

# **COMPACT DRIVE INSTALLATION MANUAL NCT ELECTRONIC UNITS DOCUMENTATION**

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**VERSION HISTORY**

<b>VERSION NUMBER</b>	<b>NAME</b>	<b>DESCRIPTION</b>
100	BT	Preliminary version.
101	BT	Installation documentation for setting up the first 50 produced drives.
102	BT	Corrections to the Installation manual, new chapters and figures, new units. Modifications for the new software were also included already.
103	BT	Addition of modifications and new information.
104	BT	Finalization and description of the drive parameters. Description of SoE commands.
105	BT	Standardization of the parameters of speed control. Content modification and addition of figures, block diagrams and basic data.

## **INTRODUCTION**

This installation manual includes mechanical and electrical data of the compact NCT synchronous and asynchronous servo drives, tie-up of electric connections necessary for their operation, their functions, and recommendations for their use. Furthermore, it contains data of the EtherCAT interface, description of the necessary process data and the SoE parameters needed for setup.

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**NCT Ipari Elektronikai Ltd.**

## 1 IDENTIFICATION

<b>Module type marking:</b>	D_C-10/20-(L/R)E, D_C-20/40-(L/R)E, D_C-40/80-(L/R)E, D_C-60/120-(L/R)E
<b>Rated values:</b>	DC bus: 540 V <sub>DC</sub> DC bus limit values: 440 V <sub>DC</sub> ~750 V <sub>DC</sub> Rated output 3-phase voltage: 290 V <sub>AC</sub> ~420 V <sub>AC</sub> Rated output phase current: 10 A <sub>eff</sub> and 20 A <sub>eff</sub> Maximum output phase current: 20 A <sub>eff</sub> and 40 A <sub>eff</sub> Rated output power: 4 kVA and 8 kVA
<b>Encoder:</b>	TTL, EnDat 2.2, Sine-Cosine
<b>Cooler:</b>	Active cooling system Controlled fan mode
<b>Software:</b>	Synchronous/asynchronous servo, inverter*
<b>Others:</b>	

### Type marking of the NCT EtherCAT servo amplifiers

#### D\_C-20/40-LE

- NCT EtherCAT servo amplifier: \_\_\_\_\_ ↑
- DSC** – for synchronous motors
- DAC** – for asynchronous motors
- DIC\*** – inverter mode
- Rated output current \_\_\_\_\_ ↑
- Maximum current \_\_\_\_\_ ↑
- Communication connection: \_\_\_\_\_ ↑
- L** – EtherCAT LVDS connection
- R** – EtherCAT RJ45 UTP connection
- C\*** – CAN connection +
- Type of measuring system: \_\_\_\_\_ ↑
- E** – EnDat 2.1/2.2
- T** – TTL incremental
- S\*** – SinCos encoder

\* Not available yet

## 2 DESIGN

Contrary to the former series, in the case of the compact series, drives with double current division are defined for both synchronous and asynchronous ones, where the first number means the rated current and the second number means the maximum current; currents that the drive is able to provide.

As far as the rated current value is concerned, it is the current value the drive can provide continuously, without interruption, over a long period of time or even up to the end of its life without overheating.

The maximum current value is the current value the drive can provide over a short period of time; if it is provided for a long time or often for a short time, the drive may get overheated and stop with an error message. (The values for operation modes will be defined later.)

The cooling design is the same for both synchronous and asynchronous drives: heat sink + fan. The size of the heat sink and the dimensions and the flow rate of the fan are calculated for the rated current value.

### 2.1 Compact mechanical design

The drive boxes can be placed side by side directly; it is not necessary to keep a distance between the units. It is a space-saving, easy-to-assemble and cost effective solution.

In the case of the drives of smaller size with up to 20 A rated current, the mounting tab can be placed in two different ways. So they can be mounted in the case of using both the slotted mounting plate technique and normal assembly technology. Units with 40 A or higher rated current are designed for technology using slotted mounting plate only.

### 2.2 Cooling outside the cabinet

More intensive cooling and higher available power. Separated electronics, minimal dirt, longer life and maintenance-free operation. Temperature dependent fan control, energy-saving solution, there is no overcooling, longer life. Heat is produced outside the cabinet, no heat in the electric cabinet, energy-saving solution.

### 2.3 Auxiliary supply voltage chainable in series and ECAT LVDS

In order to decrease cabling and costs, the EtherCAT connection to the NCT control can also be realized by settling the Ethernet connector (RJ45) on the power-supply unit only, and by stringing the drives into an LVDS channel using flat cable.

Furthermore, the auxiliary supply voltage is linked using the same cable. Thus, the auxiliary supply voltage should be input in a compact drive group at one place only, or, if the main power-supply unit provides auxiliary supply voltage due to its construction, such cable design will not be necessary at all. The drives get the supply voltage for their operation through the chaining cable.

### 2.4 Hidden bus design

A pair of buses sunk into the front panel is used to provide high-voltage power supply for the drive modules. After simple removing the plastic shock-proof protection front panel, any of the units can be taken out from the drive series by swinging out the bus elements without dismantling them.

### 3 SPECIFICATIONS

#### 3.1 Absolute limit values

	Minimum	Maximum
Rated DC voltages	230 V <sub>DC</sub>	540 V <sub>DC</sub>
DC voltage limit values	80 V <sub>DC</sub>	750 V <sub>DC</sub>
Limit values of output AC effective voltage	0 V <sub>AC</sub>	420 V <sub>AC</sub>
Ambient temperature	0 °C	55 °C
Storage temperature	-10 °C	70 °C
Relative humidity		60%
IP class of protection against electric shock	IP00	IP20 (together with all covering elements)

#### 3.2 Rated working values

	D_C-10/20-xy	D_C-20/40-xy	D_C-40/80-xy	D_C-60/120-xy
Rated DC voltage	540 V			
Output A <sub>RMS</sub> voltage	0~400 V <sub>RMS</sub>			
Switching frequency	8 kHz			
Control cycle time	125 μs			
Effective value of the rated output current at duty cycle S1	10 A <sub>RMS</sub>	20 A <sub>RMS</sub>	40 A <sub>RMS</sub>	60 A <sub>RMS</sub>
Effective value of the maximum output current at duty cycle S6 30% or 30 second	20 A <sub>RMS</sub>	40 A <sub>RMS</sub>	80 A <sub>RMS</sub>	120 A <sub>RMS</sub>
Peak value of the output current at 1ms	40 A <sub>pk</sub>	80 A <sub>pk</sub>	160 A <sub>pk</sub>	240 A <sub>pk</sub>
Rated output power	7 kVA	14 kVA	28 kVA	42 kVA
Recommended maximum asynchronous motor power	5 kW	10 kW	20 kW	30 kW
Weight	3.5 kg	4.0 kg	7.0 kg	7.5 kg

#### 3.3 Safety precautions

Only person who knows general rules for electric safety and is properly trained is allowed to carry out commissioning, inspection, repair and maintenance of the servo drives manufactured by the NCT Ltd. In addition, he/she should know all the dangers of the given equipment and all the rules of avoiding accident. The person working on the electric equipment is not only

responsible for his/her own physical integrity, but he/she should prevent other person for being exposed to danger.

### 3.3.1 Protection against shock hazard

Commissioning, repair and maintenance of the servo drives manufactured by the NCT Ltd. should be carried out in accordance with the standard MSZ 172-4:1978.

The metal case of the compact servo amplifiers should always be connected to the protective conductor by the use of a wire of specified thickness. Applying a voltage higher than the extra-low voltage to the compact servo amplifiers is allowed only in the case if they are properly connected to the protective conductor. Only wires with undamaged insulation, undamaged connecting counterparts without cracks and core end sleeves with insulating shrouds should be used during commissioning the compact servo amplifiers. When the compact servo amplifiers are purchased, their DC bus terminals can be touched freely; however, after installation of the servo amplifiers inaccessibility of these terminals should be ensured. While the DC bus terminals can be touched freely, it is forbidden to apply voltage to the drive system. High-capacity capacitors connected to the DC bus retain the charge stored on them for a long time even after disconnection from the mains. If, for any reason, it is needed to handle the compact servo amplifier, make sure that the voltage of the DC bus has already decreased to zero.

### 3.3.2 Hot surfaces

The compact servo amplifiers produce heat during operation, and this heat warms them and their surroundings as well. During operation, the compact servo amplifiers can heat up to such a high temperature that they can cause burns by touching them; especially the heat-transferring surfaces can become extremely hot. Always make sure whether the temperature of the surface to be touched can cause burn.

### 3.3.3 Accidental motor motions

If motors are connected to live compact servo amplifiers, there is always a danger that these motors will come into motion; these accidental motor motions can cause personal injury or serious damage. A motor can start up because of drive failure, external interference or unintended switch-on. After turning off the supply voltage, capacitors on the DC bus will have energy for a long time enough to rotate the motor. Basic problem is the noise in the factories which make it more difficult to sense unintentional mechanical motions and to react rapidly.

## 3.4 Requirements on the high-current DC input

The high-current DC voltage inputs of the compact drives can be chained; they can be connected to the adjacent units and to the main power supply unit by the use of copper busing. It is the main power supply unit that provides the DC bus input with rated (sufficient) voltage and that is also used for avoiding and eliminating overvoltage. During operation, even voltage of 750 V<sub>DC</sub> may appear on this input for a short time. For this reason, and in order to comply with the safety-of-life points, assembling the DC busing should be carried out only by the person specially trained for this. It is **FORBIDDEN** to assemble equipment being under effective voltage or partial voltage. Existence of the DC bus voltage is indicated by a red light LED placed on each unit for this purpose, between two buses. If this LED can give even a poor light, it is not allowed to commence assembly.

The compact drive units, through the DC bus, may consume or deliver the maximum current value indicated on their type marking, for a short period. For that very reason, proper contact should be provided over the entire bus from the main power supply unit up to the last unit. To achieve proper contacts, the copper bus elements are covered with special coating. In addition, the force clamping the elements might substantially affect the quality of contact, so the screws should be tightened to the torque specified in the Subchapter 4.3. Because of this, in order to provide proper contact, it is recommended to chain the DC bus system of the units by the use of the two coated copper clenches which are provided as accessories to the drive unit; and, the proper clamping force can be ensured by the use of the torx screws attached.

Because of the protection against shock hazard and the accident danger, it is **IMPORTANT** to mount the plastic insulating front panel cover on the DC bus before turning the power supply on, and also to mount the plastic end-closing elements at the two ends of the bus system.

### **3.5 Requirements on furnishing with auxiliary supply voltage**

It is allowed to operate the units after applying  $24 V_{DC}$  (+10%, -10%) voltage to the auxiliary supply voltage input of the compact drives. This voltage operates the internal switched mode power supply unit of the drives and also the internal fans cooling the drives. That is why it is necessary to provide this input with a filtered and low waviness DC voltage meeting the requirements described in the Subchapter 5.2.3.

### **3.6 Lifetime**

The factors affecting particularly the lifetime of the devices are the following:

- Ambient working temperature
- Working voltage
- Continuous working current load
- Contaminating agent

## 4 MECHANICAL INSTALLATION

For installation of the compact servo amplifiers, the following four points should be considered:

- Protection against accidents
- Protection against hazardous agents
- Avoiding overheating
- Mechanical installation

### Protection against accidents

On the compact servo amplifiers, there are live points that might be touched. For this reason, such installation place should be selected where it is not possible to access to the compact servo amplifiers under normal circumstances. The most commonly used solution is building them in the switching cabinet.

The compact servo amplifiers themselves are protected in accordance with the IP00 class, and they will have an IP20 class protection only after mounting protecting cover over the DC buses.

### Protection against hazardous agents

Compact servo amplifiers – like other electronic devices – are sensitive to various contaminating agents and moisture. Certainly, it is necessary to avoid entering water and several stable and liquid materials into the drives. Similarly, it is necessary to prevent air contaminated with coolant, oil spray, graphite dust and sawdust etc., or humid air from entering the inner space of the device.

If the compact servo amplifiers are operated in a room where the air is not clean properly, protection of the devices should be ensured. When you provide properly clean environment, do not forget heat generated a part of which should be delivered away by the air surrounding the drive. Nowadays, the switching cabinet with heat exchanger or the cabinet air-conditioned and sealed seems to be the best solution.

### Avoiding overheating

In the course of their operation, the compact servo amplifiers generate heat which warms them and their surroundings. If the heat generated is unable to leave the device with sufficient intensity, the device will overheat. One of the most important aspects of the installation is to avoid this case. The proper design of heat removal is given in the Subchapter 4.5.

### Mechanical clamping

Clamping of the compact servo amplifiers is described in the Subchapter 4.4.





**Figure 1 40 A and 60 A rated current drive**

#### **4.1 EtherCAT communication using RJ45 UTP cable**

Industrial UTP cable connection is done on the drives in a well-proven way, as we used to on older types.

#### **4.2 Chainability by the use of LVDS flat cable**

If the drives should be connected to one another by the use of flat cable, it can be done by the use of 20-core flat cable in the following way: a longer flat cable between the head card of the power supply unit and the first drive and a shorter one between two drives are needed. The flat cables should be inserted into 20-pin flat cable connector in such a manner so that the positioning extension of the both connectors is in the same direction, and then they should be folded back by the use of a crinkle preventer.

Not only the EtherCAT communication but also the 24 V auxiliary supply voltage of all the units link to one another. Therefore, on a chained block, it is enough to apply 24 V<sub>DC</sub> auxiliary power supply to one unit of a block on a blocked block



**Figure 2 LVDS flat cable chaining**

Cable length to be cut off for linking:

- Long cable: 115 mm
- Short cable: 87 mm

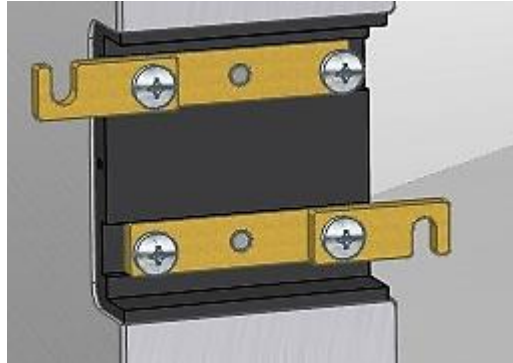
Connection can be realized in the manner shown in the Figure 2. The power supply unit should be placed at the left end of the row so that the order is proper in the EtherCAT.



**Figure 3 LVDS EtherCAT connection of the 40 A and 60 A rated current compact drive**

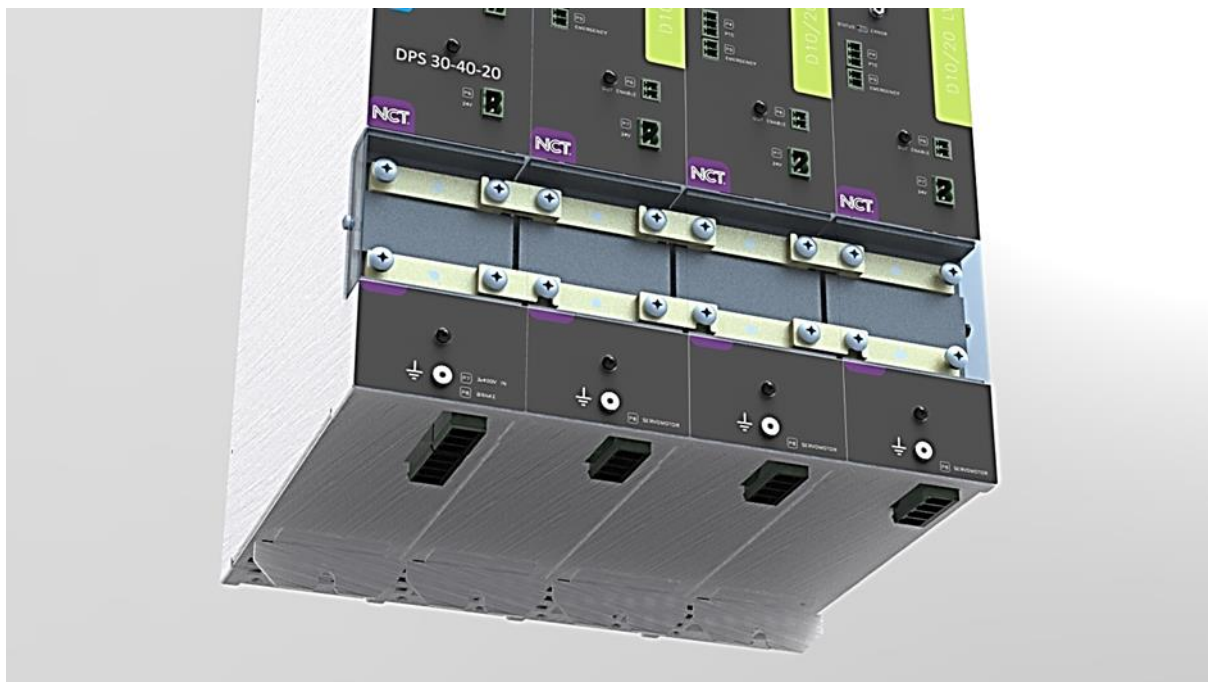
### 4.3 Power bus chaining

Chaining can be realized by the use of plastic pieces and copper parts made especially for this purpose. Two drives can be chained to one another by the use of handle-shaped copper forms length of which is identical for each drive size. The bus form is adjusted to the width of the drive.



**Figure 4 DC bus clenches**

The clenches should be placed onto the DC bus form as shown in the picture. In this arrangement, when the screws are being tightened, the clenches turn onto the screws. In the case of other arrangements, the clenches may slide off the screws. It is recommended to assemble the buses by the use of the specified screws. In the case, when such screws are not available, the assembly can be carried out by the use of M5×15 D cross recessed head screws, but it is absolutely necessary to use a plain washer and a spring washer. However, the washers may hinder the clenches from turning.



**Figure 5 Chainability of the power DC outputs**



**Figure 6 DC bus system of the 40 A and 60 A current drive size**

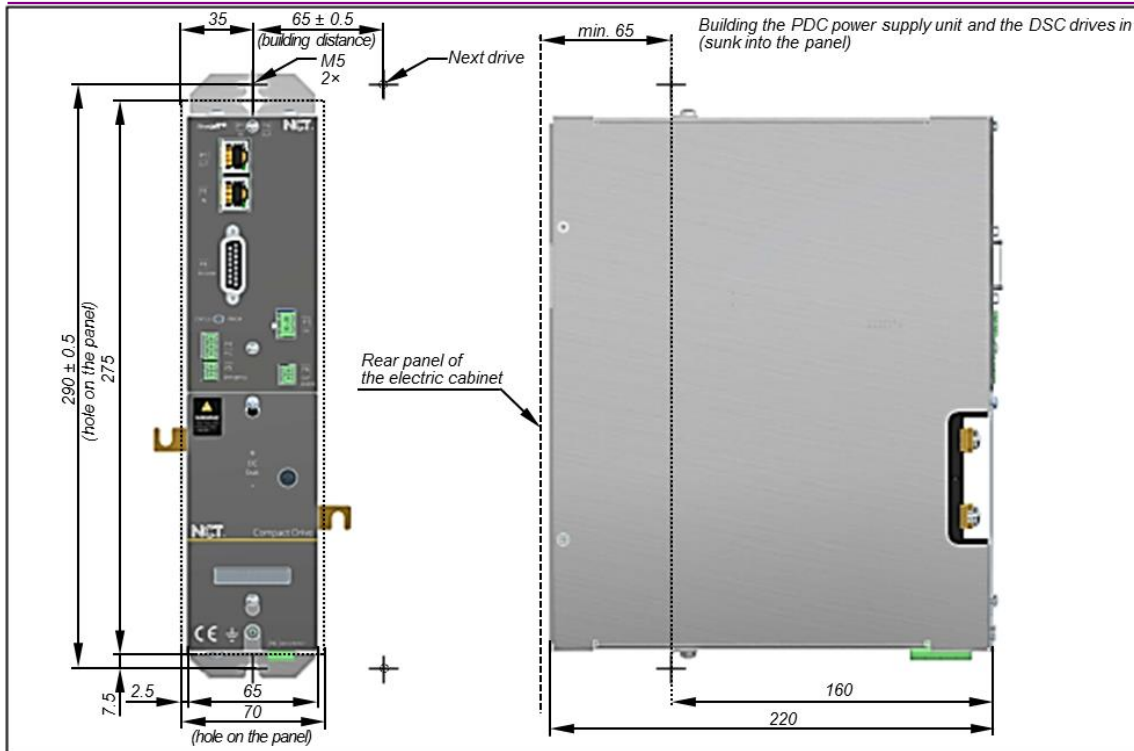
#### **4.4 Clamping**

Mounting tabs should be used for clamping the drives. The lower and the upper mounting tabs are different. The upper mounting tabs have a keyhole design for M5 pan head screw.

The tabs can be mounted on the side of the drive in two different positions. They can be mounted by the use of M4 screws which have a special groove under the head to prevent them from falling out from the tabs during mounting.

If the intension is to install the drives in a cabinet in a standard manner, the tabs should be mounted at the very rear position.

If the intension is to install the drives by the use of slotted mounting plate technique in order to exclude heat of the power cascades from the closed interior of the cabinet, the tabs should be mounted in front of the perforated cooling grill.



## 4.5 Heat removal

Heat energy derived from the dissipation of high-power IGBT modules is confined in a heat channel at the rear part of the box. By relocating the mounting tabs and building in the slotted mounting plate, this heat channel goes into the heat removal channel being outside the cabinet. In this case, the generated heat gets stuck outside the cabinet and it is not necessary to use an air conditioner or a heat exchanger if it is not required by another unit installed in the cabinet. In the rear part of the box cooling is realized by free air flow until reaching the threshold temperature and then when it is passed the cooling fan switches on. Depending on the temperature, air flow of the fan can be controlled in several stages, so the lifetime of the fan and therefore lifetime of the drive increases. In addition, the fan blows the air only to the heat sink, so if the air is contaminated it will not get into the electronic parts where it would cause trouble. In the case of contamination, the drive would indicate overheat error which could be remedied by simple cleaning or replacing the air filter.

### 4.5.1 Requirements to be met by the heat removal channel

Wasted energy generates or dissipation takes place on every device providing energy for other devices. The heat generated by the main power supply units and the drives is, mainly on semiconductors, the sum of the power loss derived from switchings and the power loss caused by the current flowing through in open status. For this reason, in the course of design it is necessary to scrutinize whether the heat being generated can be removed from the inside of the cabinet.

Local heat flows can also be generated in the inside of the cabinet. Since the warm air flows upwards due to the chimney effect, several aspects should be studied with regard to installation of the devices that produce most of the heat. These devices cannot be placed at the top of the cabinet because the warm air trapped impedes the proper heat dissipation that causes overheat. Of course, it is a correct design in the case where there is an output heat remover

just over them. However, they cannot be placed fully at the bottom either since there are such devices in a cabinet that are sensitive to the warming and to the change of ambient temperature. Therefore, the optimum place may be found somewhere at the centre.

The most important feature of the new compact drives is that, in the case of application of the slotted mounting plate technique, the heat-transferring surfaces of the units are placed in the rear part of the cabinet designed especially for this purpose; in a heat channel space opened by filters that is separated from the inner space of the cabinet. It is the heat channel created in the rear part of the servo drives and equipped with fan. It is why the mounting tabs can be mounted in two positions. In such a way, the problem mentioned above will diminish because much less heat dissipation should be transferred from the cabinet space to the outside world. It can be realized by location of the rear parts of the drives 'out of the cabinet'. In this case, it could be enough to place a normal heat exchanger inside the cabinet or even it is not needed either.

## 5 ELECTRICAL INSTALLATION

For creating a compact drive series, the connections are named and numbered in a uniform manner. Thus, in the case of any size, a connection with the same function will have the same name and number. In addition, there are also connections whose function is the same both in the main and the auxiliary power supply units. The connector names and numbers are given in the Table 1.

### Command inputs

SoE (Servo drive over EtherCAT) – State-of-the-art high-speed Ethernet-based digital interface

### Measuring system inputs

TTL – Mainly for retrofitting, with 5 V TTL incremental encoder reception commutation signals

SINUS-COSINUS – High-speed 1 V<sub>pp</sub> analog incremental channel

HEIDENHAIN EnDat 2.2 – High-resolution high-speed absolute position measurement

**Table 1 Compact connector names and numbers**

Function	Group	Direction	Connector number	Function mark
Compact drive/power supply unit EtherCAT input RJ45 connector	Process	Input	X1	IN
Compact drive/power supply unit EtherCAT output RJ45 connector	Process	Output	X2	OUT
Compact drive EtherCAT input LVDS connector	Process	Input	X3	IN
Compact drive/power supply unit EtherCAT output LVDS connector	Process	Output	X4	OUT
Compact drive high-current/high-voltage DC input	High-current	Input	X10	DC bus
Compact drive high-current/high-voltage motor output	High-current	Output	X13	Motor
Compact drive measuring system encoder connector	Encoder	Input	X21	Encoder
Compact drive/power supply unit 24 VDC auxiliary supply voltage input	Auxiliary power supply unit	Input	X31	Aux power
Compact drive IGBT/power supply unit contactor enabling input	Interface	Input	X41	Enable

Function	Group	Direction	Connector number	Function mark
Compact drive KTY/PTC analog motor protection input	Interface	Input	X43	Temp.
Compact drive emergency status indication output	Interface	Output	X44	Emergency

## 5.1 High-current connections

### 5.1.1 Ground connection lug

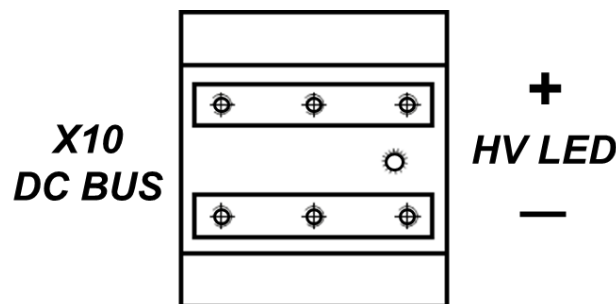
The connection is located at the bottom of the front panel; the cable with lug can be connected to it by the use of an M5×8 screw. The cross section of the wire should be at least 2.5 mm<sup>2</sup>.

The housing of the compact servo amplifier should be connected to the guard wire; for this, on the metal cover of every device there is a connecting point marked with generally accepted grounding symbol. The cross section of the guard wire and the cross section of the mains wire of the power supply unit should be the same.

### 5.1.2 DC bus

Connection of the drives and the main power supply unit together can be realized by the use of the handle-shaped connecting pieces enclosed to the package in a manner illustrated in the Figures 2 and 3.

In certain cases, cabled connection may also be needed, for example, when drives placed in several rows should be supplied. In the case of such connection, the distance between cables signal wires should be at least 10 cm. In the case of a longer connection, it is recommended to use high-current shielded cable with grounded shielding at both ends.



### 5.1.3 Motor connection

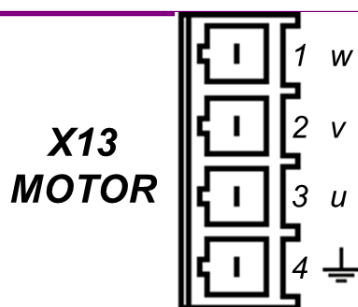
Up to the compact 20 A rated current drive size (D\_C-20/40-xy):

The motor connections are placed at the bottom side of the drive, the marking is X13.

The type of the connector to be mounted on the motor cable: PC 4/4-ST-7.62.

Connection should be carried out by the use of standard NCT motor cable in a manner compatible with the former drives. It is allowed to connect to the counterpart of the connector only a wire the cross section of which is not more than 4 mm<sup>2</sup>.





**Figure 7 Motor output connection**

In the case of the compact (D\_C) 40/80 and 60/120 drive size:

At the bottom side of the drive housing there are three HDFKV 16 type panel feed-through terminal blocks; it is allowed to connect it a wire the cross section of which is not more than  $16 \text{ mm}^2$ . The guard ground wire of the motor cable and the shielding of the cable can be connected to the ground lugs on the front panel.

The cross section of the phase conductor of the motor cable should be specified on the basis of the motor current in accordance with the standard MSZ EN 60204-1:2010; the cross section of the guard wire and the cross sections of the phase conductors are the same.

In order to decrease emitted electromagnetic interference, the wires should be shielded; the shield should be connected to the metal cover galvanically at both ends.

A motor connector counterpart is a standard accessory to the compact servo amplifiers and, to the motors of given types, pre-fabricated motor cable with specified length can be ordered.

## 5.2 Low-current connections

### 5.2.1 Emergency status output

Connector mark: X44, EMERGENCY

It is connected by the use of a 2-pole 3.81 mm raster connector.

The type of the connector: AKZ1550

Output load capacity: max. 2 A; rated value  $0.5 \text{ A}_{AC}$  ( $250 \text{ V}_{AC}$ ) or  $1 \text{ A}_{DC}$  ( $30 \text{ V}_{DC}$ ).

The connector is a contactor output which is in closed status during normal operation of the drive. In the case of such error the drive cannot manage, i.e. it releases the motor output, this emergency output comes to the open status.

In the case of manageable errors, there is no need to indicate the emergency status from the drive side because the event can be monitored.



### 5.2.2 Enabling the motor output (IGBT transistor)

Connector mark: X41, ENABLE

It is connected by the use of a 2-pole 3.81 mm raster connector.

The type of the connector: AKZ1550.

Input load capacity is max 28 V<sub>DC</sub>.

Activation time is 4~5 ms (millisecond).

Deactivation time is 200~250 ms (millisecond).

Input resistance is 2880 Ω.

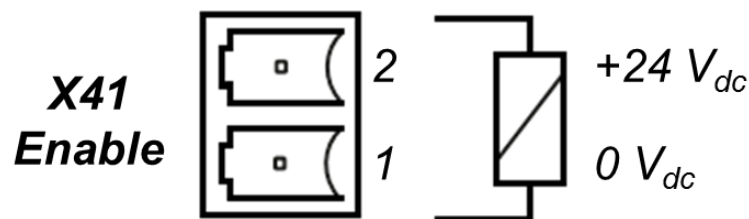
Minimum input activation voltage level is 18 V<sub>DC</sub>.

For deactivation from the active status, the maximum allowed voltage is 0~2.4 V<sub>DC</sub>.

This input determines whether the high-current transistor (IGBT) module will operate or not. If the voltage on this input is smaller than 10 V<sub>DC</sub>, control signals cannot arrive at the semiconductor.

The purpose of this function is to eliminate the need to interrupt the connection between the drive and the motor by the use of a magnetic switch from the PLC, even in the case of the main motors. Driving a suitable input is a space-saving and cost-effective solution.

If this input is in disabled status, the motor will not start under any circumstances because high-voltage signal producing rotating field cannot get on to it.



**Figure 8 Enabling the motor output**

In the above-mentioned manner, 24 V<sub>DC</sub> supply voltage should be applied to this input.

Now, the input is NOT potential-independent with the relay used in the drive, but it can be switched by the use of an external contactor. The number 2 indicates the +24 V<sub>DC</sub> voltage, the number 1 indicates the 0 V<sub>DC</sub> voltage. If the input is already in active status, a voltage near to 0 will be needed for deactivation which, at a low level, is a factor determining sensitivity of the input to interferences. In addition, the input works with delayed release in order to help managing the emergency status.

### 5.2.3 Input of auxiliary supply voltage

Connector mark: X31

Voltage of the auxiliary power supply unit: 24 V<sub>DC</sub> (+10%, -10%)

It is connected by the use of a 2-pole 5.08 mm raster connector.

Manufacturer of the connector: Phoenix Contact

The type of the connector: MSTBA 2,5/2-G-5,08

The type of the counterpart: MSTB 2,5/2-ST-5,08

Maximum input load capacity is 27 V<sub>DC</sub> and 0.5 A<sub>DC</sub> at continuous average load.

In the case of drives, this input exists only when the drive has RJ-45 EtherCAT inputs. Otherwise, there is LVDS EtherCAT input which ensures chainability of the 24 V auxiliary supply voltage and the power supply.



Current drain through the connector of the 24 V<sub>DC</sub> auxiliary power supply unit: 0.44 A (drive + operating cooling fan)

### 5.3 Communication and signal inputs

#### 5.3.1 EtherCAT RJ45 IEEE802.3

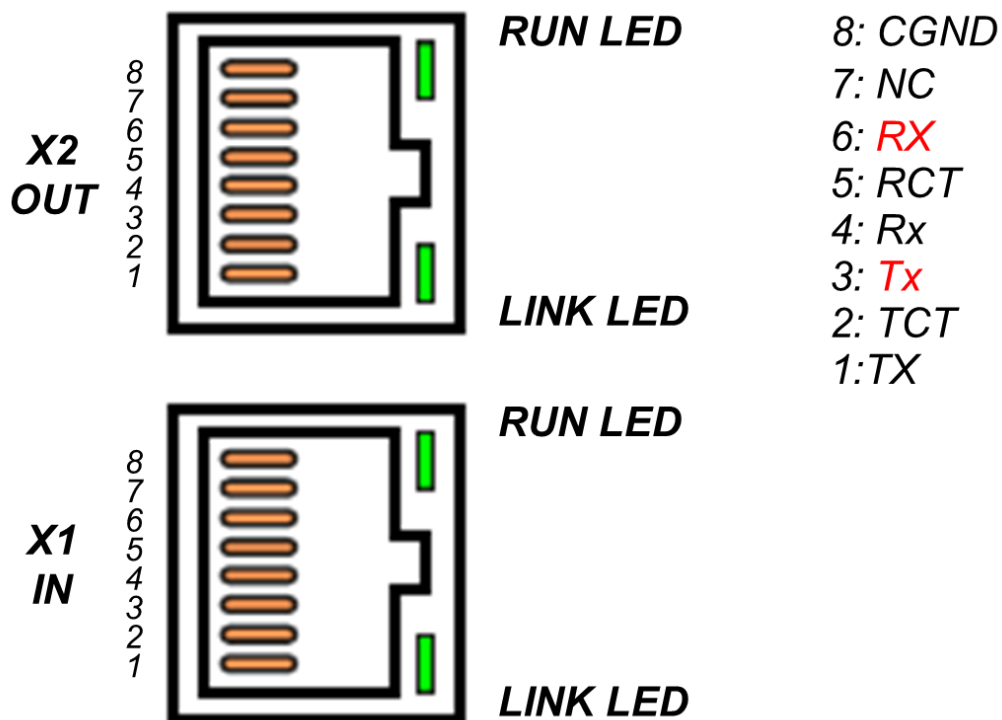
Manufacturer of the connector: Amphenol

The type of the connector: LMJ2018813130DL3T1

Manufacturer of the counterpart: Harting

The type of the counterpart: 09 45 151 1100

Connector marks: X1 (lower) IN, X2 (upper) OUT



EtherCAT connection can be chosen from two kinds when drives are ordered. In the case of the RJ-45 UTP connection, the head unit module that can be incorporated in the power supply unit is not needed, the drives can be cabled anywhere in the EtherCAT communication.

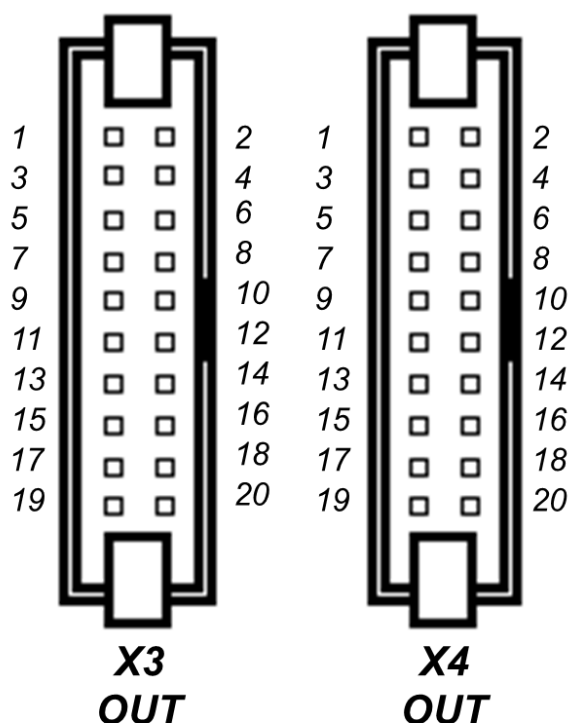
### 5.3.2 EtherCAT LVDS flat cable

Manufacturer of the connector: E-tec

The type of the connector: PSL20W

The type of the counterpart: IDS-020-S100-01/P

Connector mark: X4 OUT



The DxC ... drives are delivered in a manner, that in the package each of the units has 1 piece 'DxC to DxC LVDS flat cable' with article number 30-00000230-00 by the use of which additional DxC servo amplifiers can be chained (the PxC ...-R power supply unit and the DxC ... servo amplifier following it can be interconnected by the use of the 'PxC to DxC LVDS flat cable' with article number 30-00000229-00). These are the flat cables through which the power supply unit provides the DxC ... servo amplifiers with 24 V<sub>DC</sub> supply voltage and with the LVDS signals of the EtherCAT industrial communication channel.

The units can be chained through the LVDS flat cable only in the manner, that the PxC ... main power supply unit is placed at the left-most-edge of the flat cable and the drive units are chained to the right of it in descending order of power.

### 5.3.3 Encoder input

Connector mark: X21, Encoder

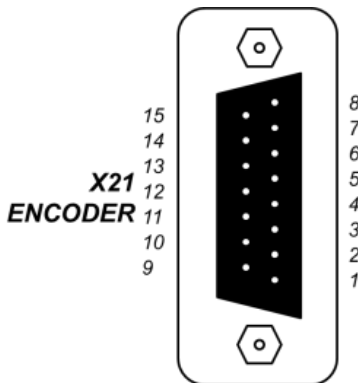
Two serial DSUB15 15-pin connectors are used for connecting.

The type of the connector: DSUB15

Maximum input load capacity is 3~5.5 V<sub>DC</sub>

NCT standard encoder connection for all the encoder types applied.

### Encoder connection

DSUB connector	In the case of EnDat encoder	In the case of incremental encoder
	1: Not used	1: <b>A</b> signal
	2: Supply voltage ground ( <b>GND</b> )	2: Supply voltage ground ( <b>GND</b> )
	3: Not used	3: $\bar{\mathbf{B}}$ signal
	4: <b>CLOCK</b>	4: <b>C</b> signal
	5: Positive supply voltage ( <b>5 V</b> )	5: Positive supply voltage ( <b>5 V</b> )
	6: Not used	6: <b>I</b> commutation signal
	7: Not used	7: <b>II</b> commutation signal
	8: Not used	8: <b>III</b> commutation signal
	9: Not used	9: $\bar{\mathbf{A}}$ signal
	10: Not used	10: <b>B</b> signal
	11: Supply voltage ground ( <b>GND</b> )	11: Supply voltage ground ( <b>GND</b> )
	12: $\bar{\mathbf{CLOCK}}$	12: $\bar{\mathbf{C}}$ signal
	13: $\bar{\mathbf{DATA}}$	13: Not used
	14: Positive supply voltage ( <b>5 V</b> )	14: Positive supply voltage ( <b>5 V</b> )
	15: <b>DATA</b>	15: Not used
	Shielding: Connector housing	

### 5.3.4 Motor thermometer signal input

Connector mark: X31, 24 V

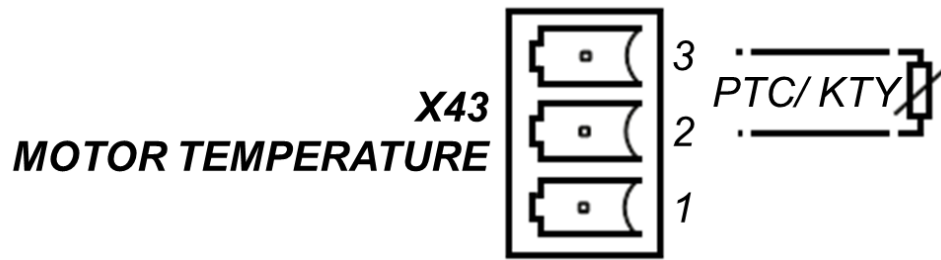
It is connected by the use of a 2-pole 5.08 mm raster connector.

The type of the connector: MSTB 3.5-3.81

Output measuring voltage: 3 V<sub>DC</sub>

Measuring range of the input: 100~10 000 Ω

Maximum input load capacity: 0~>1 MΩ



**Figure 9 Motor thermometer input**

The input is capable of receiving thermal circuit-breaker, PTC thermal sensor, and thermometer built in the KTY-83 and KTY-84 coil ends.

## 6 UPDATING THE DRIVE FIRMWARE PROGRAM

On the control, updating the firmware of the compact drives can be initiated and executed on the EtherCAT communication interface. The course of software update runs in a standard way in accordance with the FoE data management protocol. On the NCT control, the software update can be initiated only by giving the authorization.

1. On the Online tab of the EtherCAT window, the status machine should be stepped back to the INIT status.
2. On the FoE tab of the EtherCAT window, after pushing the 'Open file' button, the file to be downloaded should be selected.
3. The 'Bootstrap' button should be pushed.
4. If it is in BOOT status according to the ECAT status label, the 'Download' button should be pushed.
5. The software update operations are started, the control clears the memory first, and then it downloads the file and burns it in the program storage of the drive.
6. If the operation is successful, **the AutoScan button should be pushed**. By this, the control will recognize the new parameters and changes.

## 7 DRIVE SETUP PARAMETERS

The compact servo amplifiers use Sercos Servo Drive over EtherCAT compatible protocol for parameterization. This standard describes, in general, that every setup data, process data and command appears on the setup interface as a parameter to which a definite identifier, IDN, belongs. The parameters can definitely be referred principally by their IDN identifiers. In general, the parameters can be classified into following three main groups:

1. Setup parameters
  - a) Password-protected parameters relating to the electrical features of the drive
  - b) Parameters needed to setup of the EtherCAT communication
  - c) Command value scaling parameters
  - d) Measuring system parameters
  - e) Motor model parameters
  - f) Parameters needed to setup the controls
2. Process data being updated in cycle time
  - a) MDT (Master Data Telegram), information and command values controlling the drive
  - b) AT (Application Telegram), information provided by the drive
3. Executable commands

### 7.1 Protected drive parameters

#### 7.1.1 Rewriting the write-protected parameters on the SoE interface

1. The protected parameters can be rewritten only in the PreOp mode and only by giving the password properly. (So, P--)
2. The following table lists the parameters rewritable in the PreOp mode.

Software version: 1.3xx		Software version: 5.4xx	
ID	Description	ID	Description
S-0-0110	Amplifier peak current	S-0-0110	Amplifier peak current
S-0-0112	Amplifier rated current	S-0-0112	Amplifier rated current
S-0-0200	Amplifier warning temperature	S-0-0200	Amplifier warning temperature
S-0-0203	Amplifier shut down temperature	S-0-0203	Amplifier shut down temperature
P-0-0020	Amplifier description code	P-0-0020	Amplifier description code
P-0-0023	Amplifier current scale limit value	P-0-0023	Amplifier current scale limit value
P-0-0025	Amplifier DC voltage scale limit value	P-0-0025	Amplifier DC voltage scale limit value
P-0-0026	Amplifier AC voltage scale limit value	P-0-0026	Amplifier AC voltage scale limit value
P-0-0028	Amplifier DC over voltage limit	P-0-0028	Amplifier DC over voltage limit
P-0-0030	Amplifier phase current offset max diff	P-0-0030	Amplifier phase current offset max diff



Software version: 1.3xx		Software version: 5.4xx	
ID	Description	ID	Description
P-0-0031	Amplifier phase current difference max.	P-0-0031	Amplifier phase current difference max.
P-0-0032	Amplifier AB phase out voltage max diff	P-0-0032	Amplifier AB phase out voltage max diff
P-0-0033	Amplifier CB phase out voltage max diff	P-0-0033	Amplifier CB phase out voltage max diff
P-0-0035	Heatsink Tmp. Sens. Const.	P-0-0035	Heatsink Tmp. Sens. Const. List
P-0-0036	Motor Tmp. Sens. Const.	P-0-0036	Motor Tmp. Sens. Const.
		P-0-0038	DCU OpAmp correction multiplier List

3. For rewriting, the drive should be switched to the PreOp mode. ECAT setup → Online → PreOp
4. Giving the password in the parameter S-0-0267 Password.
5. If the password is correct, the parameters indicated above will be writable.
6. When writing is finished, a Command will start recording the data entered:
  - a) The 0xF2 hex should be written in the parameter P-0-0115 'Parameter writing mode preselection'. The code of the function to be executed should be written in this parameter, and then, the code of the result of execution will appear here. The operation will be successful if the 0XFF code appears.
  - b) Execution of the function written in the P-0-0115 can be initiated by the command P-0-0216 (process command, PC) 'Parameter write command'. By double-clicking on the value field and by pushing the Start button in the pop-up window, the function will be executed. A text message about the result of the operation will be received in the window.
  - c) Any return value of the P-0-0115 will be an error code.
7. To activate the data entered, it is necessary to return to the INIT status and then switch to the PreOp mode again, or, simply to push the Set Config on the control.
8. Checking the data entered.

The protected parameters are burnt always in the course of the electronics manufacturing. Changing them may cause either failure of the drive or malfunction. Our company does not take responsibility for changing the parameters. Changing together with a time stamp will also be burnt and will be stored there through entire life of the drive.

7.2 The control technique flowchart for the version 5.4xx

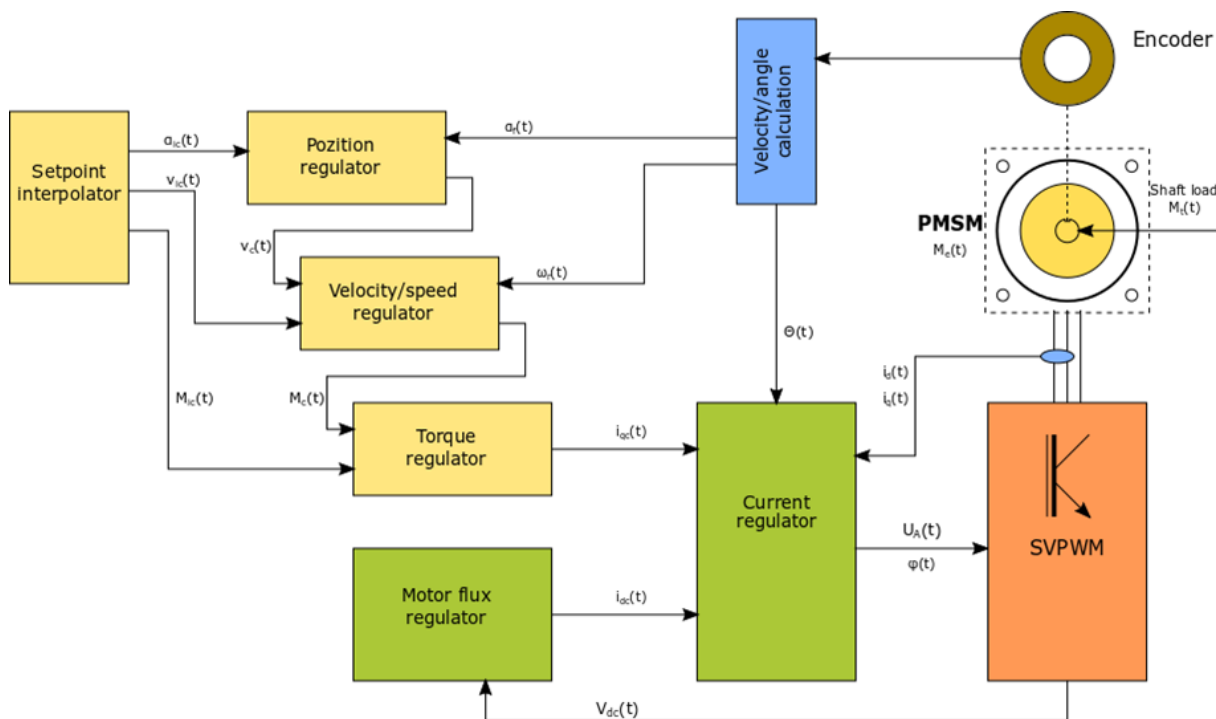


Figure 10 Simplified flowchart of the PMSM servo

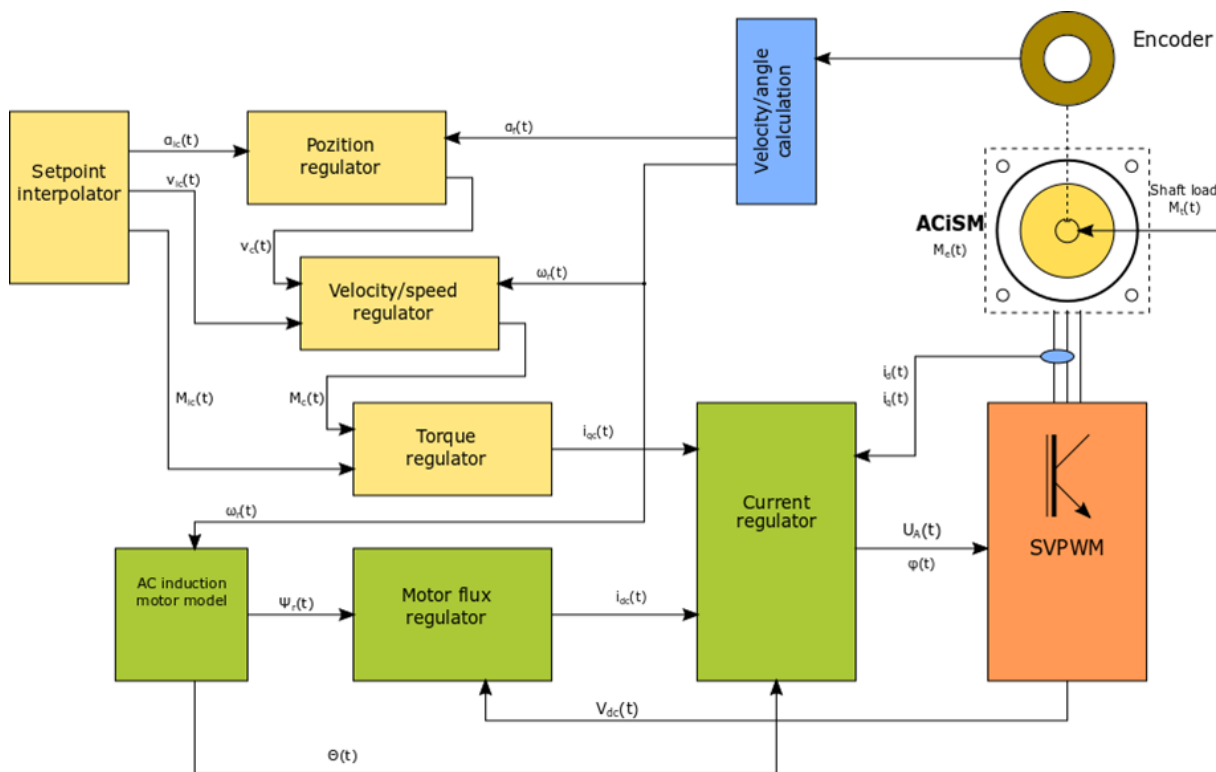
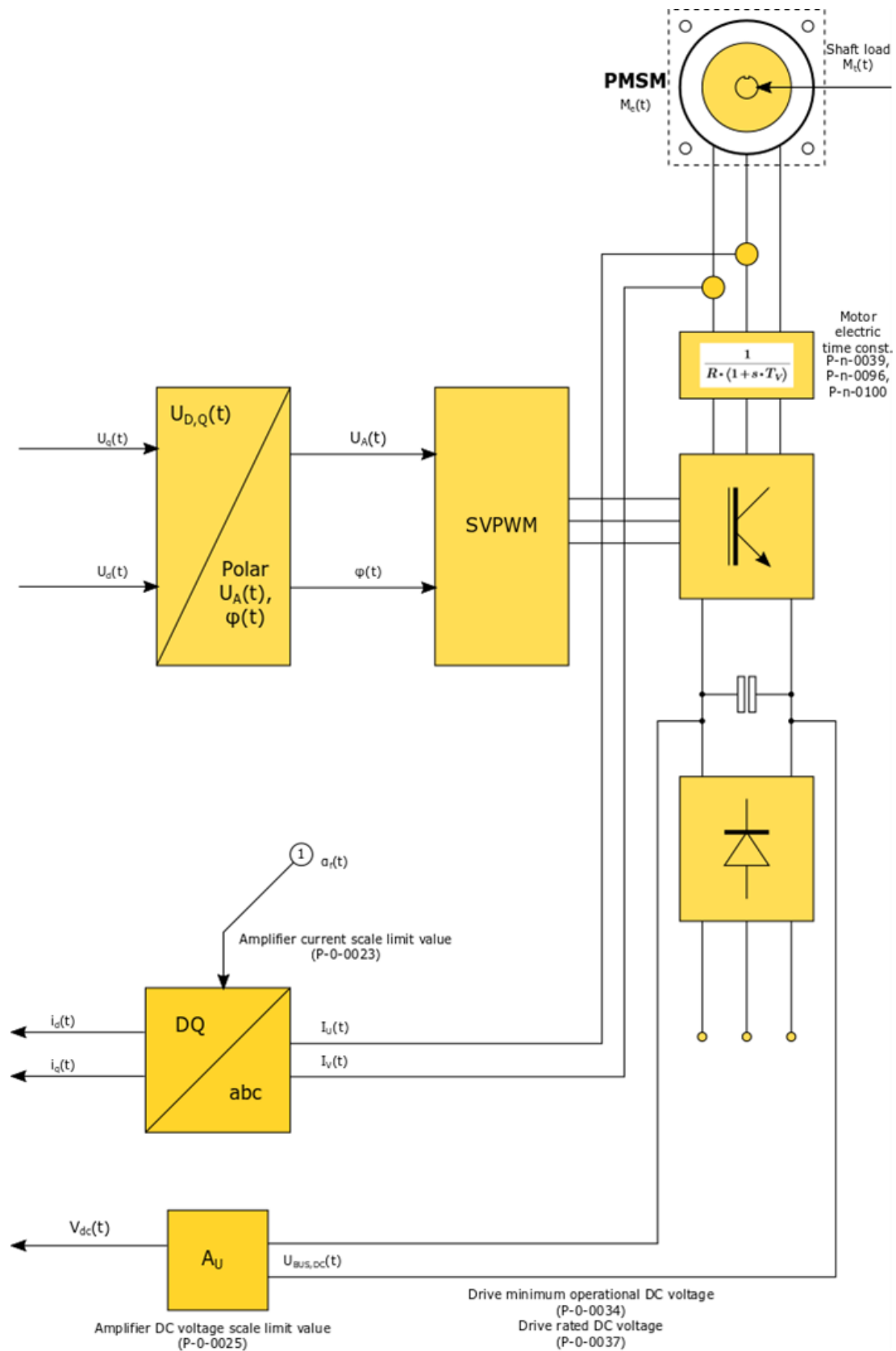


Figure 11 Simplified flowchart of the asynchronous servo



**Figure 12 Drive SVPWM and motor**

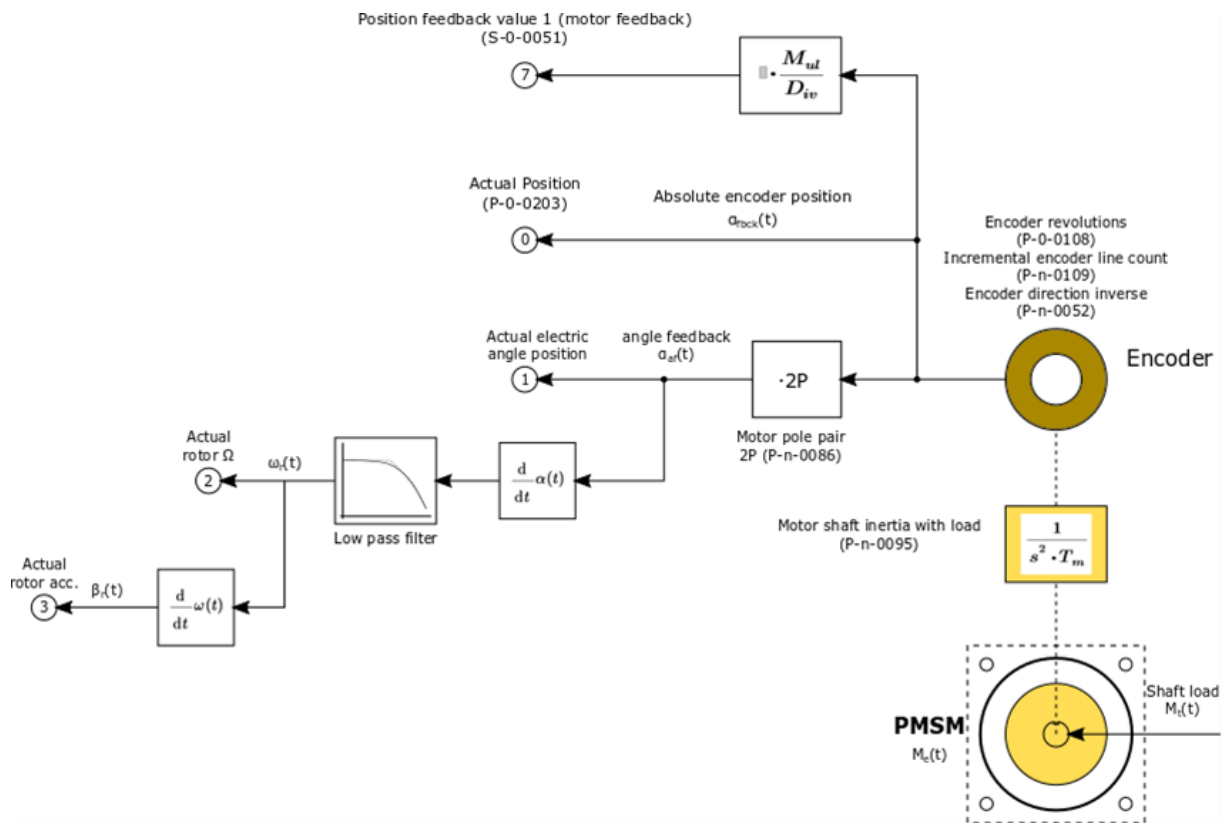


Figure 13 Measuring system

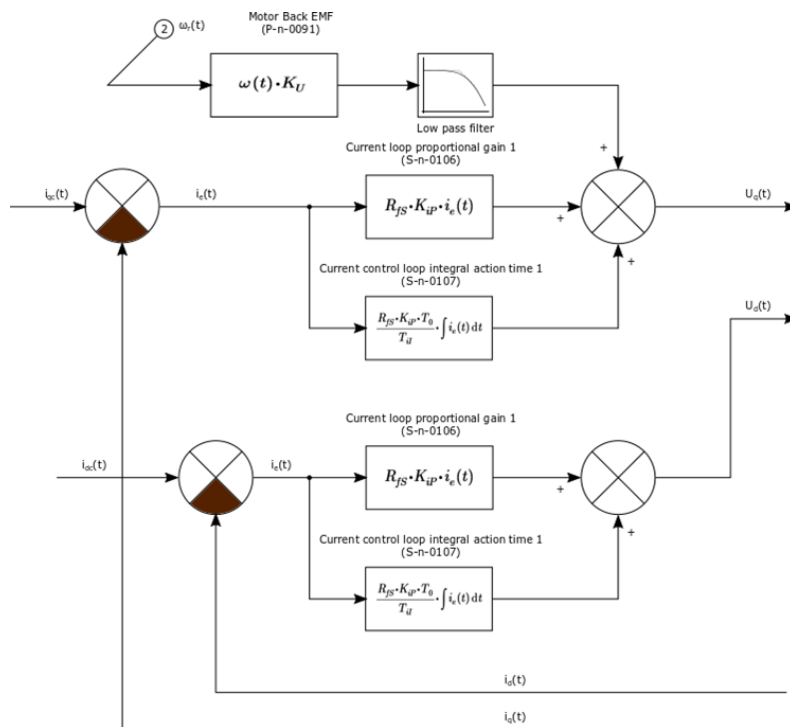
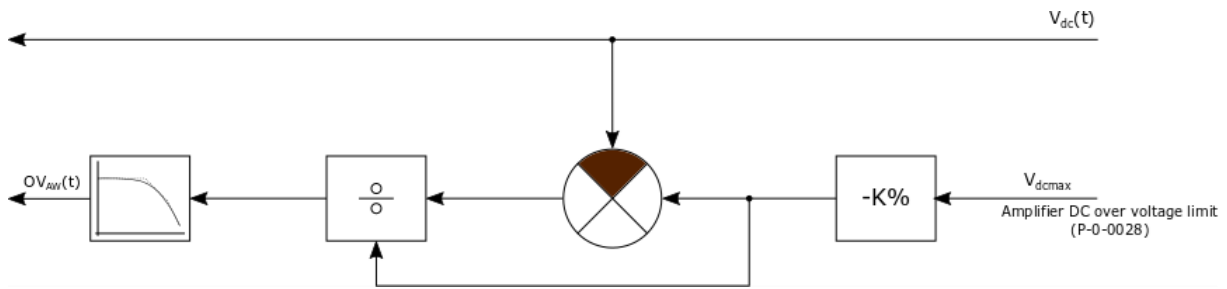
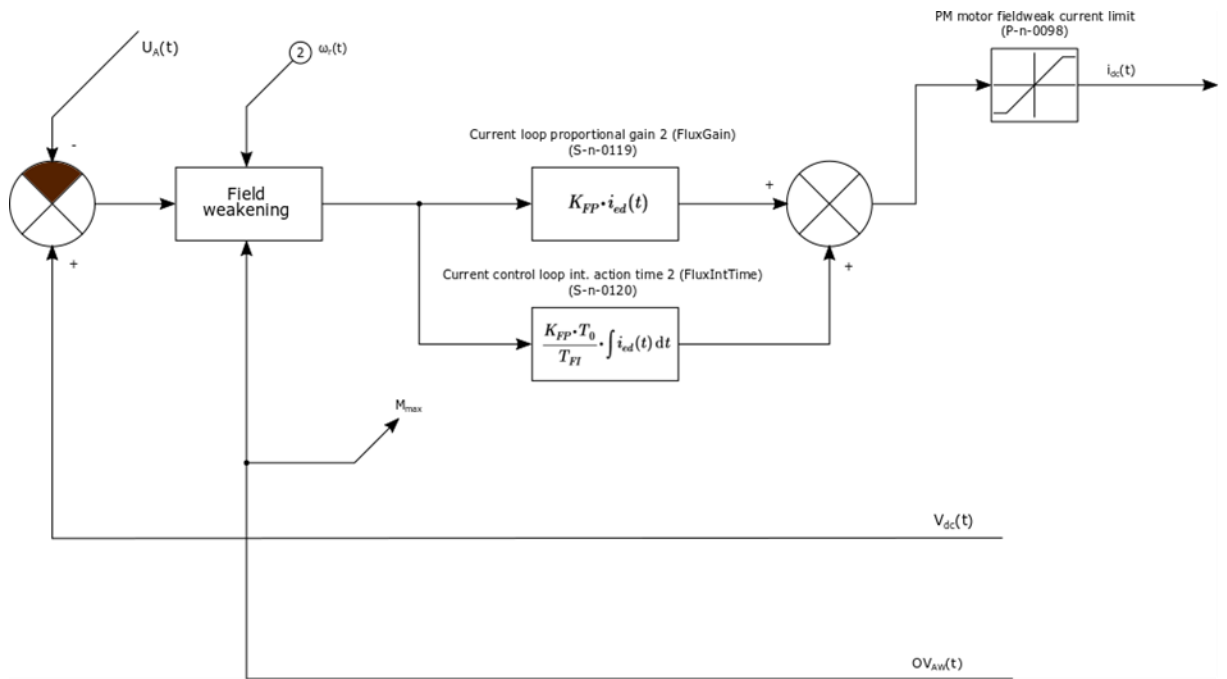


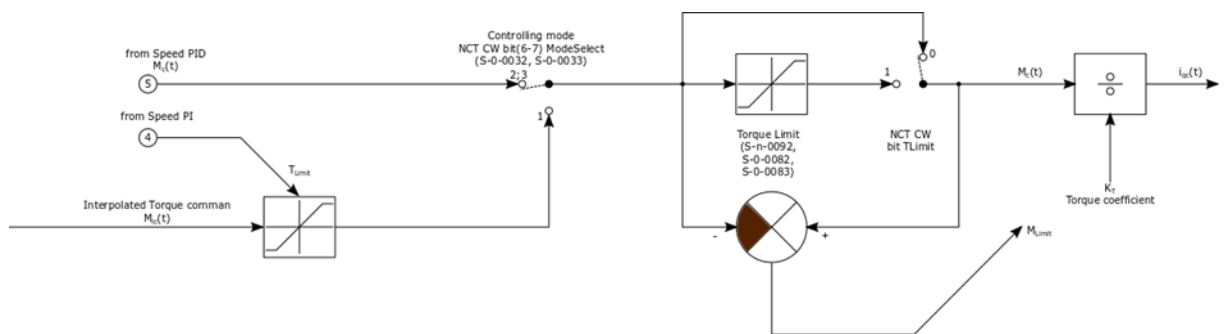
Figure 14 Current control



**Figure 15 Overvoltage resetter**



**Figure 16 PMSM flux control**



**Figure 17 Torque control**

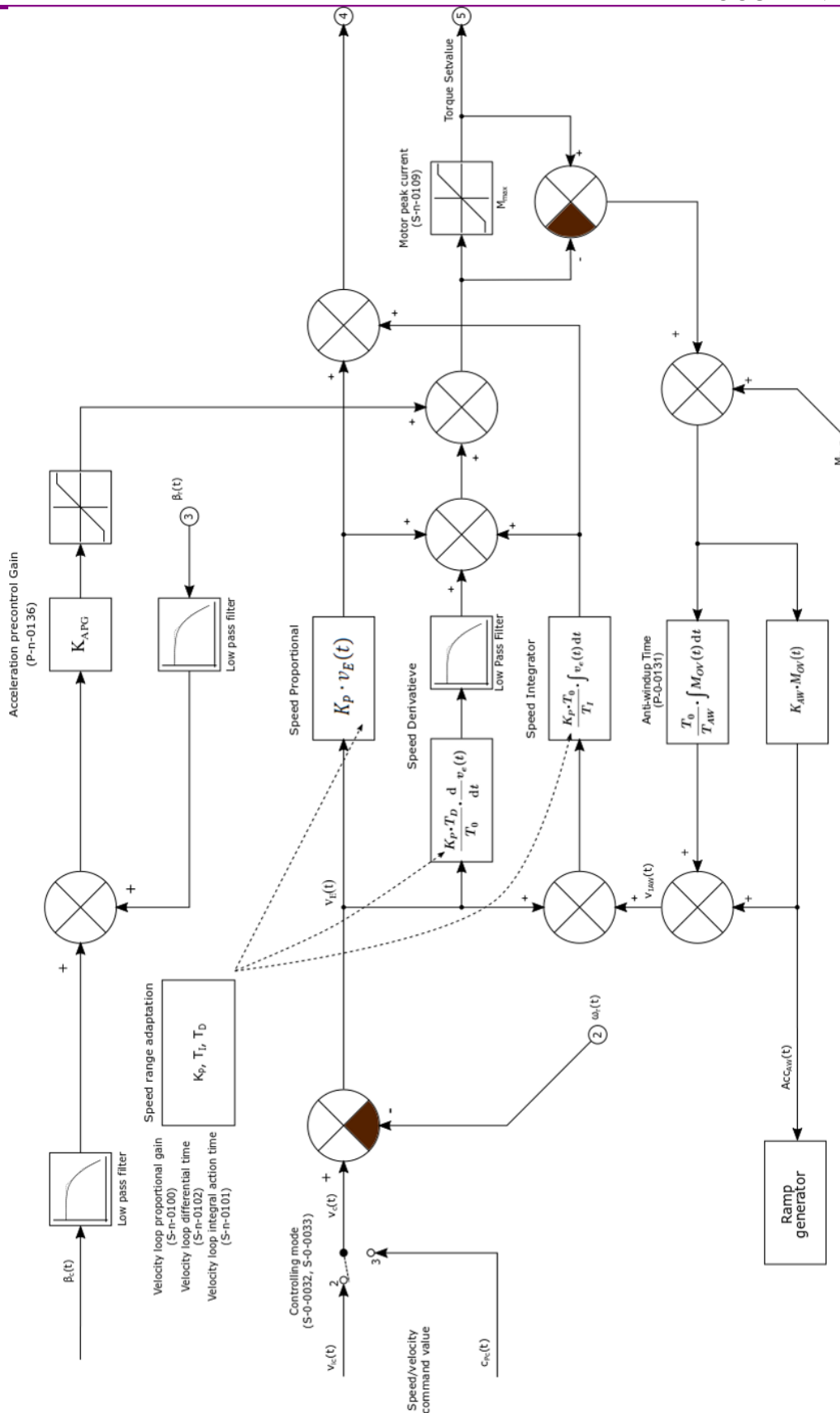


Figure 18 PID speed control with acceleration feedforward

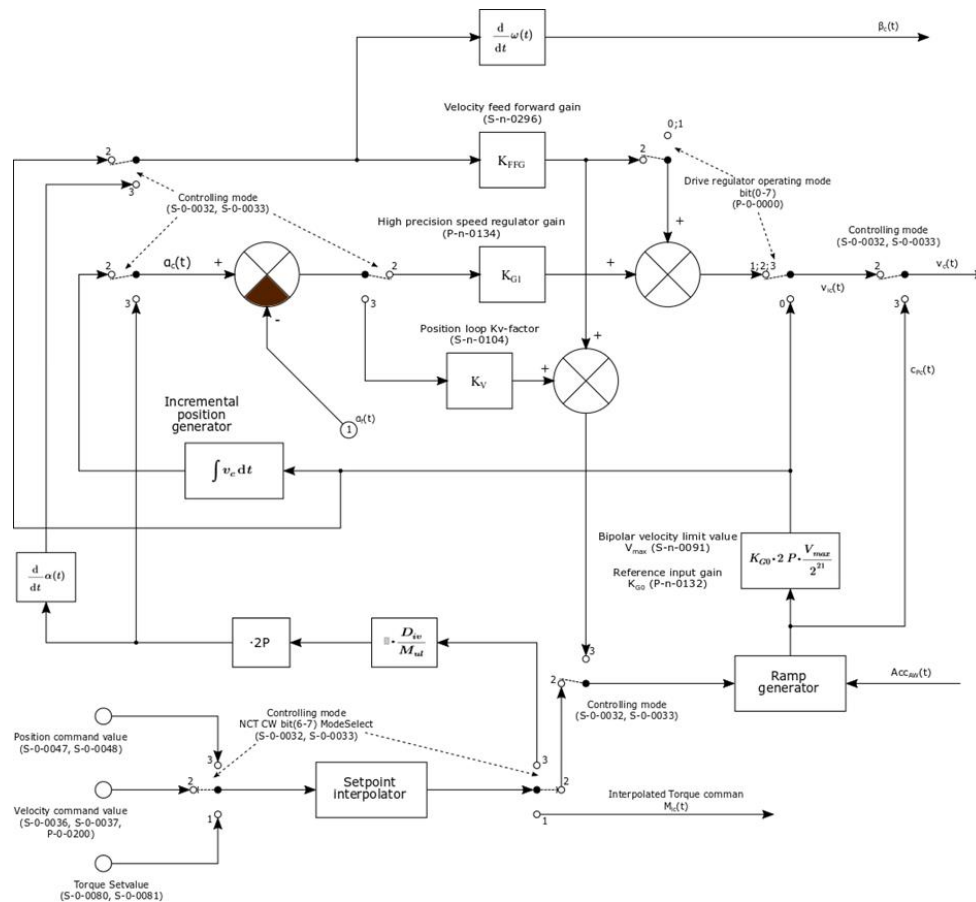


Figure 19 Interpolator and position control

### 7.3 Parameters relating to the version 5.4xx

#### 7.3.1 S-0-0001 Control unit cycle time (TNcyc)

It defines that control cycle time at which one control data is produced. It can be the internal control cycle time of the drive.

Data type:	2-byte unsigned integer
Changeable:	Ø
Unit of measure:	microsecond [ $\mu s$ ]
Range:	125
Default value:	125
Cyclic process data:	Ø
Decimal point:	0

### 7.3.2 S-0-0002 Communication cycle time (tSync)

This is the cycle time value at which the process data are received from the control.

Data type: 2-byte unsigned integer  
 Changeable: PreOp  
 Unit of measure: microsecond [ $\mu$ s]  
 Range: 500~10000  
 Default value: 1000  
 Cyclic process data:  $\emptyset$   
 Decimal point: 0

### 7.3.3 S-0-0012 Class 2 diagnostic (C2D)

This is the register of the warning flag bits which can generate drive going down error.

Data type: 2-byte binary data  
 Changeable:  $\emptyset$   
 Unit of measure:  $\emptyset$   
 Values:

Bit 0	Warning about overload
Bit 1	Warning about overtemperature of the drive heat sink
Bit 2	Warning about overtemperature of the motor
Bit 3	Warning about cooling unit failure
Bit 4~8	Reserved
Bit 9	Warning about undervoltage of the DC-BUS
Bit 10~14	Reserved
Bit 15	Manufacturer-specific warning

Cyclic process data:  $\emptyset$

### 7.3.4 S-0-0015 Telegram type

Process data telegram types. At this moment, the system works only with the selected process data. Standard telegram types are not available.

Data type: 2-byte hexadecimal data  
 Changeable: PreOp  
 Unit of measure:  $\emptyset$   
 Values: 0x7  
 Cyclic process data:  $\emptyset$



### **7.3.5 S-0-0016 Configuration list of AT**

The list of the process data to be sent back by the drive.

Data type: List of the 2-byte IDN elements  
Changeable: PreOp  
Values: IDN elements  
Cyclic process data: Ø

### **7.3.6 S-0-0017 IDN-list of all operation data**

The list of all the available EtherCATparameters. Their order in the list and on the control panel is the same.

Data type: List of the 2-byte IDN elements  
Changeable: Ø  
Values: IDN elements  
Cyclic process data: Ø

### **7.3.7 S-0-0018 IDN-list of operation data for CP2**

The list of the parameters that are necessary for the PreOp → SafeOp transition and that are to be loaded. The values of these parameters are waited by the device for operation during transition and also they are included in the StartUp list of the control in the case of the NCT control.

Data type: List of the 2-byte IDN elements  
Changeable: Ø  
Values: IDN elements  
Cyclic process data: Ø

### **7.3.8 S-0-0021 IDN-list of invalid operation data for CP2**

The list of those parameters which are invalid according to the S-0-0018 list necessary for the PreOp → SafeOp transition. The values of the parameters found in the list will not be transmitted in the course of the process, or they are incorrect and are out of range.

Data type: List of the 2-byte IDN elements  
Changeable: Ø  
Values: IDN elements  
Cyclic process data: Ø

### **7.3.9 S-0-0024 Configuration list of MDT**

The list of the process data required by the drive; these control data from the master unit are waited by the device.

Data type: List of the 2-byte IDN elements  
Changeable: PreOp  
Values: IDN elements  
Cyclic process data: Ø

### **7.3.10 S-0-0025 IDN-list of all procedure commands**

The IDN list of the commands that can be executed.

Data type: List of the 2-byte IDN elements  
Changeable: Ø  
Values: IDN elements  
Cyclic process data: Ø

### **7.3.11 S-0-0030 Manufacturer Version**

The version number of the current firmware in the drive.

Data type: Text (list of the 1-byte elements)  
Changeable: Ø  
Values: The number and the subversion of the version  
Cyclic process data: Ø

### **7.3.12 S-0-0031 Hardware version**

The current hardware version of the modules in the drive.

Data type: Text (list of the 1-byte elements)  
Changeable: Ø  
Values: The version number of the control board and the version number of the high-current unit  
Cyclic process data: Ø

### 7.3.13 S-0-0032 Primary operation mode

The main control mode of the drive. Only those modes can be selected which are contained in the S-0-0292 List of supported operation modes.

Data type:	2-byte unsigned integer
Changeable:	PreOp
Values:	0 No mode of operation is selected 1 Torque control mode 2 Speed control mode 3 Position control, feedback 1 4 Position control, feedback 2 11 Position control, feedback 1, without lag 12 Position control, feedback 2, without lag
Cyclic process data:	∅

### 7.3.14 S-0-0033 Secondary operation mode 1

The secondary control mode of the drive. Only those modes can be selected which are contained in the S-0-0292 List of supported operation modes.

Data type:	2-byte unsigned integer
Changeable:	PreOp
Values:	0 No mode of operation is selected 1 Torque control mode 2 Speed control mode 3 Position control, feedback 1 4 Position control, feedback 2 11 Position control, feedback 1, without lag 12 Position control, feedback 2, without lag
Cyclic process data:	∅

### 7.3.15 S-0-0095 Diagnostic message

Information about the current operation mode of the drive.

Data type:	Text (list of the 1-byte elements)
Changeable:	∅
Values:	Text message
Cyclic process data:	∅

### **7.3.16 S-0-0185 Length of the configurable data record in the AT**

The length of the AT process data record sent by the drive, in byte.

Data type: 2-byte hexadecimal data

Changeable: Ø

Values:

Cyclic process data: Ø

### **7.3.17 S-0-0186 Length of the configurable data record in the MDT**

The length of the MDT process data record received by the drive, in byte.

Data type: 2-byte HEX

Changeable: Ø

Values:

Cyclic process data: Ø

### **7.3.18 S-0-0187 IDN-list of configurable data in the AT**

The list of the process data that can be sent back by the drive. The S-0-0016 list can be compiled from these IDNs.

Data type: List of the 2-byte IDN elements

Changeable: Ø

Values: IDN elements

Cyclic process data: Ø

### **7.3.19 S-0-0188 IDN-list of configurable data in the MDT**

The list of the process data that can be required by the drive; this list can be sent by the master unit. The S-0-0024 list can be compiled from these IDNs.

Data type: List of the 2-byte IDN elements

Changeable: Ø

Values: IDN elements

Cyclic process data: Ø

### 7.3.20 S-0-0217 Parameter set preselection

The number of the parameter table to be selected exchange to which can be carried out by running the S-0-0216 Switch parameter set (pc) command.

Data type: 2-byte unsigned integer  
Unit of measure: Ø  
Changeable: PreOp, SafeOp, Op  
Values: 0 to 7  
Cyclic process data: Ø

### 7.3.21 S-0-0219 IDN-list of parameter set

The list of the identifiers (IDN) of those parameters that can change in the case of table change.

Data type: List of the 2-byte IDN elements  
Changeable: Ø  
Values: IDN elements  
Cyclic process data: Ø

### 7.3.22 S-0-0254 Actual parameter set

The number of the actual parameter table that was exchanged in a standard manner or in accordance with the NCT MDT CW.

Data type: 2-byte unsigned integer  
Changeable: Ø  
Values: 0 to 7  
Cyclic process data: Ø

### 7.3.23 S-0-0267 Password

Password protection.

Data type: Text (List of the 1-byte elements)  
Changeable: PreOp, SafeOp, Op  
Values: Password  
Cyclic process data: Ø  
Maximum length: 8 characters

### 7.3.24 S-0-0279 IDN-list of password-protected operation data

The list of the parameters protected by password.

Data type: List of the 2-byte IDN elements

Changeable: Ø

Values: IDN elements

Cyclic process data: Ø

### 7.3.25 S-0-0292 List of supported operation modes

The list of the supported modes of operation for selection; it can be set during selection of the mode.

Data type: List of the 2-byte unsigned integer elements

Changeable: Ø

Values:

- 0 No mode of operation is selected
- 1 Torque control mode
- 2 Speed control mode
- 3 Position control, feedback 1
- 4 Position control, feedback 2
- 11 Position control, feedback 1, without lag
- 12 Position control, feedback 2, without lag

Cyclic process data: Ø

### 7.3.26 S-0-0375 Diagnostic numbers list

The list of the error elements. Those error codes appear here which may be seen on the display of the drive.

Data type: List of the 2-byte unsigned integer elements

Changeable: Ø

Values:

- 00: NCT Compact Servo Drive – ready to operate
- 01: Encoder error in the A channel
- 02: Encoder error in the B channel
- 03: TTL incremental encoder C error
- 04: SIN-COS incremental encoder error
- 05: DC-BUS voltage error
- 06: Servo amplifier overcurrent error
- 07: Current input DC offset reference error
- 08: Commutation failure

- 09: Follower error in the motor position
- 10: Encoder initialization error
- 11: Motor overspeed error
- 12: Current input DC offset difference error
- 13: The motor temperature is lower than  $-10\text{ }^{\circ}\text{C}$
- 14: EtherCAT initialization error
- 15: EtherCAT watchdog timeout error
- 16: IGBT transistor failure
- 17: Drive enabling error
- 18: Servo readiness error
- 19: Motor overheat error
- 20: Motor overload error
- 25: Servo amplifier overheat error
- 26: IGBT transistor enabling error
- 27: EnDat encoder run-down battery
- 28: Servo amplifier cooling unit failure
- 29: EtherCAT AL incorrect change of status
- 30: Parameter table CRC error (EEPROM)
- 32: Servo amplifier EEPROM read-write error
- 33: Parameter calculation error. See the P145 list.
- 34: Wrong servo operation mode. See the P145 list.
- 35: Error occurred during the program run. See the S374 list.

### **7.3.27 P-0-0145 Calculation error parameter list**

The list of the parameters that should be checked so that calculations can produce a valid and operable motor model and controls for setup.

Data type: List of the 2-byte IDN elements

Changeable:  $\emptyset$

Values: IDN elements

Cyclic process data:  $\emptyset$

### 7.3.28 S-0-0432 Serial number drive control

The serial number of the drive. The value read out from the EtherCAT ET1100 EEPROM.

Data type: Text (List of the 1-byte elements)

Changeable: Ø

Values: SN (serial number)

Cyclic process data: Ø

Maximum length: 18 characters

### 7.3.29 P-0-0115 Parameter writing mode preselection

Reading or writing the parameters in the internal memory of the drive, (saving in the EEPROM), or, in the case of the EnDat encoder, it is the code of reading/writing the EnDat OEM area.

Data type: 2-byte HEX

Changeable: PreOp

Values:

- 0: There is no operation
- 0x01: Reading the motor parameters, table with index 0
- 0x11: Reading the motor parameters, table with index 1
- 0x21: Reading the motor parameters, table with index 2
- 0x31: Reading the motor parameters, table with index 3
- ~0x71:
- 0x02: Writing the motor parameters, table with index 0
- 0x12: Writing the motor parameters, table with index 1
- 0x22: Writing the motor parameters, table with index 2
- 0x32: Writing the motor parameters, table with index 3
- ~0x72:
- 0x81: Reading the common drive parameters
- 0x82: Writing the common drive parameters
- 0xF1: Reading the servo amplifier parameters in
- 0xF2: Writing the servo amplifier parameters out

Cyclic process data: Ø



### 7.3.30 S-0-0110 Amplifier peak current

The peak value of the servo amplifier current; a value limited by the hardware construction.

Data type:	4-byte unsigned integer
Unit of measure:	ampere [A]
Changeable:	PreOp
Values:	40, 80, 160, 240
Cyclic process data:	Ø
Maximum value:	1000.000
Minimum value:	10.000
Protection:	Password
Decimal point:	3 (0.001)

### 7.3.31 S-0-0112 Amplifier rated current

The current value with which the servo amplifier can be loaded continuously; a value limited by the hardware construction.

Data type:	4-byte unsigned integer
Unit of measure:	ampere [A]
Changeable:	PreOp
Values:	10, 20, 40, 60
Cyclic process data:	Ø
Maximum value:	500.000
Minimum value:	1.000
Protection:	Password
Decimal point:	3 (0.001)

### 7.3.32 S-0-0200 Amplifier warning temperature

When the temperature of the heat sink reaches the value defined here, the drive sets the 'Heat sink over temperature' warning bit in its status registers, namely in the 'NCT Status Word P-0-0204' register and in the standard 'C2D (S-0-0012)' register.

Data type:	2-byte unsigned integer
Unit of measure:	degree centigrade [°C]
Changeable:	PreOp
Values:	60, 95
Cyclic process data:	Ø
Maximum value:	90.0
Minimum value:	50.0
Protection:	Password
Decimal point:	1 (0.1)

### 7.3.33 S-0-0203 Amplifier shut down temperature

When the temperature of the heat sink reaches the value defined here, the drive sets the 'Heat sink over temperature shut down' error bit in its status registers, namely in the 'NCT Status Word P-0-0204' register and in the standard 'C1D' register.

Data type:	2-byte unsigned integer
Unit of measure:	degree centigrade [°C]
Changeable:	PreOp
Values:	80, 110
Cyclic process data:	Ø
Maximum value:	150.0
Minimum value:	20.0
Protection:	Password
Decimal point:	1 (0.1)

### 7.3.34 P-0-0020 Amplifier description code

The identification code relating to the servo amplifier; it describes the features of the amplifying and measuring units.

Data type:	Text (List of the 1-byte elements)
Changeable:	PreOp
Values:	
Cyclic process data:	Ø
Maximum length:	8 characters

**7.3.35 P-0-0023 Amplifier current scale limit value**

The greatest current peak value [A] that can be measured by the current transformer. When, during operation, the instantaneous value of the output current exceeds this value, the system turns off because of overcurrent error.

Data type:	4-byte floating-point
Unit of measure:	ampere [A]
Changeable:	PreOp
Values:	50, 100, 200, 300
Cyclic process data:	Ø
Maximum value:	2000.0
Minimum value:	20.0
Protection:	Password
Decimal point:	floating-point

**7.3.36 P-0-0025 Amplifier DC voltage scale limit value**

The greatest voltage value [V] of the direct-current supply that can be measured. It is a scaling value for proper voltage measurement.

Data type:	4-byte floating-point
Unit of measure:	volt [V]
Changeable:	PreOp
Values:	1000
Cyclic process data:	Ø
Maximum value:	1500.0
Minimum value:	0.0
Protection:	Password
Decimal point:	floating-point

### 7.3.37 P-0-0026 Amplifier AC voltage scale limit value

The greatest value of the AC voltage [V] that can be transformed from the rated DC voltage. It is a scaling value for measuring the 3-phase AC output voltage. (Today, this measurement is not available in the drives.)

Data type:	4-byte floating-point
Unit of measure:	volt [V]
Changeable:	PreOp
Values:	848.528
Cyclic process data:	Ø
Maximum value:	1500.0
Minimum value:	0.0
Protection:	Password
Decimal point:	floating-point

### 7.3.38 P-0-0028 Amplifier DC over voltage limit

The greatest instantaneous value of the DC bus voltage [V]. When the instantaneous value of the DC bus voltage exceeds the value set here, the drive shuts down because of DC bus voltage error.

Data type:	4-byte unsigned integer
Unit of measure:	volt [V]
Changeable:	PreOp
Values:	750
Cyclic process data:	Ø
Maximum value:	1500.0
Minimum value:	100.0
Protection:	Password
Decimal point:	1 (0.1)

**7.3.39 P-0-0030 Amplifier phase current offset max diff**

The maximum DC offset value of the servo amplifier output motor current measurement. Below this value, the drive considers the input suitable for measurement; beyond this value, the drive considers the input not suitable for measurement. When the drive measures a greater offset value, the current supply ceases because of the DC offset error, or, even the motor is not allowed to start.

Data type:	2-byte signed integer
Unit of measure:	millivolt [mV]
Changeable:	PreOp
Values:	60
Cyclic process data:	Ø
Maximum value:	200.0
Minimum value:	-200.0
Protection:	Password
Decimal point:	1 (0.1)

**7.3.40 P-0-0031 Amplifier phase current difference max.**

The maximum DC offset difference when phase currents are measured. Below this value, the drive considers the input suitable for measurement; beyond this value, the drive considers the input not suitable for measurement. When the drive measures a greater offset value, the current supply ceases because of the DC offset difference error, or, even the motor is not allowed to start.

Data type:	2-byte signed integer
Unit of measure:	millivolt [mV]
Changeable:	PreOp
Values:	80
Cyclic process data:	Ø
Maximum value:	200.0
Minimum value:	-200.0
Protection:	Password
Decimal point:	1 (0.1)

### 7.3.41 P-0-0032 Amplifier AB phase out voltage max diff

The maximum DC offset difference when motor input voltages are measured in the phases AB (UV). At this moment it is not used.

Data type:	2-byte signed integer
Unit of measure:	millivolt [mV]
Changeable:	PreOp
Values:	60
Cyclic process data:	Ø
Maximum value:	400.0
Minimum value:	-400.0
Protection:	Password
Decimal point:	1 (0.1)

### 7.3.42 P-0-0033 Amplifier CB phase out voltage max diff

The maximum DC offset difference when motor input voltages are measured in the phases CB (WV). At this moment it is not used.

Data type:	2-byte signed integer
Unit of measure:	millivolt [mV]
Changeable:	PreOp
Values:	60
Cyclic process data:	Ø
Maximum value:	400.0
Minimum value:	-400.0
Protection:	Password
Decimal point:	1 (0.1)

**7.3.43 P-0-0035 Heatsink Tmp. Sens. Const.**

The list of the constants that are necessary for measuring the heat sink temperature.

Data type:	The list of the 2-byte unsigned integers	
Unit of measure:	Ø	
Changeable:	PreOp	
Values:	10000	5000
	3988	3375
Cyclic process data:	Ø	
Maximum value:	64000	
Minimum value:	0	
Protection:	Password	
Decimal point:	0	
The length of the list:	2 elements	

**7.3.44 P-0-0036 Motor Tmp. Sens. Const.**

The constant necessary for measuring the motor temperature. The hardware-dependent factor of the drive input.

Data type:	2-byte signed integer
Unit of measure:	Ø
Changeable:	PreOp
Values:	1.00
Cyclic process data:	Ø
Maximum value:	32000.0
Minimum value:	-32000.0
Protection:	Password
Decimal point:	2 (0.1)

### 7.3.45 P-0-0038 DCU OpAmp correction multiplier List

This is a specific correction table for calibrating current and voltage measurements. In each case, it is individually set during production by calibration measurement.

Data type:	The list of the 2-byte unsigned integers
Unit of measure:	Ø
Changeable:	PreOp
Values:	4096 4096 4096 4096 4096
Cyclic process data:	Ø
Maximum value:	Ø
Minimum value:	0
Protection:	Password
Decimal point:	0
The length of the list:	5 elements

### 7.3.46 P-0-0000 Drive control operating mode

Parameter for selecting the speed and internal position control modes. The 'M' values of the parameter are effective only in the speed control mode (operation by the velocity command value); they are ineffective in the case of torque control (operation by the torque command value) or position control (operation by the position command value).

Data type:	2-byte unsigned hexadecimal integer
Unit of measure:	Ø
Changeable:	PreOp
Values:	0xYM
Values of Y:	0: No mode of control is selected 1: Algorithm operating a permanent-magnet synchronous servo motor, i.e. PMSM 2: Algorithm operating an AC induction, i.e. asynchronous servo motor 4: Simple inverter mode (sensorless)
Values of M:	0: Classic PID velocity control (Y: 1,2) 1: Conventional PID speed control + Internal incremental position control (Y:1)



- 2: Conventional PID speed control + Internal incremental position control + Velocity command value feedforward (Y:1)
- 3: Speed-dependent (Conventional PID speed control + Internal incremental position control) (Y:1)
- 4: Tandem master with PID speed control (Y:1)
- 5: Tandem slave with PID speed control (The slave rotates in the direction opposite to the master) (Y:1)
- 6: Tandem slave with PID speed control (The slave and the master rotate in the same direction) (Y:1)
- 9: Classic PID control + Internal incremental angle control with attenuation (Y:2)

Cyclic process data: Ø  
 Maximum value: Ø  
 Minimum value: Ø  
 Protection: Ø  
 Decimal point: Ø

### 7.3.47 P-0-0006 Drive ready mode

This is used to select the inputs necessary to issue the drive ready to operate signal of the status word.

Data type: 2-byte unsigned integer

Unit of measure: Ø

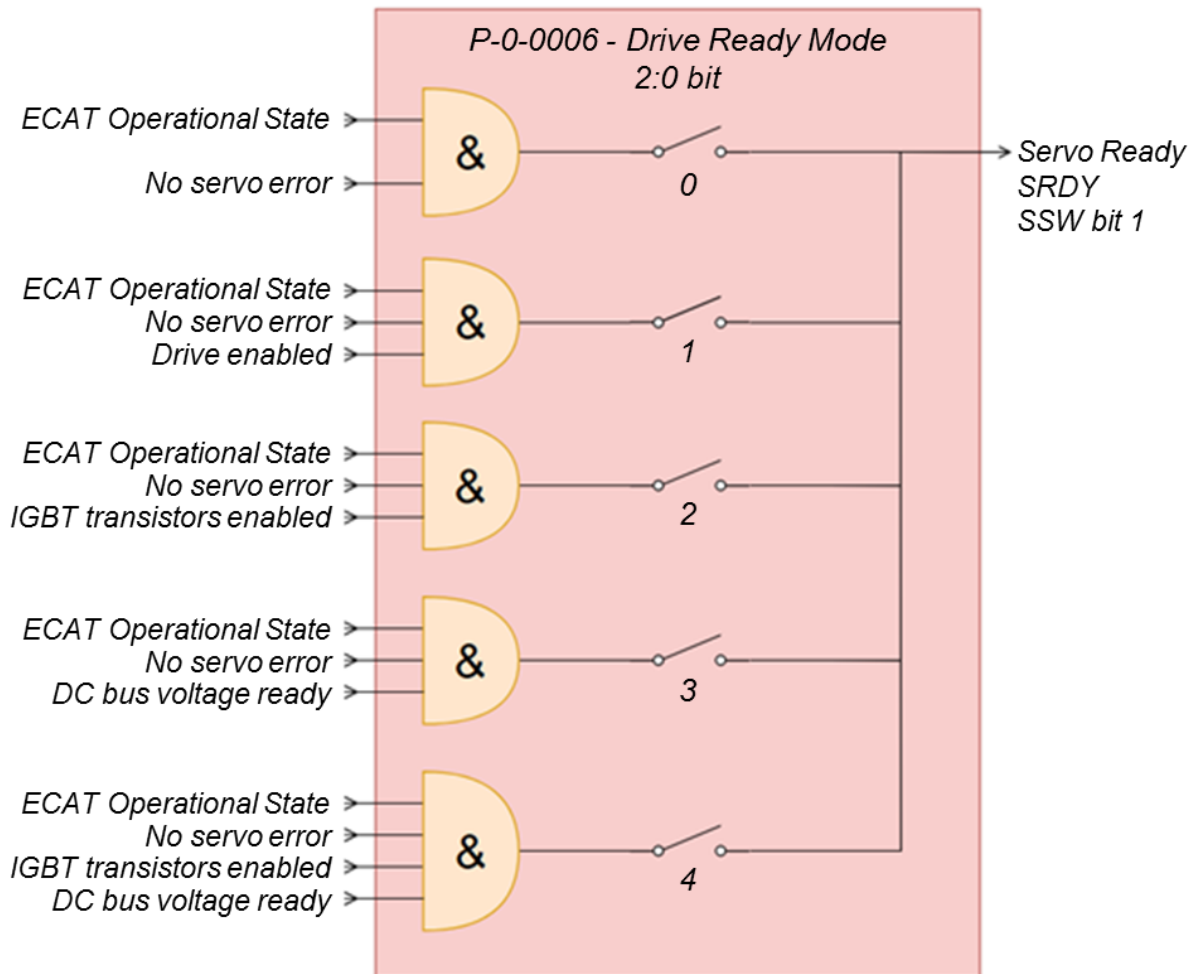
Changeable: PreOp

Values:

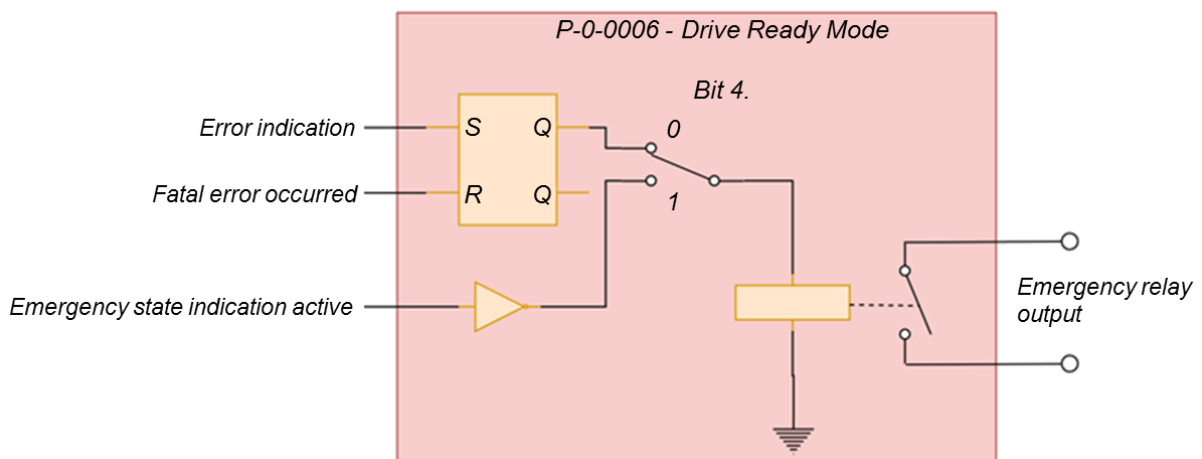
Bit	Name	Meaning
0~2	RDY	Selection of the condition Ready to Operate
3		Reserved
4	EMGRLY	Selection of the emergency relay operating mode (see later)
5~7		Reserved

Cyclic process data: Ø  
 Maximum value: Ø  
 Minimum value: Ø  
 Protection: Ø  
 Decimal point: Ø

The following figures show the conditions assigned to the selecting bits.



**Figure 20 Servo is ready to operate signal**



**Figure 21 Operation of the emergency relay output**

### 7.3.48 P-0-0034 Minimum operational DC voltage

The minimal value of the DC bus voltage. If its value is 0, the value of the minimum DC voltage monitoring will be 65% of the rated voltage. If it has a value, the monitoring will be active in accordance with the given value. In accordance with the parameter P-0-0006 Drive ready mode, the monitoring can be associated with the signal of the operational readiness (Figure 20 Servo is ready to operate signal), and, during operation in controlled mode, the error management system monitors that the level of the DC voltage does not fall below this value. If it is not specified by the use of the P-0-0006, monitoring the minimum voltage will not work.

Data type:	2-byte unsigned integer
Unit of measure:	volt [V]
Changeable:	PreOp
Values:	420
Cyclic process data:	∅
Maximum value:	750.0
Minimum value:	0.0
Protection:	∅
Decimal point:	1 (0.1)

### 7.3.49 P-0-0037 Drive rated DC voltage

This is the DC bus voltage of the drive during operation. It is important for feeding the motor.

Data type:	2-byte unsigned integer
Unit of measure:	volt [V]
Changeable:	PreOp
Values:	540
Cyclic process data:	∅
Maximum value:	750.0
Minimum value:	48.0
Protection:	∅
Decimal point:	1 (0.1)

### 7.3.50 S-0-0043 Velocity polarity parameter

This is a standard parameter for inverting the polarity of the velocity command value.

Data type:	2-byte binary data
Unit of measure:	∅
Changeable:	PreOp
Values:	0 – polarity is not inverted; 1 – polarity is inverted

---

Bit 0:	Velocity command value
Bit 1:	Additive velocity command value
Bit 2:	Velocity feedback value 1
Bit 3:	Velocity feedback value 2
Bit 4~15:	Not used

Cyclic process data: Ø

Maximum value: Ø

Minimum value: Ø

Protection: Ø

Decimal point: 0 (1)

### 7.3.51 S-0-0044 Velocity data scaling type

This is a standard parameter for setting the velocity data scaling.

Data type: 2-byte binary data

Unit of measure: Ø

Changeable: PreOp

Values:	Bit 0~2:	Scaling method: 0 – default scaling, 1 – linear, 2 – rotary, 0 – no scaling
	Bit 3:	Scaling type: 0 – preferred scaling, 1 – parameter scaling
	Bit 4:	Units of linear / rotational scaling 0 – meter or rev, 1 – inch
	Bit 5:	Time units: 0 – min, 1 – sec
	Bit 6:	Data reference: 0 – at the motor shaft 1 – at the load
	Bit 7~15:	Reserved

Cyclic process data: Ø

Maximum value: Ø

Minimum value: Ø

Protection: Ø

Decimal point: 0 (1)

### 7.3.52 S-0-0045 Velocity data scaling factor

This parameter defines scaling factor for all velocity data in the drive. This parameter cannot be changed. Interpretation:  $xxxxx \cdot 2^{yy}$

Data type:	2-byte unsigned integer
Unit of measure:	∅
Changeable:	∅
Values:	0x200000/(max. velocity)
Cyclic process data:	∅
Maximum value:	65535
Minimum value:	0
Protection:	∅
Decimal point:	0 (1)

### 7.3.53 S-0-0046 Velocity data scaling exponent

This parameter defines scaling exponent for all velocity data in the drive. This parameter cannot be changed. Interpretation:  $xxxxx \cdot 2^{yy}$

Data type:	2-byte signed integer
Unit of measure:	∅
Changeable:	∅
Values:	0x200000/(max. velocity)
Cyclic process data:	∅
Maximum value:	32
Minimum value:	-32
Protection:	∅
Decimal point:	0 (1)

### 7.3.54 S-0-0055 Position polarity parameters

This is the parameter for inverting the position command value data.

Data type:	2-byte binary data
Unit of measure:	∅
Changeable:	PreOp
Values:	0 – polarity is not inverted; 1 – polarity is inverted
	Bit 0: Position command value
	Bit 1: Additive position command value
	Bit 2: Position feedback value 1

---

	Bit 3:	Position feedback value 2
	Bit 4~15:	Not used
Cyclic process data:		Ø
Maximum value:		Ø
Minimum value:		Ø
Protection:		Ø
Decimal point:		0 (1)

### 7.3.55 S-0-0076 Position data scaling type

This parameter is used for setting the position command value data scaling.

Data type:		2-byte binary data
Unit of measure:		Ø
Changeable:		PreOp
Values:	Bit 0~2:	Scaling method: 0 – no scaling, 1 – linear, 2 – rotary
	Bit 3:	Scaling type: 0 – preferred scaling, 1 – parameter scaling
	Bit 4:	Units of linear / rotational scaling 0 – meter or angle, 1 – reserved
	Bit 5:	Reserved
	Bit 6:	Data reference: 0 – at the motor shaft 1 – at the load
	Bit 7:	Processing format: 0 – absolute format, 1 – modulo format
	Bit 8~15:	Reserved
Cyclic process data:		Ø
Maximum value:		Ø
Minimum value:		Ø
Protection:		Ø
Decimal point:		0 (1)

### 7.3.56 S-0-0085 Torque polarity parameter

This is the parameter for inverting the torque command value data.

Data type:		2-byte binary data
Unit of measure:		Ø
Changeable:		PreOp
Values:		0 – polarity is not inverted; 1 – polarity is inverted
	Bit 0:	Torque / force command value
	Bit 1:	Additive torque / force command value

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	Bit 2:	Torque / force feedback value
	Bit 3~15:	Not used
Cyclic process data:		Ø
Maximum value:		Ø
Minimum value:		Ø
Protection:		Ø
Decimal point:		0 (1)

### 7.3.57 S-0-0086 Torque/Force data scaling type

This parameter is used for setting the torque data scaling.

Data type:		2-byte binary data
Unit of measure:		Ø
Changeable:		PreOp
Values:	Bit 0~2:	Scaling method: 0 – percentage, 1 – reserved, 2 – reserved
	Bit 3:	Scaling type: 0 – preferred scaling, 1 – parameter scaling
	Bit 4:	Units of linear / rotational scaling: 0 – N / Nm, 1 – reserved
	Bit 5:	Reserved
	Bit 6:	Data reference: 0 – at the motor shaft 1 – at the load
	Bit 7~15:	Reserved
Cyclic process data:		Ø
Maximum value:		Ø
Minimum value:		Ø
Protection:		Ø
Decimal point:		0 (1)

### 7.3.58 S-0-0160 Acceleration data scaling type

This parameter is used for setting the acceleration data scaling.

Data type:		2-byte binary data
Unit of measure:		Ø
Changeable:		PreOp
Values:	Bit 0~2:	Scaling method: 0 – no scaling, 1 – linear scaling, 2 – rotary scaling; 3 – ramp time
	Bit 3:	Scaling type: 0 – preferred scaling, 1 – parameter scaling
	Bit 4:	Units for linear / rotational scaling: 0 – $m \cdot \min^{-1}$ or $\min^{-1}$ ; other

Bit 5: Time unit: 0 – second; 1 – other

Cyclic process data: Ø  
 Maximum value: Ø  
 Minimum value: Ø  
 Protection: Ø  
 Decimal point: 0 (1)

### 7.3.59 S-0-0161 Acceleration data scaling factor

This is the scaling factor of the acceleration data in the drive.

Data type: 2-byte unsigned integer  
 Unit of measure: Ø  
 Changeable: Ø  
 Values: 1  
 Cyclic process data: Ø  
 Maximum value: 16  
 Minimum value: 0  
 Protection: Ø  
 Decimal point: 0 (1)

### 7.3.60 S-0-0162 Acceleration data scaling exponent

This is the scaling exponent of the acceleration data in the drive.

Data type: 2-byte signed integer  
 Unit of measure: Ø  
 Changeable: Ø  
 Values: 1  
 Cyclic process data: Ø  
 Maximum value: 32  
 Minimum value: -32  
 Protection: Ø  
 Decimal point: 0 (1)



### 7.3.61 S-n-0091 Bipolar velocity limit value

This is the absolute limit of the velocity command value. This is the maximum velocity value belonging to the maximum scaling value of the velocity command value.

Basically, this is the maximum speed value with which the motor will rotate if 0x200000 hexadecimal value is placed on the command value input (221=2097152).

Data type: 4-byte unsigned integer

Unit of measure:  $\text{m}\cdot\text{min}^{-1}$  or  $\text{min}^{-1}$

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data:  $\emptyset$

Maximum value: 100000.0000

Minimum value: 1.0000

Protection:  $\emptyset$

Decimal point: 4 (0.0001)

### 7.3.62 S-n-0092 Bipolar torque limit value

This is value of the lower (negative) and upper (positive) limit of the torque/force command value.

Data type: 2-byte unsigned integer

Unit of measure: %

Changeable: PreOp, SafeOp, Op

Values: 100%  $\equiv$  rated motor torque

Cyclic process data:  $\emptyset$

Maximum value: 600

Minimum value: 10

Protection:  $\emptyset$

Decimal point: 1 (0.1)

### 7.3.63 P-n-0073 Velocity error limit value (observed)

This is the measure of the velocity error. By the use of a single-capacity element, it approximates the error limit which is the difference between the estimated (required) velocity and the current (real) velocity. It is expressed as a % of the maximum speed. When this limit is exceeded, the drive takes the torque (the PWM signals) away from the motor immediately with the indication of follower error.

Data type:	2-byte unsigned integer
Unit of measure:	%
Changeable:	PreOp, SafeOp, Op
Values:	100% $\equiv$ maximum motor velocity/speed
Cyclic process data:	Ø
Maximum value:	100.0
Minimum value:	0.0
Protection:	Ø
Decimal point:	2 (0.01)

### 7.3.64 P-0-0105 Encoder pos. value in revolution

This is the number of pulses per one revolution of the motor encoder, or, in the case of a linear motor, the number of encoder pulses per one pole pitch; it is only readable.

Data type:	4-byte unsigned integer
Unit of measure:	increment
Changeable:	Ø
Values:	The value read out from the encoder in the case of EnDat. Four times the 'Encoder Line Count' parameter in the case of TTL encoder
Cyclic process data:	Ø
Maximum value:	Ø
Minimum value:	Ø
Protection:	Ø
Decimal point:	0 (1)

### 7.3.65 P-0-0106 Encoder type code

It gives back the type code of the encoder used, with which the motor works.

Data type:	2-byte hexadecimal number
Unit of measure:	Ø

Changeable: Ø

Values:	EnDat battery-fed absolute (multiturn) encoder, e.g. EBI 1135	0xD001
	EnDat absolute (multiturn) encoder, e.g. EQN 1335	0xE001
	EnDat rotary encoder (singleturn)	0xC001
	EnDat absolute (linear) scale	0x4001
	Incremental TTL encoder	0x0011

Cyclic process data: Ø

Maximum value: Ø

Minimum value: Ø

Protection: Ø

Decimal point: 0 (1)

### 7.3.66 P-0-0107 Encoder total bits number

This is the total bit number on which the value of the encoder position appears. So, the maximum absolute value of the position can be  $2^{xx}$ . In the case of the EnDat encoder, it is the factory value read out from the encoder on which the complete position is represented in increment. In the case of the incremental encoder, the originated position appears on 32 bits.

Data type: 2-byte unsigned integer

Unit of measure: Ø

Changeable: Ø

Values: In the case of an EnDat encoder it is the read-out value; in the case of a TTL encoder it is 32 bits

Cyclic process data: Ø

Maximum value: Ø

Minimum value: Ø

Protection: Ø

Decimal point: 0 (1)

### 7.3.67 P-0-0108 Encoder revolutions

The number of revolutions of the encoder which is represented in the complete absolute position.

Data type:	2-byte unsigned integer
Unit of measure:	increment
Changeable:	Ø
Values:	$\frac{2^{\text{Total bits number}}}{\text{Encoder pos.value in revolution}}$
Cyclic process data:	Ø
Maximum value:	Ø
Minimum value:	Ø
Protection:	Ø
Decimal point:	0 (1)

### 7.3.68 P-0-0113 Encoder Op.Stat.Err. Message

Correct descriptor code relating to the status and the error of the encoder.

Only readable information is contained in the parameter. There are three types of codes that may appear:

- Initialization problem: (the 0x80008000 code, with changing values on the underlined places) During encoder recognition as well as resetting, the operation is jammed because of error message. The encoder input will not work.
- Communication problem: When resetting, such error message is received rarely, but in the course of a continuous operation, it is more likely to receive it. In this case, the information received via the encoder cable is damaged and the position data may be incorrect.
- The EnDat encoder indicates error: standard error bits in accordance with the EnDat description appear here on the basis of which the reason of the encoder failure can be found.

Data type:	4-byte hexadecimal number
Unit of measure:	Ø
Changeable:	Ø

Values:

Bit	Name (Init)	Name (Comm.)	Name (EnDat 2.2)	Meaning
0	INITCNT	NU	LIGHTSRC	Init: That number appears on the bits 0~7, at which the process stopped. EnDat: Encoder internal error, faulty optical sensor.
1		FIERROR	SIGNALAMP	Comm.: Encoder merged error message according to the EnDat specification. EnDat: Internal encoder signal amplitude problem.
2		CRCPARITY	POSVALUE	Comm.: CRC parity error. EnDat: Incorrect encoder position.
3		FTYPE_I	OVERVOLT	Comm.: Encoder error message according to the EnDat specification. EnDat: Overvoltage error
4		FTYPE_II	UNDERVOLT	Comm.: Encoder error message according to the EnDat specification. EnDat: Too low supply voltage or, in the case of an encoder with battery, indication because of the battery run down too.
5		MRS_ADR	OVERCURR	Comm.: Encoder error message according to the EnDat specification. EnDat: Overcurrent error
6	NU	NU	BATTERY	EnDat: Battery error in the encoder with battery
7			NU	
8			FREQCOLL	EnDat: Warning of clock signal problem
9			TMPEXC	EnDat: Warning of overheat.
10		F2ERRN	LSCR	Comm.: Encoder merged error message according to the EnDat specification. EnDat: Warning of encoder internal optical problem.
11		CRCZI1	BATTCH	Comm.: Signal flow CRC error according to the Mazet specification. EnDat: Warning of low battery voltage.
12		CRCZI2	REFP	Comm.: Signal flow CRC error according to the Mazet specification. EnDat: Reference problem, deviation
13		NU	NU	

Bit	Name (Init)	Name (Comm.)	Name (EnDat 2.2)	Meaning
14	COMMERR			Init: Indication of communication error during operation (not only init)
15	HALTENCODER			Init: Setting the encoder to the reference position was unsuccessful, it does not work.
16	INITERRCODE	SPIKE	LIGHTSRC2	Init: Code of initialization error. Comm.: Interference signal in the data line, Mazet specification error. EnDat: Encoder internal optical problem in the case of E2.2
17		WATCHDOG	SIGNALAMP2	Comm.: Information flow watchdog error according to the Mazet specification. EnDat: Encoder internal signal amplitude error in the case of E2.2.
18		FTYPE_III	S_POS1	Comm.: Encoder merged error message according to the EnDat specification. EnDat: Warning of position problem in the case of E2.2.
19		NU	OVERVOLTAGE	EnDat: Overvoltage in the case of E2.2.
20	NU		UNDERVOLTAGE	EnDat: Too low supply voltage or, in the case of an encoder with battery, indication because of the battery run down too, E2.2.
21			OVERCURRENT	EnDat: Overcurrent error E2.2
22			TEMPEXCEEDED	EnDat: Overheat E2.2
23			S_POS2	EnDat: Warning of position 2 problem, E2.2
24			S_SYSTEM	EnDat: System problem.
25			S_ALL_POWERDWN	EnDat: Supply voltage problem.
26			M_POS1	EnDat: Incorrect position.
27			M_POS2	EnDat: Incorrect position 2.
28			M_SYSTEM	EnDat: System error.
29			M_ALL_POWERDWN	EnDat: All the power supplies are ceased.
30			M_OVERUNDERFLOW	EnDat: Overflow error.
31	INITERR_OCC		M_BATTERY	Init: Merged error message when initialization error occurs. EnDat: Battery error indication.

Cyclic process data: Ø  
Maximum value: Ø  
Minimum value: Ø  
Protection: Ø  
Decimal point: 0 (1)

### 7.3.69 P-0-0114 Encoder operational mode

This is the mode of handling the encoder.

Data type: 2-byte binary number

Unit of measure: Ø

Changeable: PreOp

Values: The values of the bits 0~3 can be changed, but the bits 4~15 are only readable.

In the case of application of a battery-fed absolute encoder (e.g. EBI-1135), when the bit 0 is used, the battery is not needed; the error message relating to the lack of battery will be cancelled automatically.

The bit 1 inverts the count direction of the encoder. It inverts the raw information received from the encoder, and then transmits it for the internal operation of the drive as well as towards the control.

The function of the bit 2 is not explained yet.

If an EnDat encoder is connected to the system, and the bit 3 is set, the encoder will be initialized entirely in the case of cancelling the encoder error during operation. It is a method suitable for reconnecting the motors of removable rotary tables and removable machining heads. It is not required to shut down the machine. (The machine should be shut down only in the case of frozen communication between the drive and the encoder; see the initialization error messages. This deficiency will also be eliminated later.)

Bit	Name	Description
0	SINGLETURN	This bit can be set specifically when an EnDat encoder is planned to be used during only one revolution (R/W, 0x0001).
1	TACHOINVERSE	Interpretation of the direction of rotation; the position count direction will be inverted (R/W, 0x0002)
2	TTLALWAYSNULL	If its value is 1, the zero pulse feedback will be cancelled during every parameter setup (R/W, 0x0004)

Bit	Name	Description
3	ENDATREINIT	Re-initialization of the EnDat encoder will be executed due to the Encoder error clear command (R/W, 0x0008)
<b>From the following bits, only information read-out can be done; the drive sets the bits internally:</b>		
4	ZFIRST	Sometime a zero pulse was already received
5	ZPULSE	Was a zero pulse found by request?
6	ZREQUEST	Zero pulse search was requested
7	INCRMODE	Incremental encoder mode
8	ABSMODE	Absolute encoder mode
9	INPUT2ND	The second encoder input is active as well
10	FULLCLOSELOOP	Full feedback realized by the use of two encoder inputs
11	SINCOS	There is SIN-COS encoder
12	ENDAT22EN	EnDat 2.2 Heidenhain encoder
13	ENDATEN	EnDat Heidenhain encoder; it may also be a 2.1 version
14	LINEAREN	Scale
15	ANGLECODER	Rotary encoder

Cyclic process data: Ø

Maximum value: Ø

Minimum value: Ø

Protection: Ø

Decimal point: 0 (1)

### 7.3.70 P-n-0052Encoder direction inverse

Interpretation and inversion of the encoder's direction of rotation in terms of the drive velocity measurement and rotative angular displacement management. It is the former tachoinverse parameter. Its effect is that there will no changes in the direction of counting the position value to be issued as process data.

Data type: 2-byte hexadecimal value

Unit of measure: Ø

Changeable: PreOp

Values: 0 – Interpretation of the direction of rotation does not change

1 – Interpretation of the direction of rotation is inverted



Cyclic process data: Ø  
Maximum value: Ø  
Minimum value: Ø  
Protection: Ø  
Decimal point: 0 (1)

### 7.3.71 P-n-0109 Incremental encoder line count

The line number of an incremental TTL or a sinusoidal (SinCos) encoder during one revolution of the motor shaft.

Data type: 2-byte unsigned integer  
Unit of measure: increment  
Changeable: PreOp  
Values: Number of increments  
Cyclic process data: Ø  
Maximum value: Ø  
Minimum value: Ø  
Protection: Ø  
Decimal point: 0 (1)

### 7.3.72 P-0-0069 Repetitive encoder error

The quantity of consecutive measurement cycles below which the encoder error is still acceptable. If its value is 0, one reference value is valid; however, 3 consecutive errors will already be indicated. Otherwise, the set value will be valid.

Data type: 2-byte unsigned integer  
Unit of measure: Ø  
Changeable: PreOp  
Values: Quantity of cycles (125 µs)  
Cyclic process data: Ø  
Maximum value: Ø  
Minimum value: Ø  
Protection: Ø  
Decimal point: 0 (1)

### 7.3.73 P-0-0070 Repetitive commutation error

The quantity of consecutive measurement cycles below which the error of commutation signals is still acceptable. When the value is 0, there will not be error monitoring.

Data type:	2-byte unsigned integer
Unit of measure:	∅
Changeable:	PreOp
Values:	Quantity of cycles (125 μs)
Cyclic process data:	∅
Maximum value:	∅
Minimum value:	∅
Protection:	∅
Decimal point:	0 (1)

### 7.3.74 P-0-0007 Motor stay window (N equ 0)

The speed of the motor shaft has decreased below the speed given here. It influences the internal operation of the drive too, for the 'shaft stays' indication, and, the N=0 (bit 5) indication in the EtherCAT process data status word works also on the basis of this.

Data type:	2-byte unsigned integer
Unit of measure:	min <sup>-1</sup> or mm·min <sup>-1</sup>
Changeable:	PreOp, SafeOp, Op
Values:	
Cyclic process data:	∅
Maximum value:	500.0
Minimum value:	0
Protection:	∅
Decimal point:	1 (0.1)

**7.3.75 P-0-0008 Motor rotate window (N equ Ns)**

The speed of the motor shaft reached the required value and is within the percental tolerance given here. The N=N<sub>s</sub> (bit 6) indication in the EtherCAT process data status word works on the basis of this.

Data type:	2-byte unsigned integer
Unit of measure:	%
Changeable:	PreOp, SafeOp, Op
Values:	
Cyclic process data:	Ø
Maximum value:	100.0
Minimum value:	0
Protection:	Ø
Decimal point:	1 (0.1)

**7.3.76 P-0-0074 Speed limit for EMG output activate**

This is the limiting speed beyond which the contact of the EMG module activating output relay releases. Its value is equal to the percental value of the maximum speed.

Data type:	2-byte unsigned integer
Unit of measure:	%
Changeable:	PreOp
Values:	
Cyclic process data:	Ø
Maximum value:	65000
Minimum value:	0
Protection:	Ø
Decimal point:	0 (1)

### 7.3.77 S-0-0206 Drive on delay time

This is the period after elapsing of which, following the drive enabling, the drive interprets the reference signal and commands, and, in addition, gives back the ServoEn (bit 0) bit in the status word.

Data type:	2-byte unsigned integer
Unit of measure:	millisecond [ms]
Changeable:	PreOp
Values:	
Cyclic process data:	Ø
Maximum value:	65000
Minimum value:	0
Protection:	Ø
Decimal point:	0 (1)

### 7.3.78 S-0-0207 Drive off delay time

If cancelling the drive enabling is requested or emergency stop occurs, the PWM signals will still be kept on the motor over this period after deceleration.

Data type:	2-byte unsigned integer
Unit of measure:	millisecond [ms]
Changeable:	PreOp
Values:	
Cyclic process data:	Ø
Maximum value:	65000
Minimum value:	0
Protection:	Ø
Decimal point:	0 (1)

### 7.3.79 S-0-0295 Drive enable delay time

If the drive is requested for enabling, it is the period after elapsing of which the drive will issue the PWM signals on the output.

Data type:	2-byte unsigned integer
Unit of measure:	millisecond [ms]
Changeable:	PreOp
Values:	
Cyclic process data:	Ø
Maximum value:	65000
Minimum value:	0
Protection:	Ø
Decimal point:	0 (1)

### 7.3.80 S-0-0273 Maximum drive off delay time

If enabling is cancelled while the motor rotates or such error occurs at which the motor is able to stop with braking, it will be the maximum period during which the drive will keep the enabling and the PWM signals on the motor; however, if the motor stops sooner, they will be cancelled.

Data type:	2-byte unsigned integer
Unit of measure:	millisecond [ms]
Changeable:	PreOp
Values:	
Cyclic process data:	Ø
Maximum value:	65000
Minimum value:	0
Protection:	Ø
Decimal point:	0 (1)

### 7.3.81 P-0-0084 Parameter setup ID number

These are the parameter identifiers sent by the control concerning the drive and the motor; the identifiers contain their merged code like this, DDDDDMMMM (D: drive, M: motor).

Data type:	Text (list of 1-byte elements)
Changeable:	Ø
Values:	Character code
Cyclic process data:	Ø
Protection:	Ø

### 7.3.82 P-0-0085 Motor description code

The unique identification code of the motor connected to the drive. In the case of a motor equipped with EnDat encoder, it is the value read out from the encoder.

Data type:	Text (list of 1-byte elements)
Changeable:	PreOp
Values:	Character code
Cyclic process data:	∅
Protection:	∅

### 7.3.83 P-n-0086 Motor pole pair

The number of the pole pairs of the motor; it is a terminal board data. On the terminal board, the number of poles is often indicated, half of which is the number of the pole pairs.

Data type:	2-byte unsigned integer
Unit of measure:	piece
Changeable:	PreOp
Values:	1-2-3-4, typically
Cyclic process data:	∅
Maximum value:	256
Minimum value:	0
Protection:	∅
Decimal point:	0 (1)

### 7.3.84 P-n-0087 Motor nominal rpm.

The rated speed of the motor; it is a terminal board and catalogue data. Its value influences the values of the internal mathematical motor model.

Data type:	2-byte unsigned integer
Unit of measure:	$\text{min}^{-1}$ or $\text{m}\cdot\text{min}^{-1}$
Changeable:	PreOp
Values:	
Cyclic process data:	∅
Maximum value:	65000
Minimum value:	0
Protection:	∅
Decimal point:	0 (1)

### 7.3.85 P-n-0088 Start of weakening speed

This is the parameter defining the limit speed of the field weakening. Normally, it is the rated speed of the motor, if the rated line voltage of the motor is around 380V<sub>AC</sub>, but in any case is a value dependent on the rated speed.

It means the value of the shaft speed beyond which the (PMSM) synchronous motor or the (AC) asynchronous motor operates already in field weakening mode. The value can be calculated by the drive software using the P-0-0167 command on the basis of the rated data of the terminal board.

Data type: 2-byte unsigned integer

Unit of measure: min<sup>-1</sup> or m·min<sup>-1</sup>

Changeable: PreOp

Values:

Cyclic process data: Ø

Maximum value: 65000

Minimum value: 0

Protection: Ø

Decimal point: 0 (1)

### 7.3.86 S-n-0109 Motor peak current

This is the effective value of the peak current of the motor. It is the current value the motor and drive system stands without damage. Practically, this current value influences the maximum torque that can be yielded from the motor.

Data type: 4-byte unsigned integer

Unit of measure: ampere [A]

Changeable: PreOp

Values:

Cyclic process data: Ø

Maximum value: 500.000

Minimum value: 0

Protection: Ø

Decimal point: 3 (0.001)

**7.3.87 S-n-0111 Motor continuous stall current**

This is the I<sub>0</sub> (M<sub>0</sub>) current value belonging to the rated static (shaft standstill) torque of mainly synchronous servo motors. This data occurs in the case of some asynchronous motors too. Its value is usually greater than the rated current value since at 0 min<sup>-1</sup> speed there is no iron loss, there is only coil loss, so the heat dissipation is less.

Data type: 4-byte unsigned integer

Unit of measure: ampere [A]

Changeable: PreOp

Values:

Cyclic process data: Ø

Maximum value: 500.000

Minimum value: 0

Protection: Ø

Decimal point: 3 (0.001)

**7.3.88 S-n-0113 Maximum motor speed**

This is the maximum rotor speed/velocity of the motor. It is the maximum permissible speed of the motor shaft; if this value is exceeded, an error message will be generated.

Data type: 4-byte unsigned integer

Unit of measure: min<sup>-1</sup> or m·min<sup>-1</sup>

Changeable: PreOp

Values:

Cyclic process data: Ø

Maximum value: 100000.0000

Minimum value: 1.0000

Protection: Ø

Decimal point: 4 (0.0001)



### 7.3.89 S-n-0136 Positive acceleration limit value

This is the motor acceleration slope in second. The time during which the maximum speed is reached should be given.

If, during operation of the motor, there is saturated operational sector (e.g. in the case of field weakening operation), in other words, the maximum torque the motor can deliver in this speed range decreases, the real ramp slope will differ from the value set here.

Data type: 4-byte unsigned integer

Unit of measure: second [s]

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: Ø

Maximum value: 2000.00

Minimum value: 0.05

Protection: Ø

Decimal point: 2 (0.01)

### 7.3.90 S-n-0137 Negative acceleration limit value

This is the motor deceleration slope in second. The time needed for breaking from the maximum speed should be given.

If, during operation of the motor, there is saturated operational sector (e.g. in the case of field weakening operation), in other words, the maximum torque the motor can deliver in this speed range decreases, the real ramp slope will differ from the value set here.

Data type: 4-byte unsigned integer

Unit of measure: second [s]

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: Ø

Maximum value: 2000.00

Minimum value: 0.05

Protection: Ø

Decimal point: 2 (0.01)

### 7.3.91 S-n-0429 Emergency Stop Deceleration

This is the motor deceleration slope in emergency status, in second. The time needed for breaking from the maximum speed should be given. This deceleration slope will be taken into account in the case when the drive indicates error and able to brake, and also in the case when it was asked to provide emergency status (EMG bit) from EtherCAT control word.

If, during operation of the motor, there is saturated operational sector (e.g. in the case of field weakening operation), in other words, the maximum torque the motor can deliver in this speed range decreases, the real ramp slope will differ from the value set here.

Data type: 4-byte unsigned integer

Unit of measure: second [s]

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: Ø

Maximum value: 2000.00

Minimum value: 0.05

Protection: Ø

Decimal point: 2 (0.01)

### 7.3.92 S-n-0196 Motor rated current

This is the  $I_r$  ( $M_r$ ) current value belonging to the rated torque of the motor. It is a data of the terminal board and catalog; its value influences the values of the internal mathematical motor model.

Data type: 4-byte unsigned integer

Unit of measure: ampere [A]

Changeable: PreOp

Values:

Cyclic process data: Ø

Maximum value: 500.000

Minimum value: 0.001

Protection: Ø

Decimal point: 3 (0.001)

### 7.3.93 S-n-0201 Motor warning temperature

This is a motor temperature warning value. If the motor temperature reaches this value, it will be indicated by the servo amplifier on the 2nd bit of the standard C2D register (Motor over-temperature) or on the 11th bit of the P-0-0204 NCT status word, generating warning by this means.

In addition, the motor overload control actuates the control on this temperature from which the information about the magnitude of the overload and about the time during which it can be maintained will be generated for the control.

Data type:	2-byte unsigned integer
Unit of measure:	degree centigrade [°C]
Changeable:	PreOp
Values:	80.0
Cyclic process data:	Ø
Maximum value:	150.0
Minimum value:	40.0
Protection:	Ø
Decimal point:	1 (0.1)

### 7.3.94 S-n-0204 Motor shut down temperature

This is an error message value relating to the motor temperature. If the motor temperature reaches this value, it will be indicated by the servo amplifier on the 2nd bit of the C1D register (Motor overtemperature shutdown) or on the 2nd bit of the P-0-0205 NCT error word, generating error message; as a result, the drive will shut down the current (PWM signals) on the motor

Data type:	2-byte unsigned integer
Unit of measure:	degree centigrade [°C]
Changeable:	PreOp
Values:	95.0
Cyclic process data:	Ø
Maximum value:	150.0
Minimum value:	0.0
Protection:	Ø
Decimal point:	1 (0.1)

### 7.3.95 P-n-0012 Motor thermo prot code

This is the code of motor thermal protection selection.

Data type:	2-byte unsigned integer
Unit of measure:	Ø
Changeable:	PreOp
Values:	<p>0 There is no thermal protection; it is switched off</p> <p>1 I2t protection monitoring the square of the phase current</p> <p>2 Protection adjusted to the PTC thermal sensor or the thermal circuit-breaker built in the coil end</p> <p>3 Monitoring the I2t and the EnDat encoder thermometer</p> <p>4 Protection adjusted to the KTY83-1xx thermal sensor built in the coil end</p> <p>5 Protection adjusted to the KTY84-1xx thermal sensor built in the coil end</p> <p>6 Only temperature of the EnDat encoder is provided, if any</p> <p>7 Other (e.g. platinic) sensor with different resistance and linear characteristics</p> <p>&gt; 7 Values that are not used; heat protection is switched off</p>
Cyclic process data:	Ø
Maximum value:	Ø
Minimum value:	Ø
Protection:	Ø
Decimal point:	0 (1)

### 7.3.96 P-n-0011 Motor temp. sensor resistance

If a thermometer of other kind is built in the motor (P-n-0012 = 7), its temperature model should be given here. In this case, the algorithm will measure the temperature in accordance with a linear model.

Data type:	4-byte unsigned integer
Unit of measure:	ohm [ $\Omega$ ]
Changeable:	PreOp
Values:	The value of resistance given at the temperature of 25 °C, in ohm
Cyclic process data:	Ø
Maximum value:	20000.0
Minimum value:	1.0
Protection:	Ø
Decimal point:	2 (0.01)

### 7.3.97 P-n-0013 Motor temp. sensor coefficient

This is the value of the coefficient of change of a temperature sensor of other kind. In this case, the algorithm will measure the temperature in accordance with a linear model.

Data type: 4-byte floating-point

Unit of measure: ohm/Kelvin [ $\Omega$ /K]

Changeable: PreOp

Values:

Cyclic process data:  $\emptyset$

Maximum value:  $\emptyset$

Minimum value:  $\emptyset$

Protection:  $\emptyset$

Decimal point: floating-point

### 7.3.98 P-n-0090 Motor weight

The motor weight is a value relating to the motor thermal capacity. The time constant of the thermal model of the motor can approximately be specified from the value of the parameter. The thermal model is influenced primarily by the motor weight and the cooling mode.

Data type: 2-byte unsigned integer

Unit of measure: kilogram [kg]

Changeable: PreOp

Values:

Cyclic process data:  $\emptyset$

Maximum value: 3000.0

Minimum value: 0.1

Protection:  $\emptyset$

Decimal point: 1 (0.1)

### 7.3.99 P-n-0095 Motor shaft theta with load

This is the value of the moment of inertia reduced to the motor shaft.

The moment of inertia of the unconnected motor shaft is usually given on the motor terminal board. This value is increased by the inertia of the driven mechanical unit connected to the shaft.

Data type: 4-byte floating-point

Unit of measure: [ $\text{kg}\cdot\text{cm}^2$ ]

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: Ø  
Maximum value: 65000  
Minimum value: 0  
Protection: Ø  
Decimal point: floating-point

### 7.3.100 P-n-0056 Motor nominal frequency

This is a value among the data of the motor name-plate; it is the frequency of the rotating field of the stator belonging to the rated speed of the motor shaft. This parameter exists only in the case of asynchronous (AC induction) motors; the drive should be in asynchronous servo or inverter mode.

Data type: 4-byte floating-point  
Unit of measure: hertz [Hz]  
Changeable: PreOp, SafeOp, Op  
Values:  
Cyclic process data: Ø  
Maximum value: 400  
Minimum value: 0  
Protection: Ø  
Decimal point: floating-point

### 7.3.101 P-n-0092 Motor rated voltage

This is a value among the data of the motor name-plate; it is the rated voltage of the motor,  $U_v$ . It is a data of the terminal board and catalog; its value influences the values of the internal mathematical motor model.

Data type: 4-byte floating-point  
Unit of measure: volt [V]  
Changeable: PreOp, SafeOp, Op  
Values: 380 V<sub>ACeff</sub> typically  
Cyclic process data: Ø  
Maximum value: 500  
Minimum value: 10  
Protection: Ø  
Decimal point: floating-point

### 7.3.102 P-n-0072 Motor minimal operate voltage

This is the value of the P-n-0092 motor rated voltage expressed in percentage; it is the minimum voltage to be delivered to the motor so that the excitation develops. This parameter is available only in the inverter drive mode.

Data type:	2-byte unsigned integer
Unit of measure:	percentage [%]
Changeable:	PreOp
Values:	
Cyclic process data:	∅
Maximum value:	100.0
Minimum value:	0.00
Protection:	∅
Decimal point:	2 (0.01)

### 7.3.103 P-n-0093 Motor nominal power

This is the rated loadability of the motor in continuous S1 mode of operation, measured on the shaft. It is a data of the terminal board and catalog; its value influences the values of the internal mathematical motor model. In addition, it is used for monitoring the overload.

Data type:	4-byte floating-point
Unit of measure:	watt [W]
Changeable:	PreOp, SafeOp, Op
Values:	$P_n = M_n \cdot 2\pi \cdot n / 60$
Cyclic process data:	∅
Maximum value:	150000
Minimum value:	1
Protection:	∅
Decimal point:	floating-point

### 7.3.104 P-n-0058 Motor cos(φ)

This is the rated power factor of the motor. It is interpreted primarily for asynchronous motors. It is a data of the terminal board and catalog; its value influences the values of the internal mathematical motor model.

Data type:	4-byte floating-point
Unit of measure:	∅
Changeable:	PreOp, SafeOp, Op
Values:	

Cyclic process data: Ø  
 Maximum value: 1  
 Minimum value: 0  
 Protection: Ø  
 Decimal point: floating-point

### 7.3.105 P-n-0096 Motor stator resistance

This is a resistance value measured between two phase terminals of the motor. In any case, it is the resistance value between the two feed points irrespective of whether the motor is star-connected or delta-connected.

In the case of higher motor powers or very low motor resistances, the resistance of the cable from the drive to the motor can also be considerable in the system, so, in this case, it is worth measuring this resistance at the cable end connecting to the drive while the cable is separated from the drive.

Data type: 4-byte floating-point  
 Unit of measure: ohm [ $\Omega$ ]  
 Changeable: PreOp, SafeOp, Op  
 Values:  
 Cyclic process data: Ø  
 Maximum value: 500  
 Minimum value: 0.01  
 Protection: Ø  
 Decimal point: floating-point

### 7.3.106 P-n-0097 Motor no load/magnetizing current in rated rpm.

This is a data derived from no-load test of the asynchronous motor which is a good estimation of the magnetizing current; its value influences the values of the internal mathematical model of the motor.

Data type: 4-byte floating-point  
 Unit of measure: ampere [A]  
 Changeable: PreOp, SafeOp, Op  
 Values:  $I_{\mu} \approx 0.9 I_n \cdot \sin(\varphi)$   
 Cyclic process data: Ø  
 Maximum value: 500  
 Minimum value: 0  
 Protection: Ø  
 Decimal point: floating-point



### 7.3.107 P-n-0098 PM motor fieldweak current limit

This is the limiting value of the weakening current for the field weakening operational mode of the synchronous servo motor with permanent magnet; its value influences the values of the internal mathematical model of the motor. For the field weakening mode of operation, the current value of the weakening current is determined by the internal mathematical model from the current value of the DC bus voltage; however, its maximum value can be the value determined in this parameter. Normally, it is not worth setting a value greater than the rated current of the motor because the motor may overheat and its copper loss may increase.

Data type:	4-byte floating-point
Unit of measure:	ampere [A]
Changeable:	PreOp, SafeOp, Op
Values:	$I_{\mu\max} \approx 1 I_n$
Cyclic process data:	Ø
Maximum value:	500
Minimum value:	0
Protection:	Ø
Decimal point:	floating-point

### 7.3.108 P-n-0061 Motor main field inductance (Lm)

The value of inductance calculated from the main field reactance of the motor. It is catalog data in case of some motors, it depends on the manufacturer whether it publishes this data or not (e.g. the Lenze provides it); its value influences the values of the internal mathematical model of the motor. It can be calculated using the data of the motor name-plate.

Data type:	4-byte floating-point
Unit of measure:	henry [Vs/A] [H]
Changeable:	PreOp, SafeOp, Op
Values:	
Cyclic process data:	Ø
Maximum value:	2
Minimum value:	0
Protection:	Ø
Decimal point:	floating-point

### 7.3.109 P-n-0040 Motor stator leakage inductance (Lσ)

This is the stator-side leakage inductance of the motor on the basis of the one-phase equivalent circuit. It is catalog data in case of some motors, it depends on the manufacturer whether it publishes this data or not (e.g. the Lenze provides it).

Data type:	4-byte floating-point
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Unit of measure: millihenry [1000·Vs/A] [mH]  
 Changeable: PreOp, SafeOp, Op  
 Values:  
 Cyclic process data: Ø  
 Maximum value: 500  
 Minimum value: 0  
 Protection: Ø  
 Decimal point: floating-point

### 7.3.110 P-n-0041 Motor rotor leakage inductance ( $Lr\sigma$ )

This is the rotor-side leakage inductance of the motor on the basis of the one-phase equivalent circuit. It is catalog data in case of some motors, it depends on the manufacturer whether it publishes this data or not (e.g. the Lenze provides it).

Data type: 4-byte floating-point  
 Unit of measure: millihenry [1000·Vs/A] [mH]  
 Changeable: PreOp, SafeOp, Op  
 Values:  
 Cyclic process data: Ø  
 Maximum value: 500  
 Minimum value: 0  
 Protection: Ø  
 Decimal point: floating-point

### 7.3.111 P-n-0060 Motor $Rr'$ rotor resistance

The rotor reduced resistance of the motor on the basis of the one-phase equivalent circuit. It is catalog data in case of some motors, it depends on the manufacturer whether it publishes this data or not (e.g. the Lenze provides it).

Data type: 4-byte floating-point  
 Unit of measure: ohm [ $\Omega$ ]  
 Changeable: PreOp, SafeOp, Op  
 Values:  
 Cyclic process data: Ø  
 Maximum value: 100  
 Minimum value: 0  
 Protection: Ø  
 Decimal point: floating-point

### 7.3.112 P-n-0091 Motor electromotive force

The value of the induced line voltage of the permanent-magnet synchronous motor (PMSM) at the speed of  $1000 \text{ min}^{-1}$ , that can be measured on the terminals. Practically, it provides information about magnetic force of the rotor.

Data type:	4-byte floating-point
Unit of measure:	volt/1000 rpm [ $\text{V}/1000 \text{ min}^{-1}$ ]
Changeable:	PreOp, SafeOp, Op
Values:	
Cyclic process data:	Ø
Maximum value:	100
Minimum value:	0
Protection:	Ø
Decimal point:	floating-point

### 7.3.113 P-n-0039 Motor PMSM Ld inductance

This is the value of the Ld inductance of the permanent magnet (PM) synchronous servo motor (SM). This parameter is necessary for a permanent magnet motor to work in field weakening mode of operation.

Data type:	4-byte floating-point
Unit of measure:	millihenry [ $1000 \cdot \text{Vs}/\text{A}$ ] [mH]
Changeable:	PreOp, SafeOp, Op
Values:	
Cyclic process data:	Ø
Maximum value:	20
Minimum value:	0
Protection:	Ø
Decimal point:	floating-point

### 7.3.114 P-n-0100 Motor Lq by Ld ratio

In the case of synchronous motors, it determines the ratio between the D-direction and Q-direction transient inductances. In typical servo applications, its value is approximately 1; in this case the motor is called cylindrically symmetric.

Data type:	4-byte floating-point
Unit of measure:	Ø
Changeable:	PreOp, SafeOp, Op
Values:	Typically 1

Cyclic process data: Ø  
 Maximum value: 5  
 Minimum value: 0  
 Protection: Ø  
 Decimal point: floating-point

### 7.3.115 P-n-0103 Pole pair distance

In the case of the encoder of a linear motor (when scale is used), the distance between the pole pairs can be given here in mm, with accuracy of 1 µm.

Data type: 4-byte unsigned integer  
 Unit of measure: millimetre [mm]  
 Changeable: PreOp  
 Values:  
 Cyclic process data: Ø  
 Maximum value: 1000.000  
 Minimum value: 0.000  
 Protection: Ø  
 Decimal point: 3 (0.001)

### 7.3.116 P-n-0110 Encoder position offset

This is a parameter by the use of which the commutation can be set in the case of a linear motor and angle encoder; it is necessary to calculate the value of the electrical angle that can be delivered to the winding. It is similar to the DatumShift value that can be set in the Heidenhain EnDat encoders. Using both results in the same thing, but only one should be set.

Data type: 4-byte signed integer  
 Unit of measure: increment  
 Changeable: PreOp, SafeOp, Op  
 Values:  
 Cyclic process data: Ø  
 Maximum value: 33554431  
 Minimum value: -33554431  
 Protection: Ø  
 Decimal point: 0 (1)

### 7.3.117 P-n-0150 List of working data of motor

This is the list of data of the internal motor model. It is for information and testing.

- 1 MotorMaxFrequency: The maximum value of the field frequency that can be applied to the motor
- 2 CurrentIs1q\_max: The maximum value of the Q-direction current that can be applied to the motor
- 3 CurrentIs1d\_max: The maximum value of the D-direction exciting current that can be applied to the motor
- 4 Motor\_Tm: The electromechanical time constant of the motor from the moment of inertia
- 5 Motor\_Tv: The electrical time constant of the motor (in the case of the permanent magnet motor, it is the D-direction transient time constant)
- 6 Motor\_Tq: The Q-direction transient time constant of the permanent magnet synchronous motor
- 7 MotorFluxLinkage: The value of the coupling main field flux to be generated in the asynchronous motor, or, in the case of PMSM, the value of the flux generated by the magnets
- 8 Motor\_Tr0: No-load rotor time constant of the asynchronous motor
- 9 LeakageFactor: Total leakage factor in asynchronous motor
- 10 BreakdownSlip: The value of the breakdown slip of the asynchronous motor
- 11 Torque max: The torque value belonging to the given maximum current
- 12 Rated Torque: The calculated rated electric torque of the motor; it should be equal to the rated torque on the terminal board

Data type: 4-byte floating-point list

Changeable: Ø

### 7.3.118 Current control parameters

#### 7.3.118.1 S-n-0119 Current loop proportional gain 2 (FluxGain)

This is the proportional member of the gain of the flux control loop.

Data type:	2-byte unsigned integer
Unit of measure:	∅
Changeable:	PreOp, SafeOp, Op
Values:	Typically 5~20
Cyclic process data:	∅
Maximum value:	500.0
Minimum value:	0.0
Protection:	∅
Decimal point:	1 (0.1)

#### 7.3.118.2 S-n-0120 Current control loop int. action time 2 (FluxIntTime)

This is the integration time constant of the flux control loop [ms]

Data type:	2-byte unsigned integer
Unit of measure:	millisecond [ms]
Changeable:	PreOp, SafeOp, Op
Values:	Typically 20~150
Cyclic process data:	∅
Maximum value:	1000.0
Minimum value:	0.0
Protection:	∅
Decimal point:	1 (0.1)

### **7.3.118.3 P-n-0044 Torque limit control int. action time**

This is the torque limit integrator, i.e. the time constant of the current control saturation feedback integrator. It should be faster than the integrator of the speed control.

Data type:	2-byte unsigned integer
Unit of measure:	millisecond [ms]
Changeable:	PreOp, SafeOp, Op
Values:	Typically 5~10
Cyclic process data:	∅
Maximum value:	1000.0
Minimum value:	0.1
Protection:	∅
Decimal point:	1 (0.1)

### **7.3.118.4 S-n-0106 Current loop proportional gain 1**

This is the proportional member of the gain of the current control loop.

Data type:	4-byte floating-point
Unit of measure:	∅
Changeable:	PreOp, SafeOp, Op
Values:	Typically 10~20
Cyclic process data:	∅
Maximum value:	100
Minimum value:	0
Protection:	∅
Decimal point:	floating-point

### 7.3.118.5 S-n-0107 Current control loop integral action time 1

This is the parameter influencing the integration time of the current control [ms].

Data type:	4-byte floating-point
Unit of measure:	millisecond [ms]
Changeable:	PreOp, SafeOp, Op
Values:	Typically 10~20
Cyclic process data:	∅
Maximum value:	100
Minimum value:	0
Protection:	∅
Decimal point:	floating-point

### 7.3.118.6 P-n-0066 Additive preload torque value

It is possible to add a preload torque for the motor. It can be a preload for the counterweight of a vertical shaft, or, in the case of a rack and pinion drive, it can be used for reaching anti-backlash engagement.

Data type:	2-byte signed integer
Unit of measure:	percentage [%] (percentage of the rated torque)
Changeable:	PreOp, SafeOp, Op
Values:	
Cyclic process data:	∅
Maximum value:	1000.0
Minimum value:	-1000.0
Protection:	∅
Decimal point:	1 (0.1)

### 7.3.119 Speed control parameters

This is a realization of a classic PID control. The integration time and the derivative-action time are to be interpreted in millisecond, and in order to keep the cut-off frequencies at a set value, the value of the proportional member influences the control characteristics.

To ensure the control precision, the drive divides the whole speed/velocity range of the motor into 7 velocity ranges, thus different values may be valid at different velocities. The characteristics of control can be approximated by linear interpolation between the ranges.

The flowchart of the speed and position control together with the parameters is illustrated in the Figure 10.



### **7.3.119.1 S-n-0100 Speed loop proportional gain**

This is the proportional gain of the speed control.

Data type:	2-byte unsigned integer
Unit of measure:	
Changeable:	PreOp, SafeOp, Op
Values:	0.3~5.00
Cyclic process data:	∅
Maximum value:	50.00
Minimum value:	0.00
Protection:	∅
Decimal point:	2 (0.01)

### **7.3.119.2 S-n-0101 Speed loop integral action time**

This is the reaction time of the integrator of the speed control [ms].

Data type:	2-byte unsigned integer
Unit of measure:	millisecond [ms]
Changeable:	PreOp, SafeOp, Op
Values:	10.0~50.0
Cyclic process data:	∅
Maximum value:	500.0
Minimum value:	0.1
Protection:	∅
Decimal point:	1 (0.1)

### **7.3.119.3 S-n-0102 Speed loop differential time**

This is the reaction time of the derivative member of the speed control [ms].

Data type:	2-byte unsigned integer
Unit of measure:	millisecond [ms]
Changeable:	PreOp, SafeOp, Op
Values:	0.10~1.00
Cyclic process data:	∅
Maximum value:	125.00
Minimum value:	0.00
Protection:	∅

Decimal point: 2 (0.01)

#### 7.3.119.4 P-n-0131 Speed control anti-windup time

This is the integration time of the anti-saturation control of the speed control.

If the speed control fell in the saturation range, i.e. it is in vain to request a greater current reference signal because it cannot be executed by the current control and the motor, the integrator of the speed control would continuously gather the error signal and would begin to decrease it when the motor shaft reaches the required velocity. Since it would take a long time, therefore the motor shaft would accelerate considerably further. The purpose of this control is to stop further gathering the errors by the integrator of the speed control when saturation occurs and to provide the control with the opportunity to return to its linear range within the period set in this parameter when the motor shaft reaches the required velocity.

Data type: 2-byte signed integer

Unit of measure: millisecond [ms]

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: Ø

Maximum value: 1000.0

Minimum value: -1000.0

Protection: Ø

Decimal point: 1 (0.1)

#### 7.3.119.5 P-n-0132 Reference input gain

This is the reference signal gain of the speed control.

It is the parameter by the use of which the speed belonging to the reference signal can be set in the mode of speed control, and, which influences the 'lag', i.e. the gain of the position controlling circuit in the case of an external position control.

Data type: 4-byte floating-point

Unit of measure: percentage [%]

Changeable: PreOp, SafeOp, Op

Values: 100%

Cyclic process data: Ø

Maximum value: 200

Minimum value: 0

Protection: Ø

Decimal point: floating-point

### 7.3.119.6 P-n-0134 High precision speed control gain

This is the gain of the high-precision speed control. It works only in the mode 1 and mode 2 of the control (Control \_mode =1, and Control \_mode =2). The modes can only be set in the case of controls that have synchronous servo motors with permanent magnets. If there is in-drive position control, this parameter will be ineffective.

Data type:	4-byte floating-point
Unit of measure:	percentage [%]
Changeable:	PreOp, SafeOp, Op
Values:	5~10%
Cyclic process data:	∅
Maximum value:	50
Minimum value:	0
Protection:	∅
Decimal point:	floating-point

### 7.3.119.7 S-n-0104 Position loop Kv-factor

This is the loop gain of the in-drive position control.

Data type:	2-byte unsigned integer
Unit of measure:	1000 revolution per minute [1000 min <sup>-1</sup> ]
Changeable:	PreOp, SafeOp, Op
Values:	0.50~20.00
Cyclic process data:	∅
Maximum value:	100.00
Minimum value:	0.00
Protection:	∅
Decimal point:	2 (0.01)

### 7.3.119.8 P-n-0133 Angle control loop gain

This is the gain of the high-precision speed control with inertial attenuation. It works only in the mode 9 of the control (Control\_mode =9). This mode can only be set in the case of the controls that have asynchronous servo motors. The control has an inertial attenuation for these applications.

Data type:	4-byte floating-point
Unit of measure:	percentage [%]
Changeable:	PreOp, SafeOp, Op
Values:	5~10%

Cyclic process data: Ø  
 Maximum value: 50  
 Minimum value: 0  
 Protection: Ø  
 Decimal point: floating-point

### **7.3.119.9 S-n-0296 Velocity feed forward gain**

This is the value of the velocity feedforward in the mode of position/high-precision speed control ('Position control without following error (lag-less)'). In the case of the position control, by the use of it, the lag and the geometrical distortion following from it can be eliminated absolutely. In the case of high-precision speed control (control mode 2), control can be accelerated.

Data type: 2-byte unsigned integer  
 Unit of measure: percentage [%]  
 Changeable: PreOp, SafeOp, Op  
 Values: 50.00~90.00  
 Cyclic process data: Ø  
 Maximum value: 100.00  
 Minimum value: 0.00  
 Protection: Ø  
 Decimal point: 2 (0.01)

### **7.3.119.10 P-n-0136 Accel\_Precont\_Gain**

This is the value of the acceleration feedforward.

Data type: 4-byte floating-point  
 Unit of measure:  
 Changeable: PreOp, SafeOp, Op  
 Values: 5~10  
 Cyclic process data: Ø  
 Maximum value: 200  
 Minimum value: 0  
 Protection: Ø  
 Decimal point: floating-point

**7.3.119.11 P-n-0137 Tandem speed lim**

This is the limiting value of the master-slave exchange in the case of the mode of tandem speed control (control mode 4, 5, 6).

Data type: 4-byte floating-point

Unit of measure:

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: Ø

Maximum value: 200

Minimum value: 0

Protection: Ø

Decimal point: floating-point

**7.3.119.12 P-n-0138 Tandem accel lim**

This is the limiting value of the master-slave exchange in the case of the mode of tandem speed control (control mode 4, 5, 6).

Data type: 4-byte floating-point

Unit of measure:

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: Ø

Maximum value: 200

Minimum value: 0

Protection: Ø

Decimal point: floating-point

**7.3.119.13 P-n-0010 Speed in Brake mode**

In the case when it was asked to provide emergency status, creeping of the axis, for example lifting the grinding wheel from the workpiece, can be realized. It works only in the ready-to-operate status of the drive.

Data type: 2-byte signed integer

Unit of measure: percentage [%]

Changeable: PreOp, SafeOp, Op

Values: 1.00~2.00

Cyclic process data: Ø

Maximum value: 10.00

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Minimum value:	0.00
Protection:	Ø
Decimal point:	2 (0.01)

#### 7.3.119.14 P-n-0066 Additive preload torque value

In the case of asymmetric loads, a preload offset torque value can be given as a percentage of the rated torque.

Data type:	2-byte signed integer
Unit of measure:	percentage [%]
Changeable:	PreOp, SafeOp, Op
Values:	1.0~2.0
Cyclic process data:	Ø
Maximum value:	100.00
Minimum value:	0.00
Protection:	Ø
Decimal point:	1 (0.1)

### 7.4 Compatibility synchrony for 1.3xx software versions

In this subchapter, only additional information is connected to the parameters listed. Those that cannot be found here are described at the new software.

#### 7.4.1 P-0-0000 Drive control operating mode

This is the parameter for setting the operation mode of the speed control.

Data type:	32-bit integer
Changeable:	Only when turned on
Values:	<ul style="list-style-type: none"> <li>=0: PID-type speed control</li> <li>=1: Control _mode =0 + High-precision speed control</li> <li>=2 : Control _mode =1 + High-precision speed control with speed feedforward and acceleration feedforward</li> <li>=3 : Control _mode =1 + High-precision speed control with speed feedforward</li> <li>=4 : Tandem control. Master axis</li> <li>=5 : Tandem control. Slave axis. Direction of rotation: opposite to that of the master axis. (Opposed motor arrangement)</li> <li>=6 : Tandem control. Slave axis. Direction of rotation: identical with that of the master axis. (Identical motor arrangement)</li> </ul>

#### **7.4.2 P-0-0010 Speed in Brake mode**

This is the parameter for providing the velocity reference signal proportional to the speed of rotation in Brake mode.

Data type: 32-bit integer

Changeable: Only when turned on

This reference signal as internal reference signal is used by the drive in the case when the drive is enforced into the Brake mode by the control (see the EMG and BRK at the part describing the NCT-Servo communication). And, at the same time, the motor will rotate at the speed proportional to the value with correct sign given in this parameter. This Brake mode will be effective as long as the drive is enabled.

#### **7.4.3 P-0-0017 Offset**

This parameter is currently not used. It is reserved for later development.

#### **7.4.4 P-0-0040 Acceleration limit**

This is the limitation of the slope of the velocity reference signal (i.e. the limitation of the motor acceleration) [incr/125 $\mu$ s]. A change in speed per a control cycle greater than the value set here is not enabled by the drive.

Data type: 32-bit unsigned integer

Changeable: When turned on and in the case of downloading a parameter

Factory data: 500

#### **7.4.5 P-0-0041 Accel/Decel mode**

This parameter is currently not used. It is reserved for later development.

#### **7.4.6 P-0-0062 Current Proportional Gain**

This is the gain of the P member of the current control.

Data type: 32-bit floating point

Changeable: Only when turned on

Values: Positive floating-point number different from zero

#### **7.4.7 P-0-0063 Current Integrator Gain**

This is the time constant of the I member of the current control [ms].

Data type: 32-bit floating point

Changeable: Only when turned on

Values: Positive floating-point number different from zero

#### **7.4.8 P-0-0064 Highest Motor Current**

This is the maximum value of the current generating the torque (the Q-direction current) [A].

Data type: 32-bit floating point

Changeable: Only when turned on

Values: Positive floating-point number different from zero

It is the current value to which the motor current is limited by the control.

#### **7.4.9 P-0-0066 PreLoad Current %**

This parameter is currently not used. It is reserved for later development.

#### **7.4.10 P-0-0086 Motor Pole Pair**

The number of the pole pairs of the electric motor. In the case of a linear motor: pole\_pair=1.

Data type: 32-bit integer

Changeable: Only when turned on

Values: Positive integer different from zero

#### **7.4.11 P-0-0088 Nominal\_speed**

This parameter is not used.

#### **7.4.12 P-0-0089 Max\_field\_speed**

This parameter is not used.

#### **7.4.13 P-0-0090 Max\_speed**

This is the maximum permissible speed of the electric motor.

Data type: 32-bit floating point

Changeable: Only when turned on

Values: Positive floating-point number different from zero

When the speed of the motor exceeds the value set here, the drive will stop with the E11 error (Overspeed).

#### **7.4.14 P-0-0091 Motor\_therm\_const**

This parameter is not used.

#### **7.4.15 P-0-0092 Motor\_Back\_EMF**

This is electromotive force (EMF) [V/1000 min<sup>-1</sup>].

Data type: 32-bit floating point



#### **7.4.16 P-0-0093 Motor\_nom\_voltage**

This parameter is not used.

#### **7.4.17 P-0-0094 Motor\_nom\_power**

This parameter is not used.

#### **7.4.18 P-0-0095 Motor\_nom\_current**

This is the rated current of the electric motor [A].

Data type: 32-bit floating point

Changeable: Only when turned on

#### **7.4.19 P-0-0096 Motor\_nom\_frequency**

This parameter is not used.

#### **7.4.20 P-0-0097 Motor\_stator\_res**

This is the stator resistance of the electric motor [ohm].

Data type: 32-bit floating point

Changeable: Only when turned on

#### **7.4.21 7 4 21 P-0-0098 Motor\_cos\_fi**

This parameter is not used.

#### **7.4.22 P-0-0099. MotorStrayRel**

This parameter is not used.

#### **7.4.23 P-0-0100 Motor\_Ts\_d**

This parameter is not used.

#### **7.4.24 P-0-0101 TqPerTd**

This parameter is not used.

#### **7.4.25 P-0-0102 PsiMaxPerPsi**

This parameter is not used.

#### **7.4.26 P-0-0103 Motor\_min\_current**

This parameter is not used.

#### **7.4.27 P-0-0104 Pole\_pair\_lenght**

This is the distance between the pole pairs in the case of linear motors [mm].

Data type: 32-bit floating point

Changeable: Only when turned on

#### **7.4.28 P-0-0105 Max. temperature**

This is the maximum permissible temperature measured by the encoder on the motor [degree centigrade].

Data type: 32-bit floating point

Changeable: Only when turned on

If a temperature measured by the drive is greater than the value set in this parameter, the drive will stop with the E19 error.

#### **7.4.29 P-0-0106 Line\_count**

This is a constant. Its value is 4096.

Data type: 32-bit integer

Changeable: Only when turned on

#### **7.4.30 P-0-0107 Direction**

This parameter is not used.

#### **7.4.31 P-0-0108 BitNumber**

This is a constant. Its value is 37.

It is the number of the useful bits of the EnDat encoder.

Data type: 32-bit integer

Changeable: Only when turned on

#### **7.4.32 7 4 32 P-0-0109 TurnNumber**

This is a constant. Its value is 4096.

It is the number of the discriminated speeds of the EnDat encoder.

Data type: 32-bit integer

Changeable: Only when turned on

#### **7.4.33 P-0-0110 PositionSet**

This parameter is not used.

#### 7.4.34 P-0-0111 Lin\_Mot\_Offset

This is the parameter for setting the commutating point of a linear motor.

Its value can be set from 0 to 65535 corresponding to setting the angular position from 0° to 360°. See the part 'Setting the linear motor'.

Data type: 32-bit integer

Changeable: When turned on and in the case of downloading a parameter

#### 7.4.35 P-0-0112 Mot\_Pos\_Setup

This parameter is not used.

#### 7.4.36 P-0-0113

This parameter is currently not used. It is reserved for later development.

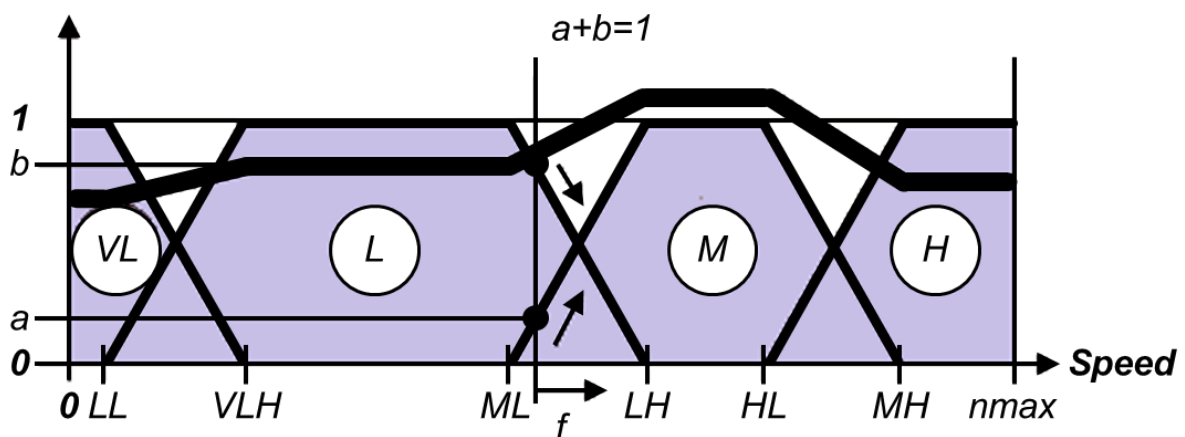
#### 7.4.37 P-0-0118

This parameter is currently not used. It is reserved for later development.

#### 7.4.38 Parameters of the speed control

This is a PID control without interaction and with possibility of setting 4 speed/velocity ranges.

Interpretation of the speed ranges is illustrated in the following figure.



Range of 'very low' speeds: VL function → 0-VLH

Range of 'low' speeds: L function → LL-LH

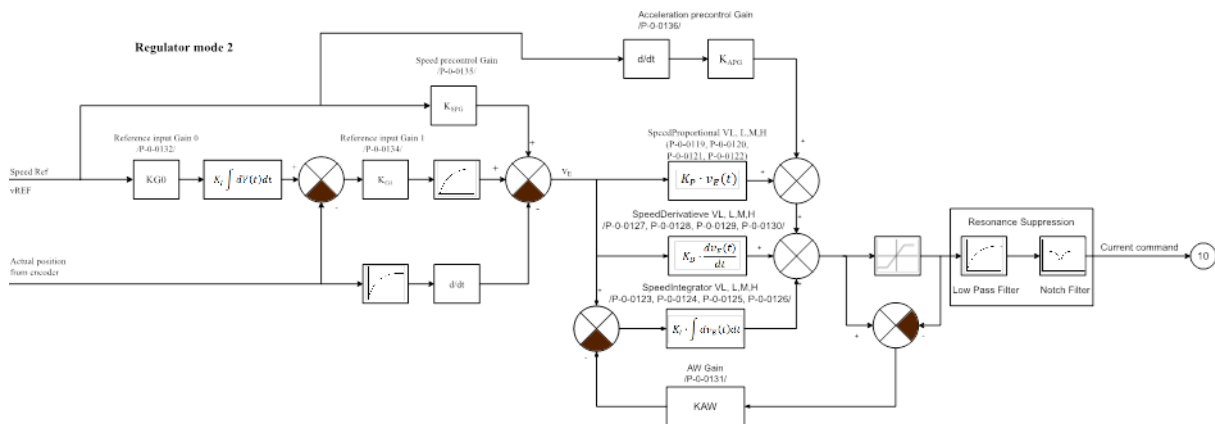
Range of 'medium' speeds: M function → ML-MH

Range of 'high' speeds: H function → HL-Max

Set range borders: These are the speeds specified in the parameter  $n_{max} = \text{Speed\_max}$  (123 Speed\_max). This speed value means the 100%. Taking this into account:

- LL → 1%
- VLH → 5%
- ML → 10%
- LH → 20%
- HL → 40%
- MH → 60%

The following figure illustrates the speed and position control with indication of the parameters.



#### 7.4.38.1 P-0-0119 Speed proportional VL

This is the part of the P member of the speed control valid in the case of 'very low' speed.

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### 7.4.38.2 P-0-0120 Speed proportional L

This is the part of the P member of the speed control valid in the case of 'low' speed.

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### 7.4.38.3 P-0-0121 Speed proportional M

This is the part of the P member of the speed control valid in the case of 'medium' speed.

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.4 P-0-0122 Speed proportional H**

This is the part of the P member of the speed control valid in the case of 'high' speed.

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.5 P-0-0123 Speed integrator VL**

This is the part of the I member of the speed control valid in the case of 'very low' speed.

Unit of measure:  $I_{VL} * 125\mu s$

It works as a multiplication member: Small set value → slow control

Great set value → fast control

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.6 P-0-0124 Speed integrator L**

This is the part of the I member of the speed control valid in the case of 'low' speed.

Unit of measure:  $I_L * 125\mu s$

It works as a multiplication member: Small set value → slow control

Great set value → fast control

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.7 P-0-0125 Speed integrator M**

This is the part of the I member of the speed control valid in the case of 'medium' speed.

Unit of measure:  $I_M * 125\mu s$

It works as a multiplication member: Small set value → slow control

Great set value → fast control

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.8 P-0-0126 Speed integrator H**

This is the part of the I member of the speed control valid in the case of 'high' speed.

Unit of measure:  $I_H * 125\mu s$

It works as a multiplication member: Small set value → slow control

Great set value → fast control

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.9 P-0-0127 Speed differential VL**

This is the part of the D (differentiating) member of the speed control valid in the case of 'very low' speed.

It works as a multiplication member:

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.10 P-0-0128 Speed differential L**

This is the part of the D (differentiating) member of the speed control valid in the case of 'low' speed.

It works as a multiplication member:

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.11 P-0-0129 Speed differential M**

This is the part of the D (differentiating) member of the speed control valid in the case of 'medium' speed.

It works as a multiplication member:

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.12 P-0-0130 Speed differential H**

This is the part of the D (differentiating) member of the speed control valid in the case of 'high' speed.

It works as a multiplication member:

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.13 P-0-0131 AntiWindUp gain**

This is the gain of the anti-saturation control of the speed control.

This control loop prevents the speed control from saturation, i.e. from falling in the nonlinear range.

Recommended set value: 0.05

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.14 P-0-0132 Ref\_in\_Gain\_0**

This is the reference signal gain of the speed control.

It is the parameter by the use of which the speed belonging to the reference signal can be set in the mode of speed control, and, which influences the 'lag', i.e. the gain of the position controlling circuit in the case of an external position control.

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.15 P-0-0135 Ref\_in\_Gain\_1**

This is the secondary reference signal gain of the speed control. It is valid only in the mode Control\_mode =1 or Control\_mode =2.

Basically, its setting is: Ref\_in\_Gain\_1=Ref\_in\_Gain\_0/20

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.16 P-0-0136 Speed precontrol gain**

This is the value of the speed feedforward. This parameter is valid only in the mode Control\_mode =2. Its set value is 0~0.9.

Basically, its set value is 0.5.

Data type: 32-bit floating-point

Changeable: When turned on and in the case of downloading a parameter

#### **7.4.38.17 P-0-0137 Accel\_Precont\_Gain**

This parameter is currently not used. It is reserved for later development.

#### **7.4.38.18 P-0-0138 Tandem\_Speed\_Lim**

This parameter is currently not used. It is reserved for later development.

**7.4.38.19 P-0-0139 Tandem\_Accel\_Lim**

This parameter is currently not used. It is reserved for later development.



## 8 TRAFFICING THE PROCESS DATA

In addition to the asynchronous acyclic and slow mailbox communication used for trafficking larger amount of data, there is a need for a high-speed cyclic communication channel via which the process data can be trafficked. While the mailbox communication is carried out via the SM0 and SM1 Syncmanager channels, the communication can be realized via the SM3 Syncmanager channel in the case of Process Data Input and via the SM2 Syncmanager channel in the case of Process Data Output. The possible message transfer modes are the following.

### 8.1 Freerun

This is the simplest mode of message transfer. Each of the Slaves sends the packets in accordance with its schedule (software timer, with hardware timer interruption) and polls the received messages in accordance also with its schedule. Since the Slaves are not synchronized either with one another or with the Master, considerable dead time and time scatter should be taken into account,

### 8.2 Syncmanager (SM) Synchron

In the case of appropriate configuration, both the SM2 event and SM3 event may cause interruption on the IQR external interruption line. This requires setting the appropriate bits in the ALEventMask register. The SM3 event occurs when the Master read the Input data, while the SM2 event occurs when the Master wrote new Output data. Reading the input data and writing the Output data occur at approximately the same time (the EtherCAT frames are the same). If, in the Slave, there is an interruption cycle faster than the cycle of the EtherCAT frame, the message management can also be carried out by the use of polling, and, in addition, the dead time can also be decreased in this case. (It was the solution in the case of non-EtherCAT drives.)

### 8.3 Distributed Clock (DC) Synchron

The essence of the DC (Distributed Clock) Synchron is that the process data sent cyclically should be trafficked in accordance with a high-precision periodic synchronized clock signal both in the Master and the Slave sides. Each of the Slaves has its own synchronizing signals even with different timing. The Master has no own synchronizing signal so it will synchronize with the messages of one of the Slaves. In the EtherCAT chip there is a high-resolution (1 ns clock signal) 64-bit timer. The Master side coordinates all the 64-bit timers in the EtherCAT chip of each Slave in such a way so that they function in synchronously without signal delay.

### 8.4 Configuring the process data

In the case of the SoE protocol, the Process Data trafficking is based also on the IDN data base. There are fixed-content (standard) packets, but it is possible to change the Input and Output data packets flexibly. If you it is possible to configure the process data, then, within defined frames, it will be possible to select what parameters (IDNs) are included in the cyclic data. For this, the first step is the parameter S-0-0015 Telegram type, by the use of which selection can be made from among the pre-defined process data structures, or, it is possible to select the process data compiled completely by the user. In accordance with the SoE standard, the process data streaming from the control to the drive are named MDT (Master Data Tele-

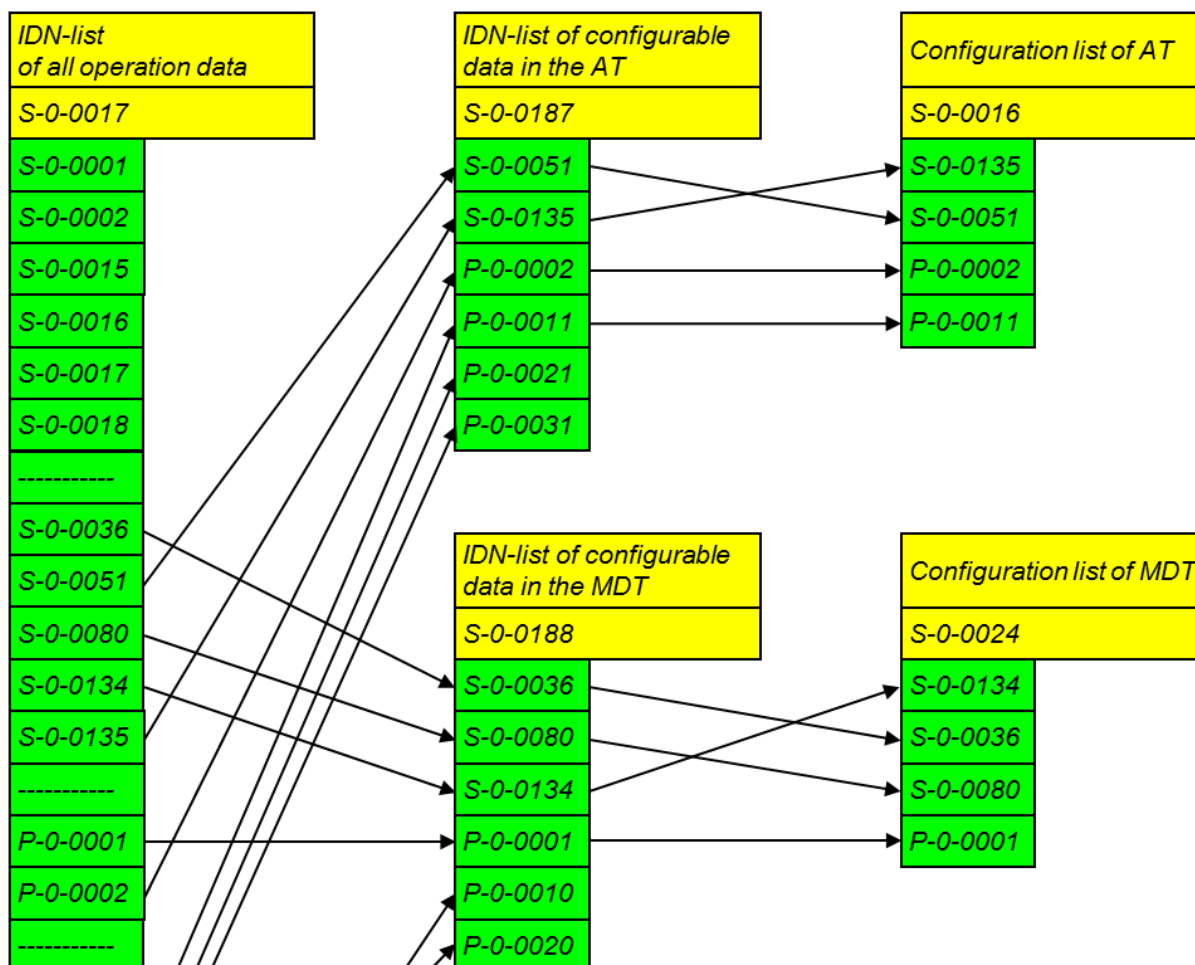
gram) and the process data streaming from the drive to the control are named AT (Acknowledge Telegram). The Table 1 contains the process data structures defined by the standard; certainly, only those can be used that are implemented in the given drive.

**Table 1**

Telegram type	S-0-0015 value	MDT	AT
Standard telegram 0	0	S-0-0134 Master control word	S-0-0135 Drive status word
Standard telegram 1	1	S-0-0134 Master control word S-0-0080 Torque comm. value	S-0-0135 Drive status word
Standard telegram 2	2	S-0-0134 Master control word S-0-0036 Velocity command value	S-0-0135 Drive status S-0-0040 Velocity feedback value 1 word
Standard telegram 3	3	S-0-0134 Master control word S-0-0036 Velocity command value	S-0-0135 Drive status word S-0-0051 Position feedback value 1 (motor feedback)
	11		S-0-0135 Drive status word S-0-0053 Position feedback value 2 (external feedback)
Standard telegram 4	4	S-0-0134 Master control word S-0-0047 Position command value	S-0-0135 Drive status word S-0-0051 Position feedback value 1 (motor feedback)
	12		S-0-0135 Drive status word S-0-0053 Position feedback value 2 (external feedback)
Standard telegram 5	5	S-0-0134 Master control word S-0-0047 Position command value S-0-0036 Velocity command value	S-0-0135 Drive status word S-0-0051 Position feedback value 1 (motor feedback) S-0-0040 Velocity feedback value 1
	13		S-0-0135 Drive status word S-0-0053 Position feedback value 2 (external feedback) S-0-0040 Velocity feedback value 1
Standard telegram 6	6	S-0-0134 Master control word S-0-0036 Velocity comm. value	S-0-0135 Drive status word
Application telegram	7	S-0-0134 Master control word S-0-0024 IDN list's content	S-0-0135 Drive status word S-0-0016 IDN list's content

*\*In the software versions published now, the only 7 telegram code is used; the other ones do not work. The standard SoE process data are not implemented in full and tested yet.*

If the drive connected to the control supports the Application telegram, it will be possible to compile the process data by the user. When the Application telegram is chosen, the MDT process data will be composed of the S-0-0134 Master control word parameter and the parameters contained in the IDN list of the S-0-0024 Configuration list of MDT parameter; however, the AT process data will be composed of the S-0-0135 Drive status word parameter and the parameters contained in the IDN list of the S-0-0016 Configuration list of AT parameter. To compose the IDN lists of the S-0-0024 and S-0-0016 parameters it should be taken into account that these lists should contain, in a maximum quantity specified in the drive's manual, only the parameters which are on the list of the S-0-0188 IDN-list of configurable data in the MDT parameter and the S-0-0187 IDN list of configurable data in the AT parameter. Both lists should be a subset of the list contained in the S-0-0017 IDN-list of all operation data parameter, and, accordingly, they should not have common element. Selection is done in PreOp. Selection results in IDN lists of the S-0-0024 Configuration list of MDT and S-0-0016 Configuration list of AT parameters. **The current change is as follows: the parameter P-0-0201 of NCT version is used instead of the parameter S-0-0134 Master control word, and the parameters P-0-0204 SW and P-0-0205 error word of NCT version are used instead of the parameter S-0-0135 Drive status word.**



In the case of PreOp-SafeOp transition, the slave **device (drive, IO card, etc.)** checks these lists, and then, if everything is in order, it creates the structure arrays elements of which contain address and data length parameters of the IDNs being on the lists. Then, trafficking start in SAFEOP and OP. The Input and Output packets can be modified only in PreOp. For example, after a SAFEOP-OP transition that followed a OP-SAFEOP transition, the Output Process Data packet remains unchanged. If the list is to be supplemented with a new IDN, it is needed to return to PreOp and a new list should be created.

The Input and Output side is always looked at from the Master side. The output-side purpose of the device is to generate a two-dimensional array (address, data length) with array elements from the Input Process Data IDN list (Application Telegram AT), (S-0-0016 parameter) downloaded in the PreOp status at the master side. The Input Process Data trafficking will be carried out on the basis of this. Before generation, it will check the array whether the elements of the list of the S-0-0016 Configuration list of AT parameter are there on the list of the S-0-0017 IDN-list of all operation data parameter and on the list of the S-0-0187 IDN list of configurable data in the AT parameter. If any of the array element of the S-0-0016 parameter are not on the lists of the S-0-0017 and the S-0-0187 parameters, error message (ALSTATUSCODE\_INVALIDINPUTMAPPING 0x0024) will be generated.

Similarly to this, the input-side purpose of the device is to generate a two-dimensional array (address, data length) with array elements from the Output Process Data IDN list (Master Data Telegram MDT, S-0-0024 parameter) downloaded in the PreOp status at the master side. The Output Process Data trafficking will be carried out on the basis of this. Before generation, it will check the array whether the elements of the list of the S-0-0024 Configuration list of MDT parameter are there on the list of the S-0-0017 IDN-list of all operation data parameter and on the list of the S-0-0188 IDN-list of configurable data in the MDT parameter. If any of the array element of the S-0-0024 parameter are not on the lists of the S-0-0017 and the S-0-0188 parameters, error message (ALSTATUSCODE\_INVALIDOUTPUTMAPPING 0x0025) will be generated.

The S-0-0185 parameter specifies the maximum permissible size of the configurable data on the list of the S-0-0016 Configuration list of AT parameter. Currently it is 128 bytes.

The S-0-0186 parameter specifies the maximum permissible size of the configurable data on the list of the S-0-0024 Configuration list of MDT parameter. Currently it is also 128 bytes.

## 8.5 Configuration errors and error messages

- The S-0-0015 Telegram type parameter is not set (currently only the 0x7 value is used).

In addition to the telegram lists and types, also the synchronization management should be set.

### 8.5.1 Incorrect input configuration (alstatuscode\_invalidinputmapping 0x0024)

- The list of the S-0-0016 parameter is empty; its length is 0 byte.
- The list of the S--0-0017 parameter does not contain the added IDN.
- The list of the S--0-00187 parameter does not contain the added IDN.
- A command-type item is added to the list (PC).
- The data length is 1 byte or a 1-byte list (there should be data lengths that are divisible by 2 bytes, 16 bits).
- In the SAFEOP status, data of different quantity is waited by the control.

### **8.5.2 Incorrect output configuration (alstatuscode\_invalidoutputmapping 0x0025)**

- The list of the S-0-0024 parameter is empty; its length is 0 byte.
- The list of the S--0-0017 parameter does not contain the added IDN.
- The list of the S--0-00188 parameter does not contain the added IDN.
- A command-type item is added to the list (PC).
- The data length is 1 byte or a 1-byte list (there should be data lengths that are divisible by 2 bytes, 16 bits).
- In the OP status, data of different quantity is sent by the control.

### **8.5.3 FMMU (0x600)**

The EtherCAT stack of the drive already knows the DC synchron mode, therefore it will also carry out checks there. The Output length of the process data should be seen in the FMMU0 Length register (0x604) and their Input length should be seen in the FMMU1 Length register (0x614).

### **8.5.4 Synchmanager (0x800)**

The maximum length, i.e. the 128 bytes should be seen and set in the SM0 Length register (0x802) and in the SM1 Length register (0x80A). The Output length should be set in the SM2 Length register (0x812) and the Input length should be set in the SM3 Length register (0x81A).

## 9 PROCESS DATA

Basically, in the software versions of the compact drives above v x.320, possibility of process data collection already exists. However, to provide assistance, the XML description of the NCT devices has a default set. In the drive, this default setting is the 7th one, the Application Telegram, which provides this possibility.

The telegram setting 7 differs a little bit from the standard one because it does not involve the S134 and S135 (command and status word) standard process data since the NCT drive has own command word (P201) and status word (P204), which length is 32 bits compared to the standard 16-bit words. Therefore it is capable of managing and representing more information. Because of it, however, the 7-type telegram sends the data only with selected list (S24 and S16) and with the length calculated from the list, and it differs from the standard implementation. During configuration it should be taken into account. (As far as the collectable list is concerned, also the TwinCAT provides possibility in order that it works without S134 and S135.)

### 9.1 Standard process data

The standard telegrams should contain only standard SoE process data. It keeps the possibilities within limits. However, in order that the NCT drive will be able to work together with other device too, the standard manageability was also created. The applied telegram settings depend on the setting of the parameter S-0-0015 Telegram type. And, when setting is 7, any of them can be collected, taking the above modification into account.

#### 9.1.1 MDT: Master Data Telegram

NC to Drive	S-0-0134	MCW: Master control word	16-bit data
	S-0-0036	VCV: Velocity command value	32-bit signed integer
	S-0-0037	AVCV: Additive velocity command value	32-bit signed integer
	S-0-0047	PCV: Position command value	64-bit absolute integer
	S-0-0048	APCV: Additive position command value	32-bit signed integer
	S-0-0080	TCV: Torque command value	16-bit signed integer
	S-0-0081	ATCV: Additive torque command value	16-bit signed integer
	S-0-0082	PTLV: Positive torque limit value	16-bit signed integer
	S-0-0083	NTLV: Negative torque limit value	16-bit signed integer

##### 9.1.1.1 S-0-0134 Master control word

The standard control word from NC control.

Data type: 2-byte binary data

Unit of measure: Ø

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: MDT  
Maximum value: Ø  
Minimum value: Ø  
Protection: Ø  
Decimal point: 0 (1)

<b>Bit</b>	15	14	13	12	11	10	9	8
<b>Name</b>	DON	DEN	DH		EOM	SYNC	OM	

<b>Bit</b>	7	6	5	4	3	2	1	0
<b>Name</b>	RTCB2	RTCB1						

Bit	Name	Description
0-5		Not used
6	RTCB1	The control bit that is read per the control cycle time and is active only after configuration.
7	RTCB2	The control bit that is read per the control cycle time and is active only after configuration.
8-9	OM	Operational mode of drive control.
10	SYNC	Synchronization
11	EOM	Operational mode of drive control.
12		Not used
13	DH	Immediate stopping the drive.
14	DEN	Enabling the drive.
15	DON	Turning the drive on.

### 9.1.1.2 S-0-0036 Velocity command value

This is the drive velocity reference signal.

Data type: 4-byte signed integer

Unit of measure: increment/ms

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: MDT

Maximum value: 2097151

Minimum value: -2097152

Protection: Ø

Decimal point: 0 (1)

### 9.1.1.3 S-0-0037 Additive velocity command value

This is the offset value of the velocity reference signal; it is added to the reference signal.

Data type: 4-byte signed integer

Unit of measure: increment/ms

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: MDT

Maximum value: 2097151

Minimum value: -2097152

Protection: Ø

Decimal point: 0 (1)

### 9.1.1.4 S-0-0047 Position command value

This is the position control reference signal.

Data type: 4-byte signed integer

Unit of measure: increment

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: MDT

Maximum value: 232

Minimum value: -231

Protection: Ø

Decimal point: 0 (1)

### 9.1.1.5 S-0-0048 Additive position command value

This is the offset value of the position control reference signal; it is added to the reference signal.

Data type: 4-byte signed integer

Unit of measure: increment

Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: MDT



Maximum value: 232  
Minimum value: -231  
Protection: Ø  
Decimal point: 0 (1)

#### **9.1.1.6 S-0-0080 Torque command value**

This is the torque control reference signal expressed in percentage of the rated torque.

Data type: 2-byte signed integer  
Unit of measure: percentage [%]  
Changeable: PreOp, SafeOp, Op  
Values:  
Cyclic process data: MDT  
Maximum value: 3276.7  
Minimum value: -3276.8  
Protection: Ø  
Decimal point: 1 (0.1)

#### **9.1.1.7 S-0-0081 Additive torque command value**

This is the offset value of the torque control reference signal; it is added to the reference signal.

Data type: 2-byte signed integer  
Unit of measure: percentage [%]  
Changeable: PreOp, SafeOp, Op  
Values:  
Cyclic process data: MDT  
Maximum value: 3276.7  
Minimum value: -3276.8  
Protection: Ø  
Decimal point: 1 (0.1)

#### **9.1.1.8 S-0-0082 Positive torque limit value**

This is the positive-direction value of the torque limit.

Data type: 2-byte signed integer  
Unit of measure: percentage [%]  
Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: MDT  
Maximum value: 3276.7  
Minimum value: -3276.8  
Protection: Ø  
Decimal point: 1 (0.1)

### 9.1.1.9 S-0-0083 Negative torque limit value

This is the negative-direction value of the torque limit.

Data type: 2-byte signed integer  
Unit of measure: percentage [%]  
Changeable: PreOp, SafeOp, Op

Values:

Cyclic process data: MDT  
Maximum value: 3276.7  
Minimum value: -3276.8  
Protection: Ø  
Decimal point: 1 (0.1)

### 9.1.2 AT: Application Telegram

Drive to NC	S-0-0135	SW: Drive status word	16-bit data
	S-0-0040	VF1: Velocity feedback value 1	32-bit data
	S-0-0051	PF1: Position feedback value 1 (motor feedback)	32-bit data
	S-0-0053	PF2: Position feedback value 2 (external feedback)	32-bit data
	S-0-0084	TF: Torque feedback value	16-bit data
	S-0-0347	VE: Velocity error	32-bit data
	S-0-0189	FD: Following distance	32-bit data
	S-0-0380	DCV: DC-BUS voltage	16-bit data
	S-0-0383	MT: Motor temperature	16-bit data
	S-0-0384	AT: Amplifier temperature	16-bit data
	S-0-0011	C1D: Class 1 diagnostic (errors)	16-bit data
	S-0-0029	MDT error counter	16-bit data
	S-0-0390	Diagnostic number	32-bit data

### 9.1.2.1 S-0-0135 Drive status word

This is the standard status word from the drive side.

Data type: 2-byte binary data

Unit of measure: Ø

Changeable: Ø

Values:

Cyclic process data: AT

Maximum value: Ø

Minimum value: Ø

Protection: Ø

Decimal point: 0 (1)

<b>Bit</b>	15	14	13	12	11	10	9	8
<b>Name</b>	RDY	C1D	C2D	C3D	OMA			

<b>Bit</b>	7	6	5	4	3	2	1	0
<b>Name</b>	RTSB2	RTSB1		HALT	CP			

Bit	Name	Description
0-2		Not used
3	CP	Indication of command execution is in progress
4	HALT	Operation of the drive stopped, it does not control, some kind of serious error occurred.
5		Not used
6	RTSB1	Status flag bit that is written in control cycle and is active only after configuration.
7	RTSB2	Status flag bit that is written in control cycle and is active only after configuration.
8-10	OMA	The acknowledgment bits of the selector of the operational mode asked from the control word.
11	C3D	There is data in the C3D status indicating word.

Bit	Name	Description
12	C2D	There is message in the C2D warning word. There are supplementary warnings in the S-0-0181 word.
13	C1D	In the C1D error word there is error message because of which the operation of the drive stopped. There are supplementary error messages in the S-0-0129 error word.
14-15	RDY	Indication of the drive operational readiness.

### 9.1.2.2 S-0-0040 Velocity feedback value 1

This is the current velocity/speed value.

Data type: 4-byte signed integer

Unit of measure: [ $\text{min}^{-1}$ ] or [ $\mu\text{m}\cdot\text{min}^{-1}$ ]

Changeable:  $\emptyset$

Values:

Cyclic process data: AT

Maximum value: 231

Minimum value: -231

Protection:  $\emptyset$

Decimal point: 2 (0.01)

### 9.1.2.3 S-0-0051 Position feedback value 1 (motor feedback)

This parameter contains the current position (Motor feedback).

Data type: 4-byte signed integer

Unit of measure: increment

Changeable:  $\emptyset$

Values:

Cyclic process data: AT

Maximum value: 231

Minimum value: -231

Protection:  $\emptyset$

Decimal point: 0 (1)

### 9.1.2.4 S-0-0053 Position feedback value 2 (external feedback)

This parameter contains the current position (External feedback) in the case of a secondary measuring system.

Data type: 4-byte signed integer

Unit of measure: increment  
 Changeable: Ø  
 Values:  
 Cyclic process data: AT  
 Maximum value: 231  
 Minimum value: -231  
 Protection: Ø  
 Decimal point: 0 (1)

#### 9.1.2.5 S-0-0084 Torque feedback value

This is the current torque-generating current relative to the rated torque-generating current of the motor, expressed in percentage.

Data type: 2-byte signed integer  
 Unit of measure: percentage [%]  
 Changeable: Ø  
 Values:  
 Cyclic process data: AT  
 Maximum value: 3276.7  
 Minimum value: -3276.8  
 Protection: Ø  
 Decimal point: 1 (0.1)

#### 9.1.2.6 S-0-0347 Velocity error

This parameter contains the difference between the set and current values of the velocity.

Data type: 4-byte signed integer  
 Unit of measure: increment  
 Changeable: Ø  
 Values:  
 Cyclic process data: AT  
 Maximum value: 231  
 Minimum value: -231  
 Protection: Ø  
 Decimal point: 0 (1)

### 9.1.2.7 S-0-0189 Following distance

This is the position follower error expressed in increment.

Data type: 4-byte signed integer

Unit of measure: increment

Changeable: Ø

Values:

Cyclic process data: AT

Maximum value: 231

Minimum value: -231

Protection: Ø

Decimal point: 0 (1)

### 9.1.2.8 S-0-0380 DC bus voltage

This is the measured DC bus voltage.

Data type: 2-byte signed integer

Unit of measure: voltage [V]

Changeable: Ø

Values:

Cyclic process data: AT

Maximum value: 1000

Minimum value: -1000

Protection: Ø

Decimal point: 1 (0.1)

### 9.1.2.9 S-0-0383 Motor temperature

This is the motor temperature expressed in degree centigrade.

Data type: 2-byte signed integer

Unit of measure: degree centigrade [°C]

Changeable: Ø

Values:

Cyclic process data: AT

Maximum value: Ø

Minimum value: Ø

Protection: Ø  
Decimal point: 1 (0.1)

### 9.1.2.10 S-0-0384 Amplifier temperature

This is the drive heat sink expressed in degree centigrade.

Data type: 2-byte signed integer  
Unit of measure: degree centigrade [°C]  
Changeable: Ø  
Values:  
Cyclic process data: AT  
Maximum value: Ø  
Minimum value: Ø  
Protection: Ø  
Decimal point: 2 (0.01)

### 9.1.2.11 S-0-0011 Class 1 diagnostic (C1D)

This is the register of the error bits that generate drive stop error.

Data type: 2-byte binary data  
Unit of measure: Ø  
Changeable: Ø  
Values:  
Cyclic process data: AT  
Maximum value: Ø  
Minimum value: Ø  
Protection: Ø  
Decimal point: 0 (1)

<b>Bit</b>	15	14	13	12	11	10	9	8
<b>Name</b>	MSE		OT	COM	EPD	PSP	UV	OV

<b>Bit</b>	7	6	5	4	3	2	1	0
<b>Name</b>	OC	MCE	FBE	CVE	CE	MOTE	AOT	OE

Bit	Name	Description
0	OE	Overload indication
1	AOT	The servo amplifier overheated.
2	MOTE	The servo motor overheated.
3	CE	The active cooling failed.
4	CVE	The control voltage is incorrect.
5	FBE	The measuring system feedback is incorrect; encoder error
6	MCE	The motor commutation signals are incorrect, or, the motor commutates with error.
7	OC	Overcurrent error on the drive output.
8	OV	Overvoltage error
9	UV	The input DC bus voltage is too low.
10	PSP	It indicates the absence of one of the input voltage phases in the case of the AC high-current drive without main power supply unit.
11	EPD	Excessive position deviation
12	COM	Communication error
13	OT	The overtravel limit is exceeded.
15	MSE	Manufacturer specific error

#### 9.1.2.12 S-0-0029 MDT error counter

At each Sync1 cycle, the drive checks whether new valid MDT data are received or not. If not, it will increase the value of this counter by one. The error can possibly be caused by late ECAT telegram or by the incorrectly-transferred ECAT telegram with invalid checksum.

Data type: 2-byte unsigned integer

Unit of measure: Ø

Changeable: Ø

Values:

Cyclic process data: AT

Maximum value: Ø

Minimum value: Ø

Protection: Ø

Decimal point: 0 (1)



### 9.1.2.13 S-0-0390 Diagnostic number

This parameter shows the internal error signals of the drive.

Data type: 4-byte hexadecimal data

Unit of measure: Ø

Changeable: Ø

Values:

Cyclic process data: AT

Maximum value: Ø

Minimum value: Ø

Protection: Ø

Decimal point: 0 (1)

## 9.2 NCT process data

### 9.2.1 Default XML setting telegram

#### 9.2.1.1 MDT: Master Data Telegram

NC to Drive	P-0-0200	SSP: Speed Set Point	32-bit data
	P-0-0201	SCW: Servo Control Word	32-bit data

#### 9.2.1.1.1 SSP: Speed Set Value

This is velocity reference signal to be sent cyclically from the NC control.

Data type: Signed decimal integer

Data length in bit 32

Decimal point: 0

Minimum: -2147483648

Maximum: 2147483647

Unit:

Changeable: Op

To be sent cyclically: MDT

### 9.2.1.1.2 SCW: Servo Control Word

This is control word to be sent cyclically from the NC control.

Data type: Hexadecimal integer

Data length in bit 32

Decimal point: 0

Minimum: 0x00000000

Maximum: 0xFFFFFFFF

Unit:

Changeable: Op

To be sent cyclically: MDT

<b>Bit</b>	31	30	29	28	27	26	25	24
<b>Name</b>	Not used							

<b>Bit</b>	23	22	21	20	19	18	17	16
<b>Name</b>	Not used				TLIM 5.4xx			

<b>Bit</b>	15	14	13	12	11	10	9	8
<b>Name</b>	Not used			EPTN	ZPR	$\overline{\text{BRK}}$ >5.4xx	EC	SIL

<b>Bit</b>	7	6	5	4	3	2	1	0
<b>Name</b>	OPM >5.4xx		PTN		PL	$\overline{\text{ESF}}$ >5.4xx	SE	

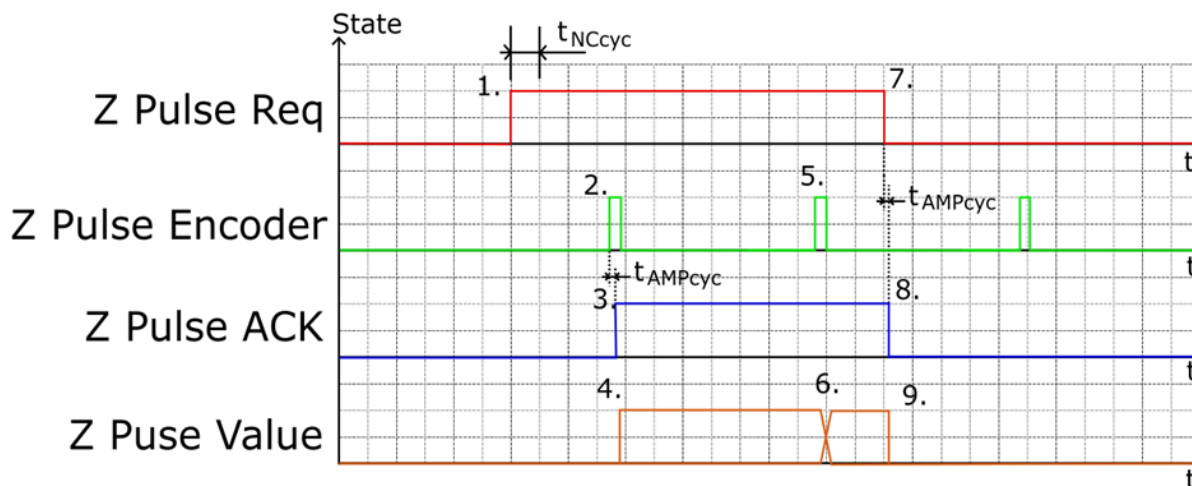
Bit	Name	Description
0-1	SE	Enabling the servo drive: It happens for the 1→0 transition of the bit 0 and for the 0→1 simultaneous transition of the bit 1 (i.e. in the course of changing from 0x1 to 0x2). In all other cases the drive is disabled.
2	$\overline{\text{ESF}}$	Emergency Stop Function  The control bit is for safe shutdown of the drive. Basically, it can work in accordance with 3 settings: STO, SS1 and SS2. The drive operates normally until the bit is set to 1. When the value of the bit changes to 0, it performs one of the configured security shutdown procedures. As long as its value remains 0, the drive cannot be re-enabled.  <i>In the case of the 1.xxx and the 2.xxx software, earlier this bit executed only the SS2 function which is now executed by the BRK bit.</i>
3	PL	Request for latching the position. The servo axis latches the position until the value of this bit is 1.
4-5	PTN	The number of the parameter table by the use of which the drive will operate. The parameter table will only change when the drive is disabled.
6-7	OPM	Selection of the control mode of the drive. The parameter can be changed even in the operating status, its efficiency will be perceivable during the next drive control cycle time.  <i>In software versions older than 5.xxx this function did not work.</i>
8	SIL	Freezing the speed control integrator can be requested if its value is 1.
9	EC	Error cancellation; its effect is identical with the effect of the S-0-0099 error cancel command.
10	$\overline{\text{BRK}}$	Request for braked status, it is a negated bit. If its value is 0, the drive will hold the motor on the 0 speed reference signal; if its value is 1, the drive will receive the SSP reference signal from the control.  <i>In software versions older than 5.xxx this function did not work.</i>
11	ZPR	Request for the position related to the zero pulse when an incremental encoder is used. It is not effective in the case of absolute encoders. There will be a position value for the arrival of a zero pulse as long as the value of the bit is 1. More details can be found in the next chapter.
12	EPTN	Selection of the extra parameter tables (tables from the table 4 to the table 7).
16	TLIM	Request for torque limit in the speed control mode. The torque limit is the value set in the value of the S-n-0092, S-0-0082 and S-0-0083 parameters.  <i>In software versions older than 5.xxx this function did not work.</i>

### ZPR – Zero Pulse Request

This control bit starts searching for zero pulse of the incremental encoder. When a zero pulse is found, it is indicated by the measuring system of the drive through the ZPA (Zero Pulse Acknowledge) flag bit. At the same time, it also indicates that the position (or angle position)

of the zero pulse in the POSW2 and POSW3 words of the ActPos is already available and can be read out. When each additional zero pulse is found, the current position of the zero pulse is automatically entered into the POSW2 and POSW3 words of ActPos until the ZPR bit is cleared by the control.

The process is illustrated in the figure below.



From the NC, with setting the ZPR=1 bit, the drive starts searching for zero pulse.

1. The zero pulse is received from the measuring system.
2. The drive, with its own cycle time later, indicates the hit using the value Z Pulse ACK=1.
3. At this moment, the position of the zero pulse can be found in the words POSW2 and POSW3.
4. Another zero pulse was received.
5. The position of the zero pulse is updated.
6. With setting the ZPR=0 bit, the drive stops searching for zero pulse.
7. The drive, with its own cycle time later, clears the ZPA bit.
8. The values of POSW2 and POSW3 words are also reset to zero.

### 9.2.1.2 AT: Application Telegram

Drive to NC	P-0-0203	AP: Actual Position	64 bits data
	P-0-0204	SSW: Servo Status Word	32 bits data
	P-0-0205	SEW: Servo Error Word	32 bits data
	P-0-0206	MC: Message Code	16 bits data
	P-0-0207	MD: Message Data	32 bits float data
	P-0-0213	TSR: Time Stamp Reference	16 bits data

### 9.2.1.2.1 SSW: Servo Status Word

This is the status word of the servo drive which is sent cyclically.

Data type: Hexadecimal integer

Data length in bit 32

Decimal point: 0

Minimum: 0x00000000

Maximum: 0xFFFFFFFF

Unit:

Changeable: Not

To be sent cyclically: AT

<b>Bit</b>	31	30	29	28	27	26	25	24
<b>Name</b>	Not used					PNCE	TCUC	PCR

<b>Bit</b>	23	22	21	20	19	18	17	16
<b>Name</b>	Not used		Tq>L	RTSO	AHE	ATW	TEA	EBL

<b>Bit</b>	15	14	13	12	11	10	9	8
<b>Name</b>	SILA	ESFA	TSR	EPTN	MTW	NENC	PTN	

<b>Bit</b>	7	6	5	4	3	2	1	0
<b>Name</b>	BRK	NENs	NEZ	ECA	ZPA	INCR	SRDY	SES

Bit	Name	Description
0	SES	The servo drive is enabled; the high voltage is applied to the motor if the value of the bit is 1.
1	SRDY	The servo drive is ready to operate. Existence of the indication depends on the value of the parameter P-0-0006 Drive ready mode. The servo drive is ready to operate if the value of the bit is 1.
2	INCR	If the value of the bit is 0, the drive works together with an encoder providing absolute position and sends the position value towards the NC through 64 bits, or there is no encoder on the motor. If the value of the bit is 1, the drive-motor works together with an incremental TTL or SinCos encoder, and the position value sent towards the NC will be represented on 32 bits.
3	ZPA	Its value is 1 if, in the control word on the ZPR bit, zero pulse position was requested and the position value was received; otherwise its value is 0.

Bit	Name	Description
4	ECA	Indication of the completion of error cancellation. If, in the control word on the EC bit, error cancellation was requested by the control, and the error was cleared, its value will change to 1.
5	NEZ	If the measured speed of the motor is 0 rpm, the value of the bit is 1. The size of the speed window can be adjusted by the parameter P-0-0007 Motor stay window. <i>In software versions older than 5.xxx this function did not work.</i>
6	NENs	If the measured speed of the motor is equal to the requested speed value, the value of the bit is 1. The size of the speed window can be adjusted by the parameter P-0-0008 Motor rotate window. <i>In software versions older than 5.xxx this function did not work.</i>
7	BRK	The motor is in the braked state.
8-9	PTN	It is the number of that parameter table by the use of which the drive currently controls.
10	NENC	There is no rotary encoder, the drive does not measure the speed of the motor.
11	MTW	It is the indication of the motor overheat.
12	EPTN	Selection of the extra parameter tables (tables from the table 4 to the table 7).
13	TSR	It indicates that time stamp is ready.
14	ESFA	It indicates that the emergency stop is in progress. <i>In software versions older than 5.xxx this function did not work.</i>
15	SILA	It indicates that the speed control integrator is frozen.
16	EBL	In the case of a battery-fed encoder, it indicates that the battery voltage is low. In the case of such an indication, after turn-off, the encoders providing absolute position may lose the position value or it may change. <i>In software versions older than 5.xxx this function did not work.</i>
17	TEA	The IGBT transistors of the drive are in enabled state, they are able to generate PWM signals for the motor output.
18	ATW	It is the indication of the drive overheat.
19	AHE	The cooling unit of the drive failed. Either the fan is not able to rotate or the temperature sensor is unserviceable.
20	RTSO	The servo drive can be switched on, high voltage can be applied to it (Ready To Switch On). <i>In software versions older than 5.xxx this function did not work.</i>
21	Tq>L	It is the case when the current torque of the motor is greater than the S-n-0092, S-0-0082 and S-0-0083 torque limit values. <i>In software versions older than 5.xxx this function did not work.</i>

Bit	Name	Description
22		
23		
24	PCR	It indicates that the command execution is in progress. <i>In software versions older than 5.xxx this function did not work.</i>
25	TCUC	It indicates that changing the parameter table is in progress. While the table is changing, its value is 1, and when the operation is completed, it returns to the default value of 0. <i>In software versions older than 5.xxx this function did not work.</i>
26	PNCE	A parameter was modified in the enabled status of the drive, i.e. when it drives the motor or controls, but changing the value of that parameter is allowed only in the disabled status. <i>In software versions older than 5.xxx this function did not work.</i>

#### 9.2.1.2.1.1 SES: Servo Enable Status

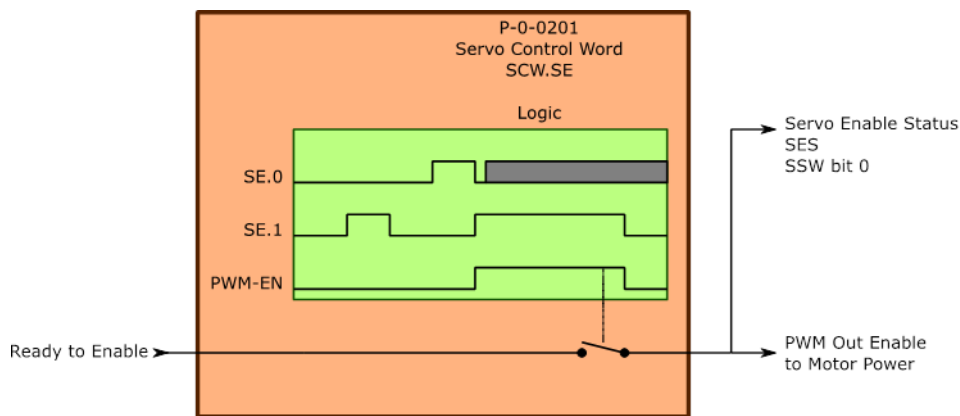


Figure 22 Servo Enable PWM Output

#### 9.2.1.2.1.2 SRDY: Servo Ready to Operate

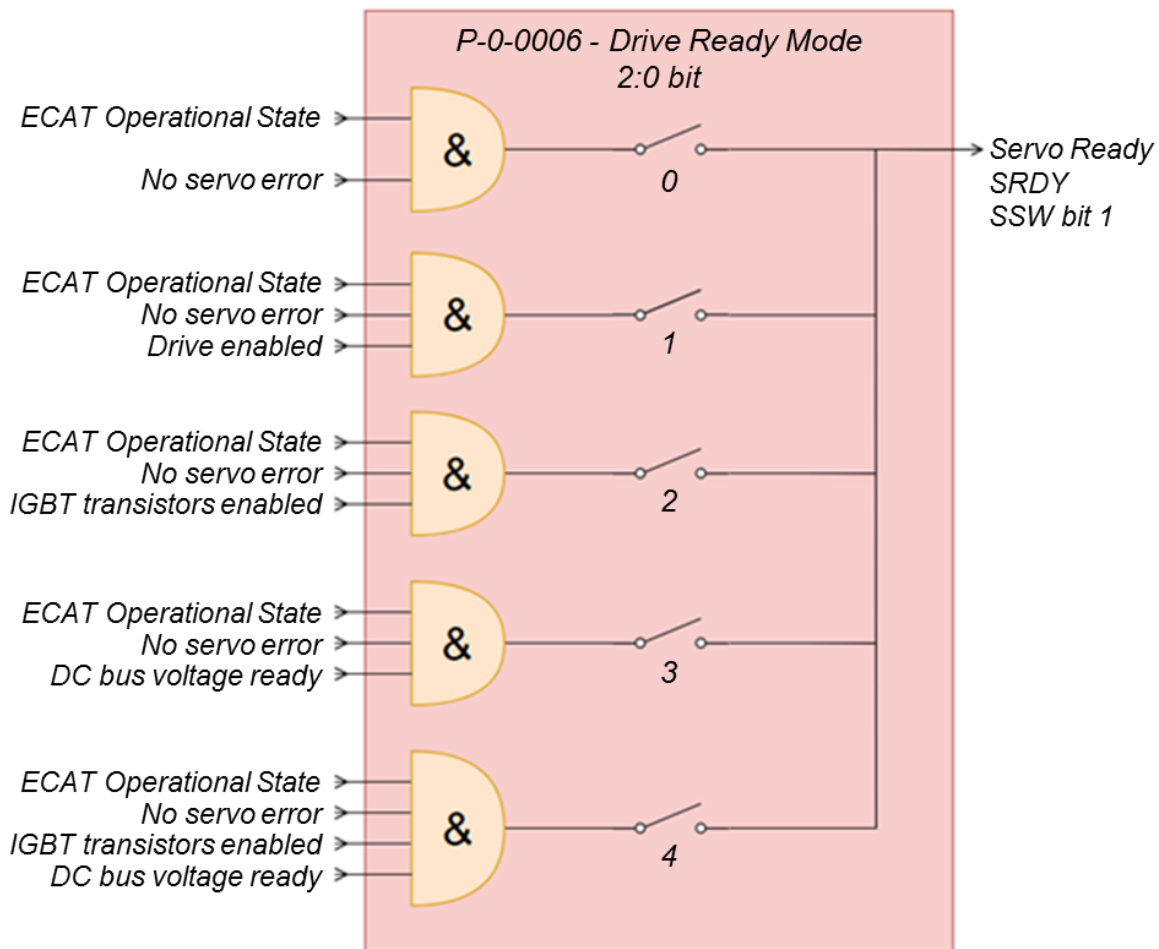
The drive can be enabled on the basis of several predefined conditions. The condition can be selected by the use of the lower 3 bits of the parameter P-0-0006 Drive Ready Mode.

#### Drive Ready Mode

Bit	7	6	5	4	3	2	1	0
Name				EMGRLY		RDY2	RDY1	RDY0

Bit	Name	Description
0~2	RDY	Selection of the condition Ready to Operate.
3		Reserved
4	EMGRLY	Selection of the operating mode of the emergency relay (see later)
5~7		Reserved

The conditions assigned to the selected bits are illustrated in the figure below.



### 9.2.1.2.1.3 Managing the emergency state

If the drive is not able to provide controlled operation of the motor driven by it, it will change over to the emergency mode, and, depending on cause and seriousness of the error, it will stop the motor or it will leave the motor coast free to run.

#### The errors causing actuation of the emergency module

- Motor commutation error (in the case of incremental encoder)
- The measured instantaneous peak current is too high
- The measured DC bus voltage is too high

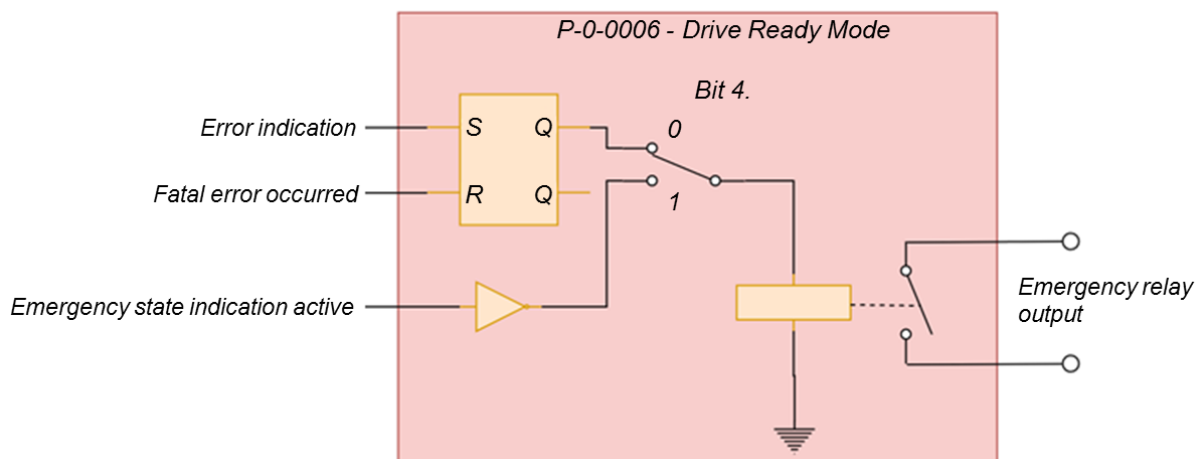


- Overcurrent error indicated by the IGBT transistor protection
- Serious error, it is necessary to stop immediately by the use of emergency stop, the transistors do not work
- Error is indicated by the encoder (EnDat rotary or linear encoder, incremental TTL and SinCos encoder)
- The speed of the motor exceeds the maximum permissible speed

In the case of changing over to the emergency mode, the drive indicates the error to the NC by setting the appropriate bits of the Servo Error Word, and, in addition, it also operates a relay controlling an emergency module. The purpose of this module is to brake the motor rotating uncontrolled in the event of a fatal error.

The contact of the relay is normally-open, and it is kept pulled (closed) by the drive during proper operation. The condition of contact break can be set by the use of the bit 4 of the parameter Drive Ready Mode mentioned in the previous chapter. If the value of the bit is 0, the relay will be in the mode operating the emergency module; it will break in the event of a fatal error. If the value of the bit is 1, the output will give an emergency state signal, therefore the relay, in spite of the serious error, will break even in the case of requesting emergency state from the NC.

Its operation can be seen in the following figure.



#### 9.2.1.2.2 SEW: Servo Error Word

It is the servo drive's word about error state sent cyclically.

Data type: Hexadecimal integer

Data length in bit: 32

Decimal point: 0

Minimum: 0x00000000

Maximum: 0xFFFFFFFF

Unit:

Changeable: Not

To be sent cyclically: AT

<b>Bit</b>	31	30	29	28	27	26	25	24
<b>Name</b>	TRENE	AOTE	PHBE	PHAE	EBE	ENE	ECTDME	CDIFE

<b>Bit</b>	23	22	21	20	19	18	17	16
<b>Name</b>	OSPE		SFAE	MOLE	FOLE		PTCSE	PDPINT

<b>Bit</b>	15	14	13	12	11	10	9	8
<b>Name</b>	ECTRTE			ELTE				HALE

<b>Bit</b>	7	6	5	4	3	2	1	0
<b>Name</b>	COFE	CURE	BVE	REFE	CFGE	MOTE	ENCE	SERR

<b>Bit</b>	<b>Name</b>	<b>Description</b>
0	SERR	Servo Error There is an error status in the servo drive if the value of the bit is 1.
1	ENCE	Encoder Error There is some kind of an encoder error if the value of the bit is 1. In the case of such error message, the value in the P-0-0113 parameter should be investigated.
2	MOTE	Motor Over Temperature Error Heat protection error based on measuring the motor temperature (> 90 °C)
3	CFGE	Config Error Incorrect parameterization, setting, the value of some parameter or the value calculated from parameters is out of the range; the motor or the drive is not able to operate with such setting.
4	REFE	Zero pulse error in the case of an incremental encoder: the incremental number between two zero pulse is incorrect or the leading and trailing edges of the C signal are missed or they are received too early.
5	BVE	Bus Voltage Error
6	CURE	Current Error
7	COFE	Current Offset Error
8	HALE	HALL Error
9~11		Reserved

Bit	Name	Description
12	ELTE	Encoder Low Temperature Error Low temperature error based on measuring the EnDat temperature ( $\leq 5\text{ }^{\circ}\text{C}$ )
13~14		Reserved
15	ECTRTE	ECAT RunTime Error
16	PDPINT	PDPINT Error
17	PTCSE	Parameter Table Checksum Error
18		Reserved
19	FOLE	Follower Error
20	MOLE	Motor Overload Error Motor overload error based on 12T heat model
21	SFAE	Serial Flash Access Error
22		Reserved
23	OSPE	OverSpeed Error
24	CDIFE	Current Difference Error In current-free state, the symmetry of the currents of the A and B phases is greater than the permissible symmetry.
25	ECTDME	ECAT Disable Mode Error Disabled mode change occurred on the EtherCAT interface.
26	ENE	Enable Error Enabling the drive was taken away at $(1.3xx)N > 20\text{ rpm}$ .
27	EBE	Encoder Battery Error In the case of a battery-fed encoder, the encoder indicates battery error, the value of absolute position is lost from the encoder, and the reference point of the measuring system should be set again.
28	PHAE	Phase A Error In the course of taking the reference, there is error in the signals of the A phase; the signal level is too low.
29	PHBE	Phase B Error In the course of taking the reference, there is error in the signals of the B phase; the signal level is too low.
30	AOTE	Amplifier Over Temperature Error The cooling rib of the drive is overheated.

Bit	Name	Description
31	TRENE	Transistor Enable Error When drive is enabled, enabling the IGBT transistor is gone or even is not received.

### 9.2.1.2.3 AP: Actual Position

The current position value measured by the measuring system.

Data type:	Decimal integer
Data length in bit	64
Decimal point:	0
Minimum:	0x0000000000000000
Maximum:	0xFFFFFFFFFFFFFFFF
Unit:	
Changeable:	Not
To be sent cyclically:	AT

### Bitmap

Bit	63	...	48	47	...	32	31	...	16	15	...	0
Words	POSW3			POSW2			POSW1			POSW0		

Depending on the encoder providing information, the content of the parameter should be interpreted in different ways.

### Allocation in the case of an absolute encoder

In the case of an absolute encoder, the content of a parameter is identical with the position value read from the encoder. Depending on the resolution of the measuring system, the bit length of this data may be different; the value of the upper bits not used is 0.

Word	Value
POSW3	POS_63÷POS_48
POSW2	POS_47÷POS_32
POSW1	POS_31÷POS_16
POSW0	POS_15÷POS_0

### Allocation in the case of an incremental encoder

In this case, the parameter is divided in two 32-bit parts. The two lower words contain the current position, while the two upper words contain – in the case of zero pulse search – the position of the zero pulse received last. If there is no zero pulse search, the 32 upper bits will take the value 0.

Word	Value
POSW3	NULLPOS_31÷ NULLPOS _16
POSW2	NULLPOS _15÷ NULLPOS _0
POSW1	POS_31÷POS_16
POSW0	POS_15÷POS_0

### Information bit about content of the register

It is the bit 2 of the abovementioned SSW status word which gives information about the representation mode of the information received. If the value of the bit is 0, the drive works together with an encoder providing absolute position, the position value is sent on 64 bits towards the NC, or, there is no encoder on the motor. If the value of the bit is 1, the drive-motor works together with an incremental TTL or SinCos encoder, and the position value sent towards the NC will be represented on 32 bits.

#### 9.2.1.2.4 MC: Message Code

This is the code relating to the content of the Message Data.

Data type: Decimal integer

Data length in bit 32

Decimal point: 0

Minimum: 0x00000000

Maximum: 0xFFFFFFFF

Unit:

Changeable: Not

To be sent cyclically: AT

The word content is incremented by the drive each NC cycle and the corresponding data is placed in the Message Data parameter. Description of the codes can be found in the following table.

Message Code	Message Data content	Unit of measurement
0	Motor speed	[rpm]
1	Motor current (I)	[A]
2	Motor relative current (I/In)	[%]
3	Bus voltage	[V]
4	Motor temperature	[°C]
5	Motor power	[kW]

#### 9.2.1.2.5 MD: Message Data

The value is marked by the Message Code with floating-point representation.

Data type: Float  
Data length in bit 32  
Decimal point: 0  
Minimum: 0x00000000  
Maximum: 0xFFFFFFFF  
Unit:  
Changeable: Not  
To be sent cyclically: AT

### 9.2.1.2.6 TSR: TimeStamp Reference

This is a 16-bit unsigned counter from which the time elapsed between two EtherCAT cycles can be determined.

Its value is 0 until the status machine reaches the Operational status and there the drive determines the cycle time of the packets sent by the control. The end of the operation is indicated by setting the bit 13 (TimeStamp Ready) of the SSW register. From that moment, the value of the counter will be incremented by 125 in each drive control cycle.

In each ECAT cycle, the control compares the new value of the counter with the value read previously, from which it can calculate the time elapsed.

Data type: Decimal integer  
Data length in bit 16  
Decimal point: 0  
Minimum: 0x0000  
Maximum: 0xFFFF  
Unit:  
Changeable: Not  
To be sent cyclically: AT

## 9.2.2 Other selectable process data

### 9.2.2.1 MDT

NC to Drive	P-0-0202	EDC: Extra Data Code	16 bits data
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### 9.2.2.2 AT

Drive to NC	P-0-0208	ED1: Extra data 1	32 bits data
	P-0-0209	ED2: Extra data 2	32 bits data
	P-0-0210	ED3: Extra data 3	32 bits data
	P-0-0211	ED4: Extra data 4	32 bits data

## 10 EXECUTION OF THE SOE COMMAND

The NCT servo drives with EtherCAT communication interface know the SoE (Sercos Servo drive Over ECAT), FoE (File Over ECAT) packed data management (MailBox) protocol standards. This chapter deals with the commands that can be initiated on the SoE interface, and execution of them.

### 10.1 Executable commands (Process Command)

As far as the execution time is concerned, there are two groups of commands: the first one comprises the commands that are executed immediately; the second one is composed of the commands that need execution time.

A certain time (a few 100 milliseconds) from the start of execution is available for the commands of the first group. If they cannot be executed within this period, they generate 'Time out' error message, and execution of them returns with failed status. When execution of the commands of the second group starts, there is no predefined time limit for execution. Execution of them may take minute or hours, or special user intervention is needed to stop it. Generally, these commands are those executing some kind of measurement, adjustment and operation mode.

When writing and reading their content, they function differently from the normal SoE parameters. Namely, they have a specific attribute parameter, the Data Status parameter (it indicates the status of the execution). When the commands are being written, the mode of execution is specified, while during reading them, information can be got about the status of the execution. The values are specified by the SoE protocol standard.

#### Writable value

- 0 Request for reference value or for cancelling the process of command execution
- 1 Request for setting the command execution mode
- 2 Request for cancelling the command execution
- 3 Request for setting and starting the command execution

#### Readable statuses (Data state)

- 0 Reference value, there is no execution in progress
- 1 Command execution mode is set
- 3 Command execution is completed successfully
- 5 Command execution is interrupted
- 7 Command execution is in progress
- 0xF Invalid execution process, error during execution

In case of general use, the following values are used: 3 – for starting the command, 0 – for stopping. In this case, the read-back execution status takes the values 0, 3, 7 and 0xF.

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**10.1.1 S-0-0099 Reset class 1 diagnostic (pc)**

This is the standard error delete command for the deletable drive errors.

**10.1.2 S-0-0216 Switch parameter set (pc)**

It executes the changeover of the parameter table which was set in the S-0-0217 parameter.

**10.1.3 P-0-0166 Motor and feedback connection check (pc)**

Due to this command, the encoder information is read again, and if the encoder non-volatile memory contains motor data, they will be read again.

**10.1.4 P-0-0167 Calculating motor modell from name plate datas (pc)**

Due to this command, in the case of asynchronous servo motor (AC induction motor) mode of operation, the drive determines approximately the values of the elements of the 1-phase equivalent circuit model from the terminal board data given in parameters, and the time constants of the mathematical model. If the calculator computes using data that are presumably incorrect and unrelated, it will input the identifiers of the parameters having presumably incorrect value in the list P-0-0145 IDN-list of invalid init or calculation data.

**10.1.5 P-0-0168 PMSM commutate finding (pc)**

This is switching on the operation mode of automatic finding the commutation position, for permanent-magnet motor.

**10.1.6 P-0-0214 Serial diag. port communication enable**

This is for enabling or disabling the communication diagnostics with serial RS-232 interface.

**10.1.7 P-0-0215 Set EnDat DATUMSHIFT (pc)**

Due to running the command, the value of the encoder position will be offset by the value specified in the parameter P-n-0110 Encoder position offset. The offset value will be valid when the encoder is restarted. After storing the offset value, the command restarts the encoder automatically.

**10.1.8 P-0-0216 Parameters write command (pc)**

Due to running the command, the writing or reading function specified in the parameter P-0-0115 Parameter writing mode preselection will be executed from the private memory of the drive (EEPROM, NVRAM), or from the private OEM memory area of the encoder in the case of an EnDat encoder.

**10.1.9 P-0-0217 Encoder error clear command (pc)**

By the use of this command, the EnDat error register contents can be deleted, for example, when the battery-fed encoder loses the position.



#### 10.1.10 S-0-0374 Procedure command error list

This is the list of the error codes generated during execution of a command.

Data type: List including 2-byte HEX elements

Changeable: Ø

Values:

- 0x7008 Invalid data
- 0x7010 Parancs ismételt indítása futás közben
- 0x7011 The run of the command is not interrupted, it cannot be interrupted
- 0x7012 The command cannot be run yet
- 0x7013 The command is not running

## 11 OPERATION

When 24 V is applied to the auxiliary power supply unit of a compact servo amplifier working properly, the green LED will give light continuously and the drive will be ready for EtherCAT communication where the status machine will start from the INIT status. Only from this mode can the shift to the BOOT mode be done where replacement of the drive software can be carried out. The INIT status will also be reached after successful programming. If the drive is shifted to the PreOp mode from here, it will execute the basic self-diagnostics. If the drive is fault-free, the status machine will be shifted to the required status, and then, the drive will wait for further status changes from the system supervising it (from the NC). The fault-free status is indicated by the flashing green LED and by the dark status of the red LED. If the Ecat status machine is successfully shifted to the Op status, and if the servo amplifier is enabled in fault-free status, the number of the current parameter table will appear on the text status display (0, 1, 2 or 3; if the command bits of parameter table selection are not used, the table according to the value of the parameter S-0-0217 Parameter set preselection will be active). Functioning the signal of the drive readiness is affected by the parameter P-0-0006 Drive ready mode, too. If this parameter is 0, the servo amplifier will become ready to operate provided that it does not detect any fault. If this parameter is 1, the fault-free status together with the EMG (NCT CW bit2 or SoE CW bit13) enabling of the drive will generate the operational readiness.

It is important to associate the number of the driving device with the number of the axis on the control unit, and, in addition, to select appropriate process data for operation. Selection should involve one CW control word and one SW status word.

The motor connected to the servo amplifier should be adapted to the servo amplifier by setting the parameters. Then, if voltage is applied to the DC bus outputs of the servo amplifier and the drive is put in the permitted control status and the reference signal is applied, the motor should rotate at the speed correspondent to the reference signal.

### 11.1 Monitoring the servo position deviation error and velocity follower error

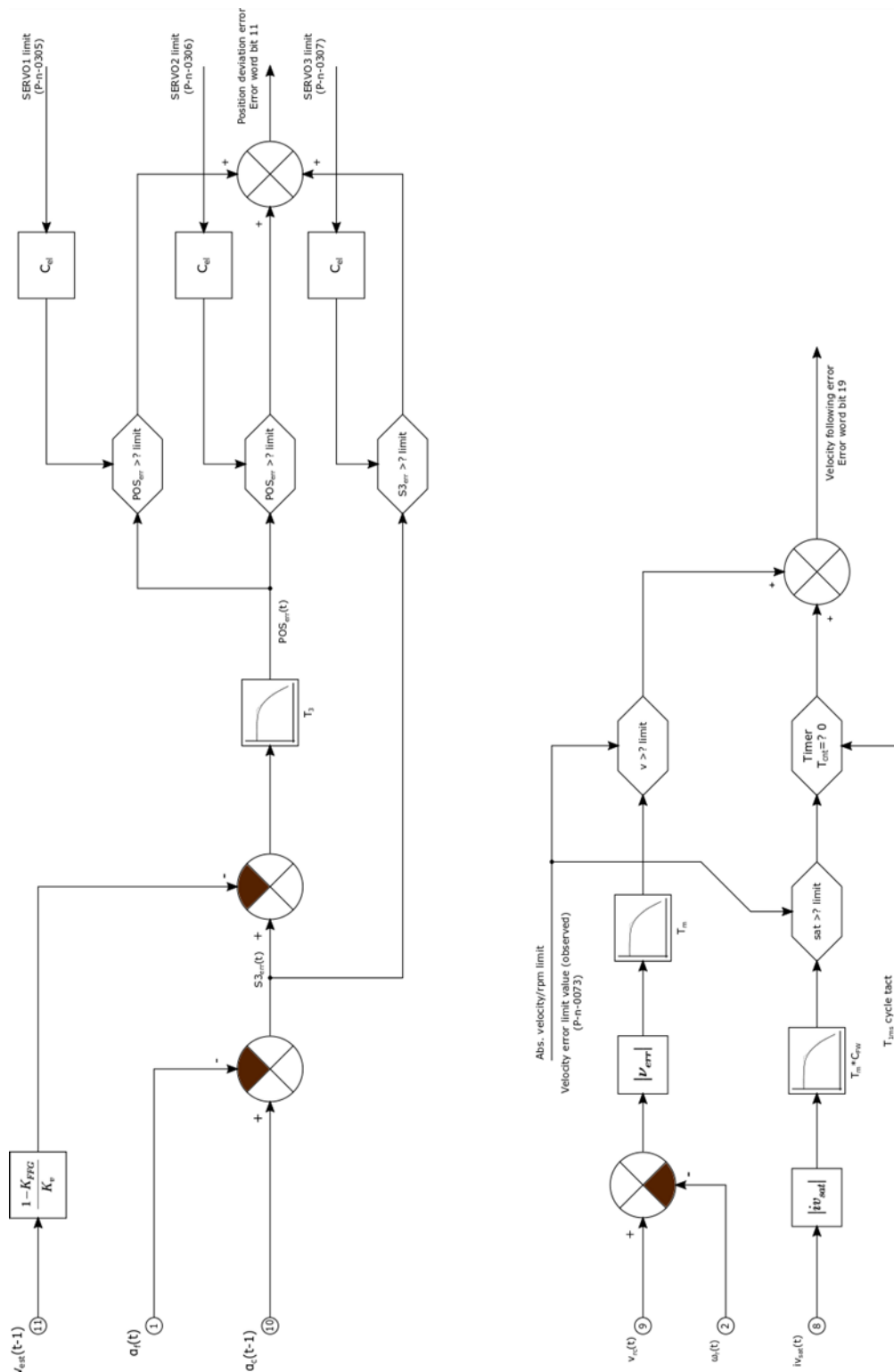


Figure 23 The flowchart of monitoring the following error

## 11.2 The error codes of the SPI EEPROM operating device

The error codes appear in the AL status code field of the operating device of the status machine. If such a code is seen, due to some kind of hardware error, the drive's private non-volatile memory storing the parameters required for operation cannot be read. The drive is not able to operate.

EEPROM_OK	0x0000
EEPROM_UNDER_OP	0xFFFE
ERR_WRITE_PROTECT_BANK	0x8100
ERR_EEPROM_NOT_COMM	0x8200
ERR_STATUS_REG_READ	0x8400
ERR_UNKNOWN_MODE	0x8300
ERR_EEPROM_ILLEGALADDR	0x8500
ERR_EEPROM_OP_TIMEOUT	0x8600
ERR_EEPROM_CRC_ERR	0x8700

For that very reason, the EtherCAT status machine stop sin PreOp mode, and does not let the drive go on until the error is cleared.

## 11.3 The error codes of the EtherCAT operating device

The error codes appear in the AL status code field of the status machine manager. The standard EtherCAT error codes also appear here in the 0x0000~0x7FFF value range. The codes above the 0x8000 value are manufacture-specific (NCT) error codes and they may be as follows:

ECAT_OK	0x0000	// ETHERCAT ET1100 working ready
ECAT_EEL_ERR	0x8010	// EEPROM not loaded
ECAT_ETNV	0x8020	// ET1100 not valid in base address

However, if such an error is generated in the case of which the EtherCAT communication interface is not able to operate, the errors as Morse flashing light will appear on the red LED of the drive.

## 11.4 The error codes of the measuring system

The error codes can be read in the EtherCAT status code register, and they are error messages generally generated when the measuring system is set in the initial position and is actuated.

In addition, the error codes can also be read in the parameter P-0-0113 Encoder Op.Stat.Err.

ENDAT_OK	0x0000
ENDAT_NOT	0x8001
ENDAT_UNKNOWN	0x8002
ENDAT_BUSY	0x8004
ENDAT_NOT_READY	0x8008

ENDAT_POSERR	0x800A
ENDAT_UNRST	0x800F
ENC_FAIL	0x8007

For interpretation of the bitmap of the error codes see the parameter description in the subchapter 7.3.68.

### 11.5 Displaying the drive error

Since, in the case of the compact drive series, there is no seven-segment LED display on the box anymore and the EtherCAT interface enables the errors to be text-represented on the standard interface S-0-0095 Diagnostic message, henceforth the errors will be displayed there.

**Table 2 The compact drive error codes**

<b>Error code Eyy</b>	<b>Text error message Short description of the error</b>	<b>Motor reaction</b>	<b>Emergency output reaction</b>	<b>P205 NCT EW</b>	<b>P204 NCT SW</b>
00	Working success: Error-free status, the drive is ready for operation.	It controls	It is closed		
01	Encoder error is in the A channel: Encoder error in the 'A' channel.	It coasts	It releases	bit 1	
02	Encoder error is in the B channel: Encoder error in the 'B' channel.				
03	TTL increment encoder C error: Incremental encoder zero pulse or position error.	It stops	It releases	bit 4	
04	SIN-COS increment encoder error: Sinusoidal encoder error.				
05	DC-BUS voltage error: Insufficient bus voltage, its value is too high or too low.	It stops?	It releases	bit 5	
06	Amplifier overcurrent peak error: Too high current value on the drive output. The motor current exceeded the value set in the drive parameter (I <sub>peak</sub> ).	It stops	It releases	bit 6	
07	Current dc offset reference error: Current measurement offset error. In no-current status, the phase currents of the motor exceeded a value set by the use of a constant.	It does not start	It is closed	bit 7	
08	Commutation error: Commutating signal error.	It stops	It is closed	bit 8	

<b>Error code Eyy</b>	<b>Text error message Short description of the error</b>	<b>Motor reaction</b>	<b>Emergency output reaction</b>	<b>P205 NCT EW</b>	<b>P204 NCT SW</b>
09	Servo-follower error in the motor position: Velocity-position follow error. The motor speed differs from the speed referred to the velocity reference signal or significant position error is measured.	It coasts	It is closed	bit 19	
10	Encoder initialisation error: Encoder error during operation reset.	It does not start	It is open		
11	Motor overspeed error: The motor speed exceeded the preset maximum speed value.	It stops	It releases	bit 23	
12	Current dc offset balance error: Current symmetry error between the phases A and B. The difference between the current values measured in no-current status exceeded a value set by the use of a constant.	It does not start	It is closed	bit 24	
13	Motor temp. less than $-10^{\circ}\text{C}$ : The motor temperature is less than $-10^{\circ}\text{C}$ ; it could only be started with damage.	It does not start	It is closed	bit 12	
14	EtherCAT initialisation error: In the Slave (Servo), incorrect address and data lengths are set by the Master (NC).	It does not start	It is closed		
15	EtherCAT watchdog timeout: On the basis of the measurement of the control signal cycle time, the control signal delayed or was not received for at least 3 consecutive cycles.	It stops	It is closed	bit 15	
16	IGBT transistor failure: The control of the IGBT transistor of the drive detected overcurrent.	It coasts	It releases	bit 16	
17	Servo enable error: Enabling the drive is taken in the case of the motor rotating at a speed above $N > N_0$ (it prevents the motor from coasting), or, other enable sequence error.	It stops	It is closed	bit 26	
18	Servo ready error in motor control: In an enabled operational status, the ready-to operate condition of the drive discontinued.	It stops	It is closed	bit 22	

<b>Error code Eyy</b>	<b>Text error message Short description of the error</b>	<b>Motor reaction</b>	<b>Emergency output reaction</b>	<b>P205 NCT EW</b>	<b>P204 NCT SW</b>
19	Motor overtemperature error: The heat protection of the motor or the encoder activated. The temperature of the EnDat encoder or the motor exceeded the value (generally 95 °C) set in the drive parameter (Max. temperature).	It stops	It is closed	bit 2	
20	Motor overload failure: The motor is overloaded. The overload protection is activated; the motor current exceeded continuously the In rated value of the motor current.	It stops	It is closed	bit 20	
25	Amplifier overtemperature error: Drive overtemperature error.	It stops	It is closed	bit 30	
26	IGBT transistor enable error: IGBT transistor enable error when the motor is enabled/driven.	It stops	It releases	bit 31	
27	EnDat encoder battery error: The battery voltage of the battery-fed EnDat 2.2 encoder decreased below the minimum level; an error could occur in the absolute position value.	It does not start	It is closed	bit 27	
28	Amplifier heat device error: Sensor error in the drive cooling unit (fan) or thermometer.	It stops	It is closed		bit 19
29	Invalid AL state change: Disabled AL operating mode change when the drive is in enabled status.	It stops	It is closed	bit 25	
30	Parameter table CRC error: Parameter table checksum error. There are incorrect data in the parameter table.	It does not start	It is closed	bit 17	
31	EtherCAT DC synchronizing failure: In the EtherCAT DC synchronization mode, at least 3 consecutive cycles occurred during operation.	It stops	It is closed	bit 15	
32	Amplifier protected EEPROM error: Serial flash access error. Fatal error occurred in the course of writing/reading of the storage space of the protected parameter table.	It does not start	It is closed	bit 21	

<b>Error code Eyy</b>	<b>Text error message Short description of the error</b>	<b>Motor reaction</b>	<b>Emergency output reaction</b>	<b>P205 NCT EW</b>	<b>P204 NCT SW</b>
33	Parameter calculation error! See P145 list: Parameter calculation error occurred. A malfunctioning motor model will be computed from one or more motor parameter. The P145 list includes the parameters presumably set incorrectly.	It stops	It is closed	bit 3	
34	Invalid drive mode, see P145 list: The drive mode is set incorrectly. The regulator mode (P0000) or the ready mode (P0006) or the op. Mode (S0032, S0033,...) contains incorrect values.	It does not start	It is closed		bit 20
35	Error occurred until PC running! See the S374 list: EtherCAT run error occurred when PC was run. Errors are included in the S374 list.				
36	Reinitialize EnDat if request error clear command: It is only a supplementary message when the automatic re-initialization is connected to the EnDat encoder.				

The compact servo amplifiers monitor themselves and their surroundings continuously; if they detect any error, they will not apply voltage to the motor connected to them and they will cease indication of drive's operational readiness. In order that the user knows what unit caused the error, the information about the error character can be found in the status or error word on the EtherCAT communication interface and, in addition, it as text message appears in the adequate (S-0-0095) parameter. When an error occurs, the servo amplifier will change the value of an error-cause-dependent store (flag), storing the error even after disappearing the phenomenon causing the error. Until the values of the different stores are reset to the initial position (error deletion), the servo amplifier cannot become ready to operate. Depending on what caused the error, there are two ways to delete the content of the store belonging to the error. There is error cause there that is so serious that the content of the store belonging to it can only be deleted by restarting the servo amplifier (it is so-called non-deletable error). In the case of a less serious error cause, by taking away the enable signal of the servo amplifier and providing the request for error deletion (note that the system is sensitive to the leading edge), the content of the error store can be deleted even without restarting the servo amplifier (it is so-called deletable error). The error deletion in accordance with NCT handling can also be initiated from the CW control word (P-0-0201) by setting the bit9 to the value 1. It is the value of the bit4 of the SW status word that provide information about occurrence of the error deletion. The error can also be deleted in the standard SoE way by issuing the S-0-0099 command of error deletion.

If the drive does not communicate, or the green LED does not flash, or both (green and red) LEDs give light continuously, it can be presumed that the processor does not work. In such cases, the power-current supply should be turned off, and the drive should be restarted by



turning on and off the voltage of the auxiliary supply unit. If the processor appears to be not ready to operate after several restarts, it means that the servo amplifier is wrong.

Short description of some important error codes can be found below.

### 11.5.1 E16

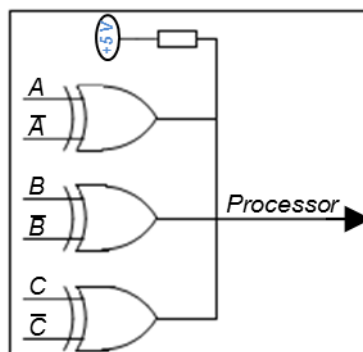
#### IGBT high-current transistor error (NON-DELETABLE!)

The power electronic unit (IGBT) used in compact servo amplifiers is equipped with several monitoring functions (monitoring the overcurrent, short circuit, overheat etc.). If protection of the IGBT module detects any anomaly, it will indicate this anomaly to the processor (PDPINT – power device protection interrupt).

If this error code is seen, the power-current supply and also the voltage of the auxiliary supply unit should be turned off. The motor cable connector should be removed from the servo amplifier, the power-current supply and also the voltage of the auxiliary supply unit should be turned on again, the drive should be enabled and a reference signal of some magnitude should be provided. If this same error code appears again, it will mean that either the servo amplifier is wrong or a very strong external interference influences the operation of the servo amplifier. If the E16 does not appear, it will mean, that presumably the motor cable or the motor is short-circuited (interturn short circuit, frame fault, leak etc.).

### 11.5.2 E01 (E02)

#### Encoder error / encoder cable error (deletable)



**Figure 24 Monitoring the incremental signal**

In the compact servo amplifiers, the incremental and reference signal pairs received from the incremental (TTL or SinCos) encoder are monitored by the antivalence unit illustrated in the Figure 24 Monitoring the incremental signal. If any of the signal pairs does not differ, the output level will be low. However, it does not cause error immediately; error will be caused only in the case when the processor detects low level many times in succession without interruption.

Using this method, the total inoperability of the encoder or the break in the encoder cable can be detected. It is the E03 error code by the use of which the drive indicates that the number of the incremental signals per one revolution is insufficient. In the case of the encoders providing analog signal (11  $\mu$ A or 1 Vpp sine/cosine), it is the E04 error code by the use of which the drive indicates the insufficient signal level.

The EnDat 2.2 is also capable of communicating on the encoder connector of the servo amplifier provided that the EnDat communication interface card is installed in the drive (if the drive

was ordered with this option). In these cases, only the E01 error code will always be activated (in the case of the two-channel measuring system, the E02 is the same code for the second channel). It is the parameter P-0-0113 Encoder Op.Stat.Err. Message, that makes possible to diagnose further error.

The possible causes of the encoder error are as follows:

- The encoder is not connected.
- The encoder cable is wrong.
- The shielding is wrong.
- The power supply voltage for the encoder is not proper.
- The encoder is wrong.
- There is strong external interference.
- The scanning head is teared off or incorrect gap is adjusted, etc.

In the case, when another device is assigned over the compact servo amplifiers which also receives the encoder signal, consideration should be given to whether the encoder monitoring of the superior device indicates an error. Usually, in such systems, the servo amplifier performs the speed control function and the superior unit performs the position control function and therefore, relative to the servo amplifiers, it has a stricter encoder monitoring. If, in such cases, only the servo amplifier indicates encoder error and the encoder monitoring of the superior device is turned on, the servo amplifier may be suspected of malfunctioning.

### 11.5.3 EtherCAT errors

These are the E14, E15, E29, E31 and E35 (deletable) error codes.

**E14** Error occurred in the course of setting the Ecat communication and stepping the status machine

It takes place when stepping the EtherCAT status machine is unsuccessful for some reason. It mainly happens if the drive does not receive all the parameter values it would have required or if any one of the values is out of the value range. In this case, generally during PreOp → SafeOp transition, it will be jammed in PreOp and it will indicate SoError, InvInpConf and InvOutConf error in the EtherCAT status code.

**E15** Indication of message about process data absence

If, according to the internal time keeping of the drive, message is absent in at least three process (NC) cycles in succession, this error will be indicated.

The error may be caused by message loss due to noise overload, communication malfunction due to cable problem or contact fault, or, simply no more process data from the NC is received or the data does not arrives to the processor due to some internal error in the drive.

**E29** Status machine change over during controlled operation

When the output of the drive is enabled, it, in a controlled way, applies voltage to the motor terminals when the motor stands or rotates (moves), meanwhile the status machine is being changed over from the Op operational mode. In this case, the drive executes a safe stop and cancels enabling in the SafeOp mode, and then changes over to the required status.

**E31** Synchronization error

Such error will be indicated in the case when the drive's control cycle time / internal clock is synchronized with other EtherCAT units' cycle / internal clock, and this synchronon cannot be established by the system or the drive falls out of the system synchron. Reaction of the drive during controlled operation is the same as in the case of the E29 error code, i.e. it executes a safe stop and returns the drive status machine to the SafeOp mode.

**E35** An error occurred during command execution

This error message is generated in the case when an error occurred during execution of some command (process).

**11.5.4 E05 error**

This is the DC bus voltage error code (it can be deleted).

The units of the compact servo amplifiers can become damaged when the voltage of the DC bus exceeds the 800 V. For this reason, a voltage monitoring system is built in which generates an error when the voltage of the DC bus exceeds the 800 V.

Every drive system has an operating state (braking mode) at which the power flows from the motor to the main power supply unit. The main power supply unit either converts this power to heat using a resistor (rheostatic braking) or forces it back into the power supply network (regenerative braking). An error occurs when the main power supply unit is unable to convert power from the motor to heat or to force it into the network. In the case of the rheostatic braking it is required to check the main power supply unit and, if there is also an external braking resistor, the connecting cables and the external braking resistor. If the error occurs several times – while the main power supply unit is fully undamaged –, it can be supposed that the braking resistor is not designed properly. Even in the case of regenerative braking, the main power supply unit should be suspected first of all. But maybe the network is not able to absorb the braking power.

Unrealistic growth of the voltage of the high-current power supply can also be the reason of the increase of voltage.

In addition, the compact drives may indicate DC bus voltage error even in the case when during operation the voltage drop due to a higher load is too big.

**11.5.5 Current errors**

These are the E06, E07, E12 current measurement and current limit (deletable) error codes.

**E06** In accordance with the processor clock time, the compact servo amplifiers compare the instantaneous value of the current with the value of the parameter S-0-0110 Amplifier peak current; if the instantaneous value is greater than the parameter value, they will generate E06 error message. The error may indicate incorrect parameters or servo amplifier or servo motor failure.

**E07** These error codes may be generated in the case, when the value of the DC component of the current measurement becomes too great and exceeds the value of the parameter and/or P-0-0030 Amplifier phase current offset max diff, or, when the difference between

**E12** the DC components of the two current measurement channels exceeds the value of the parameter P-0-0031 Amplifier phase current difference max..

### 11.5.6 E09 follower error

The most important task of a servo amplifier is to force the servo motor connected to it in a state adequate to the reference signal on its input. If, within a given time after the reference signal change, the motor is not in the given range of the required state, the servo amplifier will generate an error message. This error indicates troubles listed below that prevent proper operation of the drive:

- The motor cable is broken.
- The motor is wrong.
- The glass disc of the encoder is wrong.
- The voltage of the DC bus is too low.
- The torque load is too high, etc.

The error will be indicated in the case, if, for a period longer than the specified one, the difference between the measured speed value from the encoder of the motor and the speed value requested in the command is greater than the percentage value specified in the parameter P-n-0073 Velocity error limit value (observed).

### 11.5.7 Motor heat protection errors

These are the E13, E19 and E20 motor temperature error codes and the I2t motor overload error code (they can be deleted)

The compact servo amplifiers can protect the servo motor from overheat in two different ways. The mode for protection can be set in the parameter P-n-0012 Motor thermo prot code.

The power converted to heat in the windings of electric motors is proportional to the square of the current flowing through them and the magnitude of the coil resistance. From thermodynamical point of view, an electric motor can be modelled as a first-order lag element in which the exciting signal is the power that converts to heat, the response is the temperature change, and the thermal time constant and the thermal resistance are those that create connection between them. The compact servo amplifiers know the current flowing through the motor coils. Additionally, for the I2t protection, it is necessary to specify in parameter the motor weight (the parameter P-n-0090 Motor weight) from which we can roughly infer the motor heat capacity and the rated current of the motor (S-n-0196 Motor rated current). Based on these data, the algorithm of the servo amplifier is able to monitor the motor temperature and when it exceeds the pre-set value, an error message will be generated by the servo amplifier. In the case of the self-cooled motors, the I2t protection is an adequate protection. If the drive detects a motor overload, it will generate **E20** error code.

However, in the case of the forced-cooled motors, the problem is that the values specified in the parameters refer to a properly functioning forced-cooling system; when the forced-cooling discontinues, the motor can be damaged. For this reason, it is recommended to use thermal circuit-breaker, PTC or KTY protection. The key point of the PTC/KTY protection is a positive-temperature-dependent resistor fixed to the end winding of the electric motors. The servo amplifier measures the resistance of the thermometer continuously, and from the data measured calculates the temperature of the stator/end winding of the motor. If it is greater than the value pre-set in the parameter S-n-0204 Motor shut down temperature, the servo amplifier will generate **E19** error code.

**E13** error code will be generated if the temperature of the motor decreases below  $-10\text{ }^{\circ}\text{C}$ . It is the lower working temperature of the encoders. Because of the moisture condensation, the definite minimum working temperature of our devices is  $0\text{ }^{\circ}\text{C}$ . Such an error code may be

received even in the case, if the parameters of the temperature sensor are set incorrectly in the drive or there is a short circuit in the circuit of temperature measurement.

## 11.6 Managing the battery errors of the battery-fed encoders

### 11.6.1 Position error after switch-on

Error will be indicated if the encoder is switched off, i.e. no supply voltage is applied from the drive and the external battery is run-down or the battery terminal is disconnected. Since the external battery is located beside the drive in the electric cabinet, this error will also occur when the encoder cable terminal is disconnected.

In addition to the position error, the encoder provides the information that the position error is because of the 'M All Power Down' error message, i.e. the absolute position is lost; and this is an askable information. Error message will be generated in the case when the battery voltage decreases typically below 2.2 V or it ceases.

In this case, the machine must get into inoperable state to prevent the user from causing mechanical breakage of the machine as the absolute position value has been lost.

The process of managing the error is as follows:

1. After switch-off, the error message appears on the control.
2. Due to the error message, the control deletes the set values of the reference point.
3. The system is inoperable until the error has been deleted in the drive and the encoder.
4. Erasing the error register in the encoder can only be initiated only from the control by the use of the related error erase command.
5. The error erase command can only be issued having proper authorization.
6. After erasing the error register in the encoder, the error in the drive becomes deletable in a normal way.
7. Then, the machine can be turned on, but the control still indicates that the no reference has been set.
8. After setting the machine reference, the REF signal disappears on the control, the machine is operable again and is ready to work.

In order to reach the accurate and error-free state, it is recommended to have the above-mentioned steps made by the NCT service specialist who is trained for this purpose. If the system is operated at a distance, a specialist should be trained for this purpose there who will be able to make the mentioned steps cautiously, at the client's expense.

### 11.6.2 Warning message about the state of the battery

Warning message may appear on the control after switch-on or even during operation just when it is indicated that the value of the battery voltage has decreased typically below 2.9 V, but is still greater than 2.2 V.

In this case, the machine remains operable until the above error (11.5.1) has been generated.

Clearing the warning from the control can be initiated by normal delete command. The warning will appear at every switch-on until the battery has been recharged or replaced. **The battery must be replaced only when the encoder power supply voltage is applied (the drive is on), otherwise an error message will be generated!** The specialist who carries out battery replacement must know this.

### 11.6.3 The parameters used and error deletion

#### **P-0-0113 ENCODER OP.STAT.ERR. MESSAGE**

The error codes described in the 11.3 subchapter appear in the case of an initialization problem, or, it will be the value of the private error register of the encoder if the encoder is initialized successfully and it communicate. Interpretation of the error codes can be found in the subchapter 7.3.68.

The system is operable if 0 can be found here in any case. When error is occurs, the content of the error register should be dictated to the dispatcher

#### **P-0-217 ENCODER ERROR CLEAR COMMAND (PC)**

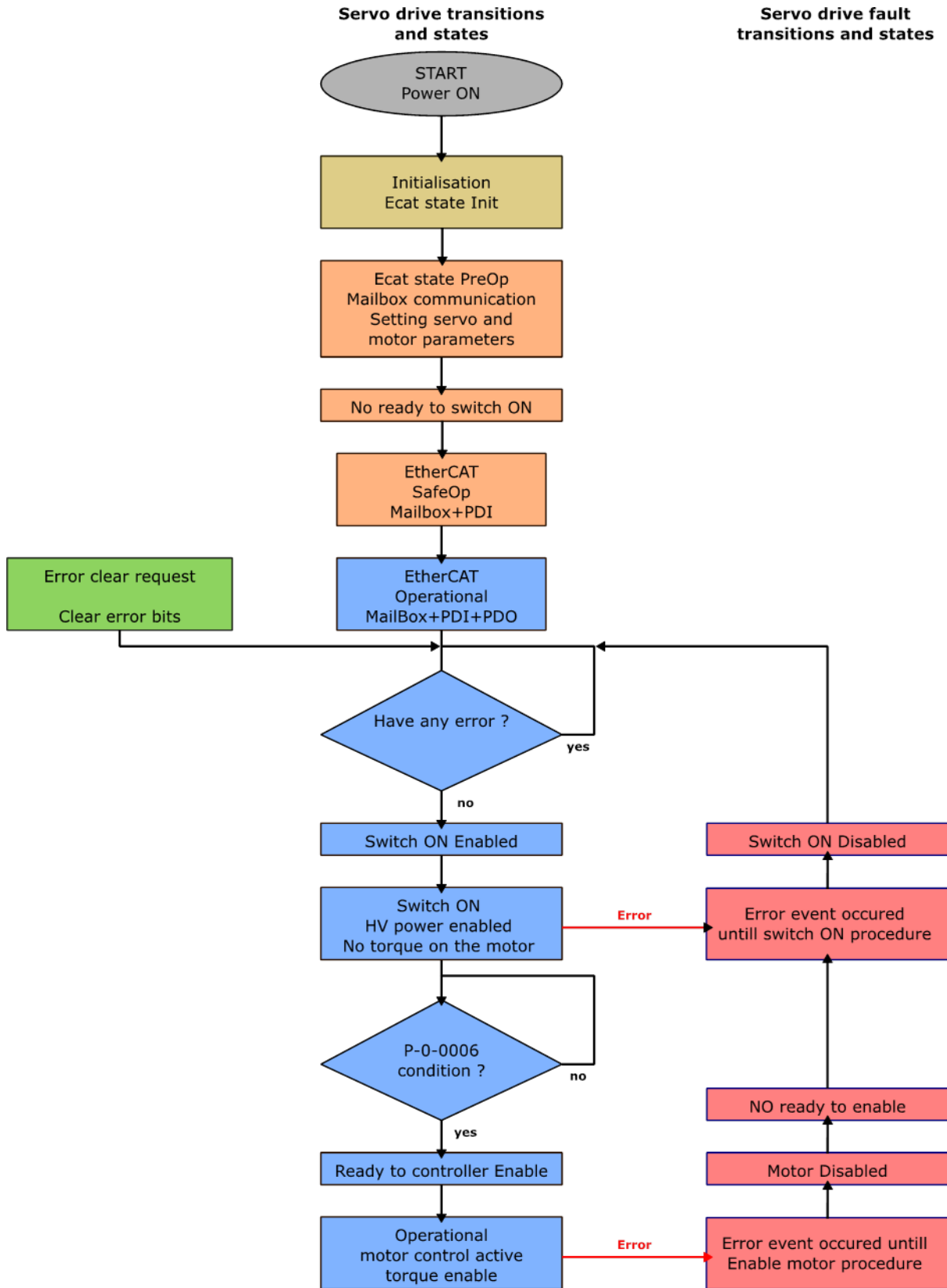
Clearing works only in the state Ecat PreOp.

Using this command, contents of the EnDat error register can be cleared, for example, in the case of the battery-fed encoder position loss.

In the case of the v1.32x software versions, the errors will be cleared from the encoder if, in the PreOp mode, 3 is written in. Such an error is, for example in the case of battery-fed encoders, the position loss error and the battery error. If the error persists, the encoder will write back the error register. The status of the error clearing will be indicated by the 0 value that will be seen after re-reading (updating) this parameter. In this software version, it is just one parameter, there is no 'command (pc)' writing in its name, and its number is the same as later on.

From the v5.4xx (kompakt pmsm/ac ind./inverter) versions, it is a command (process command); by clicking two times on the value, a pop-up window appears where the command can be started by the use of the Start button. Success is indicated by the messages of the window.

**11.7 The drive status machine**



## 12 SAFE OPERATION

With regard to the servo amplifiers, regulations on the safe operation are included in the ISO 61800-5-2 standard. It contains the regulations of the ISO 61508 standard on the programmable electronic devices which are related to the drives.

<b>Safe Torque Off</b>	<b>STO</b>	This is the stopping category 0 where the torque rotating the motor is ceased by switching the power supply off; the motor coasts in uncontrolled way and then stops.
<b>Safe Stop 1</b>	<b>SS1</b>	This is the stopping category 1 where the motor rotation is stopped in a controlled way, and then the operating voltage is switched off after the coming to a standstill.
<b>Safe Stop 2</b>	<b>SS2</b>	This is the stopping category 2 where the motor rotation is stopped in a controlled way, and then, after the coming to a standstill, the zero speed/the motor is maintained meanwhile the power supply is maintained.
<b>Safe Operating Stop</b>	<b>SOS</b>	This is the stopping category where, by setting the value of the reference signal to 0 during operation, the motor comes to a standstill by braking and remains safely in this state meanwhile the power supply is maintained.

According to the ISO 61800-5-2 standard, the moving systems designed by the use of servo drives must complete the four functions above in order to meet the minimum requirements.

And, in the permitted operating state, a lot of safety functions should be completed.

The use of the relevant functions is described in the subchapters 7.3.47 P-0-0006 Drive ready mode and the 9.2.1.2.1.3 Managing the emergency state.



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