# INSTALLATION, USE AND MAINTENANCE MANUAL

*FCL Fast Change Linear*

Riccardo Piccinini
Mini Motor S.P.A.

FCL-GEN-EN
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# 1. Safety

## 1.1. Safety Warning

Closely follow the warnings given in this chapter, as they are crucial for safety. The warning levels used in this manual are the following:

**General hazard**: risk of harm to people, the environment or the product.

**Dangerous electrical voltage**: risk of electric shock.

## 1.2. Storage and Installation Environment

Do **not** store or use the product in the following environments:

- Exposed to direct sunlight
- Exposed to higher levels of temperature, condensation and relative humidity than ones indicated in the specifications table
- Exposed to dust, salinity, water, oil, chemicals, corrosive or inflammable gases, fuels
- Pollution degree higher than 3
- When subject to impact or vibrations

## 1.3. Transport, installation and wiring

- Do not drop the product
- Grasp the product by the motor, always checking first to ensure it is not hot – burn danger!
- Do not install the product if there are damage signs on the packaging or on the product itself
- Wiring must be performed by qualified personnel, with the power supply disconnected
- During the installation and wiring operations, protect any product openings with appropriate guards in order to avoid that any kind of conductive metallic object is able to get in
- Ensure the connectors are firmly tightened
- Install appropriate safety components (fused disconnect switch) up line of the power supply
- Use shielded cables in locations subject to static electricity, strong magnetic fields or in the presence of electrical lines
- Use suitable and appropriately sized cables for connection of the power supply, motor and control signals connections;

- For control signal connections longer than 1m, it is recommended to use shielded cables with the shielding connected to an available earth signal;
- Make sure that the power supply voltage complies with the one on the rating plate;
- Ensure that there is sufficient ventilation to dissipate the heat produced by the product.
- Connect service usb only with the drive powered.

## 1.4. Operation and adjustments

- At first power on or after a period of more than two months of inactivity, it's recommended to keep fed the logical part for at least 24 hours;
- Activate the product only after checking the compatibility of the load and of the machine in which it will be installed;
- Stay away from the machine when the product is in reboot phase from an error (if the automatic reboot is enabled), because the machine could restart suddenly;
- Do not place body parts near the rotating parts;
- Use appropriate personal protective equipment during the work near to the axis ends (presence of sharp edges in the tongue seat);
- Before performing the machine test, provide adequate protections around the rotating parts (joints, etc.);
- Never activate the device or its switches with wet hands

## 1.5. Maintenance and Inspection

- The product is equipped with a backup battery used for the multi turn position retain. To guarantee the life performance and expected life it is necessary to perform a complete charge cycle for a minimum time of 24 consecutive hours every 6 months.
- Ensure that all safety precautions have been taken before performing maintenance or inspection operations
- Do not touch the heatsink and the motor as these components heat up when the product is operational and remain hot even after it is switched off
- Do not uninstall the product when it is powered, switch it off then wait at least two minutes before doing so
- Do not change the wiring, the supply voltages, etc. while the product is powered
- Do not repair or modify the product
- The product does not require any particular preventive maintenance. However, we recommend performing the following checks regularly:
  - Check the condition and tightening of the connections
  - Check that the heatsink is clean and ventilated

Do not treat the product as normal domestic waste: it must be taken to an appropriate

> collection point for electrical and electronic waste. Failure to observe this requirement can lead to civil and/or criminal penalties, and could have damaging consequences for the environment and human health.

# 2. General Information

## 2.1. Introduction

Thank you for choosing this product. This document is an integral part of the product, as it contains the procedures and parameters necessary for the assembly, installation, wiring, commissioning and support of the product. The buyer and/or qualified person with knowledge of electrical and/or electronic systems who will use the product need the use and maintenance manual and must keep it available for reference at any moment.

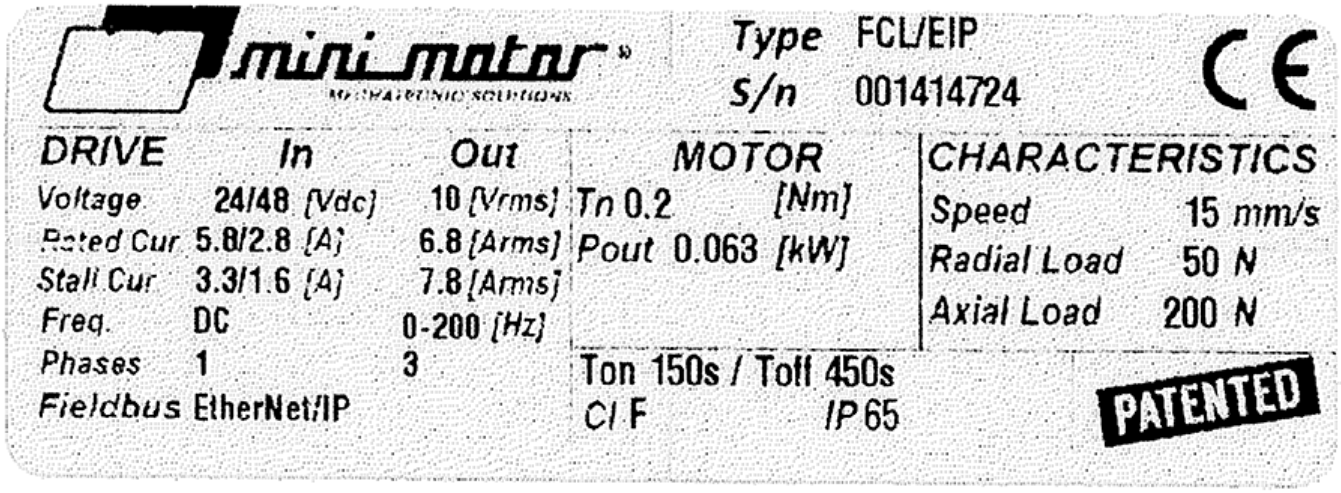
## 2.2. Product Checks

Upon delivery of the product, we recommend checking that it corresponds to that ordered and is complete. Keep in mind that only the connectors to wire the device (power, signals and bus) are included in the package. Contact the supplier’s technical support service for any problems relating to the product. For UR products check acceptability conditions and end user advice, which can be found on UL database at the file number 503911.

# 2.3. Label check

## 2.3.1. CE label

Example of label applied to the product:

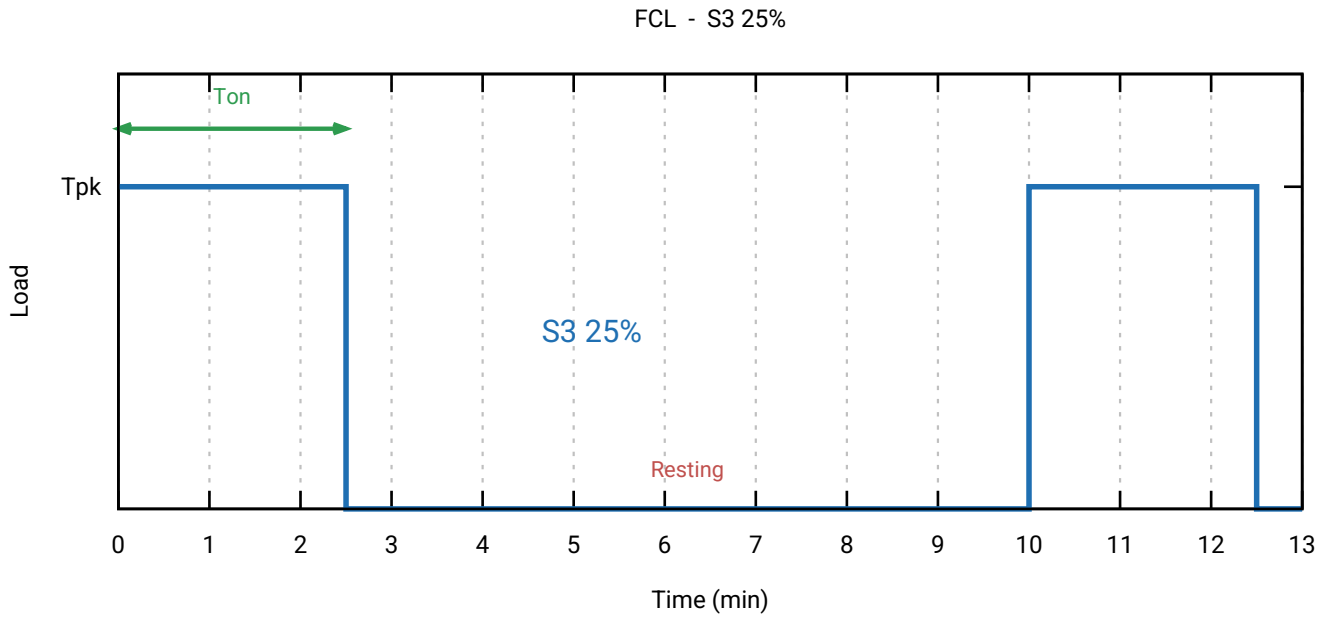



| Type | Product Name | |
|---|---|---|
| **S/n** | Serial Number | |
| | **DRIVE** | |
| | DRIVE IN | DRIVE OUT |
| **Voltage** | Drive Input Voltage [Vdc] | Drive Output Voltage [VRMS] |
| **Current** | Driver Input Current [A] | Drive Output Current [Arms] |
| **Stall Cur.** | Stall Current | |
| **Freq** | Drive input frequency | Drive output frequency |
| **Phases** | Drive input phases | Drive output phases |
| **Fieldbus** | Fieldbus protocol and optionals CSP/TP/DP/STO/MA | |
| | **MOTOR** | |
| **Tn** | Nominal motor torque [Nm] | |
| **Pout** | Output motor power [kW] | |
| **Cl** | Insulation class | |
| **IP** | IP protection code | |
| **S3** | Duty Service according to IEC 34-1 with on and off times. If absent, assume S1 service | |
| | **CHARACTERISTICS** | |
| **Speed** | Nominal linear speed | |
| **Radial Load** | Maximum radial load | |
| **Axial Load** | Push/Pull axial force | |

## 2.4. Product technical specification

| | FCL100 | FCL200 |
|---|---|---|
| Max Stroke | 100mm | 200mm |
| Nominal Supply Voltage | 24/48Vdc | |
| Nominal Supply Current | 1.8A @ 24V - 0.9A @ 48V | |
| Logic Power Draw | 2.4W | |
| Motor power output | 3W | |
| Nominal speed | 15mm/s | |
| Max axial force | 200N | |
| Max radial load | 50N | |
| PWM Frequency | 4/8/12 kHz | |
| Motor Control Algorithm | Sinusoidal Brushless<br>Magnetic multi turn absolute encoder (12bit single turn 20bit multi turn) 4096 pulses/rev | |
| Fieldbus operative mode | Velocity, Torque, position, Homing control | |
| Service communication | µUSB | |
| Communication fieldbus | EtherCAT, EtherNet/IP, Powerlink, ProfiNET, Modbus RTU, CANopen | |
| (Main) protection features | Polarity inversion, overcurrent, overvoltage, under voltage, overheating, overload, memory error, communications error | |
| Cooling | Natural | |
| Standard ingress protection | IP65 | |
| Ambient operating temperature | [0 + 40]°C | |
| Installation environment | Pollution class 3 Free from direct sunlight, vibrations, dust, corrosive or inflammable gases, oil vapour, fogs, water and humidity with or without a high salinity level | |
| Humidity | [20 - 90]% RH (Not condensing - not corrosive) | |
| Maximum altitude | 1000m asl | |
| Storage temperature | [-20 +60]°C (transient temperatures during transport only) | |
| Weight | 1,580 kg | |
| Conformity | CE, complies with EMC directive 2008/104/CE, Class C3, Industrial Environment [1]<br>cURus | |
| Life time | 35.000 ÷ 45.000 placements at maximum axial load | |

## 2.5. S3 Service



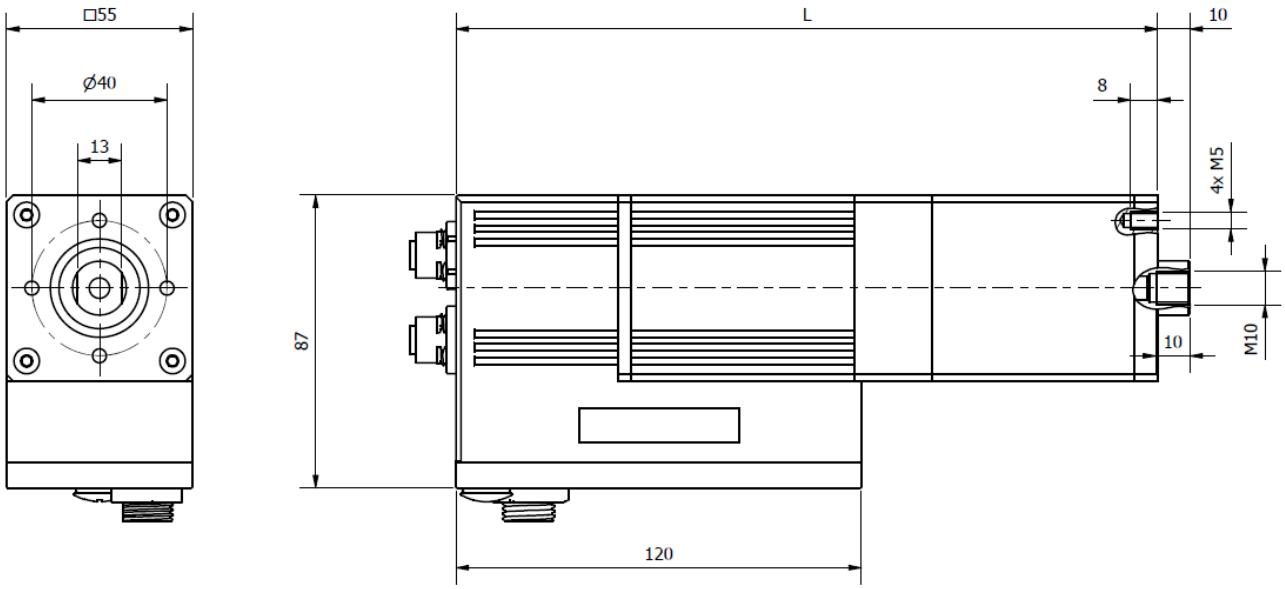

The FCL has a S3 cycle time of 25% over 10 minutes of total time.

- **Time working**: 2 minutes and 30 seconds using S3 torque.
- **Resting time**: 7 minutes and 30 seconds.

[1] Class C3, installation in second environment category.

# 3. Installation

## 3.1. Dimensions FCL




| Model | Stroke [mm] | L |
|---|---|---|
| FCL100 | 100 | 208 |
| FCL200 | 200 | 328 |

For detailed information on the overall dimensions and to download 3D models in a variety of formats, we recommend going to the dedicated product page.

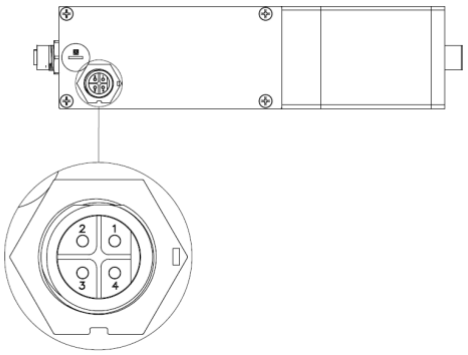
https://www.minimotor.com/en/products/fc3/

## 3.2. Electric Connections

Please note that the device power supply does not have a direct connection with the system earth.

**WARNING**: The Power must be supplied by a stabilized PSU. Protection fuse advised.

## 3.3. Power Supply Connector CN1




| CN1 | | |
|---|---|---|
| Pin | Description | FCL |
| 1 | Logic GND | 0V |
| 2 | Power GND | 0V |
| 3 | + Power | From 24 to 48Vdc |
| 4 | + Logic | From 24 to 48Vdc |

**WARNING**: the picture represents the top view of the connector fixed on the motor case.

**WARNING**: Logic and Power GND must have common ground.

Awg 18 cable is recommended for power connection.

## 3.4. USB service connector CN4

Unscrew the metal cap to access the connector as shown in the picture

By using this micro USB connection, it is possible to set the device through the specific BSI software. You can download it here: https://www.minimotor.com/en/products/fc3/

⚠ The USB cable must be connected to the FCL system only with the drive powered up

## 3.5. Fieldbus connection

The optional available fieldbuses are:

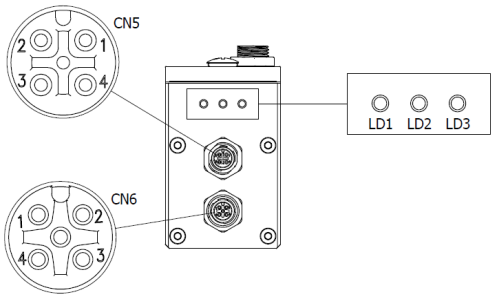
- CanOpen/Modbus RTU defined by “C” in the final part of the product name;
- Ethercat defined by “ETH” in the final part of the product name;
- Ethernet IP defined by “EIP” in the final part of the product name;
- Powerlink defined by “EPL” in the final part of the product name;
- Profinet defined by “EPN” in the final part of the product name.

Maximum tightening torques for connections: 0.5 Nm.

For the CanOpen/Modbus model the connectors on the FCL are M12 5 poles A coded, one male and one female.

For the EtherCAT/Profinet/Powerlink/EthernetIP models the connectors on the FCL are M12 4 poles D coded female

### 3.5.1. Canopen/Modbus RTU

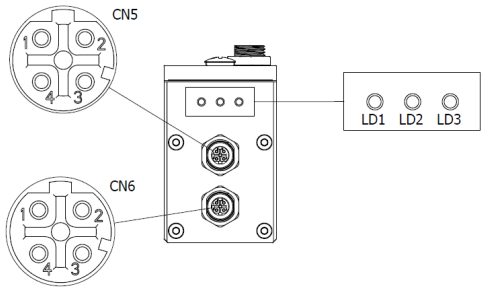



The pin function is the same for CN5 and CN6.

**WARNING**: if more devices are connected together, pin 3 (GND) need to be connected ONLY if the logic power supply is not common (different GND).

| Pin | Canopen | Modbus RTU |
|---|---|---|
| 1 | Housing shield | |
| 2 | Not connected | |
| 3 | CAN GND | GND |
| 4 | CAN H | 485 B |
| 5 | CAN L | 485 A |

### 3.5.2. Ethernet IP

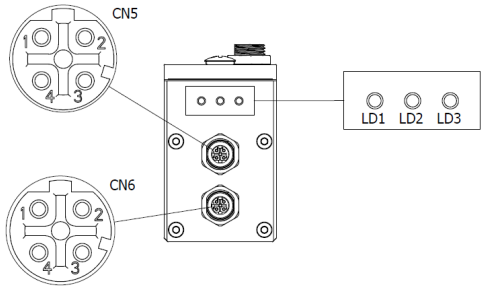



The pin function is the same for CN5 and CN6.

Connector CN5 = Connector CN6 = SWITCH

| Pin | Ethernet IP |
|---|---|
| 1 | TX+ |
| 2 | RX+ |
| 3 | TX- |
| 4 | RX- |

### 3.5.3. Profinet




The pin function is the same for CN5 and CN6.

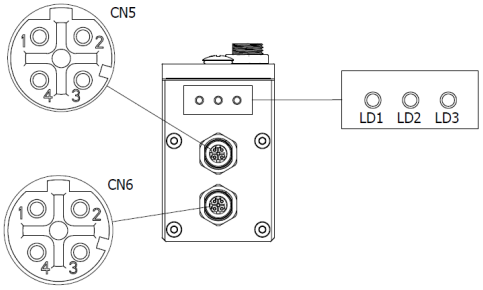
Connector CN5 = Connector CN6 = SWITCH

CN5 connector --- Port A

CN6 connector --- Port B

| Pin | Profinet |
|---|---|
| 1 | TX+ |
| 2 | RX+ |
| 3 | TX- |
| 4 | RX- |

### 3.5.4. Powerlink




The pin function is the same for CN5 and CN6.

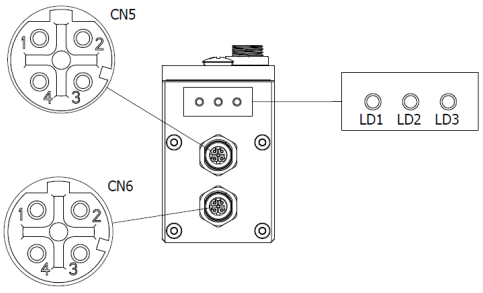
Connector CN5 = Connector CN6 = SWITCH

CN5 connector --- Port A

CN6 connector --- Port B

| Pin | Powerlink |
|---|---|
| 1 | TX+ |
| 2 | RX+ |
| 3 | TX- |
| 4 | RX- |

### 3.5.5. EtherCAT




The pin function is the same for CN5 and CN6.

CN5 connector --- Input

CN6 connector --- Output

| Pin | CanOpen over EtherCAT |
|---|---|
| 1 | TX+ |
| 2 | RX+ |

| Pin | CanOpen over EtherCAT |
|---|---|
| 3 | TX- |
| 4 | RX- |

## 3.6. Protective Device Installation

In order to prevent short circuits, the product must be connected to a power-supply line protected by devices to protect against overcurrent and short circuits, in compliance with electrical safety legislation, using standard fused, disconnect switches, etc.

For the installation of a switch up line of the power supply connection, we suggest to use isolating switch with slow blow fuse 20A.

# 4. Parametrization interface

## 4.1. Software Installation

1. Download the “BSI software” and “BSI Usb Driver“ at the following link:
2. https://www.minimotor.com/prodotti/dbs/
3. Extract and run the downloaded files. Follow the installation guide procedure until it is finished.

   After the download extract the .zip file and run BSI.exe inside the folder (BSI icon).

   **WARNING**: this is not an installation file. It directly runs the interface software, so you do not need to install it. Because of this, every time the user wants to use the software only need to double click on this icon.

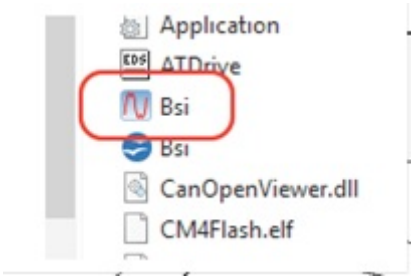



*Figure 1. BSI icon*

4. Connect the device through the micro USB to the pc and check that the logic is connected to the power.
5. Once the program is run, select the connection type. If choosing USB, wait for the device to be found and connect. If the DBS is connected via Fieldbus to a net that can exchange data over Ethernet (Ethernet IP, Profinet, Powerlink and EtherCAT with EoE functionality) you can connect typing the DBS IP address. (BSI connection interface). UDP port used: 25113.

*Figure 2. BSI connection interface*

6. If the firmware stored in the device is not up to date the screen BSI update interface

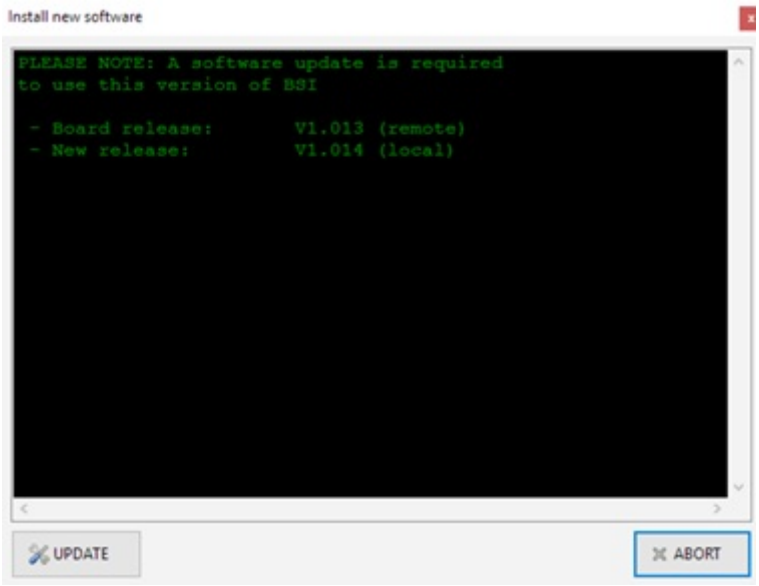



*Figure 3. BSI update interface*

## 4.2. Software

BSI update interface represents the main screen of BSI software. Following the menu it is possible to act on the motor parameter and to monitor the functional settings.

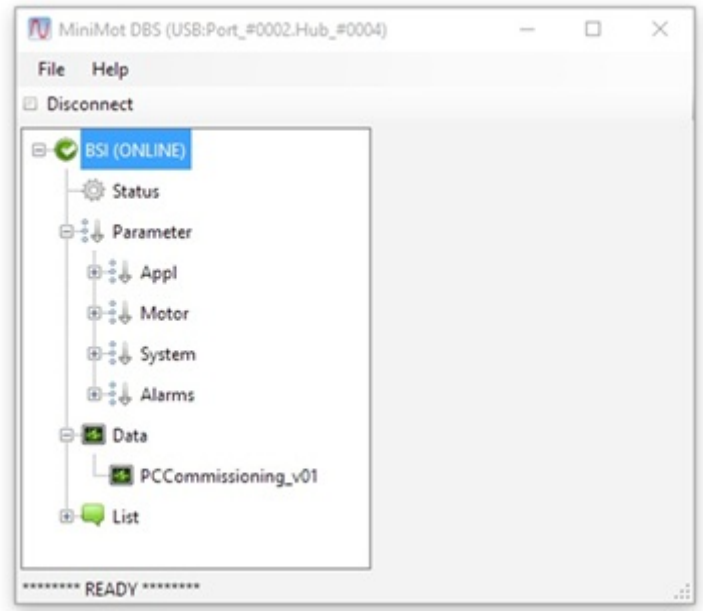



*Figure 4. BSI update interface*

### 4.2.1. Status

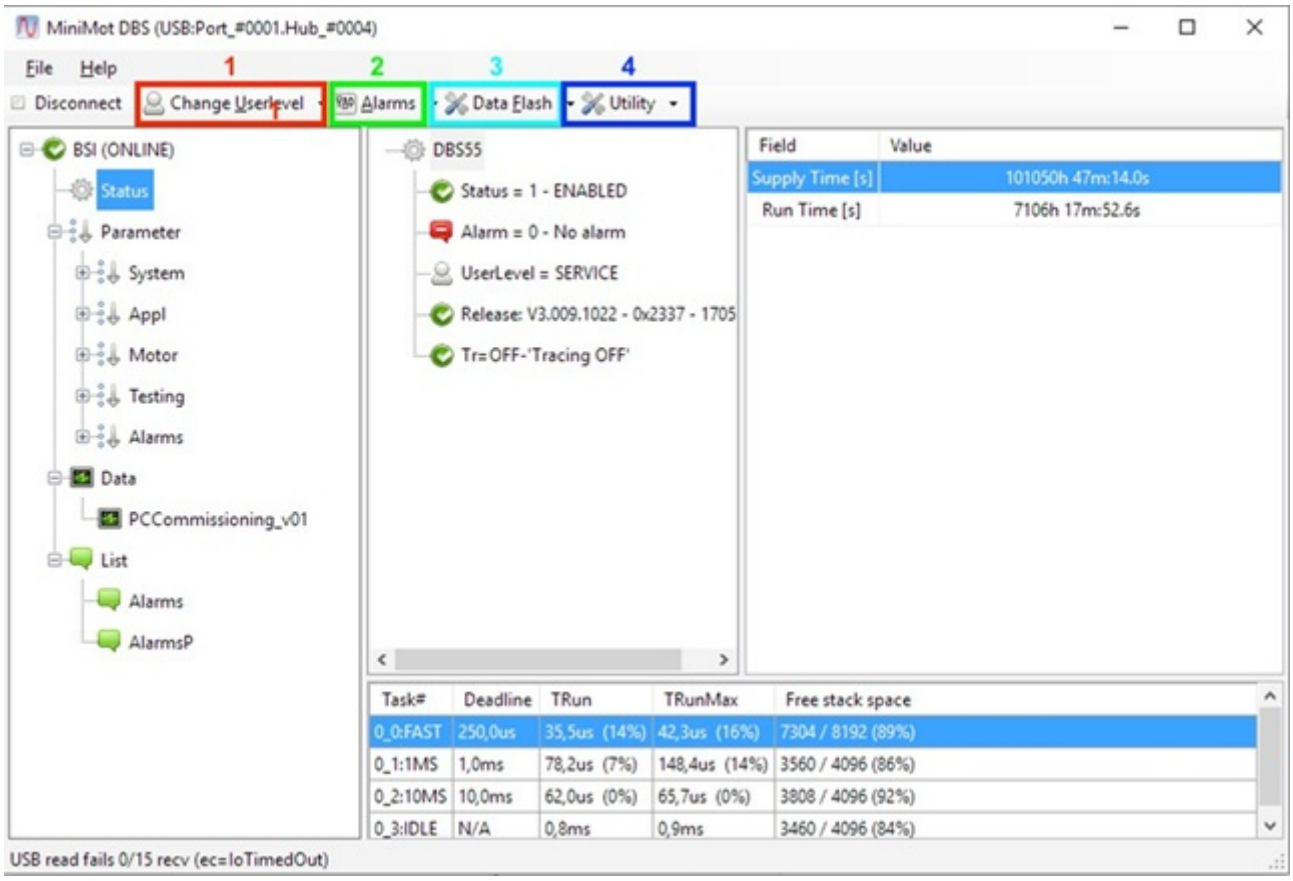



*Figure 5. BSI main menu*

Click on “Status” in order to know the motor status, manage the presence of fault and change the software user level.

1. “Change User Level”: use this option in order to change the software user level and have access to more setting parameters.

| | |
|---|---|
| User | Free Access |
| Advance | Free Access |
| Eol | PW required |
| Service | PW required |

2. “Alarms”: this button gives access to the alarm menu, in which you can reset the current alarm
3. “Data Flash”: diagnostic tool to save the Flash memory image.;
4. “Utility”: Diagnostic tool.

### 4.2.2. Alarm List

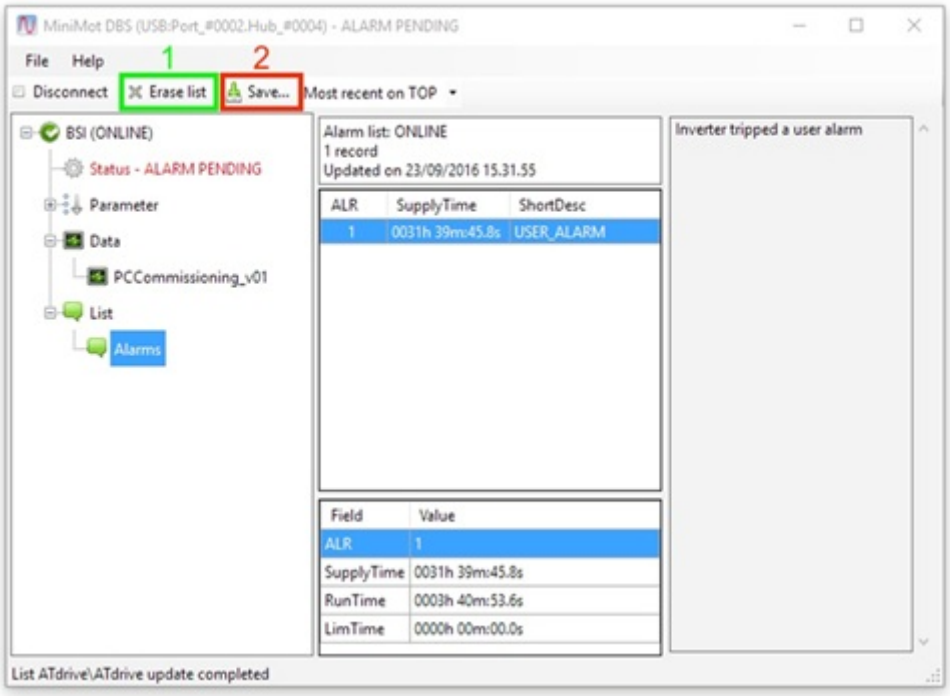



*Figure 6. BSI Alarm list*

By selecting “list” under the “alarm” voice, it is possible to find the alarm history list.

1. “Erase List”: use this command to erase the whole list.
2. “Save”: use this button to save the list into an external file.

### 4.2.3. Event List

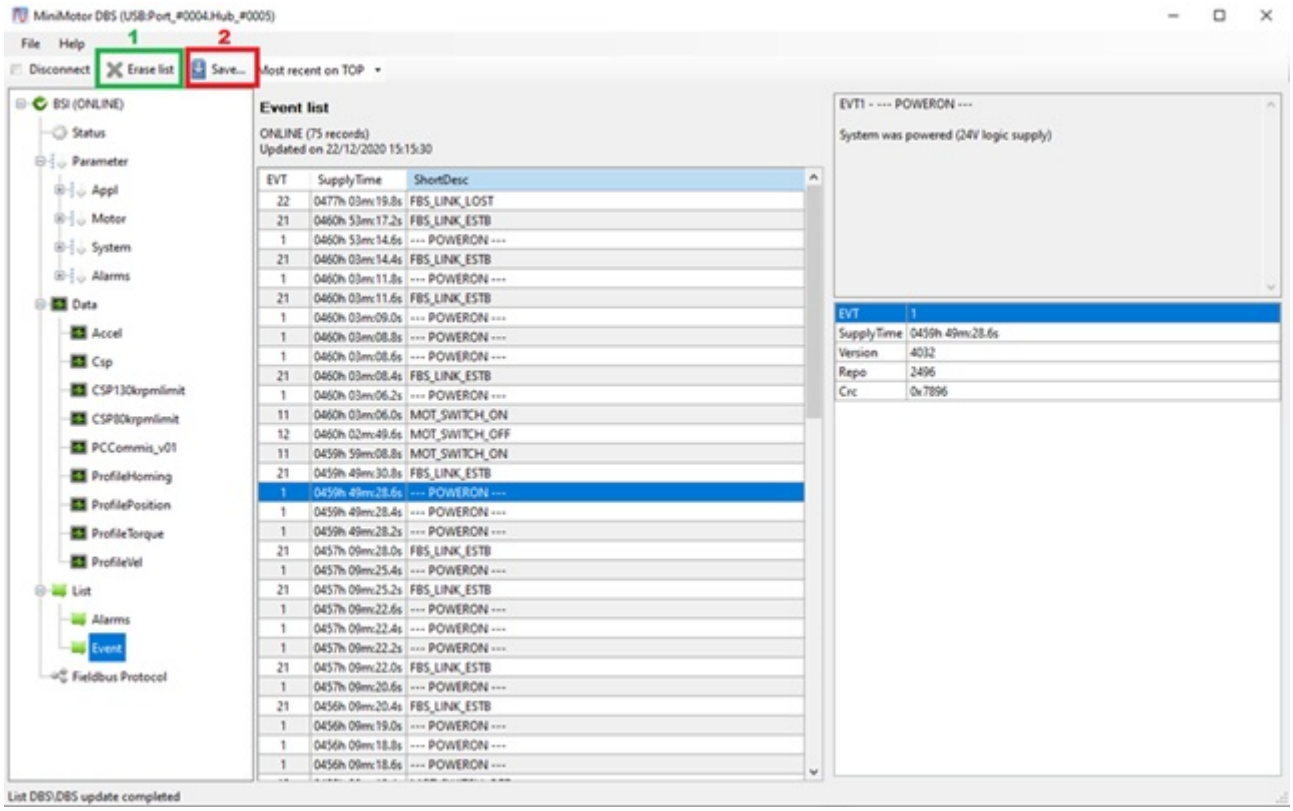



*Figure 7. BSI Event List*

By selecting “list” under the “event” voice, it is possible to find the event history list.

1. “Erase List”: use this command to erase the whole list.
2. “Save”: use this button to save the list into an external file.

### 4.2.4. Parameter

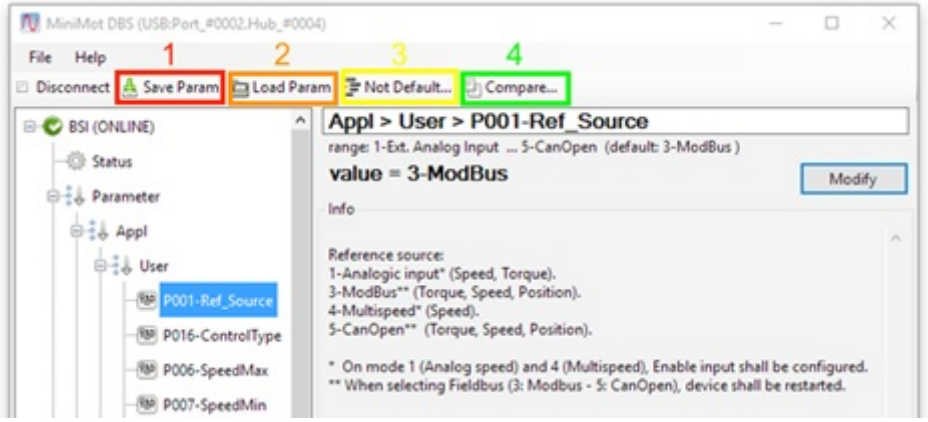



*Figure 8. BSI Parameters*

Under “Parameter” it is possible to find and set all the motor parameters. See the section of this guide in order to understand the meaning of all points and set the desired configuration.

In order to change the value or to select a different voice in one of the parameters, click on modify, change the value and then select Update to load the changes.

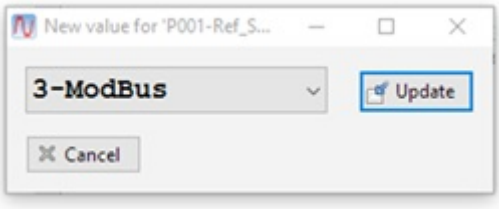



*Figure 9. BSI P001*

When the voice “parameter” is selected in the top of the window there are several useful options: . “Save Param”: allows to save the parameter setting into an external file.

1. “Load Param”: allows to upload the parameter stored into an external file, directly in the driver storage.
2. “Not default”: shows which parameter have been changed in respect of the default value.
3. “Compare”: allows to compare the parameter stored in the device with the parameters contained into an external file.

### 4.2.5. Monitoring

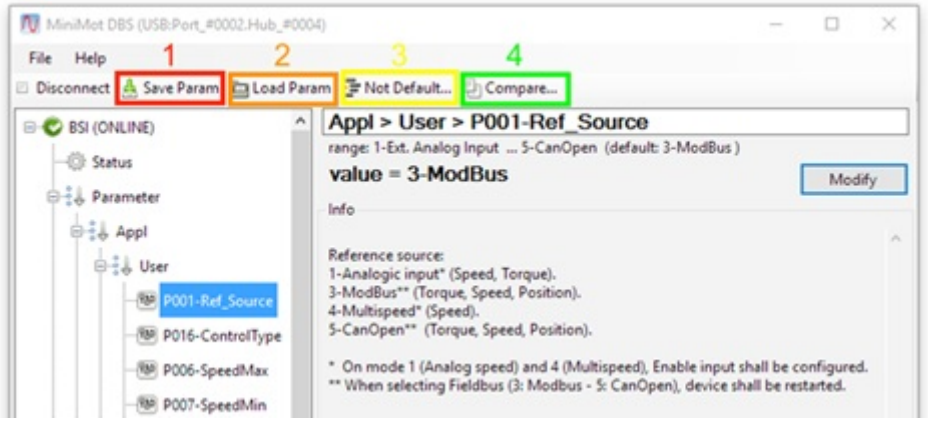



*Figure 10. BSI Parameter monitoring*

The program BSI is equipped with a tool useful in order to monitor the variables during the motor employment. Click on data and select PCCommissioning to see window shown in Figure 19 To activate the control of one or more variables toggle the white square under column “Upd”. The value is represented under the column “Value”. To use the oscilloscope, open the window settings and set the desired measurement, then click on single in order to obtain the measurement.

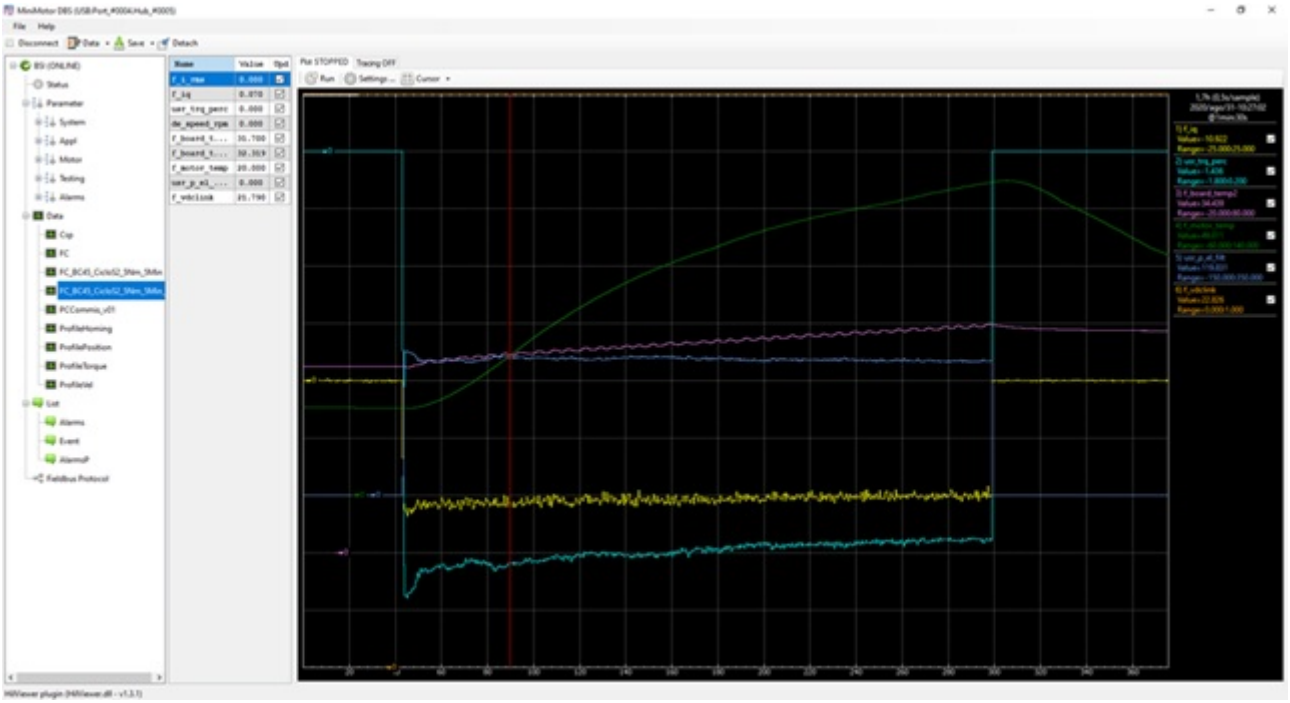


*Figure 11. BSI Plot*

The PLOT function, shown in BSI Plot, , enables to track values over longer period of time.

Here a table for common variables useful to monitor

| NAME | DESCRIPTION |
|---|---|
| co_op_mode | DS402 6061h Mode of Operation Display |
| co_control_word | DS402 6040h Control Word |
| co_status_word | DS402 6041h Status Word |
| co_pp_target_pu | DS402 607Ah Target Position |
| co_pp_max_pu | DS402 607Dh.2 Positive position limit |
| co_pp_min_pu | DS402 607Dh.1 Negative position limit |
| co_pp_tlimit | DS402 6072h Max Torque |
| co_pp_wm | DS402 6082h Profile Velocity |
| co_pv_accel | DS402 6083h Profile Acceleration |
| co_pv_decel | DS402 6084h Profile Deceleration |
| de_speed_rpm | DS402 606Ch Velocity Actual Value |
| usr_trq_perc | DS402 6077h Torque Actual Value |
| usr_pos_pu_1ms | DS402 6064h Position Actual Value |
| co_pp_cmdnewset | DS402 6060h Bit 4 “new setpoint” |
| f_iq | Apk of current output of the drive |
| usr_poserror | Position error in encoder pulses from the position loop |
| diag_alr_code | 3008h Actual Alarm |
| co_dc_ferror_win | DS402 6065h Following Error Window |
| co_dc_pos_window | DS402 6067h Position Window |

# 5. Parameters

## 5.1. System

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| 000 | MiniMotType | Motor Type | Read only |
| 082 | UndervoltMode | Undervolt error reporting logic | When Run → When the motor is running<br>Always → Every time VDC is lost |
| 201 | Year | Production year | Read only |
| 203 | SerialNo | Motor serial number | Read only |
| 202 | StartUL | User level at start of motor | |

## 5.2. Appl

### 5.2.1. User

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P001 | MODE | Reference source selection | 1 → Speed Analog Input1 Speed<br>2 → ModBus + Dig.Input1 Speed, Torque, Position, Homing<br>3 → ModBus Speed, Torque, Position, Homing<br>4 → Multispeed1 Speed<br>5 → CanOpen² Speed, Torque, Position, Homing<br>6 → CanOverECAT² Speed, Torque, Position, Homing<br>7 → Ethernet PowerLink² Speed, Torque, Position, Homing<br>8 → Ethernet/IP² Speed, Torque, Position, Homing<br>9 → Profinet IO² Speed, Torque, Position, Homing<br>10 → CanOverAir² Speed, Torque, Position, Homing<br>11 → TrqAnalogIn¹ Torque<br>12 → MultiTrq¹ Torque<br>13 → MultiPos¹ Position<br>14 → Ain Speed + Modbus Speed, Torque, Position, Homing<br>15 → MultiSpeedCycle¹ Speed<br>16 → MultiposCycle¹ Position<br>¹ In MODE 1, 2, 4, 11, 12, 13, 15 and 16 there must be at least one input as Enable<br>² Reboot is necessary when switching between modes |
| P006 | Speed Max | Max speed reference | 0 ÷ 6000 [rpm] |
| P007 | Speed Min | Minimum speed reference in Analog mode | 0 ÷ 6000 [rpm] |
| P008 | Ramp Acc | Acceleration for speed/position control | 1 ÷ 120000 [rpm/s] |
| P009 | Ramp Dec | Deceleration for speed/position control | 1 ÷ 120000 [rpm/s] |

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P017 | IMax | Maximum operative current | 0 ÷ 22.1 / 18.7 [A] (55-50 / 55-100) |
| P021 | MotorChangeDir1 | Parameter to change motor rotation direction | 1 → None (Disable)<br>2 → Inverted (Invert rotation)<br>¹ Only if P001=1,4,11,12 or 13 |
| P164 | PosMin | Minimum position limit | 0 ÷ −2147483648 [position units] |
| P166 | PosMax | Maximum position limit | 0 ÷ +2147483647 [position units] |

## 5.2.2. Input Output

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| **Analog** | | | |
| P004 | MinRefAnalog | Min analog reference | 0.0% ÷ 100.0% |
| P005 | MaxRefAnalog | Max analog reference | 0.0% ÷ 100.0% |
| P043 | AinMode | Set the analog input function | 0 → Voltage ref input 0÷10 [V]<br>1 → Voltage ref input −10÷10 [V]<br>2 → Current ref input 0÷20 [mA]<br>3 → Current ref input 4÷20 [mA]<br>WARNING: mode 2 and 3 are available only with MA option |
| P045 | AinOffs | Offset correction for analog input | −10÷10 [V] |
| P046 | AinGain | Gain correction for analog input | 0.000÷2.000 |
| P047 | AinThre | Analog input threshold, as percentage | 0.0÷100.0 [%] |
| **Digital** | | | |

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P010 | InputFunc1 | Digital input function 1: enables control via digital pnp input 1<br>Defines function mapped to input 1 | 0 → Not Used<br>1 → Enable/Stand-By²<br>2 → Run/Stop²<br>3 → Run Edge Triggered²<br>4 → Stop Edge Triggered²<br>5 → Forward/Reverse²<br>6 → Run/Stop Forward²<br>7 → Run/Stop Reverse²<br>8 → Error Reset<br>9 → User Error<br>10 → Multispeed Binary Selection Bit 0²<br>11 → Multispeed Binary Selection Bit 1²<br>12 → Multispeed Binary Selection Bit 2²<br>14 → Brake Unlock<br>15 → CollisionSignal²<br>28 → Homing Start (edge triggered)<br>29 → Homing Start (level triggered)<br>30 → Home Switch¹<br>31 → Fwd Limit Switch¹<br>32 → Rev Limit Switch¹<br>¹ Available in homing mode and local modes<br>² Only if P001=1,4,11,12,13 |
| P011 | InputFunc2 | Digital input function 2 | See P010 |
| P012 | InputFunc3 | Digital input function 3 | See P010 / STO 1 (optional) |
| P013 | InputFunc4 | Digital input function 4 | See P010 / STO 2 (optional) |
| P014 | InputFunc5 | Digital input function 5 | See P010 |
| P032 | AinFunc | Digital input associated to Analog Input | See P010 |
| P020 | DigInInvMask | Active low/high status of digital inputs | 0b00001 → Input 1 Active Low<br>0b00101 → Inputs 1 & 3 Active Low |
| P015 | OutFunc | Digital output — defines trigger condition for output signal | 0 → Always Off<br>1 → Run<br>2 → Ready<br>7 → Homing Done<br>8 → Error<br>9 → Target Reached<br>10 → FieldBus DSP402 |
| P064 | TargReachedHyst | Window for “target reach” event | Speed [rpm] 0÷9999<br>Torque [mA]<br>Position [step] |
| P065 | TargReachHyst | Time window for “target reach” event completion | 0÷9999 [ms] |
| P033 | ExpOutEnable | Port expander configuration mask (only on WBS/WDBS) | 0b00000000000 [bit] |

## 5.2.3. Accelerometer

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P035 | Endscale | Defines the Accelerometer End-Scale | 2 – 4 – 8 [G] |
| P036 | DataRate | Defines Accelerometer Output Rate | 10–50–100–200–400–800 [Hz] |
| P037 | RmsTau | Time filter constant for RMS computation of accelerations | 1 ÷ 1000 [ms] |
| P038 | EventLevel | Acceleration threshold for logging over-acceleration event | 0.1 ÷ 10 [G] |
| P039 | EventTime | Time filter constant for logging and over-acceleration event | 1 ÷ 1000 [ms] |
| P040 | EventInhibit | Inhibition time before logging a second over-acceleration event | 1 ÷ 2400 [minutes] |

### 5.2.4. Collision

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| 050 | Deceleration | Deceleration after input trigger | Krpm/s |
| 051 | Bwspeed | Maximum speed for backward movement | rpm |
| 052 | BwAcc | Acceleration limit for backward movement | Krpm/s |
| 053 | BwDelta | Position of backward movement | Pulses |

### 5.2.5. Multitrq

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P102 | Multitorque 1 | Defines the torque presets for the binary combinations of MultiTorque mode.<br>In Multispeed/MultiPosition it works as torque limit for the corresponding profile<br>Only with P001=4,12,13 | -200 ÷ +200 [% nominal] |
| P103 | Multitorque 2 | See P102 | -200 ÷ +200 [% nominal] |
| P104 | Multitorque 3 | See P102 | -200 ÷ +200 [% nominal] |
| P105 | Multitorque 4 | See P102 | -200 ÷ +200 [% nominal] |
| P106 | Multitorque 5 | See P102 | -200 ÷ +200 [% nominal] |
| P107 | Multitorque 6 | See P102 | -200 ÷ +200 [% nominal] |
| P108 | Multitorque 7 | See P102 | -200 ÷ +200 [% nominal] |
| P109 | Multitorque 8 | See P102 | -200 ÷ +200 [% nominal] |

## 5.2.6. Multispeed

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P110 | Multispeed 1 | Defines the speed presets for the binary combinations of MultiSpeed mode.<br>In MultiTorque/MultiPosition it works as speed limit for the corresponding profile<br>Only with P001=4,12,13 | -6000 ÷ 6000 [rpm] |
| P111 | Multispeed 2 | See P110 | -6000 ÷ 6000 [rpm] |
| P112 | Multispeed 3 | See P110 | -6000 ÷ 6000 [rpm] |
| P113 | Multispeed 4 | See P110 | -6000 ÷ 6000 [rpm] |
| P114 | Multispeed 5 | See P110 | -6000 ÷ 6000 [rpm] |
| P115 | Multispeed 6 | See P110 | -6000 ÷ 6000 [rpm] |
| P116 | Multispeed 7 | See P110 | -6000 ÷ 6000 [rpm] |
| P117 | Multispeed 8 | See P110 | -6000 ÷ 6000 [rpm] |

## 5.2.7. Multipos_ref

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P120 | Multiposition1 | Defines the position presets for the binary combinations of MultiPosition mode<br>Only with P001=13 | -2147483648 ÷ +2147483647 [user units] |
| P122 | Multiposition2 | See P120 | -2147483648 ÷ +2147483647 [user units] |
| P124 | Multiposition3 | See P120 | -2147483648 ÷ +2147483647 [user units] |
| P126 | Multiposition4 | See P120 | -2147483648 ÷ +2147483647 [user units] |
| P128 | Multiposition5 | See P120 | -2147483648 ÷ +2147483647 [user units] |
| P132 | Multiposition6 | See P120 | -2147483648 ÷ +2147483647 [user units] |
| P134 | Multiposition7 | See P120 | -2147483648 ÷ +2147483647 [user units] |
| P135 | Multiposition8 | See P120 | -2147483648 ÷ +2147483647 [user units] |

### 5.2.8. Multipos_mMode

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P221 | Multiposref 1_mode | Defines the logic behind the positioning (absolute, relative or additive)<br>Solo con P001=13 | 0 → Absolute<br>1 → Relative<br>2 → Additive |
| P222 | Multiposref 2_mode | See P221 | 0 → Absolute<br>1 → Relative<br>2 → Additive |
| P223 | Multiposref 3_mode | See P221 | 0 → Absolute<br>1 → Relative<br>2 → Additive |
| P224 | Multiposref 4_mode | See P221 | 0 → Absolute<br>1 → Relative<br>2 → Additive |
| P225 | Multiposref 5_mode | See P221 | 0 → Absolute<br>1 → Relative<br>2 → Additive |
| P226 | Multiposref 6_mode | See P221 | 0 → Absolute<br>1 → Relative<br>2 → Additive |
| P228 | Multiposref 8_mode | See P221 | 0 → Absolute<br>1 → Relative<br>2 → Additive |

### 5.2.9. Multidelay

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P142 | MultiDelay1 | Time spent in the various positions/velocities in the automatic cyclic modes<br>Only with P001=15,16 | 0.001 ÷ 32 [sec] |
| P143 | MultiDelay2 | See P142 | 0.001 ÷ 32 [sec] |
| P144 | MultiDelay3 | See P142 | 0.001 ÷ 32 [sec] |
| P145 | MultiDelay4 | See P142 | 0.001 ÷ 32 [sec] |
| P146 | MultiDelay5 | See P142 | 0.001 ÷ 32 [sec] |
| P147 | MultiDelay6 | See P142 | 0.001 ÷ 32 [sec] |
| P148 | MultiDelay7 | See P142 | 0.001 ÷ 32 [sec] |
| P149 | MultiDelay8 | See P142 | 0.001 ÷ 32 [sec] |

### 5.2.10. Homing

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P152 | HomingType | Defines the homing type according to the CanOpen CIA402 standard. See section 11 | Available Homing:<br>1 ÷ 14<br>33, 34, 37 |

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P153 | HomingSwitchSpeed | Speed used to search the home or limit switch | 0 ÷ 4000 [rpm] |
| P154 | HomingIndexSpeed | Positioning speed at the index pulse | 0 ÷ 4000 [rpm] |
| P155 | HomingAccel | Motor acceleration to reach homing speed from stop | 0 ÷ 10000 [rpm/s] |
| P156 | HomingDecel | Deceleration used to stop motor running at homing speed | 0 ÷ 10000 [rpm/s] |
| P157 | HomingTimeOut | Time limit for data exchange during homing process | 1 ÷ 200 [s] |
| P158 | HomingMaxCurr | Limit of motor current available during homing | 0.001 ÷ 10 [A] |
| P159 | HomingEnable | Enable or disable homing | 0 → DISABLE<br>1 → ENABLE |
| P168 | HomingOffsetLOW | Defines the offset value used in homing, composed of Low Word + High Word | Examples:<br>Offset = 68000 (dec) → 0x109A0 (hex)<br>P169 = 0x0001 P168 = 0x09A0<br>Offset = −1000 (dec) → FFFFFC18 (hex)<br>P169 = 0xFFFF P168 = 0xFC18 |

## 5.2.11. Posscaling

| ID | NOME | DESCRIZIONE | NOTE |
|---|---|---|---|
| P160 | PosFactorNum | Defines the numerator used to calculate the scaling factor (position factor) used to represent the position in user defined unit. See 8.1.3 section | 0 ÷ 32767 |
| P161 | PosFactorDen | Defines the denominator used to calculate the scaling factor (position factor) used to represent the position in user defined unit. See 8.1.3 section | 0 ÷ 32767 |
| P162 | PosFactorDecimal | Defines the number of decimal places used to represent the profile unit. | 0 ÷ 32767 |
| P163 | UserPosInversion | Allows the user to invert the count of the encoder based on motor rotational direction | None → Positive counting with clockwise rotation<br>Inverted → Negative counting with clockwise rotation |

## 5.2.12. Fieldbus

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| **EthernetIP** | | | |
| P170 | IpAddr | Allows to set the slave address of the motor using Ethernet/IP | 192.168.250.100 |
| P172 | IpMask | Defines the Ethernet/IP subnet mask | 255.255.0.0 |
| P174 | IpGateway | Defines the Ethernet/IP gateway address | 0.0.0.0 |

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P215 | IpMode | Ethernet/IP address assignment mode | 0-Static<br>1-DHCP |
| | | | |
| P176 | ProcDataLayout | Set default or extended process data for EIP and Profinet | 0 Default<br>1 Extended_A (D I/O)<br>2 Extended_B (Touch probe 402)<br>3 Extended_C (Touch probe MM)<br>4 Extended_D (Accelerometer) |
| P177 | SpeedUnitMode | Speed and acceleration object scaling | 0 RPM – RPM/s<br>1 Increments/s – Increments/s² |
| **CSP (Cyclic Synchronous Positioning)** | | | |
| P178 | WrongRefDelay | Delay of CSP position reference consistency | 0 ÷ 1000 [ms] |
| P179 | WrongRefBeh | Behaviour of CSP position target protection | 0 NO ACTION<br>1 CORRECT<br>2 ALARM |
| P180 | AccelMax | Acceleration limit for CSP pos. Ref. | 1 ÷ 3000 krpm/s |
| P190 | CSP_FF_Mode | CSP feedforward speed mode | 1 Offset 60B1.0<br>2 Computed |
| **Modbus** | | | |
| P182 | ModbusAddress | Set the slave address via RS485 using Modbus | 1 ÷ 500 |
| P183 | ModbusMode | Defines Modbus RTU configuration: Word, Parity, Stop bits | 8-N-2 → 8bit, none, 2bits<br>8-E-2 → 8bit, even, 1bits<br>8-O-1 → 8bit, odd, 1bits |
| P184 | ModbusBaudrate | Baudrate for Modbus communication | 0 → 9.6 [Kbaud]<br>1 → 19.2<br>2 → 38.4<br>3 → 57.6<br>4 → 115.2 |
| | | | |
| P185 | WIPProcDataLayout | Layout selection for CoA | 0 WL_Default<br>1 CIP_Layout0<br>2 WL_XS_IO1<br>3 WL_XS_IO2 |
| **CanOpen** | | | |
| P191 | CanOPEN_Nodeid | Bus node address of the device | 1 ÷ 127 |
| P192 | CanOPEN_Baudrate | Baudrate for CanOPEN communication | 1 → 20 [Kbaud]<br>2 → 50<br>3 → 125<br>4 → 250<br>5 → 500<br>6 → 1 [Mbaud] |
| P193 | CanOPEN_GuardTime | Defines the NMT Guard Time | 0–1000 [ms] (0 disables) |

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P194 | CanOPEN_LifeFactor | Defines the NMT Life Factor | 0–50 (0 disables) |
| **Ecat (EtherCAT)** | | | |
| P195 | StationAddress | Default station address | 0 ÷ 32767 |
| P198 | ProductCsp | EtherCAT product-id selection | 0 PROFILE<br>1 CSP |
| **PowerLink** | | | |
| P197 | NodeId | Default Node-ID for PowerLink node | 0 ÷ 32767 |
| **ProfinetIO** | | | |
| P199 | ByteOrder | Set byte order style | Little / Big endian |
| **Modulo** | | | |
| P205 | PosOptCode | Set value for 60F2h | As for CanOpen DS402 |
| P206 | PosRangeLimitMin | Modulo minimum range | posunits |
| P208 | PosRangeLimitMax | Modulo maximum range | posunits |

## 5.3. Motor

### 5.3.1. Brake

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P022 | BrakeDeactTime | Deactivation time of brake AFTER motor control start | [ms] |
| P023 | BrakeActTime | Activation time of brake BEFORE motor control stop | [ms] |
| P024 | BrkUnlockTime | Elapsed time between Unlock V and Hold V states | [ms] |
| P025 | BrkUnlockV | Voltage to Unlock the brake | 0–48 Volt |
| P026 | BrkHoldV | Voltage to Hold the brake unlocked | 0–48 Volt |
| P034 | BrakeFreq | Brake PWM frequency | 400–10000 Hz |
| P057 | BrkRand | PWM frequency randomizer | OFF–200% |

### 5.3.2. Encoder

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P094 | EncStRes | Single turn resolution selector. Values higher than 12bit are only valid on motors with HRE option | 12–24 [bit] |

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P252 | EncLPFTau | Defines the time constant considered in the low-pass filter used to filter the speed measures from the encoder | 0.001 ÷ 1.000 [s] |

### 5.3.3. Control

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P237 | KpSpeed | Defines the proportional gain in PI speed control | 0 ÷ 3.2000 |
| P238 | kiSpeed | Defines the integral gain in speed PI control | 0 ÷ 3.2000 |
| P253 | kpPos | Defines the proportional gain in P position control | 0 ÷ 3.2000 |
| P254 | WstarFiltEnable | Enable the filter on the Speed reference | Enable - Disable |
| P256 | Jloadff | Load Inertia | 0 ÷ 327.67 Kgcm² |

## 5.4. Alarms

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| P210 | Nreset | Defines the number of autoresettable alarm event exceeded which the fault is generated | 0 ÷ 100 |
| P211 | TminReset | Defines the time after which the alarm can be autoresetted | 0.5 ÷ 30 [s] |
| P212 | Trestore | Defines the time after which the autoresettable alarm count is resetted | 0.5 ÷ 1800 [s] |

# 6. LED status

LED color and operating modes (flashing / powering mode) depend on the fieldbus expansion Board mounted (i.e. CanOpen, Ethercat, etc).

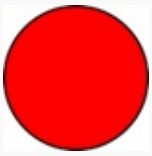
## 6.1. Fieldbus Board CanOpen\Modbus

The indication LEDs are three and they are mapped on the drive's LEDs in the following way:

| LED | Indicazione | Stato |
|---|---|---|
| LD1 | FLASHING (Red) | **Inverter alarm**<br>Tacc = 0.5s<br>Tperiod = 1s |
| | FLASHING (Red) | **PWM off**<br>The number of flashes represent the type of control set<br>• 0 flash: unchecked control<br>• 1 flash: torque control<br>• 2 flash: speed control<br>• 3 flash: position control |
| | ON (Red) | **PWM on** |
| LD2 | OFF | **Yellow LED always off** |

| LED | Indicazione | Stato |
|---|---|---|
| LD3 | OFF | **Inverter alarm** |
| | FLASHING (Green) | **PWM off**<br>The number of flashes represent the type of control set<br>• 1 flash: Analog reference<br>• 3 flashes: Modbus reference<br>• 4 flashes: Multispeed reference<br>• 5 flashes: CanOpen reference |
| | ON (Green) | **PWM on** (Intermittent speed proportional to rotation speed P006) |

## 6.2. Fieldbus Board EtherCAT

| LD1 | LD2 | LD3 |
|---|---|---|
| RUN/ERR | ERR | L/A IN |
| |  | |

| LED | Indicazione | Stato |
|---|---|---|
| LD1 | OFF | **INIT** |
| | ON (green) | **OPERATIONAL** |
| | BLINKING (2.5hz Green) | **PRE-OPERATIONAL** |
| | SINGLE FLASH (Green) | **SAFE-OPERATIONAL** |
| LD2 | OFF | **No Error** The communication is working properly |
| | BLINKING (2.5hz Red) | **Invalid Configuration** General Configuration Error Possible reason: State change commanded by master is impossible due to register or object settings. |
| | SINGLE FLASH (Red) | **Local error**: Slave device application has changed the EtherCAT state autonomously. Possible reason 1: A host watchdog timeout has occurred. Possible reason 2: Synchronization Error, device enters Safe- Operational automatically. |
| | DOUBLE FLASH (Red) | **Local error**: Slave device application has changed the EtherCAT state autonomously. Possible reason 1: A host watchdog timeout has occurred. Possible reason 2: Synchronization Error, device enters Safe- Operational automatically. |

| LED | Indicazione | Stato |
|---|---|---|
| LD3 | OFF | **No Connection** The device has no link to the Ethernet |
| | ON (Green) | **Connected** The device is connected but does not send/receives frames. |
| | FLICKERING (Green) | **Activity** Frames are being send/received. |

| Indicator State | Definition |
|---|---|
| ON | Constantly on |
| OFF | Constantly off |
| SINGLE FLASH | One short flash (200 ms) followed by a long off phase (1,000 ms) |
| DOUBLE FLASH | Two short flashes (200 ms each) separated by a short off phase (200 ms), followed by a long off phase (1,000 ms) |
| BLINKING (2.5 Hz) | Turns on and off at 2.5 Hz: 200 ms on, 200 ms off |
| FLICKERING (Load Dependent) | Approx. 10 Hz frequency to indicate high Ethernet activity: ~50 ms on, ~50 ms off. The indicator turns on and off in irregular intervals to indicate low Ethernet activity |

## 6.3. Fieldbus Board EthernetIP

| LD1 | LD2 | LD3 |
|---|---|---|
| MS | NS | L/A IN |
| | | |

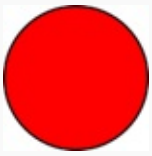
| LED | Indicazione | Stato |
|---|---|---|
| LD1 | OFF | **No Power**: the device is powered off. |
| | ON (green) | **Device operational** the device is operating correctly. |
| | FLASHING (1hz Green) | **Standby** the device has not been configured |
| | ON (Red) | **Major Unrecoverable fault** the device has detected a non recoverable major fault |
| | BLINKING (1 Hz Red) | **Major Unrecoverable fault** the device has detected a non recoverable major fault. An incorrect or inconsistent configuration would be considered a major recovereable fault |
| | FLASHING (Green/Red/Green) | **Major Unrecoverable fault** the device has detected a non recoverable major fault. An incorrect or inconsistent configuration would be considered a major recovereable fault |

| LED | Indicazione | Stato |
|---|---|---|
| LD2 | OFF | **Not powered, no IP address** The device doesn't have an IP address (or is powered off). |
| | ON (Green) | **Connected** An IP address is configured, at least one CIP connection (any transport class) is established device has at least one established, and an Exclusive Owner connection has not timed out.. |
| | BLINKING (1Hz Green) | **No Connections**: The device has obtained an IP address, the network; and no CIP connection are established and an exclusive Owner connection has not timed out. |
| | ON (Red) | **Duplicate IP**: The device has detected that its IP address is already in use. |
| | BLINKING (1 Hz Red) | **Connection Timeout**: An IP address is configured, and an Exclusive Owner connection for which the device is the target has timed out. The network status indicator returns to steady green only when all timed out Exclusive Owner connections are reestablished. |
| | FLASHING (Green/Red/off) | **Serftest**: Thedevice is performing its power-up testing. Refer to description for module status LED self-test. |
| LD3 | OFF | **No Connection** The device has no link to the Ethernet |
| | ON (Green) | **Connected** The device is connected but does not send/receives frames. |
| | FLASHING (Yellow) | **Activity** Frames are being send/received. |
| | OFF (Yellow) | **No Activity** The device does not send/receive Ethernet frames. |

| Indicator State | Definition |
|---|---|
| ON | Constantly on |
| OFF | Constantly off |
| BLINKING (1 Hz) | Turns on and off iso-phase at a frequency of 2.5 Hz: on for 200 ms, off for 200 ms |

| Indicator State | Definition |
| --- | --- |
| FLICKERING (Load Dependent) | Approx. 10 Hz to indicate high Ethernet activity: ~50 ms on, ~50 ms off. Irregular intervals to indicate low Ethernet activity |

## 6.4. Fieldbus Board Ethernet Powerlink

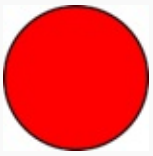
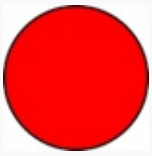
| LD1 | LD2 | LD3 |
|---|---|---|
| Status | Error | L/A IN |
| |  | |

| LED | Indicazione | Stato |
|---|---|---|
| LD1 | OFF | **No Power**: the device is powered off. |
| | ON (green) | **Operational** the device in the "operational" state. |
| | TRIPLE FLASH (Green) | **ReadytoOperate** the device in the "Readytooperate" state. |
| | DOUBLE FLASH (Green) | **Pre Operational 2** the device in the "Pre Operational 2" state. |
| | SINGLE FLASH (Green | **Pre Operational 1** the device in the "Pre Operational 1" state. |
| | FLICKERING (10hz) | **Basic Ethernet** the device in the "Basic Ethernet" state. |
| | BLINKING (Green) | **Stopped** the device in the "Stopped" state. |
| LD2 | OFF | **No Error** The device has no error. |
| | ON (Red) | **Error** The device has detected an error. |

| LED | Indicazione | Stato |
|---|---|---|
| LD3 | OFF | **No Connection** The device has no link to the Ethernet |
| | ON (Green) | **Connected** The device is connected but does not send/receives frames. |
| | FLASHING (Green) | **Activity** Frames are being send/received. |

| Indicator State | Definition |
|---|---|
| ON | Constantly on |
| OFF | Constantly off |
| BLINKING (2.5 Hz) | Turns on and off iso-phase at 2.5 Hz: 200 ms on, 200 ms off |
| TRIPLE FLASH | Three short flashes (200 ms each) separated by 200 ms off phases; followed by a long off phase (1,000 ms) |
| DOUBLE FLASH | Two short flashes (200 ms each) separated by a 200 ms off phase; followed by a long off phase (1,000 ms) |
| SINGLE FLASH | One short flash (200 ms) followed by a long off phase (1,000 ms) |
| FLICKERING (10 Hz) | Alternates red and green LEDs at 10 Hz: 50 ms on, 50 ms off |
| FLICKERING (Load Dependent) | Approx. 10 Hz for high Ethernet activity: ~50 ms on, ~50 ms off. Irregular intervals indicate low Ethernet activity |

## 6.5. Fieldbus Board Ethernet ProfiNet IO

| LD1 | LD2 | LD3 |
|---|---|---|
| System failure | Bus Failure | L/RX/TX |
|  |  | |

| LED | Indicazione | Stato |
|---|---|---|
| LD1 | OFF | **No Error** |
| | ON (Red) | **Error** Watchdog timeout; channel, generic or extended diagnosis present; system error. |
| | FLASHING (Red, 1Hz, 3s) | **DCP Signal Service** Device discovery initiated via BUS |
| LD2 | OFF | **No Error** The device has no error. |
| | ON (Red) | **Error** No configuration or low speed physical link; or no physical link. |
| | FLASHING (2 Hz Red) | No Data exchange |
| LD3 | OFF | **No Connection** The device has no link to the Ethernet |
| | ON (Green) | **Connected** The device is connected but does not send/receives frames. |
| | FLASHING (Yellow) | **Activity** Frames are being send/received. |
| | OFF (Yellow) | **No Activity** The device does not send/receive Ethernet frames. |

| Indicator State | Definition |
|---|---|
| ON | Constantly on |
| OFF | Constantly off |
| FLASHING (1 Hz, 3 s) | Turns on and off for 3 seconds at 1 Hz: 500 ms on, 500 ms off |
| FLASHING (2 Hz) | Turns on and off at 2 Hz: 250 ms on, 250 ms off |
| FLICKERING (Load Dependent) | Approx. 10 Hz for high Ethernet activity: ~50 ms on, ~50 ms off. Irregular intervals for low Ethernet activity |

# 7. Alarms

| ID | NAME | DESCRIPTION |
|---|---|---|
| 0 | NONE | No alarm |
| 1 | USER | User alarm |
| 2 | DATAFLASH | Data flash error |
| 3 | OVERVOLT | Overvoltage (autoresettable) |
| 4 | OVERCURR_HW1 | Overcurrent hardware (autoresettable) |
| 5 | OVERCURR_SW1 | Overcurrent software (autoresettable) |
| 6 | OVERTEMP_BOARD1 | Board overtemperature (autoresettable) |
| 7 | OVERTEMP_MOTOR1 | Motor overtemperature (autoresettable) |
| 8 | ENC_SPI_COMM | Encoder SPI communication error (autoresettable) |
| 9 | UNDERVOLT | Undervoltage (autoresettable) |
| 10 | ENC_ERR | Maximum encoder speed exceeded |
| 11 | MDB_WATCHDOG | Modbus Watchdog alarm |
| 20 | PARAM_ERROR | Parameter storage not available or damaged |
| 21 | PARAM_VAL_ERROR | Wrong value parameter |
| 22 | PARAM_RESTORE_DEFAULT | Restore parameter default error |
| 23 | MOTOR_PARAM_RESTORE_DEFAULT | Restore motor parameter default error |
| 24 | DATAFLASH_READ | Error in Flash Read |
| 25 | COLLISION_DETECTED | A collision was detected and motor stopped |
| 30 | FUNC_NOT_ENABLED | The function commanded is not enabled |
| 90 | EXT_DIG | User alarm generated by digital input |
| 91 | APPL_SWITCH_CONSISTENCY | Homing switch error |
| 92 | APPL_MOT_UNDEFINED | Motor type not selected |
| 99 | SILCHK_ALARM | Error in STO HW consistency |
| 101 | CSP_SYNC | Error in the CSP Synchronization |
| 102 | CSP_WRONGREF | Error in the CSP reference position |
| 105 | 1MS_OVERRUN | Task 1ms exceeded the deadline (real-time) |
| 106 | 10MS_OVERRUN | Task 10ms exceeded the deadline (real-time) |
| 107 | FB_BOARD_MISMATCH | Fieldbus board mismatched |
| 108 | FB_BOARD_FAILURE | Fieldbus board not correctly initialized |
| 109 | FB_SEC_MEMORY | Fieldbus board’s secure memory not working |

| ID | NAME | DESCRIPTION |
|---|---|---|
| 110 | FB_APP_FAILURE | Fieldbus mode not compatible with hardware |
| 120 | WL_BOARD_FAILURE | Wireless Board not working |
| 150 | WRONG_HOMING_PROCEDURE | Homing error |
| 151 | TIMEOUT_HOMING | Timeout Homing Error |
| 200 | PMSM_ENCNOTALIGNED | Encoder not aligned |
| 201 | PMSM_ENCALRMOTION | Encoder cannot detect the movement |
| 202 | PMSM_ENCALRVERSO | Wrong encoder direction |
| 203[1] | PMSM_ENCSPI_MT | Multi-turn encoder error. The multiturn position is not reliable. (autoresettable) |
| 204 | PMSM_ENCSPI_ST | Single-turn encoder error. The single-turn position is not reliable. (autoresettable) |
| 205 | PMSM_ENCALRTIMEOUT | Alignment was not completed within the prescribed time |
| 206 | PMSM_24BIT_ENCSPI | Error in 24bit encoder |
| 210 | ELPARAUTOTUNE_TIMEOUT | Time-out auto tuning error |

## 7.1. Events

| ID | NAME | DESCRIPTION |
|---|---|---|
| 1 | STARTUP | System restarted |
| 2 | USER | User event |
| 3 | ACCMAX_REACHED | Acceleration Limit reached |
| 11 | MOT_SWITCH_ON | Motor was switched on by user |
| 12 | MOT_SWITCH_OFF | Motor was switched off by user |
| 13 | MOT_SWITCH_OFF_ALR | Motor was switched off by an alarm |
| 21 | FBS_LINK_ESTB | Fieldbus Link Established |
| 22 | FBS_LINK_LOST | Fieldbus Link Lost |
| 23 | FBS_UPTIME_DSC_VHIGH | Netx time discontinuity |
| 24 | FBS_UPTIME_DSC_VLOW | Netx time discontinuity with low voltage |
| 25 | FBS_UPTIME_DSC_KO | Netx time discontinuity (not responding) |

## 7.2. Troubleshooting

### 7.2.1. ALR3 Overvoltage

- *Event*: The drive exceeds the voltage limit of 55V.
- *Most common cause*: Overvoltage induced by motor regeneration.

- *Solution*: Reduce deceleration/motor gains. Add a braking resistor to dissipate energy. Read the **Regenerative Braking** appendix for more information.

### 7.2.2. ALR5 Overcurrent SW

- *Event*: Current to be supplied calculated by the drive higher than the maximum limits.
- *Most common cause*: Dynamics required by the motor too high
- *Solution*: Check and possibly decrease the calibration of gains, accelerations, and decelerations. Check for possible mechanical jams that increase the load unexpectedly. Evaluate a larger motor.

### 7.2.3. ALR9 Undervoltage

- *Event*: Power voltage drops below 9V
- *Most common cause*: Electrical connections and/or power supply.
- *Solution*: Check that the power supply size is adequate to support the motor load. Check the electrical connections and the physical condition of connectors on the cable and motor.

Note: An emergency power shutdown with the motor activated generates an alarm 9. If the motor has parameter P082 set to 1-Always, this alarm is also signaled when power is lost with the motor not activated.

### 7.2.4. ALR8, 102, 108

- *Event*: Self-diagnosis of the drive's electronic components identifies an error.
- *Most common cause*: The specific component is not working correctly.
- *Solution*: Contact the brand's technical support.

### 7.2.5. ALR 6,7

- *Event*: Exceeding the temperature limits. Motor >=140°C, Electronics >=90°C.
- *Most common cause*: Heavy workload, operation outside specifications.
- *Solution*: Check ambient temperature such that ⇐40°C. Check for possible obstructions, dirt, or poor ventilation in the motor environment. Check the motor duty cycle.

### 7.2.6. ALR 203, 204

- *Event*: The encoder no longer has confidence in the value of the multi-turn encoder position.
- *Most common cause*: Encoder battery discharged.
- *Solution*: Leave the motor connected to the logic power supply for at least 24 hours before disconnecting it. Read the **Encoder** appendix for more information.

### 7.2.7. Frequent Disconnect from fieldbus Network - Event 22

- *Event*: Physical connection with the fieldbus cable lost. Signaled by events 22 on BSI.
- *Most common cause*: Inconsistent electrical connection of the cable.
- *Solution*: Check cable continuity. Check connector tightness. Check for physical damage to motor

connectors.

[1] The multiturn position is not reliable, so is mandatory to make a homing procedure.

# 8. Modbus Registers

Note: Available only in CanOpen/Modbus RTU driver version (DBS55/---/C)(DBS80/--/C)

## 8.1. Read and Write Registers

| ID | NAME | DESCRIPTION | NOTE |
|---|---|---|---|
| 3 | Control type | Available motor control type | RW 16-bit unsigned integer + Equivalent to P016 parameter<br>0 None<br>1 Torque<br>2 Speed<br>3 Position |
| 20 | Watchdog time | Watchdog time (ms) | RW 16-bit unsigned integer<br>Default value: 0<br>- If value is set to zero, watchdog is disabled<br>- If set between 100ms–65000ms, register 840 is cleared and alarm MODBUS_WATCHDOG is triggered<br>[1] |
| 840 | Run and direction | Enable the drive and set the rotating direction | RW 16-bit unsigned integer<br>Equivalent to P021 parameter<br>Bit 0: 0 Not enable / 1 Enable<br>Bit 1: 0 Forward / 1 Reverse |
| 829 | Last alarm / clear alarm list | Shows last alarm stored and allows clearing the list | RW 16-bit unsigned integer<br>Read = Last alarm<br>Write = 0 → Clear alarm list |
| 843 | Alarm reset | Allows alarm reset | RW 16-bit unsigned integer<br>0 No reset<br>0 → 1 Clear on rising edge |
| 4144 | Actual alarm | Shows actual error code | See error description in Alarm Section |
| 4177 | Enable write params | Stores settled parameters in flash | 0: storing disabled<br>0 → 1: changes are stored |
| 11 | Max current | Maximum motor current in torque control | RW 16-bit unsigned integer<br>Equivalent to P017 parameter<br>Range: 0–20000 [mA] |
| 16 | Max acceleration | Maximum acceleration (speed/position) | RW 16-bit unsigned integer<br>Equivalent to P008 parameter<br>Range: 1–15000 [rpm/s] |
| 17 | Max deceleration | Maximum deceleration (speed/position) | RW 16-bit unsigned integer<br>Equivalent to P009 parameter<br>Range: 1–15000 [rpm/s] |
| 841 | Speed target | Define motor target speed | RW 16-bit signed integer<br>[rpm] |
| 844 – 845 | Position target | Define target position | RW 32-bit signed integer<br>[User Unit] |

## 8.2. Read only registers

| ID | NOME | DESCRIZIONE | NOTE |
|---|---|---|---|
| 801 | Motor Speed | Shows the actual motor speed | R 16-bit signed integer [rpm] |
| 802 | Motor RMS Current | Shows the RMS current absorbed by the motor | R 16-bit signed integer [Arms*0.1] |
| 804 | Power supply voltage | Shows the DC motor bus voltage | R 16-bit unsigned integer [V*0.1] |
| 805 | Motor voltage supply | Shows the RMS voltage on the motor | R 16-bit signed integer [Vrms*0.1] |
| 806 | Motor temperature | Shows the motor temperature | R 16-bit signed integer [0.1°C] |
| 808-809 | Motor position | Shows the actual motor position | R 32-bit signed integer [User Unit] |
| 810 | Motor direction | Shows the rotating direction of the motor<br>• 0 – Forward<br>• 1 – Reverse | R 16-bit signed integer |
| 812 | Analog input value | | R 16-bit signed integer |
| 815 | Board temperature Sensor 1 | Shows the board temperature | R 16-bit signed integer [0.1°C] |
| 816 | Board temperature Sensor 2 | Shows the board temperature | R 16-bit signed integer [0.1°C] |
| 818 | Digital Input | Shows the digital inputs status | R 16-bit signed integer |
| 820 | Digital output | Shows the digital outputs status | R 16-bit signed integer |
| 822 | Brake output | Shows the electromagnetic brake status | R 16-bit signed integer |
| 825 | Register Overload % | Describe the voltage overload percentage referred to the motor | R 16-bit signed integer [0–100%] |
| 832 | Supply time 16LSB | Supply time (seconds) – 16LSB | R 16-bit signed integer (latched on reading) |
| 833 | Supply time 16MSB | Supply time (seconds) – 16MSB | R 16-bit signed integer (latched on reading) |
| 834 | Inverter on 16LSB | Inverter on (seconds) – 16LSB | R 16-bit signed integer (latched on reading) |
| 835 | Inverter on 16MSB | Inverter on (seconds) – 16MSB | R 16-bit signed integer (latched on reading) |
| 837 | SW version micro | Indicates the software version stored in the drive | R 16-bit signed integer |
| 838 | SW version encoder | Indicates the software version stored in the encoder | R 16-bit signed integer |

| ID | NOME | DESCRIZIONE | NOTE |
|---|---|---|---|
| 4132 | Reference generator state | Indicates the drive status | * 0 – OFF: No enable<br>* 1 – ENABLED: Enabled without run<br>* 2 – HALTED: PWM on with zero speed control<br>* 3 – ACCEL: PWM on with acceleration control<br>* 4 – DECEL: PWM on with deceleration control<br>* 5 – STEADY: PWM on with non-zero speed control<br>* 6 – STOPPING: PWM with deceleration until zero speed |

## 8.3. Homing Registers

| ID | NOME | DESCRIZIONE | NOTE |
|---|---|---|---|
| 257 | Homing type | Defines the homing type according to the CanOpen CIA402 standard. Equivalent to P152 parameter.<br>• Homing available:<br>• 1 – 15<br>• 33 – 35 | RW 16-bit signed integer |
| 258–259 | Home Offset | Defines the offset value taken into account during the homing. Equivalent to P168–169 parameters | RW 32-bit unsigned integer [User unit] |
| 260 | Homing switch search speed | Defines the motor speed during the research of the limit switch. Equivalent to P153 parameter | RW 16-bit unsigned integer [rpm] |
| 261 | Homing index search speed | Defines the motor speed during the achievement of the index pulse. Equivalent to P154 parameter | RW 16-bit unsigned integer [rpm] |
| 262 | Homing acceleration | Motor acceleration to reach the settled home velocity from zero. Equivalent to P155 parameter | RW 16-bit unsigned integer [rpm/s] |
| 263 | Homing deceleration | Motor deceleration to reach zero velocity from the target. Equivalent to P156 parameter | RW 16-bit unsigned integer [rpm/s] |
| 264 | Homing max time out | Time limit for data exchange during homing. If exceeded, an error is triggered. Equivalent to P157 parameter | RW 16-bit unsigned integer [s] |
| 265 | Homing max current | Current limit during homing. If exceeded, an error is triggered. Equivalent to P158 parameter | RW 16-bit unsigned integer [mA] |
| 266 | Homing Cmd | Enables or disables the homing procedure | RW 16-bit unsigned integer<br>* 0 – None<br>* 1 – Enable |

[1] Note: values from 1ms–99ms are internally set as 100ms (timeout <100ms not allowed)

# 9. CiA402 - Servodrive application profile

## 9.1. DS402 overview

The **CiA 402** profile (also known as **DS402** or **DSP402**, standardised as *IEC 61800-7-201/301*) is the device profile dedicated to *drives and motion control*. Independently from the fieldbus, it defines the *object dictionary*, the *state machine*, the *modes of operation* and the encoding of the *Control Word* and *Status Word*. Its purpose is to make the drive interoperable: a master can command servo drives from different manufacturers using the same standard objects.

### 9.1.1. How the servo drive is commanded

The interaction between the master (the controller) and the slave (the servo drive) always follows the same pattern, regardless of the selected operating mode:

- The servo drive exposes an **object dictionary**: every quantity (commands, references, state, feedback) is an object identified by a 16-bit hexadecimal index (e.g. `6040h`).
- The master enables power by walking the **state machine** (see State Machine): by writing the **Control Word** (`6040h`) it transitions from *Switch On Disabled* up to *Operation Enabled*, the only state in which the motor produces torque.
- The actual drive state is read from the **Status Word** (`6041h`).
- The active **operating mode** is selected with the *Modes of Operation* object (`6060h`) and confirmed by the drive in *Modes of Operation Display* (`6061h`).
- References and feedback are exchanged through the objects specific to the selected mode (for example *target position* `607Ah`, *target velocity* `60FFh`, *target torque* `6071h`, *position actual value* `6064h`).

In short: power is enabled through the state machine, the operating mode is chosen with `6060h`, references are written and motion is commanded by acting on the Control Word bits, reading the outcome from the Status Word.

### 9.1.2. Supported modes of operation

The implemented modes of operation are the following:

| Mode | Code | Description |
|---|---|---|
| Profile Position | 1 | Point-to-point positioning: the motor reaches a target position following a trapezoidal profile with settable velocity and acceleration/deceleration. Suited to classic absolute or relative positioning moves. |
| Profile Velocity | 3 | Velocity control: the motor follows a target speed reached through acceleration and deceleration ramps. |
| Profile Torque | 4 | Torque control: the motor delivers the requested torque (current), reached along a settable ramp. |
| Homing | 6 | Zero search: the motor runs a homing procedure to establish the absolute position reference according to the selected method. |
| Interpolated Position | 7 | Interpolated position (optional): the master sends a position reference every synchronisation cycle and the drive interpolates the trajectory. Typical of numeric control. |
| Cyclic Synchronous Position | 8 | Cyclic synchronous position (optional): position reference updated every cycle with optional feedforward offsets, for the tightest master control. Available only on EtherCAT/Powerlink. |

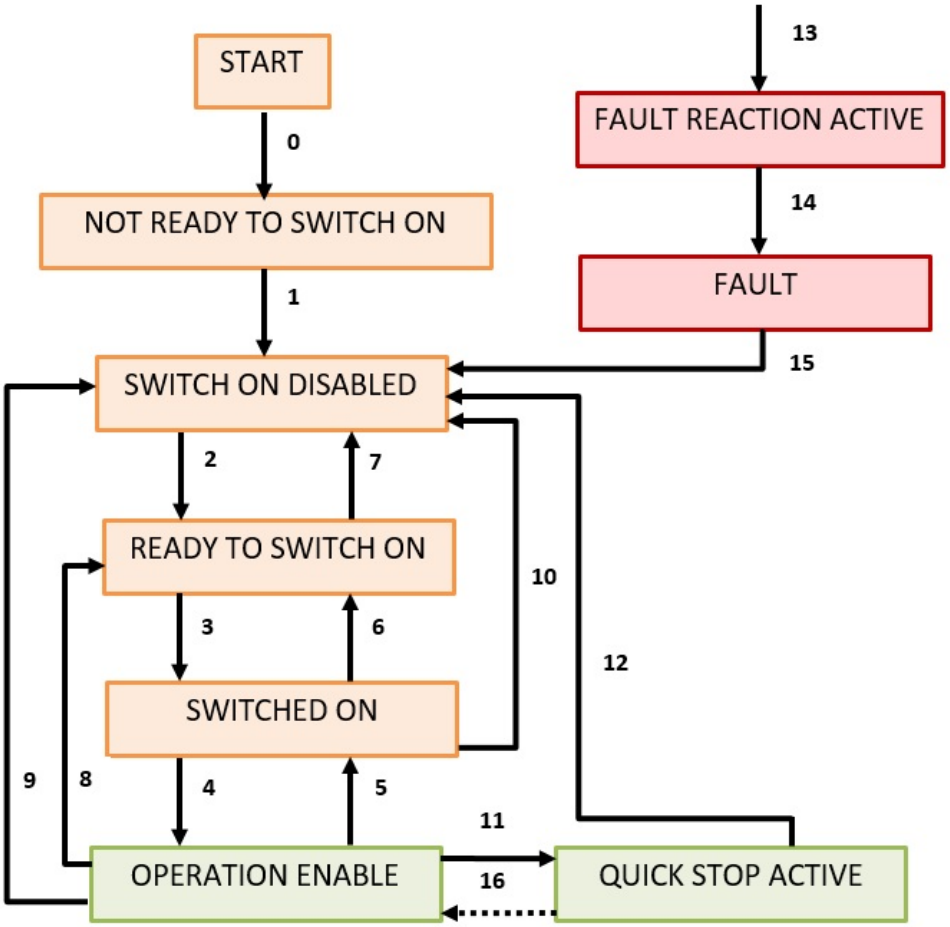
Each mode is detailed in its own section later in this chapter.

### 9.1.3. Fieldbuses and Modbus

The motor is commanded in DS402 over all the supported fieldbuses — **CANopen**, **EtherCAT**, **EtherNet/IP**, **PROFINET** and **Powerlink** — keeping *the same object model and the same application code*: only the transport layer changes, while the objects (`6040h`, `6041h`, `6060h`, …) and the logic described in this chapter stay identical.

The only exception is **Modbus**, which does not adopt the DS402 profile but works through *dedicated registers*: for its use refer to the Modbus Registers chapter.

## 9.2. State Machine




States in orange have power disabled. States in green have power enabled. Red states are alarm states. State machine description

| State | Descriptions |
|---|---|
| Not Ready to Switch On | Axis not ready to start, initialization not completed. |
| Switch On Disable | Axis ready to be started, parameters can be transferred, power can be enabled. |
| Ready To Switch On | Parameters can be transferred, power can be enabled, motor cannot be actuated |
| Switched On | Parameters can be transferred, power can be enabled, motor cannot be actuated |
| Operation Enable | No fault Present, Motor functions and power are enabled. |
| Quick Stop Active | Drive stopped with an emergency ramp, power enabled, functions disabled. |
| Fault Reaction Active | An Error occurred, drive is stopping. |
| Fault | A fault is active, drive is stopped and disabled. |

To change between states, following the numbered transitions, you need to send the correct control word, object 6040h, with specific bits enabled as shown in the following table.

| Command | Bit 7 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | Transitions |
|---|---|---|---|---|---|---|
| Shutdown | 0 | X | 1 | 1 | 0 | 2,6,8 |

| Command | Bit 7 | Bit 3 | Bit 2 | Bit 1 | Bit 0 | Transitions |
|---|---|---|---|---|---|---|
| Switch On | 0 | 0 | 1 | 1 | 1 | 3 |
| Disable Voltage | 0 | X | X | 0 | X | 7,9,10,12 |
| Quick Stop | 0 | X | 0 | 1 | X | 7,10,11 |
| Disable Operation | 0 | 0 | 1 | 1 | 1 | 5 |
| Enable Operation | 0 | 1 | 1 | 1 | 1 | 4,16 |
| Fault Reset | | X | X | X | X | 15 |

Control Word encoding is as follows:

| Bit | abbreviation | Name | Specific Functionality |
|---|---|---|---|
| 0 | so | Switch On | |
| 1 | ev | Enable Voltage | |
| 2 | qs | Quick Stop | |
| 3 | eo | Enable Operation | |
| 4 | oms | Operating Mode Specific | New Setpoint - Homing Start - Enable Interpolation |
| 5 | oms | Operating Mode Specific | Change Setpoint Immediately |
| 6 | oms | Operating Mode Specific | Absolute/Relative |
| 7 | fr | Fault Reset | |
| 8 | h | Halt | |
| 9 | oms | Operating Mode Specific | Change on Setpoint |
| 10 | r | Reserved | |
| 11 | ms | Manufacturer Specific | Touch Probe Offset Mode (optional) |
| 12 | ms | Manufacturer Specific | Touch Probe Module mode (optional) |
| 13 | ms | Manufacturer Specific | |
| 14 | ms | Manufacturer Specific | |
| 15 | ms | Manufacturer Specific | |

The drive state is communicated with object 6041h, the Status Word. The DS402 State Machine States are communicated with the following bits from the Status Word

| StatusWord bit values | State Machine State |
|---|---|
| xxxx xxxx x0xx 0000 | Not Ready To Switch On |
| xxxx xxxx x1xx 0000 | Switch On Disabled |
| xxxx xxxx x01x 0001 | Ready To Switch On |

| StatusWord bit values | State Machine State |
|---|---|
| xxxx xxxx x01x 0011 | Switched On |
| xxxx xxxx x01x 0111 | Operation Enabled |
| xxxx xxxx x00x 0111 | Quick Stop Active |
| xxxx xxxx x0xx 1111 | Fault Reaction Active |
| xxxx xxxx x0xx 1000 | Fault |

Status Word encoding is the following:

| Bit | abbreviation | Nome |
|---|---|---|
| 0 | rtso | Ready to Switch On |
| 1 | so | Switched On |
| 2 | oe | Operation Enabled |
| 3 | f | Fault |
| 4 | ve | Voltage Enabled |
| 5 | qs | Quick Stop |
| 6 | sod | Switch On Disabled |
| 7 | w | Warning |
| 8 | ms | Manufacturer Specific |
| 9 | rm | Remote |
| 10 | tr | Target Reached |
| 11 | ila | Internal Limit Active |
| 12 | oms | Operating Mode Specific |
| 13 | oms | Operating Mode Specific |
| 14 | ms | Manufacturer Specific |
| 15 | ms | Manufacturer Specific |

The Operating Mode Specific bits of the Status Word have the following meaning depending on the Operating Mode.

| Bit | Profile Position | Profile Velocity | Profile Torque | Homing | Interpolation | CSP |
|---|---|---|---|---|---|---|
| 10 | Target Reached | | | Homing Done | Target Reached | Toggle |
| 12 | Set Point Ack | Zero Speed | – | – | Interpolation Active | Following Setpoint |
| 13 | Following Error | – | – | Homing Error | – | Following Error |

## 9.3. position/speed/torque scaling

Position scaling is managed using a manufacturer specific mechanism. By changing servodrive parameters is possible to set the relation from position pulses and “position units” by means of:

- PosFactorNum (NUM)
- PosFactorDen (DEN)
- PosFactorDecimal (DEC)
- UserPosInversion (INV)

$PPulses = PPosUnits * NUM/DEN * 10^{DEC} * INV$
$PPosUnits = PPulses * DEN/NUM * 10^{-DEC} * INV$

Numeric Example:

- Motor pulses: 4096/rev.
- Gearbox Ratio: 7
- Screw pitch: 3

I need the position to be in millimeter and I want 0.1 precision.

$$(4096 * 7) / 3 = > 28672 / 3$$

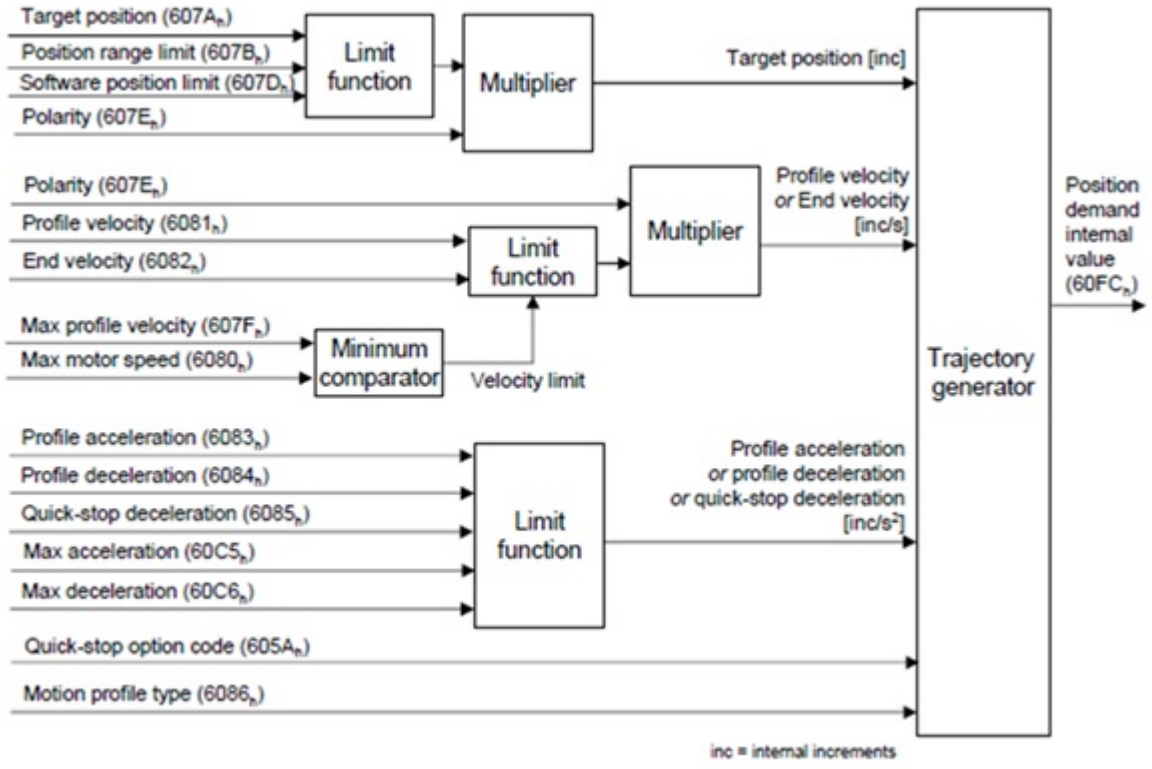
So the final numbers to put in the parameters for the scaling are:
PosFactorNum = 28672
PosFactorDen = 3
PosFactorDecimal = 1

Furthermore, is possible to set the polarity of the position and the speed information; the position scaling is not accessible via CanOpen but the position scaling defined via parameter is applied to all position objects that are specified as “Position units”.

The only exception is the polarity object (607Eh) that allows from the bus to change the direction of the position and/or velocity as defined by CiA402:

- Position Polarity Flag affects Profile position
- Velocity Polarity Flag affects Profile velocity

Homing mode and Torque mode are not affected by polarity. Velocity units are RPM (round per minute) and acceleration units are RPM/S (round per minute over a second). <<< === Profile Position




The profile position implementation includes the following features:

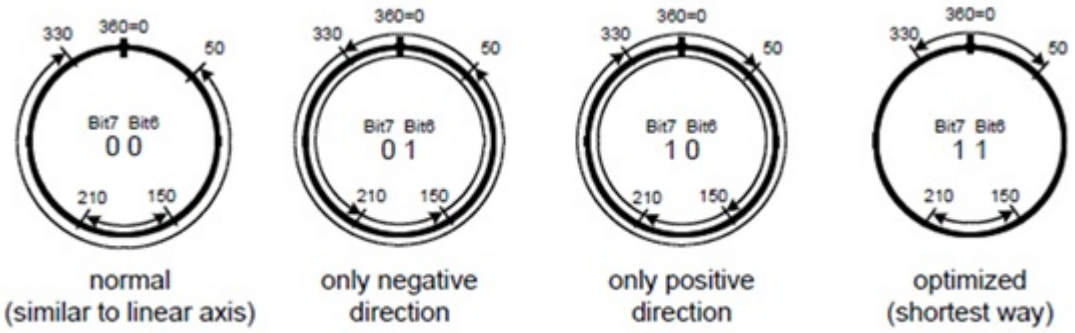
- Standard (Set of set-point) mode: up to 5 position targets can be stored using NEW_SET/SET_ACK mechanism
- Change Setpoint Immediately mode: after NEW_SET/SET_ACK the target is applied immediately
- Relative/Absolute
- Position limits (607Dh)
- Online limit change for Profile Velocity/Acceleration/Deceleration

Optional features **NOT** IMPLEMENTED:

- Change on setpoint mode: this mode is ignored and set of setpoint will be used
- Halt option code (605Dh): halt will always happen using profile deceleration
- End velocity is always zero rpm (6082h)
- Motion profile type (6086h) is not supported, profile is always speed-trapezoidal.
- The following Positioning option code (60F2h):
- Relative positioning is always referred to previous target
- Change setpoint immediately will always take place immediately
- Newset/setack will always take place as specified in section 10.2 of CiA402
- Position wrap of the range is not supported and will saturate to position limits

Modulo Implementation

- Modulo range is defined with the Position range objects (607Bh).
- Bit 6 and 7 of the Position Option Code (60F2h) regulate the behaviour of the modulo positioning.




| Position Option Code 60F2h | Bit7 | Bit6 |
|---|---|---|
| Normal | 0 | 0 |
| Only Negative | 0 | 1 |
| Only Positive | 1 | 0 |
| Optimized (Shortest Way) | 1 | 1 |

Manufacturer specific function implemented:

- using manufacturer specific bits in the control word (Bit11…15) is possible to enable manufacturer specific functions
- implemented function are triggered by values in the next table

| Function | Bit15 | Bit14 | Bit13 | Bit12 | Bit11 |
|---|---|---|---|---|---|
| Standard behaviour | 0 | 0 | 0 | 0 | 0 |
| Touchprobe positioning (DIN1 rising edge) | 0 | 0 | 0 | 0 | 1 |
| Touchprobe positioning (DIN1 falling edge) | 0 | 0 | 0 | 1 | 0 |
| Touchprobe modulo positioning (DIN1 rising edge) | 0 | 0 | 0 | 1 | 1 |
| Touchprobe modulo positioning (DIN1 falling edge) | 0 | 0 | 1 | 0 | 0 |
| Wait for global time | 0 | 1 | 0 | 0 | 0 |
| Wait for sync | 0 | 1 | 0 | 0 | 1 |

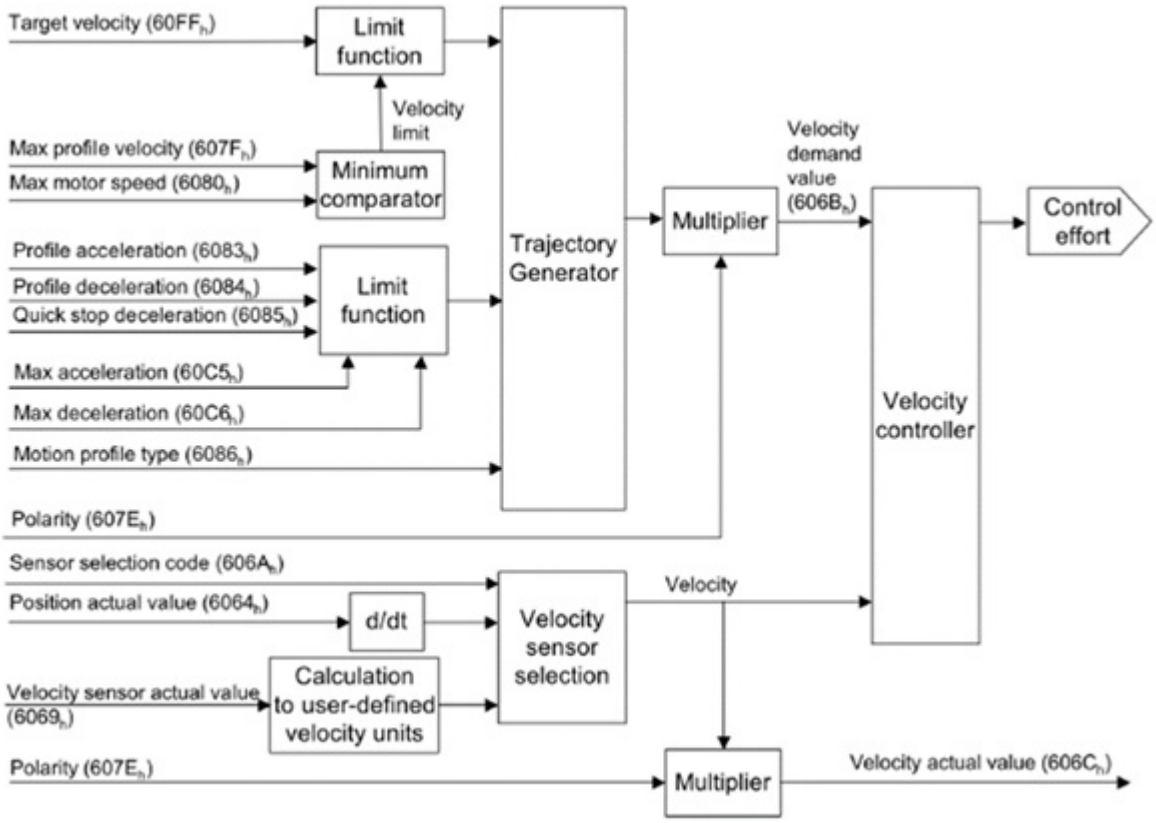
- During Touch-probe positioning the status_word is extended using manufacturer specific Bit14/Bit15 with the following meaning:

| Function | Bit15 | Bit14 |
|---|---|---|
| Standard behaviour | 0 | 0 |
| Touchprobe positioning: armed (wait for touch_probe) | 0 | 1 |
| Touchprobe positioning: position sensed, wait to complete | 1 | 1 |
| *Not allowed* | *1* | *0* |

See section DBS touch-probe extensions.

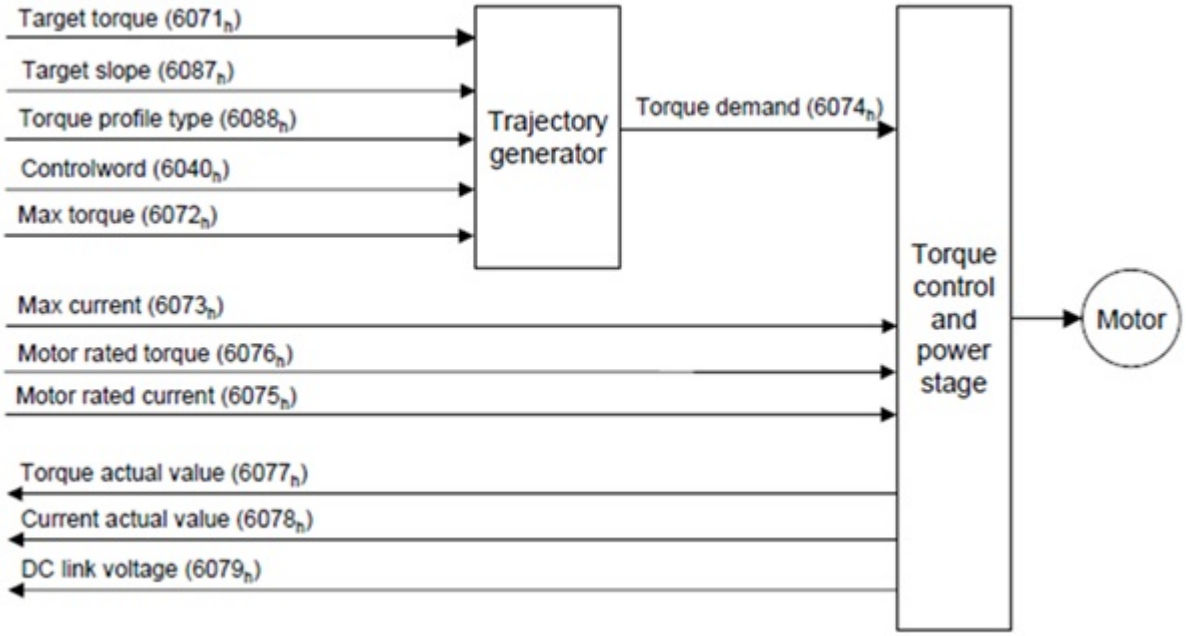
The “wait for global time” and “wait for sync” modes allow to defer the start of the profile generation on a particular event:

- Wait for global time: in fieldbus where the global time exists (e.g. Ethercat, CanopenOverAir) using object 3018h (profile position sync time) is possible to defer the profile generation until the sync time reaches a given value
- Wait for sync: in CanOpen over can-bus, is possible to defer the start of the profile until the drive detects a SYNC message on the bus <<< === Profile Velocity




Optional feature **NOT** IMPLEMENTED:

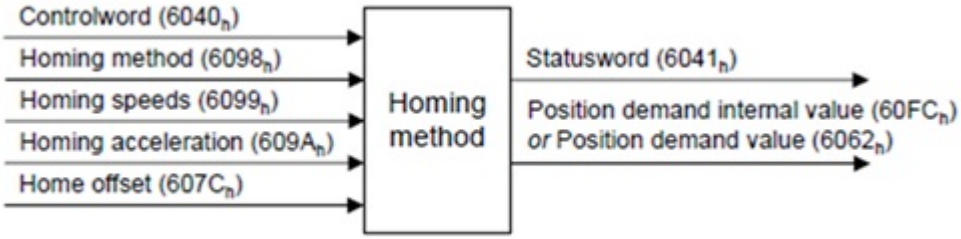
- Sensor code (6069h); the velocity is derived from the position information
- Sensor selector code (606Ah); position sensor cannot be selected
- Max slippage (60F8h) is not implemented since the max slippage control does not make sense for servodrive
- Motion profile type (6086h) is not supported, profile is always speed-trapezoidal. <<< === Profile Torque




Optional feature **NOT** IMPLEMENTED:

- Torque profile type (6088h) is not supported, profile is always torque-trapezoidal

## 9.4. Homing




Implemented homing types:

- Negative/positive switches (1, 2)
- Home + index (3,4,5,6)
- Home on the right + index (7,8,9,10)
- Home on the left + index (11,12,13,14)
- Index (33, 34)
- Set quota (37)

Homings are described in paragraph 11.

Optional feature **NOT** IMPLEMENTED:

- Supported homing methods object (60E3h): the supported homing methods are described in the previous section and in the servodrive manual.

## 9.5. Touch Probe (optional)

This functionality is implemented and uses DIN1. Touchprobe allows precise capture of the position while motor is running.

Touch-probe function 60B8h

| Bit | Value | Definition |
|---|---|---|
| 0 | 0 | Switch off touch probe 1 |
| | 1 | Enable touch probe 1 |
| 1 | 0 | Trigger first event |
| | 1 | continous |
| 4 | 0 | Switch off sampling at positive edge of touch probe 1 |
| | 1 | Enable sampling at positive edge of touch probe 1 |
| 5 | 0 | Switch off sampling at negative edge of touch probe 1 |
| | 1 | Enable sampling at negative edge of touch probe 1 |

bit 2..3 and 6..15 are reserved and should be left to zero.

Touch-probe status 60B9h

| Bit | Value | Definition |
|---|---|---|
| 0 | 0 | Touch probe 1 is switched off |
| | 1 | Touch probe 1 is enabled |
| 1 | 0 | Touch probe 1 no positive edge value stored |
| | 1 | Touch probe 1 positive edge position stored |
| 2 | 0 | Touch probe 1 no negative edge value stored |
| | 1 | Touch probe 1 negative edge position stored |

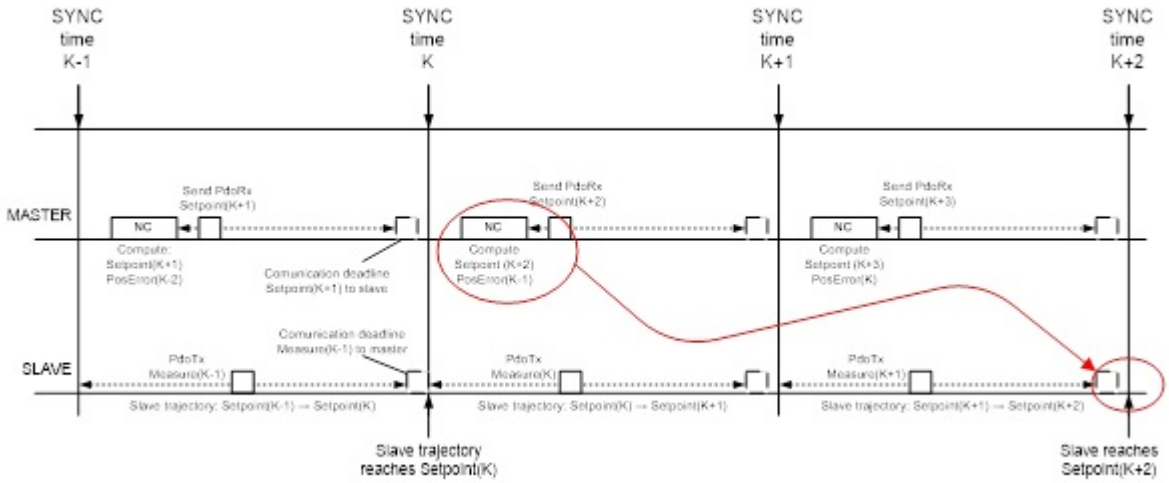
bit 3..15 are not used and will be read as zero.

Operation:

1. Touch-probe is armed via Bit0 of Function; capture can happen on first event or continuously (Bit1 of Function) and on rising or falling edge of the DIN1 input. At least one of Bit4 or Bit5 must be set in order to arm touch-probe sensing
2. Function is detected as armed via Status object Bit0
3. Whenever the first capture happens (either on rising edge or falling edge or both) Bit1 and Bit2 of Status will provide feedback to master. Objects 60BAh and 60BBh will allow master to read the probed motor position
4. If continuous operation is selected, subsequent events will update position read by master but Bit1/Bit2 of Status will retain set state

## 9.6. Interpolated mode (optional)

This profile allows operation with a numerical control; target buffering on the device side is NOT implemented: one value needs to be sent by the master to the device for each sync period and the device will generate a ramp that will drive the motor to that position on the end of the NEXT sync period; the next figure illustrates how the data exchange works.




Is worth noting that interpolated position mode inserts a delay of two sync periods from the master point of view: for example at time K, the numeric control will compute the position error of the previous sync period (K-1) and will compute the target that the slave will reach at time (K+2). Implemented features details:

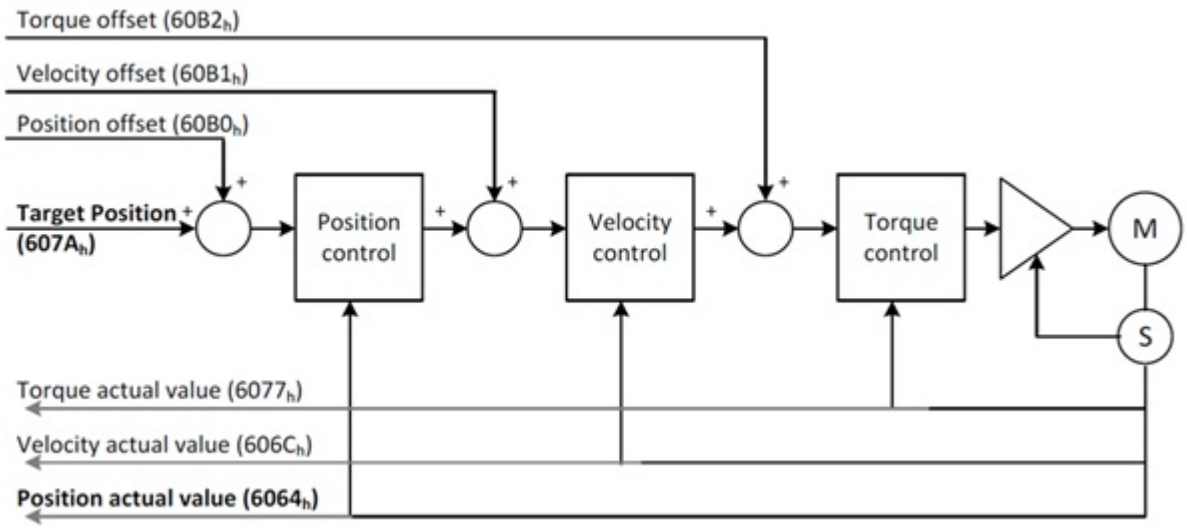
- interpolation submode selection (60C0h, type 0), only default linear interpolation can be selected
- allowed interpolation period range is 1.0ms … 100.0ms

Optional features **NOT** implemented:

- position range objects not implemented (607Bh)
- interpolation data configuration (60C4h) is not implemented since there is NO interpolation data buffer on the device; one target must be transferred from master on each synchronization period
- profile parameters don’t influence trajectory generation; the master is responsible of limiting speed/acceleration/deceleration in this mode

## 9.7. Cyclic Synchronous Position mode (CSP) (optional) - Only EtherCAT/Powerlink

The cyclic synchronous position mode allows interpolation in a similar way of the interpolated mode; this mode allows the master to manage more precisely the reference generation inside the servodrive. The following scheme is employed:




Using the offset objects, master can give feedforward actions in the inner loops of the servodrive allowing, for example, load torque compensation. The following optional functionalities are not supported in the CSP implementation:

- Output Cycle Counter (bit5/6 of control word) is not supported; objects 60D9h, 60DAh are not implemented
- Bit13 of the status word is the following error and not the second bit of Input Cycle Counter.

## 9.8. Default PDO Mapping

| PDO | COB-ID | Mapping | Trasm Type |
|---|---|---|---|
| PDORX1 | 0200h + NODEID | 6040h: control word<br>607Ah: target position<br>3012h: Max current [mA] | Enabled by default |
| PDORX2 | 0300h + NODEID | 60FFh: target velocity<br>6071h: target torque<br>6060h: mode of operation | Enabled by default |
| PDORX3 | 0400h + NODEID | – | Disabled by default |
| PDORX4 | 0500h + NODEID | – | Disabled by default |
| PDOTX1 | 0180h + NODEID | 6041h: status word<br>6064h: position actual value<br>3011h: current value [mA] | 255 + event time 100ms<br>Enabled by default |
| PDOTX2 | 0280h + NODEID | 606Ch: velocity actual value<br>3010h: tension value<br>6061h: mode of operation display | 255 + event time 100ms<br>Enabled by default |
| PDOTX3 | 0380h + NODEID | – | Disabled by default |
| PDOTX4 | 0480h + NODEID | – | Disabled by default |

## 9.9. EMCY codes

The following table summarizes the emergency codes emitted by the servodrive whenever an alarm is

detected.

| Code | Meaning |
|---|---|
| 2220h | Continuous overcurrent |
| 2230h | Instantaneous overcurrent |
| 3110h | Overvoltage in power supply |
| 4210h | Overtemperature in the power stage |
| 4310h | Overtemperature in the motor |
| 5530h | Hardware data storage error |
| 5531h | Software data storage error |
| 5532h | Parameter value error |
| 6200h | User generated alarm |
| 9000h | Digital input generated alarm |
| FF04h | Motor parameters copy error |
| FF05h | Motor parameter copy error (speed loop) |
| FF15h | 1ms task overtime |
| FF16h | 10ms task overtime |
| FF19h | Parameter restore error |
| FF20h | Motor not calibrated |
| FF21h | No movement during encoder calibration procedure |
| FF22h | Wrong direction during encoder calibration procedure |
| FF23h | Error during autoconfiguration procedure |
| FF24h | Error reading encoder multiturn information |
| FF25h | Error reading encoder singleturn information |

## 9.10. DBS touch-probe extension (optional)

The DBS family provide some extension to the standard touch probe mechanism.

### 9.10.1. Touch-probe positioning

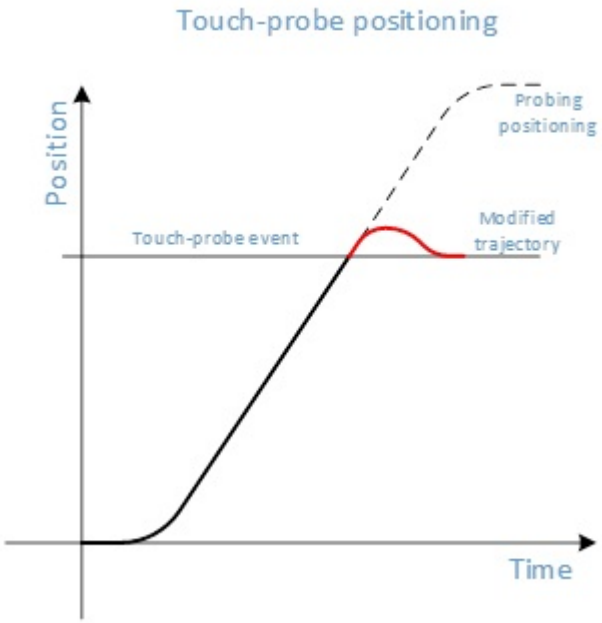
This function allows to modify on the fly the trajectory of the on-going positioning in order to reach the position related to the touch-probe event. This function is available when profile position is active.

The touch-probe positioning allows the following operation:

- motor is standstill
- master start a movement via standard “new_set” bit (control_word=001Fh)

- motor starts with defined profile position kinematic constraints (speed/acceleration)
- Master enables touch-probe positioning via Bit11..15 of the control word; for example touch-probe positioning on the rising edge of DIN1 is triggered by updating control_word=081Fh; status word Bit14 is set by motor reflecting positioning “armed”
- when the touch-probe is sensed the related position is captured (TP_Pos) and the status word Bit15 is set by motor signaling “position captured”
- motor modifies the trajectory in order to reach the target TP_Pos+TP_Offset (object 3020h)
- Motor reaches the position and stops (status word is updated as usual with Bit10 target reached).

The following diagram shows the behavior of the motor in “touch-probe positioning”:




## 9.10.2. Touch-probe modulo positioning

This function is similar to the previous but allows to manage positioning by means of “modulo” position. This allows for example to deal with circular axis where the same point can be reached in a given position P1, in the next modulo P1+MOD, after two modulo P1+2*MOD etc.

The typical example is where the modulo MOD is 1 motor turn; in the DBS the resolution of one turn is 4096 pulses/rev so in this example a given application point can be reached when the motor position is 0, 4096, 8192 etc; default value for object TP_Modulo 3021h is 4096.

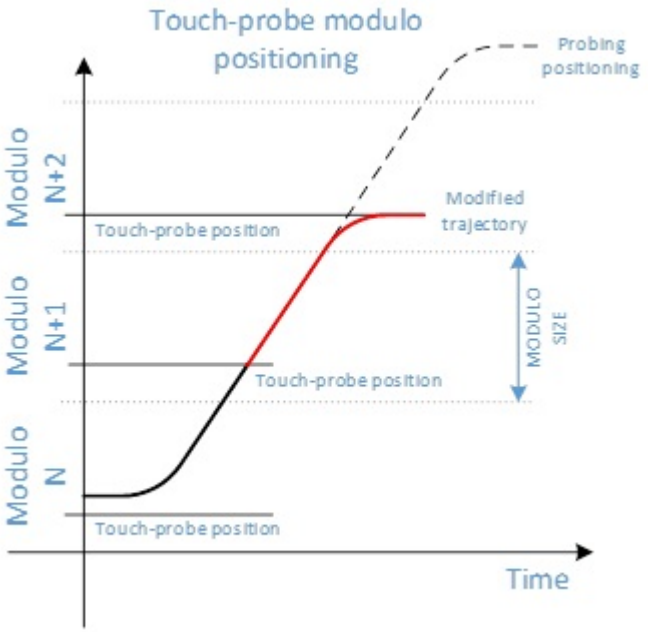
The purpose of the Touch-probe modulo positioning is reach the probed position without inverting the motion direction as soon as possible.

A typical operation is described by these steps:

- motor is standstill
- master start a movement via standard “new_set” bit (control_word=001Fh)
- motor starts with defined profile position kinematic constraints (speed/acceleration)
- master enables touch-probe positioning via Bit11..15 of the control word; for example touch-probe modulo positioning on the rising edge of DIN1 is triggered by updating control_word=181Fh; status word Bit14 is set by motor reflecting positioning “armed”

- when the touch-probe is sensed the related position is captured (TP_Pos) and the status word Bit15 is set by motor signaling “position captured”
- motor modifies the trajectory in order to reach the target TP_Pos+TP_Modulo (object 3021h) without changing direction
- motor reaches the position and stops (status word is updated as usual with Bit10 target reached).

The following diagram shows the behavior of the touch-probe modulo positioning:




Is worth noting that depending on kinematic constraints (profile velocity, acceleration, deceleration), the position that can be reached without inverting the direction could be farther than the position in the next modulo.

This example clarifies the scenario:

- modulo size: 4096
- start position: 2048
- probe position: 0 (and 4096, 8192,12288 etc.)
- the probing positioning in started in positive direction with high acceleration/speed and with low deceleration
- then motor reaches the first time the probe (position=4096);
- with given deceleration, the halt space is greater than 4096 pulses (e.g. 6000pulses); the motor modifies the target position to 12288 (2 turns after the probe)
- the motor reaches 12288 and stops.

In order to deal with this problem, when the touch probe event trigger the destination change, the DBS computes the halting space and modifies the destination in order to prevent direction change.

# 10. CanOpen/EtherCAT/Powerlink

## 10.1. Overview

Note: available only for drivers equipped with CanOpen/Modbus RTU, CanOpen over EtherCAT or Ethernet PowerLink. (---/---/C; ---/---/ETH; ---/---/EPL).

The present document describes the adherence of the Minimotor stack to the following specification:

CanOPEN

- CiA DS301 v4.02 (CanOPEN DLL)
- CiA DS402 v3.0.1.15 (servodrive profile)

CanOPEN over EtherCAT:

- ETG1000-2 v1.0.1 (physical layer)
- ETG1000-3 v1.0.1 (DLL services)
- ETG1000-4 v1.0.1 (DLL protocols)
- ETG1000-5 v1.0.1 (AL services)
- ETG1000-6 v1.0.1 (AL protocols)
- CiA DS402 v3.0.1.15 (servodrive)
- ETG6010 v1.1.0 (CiA 402 impl. directives)

Ethernet PowerLink (EPL)

- EPSG DS 301 V1.2.0 (Powerlink DLL)

The purpose of the present document is to describe what optional features are implemented by the servo-motor CanOPEN, CoE or EPL.

***Applicable ---/---/--- software release: ≥v4.036***

## 10.2. DS301 Communication Layer

This paragraph describes the details of the DS301 layer of the CanOpen interface. It applies only to the CanOPEN over can-bus implementation.

### 10.2.1. Physical Layer

Supported baudrate:

- 1Mbps tq=71ns SamplingPoint=11tq
- 500Kbps tq=142ns SamplingPoint=12tq

- 250Kbps tq=284ns SamplingPoint=12tq
- 125Kbps tq=571ns SamplingPoint=12tq
- 50Kbps tq=1.43us SamplingPoint=12tq
- 20Kbps tq=3.57us SamplingPoint=12tq

### 10.2.2. SDO protocol

- Maximum supported object size: 32bit
- Expedited transfer supported SUPPORTED
- Segmented transfer: NOT SUPPORTED
- Block transfer: NOT SUPPORTED

### 10.2.3. TIME protocol

The time protocol is NOT supported.

### 10.2.4. PDO protocol

The implementation supports up to 4 Pdo TX and 4 Pdo RX; each object can map up to 8 objects; mapping can be done only using the whole size of the object (i.e. is not possible to map 8 bit of a 32 bit object).

The following transmit type are implemented for PDO TX:

| Transmission Type | Description |
|---|---|
| 0 | PDO is emitted when changes occur after SYNC is received |
| 1..240 | PDO emitted after SYNC, depending on SYNC message occurrence (e.g. 1 = every SYNC, 2 = every 2 SYNC, etc.) |
| 241..251 | Not supported |
| 252 | PDO emitted after RTR reception<br>* Data sampled on SYNC<br>* Emitted after RTR |
| 253 | PDO emitted after RTR reception<br>* Data sampled and emitted after RTR |
| 254 | Not supported |
| 255 | PDO emitted asynchronously<br>Two features supported for emission control:<br>* Inhibit time (emission only when PDO content changes)<br>* Event timer (periodical asynchronous emission) |

Defaults:

- inhibit time: 100ms
- event time: 0 (periodic emission on TT=255 disabled by default)

See application profile for default PDO configuration. ==== EMCY protocol

Emergency protocol is implemented for reporting alarms from the servodrive; to control the emission of

EMCY messages, the inhibit time (object 1015h) can be modified. See the application profile for detailed list of alarms. (See paragraph 8.3)

### 10.2.5. NMT protocol

The NMT implementation includes standard commands for NMT state machine management. For node alive checking, the NODE GUARDING protocol is implemented; the behaviour of node guarding is set by objects 100Ch (guard time) and 100Dh (life factor).

### 10.2.6. HEARTBEATING

Heartbeating Protocol is supported. Register 1016h defines the time in multiples of 1ms for the Heartbeat protocol consumer. Register 1017h determines the time in multiples of 1ms for the producer of the protocol. Object 1029h determines the behaviour when the error is triggered.

## 10.3. Object Dictionary

Object dictionary is divided in the following sections:

| Range Objects | Functions |
|---|---|
| 1000h .. 1FFFh | Communication profile area |
| 2000h .. 21FFh | Manufacturer parameter area |
| 3000h .. 3FFFh | Manufacturer specific object area |
| 6000h .. 67FFh | Profiled objects |

Other areas are unused; the object list is common between CanOPEN, CoE and EPL implementation.

### 10.3.1. Communication area

The following table shows the list of communication area objects; since some objects are relevant only for CanOPEN or CoE implementation, the table shows in which fieldbus the object is relevant.

| Index | Description | CANopen | CoE | EPL |
|---|---|---|---|---|
| 1000 | Device type | X | X | X |
| 1001 | Error register | X | X | X |
| 1003 | Predefined error | X | X | |
| 1006 | Cycle length | | | X |
| 100C | Guard time | X | | |
| 100D | Life factor | X | | |
| 1010 | Store parameters, see Saving parameters to non-volatile memory | X | X | X |
| 1014 | EMCY cob-id | X | | |

| Index | Description | CANopen | CoE | EPL |
|---|---|---|---|---|
| 1015 | EMCY inhibit time | X | X | |
| 1016 | Consumer Heartbeat Time | X | | |
| 1017 | Producer Heartbeat Time | X | | |
| 1018 | Identity object | X | X | X |
| 1020 | CFM Verify Configuration | | | X |
| 1029 | Error Behaviour | X | | |
| 1030 | NMT Interface Group 0h | | | X |
| 1300 | SDO Sequ Layer Timeout | | | X |
| 1400 | PDO RX 1 – config [1] | X | X | X |
| 1401 | PDO RX 2 – config | X | | |
| 1402 | PDO RX 3 – config | X | | |
| 1403 | PDO RX 4 – config | X | | |
| 1600 | PDO RX 1 – mapping [1] | X | X | X |
| 1601 | PDO RX 2 – mapping | X | | |
| 1602 | PDO RX 3 – mapping | X | | |
| 1603 | PDO RX 4 – mapping | X | | |
| 1800 | PDO TX 1 – config [1] | X | X | X |
| 1801 | PDO TX 2 – config | X | | |
| 1802 | PDO TX 3 – config | X | | |
| 1803 | PDO TX 4 – config | X | | |
| 1A00 | PDO TX 1 – mapping [1] | X | X | X |
| 1A01 | PDO TX 2 – mapping | X | | |
| 1A02 | PDO TX 3 – mapping | X | | |
| 1A03 | PDO TX 4 – mapping | X | | |
| 1C00 | Sync manager types | | X | |
| 1C0A | DLL_CnCollision REC | | | X |
| 1C0B | DLL_CnLoss REC | | | X |
| 1C0C | DLL_CnLossSoC_REC | | | X |
| 1C0D | DLL_CnLossSoA REC | | | X |
| 1C0E | DLL_CnSpCJitter REC | | | X |
| 1C0F | DLL_CnCRCError REC | | | X |
| 1C10 | Sync manager 0 config | | X | |
| 1C11 | Sync manager 1 config | | X | |

| Index | Description | CANopen | CoE | EPL |
|---|---|---|---|---|
| 1C12 | Sync manager 2 config | | X | |
| 1C13 | Sync manager 3 config [1] | | X | |
| | DLL_CnSocJitterRange [1] | | | X |
| 1C14 | DLL_CnLossOfSocTolerance | | | X |
| 1C32 | Output sync parameters | | X | |
| 1C33 | Input sync parameters | | X | |
| 1E40 | NWL_IpAddrTable_0h_REC | | | X |
| 1E4A | NWL_IpGroup_REC | | | X |
| 1F82 | NMT_FeatureFlags_U32 | | | X |
| 1F83 | NMT_EPLVersion_U8 | | | X |
| 1F8C | NMT_CurrNMTState_U8 | | | X |
| 1F93 | NMT_EPLNodeID_REC | | | X |
| 1F98 | NMT_CycleTiming_REC | | | X |
| 1F99 | NMT_CNBasicEthernetTimeout_U32 | | | X |
| 1F9A | NMT_HostName_VSTR | | | X |
| 1F9E | NMT_ResetCmd_U8 | | | X |

*Saving parameters to non-volatile memory*

Writing an object in the 2000h … 21FFh range only alters the RAM image of the parameter: at the next power-up the drive reloads the values stored previously.

To make a change permanent, perform a 32 bit write of the value `65766173h` (the ASCII string "SAVE") to the *Store parameters* object `1010h.1`.

## 10.3.2. Manufacturer parameter area

The object range 2000h … 21FFh allows to access servodrive parameters; the following table summarize the details of a parameter object:

Object details

| Campo | Valore |
|---|---|
| Subidx | 0 |
| Object type | 16bit, signed integer |
| Access | Read/Write |
| PDO mappable | NO |

Object dictionary for manufacturer parameters

| Index | Description |
|---|---|
| 2000h | Parameter 0 |
| 2001h | Parameter 1 |
| … | … |
| 21FFh | Parameter 511 |

For details of the parameter meaning and encoding refer to the servodrive manual. IMPORTANT: Writing objects in the 2000h … 21FFh range will alter only the RAM image of the parameter; to actually save a parameter to non-volatile storage a 32 bit write of the value `65766173h` ("SAVE") to object `1010h.1` needs to be performed, as described in Saving parameters to non-volatile memory.

### 10.3.3. Manufacturer Specific Area

This area contains several object that allows to read/write manufacturer specific data.

| Index | Access | Data type | PDO mappable | Description |
|---|---|---|---|---|
| 3000h | RO | INT16 | YES | Ain0 value (-32768 to 32768) |
| 3001h | RO | UINT16 | YES | Digital input bits 0–4 |
| 3002h | RW | UINT16 | YES | Digital output bit0 |
| 3003h | RO | INT16 | YES | Heatsink temperature (x0.1 °C) |
| 3005h | RO | INT16 | YES | Motor temperature (x0.1 °C) |
| 3008h | RO | UINT16 | YES | Actual alarm code (not EMCY) |
| 3009h | RO | UINT | NO | Events (0–16, see section 6.1) |
| 3010h | RO | UINT16 | YES | Power stage tension (x0.1 V) |
| 3011h | RO | INT16 | YES | Motor IQ current (mA) |
| 3012h | RW | UINT16 | YES | Motor IQ limit (mA) |
| 3014h | RO | INT16 | YES | Output power (1W/lsb) |
| 3020h | RW | INT32 | YES | Touchprobe positioning offset |
| 3021h | RW | UINT32 | YES | Touchprobe positioning modulo |
| 3030h | RO | UINT16 | YES | Acceleration RMS modulus (milli-G) |
| 3031h | RO | UINT16 | YES | Acceleration RMS x (milli-G) |
| 3032h | RO | UINT16 | YES | Acceleration RMS y (milli-G) |
| 3033h | RO | UINT16 | YES | Acceleration RMS z (milli-G) |
| 3034h | RO | UINT16 | YES | Acceleration DC x (milli-G) |
| 3035h | RO | UINT16 | YES | Acceleration DC y (milli-G) |
| 3036h | RO | UINT16 | YES | Acceleration DC z (milli-G) |

| Index | Access | Data type | PDO mappable | Description |
|---|---|---|---|---|
| 3037h | RO | INT16 | YES | Instantaneous Acceleration x (milli-G) |
| 3038h | RO | INT16 | YES | Instantaneous Acceleration y (milli-G) |
| 3039h | RO | INT16 | YES | Instantaneous Acceleration z (milli-G) |

### 10.3.4. Profiled Objects

The range 6000h … 67FFh of objects are defined as specified by CiA402; refer to the application area for further information.

| Index | Access | Type | PDO mappable | Description |
|---|---|---|---|---|
| 6040h | RW | U16 | YES | Control word |
| 6041h | RO | U16 | YES | Status word |
| 605Ah | RW | U16 | | Quickstop option code |
| 605Bh | RW | U16 | | Shutdown option code |
| 605Ch | RW | U16 | | Disable operation option code |
| 605Dh | RW | U16 | | Halt option code |
| 605Eh | RW | U16 | | Fault reaction option code |
| 6060h | RW | S8 | YES | Mode of operation |
| 6061h | RO | S8 | YES | Mode of operation display |
| 6062h | RO | S32 | YES | Position demand value |
| 6064h | RO | S32 | YES | Position actual value |
| 6065h | RW | U32 | | Following error window |
| 6066h | RW | U16 | | Following error time |
| 6067h | RW | U32 | | Position window |
| 6068h | RW | U16 | | Position window time |
| 606Bh | RO | S32 | YES | Velocity demand |
| 606Ch | RO | S32 | YES | Velocity actual value |
| 606Dh | RW | U16 | | Velocity window |
| 606Eh | RW | U16 | | Velocity window time |
| 606Fh | RW | U16 | | Velocity threshold |
| 6070h | RW | U16 | | Velocity threshold time |
| 6071h | RW | S16 | YES | Target torque |
| 6072h | RW | U16 | YES | Max torque |
| 6073h | RW | U16 | YES | Max current |

| Index | Access | Type | PDO mappable | Description |
|---|---|---|---|---|
| 6074h | RO | S16 | YES | Torque demand value |
| 6075h | RO | U32 | YES | Motor rated current |
| 6076h | RO | U32 | YES | Motor rated torque |
| 6077h | RO | S16 | YES | Torque actual value |
| 6078h | RO | S16 | YES | Current actual value |
| 6079h | RO | U32 | YES | DC link voltage |
| 607Ah | RW | S32 | YES | Target position |
| 607Bh.0 | RO | U8 | YES | Position Range Limit – number of subindex |
| 607Bh.1 | RW | S32 | YES | Negative limit |
| 607Bh.2 | RW | S32 | YES | Positive limit |
| 607Ch | RW | S32 | YES | Home offset |
| 607Dh.0 | RO | U8 | YES | Software position limit – number of subindex |
| 607Dh.1 | RW | S32 | YES | Negative limit |
| 607Dh.2 | RW | S32 | YES | Positive limit |
| 607Eh | RW | U8 | | Polarity |
| 607Fh | RO | U32 | YES | Max speed |
| 6080h | RO | U32 | YES | Max speed (duplicate index) |
| 6081h | RW | U32 | YES | Profile velocity |
| 6083h | RW | U32 | YES | Profile acceleration |
| 6084h | RW | U32 | YES | Profile deceleration |
| 6085h | RW | U32 | YES | Quick stop deceleration |
| 6087h | RW | U32 | YES | Torque slope |
| 6098h | RW | S8 | YES | Homing method |
| 6099h.0 | RO | U8 | YES | Homing speed – number of subindex |
| 6099h.1 | RW | U32 | YES | Switch speed |
| 6099h.2 | RW | U32 | YES | Index speed |
| 609Ah | RW | U32 | YES | Homing acceleration |
| 60B0h | RW | S32 | YES | Position offset |
| 60B1h | RW | S32 | YES | Velocity offset |
| 60B2h | RW | S16 | YES | Torque offset |
| 60B8h | RW | U16 | YES | Touch-probe function |
| 60B9h | RW | U16 | YES | Touch-probe status |

| Index | Access | Type | PDO mappable | Description |
|---|---|---|---|---|
| 60BAh | RW | S32 | YES | Touch-probe positive edge latched position |
| 60BBh | RW | S32 | YES | Touch-probe negative edge latched position |
| 60C0h | RO | S16 | NO | IpData submode selection |
| 60C1h.0 | RO | U8 | YES | IpDataRecord – number of subindex |
| 60C1h.1 | RW | S32 | YES | IpData record |
| 60C2h.0 | RO | U8 | | Interpolation time period – number of subindex |
| 60C2h.1 | RW | S8 | | Ip time units |
| 60C2h.2 | RW | S8 | | Ip time index |
| 60F2h | RW | U16 | YES | Position Option Code |
| 60F4h | RO | U32 | YES | Following Error |
| 60FDh | RO | U32 | YES | Digital inputs |
| 60FEh.0 | RO | U8 | YES | Digital outputs – number of subindex |
| 60FEh.1 | RW | U32 | YES | Physical outputs |
| 60FEh.2 | RW | U32 | YES | Output mask |
| 60FFh | RW | S32 | YES | Target velocity |
| 6502h | RO | U32 | NO | Supported mode of operation |

[1] PDO config and mapping have different encoding for CoE/CanOPEN and EPL. Please check DLL manual for details.

# 11. Ethernet IP

Note: available only for drivers equipped with Ethernet IP optional board (---/---/EIP).

This document outlines the conformance of the Ethernet/IP and CIP stack implemented in the servodrive; the following documents apply unless otherwise stated:

- CIP Network library – Volume 1 (edition 3.3, november 2007)
- CIP Network library – Volume 2; Ethernet/IP adaptation of CIP (edition 1.4, november 2007)
- CiA DS402 v3.0.1.15

Furthermore the CiA DS402 adaptation to CIP are described in the relevant section.

## 11.1. CIP Objects

### 11.1.1. Overview

The servodrive implements the following objects of the CIP object model:

- CIP common objects
  - Identity object – 01h
  - Assembly object – 04h
  - TCP object – F5h
  - Ethernet object – F6h;
- Manufacturer specific objects
  - COM object – 0x64
  - PAR object – 0x65
  - MISC object – 0x66
  - CIA402 objects – 0x67

Furthermore the following ASSEMBLIES contain process data:

- O>>T: Assembly 0x64

- T>>O: Assembly 0x65
- CFG: Assembly 0x66

### 11.1.2. COM object - 0x64

| Instance | Attribute ID | Name | Data Type | Unit meas. | Access |
|---|---|---|---|---|---|
| 0x0 | 0x01 | Revision | UINT | | RO |
| 0x1 | 0x01 | Software edition | UINT | | RO |
| | 0x02 | Software CRC | UDINT | | RO |
| | 0x10 | Save parameters | UDINT | | RW |

*Saving parameters to non-volatile memory*

Writing an attribute of the PAR object only alters the RAM image of the parameter: at the next power-up the drive reloads the values stored previously.

To make a change permanent, perform a 32 bit write of the value `65766173h` (the ASCII string "SAVE") to the *Save parameters* attribute of the COM object: class `0x64`, instance `0x1`, attribute `0x10`.

### 11.1.3. COM object - 0x65

| Instance | Attribute ID | Name | Data Type | Unit meas. | Access |
|---|---|---|---|---|---|
| 0x0 | 0x01 | Revision | UINT | | RO |
| 0x1 | 0x00–0xFF | P000–P255 | UINT | | RW |
| 0x2 | 0x00–0xFF | P256–P511 | UINT | | RW |

**Special parameters** All 32 Bit parameter are divided in two 16 bits parameters of continguous numbering for the most significant and least significant bits.

These parameters are:

- P170 - Ip Addr
- P172 - Ip Mask
- P174 - Ip Gateway
- P120-135 - Multipos Ref 1 - 8

### 11.1.4. Misc objects - 0x66

| Instance | Attribute ID | Name | Data Type | Unit meas. | Access |
|---|---|---|---|---|---|
| 0x0 | 0x01 | Revision | UINT | | RO |

| Instance | Attribute ID | Name | Data Type | Unit meas. | Access |
|---|---|---|---|---|---|
| 0x30 (48) | 0x00 | Analog input 0 | UINT | | RO |
| | 0x01 | Digital inputs | UINT | | RO |
| | 0x02 | Digital outputs | UINT | | RW |
| | 0x03 | Heatsink temperature | UINT | 0.1 °C | RO |
| | 0x05 | Board temperature | UINT | 0.1 °C | RO |
| | 0x08 | Actual Alarm | UINT | N/A | RO |
| | 0x10 | Dclink voltage | UINT | 0.1 V | RO |
| | 0x11 | Current actual value | UINT | mA | RO |
| | 0x12 | Current limit for PP/PV/PT | UINT | mA | RO |

### 11.1.5. CiA 402 Objects - 0x67

| Instance | Attr. ID | Name | Data Type | Unit meas. | Access |
|---|---|---|---|---|---|
| 0x0 | 0x01 | Revision | UINT | | RO |
| 0x60 (96) | 0x40 | Control word | UINT | | RW |
| | 0x41 | Status word | UINT | | RO |
| | 0x5A | Quick-stop option code | INT | | RW |
| | 0x5C | Disable operation option code | INT | | RW |
| | 0x5E | Fault reaction code | INT | | RW |
| | 0x60 | Mode of operation | SINT | | RW |
| | 0x64 | Position actual value | DINT | pulses | RO |
| | 0x65 | Following error window | DINT | pulses | RW |
| | 0x66 | Following error time | INT | ms | RW |
| | 0x67 | Position window | DINT | pulses | RW |
| | 0x68 | Position window time | INT | ms | RW |
| | 0x6C | Velocity actual value | DINT | rpm | RO |
| | 0x6D | Velocity window | DINT | rpm | RW |
| | 0x6E | Velocity window time | INT | ms | RW |
| | 0x6F | Velocity threshold | DINT | rpm | RW |
| | 0x70 | Velocity threshold time | INT | ms | RW |
| | 0x71 | Target torque | INT | thousand-th of rated | RW |
| | 0x72 | Max torque | INT | thousand-th of rated | RW |

| Instance | Attr. ID | Name | Data Type | Unit meas. | Access |
|---|---|---|---|---|---|
| | 0x73 | Max current | INT | thousand-th of rated | RW |
| | 0x75 | Motor rated current | DINT | milliA | RO |
| | 0x76 | Motor rated torque | DINT | milliNm | RO |
| | 0x77 | Torque actual value | INT | thousand-th of rated | RO |
| | 0x78 | Current actual value | INT | thousand-th of rated | RO |
| | 0x7A | Target position | DINT | pulses | RW |
| | 0x7B | Position Range index1: min limit index2: max limit | ARRAY[1..2] OF DINT | pulses | RW |
| | 0x7C | Home offset | DINT | pulses | RW |
| | 0x7D | Position limits index1: min limit index2: max limit | ARRAY[1..2] OF DINT | pulses | RW |
| | 0x7E | Polarity | USINT | | RW |
| | 0x80 | Max motor speed | DINT | rpm | RO |
| | 0x81 | Profile velocity | DINT | rpm | RW |
| | 0x83 | Profile acceleration | DINT | rpm/s | RW |
| | 0x84 | Profile deceleration | DINT | rpm/s | RW |
| | 0x85 | Quick stop deceleration | DINT | rpm/s | RW |
| | 0x87 | Torque slope | INT | thousandth of rated / s | RW |
| | 0x98 | Homing method | SINT | | RW |
| | 0x99 | Homing speed index1: switch speed index2: index speed | ARRAY[1..2] OF DINT | rpm | RW |
| | 0x9A | Homing acceleration | DINT | rpm/s | RW |
| | 0xF2 | Profile Option Code | INT | | RW |
| | 0xFF | Target velocity | DINT | rpm | RW |

## 11.2. Process Data

**_Valid from Firmware ≥ v4.036 _** There are four possible configurations of the Ethernet IP process data.

- **Default (DFL)**: the standard process data implementing the profile velocity/torque/position/homing
- **A**: Standard process data with the possibility to read Digital and Analog inputs and command via fieldbus the Digital Out. The latter needs the parameter P015 on 10-Fieldbus to receive commands.
- **B**: A process data with the CiA 402 Touch probe functionality
- **C**: A process data with our manufacturer custom Touch Probe implementation

- **D**: A process data with acceleration three axis rms values

You must select the corresponding device description and set the parameter P176 to the desired value.

### 11.2.1. Layout Default (DFL)

The configuration for process data is the following:

Assembly 0x64 (Originator to Target, DBS/FC inputs - PLC outputs)
Assembly Length : 50 Bytes

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x00 | U16 | ControlWord | 0x67 | 0x60 | 0x40 | 0000h | see DSP402 |
| 0x02 | S32 | TargetPosition | 0x67 | 0x60 | 0x7A | +0 | position units |
| 0x06 | U16 | TorqueLimit | 0x67 | 0x60 | 0x72 | 1000 | × 0.1% Trq |
| 0x08 | S32 | TargetVelocity | 0x67 | 0x60 | 0xFF | +0 | rpm |
| 0x0C | S16 | TargetTorque | 0x67 | 0x60 | 0x71 | +0 | × 0.1% Trq |
| 0x0E | U8 | ModeOfOperation | 0x67 | 0x60 | 0x60 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | | | |
| 0x10 | U32 | ProfileVelocity | 0x67 | 0x60 | 0x81 | +3000 | rpm |
| 0x14 | U32 | ProfileAccel | 0x67 | 0x60 | 0x83 | +3000 | rpm/s |
| 0x18 | U32 | ProfileDecel | 0x67 | 0x60 | 0x84 | +3000 | rpm/s |
| 0x1C | S32 | PositionLimit.Neg | 0x67 | 0x60 | 0x7D.1 | -2147483648 | position units |
| 0x20 | S32 | PositionLimit.Pos | 0x67 | 0x60 | 0x7D.2 | +2147483647 | position units |
| 0x24 | S32 | HomingOffset | 0x67 | 0x60 | 0x7C | +0 | position units |
| 0x28 | S8 | HomingMethod | 0x67 | 0x60 | 0x98 | 37 | SetQuota [1] |

Assembly 0x65 (Target to Originator, DBS/FC outputs - PLC inputs)
Assembly Length : 20 Bytes

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x00 | U16 | StatusWord | 0x67 | 0x60 | 0x41 | 0250h | Motor Status [1] |
| 0x02 | S32 | PositionActualValue | 0x67 | 0x60 | 0x64 | +0 | position units |

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x06 | S16 | TorqueActualValue | 0x67 | 0x60 | 0x77 | +0 | × 0.1% Trq |
| 0x08 | S32 | VelocityActualValue | 0x67 | 0x60 | 0x6C | +0 | rpm |
| 0x0C | U16 | VDclink | 0x67 | 0x30 | 0x10 | +0 | × 0.1 V |
| 0x0E | U8 | ModeOfOperation | 0x67 | 0x60 | 0x60 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | | | |
| 0x10 | U16 | ActualAlarm | 0x67 | 0x30 | 0x08 | 0 | see DBS Manual |

### 11.2.2. Layout A

The configuration for process data is the following:

Assembly 0x64 (Originator to Target, DBS/FC inputs - PLC outputs)
Assembly Length : 50 Bytes

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x00 | U16 | ControlWord | 0x67 | 0x60 | 0x40 | 0000h | see DSP402 |
| 0x02 | S32 | TargetPosition | 0x67 | 0x60 | 0x7A | +0 | position units |
| 0x06 | U16 | TorqueLimit | 0x67 | 0x60 | 0x72 | 1000 | × 0.1% Trq |
| 0x08 | S32 | TargetVelocity | 0x67 | 0x60 | 0xFF | +0 | rpm |
| 0x0C | S16 | TargetTorque | 0x67 | 0x60 | 0x71 | +0 | × 0.1% Trq |
| 0x0E | U8 | ModeOfOperation | 0x67 | 0x60 | 0x60 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | | | |
| 0x10 | U32 | ProfileVelocity | 0x67 | 0x60 | 0x81 | +3000 | rpm |
| 0x14 | U32 | ProfileAccel | 0x67 | 0x60 | 0x83 | +3000 | rpm/s |
| 0x18 | U32 | ProfileDecel | 0x67 | 0x60 | 0x84 | +3000 | rpm/s |
| 0x1C | S32 | PositionLimit.Neg | 0x67 | 0x60 | 0x7D.1 | -2147483648 | position units |
| 0x20 | S32 | PositionLimit.Pos | 0x67 | 0x60 | 0x7D.2 | +2147483647 | position units |
| 0x24 | S32 | HomingOffset | 0x67 | 0x60 | 0x7C | +0 | position units |
| 0x28 | S8 | HomingMethod | 0x67 | 0x60 | 0x98 | 37 | SetQuota [1] |

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x29 | U8 | Padding Byte | | | | | |
| 0x2A | U16 | Digital output | 0x67 | 0x30 | 0x02 | 0 | bit0: DOUT1<br>bit1..15: not used [2] |

Assembly 0x65 (Target to Originator, DBS/FC outputs - PLC inputs)
Assembly Length : 30 Bytes

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x00 | U16 | StatusWord | 0x67 | 0x60 | 0x41 | 0250h | Motor Status [1] |
| 0x02 | S32 | PositionActualValue | 0x67 | 0x60 | 0x64 | +0 | position units |
| 0x06 | S16 | TorqueActualValue | 0x67 | 0x60 | 0x77 | +0 | × 0.1% Trq |
| 0x08 | S32 | VelocityActualValue | 0x67 | 0x60 | 0x6C | +0 | rpm |
| 0x0C | U16 | VDclink | 0x67 | 0x30 | 0x10 | +0 | × 0.1 V |
| 0x0E | U8 | ModeOfOperation | 0x67 | 0x60 | 0x60 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | | | |
| 0x10 | U16 | ActualAlarm | 0x67 | 0x30 | 0x08 | 0 | see DBS Manual |
| 0x12 | S16 | Analog Input | 0x67 | 0x30 | 0x00 | 0 | -32768 … +32767 |
| 0x14 | U16 | Digital Input | 0x67 | 0x30 | 0x01 | 0 | Bit0: DIN1<br>Bit1: DIN2<br>Bit2: DIN3<br>Bit3: DIN4<br>Bit4: DIN5<br>Bit5..15: not used |

### 11.2.3. Layout B

The configuration for process data is the following:

Assembly 0x64 (Originator to Target, DBS/FC inputs - PLC outputs)
Assembly Length : 50 Bytes

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x00 | U16 | ControlWord | 0x67 | 0x60 | 0x40 | 0000h | see DSP402 |
| 0x02 | S32 | TargetPosition | 0x67 | 0x60 | 0x7A | +0 | position units |
| 0x06 | U16 | TorqueLimit | 0x67 | 0x60 | 0x72 | 1000 | × 0.1% Trq |
| 0x08 | S32 | TargetVelocity | 0x67 | 0x60 | 0xFF | +0 | rpm |
| 0x0C | S16 | TargetTorque | 0x67 | 0x60 | 0x71 | +0 | × 0.1% Trq |

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x0E | U8 | ModeOfOperation | 0x67 | 0x60 | 0x60 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | | | |
| 0x10 | U32 | ProfileVelocity | 0x67 | 0x60 | 0x81 | +3000 | rpm |
| 0x14 | U32 | ProfileAccel | 0x67 | 0x60 | 0x83 | +3000 | rpm/s |
| 0x18 | U32 | ProfileDecel | 0x67 | 0x60 | 0x84 | +3000 | rpm/s |
| 0x1C | S32 | PositionLimit.Neg | 0x67 | 0x60 | 0x7D.1 | -2147483648 | position units |
| 0x20 | S32 | PositionLimit.Pos | 0x67 | 0x60 | 0x7D.2 | +2147483647 | position units |
| 0x24 | S32 | HomingOffset | 0x67 | 0x60 | 0x7C | +0 | position units |
| 0x28 | S8 | HomingMethod | 0x67 | 0x60 | 0x98 | 37 | SetQuota [1] |
| 0x29 | U8 | Padding Byte | | | | | |
| 0x2A | U16 | Digital output | 0x67 | 0x30 | 0x02 | 0 | bit0: DOUT1<br>bit1..15: not used [2] |
| 0x2C | U16 | Touch Probe Function | 0x67 | 0x60 | 0xB8 | 0 | [1] |

Assembly 0x65 (Target to Originator, DBS/FC outputs - PLC inputs)
Assembly Length : 40 Bytes

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x00 | U16 | StatusWord | 0x67 | 0x60 | 0x41 | 0250h | Motor Status [1] |
| 0x02 | S32 | PositionActualValue | 0x67 | 0x60 | 0x64 | +0 | position units |
| 0x06 | S16 | TorqueActualValue | 0x67 | 0x60 | 0x77 | +0 | × 0.1% Trq |
| 0x08 | S32 | VelocityActualValue | 0x67 | 0x60 | 0x6C | +0 | rpm |
| 0x0C | U16 | VDclink | 0x67 | 0x30 | 0x10 | +0 | × 0.1 V |
| 0x0E | U8 | ModeOfOperation | 0x67 | 0x60 | 0x60 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | | | |
| 0x10 | U16 | ActualAlarm | 0x67 | 0x30 | 0x08 | 0 | see DBS Manual |
| 0x12 | S16 | Analog Input | 0x67 | 0x30 | 0x00 | 0 | -32768 … +32767 |

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x14 | U16 | Digital Input | 0x67 | 0x30 | 0x01 | 0 | Bit0: DIN1<br>Bit1: DIN2<br>Bit2: DIN3<br>Bit3: DIN4<br>Bit4: DIN5<br>Bit5..15: not used |
| 0x16 | U16 | Touch Probe Status | 0x67 | 0x60 | 0xB9 | 0 | [1] |
| 0x18 | S32 | Touch Probe Rising Edge position | 0x67 | 0x60 | 0xBA | 0 | position units |
| 0x1C | S32 | Touch Probe Falling Edge position | 0x67 | 0x60 | 0xBB | 0 | position units |

### 11.2.4. Layout C

The configuration for process data is the following:

Assembly 0x64 (Originator to Target, DBS/FC inputs - PLC outputs)
Assembly Length : 60 Bytes

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x00 | U16 | ControlWord | 0x67 | 0x60 | 0x40 | 0000h | see DSP402 |
| 0x02 | S32 | TargetPosition | 0x67 | 0x60 | 0x7A | +0 | position units |
| 0x06 | U16 | TorqueLimit | 0x67 | 0x60 | 0x72 | 1000 | × 0.1% Trq |
| 0x08 | S32 | TargetVelocity | 0x67 | 0x60 | 0xFF | +0 | rpm |
| 0x0C | S16 | TargetTorque | 0x67 | 0x60 | 0x71 | +0 | × 0.1% Trq |
| 0x0E | U8 | ModeOfOperation | 0x67 | 0x60 | 0x60 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | | | |
| 0x10 | U32 | ProfileVelocity | 0x67 | 0x60 | 0x81 | +3000 | rpm |
| 0x14 | U32 | ProfileAccel | 0x67 | 0x60 | 0x83 | +3000 | rpm/s |
| 0x18 | U32 | ProfileDecel | 0x67 | 0x60 | 0x84 | +3000 | rpm/s |
| 0x1C | S32 | PositionLimit.Neg | 0x67 | 0x60 | 0x7D.1 | -2147483648 | position units |
| 0x20 | S32 | PositionLimit.Pos | 0x67 | 0x60 | 0x7D.2 | +2147483647 | position units |
| 0x24 | S32 | HomingOffset | 0x67 | 0x60 | 0x7C | +0 | position units |

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x28 | S8 | HomingMethod | 0x67 | 0x60 | 0x98 | 37 | SetQuota [1] |
| 0x29 | U8 | Padding Byte | | | | | |
| 0x2A | U16 | Digital output | 0x67 | 0x30 | 0x02 | 0 | bit0: DOUT1<br>bit1..15: not used [2] |
| 0x2C | S32 | Touch Probe positioning offset | 0x67 | 0x30 | 0x20 | 0 | Position Units |
| 0x2C | S32 | Touch Probe positioning modulo | 0x67 | 0x30 | 0x21 | 0 | Position Units |

Assembly 0x65 (Target to Originator, DBS/FC outputs - PLC inputs)
Assembly Length : 30 Bytes

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x00 | U16 | StatusWord | 0x67 | 0x60 | 0x41 | 0250h | Motor Status [1] |
| 0x02 | S32 | PositionActualValue | 0x67 | 0x60 | 0x64 | +0 | position units |
| 0x06 | S16 | TorqueActualValue | 0x67 | 0x60 | 0x77 | +0 | × 0.1% Trq |
| 0x08 | S32 | VelocityActualValue | 0x67 | 0x60 | 0x6C | +0 | rpm |
| 0x0C | U16 | VDclink | 0x67 | 0x30 | 0x10 | +0 | × 0.1 V |
| 0x0E | U8 | ModeOfOperation | 0x67 | 0x60 | 0x60 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | | | |
| 0x10 | U16 | ActualAlarm | 0x67 | 0x30 | 0x08 | 0 | see DBS Manual |
| 0x12 | S16 | Analog Input | 0x67 | 0x30 | 0x00 | 0 | -32768 … +32767 |
| 0x14 | U16 | Digital Input | 0x67 | 0x30 | 0x01 | 0 | Bit0: DIN1<br>Bit1: DIN2<br>Bit2: DIN3<br>Bit3: DIN4<br>Bit4: DIN5<br>Bit5..15: not used |

### 11.2.5. Layout D

The configuration for process data is the following:

Assembly 0x64 (Originator to Target, DBS/FC inputs - PLC outputs)
Assembly Length : 50 Bytes

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x00 | U16 | ControlWord | 0x67 | 0x60 | 0x40 | 0000h | see DSP402 |
| 0x02 | S32 | TargetPosition | 0x67 | 0x60 | 0x7A | +0 | position units |
| 0x06 | U16 | TorqueLimit | 0x67 | 0x60 | 0x72 | 1000 | × 0.1% Trq |
| 0x08 | S32 | TargetVelocity | 0x67 | 0x60 | 0xFF | +0 | rpm |
| 0x0C | S16 | TargetTorque | 0x67 | 0x60 | 0x71 | +0 | × 0.1% Trq |
| 0x0E | U8 | ModeOfOperation | 0x67 | 0x60 | 0x60 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | | | |
| 0x10 | U32 | ProfileVelocity | 0x67 | 0x60 | 0x81 | +3000 | rpm |
| 0x14 | U32 | ProfileAccel | 0x67 | 0x60 | 0x83 | +3000 | rpm/s |
| 0x18 | U32 | ProfileDecel | 0x67 | 0x60 | 0x84 | +3000 | rpm/s |
| 0x1C | S32 | PositionLimit.Neg | 0x67 | 0x60 | 0x7D.1 | -2147483648 | position units |
| 0x20 | S32 | PositionLimit.Pos | 0x67 | 0x60 | 0x7D.2 | +2147483647 | position units |
| 0x24 | S32 | HomingOffset | 0x67 | 0x60 | 0x7C | +0 | position units |
| 0x28 | S8 | HomingMethod | 0x67 | 0x60 | 0x98 | 37 | SetQuota [1] |
| 0x29 | U8 | Padding Byte | | | | | |
| 0x2A | U16 | Digital output | 0x67 | 0x30 | 0x02 | 0 | bit0: DOUT1<br>bit1..15: not used [2] |

Assembly 0x65 (Target to Originator, DBS/FC outputs - PLC inputs)
Assembly Length : 30 Bytes

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x00 | U16 | StatusWord | 0x67 | 0x60 | 0x41 | 0250h | Motor Status [1] |
| 0x02 | S32 | PositionActualValue | 0x67 | 0x60 | 0x64 | +0 | position units |
| 0x06 | S16 | TorqueActualValue | 0x67 | 0x60 | 0x77 | +0 | × 0.1% Trq |
| 0x08 | S32 | VelocityActualValue | 0x67 | 0x60 | 0x6C | +0 | rpm |
| 0x0C | U16 | VDclink | 0x67 | 0x30 | 0x10 | +0 | × 0.1 V |
| 0x0E | U8 | ModeOfOperation | 0x67 | 0x60 | 0x60 | 1 | Profile [1] |

| Offset | Type | Attribute | Class | Instance | Attr. ID | Default | Meaning |
|---|---|---|---|---|---|---|---|
| 0x0F | U8 | Padding Byte | | | | | |
| 0x10 | U16 | ActualAlarm | 0x67 | 0x30 | 0x08 | 0 | see DBS Manual |
| 0x12 | S16 | Analog Input | 0x67 | 0x30 | 0x00 | 0 | -32768 … +32767 |
| 0x14 | U16 | Digital Input | 0x67 | 0x30 | 0x01 | 0 | Bit0: DIN1<br>Bit1: DIN2<br>Bit2: DIN3<br>Bit3: DIN4<br>Bit4: DIN5<br>Bit5..15: not used |
| 0x16 | U16 | Acceleration rms | 0x67 | 0x30 | 0x31 | | |
| 0x19 | U16 | Acceleration rms | 0x67 | 0x30 | 0x32 | | |
| 0x1A | U16 | Acceleration rms | 0x67 | 0x30 | 0x33 | | |

[1] see DSP402

[2] P015=10 required for fieldbus operation

# 12. ProfiNET

Note: available only for drivers equipped with Profinet optional board (---/---/EPN).

This document outlines the details of the Profinet implementation for Minimotor DBS55 integrated servomotor. By enabling Profinet/DSP402 “reference mode”, the servodrive is commanded by means of CanOpen DSP402 state machine and profiles.

For further information, please refer to:

- DBS55 user manual: information about parametrization through USB and PC interface
- Dsp402 v3: information about device state machine, control word/status word encoding and object dictionary.

## 12.1. Device identity

- Vendor_ID: 0x0419
- Device_ID: 0x0001

## 12.2. Process Data

There are four possible configurations of the Profinet process data.

- **Default(DFL)**: the standard process data implementing the profile velocity/torque/position/homing
- **A**: Standard process data with the possibility to read Digital and Analog inputs and command via fieldbus the Digital Out. Parameter P015 must be on 10-Fieldbus.
- **B**: A process data with the CiA 402 Touch probe functionality
- **C**: A process data with our manufacturer custom Touch Probe implementation
- **D**: A process data with rms acceleration values of the three axis

You must select the corresponding device description and set the P176 parameter to the desired value.

### 12.2.1. Layout Default (DFL)

The configuration for process data is the following:

PLC Outputs (42 Bytes)

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x00 | U16 | ControlWord | 0x6040 | 0000h | see DSP402 |
| 0x02 | S32 | TargetPosition | 0x607A | +0 | position units |
| 0x06 | U16 | TorqueLimit | 0x6072 | 1000 | × 0.1% Trq |
| 0x08 | S32 | TargetVelocity | 0x60FF | +0 | rpm |
| 0x0C | S16 | TargetTorque | 0x6071 | +0 | × 0.1% Trq |
| 0x0E | U8 | ModeOfOperation | 0x6060 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | |
| 0x10 | U32 | ProfileVelocity | 0x6081 | +3000 | rpm |
| 0x14 | U32 | ProfileAccel | 0x6083 | +3000 | rpm/s |
| 0x18 | U32 | ProfileDecel | 0x6084 | +3000 | rpm/s |
| 0x1C | S32 | PositionLimit.Neg | 0x607D.1 | -2147483648 | position units |
| 0x20 | S32 | PositionLimit.Pos | 0x607D.2 | +2147483647 | position units |
| 0x24 | S32 | HomingOffset | 0x607C | +0 | position units |
| 0x28 | S8 | HomingMethod | 0x6098 | 37 | SetQuota [1] |
| 0x29 | U8 | Padding Byte | | | |

PLC Inputs (18 Bytes)

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x00 | U16 | StatusWord | 0x6041 | 0250h | Motor Status [1] |
| 0x02 | S32 | PositionActualValue | 0x6064 | +0 | position units |
| 0x06 | S16 | TorqueActualValue | 0x6077 | +0 | × 0.1% Trq |
| 0x08 | S32 | VelocityActualValue | 0x606C | +0 | rpm |
| 0x0C | U16 | VDclink | 0x3010 | +0 | × 0.1 V |
| 0x0E | U8 | ModeOfOperation | 0x6060 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | |
| 0x10 | U16 | ActualAlarm | 0x3008 | 0 | see DBS Manual |

### 12.2.2. Layout A

The configuration for process data is the following:

PLC outputs (44 Bytes)

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x00 | U16 | ControlWord | 0x6040 | 0000h | see DSP402 |
| 0x02 | S32 | TargetPosition | 0x607A | +0 | position units |
| 0x06 | U16 | TorqueLimit | 0x6072 | 1000 | × 0.1% Trq |
| 0x08 | S32 | TargetVelocity | 0x60FF | +0 | rpm |
| 0x0C | S16 | TargetTorque | 0x6071 | +0 | × 0.1% Trq |
| 0x0E | U8 | ModeOfOperation | 0x6060 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | |
| 0x10 | U32 | ProfileVelocity | 0x6081 | +3000 | rpm |
| 0x14 | U32 | ProfileAccel | 0x6083 | +3000 | rpm/s |
| 0x18 | U32 | ProfileDecel | 0x6084 | +3000 | rpm/s |
| 0x1C | S32 | PositionLimit.Neg | 0x607D.1 | -2147483648 | position units |
| 0x20 | S32 | PositionLimit.Pos | 0x607D.2 | +2147483647 | position units |
| 0x24 | S32 | HomingOffset | 0x607C | +0 | position units |
| 0x28 | S8 | HomingMethod | 0x6098 | 37 | SetQuota [1] |
| 0x29 | U8 | Padding Byte | | | |
| 0x2A | U16 | Digital output | 0x3002 | 0 | bit0: DOUT1<br>bit1..15: not used [2] |

PLC inputs (22 bytes)

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x00 | U16 | StatusWord | 0x6041 | 0250h | Motor Status [1] |
| 0x02 | S32 | PositionActualValue | 0x6064 | +0 | position units |
| 0x06 | S16 | TorqueActualValue | 0x6077 | +0 | × 0.1% Trq |
| 0x08 | S32 | VelocityActualValue | 0x606C | +0 | rpm |
| 0x0C | U16 | VDclink | 0x3010 | +0 | × 0.1 V |
| 0x0E | U8 | ModeOfOperation | 0x6060 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | |

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x10 | U16 | ActualAlarm | 0x3008 | 0 | see DBS Manual |
| 0x12 | S16 | Analog Input | 0x3000 | 0 | -32768 … +32767 |
| 0x14 | U16 | Digital Input | 0x3001 | 0 | Bit0: DIN1<br>Bit1: DIN2<br>Bit2: DIN3<br>Bit3: DIN4<br>Bit4: DIN5<br>Bit5..15: not used |

### 12.2.3. Layout B

The configuration for process data is the following:

PLC outputs (46 bytes)

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x00 | U16 | ControlWord | 0x6040 | 0000h | see DSP402 |
| 0x02 | S32 | TargetPosition | 0x607A | +0 | position units |
| 0x06 | U16 | TorqueLimit | 0x6072 | 1000 | × 0.1% Trq |
| 0x08 | S32 | TargetVelocity | 0x60FF | +0 | rpm |
| 0x0C | S16 | TargetTorque | 0x6071 | +0 | × 0.1% Trq |
| 0x0E | U8 | ModeOfOperation | 0x6060 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | |
| 0x10 | U32 | ProfileVelocity | 0x6081 | +3000 | rpm |
| 0x14 | U32 | ProfileAccel | 0x6083 | +3000 | rpm/s |
| 0x18 | U32 | ProfileDecel | 0x6084 | +3000 | rpm/s |
| 0x1C | S32 | PositionLimit.Neg | 0x607D.1 | -2147483648 | position units |
| 0x20 | S32 | PositionLimit.Pos | 0x607D.2 | +2147483647 | position units |
| 0x24 | S32 | HomingOffset | 0x607C | +0 | position units |
| 0x28 | S8 | HomingMethod | 0x6098 | 37 | SetQuota [1] |
| 0x29 | U8 | Padding Byte | | | |
| 0x2A | U16 | Digital output | 0x3002 | 0 | bit0: DOUT1<br>bit1..15: not used [2] |
| 0x2C | U16 | Touch Probe Function | 0x60B8 | 0 | [1] |

PLC inputs (32 bytes)

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x00 | U16 | StatusWord | 0x6041 | 0250h | Motor Status [1] |
| 0x02 | S32 | PositionActualValue | 0x6064 | +0 | position units |
| 0x06 | S16 | TorqueActualValue | 0x6077 | +0 | × 0.1% Trq |
| 0x08 | S32 | VelocityActualValue | 0x606C | +0 | rpm |
| 0x0C | U16 | VDclink | 0x3010 | +0 | × 0.1 V |
| 0x0E | U8 | ModeOfOperation | 0x6060 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | |
| 0x10 | U16 | ActualAlarm | 0x3008 | 0 | see DBS Manual |
| 0x12 | S16 | Analog Input | 0x3000 | 0 | -32768 … +32767 |
| 0x14 | U16 | Digital Input | 0x3001 | 0 | Bit0: DIN1<br>Bit1: DIN2<br>Bit2: DIN3<br>Bit3: DIN4<br>Bit4: DIN5<br>Bit5..15: not used |
| 0x16 | U16 | Touch Probe Status | 0x60B9 | 0 | [1] |
| 0x18 | S32 | Touch Probe Rising Edge position | 0x60BA | 0 | position units |
| 0x1C | S32 | Touch Probe Falling Edge position | 0x60BB | 0 | position units |

### 12.2.4. Layout C

The configuration for process data is the following:

PLC outputs (52 Bytes)

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x00 | U16 | ControlWord | 0x6040 | 0000h | see DSP402 |
| 0x02 | S32 | TargetPosition | 0x607A | +0 | position units |
| 0x06 | U16 | TorqueLimit | 0x6072 | 1000 | 0.1% Trq |
| 0x08 | S32 | TargetVelocity | 0x60FF | +0 | rpm |
| 0x0C | S16 | TargetTorque | 0x6071 | +0 | 0.1% Trq |
| 0x0E | U8 | ModeOfOperation | 0x6060 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | |
| 0x10 | U32 | ProfileVelocity | 0x6081 | +3000 | rpm |
| 0x14 | U32 | ProfileAccel | 0x6083 | +3000 | rpm/s |

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x18 | U32 | ProfileDecel | 0x6084 | +3000 | rpm/s |
| 0x1C | S32 | PositionLimit.Neg | 0x607D.1 | -2147483648 | position units |
| 0x20 | S32 | PositionLimit.Pos | 0x607D.2 | +2147483647 | position units |
| 0x24 | S32 | HomingOffset | 0x607C | +0 | position units |
| 0x28 | S8 | HomingMethod | 0x6098 | 37 | SetQuota [1] |
| 0x29 | U8 | Padding Byte | | | |
| 0x2A | U16 | Digital output | 0x3002 | 0 | bit0: DOUT1<br>bit1..15: not used [2] |
| 0x2C | S32 | Touch Probe positioning offset | 0x3020 | 0 | Position Units |
| 0x2C | S32 | Touch Probe positioning modulo | 0x3021 | 0 | Position Units |

PLC inputs (22 bytes)

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x00 | U16 | StatusWord | 0x6041 | 0250h | Motor Status [1] |
| 0x02 | S32 | PositionActualValue | 0x6064 | +0 | position units |
| 0x06 | S16 | TorqueActualValue | 0x6077 | +0 | × 0.1% Trq |
| 0x08 | S32 | VelocityActualValue | 0x606C | +0 | rpm |
| 0x0C | U16 | VDclink | 0x3010 | +0 | × 0.1 V |
| 0x0E | U8 | ModeOfOperation | 0x6060 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | |
| 0x10 | U16 | ActualAlarm | 0x3008 | 0 | see DBS Manual |
| 0x12 | S16 | Analog Input | 0x3000 | 0 | -32768 … +32767 |
| 0x14 | U16 | Digital Input | 0x3001 | 0 | Bit0: DIN1<br>Bit1: DIN2<br>Bit2: DIN3<br>Bit3: DIN4<br>Bit4: DIN5<br>Bit5..15: not used |

### 12.2.5. Layout D

The configuration for process data is the following:

PLC outputs (44 Bytes)

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x00 | U16 | ControlWord | 0x6040 | 0000h | see DSP402 |
| 0x02 | S32 | TargetPosition | 0x607A | +0 | position units |
| 0x06 | U16 | TorqueLimit | 0x6072 | 1000 | × 0.1% Trq |
| 0x08 | S32 | TargetVelocity | 0x60FF | +0 | rpm |
| 0x0C | S16 | TargetTorque | 0x6071 | +0 | × 0.1% Trq |
| 0x0E | U8 | ModeOfOperation | 0x6060 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | |
| 0x10 | U32 | ProfileVelocity | 0x6081 | +3000 | rpm |
| 0x14 | U32 | ProfileAccel | 0x6083 | +3000 | rpm/s |
| 0x18 | U32 | ProfileDecel | 0x6084 | +3000 | rpm/s |
| 0x1C | S32 | PositionLimit.Neg | 0x607D.1 | -2147483648 | position units |
| 0x20 | S32 | PositionLimit.Pos | 0x607D.2 | +2147483647 | position units |
| 0x24 | S32 | HomingOffset | 0x607C | +0 | position units |
| 0x28 | S8 | HomingMethod | 0x6098 | 37 | SetQuota [1] |
| 0x29 | U8 | Padding Byte | | | |
| 0x2A | U16 | Digital output | 0x3002 | 0 | bit0: DOUT1<br>bit1..15: not used [2] |

## PLC inputs (28 Bytes)

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x00 | U16 | StatusWord | 0x6041 | 0250h | Motor Status [1] |
| 0x02 | S32 | PositionActualValue | 0x6064 | +0 | position units |
| 0x06 | S16 | TorqueActualValue | 0x6077 | +0 | × 0.1% Trq |
| 0x08 | S32 | VelocityActualValue | 0x606C | +0 | rpm |
| 0x0C | U16 | VDclink | 0x3010 | +0 | × 0.1 V |
| 0x0E | U8 | ModeOfOperation | 0x6060 | 1 | Profile [1] |
| 0x0F | U8 | Padding Byte | | | |
| 0x10 | U16 | ActualAlarm | 0x3008 | 0 | see DBS Manual |
| 0x12 | S16 | Analog Input | 0x3000 | 0 | -32768 … +32767 |

| Offset | Type | Attribute | CIA402 Object | Default | Meaning |
|---|---|---|---|---|---|
| 0x14 | U16 | Digital Input | 0x3001 | 0 | Bit0: DIN1<br>Bit1: DIN2<br>Bit2: DIN3<br>Bit3: DIN4<br>Bit4: DIN5<br>Bit5..15: not used |
| 0x16 | U16 | Acceleration rms x | 0x3031 | | |
| 0x19 | U16 | Acceleration rms y | 0x3032 | | |
| 0x1A | U16 | Acceleration rms z | 0x3033 | | |

## 12.3. Saving parameters

*Saving parameters to non-volatile memory*

An acyclic write to a parameter only alters its RAM image: at the next power-up the drive reloads the values stored previously.

To make a change permanent, perform a 32 bit write of the value `65766173h` (the ASCII string "SAVE") to the *Store parameters* index `1010h`, whose subindex is not addressable.

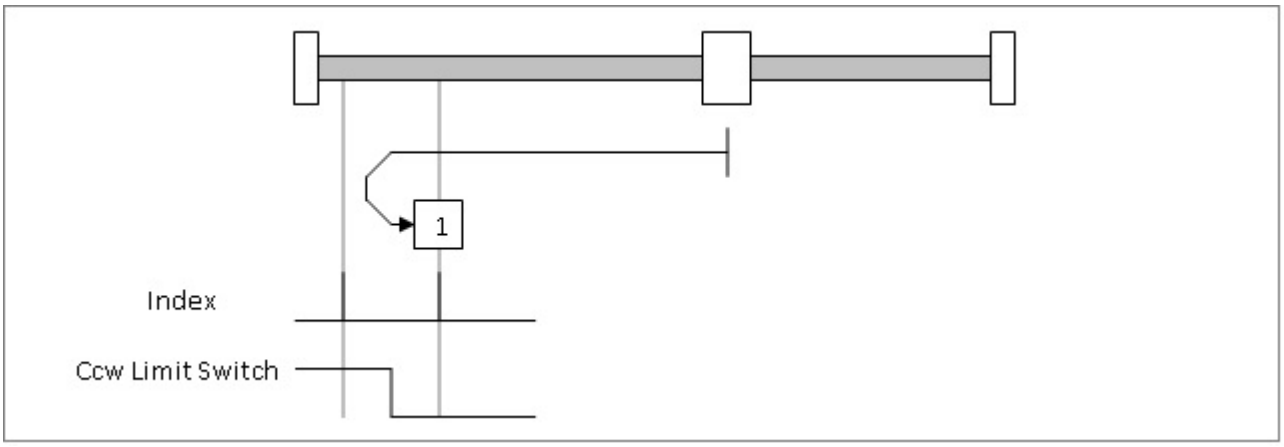
[1] see DSP402

[2] P015=10 required for fieldbus operation

# 13. Homing Types

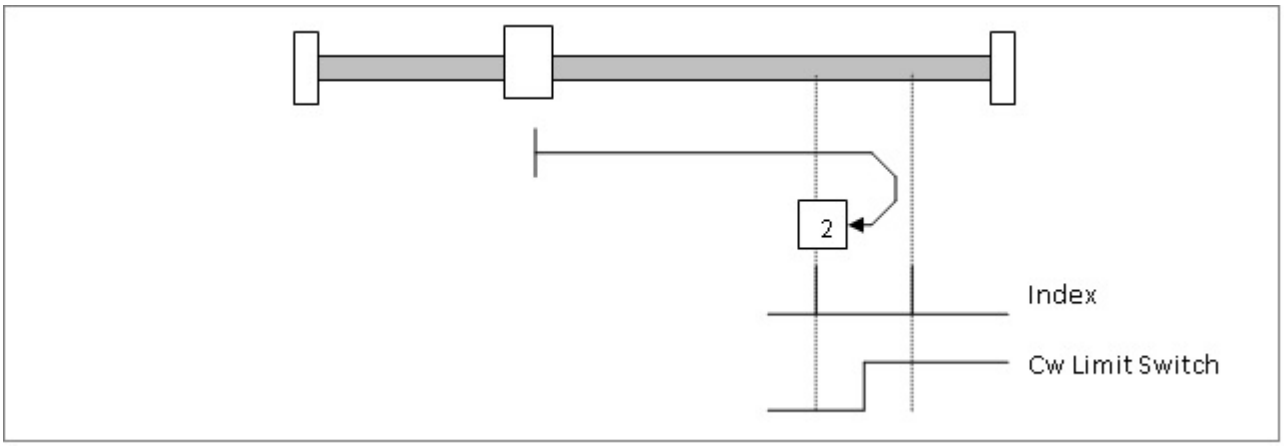
## 13.1. Type 1: Homing on anticlockwise limit switch and index pulse (resolver zero).

The initial direction of movement is anticlockwise towards the (anticlockwise) limit switch if this is inactive. The reference (home) position is on the first index pulse (resolver zero) to the right of the anticlockwise limit switch, when the value on the latter switches to low.




## 13.2. Type 2: Homing on clockwise limit switch and index pulse (resolver zero)

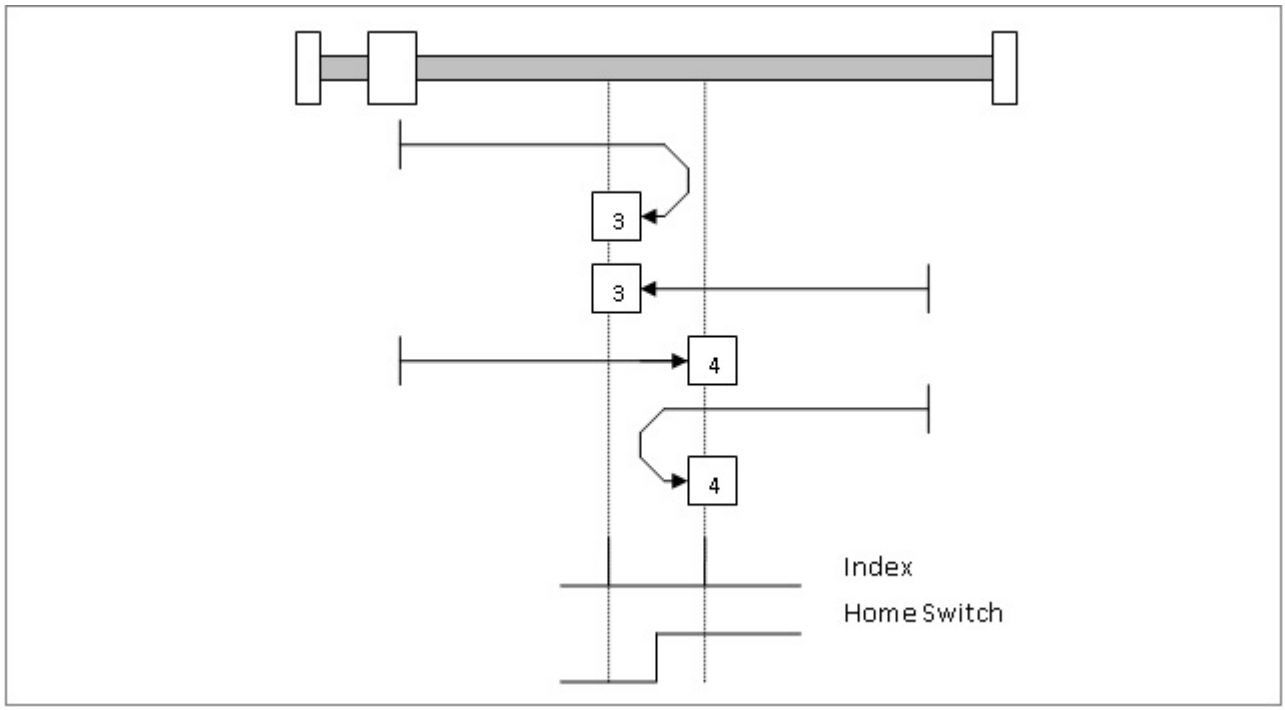
The initial direction of movement is clockwise towards the (clockwise) limit switch if this is inactive. The reference (home) position is on the first index pulse (resolver zero) to the left of the clockwise limit switch, when the value on the latter switches to low




## 13.3. Type 3 and 4: homing on the positive Home Switch and Index Pulse (resolver zero)

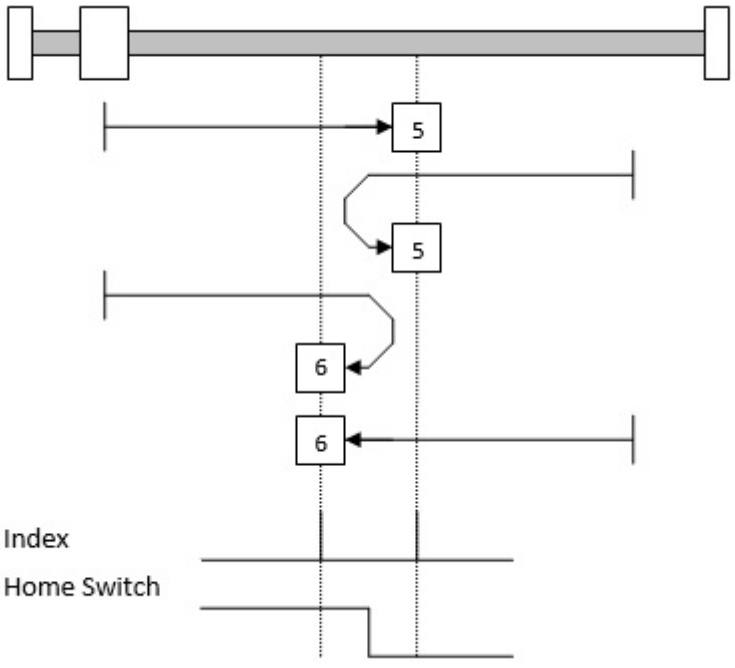
The initial direction of movement depends on the state of the home switch. The reference (home) position is on the index pulse (resolver zero) to the left (type 4) or right (type 3) of the switching point of the home switch. If the starting position is such that a reversal of direction is required, the reversal takes place after the

state of the home switch changes.



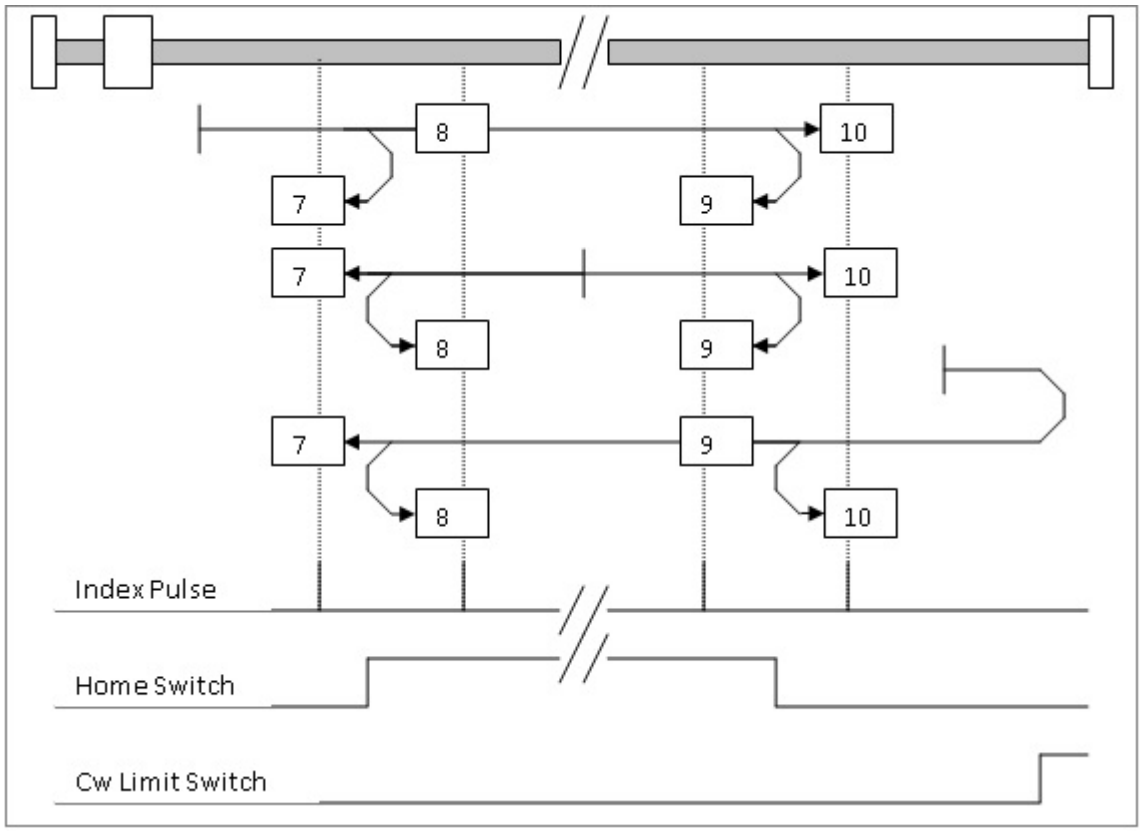

## 13.4. Type 5 and 6: homing on the negative Home Switch and Index Pulse (resolver zero)

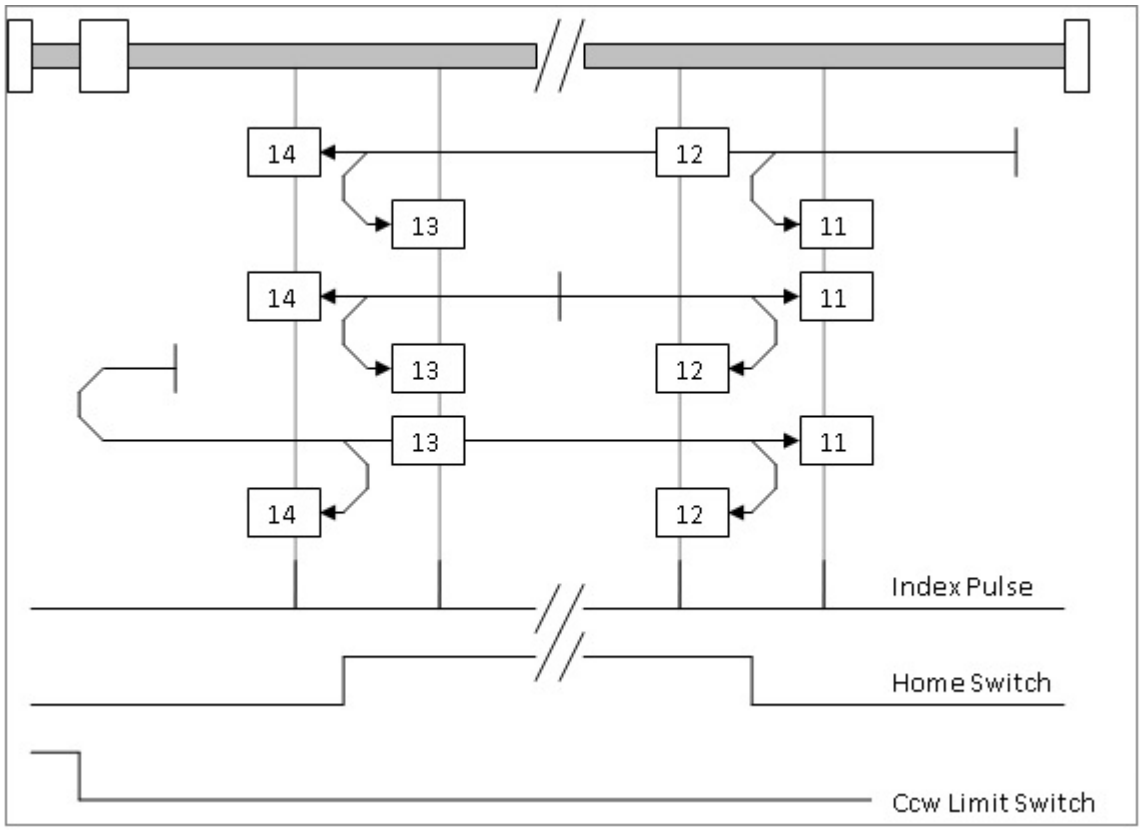
The initial direction of movement depends on the state of the home switch. The reference (home) position is on the index pulse (resolver zero) to the left (type 6) or right (type 5) of the switching point of the home switch. If the starting position is such that a reversal of direction is required, the reversal takes place after the state of the home switch changes



## 13.5. Type 7, 8, 9, 10, 11, 12, 13, 14: homing on the Home Switch and Index Pulse (resolver zero)

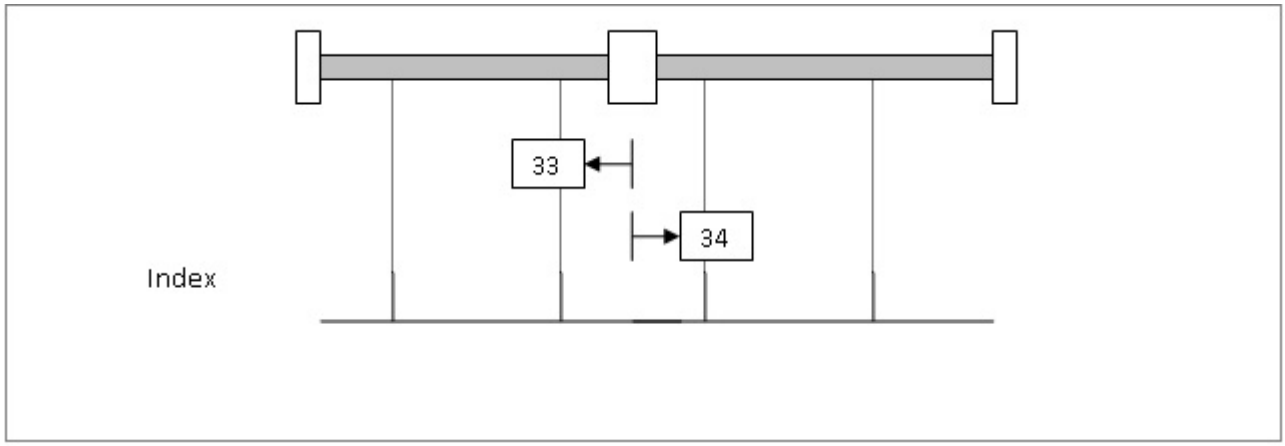
The initial direction of movement is clockwise for types 7 to 10 and anticlockwise for types 11 to 14, except when the Home Switch is high at the beginning of movement. These types of homing procedures use the home switch, which is at a high logic level only for a portion of the excursion. In this case, the initial direction of movement depends on the desired change in state of the home switch. The reference (home) position is on the index pulse (resolver zero) to the left or right of the ascending or descending change in state of the home switch. If the initial direction does not meet the home switch, the direction is reversed toward the limit switch.






## 13.6. Types 33 and 34: Homing on Index Pulse (resolver zero).

With Homing type 33, initial motion direction is counter clockwise; vice versa, with type 34 it is clockwise. The reference position (Home Position) is on the first Index Pulse (resolver zero) found in the direction selected.




## 13.7. Type 37: homing in current position.

# 14. Warranty Conditions

We recommend reading this document closely and ensuring you have understood it before purchasing the product. Contact the manufacturer directly with any queries.

The manufacturer guarantees its products from defects in materials and/or workmanship for a period of **twelve (12) months** (unless otherwise specified in contractual documentation) from the date of delivery. The warranty is limited to repair of the product, or replacement, at the manufacturer's discretion.

The warranty does not cover damage, malfunctions, losses or requests for compensation due to:

- Operational errors in use and/or installation
- Modifications performed by the purchaser
- Unauthorised repairs
- Dropping of the device
- Natural disasters (fire, flood, lightning strikes etc.)
- Incorrect storage and/or maintenance

The burden of proof of any defect (and for any request for assistance in the place of use) lies with the purchaser.

# 15. Disclaimer

The manufacturer shall not be liable:

- For determining the suitability of the product to meet the customer's needs; this shall remain the responsibility of the customer themselves
- For the use of this product as a safety device for machinery which represents a hazard to persons or property
- For conformity of the product with legislation, standards and regulations applicable to the collection of products required for the purchaser's application. The purchaser shall therefore be responsible for guaranteeing the conformity of their machinery to such standards.

Furthermore:

- The product performance specified in this document does not represent a guarantee but merely a reference for the choice of the most appropriate solution for the purchaser's requirements, as it is the result of the manufacturer's testing conditions
- The product may be subject to modifications in order to make improvements, or for other reasons. Contact the manufacturer to confirm these.
- The information contained in the following document has no contractual validity and may contain omissions, typographical and/or spelling errors, and may therefore be subject to modification and/or updating without notice.

# Appendix A: Gains tuning

The drive features a PIV control with two nested loops, position and speed, whose gains are accessible to the user. The default values cover most applications: only act on them if the behaviour of the system is not satisfactory.

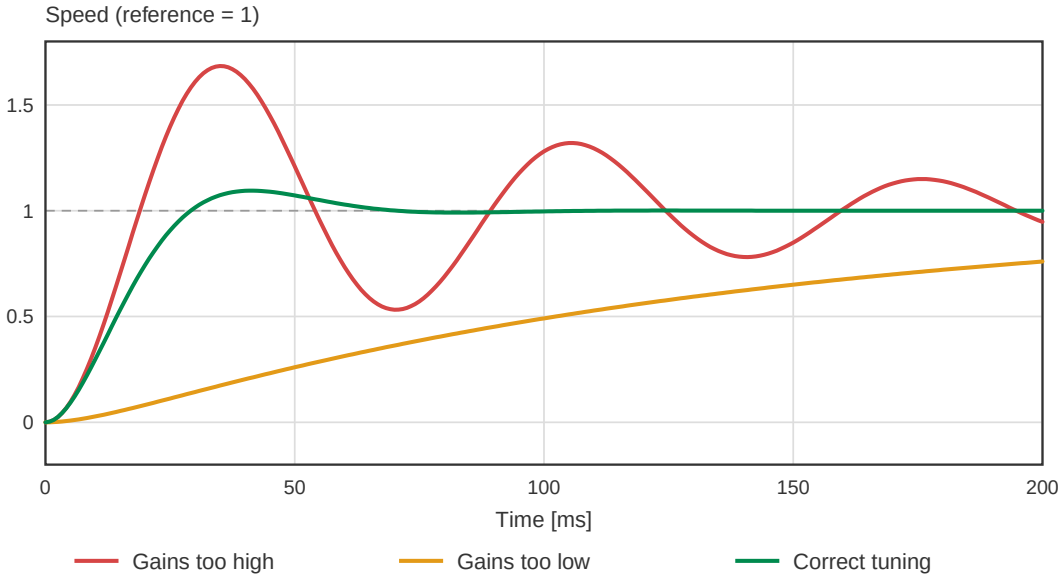



*Figure 12. Response to a speed step with three different tunings*

Tuning that is too aggressive leads to oscillation, with consequences ranging from unwanted behaviour to actual danger for the machine. Tuning that is too conservative gives up performance without there being any fault to look for.

## A.1. Tuning parameters

| ID | BSI NAME | FUNCTION | DEFAULT | RANGE | OBJECT |
|---|---|---|---|---|---|
| P237 | kpSpeed | Proportional gain of the speed loop ($K_{ps}$) | 0.0030 | 0 ÷ 3.2000 | 20EDh |
| P238 | kiSpeed | Integral gain of the speed loop ($K_{is}$) | 0.2000 | 0 ÷ 3.2000 | 20EEh |
| P253 | kpPos | Proportional gain of the position loop ($K_{pp}$) | 0.050 | 0 ÷ 3.2000 | 20FDh |
| P252 | EncLPFTau | Time constant of the filter on the speed estimate | 0.005 | 0.001 ÷ 1.000 [s] | 20FCh |
| P254 | WstarFiltEnable | Enables the filter on the speed reference | Enable | Enable – Disable | 20FEh |
| P256 | Jloadff | Load inertia for the acceleration feedforward | 0.00 | 0 ÷ 327.67 [kgcm²] | 2100h |

In BSI the parameters are found under **Motor > Control**, with the exception of P252 which is in **Motor > Encoder**, and they are only visible once the user level is set to **Advanced** from the **Change Userlevel** button. The OBJECT column gives the address in the fieldbus parameter area, reachable with an acyclic write: SDO on CanOpen, EtherCAT and Powerlink, Explicit Message on Ethernet/IP, Record Data on ProfiNET.

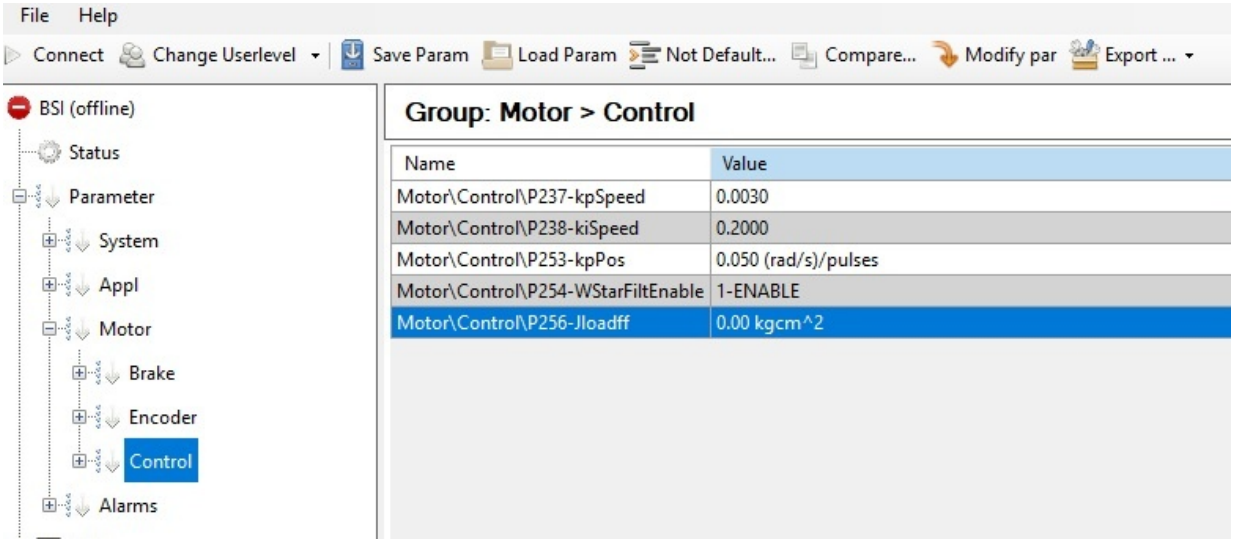



*Figure 13. The Motor > Control group in the BSI parameter tree*

When a parameter is changed from BSI it is saved to non-volatile memory automatically. Over the fieldbus it is not.

Writes in the 2000h … 21FFh area only affect the RAM image of the parameter. To make a tuning performed over the fieldbus permanent, a 32-bit write with the value 65766173h ("SAVE") must be performed on the *Store parameters* object: `1010h.1` on CanOpen, EtherCAT and Powerlink, `1010h` on Ethernet/IP and ProfiNET, where the subindex is not addressable. Without this step the gains revert to their previous values at the first restart.

## A.2. Control scheme

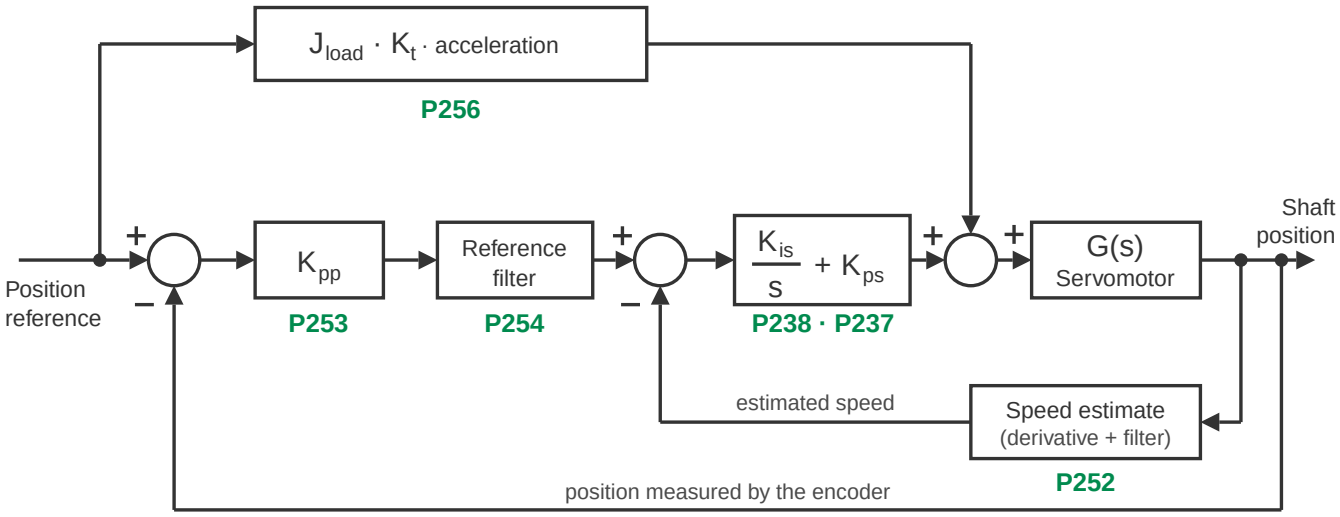



*Figure 14. PIV loop with the tuning parameter associated to each block*

The position reference is compared with the position read by the encoder and the resulting error is multiplied by $K_{pp}$ (P253), which turns it into a speed reference. This reference, filtered or not depending on P254, is compared with the estimated speed and the error feeds the speed PI, made up of the proportional action $K_{ps}$ (P237) and the integral action $K_{is}$ (P238). The output of the PI is the torque reference.

Two details of the scheme have a bearing on tuning:

- The feedback speed is not measured: it is the derivative of the encoder position, filtered with the time constant P252. The bandwidth of the speed loop cannot exceed that of this estimate.
- The feedforward branch (P256) does not belong to any loop. It adds to the torque reference the contribution required by the acceleration of the profile directly, without waiting for an error to build up.

The proportional action reacts to the instantaneous error and is tied to the stiffness of the system: the higher it is, the more the motor opposes deviations, up to the limit beyond which the system oscillates. The integral action accumulates the error over time and cancels it at steady state, but it introduces delay and therefore overshoot.

## A.3. Preparation

Tuning means deliberately driving the system towards its stability limit on a real machine. Work with the load disconnected or on free travel, keep the emergency stop within reach and, where possible, reduce P017 (IMax) to limit the torque available during the tests.

Tuning is normally performed with the motor already connected to the fieldbus and commanded in DS402: references and ramps are therefore set on the profile objects.

1. Select **Profile Velocity** mode by writing 3 to *Modes of Operation* (`6060h`) and check the confirmation on `6061h`.
2. Set the reference on *Target velocity* (`60FFh`) and the ramps on *Profile acceleration* (`6083h`) and *Profile deceleration* (`6084h`).
3. Bring acceleration and deceleration to the maximum operating values of the machine and write down the starting values: they must be restored at the end.
4. In BSI open **Data > Trace** and plot `de_speed_rpm` (actual speed), `usr_poserror` (error of the position loop) and `f_iq` (output current), triggering on the command.
5. Use the BSI “Not Default” function to take a snapshot of which parameters already differ from the factory values, before adding more.

An ideal step is not required: tune with the most demanding profile the machine actually runs, because that is the condition that has to be stable. Bear in mind, though, that if the ramps are gentle compared to the speed of the loop what you are measuring is the profile generator and not the control: the response looks clean but tells you nothing about how much margin you have. To find out the margin, steepen the ramps until overshoot appears.

In local control, without a fieldbus, the equivalents are P001 for mode selection and P008 / P009 for the acceleration and deceleration ramps.

## A.4. Tuning the speed loop

The speed loop is tuned first: the position loop works on top of it and cannot be better than what it has underneath.

1. Command a speed transient of roughly half the cycle speed, with the ramps at the maximum operating

values, and watch `de_speed_rpm`.

2. Increase $K_{ps}$ (P237), doubling it at each step, until overshoot appears. Go back to the last good value and refine it in 10 ÷ 20% increments. Stop just below the overshoot threshold.
3. Increase $K_{is}$ (P238) until a contained overshoot appears, in the order of 5 ÷ 10% of the target speed. That is the sign that the integral action is enough to cancel the steady-state error without destabilising the response.

If a whistle or a hum appears before the overshoot does, or if ALR4/ALR5 Overcurrent trips, you are exciting a mechanical resonance: the stability margin is already used up and the value to keep is the previous one.

## A.5. Tuning the position loop

1. Select **Profile Position** mode (value 1 on `6060h`), set *Profile velocity* (`6081h`) to roughly half the speed of the final cycle and leave the `6083h` / `6084h` ramps at the maximum operating values. Command the targets on *Target position* (`607Ah`).
2. Start from a low value of $K_{pp}$ (P253) and increase it until overshoot appears, then go back to the previous step.
3. Bring `6081h` back to the speed of the real cycle, restore `6083h` and `6084h` to the operating values and check the behaviour over the whole cycle.

The acceptance criterion is `usr_poserror`: while moving it must stay within the following error window (6065h, `co_dc_ferror_win`) and at the end of the positioning it must fall inside the position window (6067h, `co_dc_pos_window`).

## A.6. Fine adjustments

The three items below are only to be touched if, once tuning is complete, performance is still not enough.

**Inertia feedforward (P256).** This is not a gain to be raised by trial and error: it is the physical value of the load inertia referred to the motor shaft, in kgcm². Entered correctly, it anticipates the torque required by the acceleration phases and reduces the following error without touching the gains. An overestimated value produces overshoot during acceleration; an underestimated one leaves part of the error you had before.

**Bandwidth of the speed estimate (P252).** Lowering the time constant of the filter on the encoder increases the useful bandwidth of the control and allows higher gains. In exchange, the noise on the speed estimate rises and is passed on to the torque reference: come down in small steps and keep an eye on `f_iq`. If the current becomes visibly noisier or the motor whistles at standstill, you have gone too far down.

**Filter on the speed reference (P254).** When the profile is generated inside the drive the reference is already continuous and the filter is superfluous: disabling it recovers bandwidth. If instead the reference comes from the master at every bus cycle, as in CSP mode (optional, available on EtherCAT and Powerlink), leave the filter enabled: without it the discontinuities of the reference are passed straight on to the torque.

## A.7. Diagnostics

| SYMPTOM | LIKELY CAUSE | ACTION |
|---|---|---|
| Marked overshoot on the speed transient | $K_{ps}$ or $K_{is}$ beyond the useful value | Reduce P237; if it persists, reduce P238 |
| Oscillation that does not settle | Gains beyond the mechanical stability limit | Reduce P237, then P253 |
| Slow response, the motor lags the reference | Gains too low | Increase P237, then P253 |
| Constant steady-state error in speed | Insufficient integral action | Increase P238 |
| High following error only during acceleration | Feedforward contribution missing | Enter the real load inertia in P256 |
| Whistle or hum at standstill | Noise of the speed estimate amplified by the gain | Increase P252, or reduce P237 |
| ALR4 / ALR5 Overcurrent during transients | Required torque beyond the limit | Reduce P237 and the profile accelerations; check P017 |
| Tuning lost after a restart | Fieldbus write not committed to non-volatile memory | Write 1010h.1 as indicated above |

# Appendix B: Accelerometer

The drive features a three-axis MEMS accelerometer that measures the mechanical vibration on the motor. It serves to keep mechanical stress under control during operation and to log excessive acceleration events even when nobody is watching.

- Selectable full scale ±2 / ±4 / ±8 g (P035)
- 16-bit resolution, data expressed in milli-g
- Sampling rate from 10 to 800 Hz (P036)

## B.1. Axes and available data

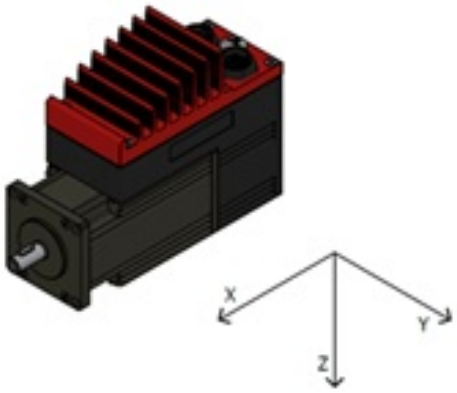



*Figure 15. Reference frame of the accelerometer, fixed to the motor body*

The frame is fixed to the motor: **X** is parallel to the shaft axis and positive towards the output shaft, **Y** is perpendicular to the shaft, **Z** is perpendicular to the face the drive is mounted on and positive downwards.

For each axis the drive makes three quantities available, all in milli-g:

| QUANTITY | BSI VARIABLES | DESCRIPTION |
|---|---|---|
| Instantaneous acceleration | `usr_acc_x` `usr_acc_y` `usr_acc_z` | Sampled value, net of the DC component |
| DC component | `usr_acc_x_ofs` `usr_acc_y_ofs` `usr_acc_z_ofs` | Constant part of the measurement: it is the gravity vector projected on the three axes and is used to work out the mounting orientation |
| RMS value | `usr_acc_x_rms` `usr_acc_y_rms` `usr_acc_z_rms` | Moving root mean square, filtered with the time constant P037 |

The DC component is recomputed at every power-up and subtracted from the instantaneous accelerations, so that these are not affected by constant forces. The motor must therefore be at standstill and in its final orientation when it receives the logic supply: if it is powered up while moving, or tilted differently from how it will work, the offset stays wrong for the whole session.

The RMS value is the figure best suited to continuous monitoring: it changes slowly, it is not affected by the single sample and it is the only one that makes sense to exchange at every fieldbus cycle.

## B.2. Parameters

| ID | BSI NAME | FUNCTION | RANGE | OBJECT |
|---|---|---|---|---|
| P035 | Endscale | Full scale of the accelerometer | 2 – 4 – 8 [g] | 2023h |
| P036 | DataRate | Sampling rate | 10 ÷ 800 [Hz] | 2024h |
| P037 | RmsTau | Time constant of the RMS filter | 1 ÷ 1000 [ms] | 2025h |
| P038 | EventLevel | Acceleration threshold that generates the event | 0.1 ÷ 10 [g] | 2026h |
| P039 | EventTime | Time constant of the filter on the event | 1 ÷ 1000 [ms] | 2027h |
| P040 | EventInhibit | Inhibition time between two consecutive events | 1 ÷ 2400 [minutes] | 2028h |

In BSI the parameters are found under **Appl > Accelerometer**.

The full scale P035 is a trade-off: a low value gives more resolution on small vibration but saturates on impacts, a high value does not saturate but loses sensitivity. Start from ±2 g and only go up if you see the measurement clipped at full scale.

## B.3. Sampling

Parameter P036 sets the rate at which the microcontroller acquires data from the sensor.

| SAMPLING RATE | PERIOD | OBSERVABLE BANDWIDTH |
|---|---|---|
| 10 Hz | 100 ms | 5 Hz |
| 50 Hz | 20 ms | 25 Hz |
| 100 Hz | 10 ms | 50 Hz |
| 200 Hz | 5 ms | 100 Hz |
| 400 Hz | 2.5 ms | 200 Hz |
| 800 Hz | 1.25 ms | 400 Hz |

The observable bandwidth is half the sampling rate: sampling at 200 Hz, components up to 100 Hz can be distinguished, beyond which two different vibrations become indistinguishable once sampled.

At the two highest rates, 400 and 800 Hz, the microcontroller cannot read the sensor at every conversion. The resulting undersampling produces aliasing: high-frequency components appear in the measurement as low-frequency ones, indistinguishable from the real ones.

The same reasoning applies downstream, on the data exchange cycle with the PLC. Sampling at 400 Hz, that is every 2.5 ms, and then exchanging data every 4 ms means undersampling a second time: the PLC receives samples taken at arbitrary instants of the vibration. This is why, over the fieldbus, the figure to acquire is the

RMS value and not the instantaneous acceleration.

## B.4. Tuning the RMS filter

The time constant of the RMS filter must span several cycles of the vibration to be measured: if it is too short the RMS value oscillates instead of giving a stable reading. It therefore has to be tuned on the specific application.

Before starting, check that P036 is set so that the vibration of interest falls inside the observable bandwidth.

1. In BSI open **Data > Trace** and plot the instantaneous accelerations `usr_acc_x`, `usr_acc_y` and `usr_acc_z`.
2. Enable the cursors and place them on two consecutive peaks of the vibration.
3. Read Δ, the interval between the two cursors, which BSI also reports as an equivalent frequency.
4. Multiply Δ by a factor between 3 and 5 and write the result into P037.

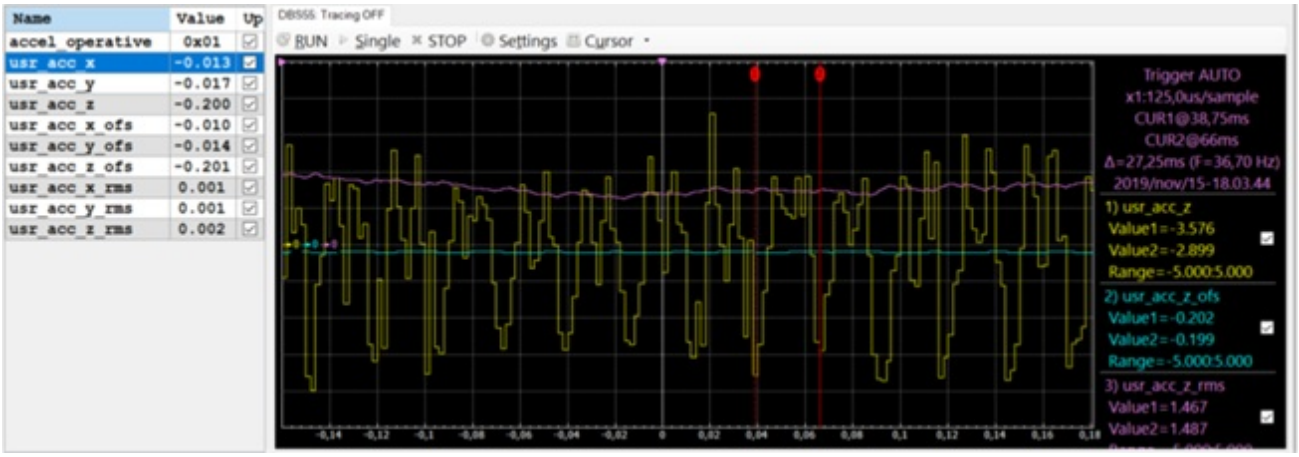



*Figure 16. Measuring the vibration period with the Trace cursors*

In the example in the figure Δ is 27.25 ms, so P037 is to be set between 82 and 136 ms. Longer time constants give a more stable reading but react more slowly; shorter ones react sooner but make the value jump around.

## B.5. Over-acceleration events

The drive logs by itself the episodes in which the acceleration exceeds a set threshold, without the PLC having to monitor it. The function is governed by three parameters:

- **P038 EventLevel** is the acceleration threshold beyond which the event is triggered.
- **P039 EventTime** is the time constant of the filter applied before the comparison with the threshold, and prevents a single isolated sample from generating a record.
- **P040 EventInhibit** is the inhibition time between one event and the next. It avoids a persistent condition filling the log with identical records.

The event logged is number 3, **ACCMAX_REACHED**, according to the coding of the Alarms chapter.

The log is read in BSI from **List > Event**. Each row reports the event code and the SupplyTime, that is the cumulative logic supply time of the drive at the moment of the record: events are therefore correlated with one another by supply hours, not by date and time. From there the list is exported to a file with “Save” and cleared with “Erase list”.

On CanOpen, EtherCAT and Powerlink the events are also accessible from object 3009h with an acyclic read; the object is not PDO mappable. On Ethernet/IP and ProfiNET it is not exposed.

## B.6. Reading over the fieldbus

| OBJECT | DATA | TYPE | PDO |
|---|---|---|---|
| 3030h | Acceleration RMS modulus | UINT16 | Yes |
| 3031h ÷ 3033h | Acceleration RMS x, y, z | UINT16 | Yes |
| 3034h ÷ 3036h | DC component x, y, z | UINT16 | Yes |
| 3037h ÷ 3039h | Instantaneous acceleration x, y, z | INT16 | Yes |

All values are expressed in milli-g.

On CanOpen, EtherCAT and Powerlink these objects can be freely mapped into the PDOs. On Ethernet/IP and ProfiNET the RMS values of the three axes are not part of the default process data: profile **D** must be selected, which adds them to the assemblies.

## B.7. Vibration analysis

The accelerometer returns data in the time domain. From these, with an offline analysis, the quantities that describe the vibration are obtained.

- **Peak-to-peak**: maximum excursion of the wave, an indicator of the severity of the mechanical stress or of backlash.
- **Peak**: maximum positive or negative excursion, an indicator of the intensity of short impacts.
- **RMS**: root mean square value, tied to the energy content of the vibration.

$$RMS = \sqrt{\frac{1}{T}\int_0^T x^2(t)\,dt}$$

- **Crest factor**: ratio between peak value and RMS value, that is between the two arrows on the right of the figure below. High values identify phenomena of an impulsive nature, low values a distributed vibration. A pure sine wave gives 1.41; the vibration in the figure gives 1.7.

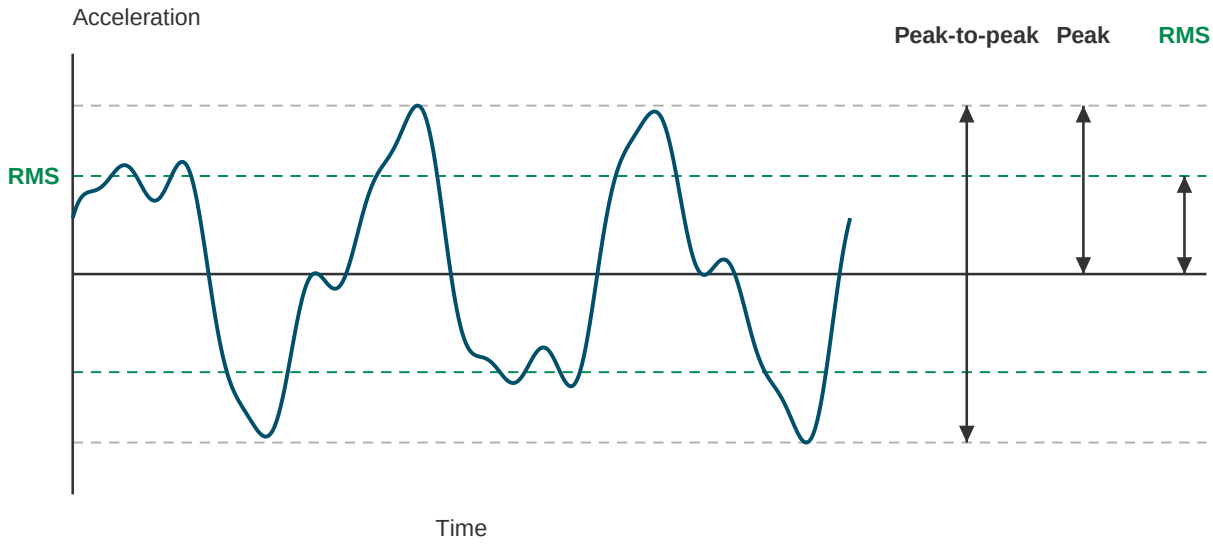



*Figure 17. The characteristic quantities measured on a vibration in the time domain*

The next step is the analysis in the frequency domain, obtained by applying a Fourier transform to the time data with any computation tool. The spectrum shows which components make up the vibration and with what amplitude.

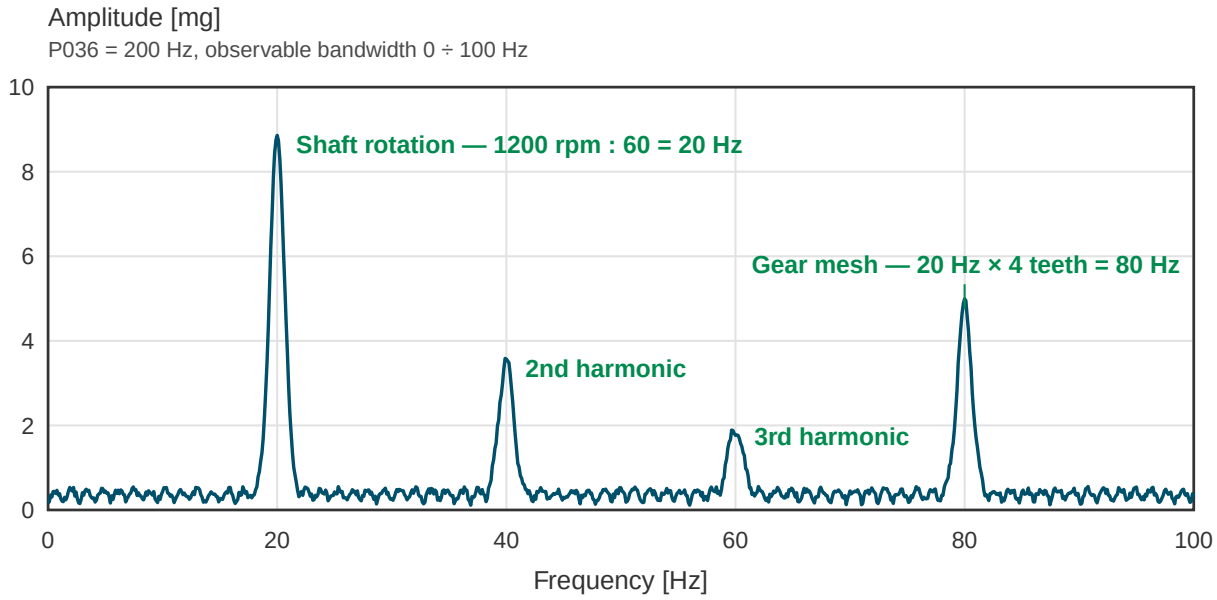



*Figure 18. Amplitude spectrum with the lines traced back to the characteristic frequencies of the machine*

The lines of the spectrum are interpreted by comparing them with the characteristic frequencies of the machine, which you can work out in advance: the shaft rotation frequency (revolutions per minute divided by 60), the gear mesh frequency of the gearbox (shaft frequency multiplied by the number of teeth) and their respective harmonics.

In the example in the figure the motor runs at 1200 rpm, so the dominant line at 20 Hz is the shaft rotation. The lines at 40 and 60 Hz are the second and third harmonic: they are not independent sources, but the sign that the phenomenon at 20 Hz is not sinusoidal. The line at 80 Hz, on the other hand, is not a dominant harmonic but coincides with the gear mesh frequency of the gearbox, 20 Hz times the 4 teeth of the pinion: it is a separate source, and is to be followed on its own.

There is no vibration threshold that is valid in absolute terms: it depends on the machine and on the

application, and providing an all-encompassing guide is beyond the scope of this manual. The method that works is to measure the vibration signature on the machine under correct operating conditions and to monitor its drift over time: it is the departure from the baseline that flags the problem, not the absolute value. As a general frame of reference for vibration levels, the ISO 20816 series of standards can be used.

# Appendix C: Encoder

The servo gearmotor features a 32-bit absolute multiturn magnetic encoder. Absolute means that the shaft position is known from power-up, with no need for a homing run, and that the motor keeps it even when switched off, even if the shaft is turned by hand in the meantime.

*Figure 19. The encoder board with the integrated backup battery*

## C.1. Resolution

The 32 bits are split into two parts:

| PART | BITS | MEANING |
|---|---|---|
| Single turn (ST) | 12 | Angular position within the turn: 4096 pulses per motor revolution |
| Multiturn (MT) | 20 | Count of the revolutions performed by the shaft: 1,048,576 turns |

The split can be changed with parameter **P094 EncStRes**, which sets the bits assigned to the single turn. The total always stays at 32 bits, so **every bit gained on the single turn is a bit lost on the revolution count**: taking P094 from 12 to 24 bits raises the angular resolution to 16,777,216 pulses per revolution, but the multiturn range drops from 1,048,576 to 256 turns.

Values above 12 bits are only allowed on motors with the **HRE** option.

Before raising P094, work out how many revolutions the axis has to travel between one homing and the next. On a continuously rotating axis, or on a long screw, 256 turns are used up quickly.

## C.2. The backup battery

The multiturn count is the only part that needs to be powered while the motor is off: the position within the turn is absolute magnetic and is read back by itself at every power-up. To retain the revolution count, the encoder electronics are supplied by a rechargeable battery integrated in the gearmotor.

- **Autonomy**: 6 months with the motor disconnected from the supply.

- **Charging**: automatic whenever the logic supply is present. A full charge takes at least 24 consecutive hours.
- **Replacement**: the battery is not replaceable. It is rechargeable, and has to be kept charged with the cycles described below.

Under normal operating conditions the battery is invisible to the system: with the logic supply present it stays fully charged and the motor runs on mains power.

There is no reading of the battery charge state. The system gives no advance notice: the first sign is the alarm at the next power-up, when the multiturn position has already been lost. This is why the preventive charging cycles must be observed.

The product receives a full charge before shipping. At the first power-up, or after a period of inactivity, leave the gearmotor with the logic supply alone switched on for at least 24 hours before putting it into service.

## C.3. Storage management

Every 6 months of non-use the battery must be recharged with a full cycle of at least 24 hours of logic supply, as also stated among the maintenance warnings of the Safety chapter.

The typical case in which the battery runs flat is not storage but transport: a machine that has been tested and packed and then spends months on a ship arrives at its destination with the multiturn count lost, even though it was working at final testing.

## C.4. Loss of the multiturn position

If the battery runs flat, at the next power-up the motor comes up in fault: bit 3 of the Status Word goes to 1 and register `3008h` *Actual Alarm* reports code **203 PMSM_ENCSPI_MT**, according to the coding of the Alarms chapter.

Under a very deep discharge, code **204** may appear as well. In that case a double reset is required, first for the 204 and then for the 203, before being able to proceed.

The error is reset by taking bit 7 of the Control Word to a logic high level.

After a 203 error the multiturn position is no longer reliable. The axis **must be homed again** before resuming normal operation: resetting the alarm puts the motor back in a condition to work, but it does not restore the position reference that was lost.

Register `3008h` is exchanged in the process data of Ethernet/IP and ProfiNET, and is freely accessible and PDO mappable on CanOpen, EtherCAT and Powerlink.

Our advice is to have a routine in the PLC that, faced with a motor in fault, reads the alarm code and handles it accordingly. If it detects a 203, it must tell the operator that this servomotor needs realigning before putting the machine back in cycle, rather than simply resetting the fault.

Mini Motor S.p.a.

Via E.Fermi, 5

42011 Bagnolo in Piano (RE), Italy

Tel. +39 0522 951889

Fax. +39 0522 952610

info@minimotor.com

www.minimotor.com