

Bus description

PSD4xx positioning system – EtherCAT

Ether**CAT**[®] 



halstrup-walcher GmbH
Stegener Straße 10
79199 Kirchzarten
Germany

Tel. +49 7661 39 63-0
info@halstrup-walcher.com
www.halstrup-walcher.com

© 2024

The manufacturer owns the copyright to this instruction manual. It contains technical data, instructions and drawings detailing the device's features and how to use them. It must not be copied either wholly or in part or made available to third parties.

The instruction manual is part of the product. Please read this manual carefully, follow our instructions, and pay special attention to the safety information provided. This instruction manual should be available at all times. Please contact the manufacturer if you do not understand any part of the instructions.

The manufacturer reserves the right to continue developing this device model without documenting such development in each individual case. The manufacturer will be happy to determine whether this manual is up-to-date.

Table of Contents

| | | |
|----------|---|-----------|
| 1 | General | 4 |
| 1.1 | Explanation of symbols..... | 4 |
| 2 | Start-up | 5 |
| 2.1 | Setting the “Explicit Device ID” and the “Configured Station Alias” | 7 |
| 2.2 | Switching on the device..... | 7 |
| 2.3 | Generating the delivery state (without the control unit) | 7 |
| 3 | Description of EtherCAT | 8 |
| 3.1 | EtherCAT interface with CoE protocol (CANopen over EtherCAT) | 8 |
| 3.2 | Status LEDs..... | 8 |
| 3.3 | Table of entries implemented from object dictionary | 9 |
| 3.4 | Table of device-dependent min., max. and default values..... | 20 |
| 3.5 | Process data format | 23 |
| 3.5.1 | Output module (from the perspective of the IO controller)..... | 23 |
| 3.5.2 | Input module (from the perspective of the IO controller)..... | 23 |
| 3.6 | Detailed description of status bits | 24 |
| 3.7 | Detailed description of control bits..... | 28 |
| 4 | Functions | 29 |
| 4.1 | Positioning..... | 29 |
| 4.2 | Types of positioning..... | 30 |
| 4.2.1 | Positioning run <i>with</i> reference loop | 30 |
| 4.2.2 | Positioning run <i>without</i> reference loop..... | 31 |
| 4.2.3 | Manual run..... | 31 |
| 4.3 | Maximum start-up and operating torque..... | 32 |
| 4.4 | How to respond if the drive encounters an obstruction | 33 |
| 4.5 | How to respond if drive is turned manually (adjustment function) | 34 |
| 4.6 | Calculate the absolute physical position..... | 35 |
| 4.7 | Set the spindle pitch..... | 38 |
| 4.8 | Abort the run when the master fails..... | 38 |
| 4.9 | Reference runs..... | 39 |
| 4.10 | Run drive in reverse..... | 40 |
| 5 | Technical data | 41 |
| 6 | Notes | 41 |

1 General

This bus description is to be used for the commissioning and integration of the drive into a field bus system.

Technical data for the electrical connections of your drive can be found in the electrical connector and pin assignment description on the website:




www.halstrup-walcher.de/technicaldocu

Please search for "PSD" and select your type, click on "Instruction manuals" and download the "connector and pin assignment" offered for your bus system.

1.1 Explanation of symbols

The device has been designed and tested to ensure its safety. However, it may still be dangerous if used inappropriately. Precautions must be taken to prevent the device being used incorrectly by mistake.

The following warnings are used in this instruction manual:

| | |
|---|--|
|  DANGER! | DANGER! Indicates a situation of imminent danger, which will lead to a fatality or serious injuries if not prevented. |
|  WARNING! | WARNING! Indicates a potentially dangerous situation, which may lead to a fatality or serious injuries if not prevented. |
|  CAUTION! | CAUTION! Indicates a potentially dangerous situation, which may lead to minor/slight injuries if not prevented. |
| NOTICE | NOTICE Indicates a potentially harmful situation, which may lead to material damage if not prevented. |

2 Start-up



WARNING!

Risk of injury if used inappropriately.
The device must be installed by trained technical personnel.



WARNING!

Risk of burns due to hot drive.
The drive can become very hot during operation.
Allow the drive to cool before touching it.



WARNING!

Risk of crushing due to rotary movement.
Do not reach into the working area of the drive when it is still turning.
The user/operator must ensure appropriate protective measures are taken.



WARNING!

Incorrect assembly can lead to the destruction of the drive.



WARNING!

Check that the supply lines are not pinched or crushed.
Lay the supply lines according to the general and specific local assembly regulations.
If the supply lines have not been delivered together with the device, please select suitable cables for the application.
Do not operate the direct drive if the supply lines are noticeably damaged.



WARNING!

Risk of injury. High contact voltages can occur in the case of malfunctions.
This can be prevented by grounding.



CAUTION!

The drive must be protected against excessive heating.
The user/operator must ensure appropriate protective measures are taken.



CAUTION!

Never apply force to the housing of the drive, e.g. for supporting weight.

2.1 Setting the “Explicit Device ID” and the “Configured Station Alias”

The device’s “Explicit Device ID” can be set using the two rotary switches (address switch value > 0). If the address is set to value 0, the “Explicit Device ID” can be set using SDO #2026. In this case, the value is only accepted into the ESC and SII after saving (see SDO #204F) and restarting.

Additionally a “Configured Station Alias” can be assigned via the bus of the EtherCAT master. This value can also be set using SDO #2026. In this case, the value is only accepted into the ESC and SII after saving (see SDO #204F) and restarting.

2.2 Switching on the device

After connecting the supply voltage, you can begin positioning or manual runs immediately.

You can find information about installing the drive as well as electrical connections and pin assignments at the following link: www.halstrup-walcher.de/technicaldocu

Please search for "PSD" and select your type, click on "Instruction manuals" and download the “connector and pin assignment” offered for your bus system.

2.3 Generating the delivery state (without the control unit)

The drive can be reset to the delivery state even if no control unit is present.

Generate the delivery state as follows:

- 1) Separate the device from the electrical power supply.
- 2) Set the address switches to 98.
- 3) Switch on the device (control unit and motor voltage).
- 4) The yellow LED now flashes for 10 seconds at 10 Hz. If, during this time period, the address is set to 99, the drive will reset all parameters to the delivery state, save this setting and bring the axle to the mid-position.
- 5) Set the address switch to 00 in order to complete the delivery state.
- 6) Switch the device off.

The 10-second period will be ended early if any communication is established.

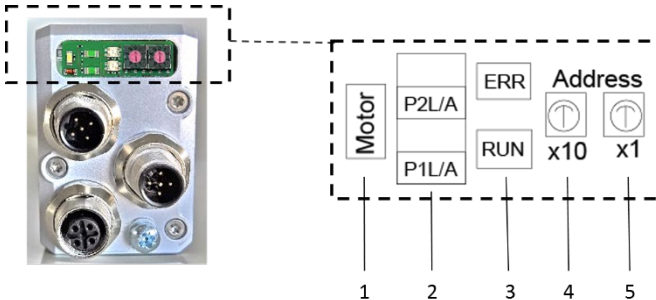
3 Description of EtherCAT

3.1 EtherCAT interface with CoE protocol (CANopen over EtherCAT)

The EtherCAT interface uses the CANopen over EtherCAT protocol in accordance with ETG1000.6 Section 5.6:

| |
|--|
| One transmit and one receive SDO per device |
| One asynchronous transmit and receive PDO, active by default |

3.2 Status LEDs



| The following LEDs are located under the sealing plug: | | |
|--|---------|------------------------------------|
| 1 | V_Motor | Yellow LED = Motor supply voltage |
| 2 | P1L/A | Green LED = Link/Activity |
| | P2L/A | Green LED = Link/Activity |
| 3 | Run | Green LED = Signals the ESM status |
| | Error | Red LED = Signals an error |
| 4 | X10 | Address switch x10 |
| 5 | X1 | Address switch x1 |

Meaning of the LEDs:

| Yellow LED motor supply voltage (V_Motor) | |
|---|--|
| Off | Motor voltage too low or too high |
| On | Motor voltage is OK |
| Flashing at 0.5 Hz | Motor voltage is OK and drive is in the delivery state |

Each of the ports (P1/P2) has an associated green LED for the “Link” and “Activity” states.

| For each port (P1/P2), the following states are possible: | |
|--|---|
| Off | No connection |
| On | Line connection is active, no data activity |
| Flashing at 10 Hz | Line connection is active, data transfer active |

| The green “Run” LED signals the ESM status: | |
|--|------------------|
| Off | INIT |
| Flashing at 2.5 Hz | PRE-OPERATIONAL |
| Flashing at 1 Hz | SAFE-OPERATIONAL |
| On | OPERATIONAL |

| The red “Error” LED signals an error: | |
|--|---|
| Off | No error |
| Single flashes at 1 Hz | Local error, application is changing ESM status |
| Double flashes at 1 Hz | Watchdog timeout |
| Flashing at 2.5 Hz | Configuration error |

3.3 Table of entries implemented from object dictionary

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|----------------------|-----------|--|-----------------|----------|-----------------|-----|
| Device type | 1000 | Device type | 0 | | 0 | R |
| Software description | 100A | Identifies the software of the EtherCAT drives; returns the string “PSD4xxIE/ECAT” when read | | | | R |
| Identity | 1018 | Sub index 0: No. of indices (= 4) | 8 bit | | 4 | R |
| | | Sub 1: Vendor-ID (= 0x000002D8) | 32 bit | | | R |
| | | Sub : Product code | 32 bit | | | R |
| | | Sub 3: Revision number (= 0x00010000) | 32 bit | | | R |
| | | Sub 4: Serial number | 32 bit | | | R |

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|--------------------------|----------------|---|---|----------|-----------------|-----------------------|
| Receive PDO 1 mapping | 1600 | Sub index 0: No. of indices (= 2) Sub 1: 0x20240010 Sub 2: 0x20010020 | 8 bit 32 bit 32 bit | | 2 | R R R |
| Transmit PDO 1 mapping | 1A00 | Sub index 0: No. of indices (= 3) Sub 1: 0x20250010 Sub 2: 0x20300010 Sub 3: 0x20030020 | 8 bit 32 bit 32 bit 32 bit | | 3 | R R R R |
| SM Comm Types | 1C00 | Sub index 0: No. of indices (= 4) Sub 1: SM0 (= 1) Sub 2: SM1 (= 2) Sub 3: SM2 (= 3) Sub 4: SM3 (= 4) | 8 bit 8 bit 8 bit 8 bit 8 bit | | 4 | R R R R R |
| SM0 PDO Assignment | 1C10 | Sub index 0: No. of indices (= 0) | 8 bit | | 0 | R |
| SM3 PDO Assignment | 1C13 | Sub index 0: No. of indices (= 1) Sub 1: 0x1A00 (1. TxPDO) | 8 bit 16 bit | | 1 | R |
| General purpose register | 2000 0...10 | 10 general purpose registers Sub index 0: No. of indices (= 10) Sub 1...10: free register | 8 bit 16 bit | Yes | 10 0 | R R/W |
| Target value | 2001 | Target position in 1/100 mm (for a 4 mm spindle and default values of numerator, (SDO #2010) and denominator (SDO #2011)). This value can only be written in the "pre-operational" state. | ±31 bit | No | 0 | R/W |

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|-------------------------------|-----------|---|---|----------|-----------------|-----|
| Actual value | 2003 | Current actual position in 1/100 mm (for a 4mm spindle and default values of numerator, (SDO #2010) and denominator (SDO #2011)). Writing to this index number causes the current position to be “referenced” to the transferred value Writing only possible when at a standstill. | ±31 bit | No | | R/W |
| Referencing value | 2004 | Correction factor for the target, actual and end limit values. Writing only possible when at a standstill. | ±31 bit | Yes | 0 | R/W |
| Drag error | 2005 | Reserved | | | | |
| Positioning window | 2006 | Permissible difference between target and actual values for the “target position reached” bit in 1/100 mm (for a 4 mm spindle and default values of numerator and denominator) The maximum setting value changes according to the same factor as the resolution. Writing only possible when at a standstill. | 1...100 16 bit equals 0.0025 ... 0.25 rotations | Yes | 2 | R/W |
| Position scaling, numerator | 2010 | These values allow you to apply any resolution to the drive that you wish. For a numerator factor of 400, the spindle pitch/resolution is stated in the denominator factor | 1...10000 16 bit | Yes | 400 | R/W |
| Position scaling, denominator | 2011 | e.g.: Spindle pitch 1.5 mm with resolution 1/100 mm: numerator = 400, denominator = 150 Writing only possible when at a standstill. | 1...10000 16 bit | Yes | 400 | R/W |

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|-----------------------------|-----------|---|-------------------------|----------|-----------------|-----|
| Target speed | 2012 | Maximum rpm to be used for positioning runs; value in rpm | See chap. 3.4 16 bit | Yes | See chap. 3.4 | R/W |
| Target speed for manual run | 2013 | Maximum rpm to be used for manual runs; value in rpm | See chap. 3.4 16 bit | Yes | See chap. 3.4 | R/W |
| Maximum torque | 2014 | Applies after the end of the start-up phase (during the start-up phase, the value of parameter #2018 applies); value in cNm | See chap. 3.4 16 bit | Yes | See chap. 3.4 | R/W |
| Upper limit | 2016 | Maximum permitted target position Permissible values: (upper mapping end - 1200 .. 1611600 * numerator/denominator) For models with an auxiliary gearbox, the range of values is reduced in accordance with the gear ratio. Writing only possible when at a standstill. | ±31 bit | Yes | 101200 | R/W |
| Lower limit | 2017 | Min. permitted target position Permissible values: (upper mapping end - 1200 .. 1611600 * denominator/numerator) For models with an auxiliary gearbox, the range of values is reduced in accordance with the gear ratio. Writing only possible when at a standstill. | ±31 bit | Yes | 1200 | R/W |
| Maximum start-up torque | 2018 | Value in cNm | See chap. 3.4 16 bit | Yes | See chap. 3.4 | R/W |

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|---|-----------|--|--|----------|-----------------|-----|
| Time period for start-up torque | 2019 | Time period during which the max. start-up torque (SDO #2018) is applied; value in ms | 10...1000 16 bit | Yes | 200 | R/W |
| Speed limit for aborting run | 201A | Value in % of the target speed | 30...90 16 bit | Yes | 30 | R/W |
| Time elapsed until speed falls below speed limit for aborting run | 201B | Value in ms | 50...500 16 bit | Yes | 200 | R/W |
| Acceleration | 201C | Value in rpm per second | See chap. 3.4 16 bit | Yes | See chap. 3.4 | R/W |
| Deceleration | 201D | Value in rpm per second | See chap. 3.4 16 bit | Yes | See chap. 3.4 | R/W |
| Length of loop | 201F | Minimum number of increments, in which the drive runs to a target in a specified direction. Value in increments (0 → no loop) The sign determines the direction of the loop: (positive → reference loop to larger values; negative → reference loop to smaller values) | 0.025...10 rotations or -0.025...-10 rotations or ± 31 bit | Yes | 250 | R/W |
| Acceleration 2 | 2020 | Reserved | | | | |
| Deceleration 2 | 2021 | Reserved | | | | |

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|--------------|-----------|--|-----------------|----------|-----------------|-----|
| Control word | 2024 | Bit 0: Manual run to larger values Bit 1: Manual run to smaller values Bit 2: Transfer target value Bit 3: Reserved Bit 4: Release: the axle will only run if bit is set. Bit 5: Reserved Bit 6: Run without a reference loop Bit 7: Reserved Bit 8: Reserved Bit 9: Reserved Bit 13: Toggle bit Bit 14: Error Acknowledge (from firmware V3.02) All other bits must be set to 0 This value can only be written in the "pre-operational" state. | 16 bit | No | 0 | R |

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|-------------|-----------|---|-------------------------|----------|-----------------|-----|
| Status word | 2025 | Bit 0: Target position reached Bit 1: Reserved Bit 2: Toggle bit Bit 3: Reserved Bit 4: Power supply to motor available Bit 5: Positioning run aborted Bit 6: Drive is running Bit 7: Max temp. exceeded Bit 8: Run in opposite direction to loop Bit 9: Error Bit 10: Positioning error (obstruction) Bit 11: Manual rotation Bit 12: Incorrect target value Bit 13: Power was unavailable to motor Bit 14: Positive range limit Bit 15: Negative range limit | 0... FFFFh 16 bit | | | R |
| Address | 2026 | Explicit Device ID Write: When writing, the value is only accepted into the ESC and SII after saving (see SDO #204F) and restarting. This value will only be used if the address switches are set to value 0. | 16 bit | Yes | 0 | R/W |

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|------------------------------|-----------|--|-----------------------------|----------|-----------------|-----|
| Upper mapping end | 2028 | Definition of the positioning range relative to the absolute value encoder Permissible values: (actual position + 3 rotations) ... (actual position + 4,029 rotations) Writing only possible when at a standstill. | ±31 bit | Yes | 102400 | R/W |
| Maximum holding torque | 202B | Holding torque at standstill in cNm (after the phase "max. holding torque at end of run") | See chap. 3.4 16 bit | Yes | See chap. 3.4 | R/W |
| Direction of rotation | 202C | 0: Clockwise rotation to larger values (if looking at the output shaft) 1: Anti-clockwise rotation to larger values Writing is only possible when at a standstill. | 0 or 1 16 bit | Yes | 0 | R/W |
| Idle period | 202E | Reserved | | | | |
| Actual speed | 2030 | Value in rpm | ±15 bit | | | R |
| Max. current during last run | 2031 | Maximum current occurring during the most recent run (the start-up phase, during which the start-up torque applies, see SDOs #2018/2019, and braking phase are not taken into account); value in mA | 16 bit | | | R |
| Actual current | 2033 | Actual current, in mA | 16 bit | | | R |
| U control | 203A | Current supply voltage to control unit, in 0.1 V | 16 bit | | | R |
| U motor | 203B | Current supply voltage to motor, in 0.1 V | 16 bit | | | R |

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|---|-----------|---|-----------------------------|----------|-----------------|-----|
| UMot limit | 203C | Voltage limit for bit 4 ("Power supply to motor available"); in 0.1 V A positioning run or manual run can only begin if the motor voltage is higher than the value set here. During the run, the voltage may fall to 17.5 V. | 180... 240 16 bit | Yes | 185 | R/W |
| UMot filter | 203D | Average time for motor voltage measurement; value in ms | 100... 1000 16 bit | Yes | 100 | R/W |
| Temp. limit | 203E | Upper temperature limit in °C | 10...80 16 bit | Yes | 80 | R/W |
| Device temperature | 203F | Internal device temperature in °C | 16 bit | | | R |
| Production date | 2040 | Year and week of manufacture (given as an integer) | YYWW 16 bit | | | R |
| Serial number | 2041 | Device serial number | 0... 65535 16 bit | | | R |
| Max. holding torque at end of run | 2042 | Value in cNm | See chap. 3.4 16 bit | Yes | See chap. 3.4 | R/W |
| Duration of max. holding torque at end of run | 2043 | Time period during which the holding torque is applied at completion of run; value in ms | 0...1000 16 bit | Yes | 200 | R/W |
| Waiting time for brakes | 2045 | Reserved | | | | |
| Drag error correction | 2046 | Reserved | | | | |
| Readjustment | 2047 | Adjustment when at a standstill 0 → off; 1 → on | 0...1 8 bit | Yes | 0 | R/W |
| Configuration for connection failure | 2049 | Reserved | | | | |

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|--------------------------------------|-----------|---|--|----------|-----------------|-----|
| Safe position for connection failure | 204A | Reserved | | | | |
| Repeat time for safety run | 204B | Reserved | | | | |
| Device type | 204D | Device type within the PSD range as a string (e.g. "PSD403-18-H") | | | | R |
| Version | 204E | Software version number | 16 bit | | | R |
| Delivery state | 204F | <p>Writing a "-6": Resets the drive (corresponds to switching the control voltage off and back on)</p> <p>Writing a "-5": Sets the values of all parameters to the delivery state, saves the parameters in EEPROM, then positions the drive in the middle of the measurement range *) (Station name and IP address are not affected)</p> <p>Writing a "-4": Sets the values of all parameters to the last values saved by the user, then positions the drive in the middle of the measurement range *) (Station name and IP address are not affected)</p> <p>Writing a "-3": Sets the values of all parameters to the delivery state, deletes the station name and IP address and saves the parameters in EEPROM</p> <p>Writing a "-2": Sets the values of all parameters to the last values saved by the user, without saving the parameters in EEPROM (Station name and IP address are not affected)</p> <p><i>Continues on next page</i></p> | -6 ... -1 or 1 (during writing) ±15 bit | No | | R/W |

| Designation | Index no. | Function | Range of values | Back-up? | De-livery state | R/W |
|----------------|-----------|--|--|----------|-----------------|-----|
| Delivery state | 204F | <p>Writing a "1": Sets the values of all parameters to the delivery state, without saving the parameters in EEPROM (Station name and IP address remain unaffected)</p> <p>Writing a "0": Saves the parameters in EEPROM</p> <p>Writing only possible when at a standstill.</p> | <p>-6 ... -1 or 1</p> <p>(during writing)</p> <p>±15 bit</p> | No | | R/W |

*) The positioning run to the middle of the measurement range can be aborted at any time by setting control word = 0 with SDO #2024 (if state is not "operational") or via the PDO control word. Furthermore, in "operational" state, the PDO control word is ignored during the positioning run to the middle of the measurement range (unless it changes). Thus, a run to the middle of the range can also be aborted by changing the PDO control word. Run commands issued before the positioning run to the middle of the range will not be automatically resumed after this run has been completed, (i.e. the PDO control word 0x14 and the old target value do not result in the drive moving to this position).

3.4 Table of device-dependent min., max. and default values

NOTICE

The operating torque setting is optimised for the nominal rated speed of the respective device model. The more the set speed deviates from the nominal rated speed (rpm), the greater the actual difference between the actual power consumption of the motor circuit and the set value.

NOTICE

Setting the value for the max. holding torque to 0 results in a maximum current consumption by the motor circuit of approx. 50 mA

| Device type | | PSD 401/411 - 5V | PSD 401/411 - 8H/14H | PSD 403/413 - 8H/14H | PSD 422/432 - 8V | PSD 422/432 - 8H/14H |
|-------------------------------------|--------------|-----------------------------------|----------------------------|----------------------------|------------------------|----------------------------|
| Name | Index no. | Range of values Delivery state | | | | |
| Upper mapping end *) | 2028 | 806,400 | 806,400 | 198,498 | 806,400 | 806,400 |
| Upper limit *) | 2016 | 805,200 | 805,200 | 197,298 | 805,200 | 805,200 |
| Lower limit *) | 2017 | -805,200 | -805,200 | -197,299 | -805,200 | -805,200 |
| Target speed for positioning run | 2012 | 1...800 200 | 1...500 200 | 1...250 50 | 1...1000 200 | 1...500 200 |
| Target speed, manual run | 2013 | 1...800 70 | 1...500 70 | 1...250 17 | 1...1000 70 | 1...500 70 |
| Acceleration | 201C | 1...5000 1000 | 1...5000 1000 | 1...1250 250 | 1...5000 500 | 1...5000 500 |
| Deceleration | 201D | 1...5000 2000 | 1...5000 2000 | 1...1250 500 | 1...5000 2000 | 1...5000 2000 |
| Maximum start-up torque | 2018 | 30...90 50 | 30...90 50 | 115...350 190 | 50...240 120 | 50...240 120 |
| Maximum torque | 2014 | 30...80 40 | 30...80 40 | 115...300 150 | 50...240 100 | 50...240 100 |

| | | | | | | |
|--------------------------------------|------|--------------|--------------|----------------|---------------|---------------|
| Maximum holding torque at end of run | 2042 | 0...80 30 | 0...80 30 | 0...325 120 | 0...200 70 | 0...200 70 |
| Maximum holding torque | 202B | 0...60 20 | 0...60 20 | 0...245 80 | 0...150 50 | 0...150 50 |

| Device type | | PSD 424/434 - 14H | PSD 426/436 - 14H | PSD 428/438 - 14H | PSD 480/490 - 5V | PSD 480/490 - 8H/14H | PSD 481/491 - 8H/14H |
|--------------------------------------|-----------|-----------------------------------|-------------------------|-------------------------|------------------------|----------------------------|----------------------------|
| Name | Index no. | Range of values Delivery state | | | | | |
| Upper mapping end *) | 2028 | 388,800 | 256,000 | 196,683 | 806.400 | 806.400 | 198.498 |
| Upper limit *) | 2016 | 387,600 | 254,800 | 195,483 | 805.200 | 805.200 | 197.298 |
| Lower limit *) | 2017 | -387,600 | -254,800 | -195,483 | -805.200 | -805.200 | -197.298 |
| Target speed for positioning run | 2012 | 1...482 100 | 1...317 63 | 1...250 50 | 1...800 200 | 1...500 200 | 1...250 50 |
| Target speed, manual run | 2013 | 1...482 34 | 1...317 22 | 1...250 17 | 1...800 70 | 1...500 70 | 1...250 17 |
| Acceleration | 201C | 1...2411 240 | 1...1587 150 | 1...1250 125 | 1...5000 1000 | 1...5000 1000 | 1...1250 250 |
| Deceleration | 201D | 1...2411 960 | 1...1587 635 | 1...1250 500 | 1...5000 2000 | 1...5000 2000 | 1...1250 500 |
| Maximum start-up torque | 2018 | 100...480 240 | 150...720 360 | 195...935 465 | 9...30 15 | 9...30 15 | 26...120 60 |
| Maximum torque | 2014 | 100...480 200 | 150...720 300 | 200...935 400 | 9...30 13 | 9...30 13 | 36...120 50 |
| Maximum holding torque at end of run | 2042 | 0...400 140 | 0...630 220 | 0...820 285 | 0...25 9 | 0...25 9 | 0...100 35 |
| Maximum holding torque | 202B | 0...300 100 | 0...470 155 | 0...615 205 | 0...19 7 | 0...19 7 | 0...75 25 |

*) The min. and max. values for the parameters cannot be specified because they are dependent on the current scaling. The value is valid for the standard scaling (400 increments per rotation).

3.5 Process data format

3.5.1 Output module (from the perspective of the IO controller)

| Bit | Byte | Meaning | Corresponding SDO index number |
|-------|------|--------------|--------------------------------|
| 0-15 | 0.1 | Status word | 2025h |
| 16-31 | 2-3 | Current rpm | 2030h |
| 32-63 | 4-7 | Actual value | 2003h |

NOTICE

Assignment (cannot be modified)

3.5.2 Input module (from the perspective of the IO controller)

| Bit | Byte | Meaning | Corresponding SDO index number |
|-------|------|--------------|--------------------------------|
| 0-15 | 0.1 | Control word | 2024h |
| 16-47 | 2-5 | Target value | 2001h |

NOTICE

Assignment (cannot be modified)

3.6 Detailed description of status bits

Bit 0 Target position reached

This bit is set:

- when a transferred target position has been reached successfully (not at the end of a manual run, except when the target position is also the specified limit)
- as a result of manual displacement during standstill, if the actual position of the drive is once again within the positioning window
- after manual displacement while at standstill, if readjustment is activated and the absolute value of the difference of actual and target value is smaller or equal to the positioning window again.

If bit 0 is set at the same time as bit 10 (obstruction), bit 0 has priority!

This bit is reset:

- after transferring a target position when the difference from the actual value is larger than the positioning window (SDO #2006)
- by a manual run
- if an invalid target value has been transferred
- as a result of manual displacement during standstill

Bit 1 Reserved

Bit 2 Toggle Bit

This bit is set:

- when bit 13 of the control word is set

This bit is reset:

- when bit 13 of the control word is deleted

Bit 3 Reserved

Bit 4 Power supply to motor available

This bit is set:

- if the supply voltage for the motor is above the UMot limit (SDO #203C) and below 30 V

This bit is reset:

- if the supply voltage for the motor is below the UMot limit or above 30 V

Bit 5 Positioning run aborted

This bit is set:

- If a positioning run is aborted because the release has been withdrawn in the control word or due to an invalid bit combination in the control word

This bit is reset:

- For every new run command
- with a 0 → 1 edge of the bit "Error Acknowledge" (from firmware V3.02)

Bit 6 Drive is running

This bit is set:

- when the drive is rotating

This bit is reset:

- when the drive is at a standstill

Bit 7 Temperature too high

This bit is set:

- when the internal device temperature exceeds the limit specified in SDO #203E

This bit is reset:

- when the internal device temperature falls below the limit value by 5 °C

Bit 8 Run in opposite direction to loop

This bit is set:

- after power up or a reset (a lash in a driven spindle which might be present has not yet been eliminated)
- when initiating a positioning run or manual run in the opposite direction to the reference loop

This bit is reset:

- when SDO #201F=0 and a positioning run or manual run is initiated
- when a transferred target position has been reached successfully in the direction of the reference loop (not after a manual run)

Bit 9 Error bit

This bit is set:

- when an internal problem is detected when calculating the position
No run commands may be transmitted when the error bit is set!

This bit is reset:

- only possible by resetting the drive

Bit 10 Positioning error (obstruction)

This bit is set:

- if a positioning run or manual run is aborted because the device is overloaded (obstructions, extreme difficulty running)

If bit 0 (target position reached) is set at the same time as bit 10 (obstruction), bit 0 has priority!

This bit is reset:

- for every new run command
- with a 0 → 1 edge of the bit "Error Acknowledge" (from firmware V3.02)

Bit 11 Manual rotation

This bit is set:

- if, while at a standstill, the drive is turned by an external force by more than the value in the positioning window, after a positioning run has been finished successfully

This bit is reset:

- for every new run command
- with a 0 → 1 edge of the bit "Error Acknowledge" (from firmware V3.02)

Bit 12 Incorrect target value

This bit is set:

- if a transferred target value lies outside the range limits, caused e.g. by the current reference value (SDO #2004)
- if a transferred target value lies within the range limits, but would leave the specified range during the required reference loop

This bit is reset:

- for every new run command
- with a 0 → 1 edge of the bit "Error Acknowledge" (from firmware V3.02)

Bit 13 Motor voltage was missing

This bit is set:

- if the motor voltage is less than the UMot limit (SDO #203C) or above 30 V when initiating a positioning run or manual run
- if the motor voltage leaves the specified range during the run

This bit is reset:

- if the motor voltage is greater than the UMot limit and under 30 V when initiating a positioning run or manual run
- with a 0 → 1 edge of the bit "Error Acknowledge" (from firmware V3.02)

Bit 14/ **Forward/reverse limit reached**

Bit 15

This bit is set:

- if the limit value is reached during a manual run (not when reached during a positioning run)
- if an end limit is modified such that the current position lies beyond it
- if, when at a standstill, the drive is moved to a position beyond the range limits by an external force

This bit is reset:

- as soon as the drive is once again within the range limits (exception: after the end of a manual run, the drive is still at the range limit within the positioning window and no new run command has yet been issued.)

3.7 Detailed description of control bits

Bit 0 Manual run to larger values

Bit 1 Manual run to smaller values

Bit 2 Transfer target value

When this bit is set, the target value in the process data is accepted as the new valid target value. A positioning run starting at the same time or later will use this target value as the new target position. If the positioning run is required to start as soon as the the target value has been transferred, bit 4 ("release") must also be set.

If bit 2 is not set, the target value will not be accepted. Instead, a positioning run can be started to the last transmitted target value that has been marked as valid.

Bit 3 Reserved

must be set to 0

Bit 4 Release

Run commands will only be executed if this bit is set. This bit must be set for positioning runs and manual runs. If this bit is deleted during a run, the run will be aborted and status bit 5 ("Positioning run aborted") will be set.

Bit 5 Reserved

must be set to 0

Bit 6 Run without a reference loop

If this bit is set, all target positions will be approached directly during positioning runs (independently of the current value of SDO #201F), without a reference loop.

Bit 7-12 Reserved

must be set to 0

Bit 13: Toggle bit

The drive always writes this bit in status word bit 2.

→ The control unit can recognise when new process data from the drive are processed.

Bit 14: Error Acknowledge

With a 0 → 1 edge of this bit, the error bits 1, 5, 10, 11, 12 and 13 in the status byte are acknowledged (from firmware V3.02)

Bit 15: Reserved

must be set to 0

4 Functions

4.1 Positioning

The drive must be switched to the ESM status “operational” before it can be controlled using PDOs.

- Transfer target value:
PDO with control word = 0x14 and desired target value
→ drive begins to run
- Aborting a run by withdrawing release:
PDO with control word = 0x00

If a new target value is transferred during a positioning run, the device will immediately proceed to the new target. This will occur with no interruption provided the direction of rotation does not need to be altered.

If a manual run command is transmitted during a positioning run, the positioning run will be aborted (velocity will be reduced to that of a slow run) and the operator may proceed with the manual run.

The following sequence of steps is also possible:

Starting conditions: release has not been set.

- Transfer target value:
PDO with control word = 0x04 and desired target value
- Set release:
PDO with control word = 0x10
→ drive begins run

NOTICE

Positioning runs may include a “reference loop”, which ensures the target is approached from a defined direction. The direction and length of the reference loop can be set to the required value before the positioning run using SDO #201F (“length of loop”). SDO #201F can also be used to deactivate the reference loop.

NOTICE

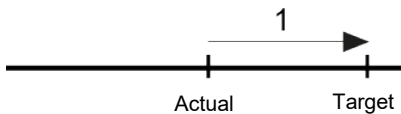
The control word and target value can only be transmitted using SDOs in the ESM status “pre-operational”.

4.2 Types of positioning

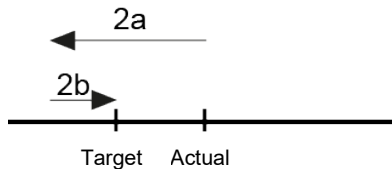
4.2.1 Positioning run *with* reference loop

The PSD4xx distinguishes between the following steps of a positioning sequence (Assumption: the target position is always approached through forward motion)

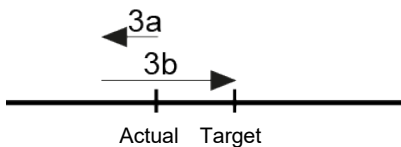
- 1) New position value is larger than the current value:
position approached directly.



- 2) New position value is smaller than the current value:
the drive reverses an additional 5/8 of one rotation (2a)
and approaches the exact position after resuming forward motion (2b).



- 3) New position value after reverse run (no reference loop):
the drive always approaches by moving forward (3b),
if necessary, it will first reverse by 5/8 of a rotation (3a).



After reaching the target position, this position is compared with the internal absolute encoder position. When positioning outside the positioning window (SDO #2006) a second positioning is automatically started and the drive will move to the target position again. If there is another deviation outside the positioning window, the status bit "Positioning error (blocking)" is set.

NOTICE

It is not possible to perform a positioning run to the upper limit (SDO #2016) with a length of loop > 0 because the drive would have to run past the upper limit in order to do so. The same applies to the lower limit (SDO #2017) with a length of loop < 0.

4.2.2 Positioning run *without* reference loop

The “positioning without a reference loop” mode is used primarily for moving the small distances involved in fine adjustments. In this case, each position is approached directly.

NOTICE

This does NOT eliminate any lash present in the driven spindle.



CAUTION!

Runs, which intentionally involve a run to an obstruction (e.g. reference runs to a block), may only be started with reduced torque (running torque to minimum value).

4.2.3 Manual run

The drive can be operated manually (so called “Manual run”). This helps to simplify start-up.

Start manual run:

- Transfer control word
PDO with control word = 0x11 and/or 0x12
→ Starts the manual run

End manual run:

- Transfer control word or reset release bit
PDO with control word = 0x10 and/or 0x00
→ Stops the manual run

NOTICE

If a positioning run is required during an active manual run, the drive must be stopped (reset the release bit). The positioning run can be initiated as soon as the drive is stationary (PDO with control word = 0x14 and the desired target value).

If pre-operational, set target value to SDO #2001. The drive then automatically deletes the manual run bits from the control word (bits 0 and 1).

Manual runs are executed using the maximum max. velocity from SDO #2013, positioning runs using the maximum velocity from SDO #2012.

For all runs, the maximum acceleration from SDO #201C and the maximum deceleration from SDO #201D apply.

As the drive approaches the target at the end of the run, the maximum deceleration is successively reduced in order to ensure a harmonious transient response.

If a stop command is executed, the drive brakes with the maximum possible deceleration ramp independently of the value in SDO #201D.

4.3 Maximum start-up and operating torque

The maximum start-up torque can be set using SDO #2018, the maximum operating torque using SDO #2014.

The start-up torque is active after each run begins for the period defined in SDO #2019.

NOTICE

The stepper motor is optimized for maximum torque. If the PSD is operated at speeds above 400 rpm, self-resonance or even self-locking occurs. Just by adding an inert mass, the natural resonance is significantly damped!

NOTICE

The start-up torque should always be slightly higher than the operating torque because the drive requires more power during the acceleration phase compared to a state of constant velocity

NOTICE

If small torque limits are to be used, the following must be considered: Small operating torque values should not be used in combination with high speed settings as this can lead to instability!

4.4 How to respond if the drive encounters an obstruction

If an obstruction is detected, the run is aborted and the "Positioning error" bit is set. The PSD4xx now operates with the specified maximum holding torque (SDO #2042).

After this, new run commands can be sent without taking further measures, i.e. transferring a new target position (changing the value of the target position in the process data) starts a new positioning run.

Exception:

The exception to this is if the target value is the same as before. In this case, cancel the release and reset it (bit 4 in the control word). Bit 2 ("Transfer target value") must be set in this case. The drive then begins a new positioning run.



CAUTION!

Runs which intentionally involve a run to an obstruction (e.g. reference runs to a block) may only be started with a reduced torque (max. operating torque < 10 % of nominal rated current or smallest possible value).

4.5 How to respond if drive is turned manually (adjustment function)

If the PSD4xx is rotated in the opposite direction from the reference loop – when at a standstill, after a correctly completed positioning run and the release bit (bit 4 in the control word) as well as the readjustment bit (SDO #2047) are activated – it will again attempt to run to the previously sent target value (adjustment). After successful readjustment bit 0 will be set again.

The device does not attempt to adjust if rotated in the direction of the reference loop, it will merely set bit 11 of the status word (“Manual rotation”) and reset bit 0 (“Target position reached”). If the reference loop is deactivated (SDO #201F = 0), the drive will adjust in both directions.

NOTICE

The device does not attempt to adjust if rotated in the direction of the reference loop, it will merely set bit 11 of the status word (“Manual rotation”) and reset bit 0 (“Target position reached”).

NOTICE

If the drive continually loses its position when at a standstill, it will attempt to adjust whenever its actual position just leaves the positioning window (provided that all of the above-mentioned conditions are met). At this time, the motor voltage must be within the permissible range (i.e. bit 4 is set in the status word).

No adjustment will start if the motor voltage is not in the permissible range. Instead, bits 10 (“Positioning error”) and 13 (“Power was unavailable to motor”) will be activated.

If the motor voltage only returns to the permissible range after leaving the positioning window, no new adjustment attempt will start. This prevents a situation in which the drive suddenly starts to move when the motor voltage is switched on.

If a positioning run or manual run is aborted while in progress by a stop command (“Release” bit in control word to 0), the drive will only adjust when a new run command is sent and completed correctly.

Deleting the release bit and/or adjustment function can completely prevent the adjustment process.

4.6 Calculate the absolute physical position

The PSD4xx actuator includes an absolute measuring system capable of covering a range of 4,026 rotations. This allows the user to determine the direction of rotation for any desired portion of these 4,026 rotations.

The mapping of the desired positioning range to the physical positioning range “mapping end” is performed via SDO #2028.

In the delivery state, the drive is positioned at 0, the upper limit is 805,200, the lower limit is - 805,200. This results in a positioning range of $\pm 2,013$ rotations ($\pm 805,200$ steps). If the desired positioning range does not exceed $\pm 2,013$ rotations, none of the steps described below are required to set the positioning range in the delivery state.

The following two options are available to allow you to realise any desired positioning run distances independently of the run distance set by the mounting orientation of the measurement system (physical positioning range):

- 1) Bring the axle to be moved (e.g. a spindle) into the desired position, run the drive to the appropriate position with the adjustable collar open and only then close the adjustable collar.

Examples:

- a) Bring the axle to be positioned into the mid-position, run the drive in neutral (with the adjustable collar open) to the mid-position (position 0), then close the adjustable collar. The drive can now run 2,013 rotations in both directions (default $\pm 805,200$ increments).
 - b) Bring the axle to be positioned all the way to the left (or bottom), run the drive in neutral (with the adjustable collar open) without a loop to the smallest position (position - 805,200), then close the adjustable collar. The drive can now run 4,026 rotations to the right (or top) (default 1,610,400 increments).
 - c) Bring the axle to be positioned all the way to the right (or top), run the drive in neutral (with the adjustable collar open) to the largest position (position 805,200), then close the adjustable collar. The drive can now run 4,026 rotations to the left (or bottom) (default 1,610,400 increments).
- 2) Mount the drive in the required position on the axle, close the adjustable collar, then adjust the positioning range using SDO #2028. SDO #2028 sets the upper end of the positioning range. Default setting: upper end at +2,016 rotations (position 806,400). If, after mounting the drive, the positioning range does not match the currently displayed position, you can select the positioning range between + 3 ... +4029 rotations.

Examples:

- a) After mounting the drive, the position 0 is displayed (which corresponds to the delivery state). The positioning range should point exclusively to the right (or top)
 - Upper mapping end = Position +4,029 rotations
 - Set SDO #2028 to 1,611,600.
- b) After assembly, the displayed position is 804,000. However, the positioning range should point exclusively to the right (or top)
 - Upper mapping end = Position +4,029 rotations
 - Set SDO #2028 to 2,415,600.
- c) After assembly, the displayed position is -804,400. However, the positioning range should point exclusively to the left (or bottom)
 - Upper mapping end = Position +3 rotations
 - Set SDO #2028 to -803,200.

Notes:

- 1) When calculating the upper mapping end (SDO #2028) (as in the above examples), it is essential to include a safety margin of 3 rotations (by default 1,200 increments), because the highest possible position value is 3 rotations below the upper mapping end. The smallest possible position value is 4,029 rotations below the upper mapping end.
- 2) The numbers of increments or position values indicated relate to the following settings, which correspond to the delivery state:
 - a) Reference value (SDO #2004) = 0
 - b) Position scaling, numerator (SDO #2010) = 400
 - c) Position scaling, denominator (SDO #2011) = 400

These 3 parameters affect the above numbers of increments or position values: The reference value can be used to shift the range of values, the numerator/denominator to stretch or extend the range of values (see below).

- 3) If the direction of rotation is changed (SDO #202C), the reference value (SDO #2004), the upper mapping end (SDO #2028) and the upper and lower limits (SDO #2016 and #2017) will be reset to the delivery states.
- 4) When the upper mapping end is changed (SDO #2028), the upper and lower limits (SDO #2016) will be reset to the delivery states.
- 5) If the positioning scaling is changed (numerator: SDO #2010 or denominator: SDO #2011), the target value, actual value, reference value, upper mapping end and the upper and lower limits, positioning window and length of loop will be recalculated.
- 6) If the reference value is changed (SDO #2004), the target value, actual value, upper mapping end and the upper and lower limits will be recalculated.

- 7) If the user wants to avoid any automatic adjustment of values when setting the parameters for the drive, the optimum order for sending the parameters is as follows:
- a) Direction of rotation (SDO #202C)
Positioning scaling, numerator (SDO #2010)
Positioning scaling, denominator (SDO #2011)
 - b) Reference value (SDO #2004)
 - c) Upper mapping end (SDO #2028)
 - d) Positioning window (SDO #2006)
Length of loop (SDO #201F)
- 8) To save the settings permanently in EEPROM write a 1 in SDO #204F.
Saving can take up to 1 second.

Reference value (SDO #2004):

The referencing process affects all transferred values, i.e., the target value, actual value, upper mapping end and upper and lower limits.

There are two ways of setting the referencing value:

- 1) Directly – by writing the referencing value in SDO #2004.
- 2) Indirectly – by writing an actual value to SDO #2003. This makes it possible to assign any “true” actual value to the current, physical actual value. The resulting difference is then the referencing value. This value will immediately be included in calculations for each transferred value and can also be read under SDO #2004.

If the reference value is changed, the target value, actual value, upper mapping end and the upper and lower limits will be recalculated.

NOTICE

Removal of the supply voltage to the **motor** has no effect on the internal measurement system.

4.7 Set the spindle pitch

Using SDO #2010 (numerator factor) and SDO #2011 (denominator factor), it is possible to represent any desired spindle pitch using positioning scaling factors:

$$\text{Number of increments per rotation} = 400 \times \frac{\text{Denominator factor}}{\text{Numerator factor}}$$

Both factors are set to a value of 400 by default, resulting in a resolution of 0.01 mm at a spindle pitch of 4 mm.

The denominator factor serves as a simple means of setting the spindle pitch and resolution. The numerator factor is primarily used for setting "uneven" resolutions.

Examples:

| Spindle pitch | Resolution | Numerator factor | Denominator factor |
|---------------|------------|------------------|--------------------|
| 4 mm | 1/100 mm | 400 | 400 |
| 1 mm | 1/100 mm | 400 | 100 |
| 2 mm | 1/10 mm | 400 | 20 |

NOTICE

Numerator and denominator factors may take on values between 1 and 10,000

4.8 Abort the run when the master fails

If the connection to the EtherCAT master is interrupted during a positioning run, the master cannot abort a run that is already underway. The connection between master and slave is monitored using a Sync Manager Watchdog so that an automatic run abort can be generated in such a case. If there is no valid process data exchange within the specified time (default value = 100 ms), a connection failure will be diagnosed. The drive will abort the run and not start a new positioning run until the connection to the EtherCAT master has been re-established.

4.9 Reference runs

The PSD4xx positioning system is equipped with an absolute measuring system, so no reference run is required when the drive is switched on. If a reference run should be required to a hard obstruction in a specific instance (e.g. once during installation of the drive on a machine), the procedure should be as follows:

- 1) Prior to ordering the reference run, adjust the settings as follows:
 - a) Set max. operating torque (SDO #2014) and max. start-up torque (SDO #2018) to 10 % of the max. value, resp. the lowest possible values.
 - b) Set max. holding torque (SDO #202B) and max. holding torque at the end of the run (SDO #2042) to 0.
 - c) Set the speed limit (rpm) for aborting run (SDO #201A) to 60.
 - d) Set the time elapsed until falls below speed limit for aborting run (SDO #201B) to 100. (The time during which the drive tries to overcome the obstruction decreases: with these reduced values, the positioning run is aborted if the speed (rpm) remains below 60 % of the target speed for longer than 100 ms. The default settings are 200 ms and 30 %.)
 - e) Set the affected end limit (SDO #2016 or SDO #2017) so that the obstruction is clearly within the limit in each case. (Otherwise there is a risk that the obstruction will lie within the positioning window and therefore not be recognised.)
 - f) If necessary, reduce the target speed for manual operation (SDO #2013)
- 2) Now start the reference run as a manual run (bit 0 or 1 in the control word).
- 3) Wait until the drive is running (bit 6 is set in the status word)
- 4) Wait until the drive is stationary and a positioning error has occurred (bit 6 of the status word is reset, bit 10 is set).
- 5) Using the same settings, perform a manual run in the opposite direction (move a little distance away from the obstruction so the drive can move freely).
- 6) Only now use desired settings for normal operation of the above SDOs.

4.10 Run drive in reverse

Depending on the model, the drive may be run in reverse up to a certain speed.



CAUTION!

Running a PSD4xx in reverse for more than 1-2 seconds at more than the permissible speed will damage the internal protection diode and the PSD4xx will be defective.

Please refer to the following table to find the maximum permissible speed:

| Device model | PSD 401/411 - 5V/8H/14H | PSD 403/413 - 8H/14H | PSD 422/432 - 8V/8H/14H | PSD 424/434 - 14H | PSD 426/436 - 14H |
|------------------------------|-------------------------------|----------------------------|-------------------------------|-------------------------|-------------------------|
| Max. permissible speed [rpm] | 200 | 48 | 200 | 95 | 60 |

| Device model | PSD 428/438 - 14H | PSD 480/490 - 5V | PSD 480/490 - 8H/14H | PSD 481/491 - 8H/14H |
|------------------------------|-------------------------|------------------------|----------------------------|----------------------------|
| Max. permissible speed [rpm] | 45 | 200 | 200 | 48 |

5 Technical data

Technical data and drawings can be found in the current data sheet on the website:
www.halstrup-walcher.de/technicaldocu

Please search for "PSD" and select your type, click on "Data sheets".

Please contact us if you require any further information.

6 Notes

