLimitNegative*.
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 to the digital inputs of the *CN4* connector.

Bit	Name	Type	Description
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 to the digital inputs of the *CN4* connector.
4 - 7	Reserved		
8	Max motor speed limit reached	W	*VelocityActualValue*limited by *MaxMotorSpeed*.
9 - 11	Reserved		
12	Torque limit reached	W	*TargetTorque*higher or equal to *ActualTorqueLimitP* in absolute value. Verify that there are not mechanical obstacles; if the limit is set through analog input (in the *TorqueLimitSelector* parameter has been set the value 2), verify the input value.
13	Peak current is zero	W	*UserPeakCurrent*is equal to 0. Set *UserPeakCurrent*.
14	Peak current limit reached	W	*ActualMotorCurrent*limited by *UserPeakCurrent*.
15	Reserved		

Table 23.10. Details about *LimitReachedError* (W = Warning, F = Fault, W/F = both).

Caution

If the *Polarity* is of Reverse type, then 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

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 is in disable state, since the enable input is or has been in not active state

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.

Feedback sensor error

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*.

The error strings that are reported are encoded according to the sensor type:

- The errors that start with 0x1 refer to incremental Encoders
- The errors that start with 0x3 refer to incremental Encoders + Hall
- The errors that start with 0x4 refer to analog SIN COS
- The errors that start with 0x5 refer to Hiperrface SIN COS
- The errors that start with 0x6 refer to Resolver

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 Motor Power Company Srl.
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 Motor Power Company Srl.
0x15B	Phasing: Quadrature signals A or B are disconected	F	The drive does not receive the encoder A and B quadrature signals. Check the encoder connections. If the problem persists, please contact Motor Power Company Srl.
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 Motor Power Company Srl.
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 Motor Power Company Srl.
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 Motor Power Company Srl.
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 Motor Power Company Srl.
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 Motor Power Company Srl.
0x35B	Phasing: Quadrature signals A or B are disconected	F	The drive does not receive the encoder A and B quadrature signals. Check the encoder connections. If the problem persists, please contact Motor Power Company Srl.
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 Motor Power Company Srl.
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 Motor Power Company Srl.
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 Motor Power Company Srl.
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.

Code	Name	Type	Description
			If the problem persists, please contact Motor Power Company Srl.
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 Motor Power Company Srl.
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 Motor Power Company Srl.
0x470	Position calculation error: Mismatch between Sine/Cosine and Incremental counter	W/F	Electrical problems on the reconstruction of the position from the Sine/Cosine signals. Reset the errors. If the problem persists, please contact Motor Power Company Srl.
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 the problem persists, please contact Motor Power Company Srl.
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.
0x473	Sine or Cosine level out of range	W	Electrical problems on the reconstruction of the position from the Sine/Cosine signals. Check the encoder connections. Reset the errors and execute the Hard Reset command (command 5000 of the *System Manager*). If the problem persists, please contact Motor Power Company Srl.
0x474	Sine or Cosine hardware error	F	Drive internal electrical problems. Reset the errors and execute the Hard Reset command (command 5000 of the *System Manager*). If the problem persists, please contact Motor Power Company Srl.
0x501 0x502 0x503 0x504 0x505 0x506 0x507 0x508 0x509 0x50A 0x50B 0x50C 0x50D 0x50E 0x50F	Internal sensor error	F	Sensor internal error. If the problem persists, please contact Motor Power Company Srl

Code	Name	Type	Description
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 Motor Power Company Srl.
0x531	Communication: Timeout sending data	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact Motor Power Company Srl.
0x535	Communication: Out of memory	F	Communication error with the sensor. Stop the oscilloscope and try again. If the problem persists, please contact Motor Power Company Srl.
0x540	Communication: Checksum error	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact Motor Power Company Srl.
0x541	Communication: Parity error	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact Motor Power Company Srl.
0x542	Communication: Framing error	F	Communication error with the sensor. Reset the errors. If the problem persists, please contact Motor Power Company Srl.
0x543	Communication: Overrun error	F	Communication error with the sensor. If the problem persists, please contact Motor Power Company Srl.
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 Motor Power Company Srl.
0x558	Phasing: Data not found (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 Motor Power Company Srl.
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 Motor Power Company Srl.
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 Motor Power Company Srl.

Code	Name	Type	Description
0x570	Position calculation error: Mismatch between analog and digital position	W/F	Electrical problems on the reconstruction of the position from analog and digital signals. Reset the errors. If the problem persists, please contact Motor Power Company Srl.
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 the problem persists, please contact Motor Power Company Srl.
0x573	Sine or Cosine level out of range	W	Electrical problems on the reconstruction of the position from the Sine/Cosine signals. Check the encoder connections. Reset the errors and execute the Hard Reset command (command 5000 of the *System Manager*). If the problem persists, please contact Motor Power Company Srl.
0x574	Sine or Cosine hardware error	F	Drive internal electrical problems. Reset the errors and execute the Hard Reset command (command 5000 of the *System Manager*). If the problem persists, please contact Motor Power Company Srl.
0x673	Sine or Cosine level out of range	W	Electrical problems on the reconstruction of the position from the Sine/Cosine signals. Check the resolver connections. Reset the errors and execute the Hard Reset command (command 5000 of the *System Manager*). If the problem persists, please contact Motor Power Company Srl.
0x674	Sine or Cosine hardware error	F	Drive internal electrical problems. Reset the errors and execute the Hard Reset command (command 5000 of the *System Manager*). If the problem persists, please contact Motor Power Company Srl.

Table 23.11. Details about *FeedbackSensorError* (W = Warning, F = Fault, W/F = both).

Digital IO 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*. The Warning becomes a Fault if you try to enable the drive.

Bit	Name	Type	Description
4-0	Code of the first hardware resource involved in the error	-	1 = I/O 0 for all drives 2 = I/O 1, In 1 for DuetHV flange 60 3 = I/O 2, In 2 for DuetHV flange 60 4 = I/O 3, In 3 for DuetHV flange 60 5 = In 4, Out 1 for DuetHV flange 60 6 = In 5, Out 2 for DuetHV flange 60 7 = In 6 for DuetHV except for flange 60 8 = In 7 for DuetHV except for flange 60 9 = In 8 for DuetHV except for flange 60 10 = In 9 for DuetHV except for flange 60 11 = Out 4 only DuetHV, except for flange 60 12 = Out 5 only DuetHV, except for flange 60
9-5	Code of the second hardware resource involved in the error	-	

Bit	Name	Type	Description
			13 = Out 6 only DuetHV, except for flange 60
16-10	1 = Exclusive function assigned to both resources	W/F	Functionality to be assigned to a hardware resource has been assigned to two resources; reprogram the functionalities;
	2 = Step function assigned to this resource without Direction		*STEP* functionality assigned without having assigned the *DIR* one; assign the lacking functionality;
	3 = Dir function assigned to this resource without Step		*DIR* functionality assigned without having assigned the *STEP* one; assign the lacking functionalities;
	4 = *Index* function assigned to this resource without FA nor FB		*Index Input (Idx)* functionality assigned without having assigned the *Quadrature Input ChA (Ch A)* and *Quadrature Input ChB (Ch B)* ones; assign the lacking functionalities;
	5 = FB function assigned to this resource without FA		*Quadrature Input ChB (Ch B)* functionality assigned without having assigned the *Quadrature Input ChA (Ch A)* one; assign the lacking functionality;
	6 = FA function assigned to this resource without FB		*Quadrature Input ChA (Ch A)* functionality assigned without having assigned the *Quadrature Input ChB (Ch B)* one; assign the lacking functionality;
	7 = Settings in permanent memory not compatible with firmware (default value restored)		The I/Os setting in the permanent memory is not compatible with the firmware in the drive, so the default values have been automatically restored; Reconfigure the I/Os with the functionalities that are allowed by the actual firmware or restore the firmware that allowed the use of the functionalities that are no more at disposal.

Table 23.12. Details about *DigitalIoConfigError* (W = Warning, F = Fault, W/F = both).

Logic voltage error

Error of the power supply voltage of the control section. For any further information, see *Section 13.2, Supply voltages*. The details can be found in the following chart and in the parameters *LogicVoltageError*.

Bit	Name	Type	Description
0	Logic voltage too low for brake	W/F	The supply voltage of the control section is too low to correctly ensure the brake. Under the "Error threshold for the brake" (see *Chapter 5, Technical features*) the drive enters in the Warning status. If the voltage remains under this threshold, the Fault activates. Increase the supply voltage or stabilize it.
1 - 15	Reserved		

Table 23.13. Details about *LogicVoltageError* (W = Warning, F = Fault, W/F = both).

Motion parameter limited

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*.

Bit	Name	Type	Description
0	Target velocity limited	W	With the *Profile Velocity Mode (CiA402)* (and CUSTOM) operative modes, *TargetVelocity* is greater or equal to *MaxMotorSpeed* or to *MaxProfileVelocity*. Decrease *TargetVelocity*. With ther *Profile Velocity AI Mode* mode, the conversion from *AI0FilteredVoltage* to the required velocity, produces a velocity value tha's grater or equal to *MaxMotorSpeed* or to *MaxProfileVelocity*. If the Warning is unexpected, check if the conversion procedure accords to the contents of *Section 16.3, Conversion*.
1	Profile velocity limited	W	*ProfileVelocity*is higher or equal to *MaxMotorSpeed* or to *MaxProfileVelocity*. Decrease *ProfileVelocity*.
2	Start velocity limited	W	*StartVelocity*is higher or equal to *MaxMotorSpeed* or to *MaxProfileVelocity*. Decrease *StartVelocity*.
3	End velocity limited	W	*EndVelocity*is higher or equal to *MaxMotorSpeed* or to *MaxProfileVelocity*. Decrease *EndVelocity*.
4	Speed during search for switch limited	W	*SpeedForSwitch*is higher or equal to *MaxMotorSpeed* or to *MaxProfileVelocity*. Decrease *SpeedForSwitch*.
5	Speed during search for zero limited	W	*SpeedForZero*is higher or equal to *MaxMotorSpeed* or to *MaxProfileVelocity*. Decrease *SpeedForZero*.
6	Velocity of the safety profile limited	W	*SafetyPrfVelocity*is higher or equal to *MaxMotorSpeed* or to *MaxProfileVelocity*. Decrease *SafetyPrfVelocity*.
7	Reserved		
8	Profile acceleration limited	W	*ProfileAccceleration*is higher or equal to *MaxAcceleration*. Decrease *ProfileAccceleration*.
9	Profile deceleration limited	W	*ProfileDeceleration*is higher or equal to *MaxDeceleration*. Decrease *ProfileDeceleration*.
10	Homing acceleration limited	W	*HomingAcceleration*is higher or equal to *MaxAcceleration* or to *MaxDeceleration*. Decrease *HomingAcceleration*.
11	Quick stop deceleration limited	W	*QuickStopDeceleration*is higher or equal to *MaxDeceleration*. Decrease *QuickStopDeceleration*.
12	Deceleration of MC_Stop/MC_Emcy function block limited	W	*SafetyPrfAcceleration*is higher or equal to *MaxAcceleration*. Decrease *SafetyPrfAcceleration*.
13	Acceleration of the safety profile limited	W	*SafetyPrfAcceleration*is higher or equal to *MaxAcceleration*. Decrease *SafetyPrfAcceleration*.
14	Deceleration of the safety profile limited	W	*SafetyPrfDeceleration*is higher or equal to *MaxDeceleration*. Decrease *SafetyPrfDeceleration*.
15	Reserved		

Table 23.14. Details about *MotionParamLimitedError* (W = Warning, F = Fault, W/F = both).

Digital output overtemperature or overload (DuetHV)[1]

Overcharge or overtemperature have been detected on the drive internal circuit of the digital output management. All digital outputs are switched off. Check the connected wirings and loads.

Over Speed

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* 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*. Please contact Motor Power Company

Bit	Name	Type	Description
0	Internal Software Reset	F	A firmware internal error has occurred. Report to Motor Power Company the codes in the *SwResetCode* and *SwResetInfo* parameters.

Table 23.15. Details about *InternalError* (W = Warning, F = Fault, W/F = both).

/STO Error

An error on the /STO has occurred. The details are reported in the *STOError* parameters.

[1]except for DuetHV flange 60, for which this error is not provided

Chapter 24

Troubleshooting

> **Tip**
>
> In case of problems run the *Save/Export parameters file* command with DuetHVSuite, so that you can record on a file the full drive situation. The saved file is useful to run in a second moment or remotely the problem analysis.

24.1. Generic problems

Problem	Solution
The leds are switched off.	• Verify that the drive is correctly supplied, in particular the control section; see what's reported in *Section 13.2, Supply voltages*; • check the wiring.
The leds are on but the drive does not communicate.	• See what reported in *Section 24.5, Communication problems*.
Interpreting the drive status on the basis of the leds status	• See what reported in *Section 7.3, Leds*.
Find the status of the Digital I/O	• Read the parameters *DigitalInputs* and *PhysicalOutputs*; • open the tab Main of DuetHVSuite • see what reported in *Chapter 15, Digital inputs and outputs*.
Value the motion performances	• See the available parameters in Show variables (*Figure 3.1*) for one first evaluation; • use the DuetHVSuite oscilloscope to estimate the performances of the motion parameters (*Section 22.2, Monitoring by oscilloscope*).
Monitor some drive parameters (temperature, currents, speed, etc...)	• See what reported in *Chapter 22, Oscilloscope and monitoring*; • see what reported in *Section 26.11, Drive status (1800-1999)*.
Load dynamic braking	• Do not use the internal brake of the DuetHV drives; • run the braking according to what is reported in *Section 21.3, Execute a stop by using the Master*; • consider what is reported in *Section 13.3, Regeneration*.
Delay the brake	• The brake is managed automatically by the drive and it cannot be enabled with *Drive enable*;

Problem	Solution
	• with *Drive disable* the brake can be delayed as described in *Section 14.6, Brake*. 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 inspection. Please contact Motor Power Company Srl.
Use the capture units.	• See what reported in *Chapter 17, Capture Peripherals*.

24.2. 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 Control supply of *CN5* (PIN B) for DuetHV except for the flange 60, for which see *X1(F60)*.

24.3. Problems with Fault and Warning

Problem	Solution
The drive is in Fault: how to proceed	• Interpret the present Fault precisely (*FaultDynamic*, *Section 23.1, Management of the errors with DuetHVSuite* or *Section 23.2, Monitoring the errors on the status leds*); • analyse the Fault type and its possible causes (*Section 23.6, Errors description*); • eliminate the causes that have caused the Fault and run the reset (*Section 23.5, Resetting the errors*).
It is not possible to eliminate the Faults	• Ready carefully what is reported in *Section 23.5, Resetting the errors*.
How to remove the Fault causes	• Analyse the occurred Faults by using what is reported in *Section 23.6, Errors description*.
How to stop the motor in case of Fault	• In case of Fault, the drive runs what is reported in *Section 23.4, 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 retentive 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 that's present after the enabling.
Enabling the drive while some Warnings are active	• In general the drive can be enabled also with active Warnings; • pay attention: some Warnings become Faults if you try to enable the drive; • it is advisable to eliminate any present 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.

24.4. Problems with parameters and configuration

Problem	Solution
How parametrizing the drive	• Use the parameters vocabulary (*Section 26.2, Reading and writing a parameter*); • use Drive Setup of DuetHVSuite (Toolbar > ); • download a parameters file (*Section 20.3, Downloading parameters file*).
Restoring a known configuration	• Run the command Restore default parameters (command 2200 of the *System Manager*): updating the current configuration and the permanent memory with the default values; • run the command Reset to default (command 2201 of the *System Manager*): updating the current configuration with the default values; • run the command Reload all parameters (command 2300 of the *System Manager*): updating the current configuration with the data in the permanent memory; • run the command Hard reset (command 5000 of the *System Manager*): it means, for all parameters, to switch on and off the drive; • run the command Soft reset (command 5001 of the *System Manager*): 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 2001 of the *System Manager*): 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.
How to manage the drive parametrization	• See what reported in *Chapter 20, Saving, restoring or cloning the drive configuration.*.
Modifying a parameters file	• Open a DuetHVSuite session and connect OFFLINE choosing the parameters file to modify (*Section 11.2, Offline mode*); • at the end of the modifications, save the modified parameters file.
Moving the parameters configuration between one drive and another	• Use the parameters file (*Section 20.2, Saving/Exporting parameters file*) only between drives with the same *ProductCode* and *HardwareProductCode*.
In the tab Motor and drive you cannot find the motor you want to use	• if the motor doesn't appair in the combo box Motor it's necessary to update the motors database (*Section 25.2, Updating the motors database*); • in the DuetHV drives the motor cannot be changed.
In the tab Motor and drive you cannot find the *FeedbackSensorCode* you want to use	• if you cannot find the sensor in the list of the *FeedbackSensorCode*, check the available sensors with the installed firmware and if necessary update the firmware (*Section 25.3, Firmware updating*); • if the sensor is not supported by any available firmware for the drive, contact Motor Power Company Srl; • in the DuetHV drives, *FeedbackSensorCode* cannot be changed.
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* (*CaptureUnitCommand_B*).

24.5. Communication problems

Problem	Solution
The drive does not communicate via Modbus	• Connect the drive and see the connection settings according to what reported in *Section 8.2, Communicate with Master Modbus RS232 (auxiliary communication port)*; • check if the drive is on: the L1 and L2 leds (*Figure 7.12*) 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 8.1, Communicate with EtherCAT Master*; • check if the drive is on: the L1 and L2 leds (*Figure 7.12*) must not be off; • check the presence of the link in the communication ports connected to the network EtherCAT: the related leds L/A 0 and L/A 1 must not be off (*Figure 7.12*); • check if the led ERR is not on and the *EtherCAT communication error* is not enabled; if necessary remove the error.
Updating request of the DuetHVSuite Configuration files	• Updating according to what is reported in *Section 25.5, Updating the Configuration File*.
Reading/Writing parameters	• See *Section 8.3, Errors in reading / writing of the parameters*.
Firmware download procedure goes in error.	• Verify that the communication with the drive is active, verify the messages that are reported in the *FirmwareStatus* and *SysMngError* parameters and follow the suggested instructions.

24.6. Motion problems

Problem	Solution
How to enable the drive	• See what reported in *Section 21.1, Enabling by using the Master*.
How to stop the load in safety	• See what reported in *Section 21.3, Execute a stop by using the Master*.
How to measure the drive load level	• Monitoring the regular drive temperatures with the parameters of the group *TemperatureStatus*; • monitoring the working of *TargetTorque*; • monitoring the working of *RMSMotorCurrent*, after having set *RMSMotorCurrentFilter* 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* o*I2T Warning threshold reached*	• Check the working of *I2TValue* and check the problem in the following line.
The drive signals *I2T limit reached* o*I2T Warning threshold reached*	• Monitoring the value of *I2TValue* and *ActualMotorCurrent* to find any anomalies; • check the mechanics working to avoid any anomalous absorptions of *ActualTorque*; • decrease the requested performances and increase the dwell times during which the motor works at low current in order to download *I2TValue*; • decrease the acceleration ramps and the requested speeds to decrease the *TargetTorque*; • increase *UserMaxI2T* till the value of *DriveMaxI2T* (*Section 13.6, I2T*).

Problem	Solution
The motor does not run the requested motion or the requested motion has been interrupted	• Check for any possible stop command (see *Section 21.3, Execute a stop by using the Master*); • check if the drive is in Fault (see *Chapter 23, Fault and Warning*); • check for any possible disabling command (see *Section 21.2, Disabling by using the Master*); • check if the *Limit reached* 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 (see *Section 21.5, On-the-fly operative mode change*); • if you work in *Interpolated Position Mode* check if the bit bit *Enable ip mode* of the *Controlword* has not been reset; • if you work in *Profile Velocity Mode (CiA402)* or *Profile Velocity Mode (CUSTOM)*, check if the absolute value of *TargetVelocity* is higher than *EndVelocity* and *StartVelocity*.
the *PositionFollowingError* doesn't resets during a positioning, while the velocity is constant	• Verificare che l'asse sia tarato correttamente (vedere *Chapter 19, System tuning*) e aumentare la dinamica dei loop per far rientrare più velocemente *PositionFollowingError*; • Check that the torque/velocity or position limits are not reached (see *Chapter 18, Motion limits*); • If the *Interpolated Position Mode* is used with *IpPosSubModeSelect* = -10: check that at every variation of *RequestedPosition*, the *FeedForwardSpeed* takes the correspondent value (see *Figure 21.5* and *Figure 21.6*); • check that the value of the *KVff* parameter is 1000;

24.7. Problems with the oscilloscope

Problem	Solution
How to do a trial capture	• Choose at least one parameter to capture from the channels list (point A in *Section 22.2, Monitoring by oscilloscope*); • check if the channel (point K) is enabled and if the display mode is Normal (point H); • select Trigger mode Auto (point B in *Section 22.3, Setting the oscilloscope Trigger*), Sampling time lower than 1ms (point C) and the option Single trigger mode (point G); • press Run (point I) and wait for some seconds for the upload to be finished; • press Autoscale in the tab Channel.
The oscilloscope does not capture any data	• No channel has been selected in the tab Channel; select at least one parameter to capture and check if the channel is enabled (point K in *Section 22.2, Monitoring by oscilloscope*); • the trigger has been stopped; the oscilloscope status is Trigger stopped; press Run; • check if the trigger is correctly set; if necessary try with Trigger mode Auto (point B in *Section 22.3, Setting the oscilloscope Trigger*).
The oscilloscope loads the data repeatedly	• Select the option Single trigger mode (point G in *Section 22.3, Setting the oscilloscope Trigger*).
There is no trigger event	• Check if the parameter the trigger is associated to can cause the event: try with Trigger mode Auto (point B in *Section 22.3, Setting the oscilloscope Trigger*); • check if the trigger is associated to the wanted channel (point A); • check if Trigger value and Trigger edge are the wanted ones; enable the option Show trigger for confirmation (point F).

Problem	Solution
The progress of the oscilloscope status bar is too slow or has stopped (point N in *Section 22.3, Setting the oscilloscope Trigger*)	• The Sampling time (point C) is too high (> 10ms) and a large time window will be captured; try to decrease the Sampling time; • the communication does not allow higher uploading speeds: wait for the procedure end or analyse any possible communication problems.
The captured time interval is not sufficient or the available track is concentrated in a limited portion of captured data	• Modifying the Sampling time: increasing it to increase the time window to capture; decrease it to concentrate the samples in a lower time interval; • zooming to enlarge the tracks (point D in *Measures*).
The first part of the profiles is not captured	• Select correctly the pre-trigger to capture one part of the profiles before the trigger event (point E in *Section 22.3, Setting the oscilloscope Trigger*).
The tracks are not sufficiently resolute	• Disable the useless channels (deselect the option at the point K in *Section 22.2, Monitoring by oscilloscope*); • decrease the Sampling time.
There are no traces in the Screen	• Run a capture; • press Autoscale in the tab Channel; • modify scale and channels offset (*Section 22.2, Monitoring by oscilloscope*); • centre the tracks in the Screen (point E in *Section 22.2, Monitoring by oscilloscope*); • select Normal in the display mode (point H).
How to measure the captured profiles	• Run a capture; • insert the scales in the screen (point N in *Tracks preferences*); • see what reported in *Measures*.
How to compare the next captures	• Save in the Screen the first set of tracks (*Section 22.4, Saving or uploading an oscilloscope capture*); • run the second capture for the comparison.
How to running motions by the Function Generator	• Select the desired Function Generator in the Function Generator tab; • press Load presets; • in order to avoid unwanted motions or collisions, take all the necessary precautions and configure precisely the drive limits (*Chapter 18, Motion limits*); • press Start and wait for some seconds for the upload of the oscilloscope data to end; • check any possible error in the field Drive information.
The Function Generator does not start	• read and interpret the errors in the field Drive information; • the network Master interferes with the Function Generator: disconnect the not used field buses or interrupt the parameters writings; • the drive is in Fault: press Show errors; • press End and try again.
The Function Generator must be promptly stopped	• Select properly the parameters for the End command (Tuning end option and Tuning end deceleration); • Press End.
The drive must not be disabled once the Function Generator is finished.	• Select for Tuning end option, Deceleration ramp and enable or Zero speed and enable; • never press Disable to stop the Function Generator.
The units of measurement of the ref-	• Modify the DuetHVSuite units of measurement (*Section 12.4, DuetHVSuite units*).

Problem	Solution
erences are not suitable for the foreseen motion	

24.8. Tuning problems

Problem	Solution
Difficulties on the visualization of the results on the oscilloscope charts	• See *Section 24.7, Problems with the oscilloscope*.
Resonances in *VelocityActualValue* and in*ActualTorqueCurrent*	• Decrease the dynamic performances by lowering the *DynamicResponse* option; • decrease the value of *KCp_Q* and *KCp_D*; bearing in mind that *CurrentLoopEstimatedBandwidth* decreases, such as the performances which can be obtained also from the VelocityLoop; • modify the filtering action of the *Sensor filter* in the *VelocityLoop* (*VFilterSensorFrequency*); • reduce the *VelocityLoop* band by decreasing *KVp*.
Resonances found at the end of the estimate of the inertia moment (*Section 19.9, Inertia estimator*) or when the motor is stopped or at the presence of pure inertial load (with low friction) coupled with less rigid joints or mechanical backlashes.	• Stabilize the system as reported in *3. System stabilisation* and *4. Filters* of the *Detailed Tuning Guide*; • see the solutions in the next line.
Resonances in *VelocityActualValue* using mechanical transmissions with considerable backlashes and tolerances (mechanical transmission at limited performances)	• Make the load more solid through the mechanical transmission; • improve the mechanical transmission: reduce backlashes, check the chains and the drive belts tension, check the joints, pulleys and gear wheels closure, use transmission components with no backlash, etc… • tighten the mechanical structure and the machine chassis; • decrease *PositionLoopEstimatedBandwidth* by decreasing *KPp*; • reduce *VelocityLoopEstimatedBandwidth* by proportionally reducing *KVp* and *KVi*; • if the resonances have a low speed, decrease *PositionStandStill* and *VelocityStandStill*; • in case of position control, increase the value of *PositionErrorDeadBand*.
Resonances in *VelocityActualValue*;	• Repeat the tuning and follow the instructions that are reported in *Section 19.5, Detailed tuning guide*;
Resonances at low speeds or at stopped motor	• Decrease the *PositionStandStill* and *VelocityStandStill* bars.
*EstimatedInertia*higher than 8-10Jm	• If *PositionLoopEstimatedBandwidth* is not at least the half of *VelocityLoopEstimatedBandwidth*, decrease *KPp* and *PositionStandStill*; • use motors with higher inertia moment and mechanical transmissions with no backlash and with high stiffness coupling among the components;

Problem	Solution
	• increase the reduction ratio of the mechanical transmission in order to reduce the load inertia moment on the part of the motor; • reduce the accelerations and decelerations, in accordance with the available torque, in order to avoid oscillations at the ramp end; • decrease *KVi* by 20-50 units; • modify the outgoing filters of the speed regulator.

Chapter 25
Software updating

In the DuetHV drives, during the functioning of the boot software and of the firmware startup, the leds don't work as the standard functioning (started firmware, referring to the *Table 7.11*). In the following table the various leds statuses are reported with a short description.

Every cell that indicates the leds configuration contains their colour and blink type, separated by a comma.

The codes for the colours are made of one letter:

- *G*: green;
- *O*: orange;
- *R* red;
- *x* unimportant (in case of led off);

The blinking codes are the same that are reported in *Section 7.3, Leds*.

<table>
<tr><th>Description</th><th>FirmwareStatus</th><th>L1</th><th>L2</th><th>L3</th><th>L4</th><th>L5</th><th>L6</th></tr>
<tr><td>Boot startup</td><td>-</td><td>x, OFF</td><td>x, OFF</td><td>O, ON</td><td>O, ON</td><td>x, OFF</td><td>x, OFF</td></tr>
<tr><td>Firmware startup</td><td>-</td><td>x, OFF</td><td>x, OFF</td><td>G, ON</td><td>G, ON</td><td>x, OFF</td><td>x, OFF</td></tr>
<tr><td rowspan="6">Firmware download phases</td><td rowspan="6">-</td><td>O, 1 FL</td><td>O, 1 FL</td><td>O, ON</td><td>O, ON</td><td>O, 1 FL</td><td>O, 1 FL</td></tr>
<tr><td>O, BLK</td><td>O, BLK</td><td>O, ON</td><td>O, ON</td><td>O, BLK</td><td>O, BLK</td></tr>
<tr><td>O, ON</td><td>O, ON</td><td>O, ON</td><td>O, ON</td><td>O, ON</td><td>O, ON</td></tr>
<tr><td>O, FLK</td><td>O, FLK</td><td>O, ON</td><td>O, ON</td><td>O, FLK</td><td>O, FLK</td></tr>
<tr><td>G, BLK</td><td>G, BLK</td><td>O, ON</td><td>O, ON</td><td>G, BLK</td><td>G, BLK</td></tr>
<tr><td>R, ON</td><td>R, ON</td><td>R, ON</td><td>R, ON</td><td>R, ON</td><td>R, ON</td></tr>
<tr><td>Firmware exception error</td><td>20</td><td rowspan="2">R, ON</td><td rowspan="2">x, OFF</td><td rowspan="2">R, ON</td><td rowspan="2">R, ON</td><td rowspan="2">R, BLK</td><td rowspan="2">R, BLK</td></tr>
<tr><td>Error during the Firmware download or corrupted Firmware flash memory</td><td>13, ≥100</td></tr>
<tr><td>CPLD programming aborted due to an error</td><td>19</td><td>R, ON</td><td>x, OFF</td><td>R, ON</td><td>R, ON</td><td>R, BLK</td><td>R, BLK</td></tr>
<tr><td>One or more incompatibility between boot, hw and fw</td><td>13, 16, 17, 18</td><td>G, BLK</td><td>x, OFF</td><td>R, ON</td><td>R, ON</td><td>R, BLK</td><td>R, BLK</td></tr>
</table>

Table 25.1. Description of the leds during the boot and the firmware startup.

25.1. DuetHVSuite updating

To update DuetHVSuite you only need to install the updated version of the programme by choosing one of the procedures proposed in *Section 3.2, Installation*.

25.2. Updating the motors database

The motors database is a file that's released by Motor Power Company Srl and contains the data of the standard motors for the DuetHV drive series. The motor database is used by DuetHVSuite to recognize the motor type that's wired to the drive with which you are connected and it's important to keep it updated.

To update the motor database of DuetHVSuite it's sufficient to the DuetHVSuite program (see *Section 3.2, Installation*)

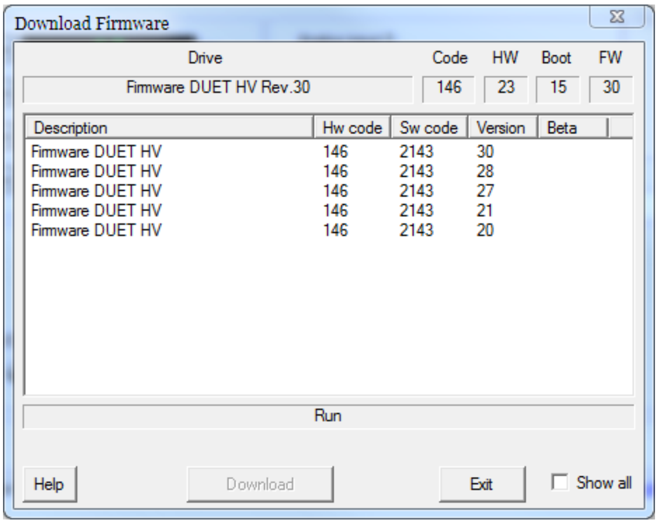
25.3. Firmware updating

> **Important**
>
> The firmware updating does not cancel any data saved in the permanent memory.

To update the firmware, connect the drive with DuetHVSuite and open the Download firmware window. Access with DuetHVSuite:

Main menu > **Drive** > **Download firmware ...**

Toolbar > 



In the Download firmware window, choose the desired firmware and press Download. If the firmware is not present in the proposed list it's sufficient to install the updated version of DuetHVSuite by selecting one of the procedures that are proposed *Section 3.2, Installation*.

> **Tip**
>
> If at the end of the download, the firmware does not start up, check what reported in the window and in the *FirmwareStatus* parameter.

25.4. Updating the boot

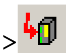
> **Warning**
>
> If during the boot updating the control section runs out of power, the drive cannot be used anymore and must be sent back to Motor Power Company Srl. During the updating, supply power to the drive with an uninterruptible power supply (UPS).

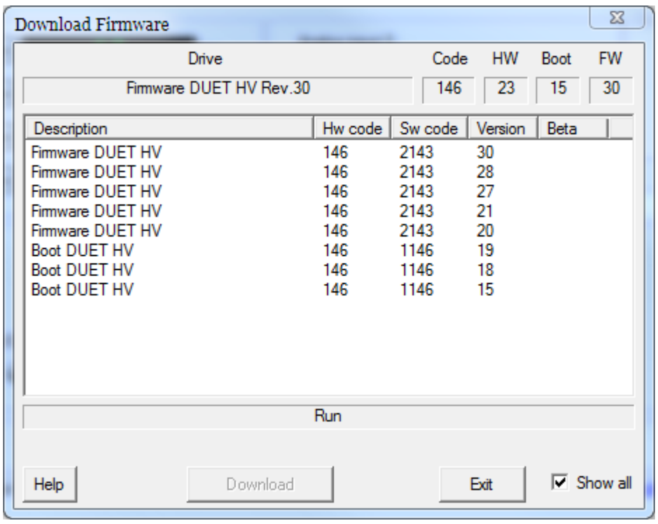
To update the boot, connect to the drive with DuetHVSuite and open the Download firmware window.

> **Important**
>
> Update the boot software only if really necessary.

Access with DuetHVSuite:

Main menu > **Drive** > **Download firmware ...**

Toolbar > 



Activate the Show all option in the download firmware window, select the desired boot and push 

. If the boot is not present in the proposed list it's sufficient to install the updated version of DuetHVSuite by selecting one of the procedures that are proposed *Section 3.2, Installation*.

Note

After downloading the boot it is necessary to download the firmware again. The data saved in the permanent memory are not cancelled.

25.5. Updating the Configuration File

The Configuration files are files xml used by DuetHVSuite to communicate with the drive.

To update the Configuration files you only need to install the updated version of the DuetHVSuite by selecting one of the procedures that are proposed in *Section 3.2, Installation*.

25.6. ESI EEPROM updating procedure on ETC drive

Updating available based on *HardwareRevision*, *BootRevision* and *FirmwareRevision*:

- Update not available: with *FirmwareRevision* < 23.
- Only manual update: with *FirmwareRevision* ≥ 23.
- Automatic update:
  - from *FirmwareRevision* 28;
  - with *BootRevision* ≥ 19;
  - with *HardwareRevision* of the DuetHV (except DuetHV flange 60) ≥ 50, of DuetHV flange 60 ≥ 1.

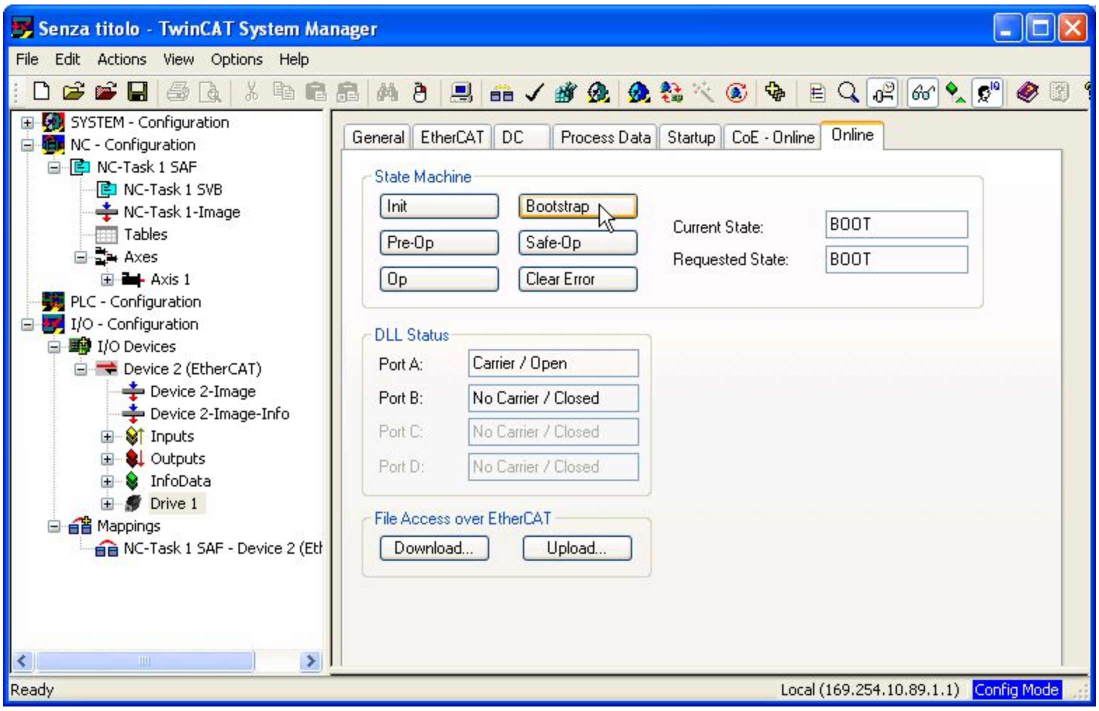
25.6.1. ESI EEPROM updating from DuetHVSuite through debug serial port

The procedure is commanded/executed by DuetHVSuite that connects to the drive through the debug serial port.

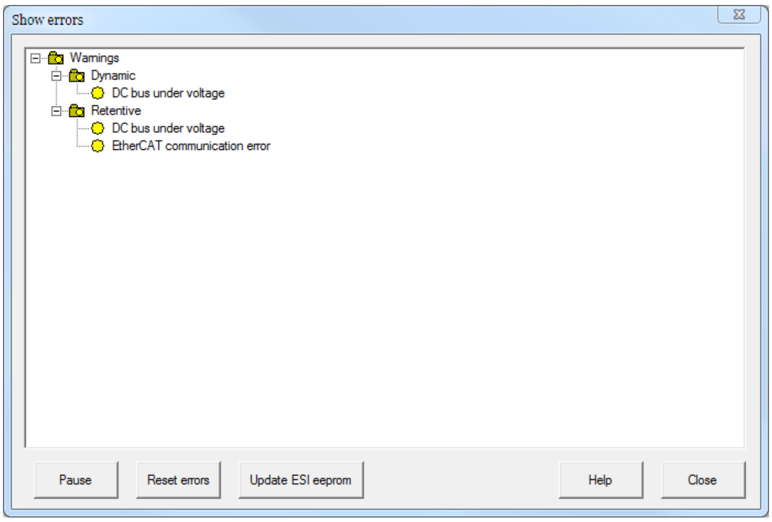
The EtherCAT Master (e.g. TwinCAT Beckhoff) must be connected to the drive through the EtherCAT port, it is assumed to have already installed on the PC the EtherCAT Master development environment and to have a project that describes all the peripherals in the EtherCAT network.

The sequence is the following:

1. start the EtherCAT Master development environment and connect to the drive
2. take the EtherCAT status of the drive to BOOTSTRAP



3. start DuetHVSuite and connect to the drive through the debug serial port
4. on DuetHVSuite select the "Show Error" button and push the "Update esi eeprom" button



5. at the end of the operation check that the "ESI eeprom may not be updated" Warning is no more present
6. execute a power-up cycle on the drive (in case there are more than one drive to update, this operation can be executed only once at the end of the sequence)

25.6.2. ESI EEPROM updating from DuetHVSuite through gateway CoDeSys

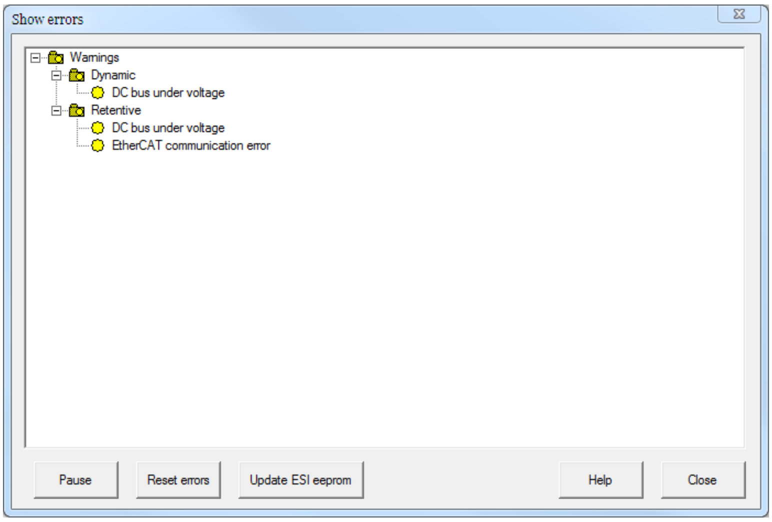
The procedure is commanded/executed by DuetHVSuite that connects to the drive through the Ethernet port to an EtherCAT CoDeSys Master.

The EtherCAT CoDeSys Master must be connected to the drive through the EtherCAT port.

The sequence is the following:

1. start DuetHVSuite and connect to the drive through the CoDeSys Master

2. on DuetHVSuite select the "Show Error" button and push the "Update ESI eeprom" button



3. at the end of the operation check that the "ESI eeprom may not be updated" Warning is no more present
4. execute a power-up cycle on the drive (in case there are more than one drive to update, this operation can be executed only once at the end of the sequence)

25.6.3. ESI EEPROM updating from EtherCAT Master in manual mode

The procedure is commanded/executed by the EtherCAT Master.

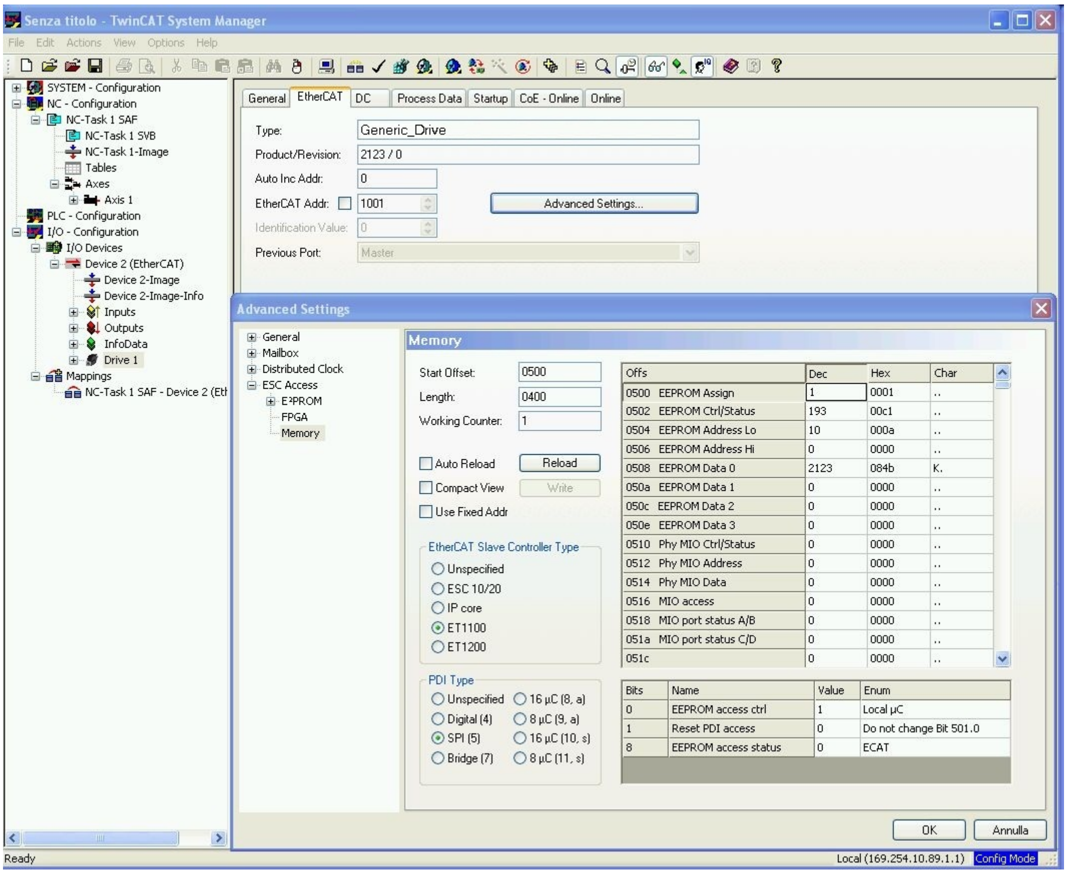
The EtherCAT Master must be connected to the drive through the EtherCAT port, it is assumed to have already installed on the PC the EtherCAT Master development environment and to have a project that describes all the peripherals in the EtherCAT network.

The following described procedure can be manually executed by an operator or can be inserted at the end of a firmware updating operation made by the Master.

The sequence is the following:

1. start the Master development environment

2. connect to the drive
3. write 1 on the 0x500 register of the ET1100 (enables the SII_EEPROM access to the DSP)



4. write the command 5400 on the *SysMngCommand* cell (0x5FF7.01 CoE)
5. execute the reading of the SystemManagerStatus cell (0x5FF7.02 CoE) to read the operation status, wait the end operation code, if it ends with an error read the error code on *SysMngError* (0x5FF7.03 CoE)
6. write 0 on the 0x500 register of the ET1100 (disabes the SII_EEPROM access to the DSP)
7. execute a power-up cycle on the drive (in case there are more than one drive to update, this operation can be executed only once at the end of the sequence)

25.6.4. ESI EEPROM updating from EtherCAT Master in automatic mode

The procedure permits to execute the update without an EtherCAT Master.

At the end of a firmware download, if the requirements listed in the *Section 25.6, ESI EEPROM updating procedure on ETC drive* are respected, the message: *ESI eeprom will be updated at the next power-up cycle* will appair in the "Show error" window of the DuetHVSuite tool. By executing the drive turn off/turn on sequence, the ESI eeprom update is automatically executed and at the firmware start-up it's sufficient to check that there is no error signals related to the update. If at the start-up the message: *ESI eeprom updating at the* *power-up failed* appairs, it means that the automatic procedure has failed due to a drive HW problem.

Note

it's anyway possible to execute always the manual procedure for the update.

The eventual warning messages are related to the bits in the *EtcErrorRetentCommMsg* parameter.

Chapter 26

Parameters vocabulary

The exchange of data with the drive takes place through a list of parameters, called *Parameters vocabulary*. The parameters define and control every single function of the drive.

26.1. 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.
Modbus	Parameter address which is accessible through protocol Modbus. The number is expressed on a decimal basis.
CANopen	Parameter address which is accessible through protocol. The value is expressed on a hexadecimal basis in the format 0xYYYY.ZZ with the following meaning: • YYYY: parameter index; • ZZ: parameter subindex. This field refers to the address of the parameter in the vocabulary accessible through the *CANopen over EtherCAT* protocol.
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 (see *Section 12.1, Units of measurement of the parameters*).
Acc	Type of access to the parameter:

Field	Description
	• 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. This field at the moment doesn't have any meaning.
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 cannot be restored on command with default values.

Table 26.1. Fields describing the parameters

26.2. Reading and writing a parameter

The dimension of every *Modbus register* is 1 Word (2 byte). Therefore each parameter takes a minimum of 2 bytes of memory. For example:

- if a parameter is 8 bit long (1 byte = 1/2 Word) it takes 1 word anyway, therefore if it is on 4100 Modbus address, the next parameter is on 4101;

- if a parameter is 16 bit long (2 byte = 1 Word) it takes 1 word, therefore if it is on 1201 Modbus address, the next parameter is on 1202;

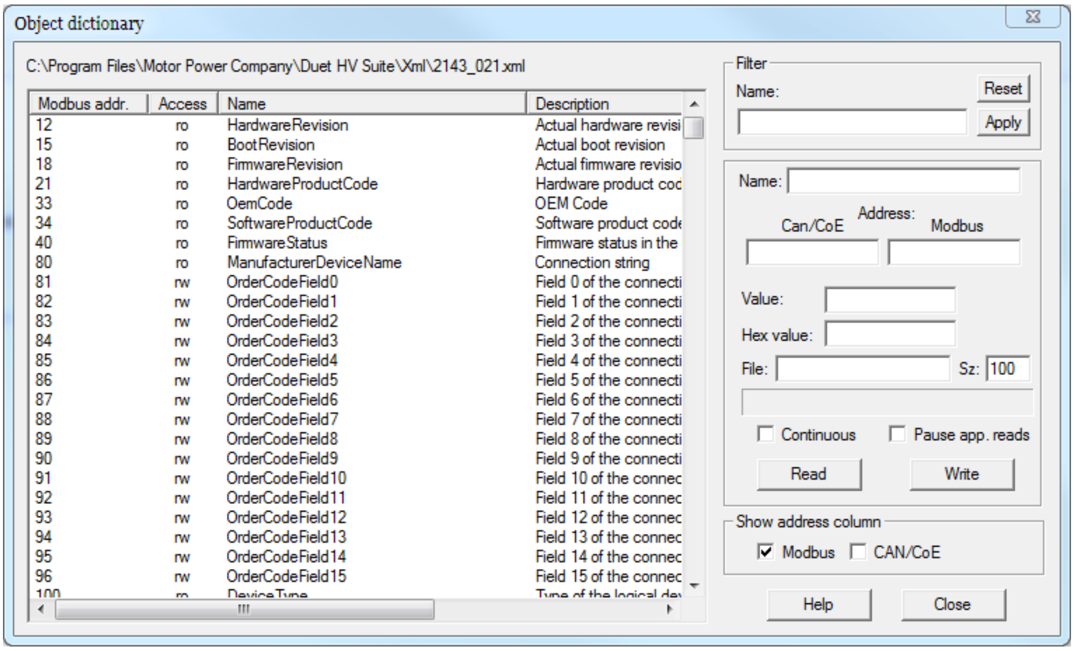
- if a parameter is 32 bit long (4 byte = 2 Word) it takes 2 words, therefore if it is on 4110 Modbus address, the contained data take even the 4111 register and, in consequence, the next parameter is on 4112;

> **Note**
>
> To read and write a parameter via EtherCAT, using the SDOs expedited (*Section 9.1, Protocol CANopen over EtherCAT (CoE)*).
> To read and write a parameter via Modbus, send a frame by using the function codes reported in *Table 10.1*.

Access with DuetHVSuite:

Main menu > **Drive** > **Object dictionary ...**

Toolbar > 



To select the parameter to read or write in the Object dictionary window, you can click on the proposed list, write the name and the address or use the search by name functions in the box Filter.

> **Tip**
>
> To interpret any error messages please see *Section 8.3, Errors in reading / writing of the parameters*.

26.3. Uploading/downloading

To upload/download via EtherCAT, use the SDOs normal (*Section 9.1, Protocol CANopen over EtherCAT (CoE)*).

Via Modbus it is not possible to run correctly an upload/download.

26.4. Initial configuration, update and board identity (0-999)

DriveInformation

Informations related to the drive.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x5FFD.00	15	15	U8	-	CST	-	-

Number of parameters in this group.

HardwareRevision

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
12	0x5FFD.01	-	-	S16	-	RO	-	-

Drive hardware revision.

BootRevision

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
15	0x5FFD.04	-	-	S16	-	RO	-	-

Boot firmware revision.

FirmwareRevision

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
18	0x5FFD.07	-	-	S16	-	RO	-	-

Firmware revision. If -1 is valid, only the boot firmware is present.

HardwareProductCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
21	0x5FFD.0A	-	-	U32	-	RO	-	-

Product hardware code.

OemCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
33	0x5FFD.0E			U16	-	CST	-	-

Code that identifies the constructor.

SoftwareProductCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
34	0x5FFD.0F	-	-	U16	-	RO	-	-

Product software code.

FirmwareStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
40	0x5FFE.01	-	-	U8	-	RO	-	-

Firmware status.

FirmwareStatus	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 Motor Power Company.
12	Reserved	-
13	CRC error	The firmware is corrupted, try again the download procedure. If the problem persists, please contact Motor Power Company.
14	Hardware is not compatible with firmware	The hardware is not compatible with firmware. Try a new download procedure with a compatible firmware or substitute the DuetHV drive with one that has a compatible hardware. In the "Download Firmware" window, choose the desired firmware and press
15	Boot is not compatible with firmware	The Boot is not compatible with the firmware. Try a new download procedure with a compatible firmware or update the boot. The “Download Firmware” window automatically shows the firmwares and the boots that are compatible.
16	Firmware is not compatible with hardware	The firmware is not compatible with the hardware. Try a new download procedure with a compatible firmware or substitute the DuetHV drive with one that has a compatible hardware. In the "Download Firmware" window, choose the desired firmware and press
17	Firmware is not compatible with boot	Firmware non compatible with the boot. Try a new download procedure with a compatible firmware or update the boot. The “Download Firmware” window automatically shows the firmwares and the boots that are compatible.
18	Reserved	-
19	CPLD error	Error during the internal memory programming, try to download again the firmware. If the problem persists, please contact Motor Power Company.
20	Firmware exception error	Due to an error that cannot be reset, the firmware start has been blocked. Try to download another firmware and then restore the parameters with the default.
21	Hardware is not compatible with boot	It has been downloaded a firmware (boot) that's not compatible with the hardware. Download a compatible firmware (boot). If the problem persists, please contact Motor Power Company.
100	Download error	Generic error during the firmware download. Try again to download the firmware. If the problem persists, please contact Motor Power Company.
101	Download: unrecognized command	The temperature sensor is managed by theInternal error during the firmware download. Try again to download the firmware. If the problem persists, please contact Motor Power Company.

FirmwareStatus	Message	Solution
106	Download: generic time out	Firmware download procedure interrupted. Check the wirings (see *Section 7.2, Electrical connections*), the parameters of the connection (see *Chapter 8, Communicating with the drive*) and, then, try a new download procedure.
113	Download: memory is busy	The memory of the drive is busy because other procedures are executing on another communication channel, wait that these are ended and try another download procedure.
153	Download: file requires unsupported features (code 5103)	The firmware download requires some functionalities that are not supported by the boot. Try to download another firmware or update 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)	
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, try to download again the firmware. If the problem persists, please contact Motor Power Company.
175	Download: memory error (code 5125)	Error during the memory programming, try to download again the firmware. If the problem persists, please contact Motor Power Company.
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)	

FirmwareStatus	Message	Solution
221	Download: memory error (code 5171)	
230	Download: memory error (code 5180)	

ManufacturerDeviceName

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
80	0x1008.00	-	-	STR	-	CST	-	-

Reading of the ManufacturerDeviceName. For further informations see *Section 28.1, OrderCode*

DeviceType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
100	0x1000.00	0x00020192	0x00020192	U32	-	CST	-	-

Code of the type of device and of its functionalities:

- The value in the two less important bytes (0x0192) shows that the device is a drive in compliance with the specification CANopen *CiA-402*;
- The value in the two most important bytes (0x0002) shows that the drive can control the motor in closed chain.

ErrorRegister

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
102	0x1001.00	Desc	-	U8	-	RO	*YES*	-

Concisely indicates the status of the drive alarms that are described in the *Table 23.1*. 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, Power or motor over current*
2	Voltage fault	*DC bus over voltage, DC bus under voltage, Logic voltage error*
3	Temperature fault	*Thermal management*
4	Communication Warning or Fault	- If it is a DuetHV/ETC:*EtherCAT communication error*
5	Fault of the Device Profile (related to the *CiA-402* regulations)	*Parameters serious error, Position following error, I2T limit reached, Digital IO configuration error*

Bit	Description	Related alarms
6	Reserved	
7	Manufacturer fault	*Real time mode error, Last command requested failed, /STO Management Error, User Fault, Feedback sensor error*

Table 26.2. Bit coding of ErrorRegister

The value of this parameter is sent with the emergency messages (see *Section 9.2, Emergency Error Code*).

ManufacturerHwVersion

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
110	0x1009.00	-	-	STR	-	CST	-	-

String in ASCII characters showing the hardware version of the drive.

ManufacturerSwVersion

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
114	0x100A.00	-	-	STR	-	CST	-	-

String in ASCII characters showing the software version of the drive.

Identity

Drive Identity.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1018.00	5	5	U8	-	CST	-	-

Number of parameter in this group.

VendorID

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
120	0x1018.01	-	-	U32	-	RO	-	-

Number code given to Motor Power Company Srl as manufacturer of EtherCAT devices.

ProductCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
122	0x1018.02	-	-	U32	-	RO	-	-

Product code.

RevisionNumber

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
124	0x1018.03	-	-	U32	-	RO	-	-

Revision of the product.

SerialNumber

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
126	0x1018.04	-	-	U32	-	RO	-	-

Drive serial number.

CpuInfo

Information about the CPU.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x5FFA.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

SwResetCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
560	0x5FFA.03	-	0	U16	-	RO	-	-

Software reset: reset code. Please contact Motor Power Company if it is different from 0.

SwResetInfo

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
561	0x5FFA.04	-	-	U32	-	RO	-	-

Software reset: RPC register value. It identifies a firmware internal problem.

CPUSiliconRevision

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
580	0x5FFA.01	-	-	U16	-	RO	-	-

CPU revision.

ResetCause

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
581	0x5FFA.02	-	-	U32	-	RW	-	-

Code of the cause that has caused the firmware reset.

ResetCause	Description
1	Reserved
2	Power-up reset (switching on the drive, command 5000 of *SysMngCommand*, firmware download *Chapter 25, Software updating*)
3	Reserved
4	Reset from watchdog
6	Reset from any other communication channel (command 5001 of *SysMngCommand*).

26.5. Communication port EtherCAT (1000-1099)

> **Note**
>
> This vocabulary section can be found only in the drive versions ETC.

EtherCATPortSetup

Parameters used to configure the EtherCAT communication port from the permanent memory.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x5102.00	1	1	U8	-	CST	-	-

Number of parameters in this group.

EtcConfiguredStationAlias

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1002	0x5102.01	-	-	U16	-	RO	-	-

Node number with which the slave can be identified in an EtherCAT network. The parameter reports the value that's contained in the "Configured Station Alias" register of the ET1100 chip (register with address 0x0012-0x0013). For further details see *Section 8.1, Communicate with EtherCAT Master*.

EtherCAT_PortActual

Current configuration of the EtherCAT communication port.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x5108.00	1	1	U8	-	CST	-	-

Number of parameters in this group.

EtcConfiguredStation

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1005	0x5108.01	-	-	U16	-	RO	-	-

Node number with which the Master recognize the drive through the Fixed addressing (Node Address). The parameter reports the value that's contained in the "Configured Station Address" register of the ET1100 chip (register with address 0x0010-0x0011). For further details see *Section 8.1, Communicate with EtherCAT Master*.

CommunicCyclePeriod

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1012	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 21.10, Interpolated Position Mode*.

EtherCAT_Diagnostics

Specific details of *EtherCAT communication error*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x5FF6.00	15	15	U8	-	CST	-	-

Number of parameters in this group.

EtcRegDllStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1020	0x5FF6.08	Desc	-	U16	-	RO	-	-

0x110:0x111 register of the ESC

EtcRegAlStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1021	0x5FF6.09	Desc	-	U16	-	RO	-	-

0x130:0x131 register of the ESC

EtcResetPdoRxLostMaxConsecReset

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1084	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.

EtcRegAlStatusCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1022	0x5FF6.0A	Desc	-	U16	-	RO	-	-

0x134:0x135 register of the ESC

EtcRegEEpromConfiguration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1023	0x5FF6.0B	Desc	-	U16	-	RO	-	-

0x500:0x501 register of the ESC

EtcRegSyncOutUnit

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1024	0x5FF6.0C	Desc	-	U16	-	RO	-	-

0x980:0x981 register of the ESC

EtcRegSyncPulseLenght

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1025	0x5FF6.0D	Desc	-	U16	-	RO	-	-

0x982:983 register of the ESC

EtcRegSyncActivationStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1026	0x5FF6.0E	Desc	-	U16	-	RO	-	-

0x984 register of the ESC

EtcRegSync0CycleTime

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1027	0x5FF6.0F	Desc	-	U32	-	RO	-	-

0x9A0:9A3 register of the ESC

EtcErrorRetentCommMsg

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1070	0x5FF6.01	Desc	-	U32	-	RO	-	-

Detail of the errors of the *EtherCAT communication error*.

> **Important**
>
> 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* parameter.

EtcPdoRxMissingTolerance

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1072	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.

> **Warning**
>
> It is suggested to set a tolerance greater than 4, because every not received and not interpreted PDO RX implies that the movement is not controlled by the Master (see *Section 9.3.2, Missing or corrupted PDO RX management*).

EtcPdoRxLostConsecutive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1073	0x5FF6.03	-	0	U16	-	RW	-	-

Counter of the maximum number of consecutively lost PDOs RX (only updated on the OPERATIONAL state).

EtcPdoRxLostTotal

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1074	0x5FF6.04	-	0	U32	-	RW	-	-

Counter of the total number of consecutively lost PDOs RX (only updated on the OPERATIONAL state).

EtcPdoRxLostTotalReset

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1076	0x5FF6.05	-	0	S32	-	RW	-	-

Counter of the total number of 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.

EtcDcPllResetOnOpe

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1078	0x5FF6.06	Desc	-	S32	-	RW	-	-

Difference between the detected *Sync Signal* number and the correctly received PDO RX messages number (the value is updated only if the drive is on OPERATIONAL state and if the synchronization mode is HardSync, see *Section 9.4, Synchronization*).

EtcPdoRxTotal

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1080	0x5FF6.07	Desc	0	U32	-	RW	-	-

Number of total frames that have been correctly received. The counter dosen't overflow, when the 32bit 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.

26.6. Auxiliary communication port (1100-1199)

AuxiliaryPortSetup

Parameters used to configure the auxiliary communication port.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x5120.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

AuxiliaryPortSetupWordOrder

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1100	0x5120.01	0 - 1	0	U16	-	RW	-	EM

Order of the words used by the drive, 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).

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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1101	0x5120.02	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	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1110	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1112	0x5120.04	19200 o 57600	57600	U32	bit/s	RW	-	EM

Baud rate of the auxiliary port.

AuxiliaryPortError

Parameters to read the last error condition in writing or reading carried out with the auxiliary communication port.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x5124.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

AuxiliaryPortErrorParam

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1120	0x5124.01	-	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 causes the resetting of this parameter and of the parameter *AuxiliaryPortErrorCode*.

AuxiliaryPortErrorCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1121	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 causes the resetting of this parameter and of the parameter *AuxiliaryPortErrorParam*. The meaning of the codes can be found in *Table 8.4*.

26.7. Motor, drive and I2T (1200-1299)

MotorParameters

Motor parameters.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x6410.00	15	15	U8	-	CST	-	-

Number of parameters in this group. For any further information, see *Section 14.1, Motor parametrization*.

MotorStallCurrent

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1201	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1202	0x6410.02	-	-	U16	100 = 1A	RW	-	EM

Motor peak current.

CoggingTorque(CoggingForce)

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1203	0x6410.03	-	-	U16	Desc	RW	-	EM

Motor cogging torque. The measurement unit depends on the motor type: rotative motor [1000 = 1Nm], linear motor [1000 = 1N].

MotorInductance

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1204	0x6410.04	-	-	U16	100 = 1mH	RW	-	EM

Phase-phase motor inductance.

MotorResistance

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1205	0x6410.05	-	-	U16	mΩ	RW	-	EM

Phase-phase motor resistance.

MotorInertia(MotorMass)

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1206	0x6410.06	-	-	U16	Desc	RW	-	EM

Motor moment of inertia. The unit of measurement depends on the motor type: rotary motor [1 = 10g cm^2], linear motor [1 = 10g].

TorqueConstant(ForceConstant)

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1212	0x6410.08	-	-	U16	Desc	RW	-	EM

Motor torque constant. The unit of measurement depends on the motor type: rotary motor [1000 = 1Nm/A], linear motor [10 = 1N/A].

MotorRatedSpeed

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1213	0x6410.09	-	-	U32	Desc	RW	-	EM

Motor nominal velocity. The unit of measurement depends on the motor type: rotary motor [rpm], linear motor [mm/s].

MotorPoles

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1215	0x6410.0A	-	-	U16	-	RW	-	EM

Number of motor poles.

FaultTemperatureThrs

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1216	0x6410.0B	-	-	U16	-	RW	-	EM

Motor temperature fault threshold.

For further details please see*Table 23.3*

MotorMotionType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1217	0x6410.0C	0 ÷ 1	-	U16	-	RW	-	EM

Motor type: 0 = rotary, 1 = linear.

PolePitch

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1218	0x6410.0D	-	-	U16	mm	RW	-	EM

Linear motor pole pitch.

MotorFaultTemperatureThrsOhm

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1219	0x6410.0E	-	-	U32	Ω	RW	-	EM

Resistance value that causes the motor temperature Fault, if the motor temperature sensor is PTC.

MotorTemperatureSensorType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1221	0x6410.0F	0-2	-	U16	-	RW	-	EM

Temperature sensor type built on the motor. For the temperature value reading, if this parameter value is 1, please refer to *MotorTemperature*, if it is 2 refer to *MotorTemperaturePTC*.

Code	Sensor type
0	No sensor – the temperature measurement is disabled (for the DuetHV except for the flange 60) No sensor selected, it's possible to estimate the temperature through a dedicated algorithm (only for DuetHV flange 60)
1	KTY84 (for DuetHV, except for flange 60)
2	PTC SWITCH (for DuetHV, except for flange 60)
3	KTY84 (for DuetHV flange 60 only)
4	PTC SWITCH (for DuetHV flange 60 only)

Code	Sensor type
5	PT1000 (for DuetHV, except for flange 60)
6	PT1000 (for DuetHV flange 60 only)

DriveParameters

Drive parameters.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x6510.00	-	4	U8	-	CST	-	-

Number of parameters in this group.

UserDriveName

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1250	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.

MaxRatedCurrent

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1253	0x6510.01	-	-	U16	100 = 1A	RO	-	-

Drive nominal current, power section.

MaxPeakCurrent

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1254	0x6510.02	-	-	U16	100 = 1A	RO	-	-

Drive peak current, power section.

MaxSupplyVoltage

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1255	0x6510.03	-	-	U16	V	RO	-	-

Maximum supply voltage, power section.

I2TParameters

Parameters of the I2T limitation.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3405.00	-	6	U8	-	CST	-	-

Number of parameters in this group. For further details see *Section 13.6, I2T*.

UserPeakCurrent

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1258	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 *UserMaxI2T*. UserPeakCurrent must be different from zero and lower or equal to *MotorPeakCurrent* and *MaxPeakCurrent*. Its default value is the lowest value between *MotorPeakCurrent* and *MaxPeakCurrent*.

I2TTime

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1259	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*. Its default value is so that *UserMaxI2T* is lower than *DriveMaxI2T*, with a maximum value of 5s.

UserMaxI2T

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1260	0x3405.02	-	-	U32	A^2s	RO	-	-

Maximum value of I2T calculated depending on *PeakCurrent* and *I2TTime*. Its value must be lower than *DriveMaxI2T*.

DriveMaxI2T

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1262	0x3405.03	-	-	U32	A^2 ms	RO	-	-

Maximum value of drive l2T.

I2TWarningThreshold

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1264	0x3405.04	0-100	80	U16	%	RW	-	ES

Warning threshold enabling the *I2T Warning threshold reached* error.

26.8. Tuning (1400-1499)

ResetWatchdogTimeout

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1400	0x3500.00	-	-	U16	-	WO	-	-

Write in this parameter the *SysMngCommand* value to execute the *Reset of the Watchdog of the System manager*.

TuningConfigurations

TuningConfigurations.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3502.00	-	4	U8	-	CST	-	-

Number of parameters in this group.

DynamicResponse

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1401	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1402	0x3502.02	-	150	U16	-	RW	*YES*	ES

Tuning configuration used to select the motor stiffness at low velocities. Low speeds are 30% lower than the parameter *HighSpeed*.

Stiffness	Description
130	Very low
140	Low

Stiffness	Description
150	Medium
160	High
170	Very high

VelocityLoopFilter1

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1403	0x3502.03	-	2	U16	-	RW	*YES*	ES

Tuning configuration that defines the filtering action of the velocity loop. For further details see *"Tuning configuration modifications"* in the *Section 19.3, "Fast tuning guide"*.

VelocityLoopFilter1	Description
1	User
2	Noise filter
3	Disable
51	Soft filter

VelocityLoopFilter2

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1404	0x3502.04	-	3	U16	-	RW	*YES*	ES

Tuning configuration selecting the second filter of the speed loop. For further details please see *"Tuning configuration modifications"* in the *Section 19.3, "Fast tuning guide"*.

VelocityLoopFilter2	Description
1	User
2	Resonance filter
3	Disable
50	Debounce filter

EstimatedLoopsBandwidth

Loops estimated bandwidths.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3501.00	-	3	U8	-	CST	-	-

Number of parameters in this group.

CurrentLoopEstimatedBandwidth

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1407	0x3501.01	-	-	U16	Hz	RO	-	-

CurrentLoop estimated bandwidth.

VelocityLoopEstimatedBandwidth

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1408	0x3501.02	-	-	U16	Hz	RO	-	-

VelocityLoop estimated bandwidth.

PositionLoopEstimatedBandwidth

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1409	0x3501.03	-	-	U16	Hz	RO	-	-

PositionLoop Estimated Bandwidth.

TuningEndOption

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1450	0x3515.08	-	22	S16	-	RW	-	-

Operation that is executed when the End button of the DuetHVSuite (command 100 of the *System Manager*) is pushedwhen the command 100 of the *System Manager* is executed.

TuningEndOption	Description
0	Immediately disable, the motor is stopped with maximum deceleration resetting *RequestedSpeed* to zero and then the drive has the *Switch On Disabled* state
10	Zero speed and disable, the motor is stopped with maximum deceleration resetting *RequestedSpeed* at zero and then the drive has the *Switch On Disabled* state
11	Zero speed and switched on, the motor is stopped with maximum deceleration, by resetting *RequestedSpeed* at zero, and then the drive has the *Switched On* state
12	Zero speed and previous 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* and then the drive has the *Switch On Disabled* state
21	Deceleration ramp and switched on, the motor is stopped with a deceleration equal to *TuningEndDeceleration* and then the drive has the *Switched On* state
22	Deceleration ramp and previous state, the motor is stopped with a deceleration equal to *TuningEndDeceleration* and then the drive has the same status before the requested tuning command

TuningEndDeceleration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1451	0x3515.09	Desc	Desc	U32	inc/s^2	RW	-	-

Motor deceleration value when the End button in DuetHVSuite is pushed (command 100 of the *System Manager*)when the command 100 of the *System Manager* is executed. The default value is 1000.0 rad/s^2 while the range of the accepted values goes from 0.32 to 205887.3 rad/s^2.

InertiaEstimator

Parameters for the inertia estimation

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3503.00	6	6	U8	-	CST	-	-

Number of parameters in this group.

InertiaEstimatorDirection

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1460	3503.01	-	0	U16	-	RW	-	-

Rotation direction of the drive shaft using the inertia estimator (0 = positive, 192 = negative).

EstimatorTorque

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1461	3503.02	0 ÷ 32767	1000	U16	10 = 1%IS	RW	-	-

Torque requested to the motor using the inertia estimator.

InertiaEstimatorVelocity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1462	3503.03	-	Desc	U32	inc/s	RW	-	-

Velocity requested to the motor using the inertia estimator. The default value is 100.0 rad/s.

EstimatedDampingFactor

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1464	3503.04	-	Desc	U16	0,0001 A s	RW	-	EM

Estimated value between the viscous friction and *TorqueConstant(ForceConstant)*.

EstimatedInertia

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1466	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1467	0x3503.06	0 ÷ 1000	1000	U16	Desc	RW	-	EM

Reduction factor of *EstimatedInertia* (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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3504.00	12	12	U8	-	CST	-	-

Number of parameters in this group.

Important

The *EstimatedPhaseResistance*, *EstimatedLDNominalP*, *EstimatedLDNominalN*, *EstimatedLDPeakP*, *EstimatedLDPeakN*, *EstimatedLQNominalP*, *EstimatedLQNominalN*, *EstimatedLQPeakP*, *EstimatedLQPeakN* parameters cannot be downloaded through the parameters file because they are specific for every axis. On the contrary, the parameters file download reset them to the default value.

EstimatedPhaseResistance

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1470	0x3504.01	-	-	U16	mΩ	RO	-	EM

Phase resistance estimated with RLEstimator(see *Section 19.7, RL estimator*).

MotorPhaseResistance

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1471	0x3504.02	-	-	U16	mΩ	RO	-	EM

Theoretical phase resistance obtained with the motor nameplate data (*MotorResistance*).

MotorSynchronousInductance

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1473	0x3504.04	-	-	U16	100 = 1mH	RO	-	EM

Theoretical synchronous inductance obtained with the motor nameplate data (*MotorInductance*).

EstimatedLDNominalP

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1474	0x3504.05	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and positive *ActualFieldCurrent* equal to *NominalCurrent*.

EstimatedLDNominalN

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1475	0x3504.06	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and negative *ActualFieldCurrent* equal to *NominalCurrent*.

EstimatedLDPeakP

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1476	0x3504.07	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and positive *ActualFieldCurrent* equal to *PeakCurrent*.

EstimatedLDPeakN

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1477	0x3504.08	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and negative *ActualFieldCurrent* equal to *PeakCurrent*.

EstimatedLQNominalP

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1478	0x3504.09	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and positive *ActualTorqueCurrent* equal to *NominalCurrent*.

EstimatedLQNominalN

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1479	0x3504.0A	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and negative *ActualTorqueCurrent* equal to *NominalCurrent*.

EstimatedLQPeakP

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1480	0x3504.0B	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and positive *ActualTorqueCurrent* equal to *PeakCurrent*.

EstimatedLQPeakN

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1481	0x3504.0C	-	-	U16	100 = 1mH	RO	-	EM

Synchronous inductance, estimated with RLEstimator and positive *ActualTorqueCurrent* equal to *PeakCurrent*.

EstimatedResonanceFrequency

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1483	0x3505.01	-	-	U16	Hz	RW	-	EM

Estimated value of the mechanical resonance frequency.

VelocityStandStill

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1490	0x3523.00	-	-	U16	-	RW	-	ES

Regulation of the gains of the speed regulator for low speeds (it modifies both *KVp_LS* and *KVi_LS*).

26.9. Loop (1500-1599)

ResetSpeedIntegrator

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1516	0x60F9.22	-	-	U16	-	WO	-	-

By writing any value in this parameter, the integrative memory of the velocity regulator is reset to 0.

LoopConfiguration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1529	0x3522.00	0 ÷ 2	2	U16	-	RW	-	ES

Loops configuration.

LoopConfiguration	Description
0	Gains not set
1	Basic configuration (available with every *FirmwareRevision*).
2	Smith configuration (available since *FirmwareRevision* ≥ 14).

VelocityLoop

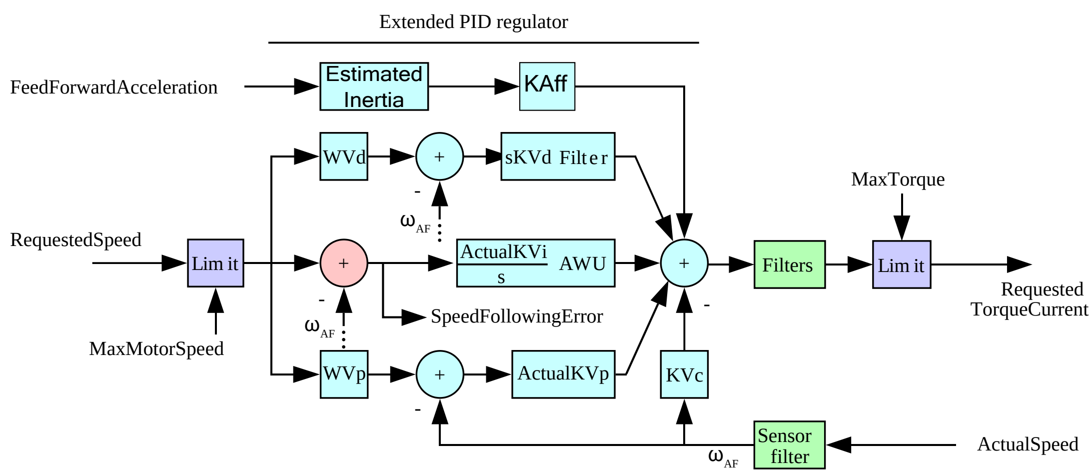


Figure 26.1. Flow chart of the speed regulator.

Velocity loop.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x60F9.00	-	33	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1500	0x60F9.17	-	-	U16	-	RW	*YES*	ES

Enabling of the *VelocityStandStill*: (0 = disabled, 1 = enabled).

LowSpeed

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1501	0x60F9.09	-	-	U32	inc/s	RW	*YES*	ES

Velocity threshold to use only the Stand still parameters.

HighSpeed

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1505	0x60F9.08	-	-	U32	inc/s	RW	*YES*	ES

Out of this velocity threshold the Stand still parameters do not have any effect.

KVp_LS

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1509	0x60F9.04	-	-	U16	-	RW	*YES*	ES

Proportional gain of the speed regulator for low velocities.

KVi_LS

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1511	0x60F9.05	-	-	U16	-	RW	*YES*	ES

Integral gain of the speed regulator for low velocities.

ActualKVp

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1513	0x60F9.0C	-	-	U16	-	RO	*YES*	-

Proportional gain currently used by the velocity regulator.

ActualKVi

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1515	0x60F9.0D	-	-	U16	-	RO	*YES*	-

Integral gain currently used by the velocity regulator.

KVp

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1517	0x60F9.01	-	-	U16	-	RW	*YES*	ES

Proportional gain of the velocity regulator.

KVi

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1519	0x60F9.03	-	-	U16	-	RW	*YES*	ES

Integral gain of the velocity regulator.

KVdFilterFrequency

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1524	0x60F9.10	-	-	U16	-	RW	*YES*	ES

Typical filter frequency on the derivative component of the velocity regulator. By increasing this parameter, the filtering action decreases.

KVd

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1525	0x60F9.11	-	-	U16	-	RW	*YES*	ES

Derivative gain of the velocity regulator.

WVd

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1526	0x60F9.12	-	-	U16	1000 = 1	RW	*YES*	ES

Weighting coefficient of the velocity reference in the calculation of the derivative component.

WVp

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1527	0x60F9.13	-	-	U16	1000 = 1	RW	*YES*	ES

Weighting coefficient of the velocity reference in the calculation of the proportional component.

KVc

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1528	0x60F9.14	-	-	U16	-	RW	*YES*	ES

Damping gain of the velocity regulator.

VFilter1Frequency

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1540	0x60F9.0E	-	-	U16	Hz	RW	*YES*	ES

Typical frequency of the first filter on the output of the velocity regulator.

VFilter1Type

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1541	0x60F9.0F	-	-	U16	-	RW	*YES*	ES

Type of the first filter on the output of the velocity regulator.

VFilterType1	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1542	0x60F9.18	-	-	U16	10 = 1	RW	*YES*	ES

Quality Q factor of the first filter on the output of the velocity regulator.

VFilter2Frequency

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1543	0x60F9.19	-	-	U16	Hz	RW	*YES*	ES

Typical frequency of the second filter on the output of the velocity regulator.

VFilter2Type

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1544	0x60F9.1A	-	-	U16	-	RW	*YES*	ES

Type of the second filter on the output of the velocity regulator.

VFilterType2	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1545	0x60F9.1B	-	-	U16	10 = 1	RW	*YES*	ES

Quality Q factor of the second filter on the output of the speed regulator.

VFilter3Frequency

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1546	0x60F9.1C	-	-	U16	Hz	RW	*YES*	ES

Typical frequency of the third filter on the output of the speed regulator.

VFilter3Type

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1547	0x60F9.1D	-	-	U16	-	RW	*YES*	ES

Type of the third filter on the output of the speed regulator.

VFilterType3	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1548	0x60F9.1E	-	-	U16	10 = 1	RW	*YES*	ES

Quality Q factor of the third filter on the output of the speed regulator.

FieldWeakeningFilterType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1557	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 homonymous regulator output and that is not part of any loop in the Loop settings page. The values that can be inserted are listed in the following table:

FieldWeaken-ingFilterType	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1570	0x60F9.1F	-	-	U16	Hz	RW	*YES*	ES

Typical frequency of the filter on the feedback position sensor.

VFilterSensorType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1571	0x60F9.20	-	-	U16	-	RW	*YES*	ES

Filter type on the sensor of the feedback position.

VFilterTypeSensor	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1572	0x60F9.21	-	-	U16	10 = 1	RW	*YES*	ES

Quality Q factor of the filter on the feedback position sensor.

KAff

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1590	0x60F9.16	-	-	U16	1000 = 1	RW	*YES*	ES

Acceleration feed forward gain.

PositionLoop

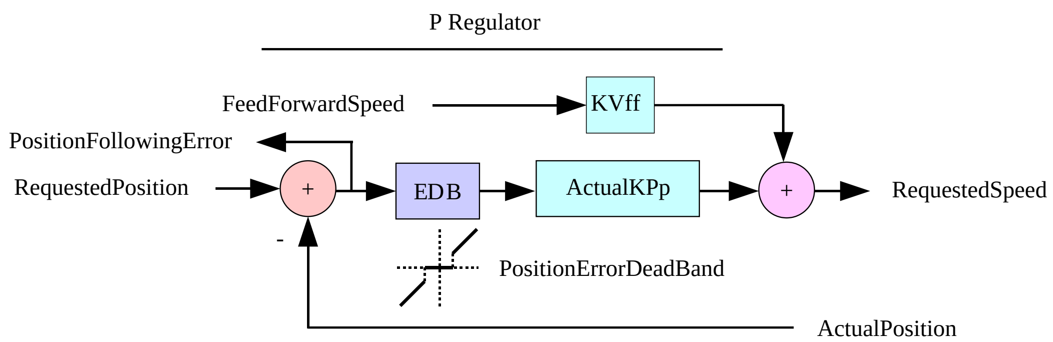


Figure 26.2. Flow chart of the position regulator.

Position loop.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x60FB.00	-	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* when it is included in the *PositionErrorDeadBand* (EDB) located near the zero.

KPp

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1560	0x60FB.01	-	-	U16	-	RW	*YES*	ES

Proportional gain of the position regulator.

KVff

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1561	0x60FB.02	-	-	U16	1000 = 1	RW	*YES*	ES

Velocity feed forward gain.

PositionStandStill

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1562	0x60FB.03	-	-	U16	-	RW	*YES*	ES

Proportional gain of the position regulator for low velocities.

EnablePositionStandStill

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1563	0x60FB.04	-	-	U16	-	RW	*YES*	ES

Enabling of the *PositionStandStill*: (0 = disabled, 1 = enabled).

ActualKPp

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1564	0x60FB.05	-	-	U16	-	RO	*YES*	-

Proportional gain currently used by the position regulator.

ClosePositionLoop

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1565	0x60FB.06	-	1	U16	-	RW	*YES*	ES

It enables the internal closure of the drive of the position loop.

PositionErrorDeadBand

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1565	0x4281.01	-	0	U16	inc	RW	-	ES

Half width of the dead band of the *PositionFollowingError*.

CurrentLoop

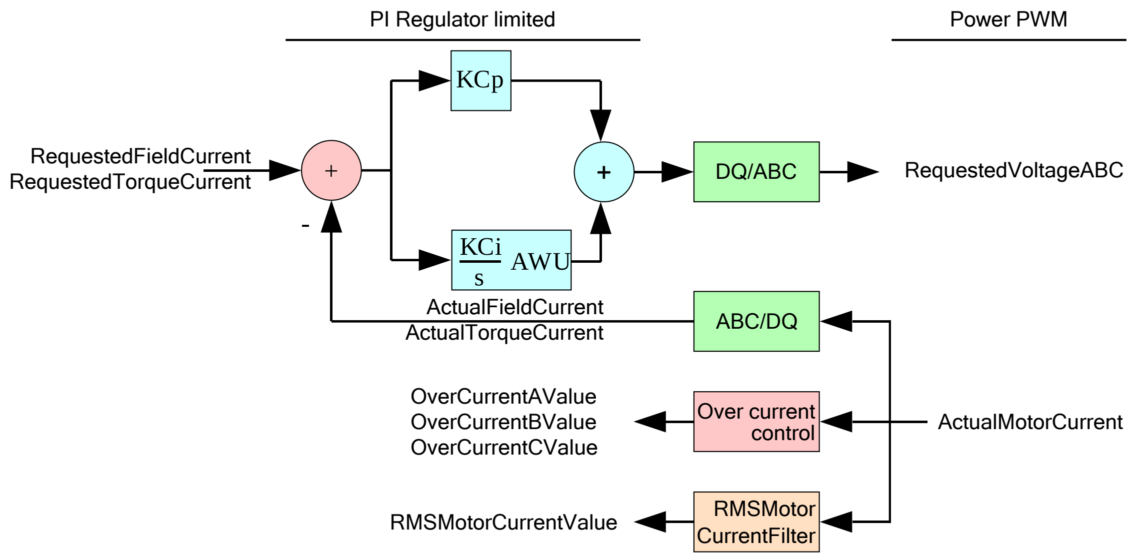


Figure 26.3. Flow chart of the logical part of the CurrentLoop. Number of parameters in this group.

Current loop.

Number of entries

Modbus	CANopen	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1580	0x60F6.01	-	-	U16	-	RW	*YES*	ES

Proportional gain of the torque current regulator.

KCi_Q

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1581	0x60F6.02	-	-	U16	-	RW	*YES*	ES

Integral gain of the torque current regulator.

KCp_D

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1582	0x60F6.03	-	-	U16	-	RW	*YES*	ES

Proportional gain of the field current regulator.

KCi_D

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1583	0x60F6.04	-	-	U16	-	RW	*YES*	ES

Integral gain of the field current regulator.

KC_FilterFrequency

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1584	0x60F6.06	-	-	U16	Hz	RW	*YES*	ES

Typical frequency of the filter on the output of the current regulators.

KC_FilterType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1585	0x60F6.07	-	-	U16	-	RW	*YES*	ES

Type of the filter on the output of the current regulator.

KC_FilterFrequency	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1586	0x60F6.08	-	-	U16	10 = 1	RW	*YES*	ES

Quality factor of the filter on the current regulators output.

KC_QReduction

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1587	0x60F6.09	0 ÷ 1000	-	U16	Desc	RW	*YES*	ES

Gains reduction factor to compensate the Lq saturation (0 = no reduction, 1000 = maximum reduction).

EnableLoopCompensation

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1588	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1589	0x60F6.0A	-	-	U16	Hz	RW	*YES*	ES

Natural frequency of the observer that estimates the rotor position.

LoopType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1595	0x3080.00	0 ÷ 1	0	U16	-	RW	-	-

Loops control mode (0 = Servo mode, 1 = Microstep).

> **Note**
>
> The Servo mode is the standard functioning mode, the Microstep is a functioning mode that's internal to the drive and that's automatically used for particular procedures.

26.10. Power Pwm (1600-1699)

PowerPwmParameters

Power pwm parameters.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3521.00	-	7	U8	-	CST	-	-

Number of parameters in this group. For further details see *Section 13.5, Power PWM*.

PwmBridgeFrequency

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1600	0x3521.01	1500-30000	5000	U16	Hz	RO	-	ES

Three-phase bridge modulation frequency.

PwmModulationMethod

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1601	0x3521.02	2	2	U16	-	RO	-	ES

Modulation type of the three-phase bridge; 2 = asymmetrical.

PwmMotionLoopDivider

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1602	0x3521.03	-	1	U16	-	RO	-	ES

Reduction factor of the loop motion period compared to the current loop period.

PwmMotionLoopCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1603	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	*PwmBridge-Frequency*	*PwmModula-tionMethod*	*PwmMotion-LoopDivider*	*Motion-LoopPeriod*	*Current-LoopPeriod*
0	5000	2	1	100	100

MotionLoopPeriod

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1610	0x3521.04	-	100	U16	μs	RO	-	-

Motion loop period.

CurrentLoopPeriod

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1611	0x3521.05	-	100	U16	µs	RO	-	-

Current loop period.

26.11. Drive status (1800-1999)

TemperatureStatus

Temperature status.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3300.00	-	5	U8	-	CST	-	-

Number of parameters in this group.

PowerTemperature

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1800	0x3300.01	-	-	S16	10 = 1°C	RO	*YES*	-

Power section actual temperature.

LogicTemperature

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1801	0x3300.02	-	-	S16	10 = 1°C	RO	*YES*	-

Control section actual temperature.

MotorTemperature

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1802	0x3300.03	-	-	S16	10 = 1°C	RO	*YES*	-

Actual motor temperature (if the selected sensor is KTY, see *MotorTemperatureSensorType*).

FeedbackSensorTemperature

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1803	0x3300.04	-	-	S16	1 = 1°C	RO	*YES*	-

Feedback sensor temperature. This parameter returns the temperature only if it is installed an Absolute encoder Hiperface position sensor (see *Section 14.4, Feedback position sensor mode: incremental/absolute*). With the other sensor types this cell returns 0.

MotorTemperaturePTC

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1804	0x3300.05	-	-	S32	Ω	RO	*YES*	-

Resistor value for the motor temperature when the selected sensor is PTC (see *MotorTemperatureSensorType*).

DCBusVoltage(+HV)

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1840	0x3310.01	-	-	U16	10 = 1V	RO	*YES*	-

DC bus voltage feeding the drive power section.

I2TValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1880	0x3405.05	-	-	U16	%	RO	*YES*	-

Actual value of I2T.

CurrentStatus

Current status.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3320.00	-	9	U8	-	CST	-	-

Number of parameters in this group.

ActualMotorCurrent

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1881	0x3320.01	-	-	U16	100 = 1A	RO	*YES*	-

Motor actual current.

ActualFieldCurrent

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1883	0x3320.02	-	-	U16	100 = 1A	RO	*YES*	-

Motor actual field current (Id).

ActualTorqueCurrent

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1884	0x3320.03	-	-	U16	100 = 1A	RO	*YES*	-

Motor actual torque current (Iq).

OverCurrentAValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1885	0x3320.05	-	-	U16	100 = 1A	RO	*YES*	-

Current of the phase U of the motor in *Power or motor over current* conditions.

OverCurrentBValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1886	0x3320.06	-	-	U16	100 = 1A	RO	*YES*	-

Current of the phase V of the motor in *Power or motor over current* conditions.

OverCurrentCValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1887	0x3320.07	-	-	U16	100 = 1A	RO	*YES*	-

Current of the phase W of the motor in *Power or motor over current* conditions.

RMSMotorCurrent

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1888	0x3320.08	-	-	U16	100 = 1A	RO	*YES*	-

Motor RMS current.

RMSMotorCurrentFilter

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1889	0x3320.09	-	100	U16	100 = 1s	RW	-	ES

Filtering time to get the *RMSMotorCurrent*. RMSMotorCurrentFilter must be different from 0. Too low values of RMSMotorCurrentFilter can generate swinging in *RMSMotorCurrent*. Too high values of RMSMotorCurrentFilter slow down the convergence of *RMSMotorCurrent*. 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* in ten machine cycles.

AI0AcquiringStatus

Acquiring through the analog input 0.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3330.00	-	2	U8	-	CST	-	-

Number of parameters in this group. For further details see *Section 16.1, Capture*.

AI0Voltage

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1930	0x3330.01	-	-	S16	mV	RO	*YES*	-

Actual value of the not filtered analog input 0. The updating time of this parameter is *CurrentLoopPeriod*.

AI0FilteredVoltage

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
1931	0x3330.02	-	-	S16	mV	RO	*YES*	-

Actual value of the filtered analog input 0. The updating time of this parameter is *MotionLoopPeriod*.

26.12. Fault and Warning (2000-2199)

FaultMask

Masks representing the Faults features. The relation between the masks bits and the Faults is shown in *Table 23.1*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3000.00	3	3	U8	-	CST	-	-

Number of parameters in this group. For further details see *Section 23.4, Reaction to the Faults*

FaultMaskAutoErase

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2000	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 *Table 23.1* you can find the errors that can become auto-restoring through this parameter.

FaultMaskEnable

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2002	0x3000.02	Desc	Desc	U32	-	RW	-	ES

Error mask the Fault signal has been enabled for. In *Table 23.1* 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*, , *EtherCAT communication error*, *Position following error*, *User Fault*, *I2T limit reached* and *Logic voltage error*.

> **Warning**
>
> 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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2004	0x3000.03	Desc	0x180	U32	-	RW	-	ES

Fault mask generating the *Safety profile*. In *Table 23.1* you can find the Faults that can generate the *Safety profile*.

FaultReactionOptionCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2049	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 23.4, Reaction to the Faults*.

FaultReactionOptionCode	Action
-1	The motor is stopped with maximum deceleration by resetting *RequestedSpeed* and then the drive reaches the *Fault* state.
1	The motor is stopped with deceleration equal to *ProfileDeceleration* and then the drive reaches the *Fault* state.
2	The motor is stopped with deceleration equal to *QuickStopDeceleration* and then the drive reaches the *Fault* state.

SafetyPrfConfiguration

Parameters to configure the *Safety profile*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x300C.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

SafetyPrfTargetPosition

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2050	0x300C.01	-	0	S32	inc	RW	-	ES

Absolute position target to reach when the safety profile is run.

SafetyPrfVelocity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2052	0x300C.02	Desc	Desc	U32	inc/s	RW	-	ES

Running speed of the safety profile. The default value and the adjustable maximum value are respectively 3.0 rad/s and 3216.9 rad/s. It cannot be set with a zero value.

SafetyPrfAcceleration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2054	0x300C.03	Desc	Desc	U32	inc/s^2	RW	-	ES

Acceleration of the safety profile. The default value is 125.0 rad/s^2 while the range of the accepted values goes from 0.32 to 205887.3 rad/s^2.

SafetyPrfDeceleration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2056	0x300C.04	Desc	Desc	U32	inc/s^2	RW	-	ES

Deceleration of the safety profile. The default value is 125.0 rad/s^2 while the range of the accepted values goes from 0.32 to 205887.3 rad/s^2.

SafetyPrfCommand

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2065	0x3010.01	Desc	0	U16	-	RW	-	-

Command to enable/disable the safety profile. Fur further information see *Section 23.4, 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*. The speed of the profile beginning and end are not valid.

> **Tip**
>
> 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 *Table 23.1*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3014.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

WarnRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2070	0x3014.01	Desc	0	U32	-	RW	-	-

Main retentive warnings.

WarnDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2072	0x3014.02	Desc	0	U32	-	RO	-	-

Main dynamic warnings.

FaultRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2074	0x3014.03	Desc	0	U32	-	RO	*YES*	-

Main retentive faults.

FaultDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2076	0x3014.04	Desc	0	U32	-	RO	*YES*	-

Main dynamic faults.

ErrorCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2078	0x603F.00	Desc	0	U16	-	RO	*YES*	-

Register that reports the error code of the last detected error. The possible codes are reported in the *Table 9.3*. The parameter is reset on the Fault Reset command (see *Table 8.7*).

RealTimeModeError

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2080	0x3018.00	Desc	0	U16	-	RO	-	-

Specific details of the *Real time mode error*.

LimitReachedError

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2081	0x3019.00	Desc	0	U16	-	RO	-	-

Specific details of the *Limit reached*.

ParamSoftError

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2082	0x301A.00	Desc	0	U16	-	RO	-	-

Specific details of the *Parameters soft error*.

MotionParamLimitedError

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2083	0x301B.00	Desc	0	U16	-	RO	-	-

Specific details of the *Motion parameter limited*.

ThermalManageError

Specific details of the *Thermal management*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x302C.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

ThermalManageWarnRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2100	0x302C.01	Desc	0	U16	-	RO	-	-

Details of the retentive Warnings of the *Thermal management*.

ThermalManageWarnDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2101	0x302C.02	Desc	0	U16	-	RO	-	-

Details of the dynamic Warnings of the *Thermal management*.

ThermalManageFaultRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2102	0x302C.03	Desc	0	U16	-	RO	-	-

Details of the retentive Faults of the *Thermal management*.

ThermalManageFaultDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2103	0x302C.04	Desc	0	U16	-	RO	-	-

Details of the dynamic Faults of the *Thermal management*.

ParamSeriousError

Specific details of the *Parameters serious error*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x302D.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

ParamSeriousWarnDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2106	0x302D.02	Desc	0	U16	-	RO	-	-

Details

of the dynamic Warnings of the *Parameters serious error*.

ParamSeriousFaultRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2107	0x302D.03	Desc	0	U16	-	RO	-	-

Details of the retentive Faults of the *Parameters serious error*.

ParamSeriousFaultDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2108	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x302E.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

DigitalIoConfigWarnRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2110	0x302E.01	Desc	0	U16	-	RO	-	-

Details of the retentive Warnings of the *Digital IO configuration error*.

DigitalIoConfigFaultRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2112	0x302E.03	Desc	0	U16	-	RO	-	-

Details of the retentive Faults of the *Digital IO configuration error*.

DigitalIoConfigFaultDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2113	0x302E.04	Desc	0	U16	-	RO	-	-

Details of the dynamic Faults of the *Digital IO configuration error*.

UserError

Specific details of the *User Fault*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x302F.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

UserFaultDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2115	0x302F.04	Desc	0	U16	-	RW	-	-

Details of the dynamic Faults of the *User Fault*.

LogicVoltageError

Specific details of the *Logic voltage error*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3030.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

LogicVoltageWarnRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2120	0x3030.01	Desc	0	U16	-	RO	-	-

Details of the retentive Warnings of the *Logic voltage error*.

LogicVoltageWarnDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2121	0x3030.02	Desc	0	U16	-	RO	-	-

Details of the dynamic Warnings of the *Logic voltage error*.

LogicVoltageFaultRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2122	0x3030.03	Desc	0	U16	-	RO	-	-

Details of the retentive Faults of the *Logic voltage error*.

LogicVoltageFaultDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2123	0x3030.04	Desc	0	U16	-	RO	-	-

Details of the dynamic Faults of the *Logic voltage error*.

FeedbackSensorError

Specific details of the *Feedback sensor error*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3031.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

FeedbackSensorWarnRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2125	0x3031.01	Desc	0	U16	-	RO	-	-

Details of the retentive Warnings of the *Feedback sensor error*.

FeedbackSensorWarnDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2126	0x3031.02	Desc	0	U16	-	RO	-	-

Details of the dynamic Warnings of the *Feedback sensor error*.

FeedbackSensorFaultRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2127	0x3031.03	Desc	0	U16	-	RO	-	-

Details of the retentive Faults of the *Feedback sensor error*.

FeedbackSensorFaultDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2128	0x3031.04	Desc	0	U16	-	RO	-	-

Details of the dynamic Faults of the *Feedback sensor error*.

STOError

Specific details of */STO Management Error*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3032.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

STOFaultRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2132	0x3032.03	Desc	0	U16	-	RO	-	-

Retentive Faults details of the */STO Management Error*.

STOFaultDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2133	0x3032.04	Desc	0	U16	-	RO	-	-

Dynamic Faults details of the */STO Management Error*.

InternalError

Specific details of *Internal Error*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x303F.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

InternalErrorFaultRetentive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2192	0x303F.03	Desc	0	U16	-	RO	-	-

Details of the retentive Faults of the *Internal Error*

InternalErrorFaultDynamic

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2193	0x303F.04	Desc	0	U16	-	RO	-	-

Details of the dynamic Faults of the *Internal Error*

26.13. CiA402 state machine (2400-2449)

Controlword

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2400	0x6040.00	Desc	-	U16	-	RW	*YES*	-

Parameter to manage the CiA402 State Machine and the specific commands offered by the operating modes. For further details see what is reported in *Section 8.4, CiA402 state machine*. For the *Gear Mode* see *Table 21.7*. The bits are divided in this way:

- *Bit 0 - 3 and 7* to command each *Transition* of the CiA402 state machine.

- *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*.
- *Bit 9 - 12*: bit not used.
- *Bit 13 - 15*: bit for the *Gear Mode* management.

For further details see what is reported in *Section 8.4, CiA402 state machine*.

Statusword

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2401	0x6041.00	Desc	-	U16	-	RO	*YES*	-

State of the CiA402 State Machine and of the specific commands of the operative modes. For further details see what is reported in *Section 8.4, CiA402 state machine*. For the *Gear Mode* see *Table 21.6*. 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*	The drive can be enabled or disabled, depending on the <x0/> parameter value.*SwitchedOnOptionCode*
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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2402	0x605A.00	Desc	6	S16	-	RW	-	ES

Action run after a *Quick Stop* command.

QuickStop-Configuratio	Action
-1	The motor is stopped with maximum deceleration by resetting *RequestedSpeed* and then the drive reaches the *Switch On Disabled* state.
-5	The motor is stopped with deceleration equal to *ProfileDeceleration* and, at the end of the braking ramp, the velocity integral part (*ResetSpeedIntegrator*) reset is executed.
-6	The motor is stopped with deceleration equal to *QuickStopDeceleration* and, at the end of the braking ramp, the velocity integral part (*ResetSpeedIntegrator*) reset is executed.
1	The motor is stopped with deceleration equal to *ProfileDeceleration* and later the drive enters the *Switch On Disabled* state.

QuickStop-Configuratio	Action
2	The motor is stopped with deceleration equal to *QuickStopDeceleration* and later the drive enters the *Switch On Disabled* state.
5	The motor is stopped with deceleration equal to *ProfileDeceleration* and the drive remains in the *Quick Stop Active* state.
6	The motor is stopped with deceleration equal to *QuickStopDeceleration* and the drive remains in the *Quick Stop Active* state.

SwitchedOnOptionCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2410	0x42E0.00	Desc	0	S16	-	RW	-	ES

Value that determines the CiA402 state machine behaviour when it's in the *Switched On* state (see *Section 8.4, "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.

26.14. System manager (2450-2499)

SysMngCommand

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2450	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*)
1002	Tuning: inertia estimator (requires the writing of *ResetWatchdogTimeout*)
1003	Tuning: RL estimator (requires the writing of *ResetWatchdogTimeout*)
1010	Function Generator current D (requires the writing of *ResetWatchdogTimeout*)
1015	Function Generator current Q (requires the writing of *ResetWatchdogTimeout*)
1020	Function Generator velocity (requires the writing of *ResetWatchdogTimeout*)
1030	Function Generator position (requires the writing of *ResetWatchdogTimeout*)
1040	Function Generator profile velocity (requires the writing of *ResetWatchdogTimeout*)

SysMngCommand	Description
1050	Function Generator profile position (requires the writing of *ResetWatchdogTimeout*)
1101	Set all loops, tuning and estimated parameters at default
1102	Parameter recalculation of all loops
1103	Parameter recalculation of motion loops
1110	Parameter recalculation of CurrentLoop
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 and 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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2451	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2452	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 *SysMngCommand* 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 are active	Please contact Motor Power Company.
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 watch dog is expired	Check if the connection is active and the *ResetWatchdogTimeout* parameter writing timing requiring.
1002	Switched on state has been required	If the *Transition* of the CiA402 State Machine is not desired, check that the drive is not commanded by other Master devices (see *Section 8.4, "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.

SysMngError	Message	Solution
1004	Quick stop has been required	If the *Transition* of the CiA402 State Machine is not desired, check that the drive is not commanded by other Master devices (see *Section 8.4, “CiA402 state machine”*).
1005	Halt has been required	If the *Transition* of the CiA402 State Machine is not desired, check that the drive is not commanded by other Master devices (see *Section 8.4, “CiA402 state machine”*).
1006	Disable has been required	If the *Transition* of the CiA402 State Machine is not desired, check that the drive is not commanded by other Master devices (see *Section 8.4, “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, see *Table 8.7*.
1008	Unknown transition has been required	If the *Transition* of the CiA402 State Machine is not desired, check that the drive is not commanded by other Master devices (see *Section 8.4, “CiA402 state machine”*).
1009	Estimator torque is out of range	*EstimatorTorque*must be lower than *ActualTorqueLimitP*.
1010	Estimator speed is out of range	*InertiaEstimatorVelocity*must be lower than *MaxMotorSpeed*.
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.
1013	Tuning mode is not achievable	Internal error, repeat the command or reset the drive. 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* state.
1015	Motor and feedback sensor are not aligned	- With incremental encoder, turn the motor for at least a half mechanical revolution; - with incremental+Hall encoder (Facoder), try to 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	Estimate inertia is too high: bandwidth is limited	The inertia moment of the mechanical load doesn't allow to obtain a high *VelocityLoopEstimatedBandwidth*; 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 me-

SysMngError	Message	Solution
		chanical. If the performances are not satisfactory, it's necessary to increase the motor size.
1019	Motor Parameters are not correctly set	Check the Warnings.
1020	Feedback position sensor is not set	Check the Warnings.
1021	Estimator security position limit reached	Decrease the value of *InertiaEstimatorVelocity* or increase the value of *EstimatorTorque* and retry. if the problem persists, try to execute a not extended estimation of the inertia moment (command 1002 in the place of command 1001 of the *SysMngCommand*). Check the mechanical parts work properly. If the problem persists, the estimator cannot be used, then try with what's described in *Section 19.4, Gains calculation*.
1022	Estimator torque greater than nominal current	Reduce *EstimatorTorque*.
1023	Estimator speed is too low: *InertiaEstimatorVelocity* is lower than 15rad/s.	Increase the value of *InertiaEstimatorVelocity*.
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*).
1025	I2T Warning threshold reached	Increase *I2TWarningThreshold*.
1026	DC bus voltage (+HV) is too low	Increase the supply voltage *DCBusVoltage(+HV)* and retry.
2000	Permanent memory address is out of range	Restore the permanent memory through the command 2200 (*SysMngCommand*). Reset the drive through the command 5000.
2001	Permanent memory data length is not valid	Restore the permanent memory through the command 2200 (*SysMngCommand*). Reset the drive through the command 5000.
2002	Message: "Dati non salvabili perché ADC di corrente non sono calibrati"	Please contact Motor Power Company.
2003	Message: "Dati non salvabili perché ADC di tensione non sono calibrati"	Please contact Motor Power Company.
2004	Last permanent memory writing was not completed correctly. Permanent memory data may be corrupted	Restore the permanent memory through the command 2200 (*SysMngCommand*). 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 (see *Section 16.2, Calibration*).
2100	No error for file system	-
2101	File system ID not exist	Restore the permanent memory through the command 2200 (*SysMngCommand*). Reset the drive through the command 5000. If the problem persists, please contact Motor Power Company.
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	

SysMngError	Message	Solution
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	Hiperface internal memory: no error	-
2301	Hiperface internal memory: driver is busy	Turn the drive off and then on again. If the problem persists, please contact MPC.
2302	Hiperface internal memory: operation not exist	Turn the drive off and then on again. If the problem persists, please contact MPC.
2303	Hiperface internal memory: data size is too large	Turn the drive off and then on again. If the problem persists, please contact MPC.
2304	Hiperface internal memory: for details, see Feedback sensor error	Check *Feedback sensor error*.
2305	Hiperface 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 MPC.
2306	Hiperface internal memory: CRC is invalid	Check the wirings of the feedback sensor and that the *FeedbackSensorTemperature* is correctly read. Turn the drive off and then on again. Repeat the phasing and the saving.
5000	Module ID is not present in ID table	Turn the drive off and then on again. If the problem persists, please contact Motor Power Company.
5101	Download: file corrupted	See the solution in *FirmwareStatus* (value 151).
5103	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 153).
5104	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 154).
5105	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 155).
5106	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 156).
5107	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 157).
5108	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 158).
5111	Download: file corrupted	See the solution in *FirmwareStatus* (value 161).
5112	Download: file corrupted	See the solution in *FirmwareStatus* (value 162).
5113	Download: file corrupted	See the solution in *FirmwareStatus* (value 163).
5114	Download: file corrupted	See the solution in *FirmwareStatus* (value 164).
5115	Download: file corrupted	See the solution in *FirmwareStatus* (value 165).
5116	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 166).

SysMngError	Message	Solution
5117	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 167).
5118	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 168).
5119	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 169).
5120	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 170).
5121	Download: file requires unsupported features	See the solution in *FirmwareStatus* (value 171).
5122	Download: memory error	See the solution in *FirmwareStatus* (value 172).
5123	Download: file corrupted	See the solution in *FirmwareStatus* (value 173).
5124	Download: file corrupted	See the solution in *FirmwareStatus* (value 174).
5125	Download: memory error	See the solution in *FirmwareStatus* (value 175).
5150	Download: memory error	See the solution in *FirmwareStatus* (value 200).
5151	Download: memory error	See the solution in *FirmwareStatus* (value 201).
5152	Download: memory error	See the solution in *FirmwareStatus* (value 202).
5153	Download: memory error	See the solution in *FirmwareStatus* (value 203).
5154	Download: memory error	See the solution in *FirmwareStatus* (value 204).
5160	Download: memory error	See the solution in *FirmwareStatus* (value 210).
5161	Download: memory error	See the solution in *FirmwareStatus* (value 211).
5162	Download: memory error	See the solution in *FirmwareStatus* (value 212).
5163	Download: memory error	See the solution in *FirmwareStatus* (value 213).
5164	Download: memory error	See the solution in *FirmwareStatus* (value 214).
5170	Download: memory error	See the solution in *FirmwareStatus* (value 220).
5171	Download: memory error	See the solution in *FirmwareStatus* (value 221).
5180	Download: memory error	See the solution in *FirmwareStatus* (value 230).
5300	Feedback position sensor is not compatibile 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 sensor is not phased: index pulse not found.	Check the wirings of the feedback sensor and that the *FeedbackSensorTemperature* 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 error persists, please contact MPC.
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 error persists, please contact MPC.
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 error persists, please contact MPC.
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 error persists, please contact MPC.

SysM-ngError	Message	Solution
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 error persists, please contact MPC.
6200	Impossible to change the IO configuration because an IO overload Warning is active (*Digital output overtemperature or overload (DuetHV)*)	Reset the Warning and try again.
7100	Message: "VGATE non presente (manca /STO o abilitazione software)"	Please contact Motor Power Company.

SysMngEnForcing

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2455	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2459	0x5FF7.0A	≤*PeakCurrent*	*NominalCurrent*	U16	100=1A	RW	-	-

Motor current used for the System Manager commands that use the microstep mode.

26.15. Capture peripherals (2800-2899)

Warning

In this section the parameters of both the capture interfaces are contained (selectable through the *CaptureInterfaceMode* parameter). When an interface has been selected, the parameters that are related to the other one are ignored and any try to access them returns a Warning. For further details see *Section 17.1, Configuration interface selection*.

Important

The parameters listed in this section are divided according to the interface to which they belong. Taking as reference the *CaptureInterfaceMode* parameter:
- the previous parameters are related to the CUSTOM interface
- The successive parameters are related to the *CiA-402* interface

CaptureParam_A

Parameters of capture peripheral (A).

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4000.00	7	7	U8	-	CST	-	-

Number of parameters in this group.

CaptureUnitCommand_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2801	0x4000.01	0÷3	0	U16	-	RW	*YES*	-

Commands for the capture peripheral A.

UnitCommand	Description
0	*Stop* Disabling the capture peripheral.
1	*Single Run* Enabling the single capture. When the selected trigger event takes place (*CaptureTriggerInput_A*), the selected values of the quantities to capture (*CaptureSource0_A*, *CaptureSource1_A*, *CaptureSource2_A*) are copied in the parameters *CapturedValue0_A*, *CapturedValue1_A*, *CapturedValue2_A*. After the capture, *CaptureUnitState_A* goes from *Single capture armed* to *Single stop*. The capture results will remain valid until the next rearmament. 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*), the selected values of the quantities to capture (*CaptureSource0_A*, *CaptureSource1_A*, *CaptureSource2_A*) are copied in the parameters *CapturedValue0_A*, *CapturedValue1_A*, *CapturedValue2_A*. After the capture, *CaptureUnitState_A* goes from *Repetitive capture armed* to *Repetitive capture done*. A further trigger event will cause a new capture by overwriting the capture values of the previous event. When at least one of the parameters of the results are read, *CaptureUnitState_A* goes to *Repetitive capture 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 behaviour 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.

Table 26.3. Codes for UnitCommand

CaptureTriggerInput_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2802	0x4000.02	Desc	0	U16	-	RW	-	ES

Trigger signal that causes the capture for the peripheral A.

TriggerInput	Description
0	Digital input In9;

TriggerInput	Description
1	Digital input In8;
3	*Index*pulse of the feedback encoder
4	*Index*pulse of the auxiliary encoder

Table 26.4. TriggerInput codes.

CaptureTriggerEdge_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2803	0x4000.03	0 ÷ 2	0	U16	-	RW	-	ES

Trigger edge that causes the capture for the peripheral A.

TriggerEdge	Description
0	Falling edge
1	Rising edge
2	Both the edges

Table 26.5. Codes for TriggerEdge.

CaptureInhibitTime_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2804	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 happens, the peripheral executes the capture and then ignore the trigger signal for the specified time.
In case of capture on both edges (*CaptureTriggerEdge_A* = 2), CaptureInhibitTime_A is applied "for edge". In case of repetitive capture (*CaptureUnitCommand_A* = 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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2809	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* 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*, while the filtering value applied to the restore edge is expressed by the parameter *CaptureRestoreSlope-ValidationFilter_A*. For further information on the working of this type of filter please see *Section 17.3, Filter on CaptureSource0_A andCaptureSource0_B*.

CaptureRestoreSlopeValidationFilter_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2810	0x4000.09	-	0	U32	Desc	RW	-	ES

Enables 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* 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. For further information please see *Section 17.3, Filter on CaptureSource0_A andCaptureSource0_B*.

CaptureActiveSlopeValidationFilter_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2812	0x4000.08	-	0	U32	Desc	RW	-	ES

Enables the filter on the value of the first quantity of the peripheral A for the capture edge. If *CaptureValidationFilterMode_A* 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* is applied to the restore edge.

CaptureState_A

Status of the capture peripheral (A).

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4001.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

CaptureUnitState_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2800	0x4001.01	-	0	U16	-	RO	*YES*	-

Status of the capture peripheral A.

UnitState	Description
0	*Capture stop*

UnitState	Description
	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 causes 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*.
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.
20	*Repetitive capture done on falling edge* The peripheral captured the selected data after the trigger event, every new trigger event causes 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 causes 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*.

Table 26.6. Codes for UnitState.

NumberCapturesRecorded_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2814	0x4001.02	-	-	U16	-	RO	*YES*	-

Counter of the capture number of the capture peripheral A.

NumberCapturesRecordedRising_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2815	0x4001.03	-	-	U16	-	RO	*YES*	-

Counter of the events that have been captured on the rising edge of the capture peripheral A.

NumberCapturesRecordedFalling_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2816	0x4001.04	-	-	U16	-	RO	*YES*	-

Counter of the events that have been captured on the falling edge of the capture peripheral A.

CapturedValues_Rising_A

Captured value on the rising edge of the capture peripheral (A).

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4007.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValueRising0_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2820	0x4007.01	-	-	S32	-	RO	*YES*	-

32 bit value of the first variable of the capture peripheral A, captured on the rising edge.

CapturedValueRising1_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2822	0x4007.02	-	-	S32	-	RO	*YES*	-

32 bit value of the second variable of the capture peripheral A, captured on the rising edge.

CapturedValueRising2_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2824	0x4007.03	-	-	S32	-	RO	*YES*	-

32 bit value of the third variable of the capture peripheral A, captured on the rising edge.

CapturedValues_Falling_A

Captured value on the falling edge of the capture peripheral (A).

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4008.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValueFalling0_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2826	0x4008.01	-	-	S32	-	RO	*YES*	-

32 bit value of the first variable of the capture peripheral A, captured on the falling edge.

CapturedValueFalling1_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2828	0x4008.02	-	-	S32	-	RO	*YES*	-

32 bit value of the second variable of the capture peripheral A, captured on the falling edge.

CapturedValueFalling2_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2830	0x4008.03	-	-	S32	-	RO	*YES*	-

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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4003.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CaptureSource0_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2835	0x4003.01	Desc	2	U16	-	RW	-	ES

Code of the first quantity to capture for the peripheral A.

CaptureX	Description
0	No quantity
1	*AuxiliaryEncoderPosition*
2	*PositionActualValue*

CaptureX	Description
4	*PositionFollowingError*

Table 26.7. Codes of the quantities to capture.

CaptureSource1_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2836	0x4003.02	Desc	1	U16	-	RW	-	ES

Code of the second quantity to capture for the peripheral A. In *Table 26.7* you can find the available codes.

CaptureSource2_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2837	0x4003.03	Desc	0	U16	-	RW	-	ES

Code of the third quantity to capture for the peripheral A. In *Table 26.7* you can find the available codes.

CapturedValues_A

Capture peripheral (A) captured values, saved in memory locations of 1 Long size.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4004.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValue0_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2840	0x4004.01	-	-	S32	-	RO	*YES*	-

Captured value of the first quantity for the peripheral A (4 bytes).

CapturedValue1_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2842	0x4004.02	-	-	S32	-	RO	*YES*	-

Captured value of the second quantity for the peripheral A (4 bytes).

CapturedValue2_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2844	0x4004.03	-	-	S32	-	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4005.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValue0_Word_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4005.01	-	-	S16	-	RO	*YES*	-

Captured value of the first quantity for the peripheral A (2 bytes).

CapturedValue1_Word_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4005.02	-	-	S16	-	RO	*YES*	-

Captured value of the second quantity for the peripheral A (2 bytes).

CapturedValue2_Word_A

Modbus	CANopen	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4006.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValue0_Byte_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4006.01	-	-	S8	-	RO	*YES*	-

Captured value of the first quantity for the peripheral A (1 byte).

CapturedValue1_Byte_A

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4006.02	-	-	S8	-	RO	*YES*	-

Captured value of the second quantity for the peripheral A (1 byte).

CapturedValue2_Byte_A

Modbus	CANopen	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

Capture peripheral (B) status.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4011.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

CaptureUnitState_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2850	0x4011.01	-	0	U16	-	RO	*YES*	-

Status of the capture peripheral B. In *Table 26.6* you can find the available codes.

NumberCapturesRecorded_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2864	0x4011.02	-	-	U16	-	RO	*YES*	-

Counter of the capture number of the capture peripheral B.

NumberCapturesRecordedRising_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2865	0x4011.03	-	-	U16	-	RO	*YES*	-

Counter of the events that have been captured on the rising edge of the capture peripheral B.

NumberCapturesRecordedFalling_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2866	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4010.00	7	7	U8	-	CST	-	-

Number of parameters in this group.

CaptureUnitCommand_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2851	0x4010.01	0÷3	0	U16	-	RW	*YES*	-

Commands for the capture peripheral B. In *Table 26.3* you can find the available codes.

CaptureTriggerInput_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2852	0x4010.02	Desc	0	U16	-	RW	-	ES

Trigger signal that causes the capture for the peripheral B. In *Table 26.4* you can find the available codes.

CaptureTriggerEdge_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2853	0x4010.03	0 ÷ 2	0	U16	-	RW	-	ES

Trigger edge that causes the capture for the peripheral B. In *Table 26.5* you can find the available codes.

CaptureInhibitTime_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2854	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 happens, the peripheral executes the capture and then ignore the trigger signal for the specified time.
In case of capture on both edges (*CaptureTriggerEdge_B* = 2), CaptureInhibitTime_B is applied "for edge". In case of repetitive capture (*CaptureUnitCommand_B* = 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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2859	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* 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*, while the filtering value applied to the restore edge is expressed by the parameter *CaptureRestoreSlopeValidationFilter_B*. For further information on the working of this type of filter please see *Section 17.3, Filter on CaptureSource0_A andCaptureSource0_B*.

CaptureRestoreSlopeValidationFilter_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2860	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. For further information please see *Section 17.3, Filter on CaptureSource0_A andCaptureSource0_B*.

CaptureActiveSlopeValidationFilter_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2862	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* is applied to the restore edge.

CapturedValues_Rising_B

Captured value on the rising edge of the capture peripheral (B).

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4017.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValueRising0_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2870	0x4017.01	-	-	S32	-	RO	*YES*	-

32 bit value of the variable 0 that has been captured on the rising edge of the capture peripheral B.

CapturedValueRising1_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2872	0x4017.02	-	-	S32	-	RO	*YES*	-

32 bit value of the variable 1 that has been captured on the rising edge of the capture peripheral B.

CapturedValueRising2_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2874	0x4017.03	-	-	S32	-	RO	*YES*	-

32 bit value of the variable 2 that has been captured on the rising edge of the capture peripheral B.

CapturedValues_Falling_B

Captured value on the falling edge of the capture peripheral (B).

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4018.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValueFalling0_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2876	0x4018.01	-	-	S32	-	RO	*YES*	-

32 bit value of the variable 0 that has been captured on the falling edge of the capture peripheral B.

CapturedValueFalling1_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2878	0x4018.02	-	-	S32	-	RO	*YES*	-

32 bit value of the variable 1 that has been captured on the falling edge of the capture peripheral B.

CapturedValueFalling2_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2880	0x4018.03	-	-	S32	-	RO	*YES*	-

32 bit value of the variable 2 that has 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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4013.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CaptureSource0_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2885	0x4013.01	Desc	2	U16	-	RW	-	ES

Code of the first quantity to capture for the peripheral B. In *Table 26.7* you can find the available codes.

CaptureSource1_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2886	0x4013.02	Desc	1	U16	-	RW	-	ES

Code of the second quantity to capture for the peripheral B. In *Table 26.7* you can find the available codes.

CaptureSource2_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2887	0x4013.03	Desc	0	U16	-	RW	-	ES

Code of the third quantity to capture for the peripheral B. In *Table 26.7* you can find the available codes.

CapturedValues_B

Capture peripheral (B) captured values, saved in memory locations of 1 Long size.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4014.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValue0_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2890	0x4014.01	-	-	S32	-	RO	*YES*	-

Captured value of the first quantity for the peripheral B (4 bytes).

CapturedValue1_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2892	0x4014.02	-	-	S32	-	RO	*YES*	-

Captured value of the second quantity for the peripheral B (4 bytes).

CapturedValue2_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2894	0x4014.03	-	-	S32	-	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4015.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValue0_Word_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4015.01	-	-	S16	-	RO	*YES*	-

Captured value of the first quantity for the peripheral B (2 bytes).

CapturedValue1_Word_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4015.02	-	-	S16	-	RO	*YES*	-

Captured value of the second quantity for the peripheral B (2 bytes).

CapturedValue2_Word_B

Modbus	CANopen	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4016.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

CapturedValue0_Byte_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4016.01	-	-	S8	-	RO	*YES*	-

Captured value of the first quantity for the peripheral B (1 byte).

CapturedValue1_Byte_B

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4016.02	-	-	S8	-	RO	*YES*	-

Captured value of the second quantity for the peripheral B (1 byte).

CapturedValue2_Byte_B

Modbus	CANopen	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2949	0x402F.00	0 ÷ 1	0	U16	-	RW	*YES*	ES

Switch to select the interface to be used to manage the capture peripherals A and B (0=custom mode, 1=*CiA-402* mode). See *Section 17.1, “Configuration interface selection”*

Important

It's not possible to change the interface if the capture functionality is active:
- in case *CaptureInterfaceMode* value is 0 (CUSTOM interface): if at least one of the *CaptureUnitState_A* and *CaptureUnitState_B* parameters value is 1;
- in case *CaptureInterfaceMode* value is 1 (*CiA-402* interface): if both the bits 0 and/or both the bits 8 of *TouchProbeFunction* and of *TouchProbeStatus* are set to 1.

TouchProbeFunction

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2950	0x60B8.00	Desc	0	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 *Index* pulse of the feedback encoder or*PositionActualValue*
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 of 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 *Index* pulse of the feedback encoder or*PositionActualValue*
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 of the user (e.g. for test)

Table 26.8. Meaning of the bits related to the capture peripherals function.

TouchProbeStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2951	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 of 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 of the user (e.g. for test)

Table 26.9. Meaning of the bits related to the capture peripherals status.

TouchProbesSource

Selection of the capture source of the capture peripheral.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x60D0.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

TouchProbe1Source

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2952	0x60D0.01	Desc	1	S16	-	RW	*YES*	-

Capture source of the capture peripheral A. he values that this parameter can take are reported in the following table.

Value	Trigger Event
-1	*Index*auxiliary encoder pulse
1	Touch probe input 1 (Digital input In8)
2	Touch probe input 2 (Digital input In9)
5	*Index*Feedback encoder pulse

Table 26.10. Codes for the selection of the trigger event of the capture peripheral.

TouchProbe2Source

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2953	0x60D0.02	Desc	0	S16	-	RW	*YES*	-

Capture source of the capture peripheral B. The values that this parameter can take are reported in the *Table 26.10*.

TouchProbePosition1PosValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2960	0x60BA.00	-	-	S32	-	RO	*YES*	-

32 bit value captured on the rising edge of the capture peripheral A.

TouchProbePosition1NegValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2962	0x60BB.00	-	-	S32	-	RO	*YES*	-

32 bit value captured on the falling edge of the capture peripheral A.

TouchProbePosition2PosValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2964	0x60BC.00	-	-	S32	-	RO	*YES*	-

32 bit value captured on the rising edge of the capture peripheral B.

TouchProbePosition2NegValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2966	0x60BD.00	-	-	S32	-	RO	*YES*	-

32 bit value captured on the falling edge of the capture peripheral B.

TouchProbe1PosEdgeCounter

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2980	0x60D5.00	-	-	U16	-	RO	*YES*	-

Counter of the number of the values that have been captured on the rising edge of the capture peripheral A.

TouchProbe1NegEdgeCounter

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2981	0x60D6.00	-	-	U16	-	RO	*YES*	-

Counter of the number of the values that have been captured on the falling edge of the capture peripheral A.

TouchProbe2PosEdgeCounter

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2982	0x60D7.00	-	-	U16	-	RO	*YES*	-

Counter of the number of the values that have been captured on the rising edge of the capture peripheral B.

TouchProbe2NegEdgeCounter

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
2983	0x60D8.00	-	-	U16	-	RO	*YES*	-

Counter of the number of the values that have been captured on the falling edge of the capture peripheral B.

26.16. Feedback sensor (3000-3999)

FeedbackSensor

Feedback sensor related values.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x36C0.00	5	5	U8	-	CST	-	-

Number of parameters in this group.

FeedbackSensorResolution

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
3000	0x36C0.02	-	8000	U32	Desc	*RO*	-	-

Feedback sensor resolution, valid only for the sensors that declare it. The unit of measurement depends on the motor type: rotary motor [count/rev], linear motor [count/PolePitch].

FeedbackSensorCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
3004	0x36C0.04	-	-	U16	-	*Desc*	-	EM

Codice che identifica il sensore di feedback (per maggiori dettagli vedere *Section 14.2, Sensor of the feedback position*).

SensorCode	Description
100	Absolute Hiperface encoder multiturn SEL 16sin/rev, 4096rev, Warning temperature 105°C, Fault temperature 115°C.
101	Absolute Hiperface encoder multiturn SKM36 128sin/rev, 4096rev, Warning temperature 100°C, Fault temperature 110°C.
102	Absolute Hiperface encoder multiturn SRM 1024sin/rev, 4096rev, Warning temperature 105°C, Fault temperature 115°C.
150	Absolute Hiperface encoder singleturn SEK 16sin/rev, Warning temperature 105°C, Fault temperature 115°C.

Note

In the drives of the DuetHV series with Hiperface encoders, the *Index* is simulated.

Note

The default value, once it has been modified, is no more restorable.

FeedbackSensorFaultTemperatureThrs

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
3005	0x36C0.05	-	-	U16	°C	RO	-	EM

Feedback sensor temperature fault threshold. In case the FeedbackSensorFaultTemperatureThrs value is 65535, it means that the encoder overheating temperature alarm management is disabled. In this case the only monitoring that remains active is, therefore, the motor temperature one, that can be read through the *MotorTemperature* parameter, that protects even the sensor.

FeedbackSensorAbsMode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
3010	0x36C0.08	-	-	S16	-	RW	-	EM

Feedback sensor functioning mode (0=incremental, 1=absolute) (for further details see *Section 14.4, "Feedback position sensor mode: incremental/absolute"*).The FeedbackSensorAbsMode default value is 1 only if the feedback position sensor is *multiturn* type and cannot be restored on command. When this parameter is written, it is even immediatly saved in the permanent memory.

> **Caution**
>
> Unit of measurement of the parameter (see *FeedbackSensorAbsMode*), see the *Table 14.2*.

FeedbackSensorPhasing

Feedback sensor phasing parameters related values.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x36C2.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

FeedbackSensorPhasingStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
3020	0x36C2.01	-	-	U16	-	RO	-	-

Feedback sensor phasing status (0=not phased, 1=phasing in progress, 2=phased, 3=phasing error).

FeedbackSensorPhasingAngleTest

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
3021	0x36C2.02	0-3600	-	S16	10 = 1deg	RW	-	-

Value of the electric angle used to execute the phasing test through the command 5300 of the *SysMngCommand*.

FeedbackSensorPhasingAngleError

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
3022	0x36C2.03	-	-	S16	10 = 1deg	RW	-	-

Error of the electric angle used to execute the phasing test through the command 5300 of the *SysMngCommand*.

HallFeedbackSensor

Incremental + Hall encoders features related values.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x3680.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

HallValidationWindow

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
3066	0x3680.0E	-	-	S16	Count	RO	-	-

Accuracy of the Hall sensors of the feedback sensor, valid only for the sensors that declare it. If the sensor doesn't respect this accuracy, the *Phasing: Validation window not respected* warning is reported (see *Table 23.11*).

26.17. Motion (4000-4999)

PositionResolution

Parameters to define the position resolution (for details see *Section 12.2, Revolution resolution*).

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x608F.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

EncoderIncrements

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4000	0x608F.01	256 - 1048576	8000	U32	inc	RW	-	ES

Number of increments of the feedback position sensor, used to calculate the *PositionResolution* (for further details see *Section 12.2, Revolution resolution*).

MotorRevolutions

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4003	0x608F.02	1	1	U32	Desc	RW	-	-

Number of motor revolutions or steps to calculate the *PositionResolution* (for further details see *Section 12.2, Revolution resolution*). For rotative motors, it indicates the motor revolutions number. For linear motors, it indicates the motor polar steps number.

Polarity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4002	0x607E.00	-	0	U8	-	RW	*YES*	ES

Motor axis rotation direction in which the *PositionActualValue* value increments. For further details see *Section 12.3, Polarity*.

Polarity	Name	Description
0	Forward	With rotary motor: positive direction clockwise towards the motor flange With linear motor: the positive direction is defined by the motor constructor, supposing the correct wiring of the motor phases.
192	Reverse	With rotary motor: positive direction counterclockwise towards the motor flange With linear motor: the positive direction is the opposite one than the direction defined by the motor constructor, supposing the correct wiring of the motor phases.

ModesOfOperation

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4100	0x6060.00	Desc	3	S8	-	RW	*YES*	ES

Selection of the operating mode of drive functioning. The accepted values are shown in the *Table 26.11*.

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*).
-126	*Gear Mode*	The drive follows the master axis position according to a following ratio configured by the user.
-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.

Table 26.11. Accepted values for the ModesOfOperation parameter.

> **Note**
>
> It is possible to change *ModesOfOperation* only if the drive is not on *Quick Stop Active* or *Fault Reaction Active* state. If the drive is on *Operation enable* state, it's possible to change the operative mode only if the bit 4 of the *Controlword* is set to 0. The operative mode change, with this method, must be done with the motor stopped, and it's user's responsibility to be sure of this condition.

ModesOfOperationDisplay

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4101	0x6061.00	Desc	3	S8	-	RO	*YES*	-

Mode of operation active in the drive. The values that can be read are the same of the *ModesOfOperation* parameter (see *Table 26.11*) with, in addition, the *Tuning Mode* (-127) used for some tuning and configuration commands.

ApplyModeOperation

Group of parameter to manage the on-the-fly change of the operative mode.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x42C0.00	9	9	U8	-	CST	-	-

Number of parameters in this group.

ApplyModeOperationCommand

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4108	0x42C0.01	Desc	-	S8	-	RW	*YES*	-

Selection of the operating mode for the functionality of on-the-fly mode change.

ApplyModeOperationComand	Name
1	*Profile Position Mode*
6	*Homing Mode*
-126	*Gear Mode*
-113	*Profile Velocity Mode (CUSTOM)*

> **Note**
>
> It is possible to change operative mode through this parameter only when the drive is in the *Operation enable* state. For further details see *Section 21.5, On-the-fly operative mode change*.

ApplyModeOperationStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4109	0x42C0.02	-	-	U8	-	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.

ApplyModeOperationStatus	Description
0	No error, change *ApplyModeOperationCommand* correctly run.
1	Error: parameter *ApplyModeOperationCommand* not correct.
2	Error: parameter 1 of *ApplyModeOperationParameters* not correct.
3	Error: parameter 2 of *ApplyModeOperationParameters* not correct.
4	Error: parameter 3 of *ApplyModeOperationParameters* not correct.
5	Error: parameter 4 of *ApplyModeOperationParameters* not correct.
6	Error: parameter 5 of *ApplyModeOperationParameters* not correct.
7	Error: parameter 6 of *ApplyModeOperationParameters* not correct.
8	Error: parameter 7 of *ApplyModeOperationParameters* not correct.

ApplyModeOperationParameters

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4110 - 4122	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* changes. For further details please see *Table 21.2*.

PositionValidationStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4150	0x42BF.00	-	-	U32	-	RW	-	-

This parameter indicates if the position read by the drive position sensors, 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 bit automatically resets. The causes that reset the bit are:

Bit	Encoder	Cause
0	Feedback encoder	See*Table 14.2*
3	Selected auxiliary encoder	, turn off, HardReset and SoftReset by SystemManager command (see *SysMngCommand*)

Bit	Encoder	Cause
4	Real auxiliary encoder	, turn off, HardReset and SoftReset by SystemManager command (see *SysMngCommand*)
5	Virtual auxiliary encoder	, turn off, HardReset and SoftReset by SystemManager command (see *SysMngCommand*)

PositionActualValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4156	0x6064.00	-	-	S32	inc	RO	*YES*	-

Actual position. For further details on its behaviour, see *Section 14.4, Feedback position sensor mode: incremental/absolute*.

FollowingErrorWindow

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4160	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* remains over this threshold longer than *FollowingErrorTimeOut*, the system signals the Fault of following error, if enabled. The default value is equal to 64 motor revolutions.

FollowingErrorWindowWarn

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4162	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* remains above this threshold longer than *FollowingErrorTimeOut*, the system signals the Warning of following error. The default value is equal to 64 motor revolutions.

PositionFollowingError

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4164	0x60F4.00	-	-	S32	inc	RO	*YES*	-

Current value of the error of position following.

FollowingErrorTimeOut

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4166	0x6066.00	-	0	U16	ms	RW	*YES*	ES

Maximum time period during which the absolute value of *PositionFollowingError* can get over the error windows (*FollowingErrorWindow* and *FollowingErrorWindowWarn*) before respectively a fault or a Warning is notified. Setting used only in the position modes.

PositionWindow

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4170	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* reached the window and remains inside it for a time period equal to at least *PositionWindowTime*, the bit *Target reached* of the *Statusword* 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*.

PositionWindowTime

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4172	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4203	0x606C.00	-	-	S32	inc/s	RO	*YES*	-

Actual drive velocity, filtered by the Sensor filter (see *Figure 26.1*.

VelocityWindow

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4205	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* reached the window and remains inside it for a time period equal to at least *VelocityWindowTime*, the bit *Target reached* of the *Statusword* 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*.

VelocityThreshold

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4206	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* is decreased with a lower value than the threshold and it stays in this for a time period at least equal to *VelocityThresholdTime*, the bit *Speed* of the *Statusword* 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*.

VelocityWindowTime

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4208	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4209	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4250	0x6071.00	-	0	S16	10 = 1%IS	RW	*YES*	-

Target torque the motor has to reach in *Torque Mode* or in *Cyclic Synchronous Torque Mode*.

MaxTorque

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4251	0x6072.00	0 ÷ 32767	1000	U16	10 = 1%IS	RW	*YES*	ES

Symmetrical limit of the torque reference [1000 = Rated current] set by the user. This value is taken as reference in case the *TorqueLimitSelector* parameter is set to 1.

ActualTorqueLimitP

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4252	0x420F.00	-	-	U16	10 = 1%IS	RO	*YES*	-

Actual torque positive limit [1000 = Rated current].

ActualTorque

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4253	0x6077.00	-	-	S16	10 = 1%IS	RO	*YES*	-

Applied torque value.

TorqueFilterFrequency

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4254	0x3321.01	-	80	U16	Hz	RW	-	ES

Typical filter frequency to obtain the *ActualFilteredTorque* parameter.

ActualFilteredTorque

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4255	0x4210.00	-	-	S16	10 = 1%IS	RO	*YES*	-

Filtered value of *ActualTorque*. The filter is a *Low-pass filter of the first order* with typical frequency equal to *TorqueFilterFrequency*.

RequestedTorque

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4256	0x6074.00	-	-	S16	10 = 1%IS	RO	*YES*	-

Value of the torque that's required to the motor.

ActualTorqueLimitN

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4257	0x4211.00	-	-	U16	10 = 1%IS	RO	*YES*	-

Actual torque negative limit [1000 = Rated current].

PositiveTorqueLimitValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4258	0x60E0.00	-	-	U16	10 = 1%IS	RW	*YES*	ES

Torque reference positive limit [1000 = Rated current].

NegativeTorqueLimitValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4259	0x60E1.00	-	-	U16	10 = 1%IS	RW	*YES*	ES

Torque reference negative limit [1000 = Rated current].

TorqueLimitSelector

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4270	0x4202.00	-	0	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*)
1	Max/Positive/Negative
2	Torque limit enabled through analog input (see *Section 16.3, Conversion*)

TorqueSlope

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4280	0x6087.00	0xFFFFFFFF	0xFFFFFFFF	U32	-	RW	*YES*	-

Torque increment per second in the torque profile ramps. This parameter is not used.

TorqueProfileType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4282	0x6088.00	-1	-1	S16	-	RO	*YES*	-

Torque profile type: -1=Torque step.

PositioningOptionCode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4300	0x60F2.00	Desc	0	U16	-	RW	*YES*	ES

Necessary options to define the behaviour of the position operating modes. Only the bits related to the behaviour of the *Profile Position Mode* have been currently implemented:

- ***Relative option*** **(bit 0 - 1)**
  Group of bits used to check the positioning behaviour when it is of relative type (the bit *Absolute / Relative* of the *Controlword* 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*.
- ***Change immediately option*** **(bit 2 - 3)**
  Group of bits used to check the positioning behaviour when the bit *Change set immediately* of the *Controlword* 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 21.9, Profile Position Mode*.

ProfilePositionStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4319	0x42A0.00	0 - 6	-	U16	-	RO	*YES*	-

Status of the position trajectory generator.

ProfilePositionStatus	Description
0	The trajectory generator is disabled: *ModesOfOperationDisplay* 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* 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*.
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*.
4	The position profile is in the *Cruise phase*. This phase is carried out at a constant speed equal to *ProfileVelocity*.
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*.
6	The position profile is in the *Phase of profile end*. This phase is carried out at a constant speed equal to *EndVelocity* before stopping the positioning. When this phase is over the trajectory generator enters the status 1, *Stationary phase*.

TargetPosition

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4320	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* or in *Cyclic Synchronous Position Mode*. In *Cyclic Synchronous Position Mode* the value is always read as absolute; in *Profile Position Mode* the value is read as absolute or relative depending on the *Absolute / Relative* bit of the *Controlword*. If the positioning is of absolute type the TargetPosition is understood as a position related to the *Zero position*, viceversa if the positioning is of relative type the TargetPosition is understood as shown in the bits @relative_opt_bit; of the *PositioningOptionCode* parameter.

Note

If in *Profile Position Mode*, in the parametrisation of a positioning, the TargetPosition value even includ the space to be travelled with speed equal to *EndVelocity* at the end of the profile, that is *EndIncrements*. However if this last value is higher than TargetPosition the motion is carried out with speed equal to *EndVelocity* and the content of the parameter *EndIncrements* is ignored.

EndIncrements

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4322	0x4284.01	-	0	U32	inc	RW	*YES*	ES

Space to cover with speed equal to *EndVelocity* at the end of the deceleration ramp of a position profile. If the value of *EndVelocity* is 0 the value of EndIncrements is ignored and the positioning ends after the deceleration ramp.

HomeOffset

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4324	0x607C.00	-	0	S32	inc	RW	*YES*	ES

Difference between *Zero position* and *Home position*. Please see *Section 21.20, Homing Mode*.

Note

In case the feedback position sensor management mode is absolute (*FeedbackSensorAbsMode* = 1), then *HomeOffset* must be included between 0 and the functioning range with inverted sign. About the range see *Table 14.1*. For example if *EncoderIncrements* value is 1000 inc, in a drive that has a single turn absolute encoder, *HomeOffset* must be between 0 and -(1*1000).

PositionLimitEnable

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4326	0x4280.01	0 - 1	0	U16	-	RW	-	ES

Parameter used to enable/disable the software position limits. See *Section 18.6, Limits of software position*.

SoftwarePositionLimit

Software position limits, for details see *Section 18.6, Limits of software position*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x607D.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

PositionLimitNegative

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4327	0x607D.01	-	-2147483648	S32	inc	RW	*YES*	ES

Negative software position limit.

PositionLimitPositive

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4329	0x607D.02	-	2147483647	S32	inc	RW	*YES*	ES

Positive software position limit.

MaxProfileVelocity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4331	0x607F.00	Desc	Desc	U32	inc/s	RW	*YES*	ES

Maximum speed of the trajectory generators. Its default value is 100% of *MotorRatedSpeed* while the maximum settable value is 3216.9 rad/s.

MaxMotorSpeed

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4333	0x6080.00	-	Desc	U32	Desc	RW	*YES*	ES

Motor velocity limit value. The default value is equal to the 120% of *MotorRatedSpeed*. The unit of measurement depends on the motor type: rotary motor [rpm], linear motor [mm/s].

ProfileVelocity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4335	0x6081.00	Desc	Desc	U32	inc/s	RW	*YES*	ES

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* or *EndVelocity*, its value is internally set with the higher between the two. The default value and the adjustable maximum value are respectively 3.0 rad/s and 3216.9 rad/s. It cannot be set with a zero value.

EndVelocity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4337	0x6082.00	Desc	0	U32	inc/s	RW	*YES*	ES

Speed which the motor has to reach at the end of the profile deceleration ramp. The maximum settable value is 3216.9 rad/s.

ProfileAcceceleration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4339	0x6083.00	Desc	Desc	U32	inc/s	RW	*YES*	ES

Value of the profile acceleration ramp. The default value is 125.0 rad/s^2 while the range of accepted values goes from 0.32 to 205887.3 rad/s^2.

ProfileDeceleration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4341	0x6084.00	Desc	Desc	U32	inc/s^2	RW	*YES*	ES

Profile deceleration ramp value. The default value is 125.0 rad/s^2 while the range of the accepted values goes from 0.32 to 205887.3 rad/s^2.

QuickStopDeceleration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4343	0x6085.00	Desc	Desc	U32	inc/s^2	RW	*YES*	ES

Quick stop ramp deceleration value. This deceleration is used in the following cases:

- the drive is in the status *Operation enable* with parameter *QuickStopConfiguration* 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).

The default value is equal to the parameter *MaxDeceleration* while the range of admitted value goes from 0.32 to 205887.3 rad/s^2.

MotionProfileType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4345	0x6086.00	0	0	S16	-	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4347	0x4244.00	Desc	0	U32	inc/s	RW	*YES*	ES

Motor speed at the beginning of the profile. The maximum settable value is 3216.9 rad/s.

HomingMethod

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4500	0x6098.00	Desc	35	S8	-	RW	*YES*	ES

Method used to start the homing procedure. Fur further details please see *Section 21.20, Homing Mode*.

Caution

If the *Polarity* is of Reverse type, then 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 +)*. This is true both in the text of this manual and in the DuetHVSuite.

Caution

If a *HomingMethod* (see also *Table 21.8*) with mechanical stop is selected (e.g. mode -1), remember to set the torque limit (see *Section 18.3, Torque limit*).

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
-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

Value	Procedure description
-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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4501	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 the *Homing Mode*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x6099.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

SpeedForSwitch

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4504	0x6099.01	Desc	Desc	U32	inc/s	RW	*YES*	ES

Speed used during the search phase of the *Home* switch or of the limit switch (depending on the chosen method), in the homing procedure. The default value and the maximum settable value are respectively 1.5 rad/s and 3216.9 rad/s. It cannot be set with a zero value.

SpeedForZero

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4506	0x6099.02	Desc	Desc	U32	inc/s	RW	*YES*	ES

Speed used during the search phase of the *Home position*. The default value and the maximum settable value are respectively 0.4 rad/s and 3216.9 rad/s. It cannot be set with a zero value.

HomingAcceleration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4510	0x609A.00	Desc	Desc	U32	inc/s^2	RW	*YES*	ES

Value of the accelerations and decelerations used during the homing procedures. The default value is 15.0 rad/s^2 while the range of the accepted values goes from 0.32 to 205887.3 rad/s^2.

HomingPosDisengagement

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4512	0x4285.03	Desc.	Desc.	U32	inc	RW	-	ES

Minimum disengagement space used in the mechanical stop *HomingMethod* without the *Index* pulse searching, described on *Table 21.8* (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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4514	0x4285.04	Desc.	Desc.	U16	inc	RW	-	ES

Range of *PositionActualValue* (0=from 0 to sensor range, 1=from -1/2 range to +1/2 range). This parameter is valid only in absolute mode(*FeedbackSensorAbsMode* = 1) and if the homing has been executed (*HomingStatus* = 1). The maximum value of the feedback sensor range is reported in the *Table 14.1*. In other words, HomingAbsRangeMode defines if the homing has to be executed with “zero at centre” or “zero at side”.

HomingStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4530	0x42A1.00	-	-	S16	-	RO	*YES*	-

Homing mode status (see details in the *Table 26.12* and in the *Section 21.20, Homing Mode*).

> **Note**
>
> The HomingStatus parameter modifies according to what's reported in the *Table 14.2*.

Value	Description
-2	Homing running.

Value	Description
-1	The drive is saving the data in the permanent memory.
0	The homing has been disabled and/or interrupted (aborted) by another command (e.g. bit *Halt*, reset bit *Homing operation start*, ..., see *Table 8.8*).
1	Homing correctly executed.
17	Error: It has not been found the *Home* switch between 2 limit switch (it concerns the *HomingMethod* with limit switches management, see also *Table 21.8*) and the axis is moving.
18	Error: it has been reached a limit switch before the *Home* switch has been found (it regards the *HomingMethod* without limit switch management, see also *Table 21.8*) and the axis is on moving.
20	Error: The *Index* pulse has already been programmed as position capture trigger in the **Capture B** peripheral and the axis is on moving (see <x2/>).
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 18.3, “Torque limit”*).
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.

Table 26.12. Accepted values for the HomingStatus parameter.

CyclicSynchronousSubMode

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4540	0x42D0.00	Desc	-136	S16	-	RW	*YES*	-

This parameter is used only to change the interpolation type that the drive has to execute when one of the synchronous cyclic modes is active (see *Section 21.12, Cyclic Synchronous Position Mode*, *Section 21.13, Cyclic Synchronous Velocity Mode*, *Section 21.14, Cyclic Synchronous Torque Mode*).

The new sub-mode is applied when the operative mode is changed by writing the value of the new operative mode in the *ModesOfOperation*. Otherwise the previous sub-mode remains active.

This parameter is applied even if an operative mode change doesn't happen, in case the drive executes a transition to switch the state machine *CiA-402* to the *Operation enable* status: in particular, it is referred to the transitions 4 and 16 (see *Table 8.7*).

ModesOfOperationDisplay	**CyclicSynchronousSubMode**	**Interpolation type**	**Auto *KVff*[a]**	**Auto *KAff*[b]**
8	-136	none	0	0

ModesOfOperationDisplay	CyclicSynchronousSubMode	Interpolation type	Auto *KVff*[a]	Auto *KAff*[b]
	-135		0	1
	-132		1	0
	-131		1	1
	-144	linear	0	0
	-143		0	1
	-140		1	0
	-139		1	1
	-148	cubic	1	0
	-147		1	1
9	-136, -132	none	-	0
	-135, -131		-	1
	-144, -140	linear	-	0
	-143, -139		-	1
10	-136, -135, -132, -131	none	-	-
	-144, -143, -140, -139	linear	-	-

[a]0 = the feed forward velocity is calculated according to the *VelocityOffset* parameter; 1 = the feed forward velocity calculation is automatically executed internally of the drive; - = not applicable.

[b]0 = the feed forward acceleration is calculated according to the *TorqueOffset* parameter; 1 = the feed forward acceleration calculation is automatically executed internally of the drive; - = not applicable.

Table 26.13. Available interpolation modes.

Sub-modes application example

- the drive is turned-on and the *ModesOfOperation* and *CyclicSynchronousSubMode* cells values are the defaults, respectively 3 and -136;
- write -139 in the parameter (the new sub-mode is selected but not applied);
- write 8 (CSP) in the parameter (the new sub-mode is applied for the CSP mode);
- write -136 in the parameter (the new sub-mode is selected but not applied);
- write 9 (CSV) in the parameter (the new sub-mode is applied for the CSV mode);
- write 8 (CSP) in the parameter (the new sub-mode is applied for the CSP mode);

PositionOffset

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4541	0x60B0.00	-	0	S32	inc	RW	*YES*	-

Position offset that will be added to the *TargetPosition* if the *Cyclic Synchronous Position Mode* is active (see *Section 21.12, Cyclic Synchronous Position Mode*).

VelocityOffset

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4543	0x60B1.00	Desc	0	S32	inc/s	RW	*YES*	-

Velocity offset that will be added to the *TargetVelocity* if the *Cyclic Synchronous Velocity Mode* is active (see *Section 21.13, Cyclic Synchronous Velocity Mode*). 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*). The range of accepted values goes from -3216.9 to 3216.9 rad/s.

TorqueOffset

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4545	0x60B2.00	-	0	S16	10 = 1%IS	RW	*YES*	-

Torque offset that will be added to the *TargetTorque* if the *Cyclic Synchronous Torque Mode* is active (see *Section 21.14, Cyclic Synchronous Torque Mode*). Instead, in case of *Cyclic Synchronous Position Mode* or *Cyclic Synchronous Velocity Mode* it can be used as acceleration feed forward (vedere *CyclicSynchronousSubMode*).

IpPosSubModeSelect

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4550	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 21.10, Interpolated Position Mode*).

IpPosSub-ModeSelect	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* * $10^{IpTimeIndex}$[s]. This parameter can be used alternatively to the *CommunicCyclePeriod* (ETC) parameter. If these parameters are used at the same time, they must express the same value.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x60C2.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

The validation is done as follows:

- With EtherCAT drives, in *Soft sync* mode : If *IpTimePeriod* or *CommunicCyclePeriod* have been implemented with an out of range or not equal value, a configuration error is reported. If *IpTimePeriod* is right and *CommunicCyclePeriod* is set to 0, then

CommunicCyclePeriod takes the value of *IpTimePeriod*. If *IpTimePeriod* has not been set (default) and *CommunicCyclePeriod* has a correct value, *CommunicCyclePeriod* is copied in *IpTimePeriod*. If both the values are within the limits and equals each other, the *CommunicCyclePeriod* parameter value is taken as cycle time.

- With EtherCAT drives in *Hard sync* mode : the *CommunicCyclePeriod* parameter is ignored, in its place the value that's written in the 0x09A0 address, in the *ET1100* registers area, is inserted. If *IpTimePeriod* or *ET1100* are set with an out of range or not equal value, a configuration error is reported. If *IpTimePeriod* has not been set and *ET1100* has a correct value, *ET1100* is copied in *IpTimePeriod*. If both the values are within the limits and equals each other, the *ET1100* value is taken as cycle time.

> **Important**
>
> For the ETC version drives, the paraemters of the *IpTimePeriod* group are writable only if the drive has not the *EtherCAT state machine* in SAFE-OPERATIONAL or OPERATIONAL state.

IpTimePeriodValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4551	0x60C2.01	0-255	1	U8	s	RW	-	-

First multiplication factor to calculate *IpTimePeriod*.

IpTimePeriodIndex

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4552	0x60C2.02	-6 ÷ -2	-3	S8	-	RW	-	-

Exponent (base 10) for the calculation of *IpTimePeriod*.

IpPosDataRecord

Group of parameters tat defines the set-point in the *Interpolated Position Mode*. It consists of *IpPosFirstParameter* and *IpPosSecondParameter*.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x60C1.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

IpPosFirstParameter

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4560	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4562	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x60C4.00	6	6	U8	-	CST	-	-

Number of parameters in this group.

IpPosDataConfigMaxBufferSize

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4592	0x60C4.01	1	1	U32	-	RW	-	-

IpPosDataRecord configuration: maximum number of buffer points.

IpPosDataConfigActualBufferSize

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4594	0x60C4.02	1	1	U32	-	RW	-	-

IpPosDataRecord configuration: actual number of buffer points.

IpPosDataConfigBufferOrganization

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4596	0x60C4.03	0	0	U8	-	RW	-	-

IpPosDataRecord configuration: it specifies the buffer organization (FIFO type buffer).

IpPosDataConfigBufferPosition

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4597	0x60C4.04	0	0	U16	-	RW	-	-

IpPosDataRecord configuration: index of *IpPosDataRecord* used for the interpolation (index of the first available point).

IpPosDataConfigSizeDataRecord

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4598	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* parameter; if *IpPosSubModeSelect*=0 then *IpPosDataConfigSizeDataRecord*=4, else *IpPosDataConfigSizeDataRecord*=8

IpPosDataConfigBufferClear

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4599	0x60C4.06	1	1	U8	-	RW	-	-

IpPosDataRecord configuration: it specifies that the *IpPosDataRecord* is enabled (it can't be disabled).

MaxAcceleration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4600	0x60C5.00	Desc	Desc	U32	inc/s^2	RW	*YES*	ES

Maximum deceleration used to run a profile. The default value is 205887.3 rad/s^2 while the range of the accepted values goes from 0.32 to 205887.3 rad/s^2.

MaxDeceleration

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4602	0x60C6.00	Desc	Desc	U32	inc/s^2	RW	*YES*	ES

Maximum deceleration used to run a profile. The default value is 205887.3 rad/s^2 while the range of the accepted values goes from 0.32 to 205887.3 rad/s^2.

TargetVelocity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4700	0x60FF.00	Desc	0	S32	inc/s	RW	*YES*	-

Target velocity the motor has to reach in *Profile Velocity Mode (CiA402)*, in *Profile Velocity Mode (CUSTOM)* or in *Cyclic Synchronous Velocity Mode*. If the drive is programmed with the *Profile Velocity Mode (CiA402)* or the *Profile Velocity Mode (CUSTOM)* and its status is *Operation enable*, the writing of a velocity that has an absolute value greater than *EndVelocity* and *StartVelocity* starts the movement, while the writing of a velocity that has an absolute value lower or equal stops the movement. The sign of the speed written in this parameter defines the motion direction. The range of accepted values goes from -3216.9 to 3216.9 rad/s.

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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4288.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

GearMasterTriggerDirection

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4710	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 is indicated in *Table 26.14*.

Value	Description
0	The adjusted ramp is launched when the position of the master axis (*AuxiliaryEncoderPosition*) is increasing and becames greater or equal to the trigger position (*GearMasterTriggerPosition*).
1	The adjusted ramp is launched when the position of the master axis (*AuxiliaryEncoderPosition*) is decreasing and becames less or equal to the trigger position (*GearMasterTriggerPosition*).

Table 26.14. Admitted values for the *GearMasterTriggerDirection* parameter.

GearSlaveTriggerPosition

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4716	0x4288.04	-	0	S32	inc	RO	*YES*	-

Reading of the axis slave (drive axis) position when the master axis position (*AuxiliaryEncoderPosition*) is equal to the trigger position (*GearMasterTriggerPosition*). This value is internally calculated when the adjustment ramp is started for a new following ratio.

GearMasterTriggerPosition

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4720	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4722	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*.

GearStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4719	0x42A2.00	0 - 4	0	S16	-	RO	*YES*	-

Gear Mode status. The states that may takes the *Gear Mode* are described in *Table 21.4*.

StartGearRatio

This parameters pair is the numerator and the denominator of the fraction that represents the following ratio that's 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. More precisely:

StartGearRatio = StartGearRatioNumerator / StartGearRatioDivisor

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x428A.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

StartGearRatioNumerator

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4728	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 *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*.

StartGearRatioDivisor

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4730	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 *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*.

> **Important**
>
> The admitted range is between -32768 and 32767 where only the value 0 is excluded.

TargetGearRatio

This parameters pair is the numerator and the denominator of the fraction that represents the following ratio that the slave axis must reach at the end of the adjustment ramp. More precisely:

TargetGearRatio = TargetGearRatioNumerator / TargetGearRatioDivisor

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4289.00	2	2	U8	-	CST	-	-

Number of parameters in this group.

TargetGearRatioNumerator

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4724	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*.

TargetGearRatioDivisor

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4726	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*.

> **Important**
>
> The admitted range is between -32768 and 32767 where only the value 0 is excluded.

SupportedDriveModes

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
4800	0x6502.00	0x3ED	0x3ED	U32	-	RO	-	ES

Seupported *CiA-402* standard operative 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*).

26.18. Brake (5000-5199)

Brake

Group of parameter to manage the brake.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x36D0.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

BrakeReleaseTime

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
5000	0x36D0.01	-	Desc	U16	ms	RW	-	EM

Brake release delay time.

BrakeCloseTime

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
5001	0x36D0.02	-	Desc	U16	ms	RW	-	EM

Brake response time.

BrakeStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
5002	0x36D0.03	-	Desc	U16	-	RW	-	-

Brake status. This parameter is writable only when the motor is disabled.. The values that it can assume are: 0=Brake close (the brake is closed and ther motor is braked), 1=Brake release (the brake is released and ther motor is not braked).

BrakePresence

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
5003	0x36D0.04	-	Desc	U16	-	RW	-	-

Type of brake installed on the motor [0=brake not present - 1=brake present]

> **Note**
>
> This parameter is available from the firmware 32.

26.19. Auxiliary position sensor (6500-6549)

RealEncParam

Group of parameters for the real auxiliary sensor functionalities configuration.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x36C9.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

RealEncoderPosition

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6500	0x36C9.01	-	0	S32	cnt	RW	*YES*	-

Position reached by the real auxiliary position sensor. Through a writing operation it's possible to modify this value.

RealEncoderVelocity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6502	0x36C9.03	-	0	S32	cnt/s	RO	*YES*	-

Velocity reached by the real auxiliary position sensor.

RealEncoderPolarity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6504	0x36C9.02	-	0	U16	-	RW	-	ES

Polarity of the real auxiliary position sensor: Rotation direction where the position value increases and that determines the value increment of *RealEncoderPosition*: 0=Forward, 1=Reverse.

VirtualEncParam

Group of parameters for the virtual auxiliary position sensor functionalities configuration.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x36C8.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

VirtualEncoderPosition

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6510	0x36C8.01	-	0	S32	cnt	RW	*YES*	-

Position reached by the virtual auxiliary position sensor.

VirtualEncoderVelocity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6512	0x36C8.03	-	0	S32	cnt/s	RW	*YES*	-

Velocity of virtual auxiliary position sensor increment.

VirtualEncoderRunStop

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6514	0x36C8.02	0-1	0	U8	-	RW	-	-

Run/stop command of the virtual auxiliary position sensor (0=stop, 1=run).

AuxiliaryEncParam

Group of parameters for the selected auxiliary position sensor functionalities configuration.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x36CA.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

AuxiliaryEncoderPosition

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6520	0x36CA.01	-	-	S32	cnt	RO	*YES*	-

Position reached by the selected auxiliary position sensor.

AuxiliaryEncoderVelocity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6522	0x36CA.03	-	-	S32	cnt/s	RO	*YES*	-

Velocity reached by the selected auxiliary position sensor.

AuxiliaryEncoderSelector

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6524	0x36CA.02	0-1	0	U16	-	RW	-	-

Auxiliary sensor selection command: 0=real encoder, 1=virtual encoder.

26.20. Digital inputs and outputs (6550-6999)

DigitalInputFunctStatus

Status of digital inputs if programmed as FC, Home, Enable.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4054.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

FcStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6558	0x4054.01	-	-	U16	-	RO	-	-

Positive and negative HW limits status. If the HW limit is engaged the status is 1, if it is not the status is 0. The HW limits status is the opposite (see *Positive limit switch (FC +)* and *Negative limit switch (FC -)*)

Caution

If the *Polarity* is of Reverse type, then 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 +)*. This is true both in the text of this manual and in the DuetHVSuite.

FcStatus	Description
Bit 0	*Positive limit switch (FC +)* status;
Bit 1	*Negative limit switch (FC -)* status;

HomeStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6559	0x4054.02	-	-	U16	-	RO	-	-

Status of the programmes input with the function of *Home*

EnableInputStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6560	0x4054.03	-	-	U16	-	RO	-	-

Status of the programmed input with the function of *Enable*. If no input is associated to the *Enable* function, EnableInputStatus is always equal to 1.

DisableOption

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6561	0x406E.00	-	2	S16	-	RW	-	ES

Disabling options through the digital input configured as *Enable*.

DisableOption	Description
-1	The motor is stopped with maximum deceleration by resetting to zero *RequestedSpeed*
2	The motor is stopped with deceleration equal to*QuickStopDeceleration*

DisableOkOutput

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6570	0x406F.00	-	1041	U32	-	RW	-	ES

Mask used to select the Faults disabling the digital output *Drive Ok (Drv OK)*: 0 = the Fault, even if present, does not disable the output; 1 = the Fault disables the output. The relation between the mask bits and the Faults is shown in *Table 23.1*.

PwmHwParam

Group of parameters for the PWM output configuration.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x403F.00	6	6	U8	-	CST	-	-

Number of parameters in this group.

PwmHwFrequencyIO0

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6580	0x403F.01	1-50000	1000	U16	Hz	RW	-	-

Frequency of the signal generated by the I/O 0 when programmed as output pwm.

PwmHwDutyCycleIO0

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6581	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6582	0x403F.03	1-50000	1000	U16	Hz	RW	-	-

Frequency of the signal generated by the I/O 0 when programmed as output pwm.

PwmHwDutyCycleIO1

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6583	0x403F.04	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.

PwmHwFrequencyIO2

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6584	0x403F.05	1-50000	1000	U16	Hz	RW	-	-

Frequency of the signal generated by the I/O 0 when programmed as output pwm.

PwmHwDutyCycleIO2

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6585	0x403F.06	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.

LogicalDigitalInputStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6600	0x4051.01	-	-	U32	-	RO	*YES*	-

Logical status of the digital inputs, after having applied *PolarityInputValue*.

Bit	DuetHV resource, except for flange 60	DuetHV flange 60 resource
0-15	Reserved	Reserved
16	IN/OUT 0	IN/OUT 0

Bit	DuetHV resource, except for flange 60	DuetHV flange 60 resource
17	IN/OUT 1	IN 1
18	IN/OUT 2	IN 2
19	IN/OUT 3	IN 3
20	IN 4	/STO
21	IN 5	
22	IN 6	-
23	IN 7	-
24	IN 8	-
25	IN 9	-
26	/STO	-
27-31	Reserved	Reserved

Table 26.15. Relation between the bits of the *LogicalDigitalInputStatus* parameter and the I/Os of the drive.

DigitalInputs

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6602	0x60FD.00	-	-	U32	-	RO	*YES*	-

Physical status of the digital inputs, for the description of the single bits see *Table 26.15*.

PhysicalOutputs

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6604	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	DuetHV resource, except for flange 60	DuetHV flange 60 resource
0-15	Reserved	Reserved
16	IN/OUT 0	IN/OUT 0
17	IN/OUT 1	OUT 1
18	IN/OUT 2	OUT 2
19	IN/OUT 3	-
20	OUT 4	-
21	OUT 5	-
22	OUT 6	-
23-31	Reserved	Reserved

Table 26.16. Association of the bits of the parameter *PhysicalOutputs* of the I/O of DuetHV.

DigitalOutputsBitMask

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6606	0x60FE.02	-	0XFFFFFFFF	U32	-	RW	*YES*	-

Enabling mask of the writing of the parameter *PhysicalOutputs* : 1=writing enabled, 0=writing not enabled. For the description of the each bit see *Table 26.15*

DebounceTime

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6608	0x405F.00	250-65000	250	U16	µs	RW	-	ES

Filtering time of the digital inputs. See *Filtering of the digital inputs*

EnableDebounce

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6609	0x405E.00	-	0	U16	-	RW	-	ES

Enabling mask of the filtering on the selected inputs. See *Filtering of the digital inputs*

PolarityInputValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6610	0x405A.00	-	0	U16	-	RW	*YES*	ES

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	DuetHV resource, except for flange 60	DuetHV flange 60 resource
0	IN/OUT 0	IN/OUT 0
1	IN/OUT 1	IN 1
2	IN/OUT 2	IN 2
3	IN/OUT 3	IN 3
4	IN 4	-
5	IN 5	-
6	IN 6	-
7	IN 7	-
8	IN 8	-
9	IN 9	-
10-15	Reserved	Reserved

Table 26.17. Association of the bits of the parameter *PolarityInputValue* of the I/O of DuetHV.

TerminationResistance

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6611	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/OUT 0
1	IN/OUT 1
2	IN/OUT 2
3-15	Reserved

Table 26.18. Association of the bits of the parameter *TerminationResistance* to the I/Os of DuetHV (except for DuetHV flange 60).

IO_0_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6700	0x4070.01	-	1	U16	-	RW	-	ES

Functionality given to the I/O 0.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the functionalities which can be given to the single resources.

Functionalities	Code
Generic Input (I/O X - In X)	1
Generic 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 (Ch A)	14
Quadrature Input ChB (Ch B)	15
Index Input (Idx)	16
Pwm out (Pwm O)	17
Motor Fan (M. Fan)	19
Drive Fan (D. Fan)	20
Drive Ok (Drv OK)	22
Simulated 24V Out (S24V)	23
Simulated GND (SGND)	24

Table 26.19. Codes related to the functionalities which can be given to the I/O resources

Warning

Simulated GND (SGND) input is not protected against overcurrent.

IO_1_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6701	0x4071.01	-	1	U16	-	RW	-	ES

Functionality assigned to I/O 1.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

IO_2_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6702	0x4072.01	-	1	U16	-	RW	-	ES

Functionality assigned to I/O 2.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

IO_3_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6703	0x4073.01	-	1	U16	-	RW	-	ES

Functionality assigned to I/O 3.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

In_1_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6721	0x4081.01	-	1	U16	-	RW	-	ES

Functionality assigned to In 1.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

In_2_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6722	0x4082.01	-	1	U16	-	RW	-	ES

Functionality assigned to In 2.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

In_3_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6723	0x4083.01	-	1	U16	-	RW	-	ES

Functionality assigned to In 3.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

In_4_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6724	0x4084.01	-	1	U16	-	RW	-	ES

Functionality assigned to In 4.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

In_5_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6725	0x4085.01	-	1	U16	-	RW	-	ES

Functionality assigned to In 5.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

In_6_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6726	0x4086.01	-	1	U16	-	RW	-	ES

Functionality assigned to In 6.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

In_7_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6727	0x4087.01	-	1	U16	-	RW	-	ES

Functionality assigned to In 7.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

In_8_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6728	0x4088.01	-	1	U16	-	RW	-	ES

Functionality assigned to In 8.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

In_9_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6729	0x4089.01	-	1	U16	-	RW	-	ES

Functionality assigned to In 9.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

Out_1_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6786	0x40C1.01	-	2	U16	-	RW	-	ES

Functionality assigned to Out 1.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

Out_2_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6787	0x40C2.01	-	2	U16	-	RW	-	ES

Functionality assigned to Out 2.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

Out_4_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6789	0x40C4.01	-	2	U16	-	RW	-	ES

Functionality assigned to Out 4.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

Out_5_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6790	0x40C5.01	-	2	U16	-	RW	-	ES

Functionality assigned to Out 5.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

Out_6_Function

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
6791	0x40C6.01	-	2	U16	-	RW	-	ES

Functionality assigned to Out 6.
The codes of the functionalities are listed in *Table 26.19*. In the *Table 15.6* you can find the resources which can be given to the single functionalities.

26.21. Analog input (7000-7999)

AI0CalibrationParameters

Calibration of the analog input 0.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4100.00	-	4	U8	-	CST	-	-

Number of parameters in this group. For further details see *Section 16.2, Calibration*.

AI0CalibrationStatus

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7001	0x4100.01	-	4	U16	-	RO	-	ES

Status of the 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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7002	0x4100.02	-	Desc	S16	-	RO	-	ES

Calibration offset of the analog input 0. The default value is calculated with the calibration run by MPC.

AI0CalibrationGain

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7003	0x4100.03	-	Desc	U16	-	RO	-	ES

Calibration gain of the analog input 0.

AI0CalibrationVoltage

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7004	0x4100.04	4000-10000	-	U16	mV	RW	-	-

Calibration voltage of the analog input 0. The default value is calculated with the calibration run by MPC.

AI0FilterParameters

Filter of the analog input 0.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4110.00	-	3	U8	-	CST	-	-

Number of parameters in this group. For further details see *Chapter 27, Digital filters*.

AI0FilterFrequency

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7011	0x4110.01	-	100	U16	Hz	RW	-	ES

Typical frequency of the filter on the analog input 0.

AI0FilterType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7012	0x4110.02	-	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7013	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x4120.00	-	8	U8	-	CST	-	-

Number of parameters in this group. For further details see *Section 16.3, Conversion*.

AI0VSettings

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7051	0x4120.01	-	1	U16	-	RW	-	ES

Setting the voltage for the conversion with the analog input 0 (0 = only positive; 1 = symmetric).

AI0RSettings

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7052	0x4120.02	-	1	U16	-	RW	-	ES

Setting the reference for the conversion with the analog input 0 (0 = only positive; 1 = symmetric).

AI0VPolarity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7053	0x4120.03	-	0	U16	-	RW	-	ES

Voltage polarity for the conversion with the analog input 0 (0 = normal; 1 = reversed).

AI0RPolarity

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7054	0x4120.04	-	0	U16	-	RW	-	ES

Reference polarity for the conversion with the analog input 0 (0 = normal; 1 = reversed).

AI0V0Zone

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7055	0x4120.05	-	10	U16	mV	RW	-	ES

Half amplitude of the dead zone of the analog input.

AI0VRefLevel

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7056	0x4120.06	-	10000	U16	mV	RW	-	ES

Voltage value to define the conversion.

AI0TRefValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7057	0x4120.07	0 ÷ 32767	1200	U16	10 = 1%IS	RW	-	ES

Torque value to define the conversion.

AI0WRefValue

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
7058	0x4120.08	-	*MotorRatedSpeed*	U32	inc/s	RW	-	ES

Speed value to define the conversion.

26.22. Sync manager and PDOs managed by the port EtherCAT

Note

This vocabulary section can be found only in the drive versions ETC.

Parameters for the PDO RX 1 mapping.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1600.00	0 - 8		U8	-	RW	-	-

Number of mapped objects.

PdoRx1_Objects

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Modbus	CANopen	Name	Default
-	0x1600.01	PdoRx1_Object1	
-	0x1600.02	PdoRx1_Object2	
-	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

Modbus	CANopen	Name	Default
-	0x1600.08	PdoRx1_Object8	0

Parameters for the PDO RX 2 mapping.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1601.00	0 - 8		U8	-	RW	-	-

Number of mapped objects.

PdoRx2_Objects

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Modbus	CANopen	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	
-	0x1601.06	PdoRx2_Object6	
-	0x1601.07	PdoRx2_Object7	
-	0x1601.08	PdoRx2_Object8	

Parameters for the PDO RX 3 mapping.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1602.00	0 - 8	2	U8	-	RW	-	-

Number of mapped objects.

PdoRx3_Objects

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Modbus	CANopen	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

Parameters for the PDO RX 4 mapping.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1603.00	0 - 8		U8	-	RW	-	-

Number of mapped objects.

PdoRx4_Objects

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Modbus	CANopen	Name	Default
-	0x1603.01	PdoRx4_Object1	0x60400010 (*Controlword*)
-	0x1603.02	PdoRx4_Object2	
-	0x1603.03	PdoRx4_Object3	
-	0x1603.04	PdoRx4_Object4	
-	0x1603.05	PdoRx4_Object5	
-	0x1603.06	PdoRx4_Object6	
-	0x1603.07	PdoRx4_Object7	
-	0x1603.08	PdoRx4_Object8	0

Parameters for the PDO TX 1 mapping.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1A00.00	0 - 8		U8	-	RW	-	-

Number of mapped objects.

PdoTx1_Objects

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Modbus	CANopen	Name	Default
-	0x1A00.01	PdoTx1_Object1	
-	0x1A00.02	PdoTx1_Object2	
-	0x1A00.03	PdoTx1_Object3	
-	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

Parameters for the PDO TX 2 mapping.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1A01.00	0 - 8	6	U8	-	RW	-	-

Number of mapped objects.

PdoTx2_Objects

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Modbus	CANopen	Name	Default
-	0x1A01.01	PdoTx2_Object1	
-	0x1A01.02	PdoTx2_Object2	
-	0x1A01.03	PdoTx2_Object3	
-	0x1A01.04	PdoTx2_Object4	0x60770010 (*ActualTorque*)
-	0x1A01.05	PdoTx2_Object5	0x60610008

Modbus	CANopen	Name	Default
			(*ModesOfOperationDisplay*)
-	0x1A01.06	PdoTx2_Object6	
-	0x1A01.07	PdoTx2_Object7	0
-	0x1A01.08	PdoTx2_Object8	0

Parameters for the PDO TX 3 mapping.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1A02.00	0 - 8	2	U8	-	RW	-	-

Number of mapped objects.

PdoTx3_Objects

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Modbus	CANopen	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

Parameters for the PDO TX 4 mapping.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1A03.00	0 - 8		U8	-	RW	-	-

Number of mapped objects.

PdoTx4_Objects

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	Desc	U32	-	RW	-	-

Parameters used for mapping the mappable parameters in the PDOs.

Modbus	CANopen	Name	Default
-	0x1A03.01	PdoTx4_Object1	0x60410010 (*Statusword*)
-	0x1A03.02	PdoTx4_Object2	0x60640020 (*PositionActualValue*)
-	0x1A03.03	PdoTx4_Object3	
-	0x1A03.04	PdoTx4_Object4	
-	0x1A03.05	PdoTx4_Object5	
-	0x1A03.06	PdoTx4_Object6	
-	0x1A03.07	PdoTx4_Object7	
-	0x1A03.08	PdoTx4_Object8	

SM_CommunicationType

Communication type set in the Sync Manager.

Number of entries

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C00.00	4	4	U8	-	CST	-	-

Number of parameters in this group.

SM0_CommunicationType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C00.01	1	1	U8	-	RO	-	ES

Communication type of the Sync manager 0. In *Table 26.20* you can find the accepted values.

Value	Communication type of the Sync Manager
1	Mailbox RX
2	Mailbox TX
3	Process data RX
4	Process data TX

Table 26.20. Sync Manager Communication Type

SM1_CommunicationType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C00.02	2	2	U8	-	RO	-	ES

Communication type of the Sync manager 1. In *Table 26.20* you can find the accepted values.

SM2_CommunicationType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C00.03	3	3	U8	-	RO	-	ES

Communication type of the Sync manager 2. In *Table 26.20* you can find the accepted values.

SM3_CommunicationType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C00.04	4	4	U8	-	RO	-	ES

Communication type of the Sync manager 3. In *Table 26.20* you can find the accepted values.

SM0_PdoAssignment

Parameters for the assignment of the PDOs to the Sync Manager 0.

Number of entries

Modbus	CANopen	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	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.

Modbus	CANopen	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

Modbus	CANopen	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	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.

Modbus	CANopen	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C12.00	0-4		U8	-	RW	-	-

Number of PDOs given to the Sync Manager 2.

SM2_PdoMapping

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	Desc	U16	-	RW	-	-

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 CANopen (without subindex) of the *PDO RX Mapping parameters* that you want to assign.

Modbus	CANopen	Name	Default
-	0x1C12.01	SM2_PdoMapping0	0x1600 (*PdoRx1_MappingParameters*)

Modbus	CANopen	Name	Default
-	0x1C12.02	SM2_PdoMapping1	
-	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C13.00	0-4	1	U8	-	RW	-	-

Number of PDOs assigned to the Sync Manager 3.

SM3_PdoMapping

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
Desc	Desc	Desc	Desc	U16	-	RW	-	-

Parameters for the assignment of the PDOs to the Sync Manager 3, for this Sync Manager it is possible to assign only PDO TX. The assignment takes place by writing the index CANopen (without subindex) of the *PDO TX Mapping parameters* that you want to assign.

Modbus	CANopen	Name	Default
-	0x1C13.01	SM3_PdoMapping0	0x1A00 (*PdoTx1_MappingParameters*)
-	0x1C13.02	SM3_PdoMapping1	
-	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C30.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

SM0_SynchronizationType

Modbus	CANopen	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

Modbus	CANopen	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

Modbus	CANopen	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C31.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

SM1_SynchronizationType

Modbus	CANopen	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

Modbus	CANopen	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

Modbus	CANopen	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C32.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

SM2_SynchronizationType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
11200	0x1C32.01	0 - 2	1	U16	-	RW	-	-

Synchronization type of the messages managed by the Sync Manager 2. In *Table 26.21* you can find the meaning of the values.

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 Sync Signal 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.

Table 26.21. Sync Manager Synchronization Type

SM2_CycleTime

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
11201	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
11203	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
-	0x1C33.00	3	3	U8	-	CST	-	-

Number of parameters in this group.

SM3_SynchronizationType

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
11300	0x1C33.01	0; 2; 34	34	U16	-	RW	-	-

Synchronization type of the messages managed by the Sync Manager 3. In *Table 26.21* you can find the meaning of the values.

SM3_CycleTime

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
11301	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

Modbus	CANopen	Range	Default	Type	Units	Acc	PDO	Mem
11303	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.

Chapter 27
Digital filters

The drives of the DuetHV series 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.

> **Tip**
>
> 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 DuetHV drive series as a Butterworth low-pass digital filter of the first order with pre-warping compensation. Here follow 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°.

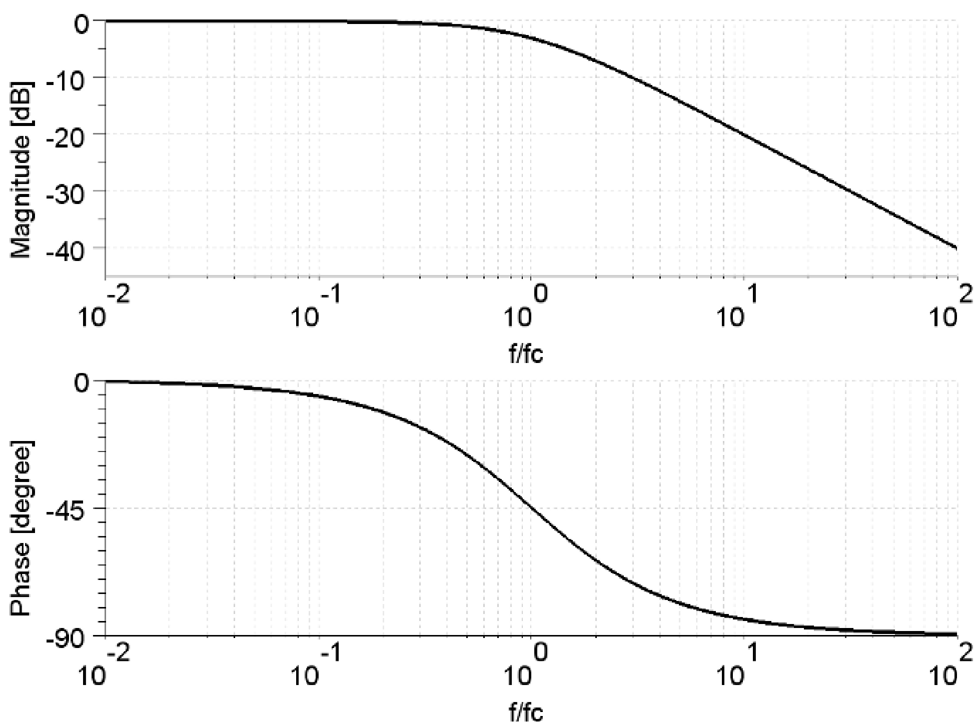


Figure 27.1. Bode diagrams of the transfer function of the low-pass filter of the first Butterworth order.

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 DuetHV drive series as a Butterworth low-pass digital filter of the second order with pre-warping compensation. Here follow 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°.

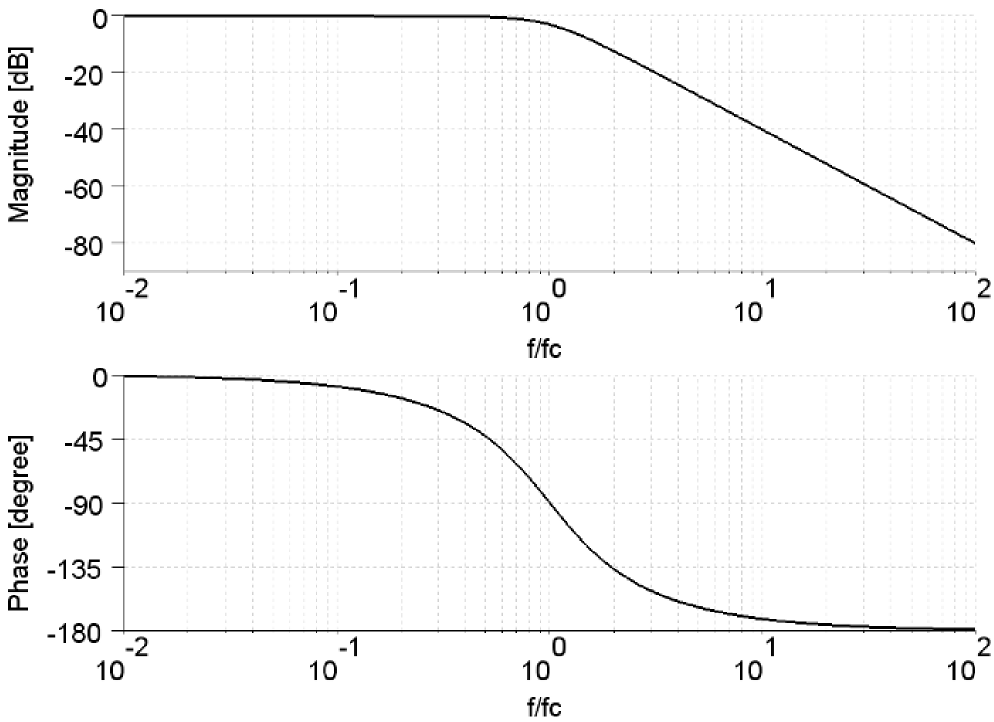


Figure 27.2. Bode diagrams of the transfer function of the low-pass filter of the second Butterworth order.

> **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.

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 DuetHV drive series as a Notch filter of the second order with pre-warping compensation. Here follow 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.

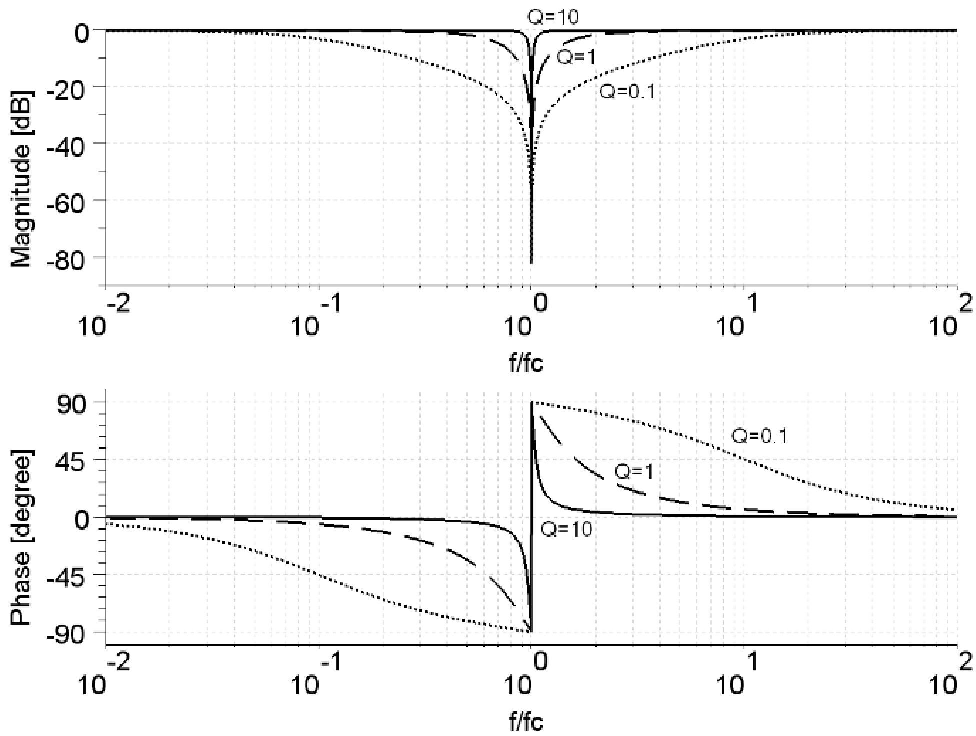


Figure 27.3. Bode diagrams of the transfer function of the Notch filter of the second order.

> **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.

Chapter 28

Order codes

The DuetHV series drives are available in different models with various functionalities. The *ManufacturerDeviceName*, that's composed by the order coded preceded by the product name, defines the drive model and defines its characteristics and functionalities.

28.1. OrderCode

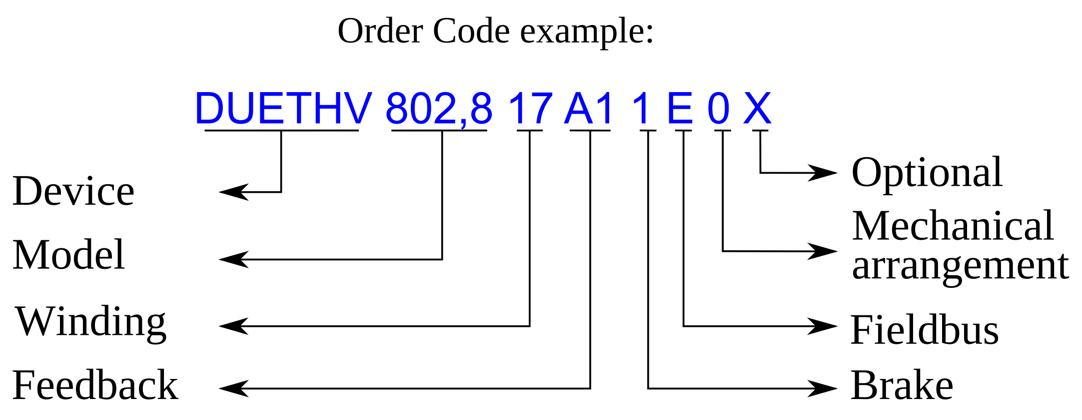


Figure 28.1. Position of the fields in the *ManufacturerDeviceName*.

ManufacturerDeviceName		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Field	**Description**	**X**	**XX XX**	**XX**	**XX**	**X**	**X**	**X**	**XXX**
Device	Device name	DuetHV							
Model	Flange 60 mm - 1,3Nm (8 poles)		60 1,3						
	Flange 80 mm - 2,8 Nm (8 poles)		80 2,8						
	Flange 80 mm - 4 Nm (8 poles)		80 4						
	Flange 100 mm - 5,6 Nm (8 poles)		100 5,6						
Flange 100 mm - 8 Nm (8 poles)		100 8							

ManufacturerDeviceName		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Field	**Description**	**X**	**XX XX**	**XX**	**XX**	**X**	**X**	**X**	**XXX**
Winding	Winding Coils (3000rpm@400Vdc)			15					
	Winding Coils (5000rpm@400Vdc)			17					
Feedback	Absolute Multiturn Encoder 12+12 Bits 128 Sin/Cos revolution				A1				
	Absolute Multiturn Encoder 9+12 Bits 16 Sin/Cos revolution				A3				
	Absolute Singleturn Encoder 9 Bits 16 Sin/Cos revolution				A5				
Brake	Without brake					0			
	With brake					1			
Fieldbus	EtherCAT						E		
Mechanical arrangement	Shaft with key / without oil seal (front flange side IP 42)							0	
	Shaft with key / with oil seal (front flange side IP 65)							1	
	Shaft without key / without oil seal (front flange side IP 42)							2	
	Shaft without key / with oil seal (front flange side IP 65)							3	
Optional	Reserved								-

Table 28.1. Fields that make up the *ManufacturerDeviceName*.

Note

Referring to the *Table 28.1* not all the combinations are possible. Please contact the sales office to verify the order possibilities.

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