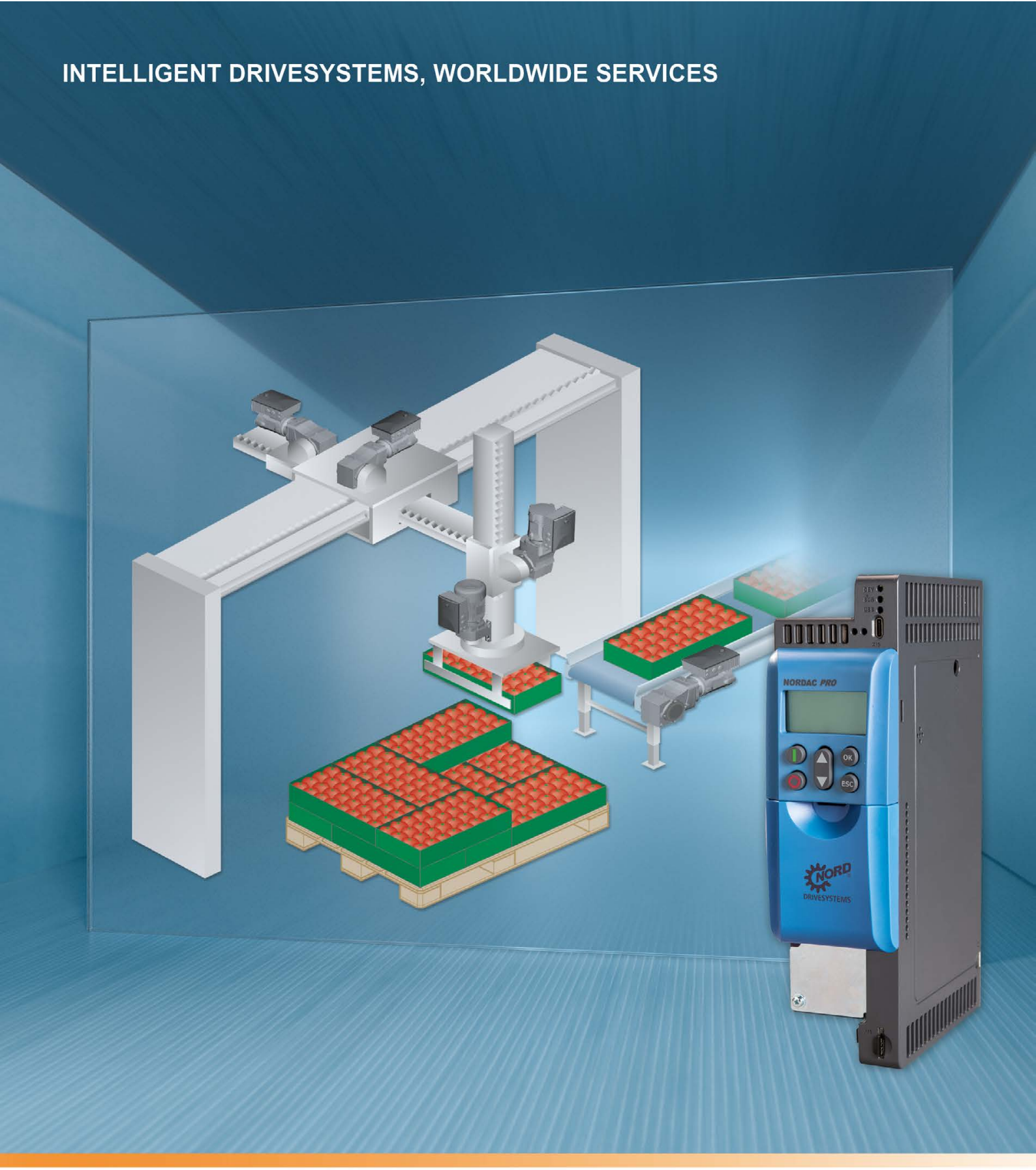
INTELLIGENT DRIVESYSTEMS, WORLDWIDE SERVICES



BU 0610 – en

POSICON positioning control

Supplementary manual for series SK 500P

NORD®
DRIVESYSTEMS

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1 Introduction

1.1 General

1.1.1 Documentation

Designation: **BU 0610**

Part number: **6076102**

Series: **POSICON for frequency inverters from the series NORDAC *PRO*** (SK 5xxP)

1.1.2 Document history

Edition Order number	Series	Version Software	Remarks
BU 0610, March 2020	SK 5xxP	V 1.1 R1	First edition
BU 0610, June 2020	SK 5xxP	V 1.1 R1	Supplements for approved absolute encoders

1.1.3 Copyright notice

1.1.4 Publisher

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1.1.5 About this manual

This manual is intended to assist you in the setup of a positioning application for a frequency inverter manufactured by Getriebebau NORD GmbH & Co. KG (abbreviated as NORD). It is intended for all qualified electricians who plan, install and set up the positioning application (📖 Section 2.2 "Selection and qualification of personnel"). The information in this manual assumes that the qualified electricians who are entrusted with this work are familiar with using electronic drive technology.and in particular with devices manufactured by NORD.

This manual only contains information and descriptions of the POSICON technology function and the relevant additional information for frequency inverters manufactured by Getriebebau NORD GmbH & Co. KG.

1.2 Other applicable documents

This document is only valid in combination with the operating instructions for the frequency inverter which is used. Safe commissioning of the drive application depends on the availability of the information contained in this document.. A list of the documents can be found in 📖 Section 9.2 "Documents and software".

The necessary documents can be found under www.nord.com.

1.3 Presentation conventions

1.3.1 Warning information

Warning information for the safety of the user and the bus interfaces are indicated as follows:

DANGER

This warning information warns against personal risks, which may cause severe injury or death.

WARNING

This warning information warns against personal risks, which may cause severe injury or death.

CAUTION

This warning information warns against personal risks, which may cause slight or moderate injuries.

NOTICE

This warning warns against damage to material.

1.3.2 Other information

Information

This information shows hints and important information.

2 Safety

2.1 Intended use

The POSICON technology function from Getriebebau NORD GmbH & Co. KG is a software-assisted functional extension for frequency inverters manufactured by NORD. It forms an integral part of the frequency inverter and cannot be used without this. Because of this, all of the specific safety information for the relevant frequency inverter contained in the relevant manual (🕮 Section 9.2 "Documents and software") apply without restriction.

The POSICON technology function is essentially used as a solution for complex drive applications with positioning functions which are implemented using frequency inverters manufactured by NORD.

2.2 Selection and qualification of personnel

The POSICON technology function may only be commissioned by qualified electricians. These must have the necessary knowledge of the technology functions and the electronic drive technology and the configuration aids which (e.g. NORD CON software) which are used, as well as the peripherals (including the controller) which are used in association with the drive application.

In addition, the qualified electricians must also be familiar with the installation, commissioning and operation of the sensors and electronic drive technology, as well as all of the accident prevention regulations, guidelines and laws which apply at the place of use.

2.2.1 Qualified personnel

Qualified personnel includes persons who due to their specialist training and experience have sufficient knowledge in a specialised area and are familiar with the relevant occupational safety and accident prevention regulations as well as the generally recognised technical rules.

These persons must be authorised to carry out the necessary work by the operator of the system.

2.2.2 Qualified electrician

An electrician is a person who, because of their technical training and experience, has sufficient knowledge with regard to

- Switching on, switching off, isolating, earthing and marking power circuits and devices,
- Proper maintenance and use of protective devices in accordance with defined safety standards.
- Emergency treatment of injured persons.

2.3 Safety information

Only use the technology function **POSICON positioning control** and the frequency inverter from Getriebebau NORD GmbH & Co. KG for their intended purposes as stated in 🕮 Section 2.2 "Selection and qualification of personnel".

Observe the instructions in this manual in order to ensure the safe use of the technology function.

Only commission the frequency inverter in a technically unmodified form and not without the necessary covers. Take care that all connections and cables are in good condition.

Work on and with the frequency inverter must only be carried out by qualified personnel, 🕮 Section 2.1 "Intended use".

3 Electrical Connection

WARNING **Electric shock**

Touching electrically conducting components may cause an electric shock and severe or possibly fatal injury.

- Disconnect the frequency inverter from the power supply before starting installation work.
- Only work on devices which have been disconnected from the power supply.

WARNING **Electric shock**

The frequency inverter carries hazardous voltage for up to 5 minutes after being switched off.

- Only start work after a waiting period of at least 5 minutes after switching off the mains supply (disconnection).

Position control by the frequency inverter can only be used if it receives immediate feedback of the current position of the drive unit.

An encoder is usually used to detect the current position.

3.1 Connection to the device

Electrical connection of the travel measurement systems is made via connection terminals.

On the frequency inverter

X11: HTL

(via digital inputs)

X12:

additional digital inputs and outputs

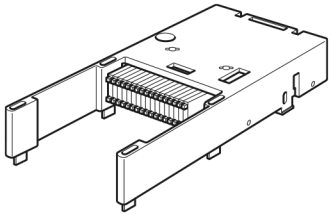
X13: TTL

(SK 530P and higher)

X15: CANopen

Note: The illustrations show special configurations.

To the SK CU5-MLT option module



X21: Universal encoder interface (SIN/COS, Hiperface, EnDat, SSI, BISS)

3.1.1 Installation of an SK CU5-... customer unit

DANGER

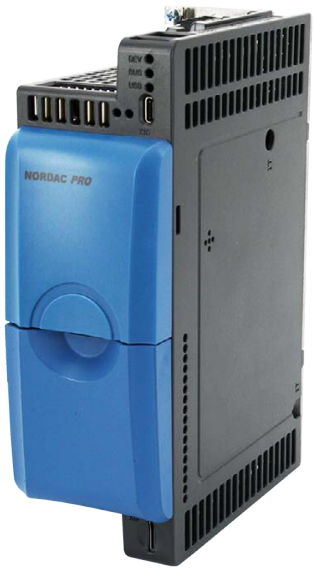
Danger of electric shock

The frequency inverter has a hazardous voltage for up to 5 minutes after it has been switched off.

- Only carry out work when the frequency inverter has been disconnected and at least 5 minutes have elapsed since the mains was switched off!

Installation must be carried out as follows:

1. Switch off the mains voltage, observe the waiting period.
2. Push the control terminal cover down or remove.
3. Remove the blank cover by activating the release mechanism at the lower edge and removing it with an upward rotating movement.
4. Hook the customer unit onto the upper edge and press in lightly until it engages. Take care that the connector strip makes proper contact.
5. Close the control terminal cover.



Remove the control terminals and blank cover.

Install the SK CU5-... customer unit.

Install the control terminals and blank cover.

3.1.2 Connection terminal details

TTL encoder interface (on board) (SK 530P and higher)

Connection X13	Designation	No.	Description
	24V	43	24 V power supply
	GND	40	Reference potential for digital signals, 0 V
	A+	51	Track A
	A-	52	Track A inverse
	B+	53	Track B
	B-	54	Track B inverse
Connection X11	**Designation**	**No.**	**Description**
	DI5	25	Digital input 5

HTL encoder interface (on board)

Connection X11	Designation	No.	Description
	DI1	21	Digital input 1
	DI2	22	Digital input 2
	DI3	23	Digital input 3, Track A/ B
	DI4	24	Digital input 4, Track A/ B
	DI5	25	Digital input 5
	24V	43	24 V power supply
	GND	40	Reference potential for digital signals, 0 V digital
	5V	41	5 V power supply
Connection X12	**Designation**	**No.**	**Description**
	DI6	26	Digital input 6

CANopen encoder interface (on board)

Connection X15	Designation	No.	Description
	SHD	90	Shielding
	GND	40	Reference potential for digital signals, 0 V
	CAN-	76	CAN_L
	CAN+	75	CAN_H

Universal encoder interface (SK CU5-MLT plug-in customer unit)

SK CU5-MLT contains all connections from X21 including the following digital inputs and outputs:

Connection X22	Designation	No.	Description
	VO_24V	43	Initiator supply (maximum 200 mA)
	VO_0V	40	Reference potential for I/O
	DIO1	30	Digital input 7 or digital output 3
	DIO2	31	Digital input 8 or digital output 4
	DIO3	32	Digital input 9 or digital output 5
	DIO4	33	Digital input 10 or digital output 6

3.2 Encoders

Each frequency inverter is equipped with a CANopen interface and an interface to which an HTL encoder can be connected. For position control, both interfaces can be independently selected in the various parameter sets of the frequency inverter, and can therefore be assigned to two different drive axes.

With SK 530P and higher, an interface is available for connection of a TTL encoder. This can be assigned to a third, independent drive axis and can also be selected by switching the parameter set.

An optional SK CU5-MLT module extends the frequency inverter (SK 530P and higher) with a fourth and fifth encoder interface (SIN/COS, EnDat, Hiperface, SSI or BISS). By switching the parameter set, position control of up to four independent drive axes can be implemented with a single frequency inverter.

Encoder input

The incremental encoder connection is an input for a type with two tracks and TTL-compatible signals for EIA RS 422-compliant drivers. The maximum current consumption of the incremental encoder must not exceed 150 mA.

The pulse number per rotation can be between 16 and 8192 increments. This is set with the normal scaling via parameter **P301** "Incremental encoder pulse number" in the menu group "Control parameters". For cable lengths > 20 m and motor speeds above 1500 min-1 the encoder should not have more than 2048 pulses/revolution.

For longer cable lengths the cable cross-section must be selected large enough so that the voltage drop in the cable is not too great. This particularly affects the supply cable, in which the cross-section can be increased by connecting several conductors in parallel.

Unlike incremental encoders, for *sine encoders or SIN/COS encoders* the signals are not in the form of pulses, but rather in the form of sine signals (shifted by 90°).

Information

Encoder signal faults

Wires that are not required (e.g. Track A inverse / B inverse) must be insulated. Otherwise, if these wires come into contact with each other or the cable shield, short-circuits can occur that can cause encoder signal problems or destruction of the encoder.

Information

SIN/COS encoder function test

For SIN/COS or TTL encoders which are connected to the SIN/COS terminals, the voltage difference between tracks A and B can be measured with the aid of parameters **P651 [-01]** and **[-02]**. If the incremental encoder is rotated, the value of both tracks must jump between -0.8 V and 0.8 V. If the voltage only jumps between 0 and 0.8 V the relevant track is faulty. The position can no longer be reliably determined via the incremental encoder. We recommend replacement of the encoder.

TTL voltages on terminal X13 cannot be measured.

Information

Rotation direction

The counting direction of the incremental encoder must correspond to the direction of rotation of the motor. If the two directions are not identical, the connections of the encoder tracks (Track A and Track B) must be switched. Alternatively, the resolution (pulse number) of the encoder in **P301** can be set with a negative prefix.

Alternatively, the motor phase sequence can be changed via parameter **P583**. In this way the direction of rotation can be changed using the software only.

Incremental encoders

Depending on the resolution (pulse number), incremental encoders generate a defined number of pulses for each rotation of the encoder shaft (Track A / Track A inverse). With this, the precise speed of the encoder or motor can be measured by the frequency inverter. By the use of a second track (B / B inverse) shifted by 90° (¼ period), the direction of rotation can also be determined.

The supply voltage for the encoder is 10 … 30 V. An external source or the internal voltage can be used as the voltage source (depending on the frequency inverter version: 12 V /15 V /24 V).

With SK 530P and higher, a TTL encoder can be connected to the frequency inverter. The corresponding connections are on board. A further TTL encoder can be connected via an optional plug-in customer unit. Parameterisation of the corresponding functions is made with the parameters from the "Control parameters" group (P300 et seq.). TTL encoders enable the best performance for control of a drive unit with frequency inverters.

The digital inputs DIN 3 and DIN 4 are used to connect an encoder with an HTL signal. The corresponding functions are parameterised with parameters P420 [-03/-04] or P421 and P423 as well as P461 … P463. In comparison with TTL encoders, HTL encoders enable restricted speed control performance (lower limit frequencies). However, they can be used with a considerably lower resolution.

Function	Wire colours	Signal type TTL			Signal type HTL	
		Encoder 1	Encoder 2			
10 … 30 V supply	Brown / Green	**X13: 43**	**X21: 49**	24V	**X11: 43**	24V
0 V supply	White / Green	**X13: 40**	**X21: 40**	GND/0V	**X11: 40**	GND/0V
Track A	Brown	**X13: 51**	**X21: 57**	ENC A+	**X11: 23**	DI3
Track A inverse	Green	**X13: 52**	**X21: 58**	ENC A-	–	–
Track B	Grey	**X13: 53**	**X22: 59**	ENC B+	**X11: 24**	DI4
Track B inverse	Pink	**X13: 54**	**X21: 60**	ENC B-	–	–
Track 0	Red	**X11: 25**	**X21: 61**	DI5/Z+	**X11: 21/22/25** **X12: 26**	DI1, DI2, DI5 DI6
Cable shield	Connect to a large area of the frequency inverter housing or shielding bracket					

Table 1: Colour and contact assignments for TTL / HTL incremental encoders

Information

If the equipment deviates from the standard equipment for the motors (Type 5820.0H40, 10… 30 V encoder, TTL/RS422 or encoder type 5820.0H30, 10 … 30 V encoder, HTL), please note the accompanying data sheet or consult your supplier.

Sine wave encoders (SIN/COS encoders)

The purpose and function of sine wave encoders are comparable with those for incremental encoders. However, the encoder delivers sine wave signals instead of digital pulses.

The supply voltage for the encoder is 10 … 30 V. An external source or the internal voltage can be used as the voltage source.

Function	Wire colours	Connection terminals	
10 … 30 V supply	Brown	**X21: 49**	VO_12V
0 V supply	White	**X21: 40**	VO_0V
Track A	Green	**X21: 57**	A+/SIN+
Track A inverse	Yellow	**X21: 58**	A-/SIN-
Track B	Grey	**X21: 59**	B+/COS+
Track B inverse	Pink	**X21: 60**	B-/COS-
Track 0	Red	**X21: 61**	Z+/RES+
Track 0 inverse	Black	**X21: 62**	Z-/RES-
Cable shield	Connect to a large area of the frequency inverter housing or shielding bracket		

Table 2: Colour and contact assignments for SIN / COS encoders

Hiperface encoders

Hiperface encoders are a mixture between incremental encoders and absolute encoders. The combine the advantages of both types of encoder. The absolute value is generated when the device is switched on and is communicated to the external counter in the controller via the bus-enabled parameter interface with RS485 specification. From this absolute value, counting is then continued incrementally with the analogue sine/cosine signals. During operation, the counted position is continuously compared with the measured absolute position of the encoder.

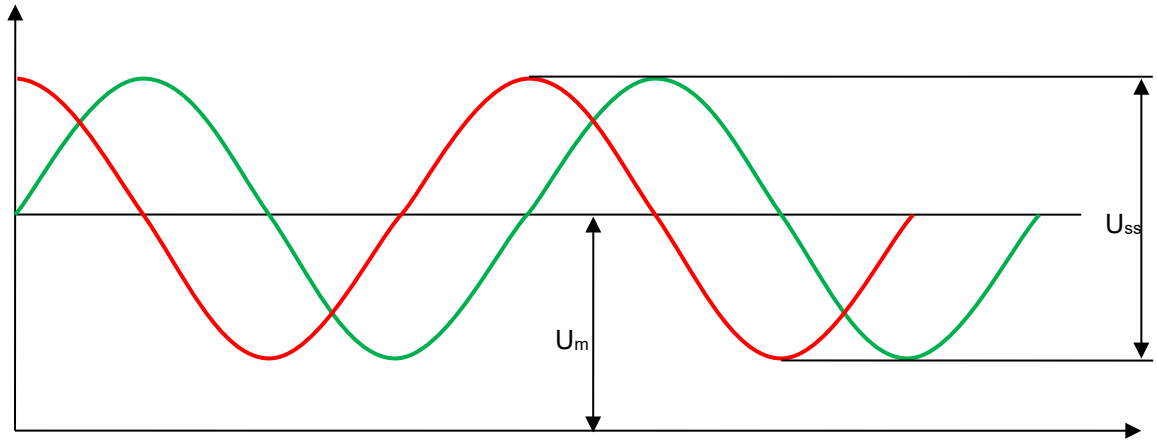
Hiperface encoders are suitable for positioning in combination with the servo mode.

The requirements for the analogue signal are shown in the following table. It should be noted that voltage tolerances have an effect on the accuracy of the determined position.

The supply voltage for the encoder is 7 … 12 V. An external source or the internal 12 V voltage can be used as the voltage source.

Function	Signal designation	Signal voltage
Sine reference voltage	Sin Ref	2.5 V U_m
Cosine reference voltage	Cos Ref	2.5 V U_m
Sine signal	Sin	1 V U_{ss}
Cosine signal	Cos	1 V U_{ss}

Table 3: Hiperface encoder signal details



Function	Wire colours	Connection terminal	
7 … 12 V supply	Red	**X21: 49**	VO_12V
0 V supply	Blue	**X21: 40**	VO_0V
+ SIN	White	**X21: 57**	A+/SIN+
REFSIN	Brown	**X21: 58**	A-/SIN-
+ COS	Pink	**X21: 59**	B+/COS+
REFCOS	Black	**X21: 60**	B-/COS-
Data + (RS485)	Grey or Yellow	**X21: 65**	DAT+/RS485+
Data - (RS485)	Green or Violet	**X21: 66**	DAT-/RS485-
Cable shield	Connect to a large area of the frequency inverter housing or shielding bracket		

Table 4: Colour and contact assignments for Hiperface encoders

Information

Rotary encoder function test

The voltage difference between the SIN and COS track is measured with parameter P651 [-01] and [-02] When the Hiperface encoder is rotated, the voltage difference should range between -0.5 V and +0.5 V.

SSI encoders

SSI encoders whose signals are TTL compatible according to EIA RS 422 can be used.

The zero point of the absolute encoder is determined by its position and should therefore be adjusted accordingly on installation.

The cycle frequency is 100 kHz. With this cycle frequency, cable lengths of up to 80 m are possible. The cables must be in the form of twisted pairs and shielded.

The encoder supply voltage is 0 … 30 V DC. An external source or the internal voltage may be used as the voltage source (depending on the frequency inverter version: 12 V / 15 V / 24 V).

Function	Wire colours [1)]	SSI	
Supply (10 … 30 V)	Brown	**X21: 49**	VO_12V
Sensor U_B	Red	**X21: 49**	VO_12V
0 V supply	White	**X21: 40**	VO_0V
Sensor 0 V	Blue	**X21: 40**	VO_0V
Cycle +	Green	**X21: 63**	CLK+
Cycle -	Yellow	**X21: 64**	CLK-
Data + (RS485)	Grey	**X21: 65**	DAT+/RS485+
Data - (RS485)	Pink	**X21: 66**	DAT-/RS485-
Cable shield	Connect to a large area of the frequency inverter housing or shielding bracket		

[1)] Colour example depending on manufacturer. Other colours are possible.

Table 5: Colour and contact assignments for SSI encoders

BISS encoders

BISS is a further development of the SSI interface. It also operates with 2 RS485 channels. With BISS encoders, the position is transmitted together with a checksum. This enables increased transmission reliability in comparison with SSI.

BISS encoders are also available with an integrated incremental track.

The encoder supply voltage is 0 … 30 V DC. An external source or the internal voltage may be used as the voltage source (depending on the frequency inverter version: 12 V / 15 V / 24 V).

Function	Wire colours [1]	BISS	
Supply (10 … 30 V)	Brown	**X21: 49**	VO_12V
0 V supply	White	**X21: 40**	VO_0V
Track A [2]	Black	**X21: 57**	A+/SIN+
Track A inverse [2]	Violet	**X21: 58**	A-/SIN-
Track 2 [3]	Grey / Pink	**X21: 59**	B+/COS+
Track B inverse [2]	Red / Blue	**X21: 60**	B-/COS-
Cycle +	Green	**X21: 63**	CLK+
Cycle -	Yellow	**X21: 64**	CLK-
Data + (RS485)	Grey	**X21: 65**	DAT+/RS485+
Data - (RS485)	Pink	**X21: 66**	DAT-/RS485-
Cable shield	Connect to a large area of the frequency inverter housing or shielding bracket		

[1] Colour example depending on manufacturer. Other colours are possible.

[2] Optionally available depending on the type of encoder.

Table 6: Colour and contact assignments for BISS encoders

3.2.1 CANopen absolute encoders

Absolute encoders are connected via the internal CANopen interface. The minimum requirement for the absolute encoder is a CANopen interface with CANopen protocol. The CAN bus with CANopen protocol can also be used for control and parameterisation as well as to read out the position of the absolute encoder.

The frequency inverter supports CANopen absolute encoders with communication profile DS 406. If an absolute encoder approved by NORD GmbH & Co. KG is used, automatic parameterisation of the encoder via the frequency encoder is possible. In this case, only the CAN address and the baud rate of the encoder need to be set on the rotary or DIP switches of the encoder. All other necessary parameters are set by the frequency inverter via the CAN bus in the encoder.

3.2.1.1 Approved CANopen absolute encoders (with bus cover)

Encoder type	**Singleturn absolute encoder**
Manufacturer	Kübler
Type	8.5878.0421.2102. S010.K014
Part number	19551882
Singleturn resolution	8192 (13 Bit)
Multiturn resolution	1
Interface	CANopen profile DS406 V3.1
CAN address/baud rate	Adjustable (adr. 51, baud rate 125k)
Bus cover	Yes
Incremental encoder output	No
Supply	10 … 30 VDC
Shaft	Blind hole D=12
Electrical connection	Terminal

Encoder type	**Multiturn absolute encoders**			
Manufacturer	Kübler	Kübler	Kübler	Baumer IVO
Type	8.5888.0421.2102. S010.K014	8.F5888M.0A50.21 22.DG4404	8.5888.0452.2102. S010.K014	GXMMS.Z10
Part number	19551883 (AG7)	19551927 (AG8)	19551881 (AG1)	19556995 (AG3)
Singleturn resolution	8192 (13 Bit)	8192 (13 Bit)	8192 (13 Bit)	8192 (13 Bit)
Multiturn resolution	4096 (12 Bit)	65536 (16 Bit)	4096 (12 Bit)	65536 (16 Bit)
Interface	CANopen profile DS406 V3.1	CANopen profile DS406 V3.1	CANopen profile DS406 V3.1	CANopen profile DS406 V3.0
CAN address/baud rate	Adjustable (adr. 51, baud rate 125k)	Fixed address 33, Baud rate 250k	Adjustable (adr. 51, baud rate 125k)	Adjustable (adr. 51, bd 125k)
Bus cover	Yes	No	Yes	Yes
Incremental encoder output	No	TTL/RS422 2048 pulses	TTL/RS422 2048 pulses	TTL/RS422 2048 pulses
Supply	10 … 30 VDC	10 … 30 VDC	10 … 30 VDC	10 … 30 VDC
Shaft	Blind hole D = 12	Hollow shaft D = 12	Blind hole D = 12	Blind hole D = 12
Electrical connection	Terminal	Cable end 1.5 m	M12 plug connector	Absolute encoder: Terminal Incremental encoder: M12 plug connector

3.2.1.2 CANopen encoder contact assignment

Function	Assigned to SK 5xxP (X9 / X10)	
24 V supply	8	24V
0 V supply	7	0V (GND)
CAN High	1	CAN_H
CAN Low	2	CAN_L
CAN Ground	3	CAN_GND
Cable shield	6	CAN_SHD

4 Function description

4.1 Introduction

The positioning function can be used for positioning and position control tasks. The various methods for setpoint specification and detection of actual values are described below.

Setpoints can be specified as absolute or relative positions. *Absolute position specification* is advisable for applications with fixed positions, for example transfer trolleys, elevators, storage and retrieval devices, etc. *Relative position specification* can be used for all axes which operate step-wise, in particular with endless axes such as turntables and cycled compartmentalised conveyor belts. Setpoint specification is also possible via the bus (e.g. PROFINET, CAN Bus, etc.). For this, the position can be specified as a value or via a combination of bits as a position number or increment. If an optional AS interface is used, in a similar manner to control via control terminals, setpoint specification is only possible by means of a combination of bits.

Switchover between positioning and speed specification is made by parameter set switching. For this, the position control in parameter **P600** is parameterised to “OFF” in one parameter set and to “≠ OFF” in another parameter set. Switching between parameter sets is possible at any time, even during operation.

4.2 Position Detection

4.2.1 Position detection with incremental encoders

For an absolute actual position, a reference point is required with the aid of which the zero position of the axis can be determined. Position detection operated independently of the enabling signal of the frequency inverter and parameter **P600** “Position control”. The pulses from the incremental encoder are counted in the frequency inverter and added to the actual position. The frequency inverter detects the actual position for as long as it is supplied with power. Position changes which are made when the frequency inverter is switched off, do not result in a change of the actual position. Therefore, a reference run is usually necessary for each “Power on” of the frequency inverter.

The resolution or pulse number of the incremental encoder is set in parameter **P301** “Encoder resolution”. By setting negative pulse numbers, the direction of rotation according to the installation position of the encoder can be changed. After switching on the frequency inverter power supply, the actual position = 0 (P619 "Incremental mode" without option “…+Save position”) or it has the value which was present on switch-off (P619 "Incremental mode" with option “…+Save position”).

Information

Frequency inverters without power supply

For frequency inverters without an integrated 24 V DC power supply, the control unit must be supplied with power for at least 5 minutes after the last change of position. This is the only way to ensure that the data are permanently saved in the FI.

If the frequency inverter is not operated in Servo Mode (**P300** “*Control method*” CFC closed-loop), the encoder can be mounted in a position other than on the motor shaft. In this case the speed ratio between the motor and the incremental encoder must be parameterised.

For this, the number of rotations of the encoder are converted into the number of rotations of the motor with the aid of parameter **P607** “Positive speed ratio” and **P608** “Negative speed ratio”.

$n_M = n_G * Ü_b / U_n$

n_M:	Number of motor rotations	
n_G:	Number of encoder rotations	
$Ü_b$:	Positive speed ratio	(**P607 [-01] ... [-03]**)
U_n:	Negative speed ratio	(**P608 [-01] ... [-03]**)

Example

The encoder is installed on the output side of the gear unit. The gear unit has a speed ratio of **i = 26.3**.

The following values are parameterised: **P607 [-01] ... [-03]** = 263

P608 [-01] ... [-03] = 10

Information

Rotation direction

The direction of rotation of the incremental encoder must correspond to the direction of rotation of the motor. With a positive output frequency (direction of rotation right) the actual position value must increase. If the direction of rotation is not correct, this can be corrected with a negative value in **P607** “Speed ratio”.

With the aid of the value in parameter **P609 [-01] ... [-03]** “Offset position” the zero point can be set to a position other than that which is determined by the reference point. The offset is taken into account after conversion of the number of encoder revolutions to the number of motor revolutions. After a change to the positive or negative speed ratio (**P607 [-01] ... [-03]** and **P608 [-01] ... [-03]** the offset must be input again.

4.2.1.1 Reference run

The reference run is started via one of the digital inputs or one of the Bus IO bits. For this, a digital input (**P420**…) or a Bus IO In bit (**P480**…) must be set to function 22. The direction of the reference point search is specified via the functions “*Enable right/left*” The actual setpoint frequency determines the speed of the reference run. The reference point is also read in via one of the digital inputs or the Bus IO In bits (setting 23).

Information

Use of BUS IO In bits

Control via Bus IO In bits requires that a bus setpoint (**P546**…) is assigned the function 17.

Reference runs

The reference run can be performed by various methods. The type of reference run and be selected in parameter **P623** ((please see chapter 6.1.5 "Positioning" on page 70)). Optionally, for the reference run, a frequency can be set via parameters **P624 [-01]** and **P624 [-02]**.

Feedback from the frequency inverter on completion of the reference point run with adoption of the valid reference point can be given via a digital signal. For this, a digital output (**P434**…) or a Bus IO Out bit (**P481**…) must be set to function 20.

Information

Loss of position

If an incremental encoder is used for position detection, in parameter P619 "Incremental mode" the setting “+ Save position” function 1 or 3) should be used. Otherwise the actual values (position, reference point) are lost when the control voltage is switched off.

The reference point run is aborted by removal of the “Enable” or by “Quick Stop” or “Disable voltage”. No error message is issued.

For referencing with the “*Reference run*” function, the position control, i.e. the present operation mode is interrupted.

4.2.1.2 Reset position

Alternative to a reference run, one of the digital inputs (**P420**…) or one of the Bus IO In bits (**P480**…) can be set to setting 61 “*Reset position*”. Unlike with function 23 “*Reference run*” the input or the Bus IO bit is always effective and sets the actual position to 0 immediately after a signal change from 0 → 1. If an offset has been parameterised in parameter **P609** the axis is moved by this value.

A position reset is performed regardless of the “*Position control*” setting in parameter **P600**. If relative positioning (function 1) is selected in parameter **P610** the setpoint position is simultaneously set to the value 0.

Referencing with function 61 “*Reset position*” can be performed during active position control, i.e. during positioning operation.

Information

IE4 motor operation

The following must be noted if a CANopen combination encoder (absolute and incremental encoder) is used to detect the rotor position of an IE4 motor and the absolute encoder is also used for positioning:

The function “*Reset position*” resets both the position and the zero position for rotor position detection. The initial rotor position can no longer be detected.

Information

Repeat accuracy

Referencing with the function “*Reset position*” depends on the tolerance of the reference point switch and the speed with which the switch is approached. Therefore, with this type of referencing, the repeat accuracy is somewhat less than with the function “*Reference run*”, however it is sufficient for most applications.

Information

Use of Bus IO In bits

Control via Bus IO In bits requires that a bus setpoint (**P546**…) is assigned with the function 17.

4.2.2 Position detection with absolute encoders

The absolute encoder digitally transmits the actual position signals to the frequency inverter. The position is always fully available in the absolute encoder and is correct, even if the axis has been moved while the frequency inverter is switched off. A reference point run is therefore not necessary.

If an absolute encoder is connected, parameter **P604** "*Travel measurement system*" must be parameterised to an absolute function (Setting 3 ... 8).

The encoder resolution is set in the parameter **P605**.

If the absolute encoder is not mounted on the motor shaft, the speed ratio between the motor and the absolute encoder must be parameterised. For this, the number of rotations of the encoder are converted into the number of rotations of the motor with the aid of parameter **P607** "*Positive speed ratio*" and **P608** "*Negative speed ratio*".

$n_M = n_G * Ü_b / U_n$

n_M:	Number of motor rotations	
n_G:	Number of encoder rotations	
$Ü_b$:	Positive speed ratio	(**P607 from [-04]**)
U_n:	Negative speed ratio	(**P608 from [-04]**)

Example

The encoder is installed on the output side of the gear unit. The gear unit has a speed ratio of **i = 26.3**.

The following values are parameterised:	**P607 from [-04]** =	263
	P608 from [-04] =	10

Information

Rotation direction

The direction of rotation of the incremental encoder must correspond to the direction of rotation of the motor. With a positive output frequency (direction of rotation right) the actual position value must increase. If the direction of rotation is not correct, this can be corrected with a negative value in **P607** "*Speed ratio*".

With the aid of a value which can be parameterised in parameter **P609 from [-04]** "*Offset position*", the zero point can be set to a position other than that which is determined by the reference point. The offset is taken into account after conversion of the number of encoder revolutions to the number of motor revolutions. After a change to the positive or negative speed ratio (**P607 from [-04]** and **P608 from [-04]** the offset must be input again.

Information

Maximum possible position

The maximum possible position in parameter **P615** "*Maximum position*" results from the resolution of the encoder and the positive or negative speed ratio **P607** and **P608**. However, the maximum value can never exceed +/- 2.000.000 rotations.

4.2.2.1 Additional settings: CANopen absolute encoders

The baud rate and the CAN address must be set on the encoder. Refer to the manufacturer's instructions for the switch assignment on the encoder

The CAN address for the absolute encoder must be set in parameter **P515 [-01]** "*CAN Address*" according to the following formula:

Absolute encoder CAN Address= Frequency inverter CAN Address (**P515 [-01]**) + 1

The CAN baud rate which is set in the encoder must be identical to that in parameter **P514** "*CAN baud rate* and all other participants in the bus system.

If the encoder is parameterised via the frequency inverter the baud rate also specifies the transmission cycle for the absolute encoder position.

If several CANopen absolute encoders are used in a bus system. e.g. for synchronous mode, different transmission cycle times can be set for the bus master and the CANopen absolute encoders.

With parameter **P552** "*CAN Master cycle*" the cycle time in array **[-01]** can be parameterised for the CAN/CANopen- master mode and for the CANopen absolute encoder in array **[-02]**. Care must be taken that parameterised values for the actual cycle time is not less than those in the Minimum Value column This value depends on the CAN baud rate (**P514**).

P514 10 kBaud	P552 [-01][1)] Bus Master [ms]	P552 [-02][1)] CANopen encoder [ms]	tz[2)] [ms]	Bus load[3)] [%]
10	50	20	10	42.5
20	25	20	10	21.2
50	10	10	5	17.0
100	5	5	2	17.0
125	5	5	2	13.6
250	5	2	1	17.0
500	5	2	1	8.5
1000[4)]	5	2	1	4.25

1 Resulting factory setting
2 Minimum value for actual cycle time
3 Caused by an encoder
4 Only for test purposes

Table 7: CANopen encoder cycle time depending on the baud rate

The bus load which is possible in the system always depends on the system-specific real time. Very good results are obtained with a bus load of less than 40%. Under no circumstances should a bus load greater than 80% be selected. Other possible bus traffic (setpoint and actual values for the frequency inverter and other pus participants) should also be taken into account for the estimation of the bus load,

Additional explanations relating to the CAN interface can be obtained from Manual BU 2500.

Information

24 V DC CAN bus supply

To enable communication via the CAN bus, this must be supplied with 24 V DC.

4.2.2.2 Additional settings: SSI Absolute encoders

The protocol settings for SSI absolute encoders are made in parameter **P617**.

This defines

- The format in which positions are to be transmitted (Binary / Gray Code),
- Whether a power failure on the encoder is reported to the frequency inverter (“*Power Fail Bit*”),
- Whether the encoder supports the communication variant “*Multiply-Transmit*”, in which the position is transmitted a second time in mirrored form in order to improve transmission reliability.

4.2.2.3 Referencing of an absolute encoder

In a similar manner to incremental encoders, via the functions 22 “*Reference run*” (🕮 Section 4.2.1.1 "Reference run") and 61 “*Reset position*“ (🕮 Section 4.2.1.2 "Reset position") absolute encoders can be set to the value “0” or the value set in parameter **P609 [-04]** (CANopen encoder) or **P609 [-05]** (universal encoder) “*Offset Position*”.

The accuracy for resetting the encoder position depends to a large extent on the actual speed of movement, the bus load and the baud rate, as well as the type of encoder. Therefore the *absolute encoder may only be reset while at a standstill*.

If both incremental encoders and absolute encoders are connected to the frequency inverter, both encoders are reset on execution of the function „*Reference run*” or “*Reset position*”

Information

Restrictions for SSI encoders

With SSI encoders, the position can only be changed with a position offset **P609 [-05]** . A reset (“*Reset position*” / “*Reference run*”) is not possible.

4.2.2.4 Manual commissioning of the CANopen absolute encoder

Configuration of the encoder is performed by parameterisation on the frequency inverter.

Alternatively, configuration can be carried out via a CAN Bus Master which must be additionally integrated into the system.

The following settings can be made if the encoder is set to the status “*Operational*” via the CAN Bus Master.

Function	Parameters	Note
Resolution	6001h and 6002h	Value according to P605
Cycle time	6200h	Recommendation: Value ≤ 20 ms (The setting affects the response speed of the position control)

4.2.3 Encoder monitoring

With active position control (**P600**, setting ≠ 0) the function of a connected absolute encoder is monitored. A corresponding error message is generated if a fault occurs. The last valid position in the frequency inverter remains visible (**P601**).

Monitoring is disabled if position control is not active (**P600**, setting = 0). No error message is generated in case of an encoder fault. The actual encoder position remains on display in parameter **P601**.

- If an absolute and an incremental encoder are present, the position difference between the two encoders can be monitored with parameter **P631** "*Slip error 2 encoders*". The maximum permissible position deviation between the absolute and the incremental encoder is specified by the value which is set in this parameter. If the permissible deviation is exceeded error message ***E14.6*** is triggered.
- With parameter **P630** "Position slip error" the actual position of the encoder is compared with the change of position which is calculated from the actual speed (estimated position) If the position difference exceeds the value set in **P630** error message ***E14.5*** is triggered.

  This method of slip error monitoring is subject to technical inaccuracies and requires larger values to be set for longer travel distances. These values must be determined experimentally.
  On reaching a target position, the estimated position is replaced by the actual position value from the encoder in order to prevent a summation of errors.

- The permissible working range can be specified with parameters **P616** "*Minimum position*" and **P615** "*Maximum position*". If the drive goes outside of the permissible range, error messages ***E14.7*** or ***E14.8*** are triggered.

  Position setpoints which are larger than the values in **P616** or smaller than those in **P615** are automatically limited by the frequency inverter to the values which are set in the two parameters.

Position monitoring is not active if the value 0 or P621, value 1 ore P619 one of the values 2 or 3 are set in the relevant parameters.

4.2.4 Linear or optimum path position methods

The encoder which is used for positioning is enabled via parameter **P604** "*Path measurement system*" Allocation of the measuring method for linear or rotary systems ("optimum path measurement") is performed with **P619** or **P621**.

If the "optimum path" measuring method is used, the overrun point must be specified in **P620**.

Parameter **P601** "*Actual position*" should be selected to check the setting and function of the encoder.

Parameter settings for linear positioning method

	Encoder type	Linear
Incremental encoders	**P604** (0 … 2)	**P619** (0 or 1)
CANopen encoder	**P604** (3)	**P621** (0)
Absolute encoder	**P604** (3 … 8)	**P621** (0)

Parameter settings for optimum path positioning method

	Encoder type	Path optimised	Overflow point
Incremental encoder	**P604** (0 … 2)	**P619** (2 or 3)	**P620**
CANopen encoder	**P604** (3)	**P621** (1)	
Absolute encoder	**P604** (3 … 8)	**P621** (1)	**P620**

4.2.4.1 Optimum path positioning

For turntable applications, the individual positions are distributed around the circumference. Use of linear positioning is not advisable for this, as the frequency inverter would not always take the shortest path to the selected position (e.g. start position -0.375, specified position +0.375, see the following illustration “linear path”

In contrast, positioning with path optimisation automatically selects the shortest path and therefore independently decides the direction of rotation of the drive. The drive also runs over the overrun point of the relevant encoder (see the following illustration “Optimum path”). The overrun point corresponds to half of a rotation of the encoder (*Singleturn applications*).

If the number of encoder rotations deviates from the number of rotations of the turntable application (*Multiturn applications*), the overrun point, i.e. the point at which the application (turntable) has rotated one half of a rotation must be determined. This value must be entered in parameter **P620** „*Absolute encoder*“.

Information

Overrun point in P620

For multiturn applications care must be taken that the overrun point can only be entered with a precision of three decimal places.

Deviations from this result in an additive error after each overrun. In this case it is advisable to reference the encoder after each rotation of the system.

The zero point of a singleturn absolute encoder is determined by its installation and can be varied with parameter **P609 from [-04]** “*Offset position*”. If an incremental encoder is used, either a “Reference run” or a “Reset position” must be performed in order to determine the zero position. The zero position can be varied by an entry in parameter **P609 [-01] ... [-03]** “*Offset position*”.

Information

Multiturn absolute encoders

A multiturn absolute encoder can also be used as a singleturn absolute encoder. For this, the multiturn resolution (**P605 [-01]**) must be set to “0”.

Information

Incremental encoder

The incremental encoder must be mounted directly onto the motor. There must be no additional speed ratio between motor and encoder.

Examples of “singleturn applications”

The overrun point for a singleturn application is calculated according to the following equation:

$\pm n_{max} = 0.5 * \ddot{U}_b / U_n$

n_{max}:	Number of motor revolution = Overflow point	**(P620)**
$\ddot{U}_b$:	Positive speed ratio	(**P607 [-xx]**)[1)]
U_n:	Negative speed ratio	(**P608 [-xx]**)[1)]

1) Depending on the encoder used for position control, e.g. CANopen encoder: [-xx] = [-04]

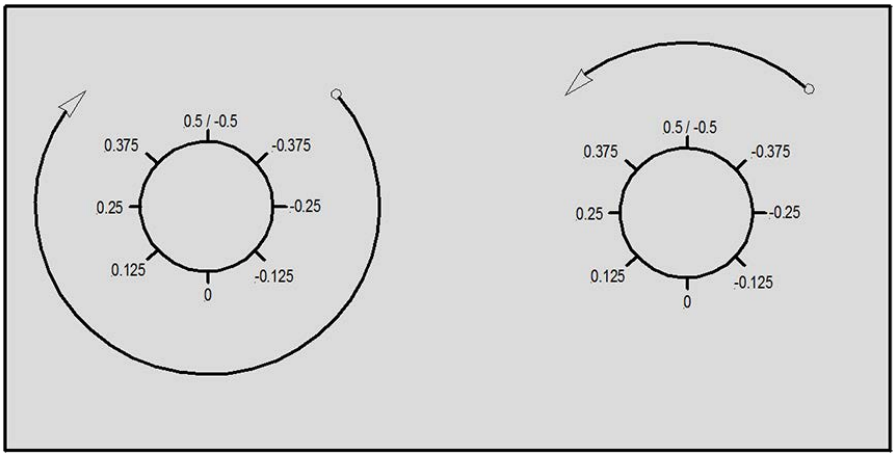
Example 1

The encoder, a CANopen encoder, is mounted on the motor shaft (positive and negative speed ratio = “1“).

$\pm n_{max} = 0.5 * 1 / 1 = 0.5$ rotations

The following values are parameterised:

P607 [-04]	=	1
P608 [-04]	=	1
P620 =	=	0.5



Linear path Optimum path

Figure 1: Turntable positioning with a Singleturn application

Information

Parameterisation P620

In this case (singleturn application, encoder on the motor shaft) **P620** can remain in the factory setting (setting 0).

Example 2

The encoder, a CANopen encoder, is installed on the output side of the gear unit. The gear unit has a speed ratio of **i = 26.3**.

$\pm n_{max} = 0.5 * 263 / 10 = 13.15$ revolutions

The following values are parameterised:

P607 [-04]	=	263
P608 [-04]	=	10
P620 =	=	13.15

Example of a “multiturn application”

The overrun point for a multiturn application is calculated according to the following equation:

The following example is shown for a positive and negative speed ratio of “1”. The entire movement path is 101 rotations of the encoder. The maximum value for the position or overrun point is calculated as follows:

$\pm n_{max} = 0.5 * U_D * Ü_b / U_n$

n_{max}:	Number of motor revolution = Overflow point	**(P620)**
$Ü_b$:	Positive speed ratio	(**P607 [-xx]**)[1)]
U_n:	Negative speed ratio	(**P608 [-xx]**)[1)]
U_D:	Number of revolutions of the encoder for one revolution of the application	

1) Depending on the encoder used for position control, e.g. CANopen encoder: [-xx] = [-04]

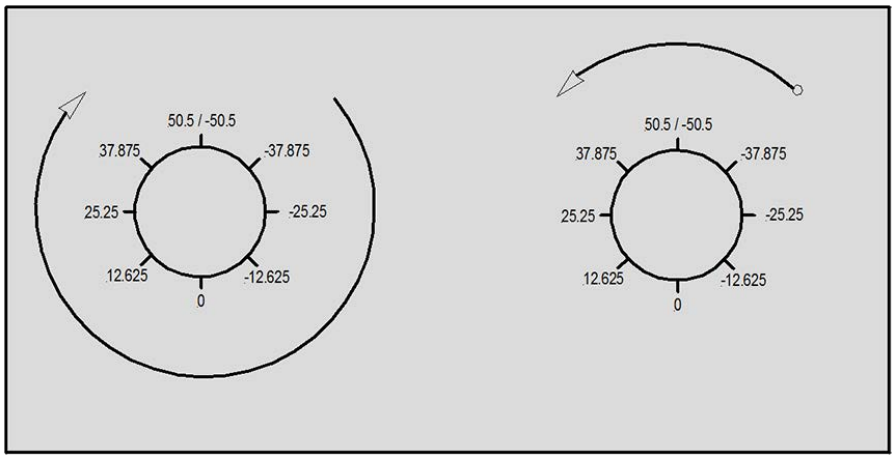
Example 1

The encoder, a CANopen encoder, is mounted on the motor shaft (positive and negative speed ratio = “1“). The entire movement path is **101** rotations of the encoder.

$\pm n_{max} = 0.5 * 101 * 1 / 1 = 50.5$ revolutions

The following values are parameterised:

P607 [-04]	=	1
P608 [-04]	=	1
P620 =	=	50.5



Linear path Optimum path

Figure 2: Turntable positioning with a multiturn application

Example 2

The encoder, a CANopen encoder, is installed on the output side of the gear unit. The gear unit has a speed ratio of **i = 26.3**. The entire movement path is **101** rotations of the encoder.

$\pm n_{max} = 0.5 * 101 * 263 / 10 = 1328.15$ revolutions

The following values are parameterised:

P607 [-04]	=	263
P608 [-04]	=	10
P620 =	=	1328.15

4.3 Setpoint specification

Setpoints can be specified by the following method:

- Digital inputs or Bus IO In bits as absolute position using position array
- Digital inputs or Bus IO In bits as relative position using position increment array
- Bus setpoint

For this, it is irrelevant whether an incremental or an absolute encoder is used for position detection, i.e. detection of the actual position.

4.3.1 Absolute setpoint position (Position array) via digital inputs or BUS IO bits

Positioning with absolute setpoint positions is used if certain fixed positions exist to which the drive is to be moved (“Move to position x”). This includes storage and retrieval equipment.

With the function 0 = “Position array” in parameter **P610** “Setpoint mode”, the positions stored in parameter **P613** can be selected via the digital inputs of the frequency inverter or Bus IO In bits..

The position numbers result from the binary value. A position setpoint (**P613**) can be parameterised for each position number. The position setpoint can be entered either via a control panel (ControlBox or ParameterBox) or with a PC by means of the NORDCON parameterisation and diagnostic software. Alternatively, a digital input or BUS IO In bit must be parameterised to function 24 “Teach-in”. Triggering of this digital function results in adoption of the actual position in the arrays of parameter **P613** (🕮 Section 4.4 "Teach-in function for saving positions")

With function 62 “*Sync. Position array*” (**P420** “*Digital inputs*“ or **P480** „*BUS I/O In bits*“) it is possible to pre-select a stored position without moving to the position immediately. The pre-selected position is only adopted as a setpoint and moved to after the input has been set to “1” (🕮 Section 4.3.3.2 "Relative setpoint position (Position increment array) via the field bus").

If the absolute position is specified via Bus IO bits, the position number results from bits 0 ... 5 of the serial interface. For this, one of the bus setpoints (**P546**…, “*Bus setpoint function*“) must be set to 17 “*Bus IO In Bits 0-7*“ and the function assigned to the relevant bits in **P480** “*BusIO In bits function*“.

Information

Setpoint addition

Position setpoints from different sources are added together. I.e. the frequency inverter adds all individual setpoints which are specified to it to form a resulting setpoint and travels to this destination (e.g. setpoint via digital input + setpoint via bus).

4.3.2 Relative setpoint position (Position array) via digital inputs or BUS IO bits

Positioning with relative setpoint positions is used if no fixed positions, but rather relative positions exist to which the drive is to be moved (“Move by x increments”). This includes endless axes.

As with fixed positions, the position increments are also defined with parameter **P613**. However, the number of increments available is restricted to the first six entries (**P613 [-01] … [-06]**).

When the signal changes from “0” to “1” the value of the selected element is added to the setpoint position. Positive and negative values are possible, so that return to the starting position is possible. Addition is performed for each positive signal flank, regardless of whether or not the frequency inverter is enabled. A multiple of the parameterised increment can therefore be specified by several consecutive pulses to the assigned input. The width of the pulse and the width of the pulse pauses must be at least 10 ms.

If the relative setpoint position is specified via Bus IO bits, the position number results from bits 0 ... 5 of the serial interface. For this, one of the bus setpoints (**P546**…, “Bus setpoint function”) must be set to 17 “*Bus IO In bits 0-7*”. The functions of the relevant bits must be assigned under **P480** “*Bus IO In bits function*”.

4.3.3 Bus setpoints

The setpoint can be transferred via various field bus systems. The position can be specified as *Rotations* or *Increments*.

A motor rotation corresponds to a resolution of 1/1000 rotations or 32768 increments.

The source of the bus setpoints must be selected via the corresponding field bus in parameter **P510** "*Setpoint source*". The settings for the position setpoints which are to be transmitted via the bus must be set in parameters **P546**… "*Bus setpoint function*".

The High word and the Low word must be used in order to be able to use the entire position range (32 bit position).

Example

One motor rotation (see value in **P602**) = 1.000 rev. = Bus setpoint 1000_{dec}

4.3.3.1 Absolute setpoint position (Position array) via the field bus

If "*Setpoint mode*" function 3 "*Bus*" is parameterised in parameter **P610** the setpoint specification for the absolute position is **only** made via a field bus system. The settings for the field bus system are made in parameter **P509** "*Control word source*". With the "*Bus*" function, the functions of the digital inputs and the Bus IO In bits for position specification from parameter **P613** "Position" / Position array element are not enabled.

4.3.3.2 Relative setpoint position (Position increment array) via the field bus

If "*Setpoint mode*" function 4 "*Bus increment*" is parameterised in parameter **P610** the setpoint specification for the relative position is only made via a field bus system. The settings for the field bus system are made in parameter **P509** "*Control word source*". The setpoint is adopted on a change of flank from "0" to "1" for function 62 "*Sync. position array*" (**P420** or **P480**).

4.4 Teach-in function for saving positions

As an alternative to direct input, parameterisation of the absolute setpoint position can also be performed via the function "*Teach-in*".

Two inputs are required for "*Teach-in*" via digital inputs or Bus IO In bits. One input or one of the parameters **P420**… or **480** is parameterised to function 24 "*Teach-in*" and a further input must be parameterised to function 25 "*Quit Teach-in*".

The "*Teach-in*" function is started with a "1" signal to the relevant input and remains active until the signal is withdrawn.

With a change from "0" to "1" of the "*Quit Teach-in*" signal the actual position value is saved as a position setpoint in parameter **P613** "*Position*". The position number or the position array element or position increment array element is specified with function 55 … 60 "*Bit 0 … 5 PosArr / Inc*" of the digital inputs **P420** or Bus IO In bits **P480**.

If no input is accessed (position 0) the position number is generated with an internal counter. The counter is increased with each position adoption.

Example

- Start of "*Teach-in*" without position specification:
  Internal counter has the value 1,
- Triggering of "*Quit Teach-in*" function
  - Saving of the actual position in the first storage space (**P613 [-01]**)
  - Increase of the internal counter to 2
- Triggering of "Quit Teach-in" function
  - Saving of the actual position in the first storage space (**P613 [-02]**)
  - Increase of the internal counter to 3

etc.

As soon as a position is addressed via the digital inputs, the counter is set to this position.

As long as "Teach-in" is active, the frequency inverter can be accessed with enable signals and frequency setpoints (as for **P600** "*Position control*" setting "*Off*")

The "Teach-in" function can also be implemented via a serial interface or Bus IO In bits. For this, one of the bus setpoints (**P546**…, "*Bus setpoint function*") must be set to "*Bus IO In bits 0..7*". The functions of the relevant bits must be assigned under **P480** "*Bus IO In bits function*".

4.5 Speed ratio of setpoint and actual values

Position values relate to motor rotations. If a different reference is required, with the aid of parameter **P607** [-07] the “Positive speed ratio” and **P608** [-07] the negative speed ratio ratio can be converted to a different unit. No decimal places can be entered in the parameters **P607** “*Positive speed ratio*” and **P608** “*Negative speed ratio*”. To achieve greater accuracy, the two values must both be multiplied by a factor which is as large as possible. The product must not exceed the value 2.000.000 i.e. the factor must not be too large.

Example

Lifting equipment

- Unit in [cm]
- Gear unit: i = 26.3
- Drum diameter: d = 50.5 cm
- Factor: 100 (selected)

$$\frac{\text{Reduction ratio (P608)}}{\text{Speed ratio (P607)}} = \frac{\pi \times 50{,}5cm}{26.3} = \frac{158.65 \times 100}{26.3 \times 100} = \frac{15865}{2630} \approx \frac{6cm}{revolution.}$$

The required unit can be selected in parameter **P640** “*Pos. value unit*”. Accordingly, for this example parameter **P640** must be parameterised to function 4 = “*cm*”.

Information

The following formula must be used for Modulo Pos:

1. **Kübler encoders AG1** (part number 19551881): **2 x P620 * P607[7]/P608[7] ≤ 1024**
2. **Kübler encoders AG8** (part number 19551927): **2 x P620 * P607[7]/P608[7] ≤ 16386**

Encoder malfunctions will occur if the value is larger. The encoder cannot be used.

4.6 Position control

4.6.1 Position control: Positioning variants (P600)

Four different positioning variants are possible.

- Linear ramp with maximum frequency (**P600**, setting 1)

  Acceleration is linear. The speed of constant movement is always according to the maximum frequency which is set in parameter **P105**. The acceleration time **P102** and the deceleration time **P103** relate to the maximum frequency **P105**.
  Example

  P105 = 50 Hz, **P102** = 10 s;
  Ramp time = **P102** = 10 s
  → The drive accelerates from 0 Hz to 50 Hz in 10 s

- Linear ramp with setpoint frequency (**P600**, setting 2)

  Acceleration is linear. The speed for constant movement is specified with the frequency setpoint. This can be changed via the analogue input or a bus setpoint. The acceleration time (**P102**) and the deceleration time (**P103**) relate to the maximum frequency (**P105**).
  Example

  P105 = 50 Hz, **P102** = 10 s, Setpoint 50 % (25 Hz);
  Ramp time = **P102*** 0.5 = 5 s
  → The drive accelerates from 0 Hz to 25 Hz in 5 s

- S-ramp with maximum frequency (**P600**, setting 3)

  The speed of constant movement is always according to the maximum frequency which is set in parameter **P105**, however in positioning mode, the S- ramps are used for the frequency ramps. In contrast to the conventional linear frequency increase or reduction according to the acceleration or deceleration time, acceleration or deceleration is according to “soft”rounding (jerk-free) from a static state. Also, the acceleration or deceleration is gradually reduced when the final speed has been reached. The S-ramp always corresponds to a rounding of 100% and only applies for positioning. The effective *ramp time is doubled* by the use of S-ramps. The acceleration time (**P102**) and the deceleration time (**P103**) relate to the maximum frequency (**P105**).
  Example

  P105 = 50 Hz, **P102** = 10 s;
  Ramp time = **P102** * 2 = 10 s* 2 = 20 s
  → The drive accelerates from 0 Hz to 50 Hz in 20 s

  The S-ramp function is disabled during reference runs.

- S-ramp with setpoint frequency (**P600**, setting 4)

  The speed for constant running is specified with the frequency setpoint. However, in positioning mode, the S-ramps are used as the frequency ramps (see previous paragraph).
  The setpoint frequency can be changed via the analogue input or a bus setpoint. The acceleration time (**P102**) and the deceleration time (**P103**) relate to the maximum frequency (**P105**) and are calculated as follows:

  Ramp time = 2 * Acceleration time * √(Setpoint frequency / Maximum frequency)

  Example

  P105 = 50 Hz, **P102** = 10 s, Setpoint 50 % = Setpoint frequency 25 Hz;
  Ramp time = 2 * **P102** * √ (Setpoint frequency/ **P105**) = 2 * 10 s * √ (25 Hz / 50 Hz)
  → The drive accelerates from 0 Hz to 25 Hz in 14.1 s

  The S-ramp function is disabled during reference runs.

Information

Setpoint frequency or ramp times

During positioning movement changes to the setpoint frequency or the ramp times have no effect on the acceleration or final speed of the drive. The new valuers are only adopted and included in the calculation for the positioning movement after the target position has been reached.

Information

P106: Ramp smoothing

Parameter P106 "*Ramp smoothing"* is disabled when position control is active (P600, setting ≠ 0).

Information

Effective ramp time

The actual or effective ramp time can deviate from the parameterised values if load limits are reached or in case of short movement distances.

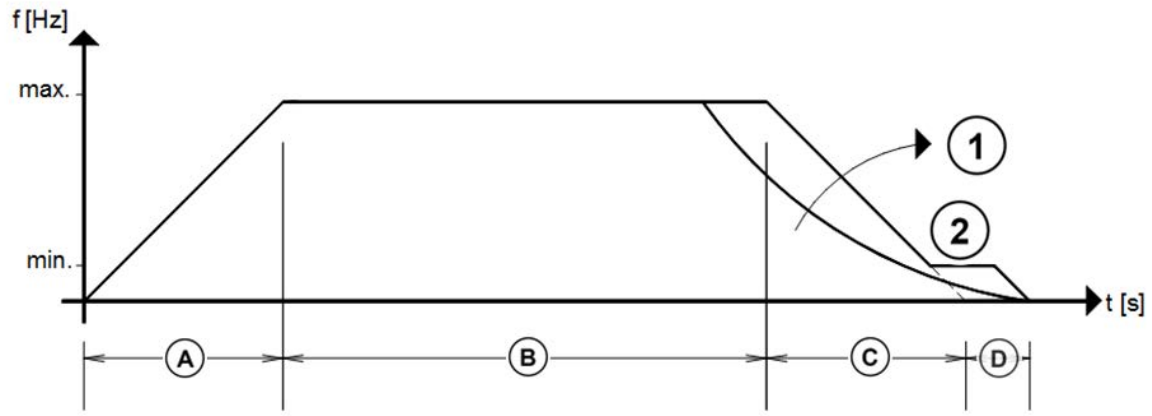
4.7 Position control: Function

Position control functions as a P control loop. The setpoint and actual positions are continuously compared with each other. The setpoint frequency is formed by multiplication of this difference with parameter **P611** "*Position controller P.*" The value is then limited to the maximum frequency which is parameterised in parameter **P105**.

A path time is calculated from the deceleration time parameterised in **P103** and the actual speed. Without consideration of the deceleration time by the path calculation, the speed would usually be reduced too late and the specified position overshot. Examples are highly dynamic applications with extremely short acceleration and deceleration times, as well as applications in which only small path increments are specified.

A so-called target window can be specified in parameter **P612** "*Large target window*". Within the target window, the setpoint is limited to the minimum frequency which is set in **P104** and therefore enables a type of slow running. This frequency cannot be less than 2 Hz. The "*Slow running*" function is especially advisable for applications with greatly varying loads or if the drive has to be operated without speed control (**P300** = „VFC open-loop").

Parameter **P612** defines the starting point and therefore the path for the slow movement, which ends at the specified position. This has no effect on the output message "*Position reached*" (e.g. parameter **P434**).



A =	Acceleration time
B =	Travel with maximum frequency
C =	Deceleration time
D =	Time determined by the "*Large target window*" (**P612**)
1 =	Position controller P
2 =	Travel with minimum frequency

Figure 3: Position control sequence

4.8 Remaining path positioning

Remaining path positioning is position control variant. For this, on a trigger pulse, the drive changes from normal speed control to position control and travels for a defined distance before coming to a standstill.

Relevant parameters for remaining path positioning

Parameters	Value	Meaning
P420… or P480	78	Remaining path trigger
P610	10	Remaining path positioning
P613 [-01]	xx	Remaining path if the drive is enabled with "*Enable right*"
P613 [-02]	xx	Remaining path if the drive is enabled with "*Enable left*"

Sequence for remaining path positioning

After enabling, the drive unit first moves with the setpoint frequency until there is a positive flank 0 → 1 from the sensor at the input with function "*Trigger remaining path*". The drive then switches to position control and then moves for the distance which has been programmed in parameter **P613** [-01] or [-02]. If a position setpoint is transmitted to the frequency inverter via the bus, this is added to the value in **P613** [-01] or [-02]. If no value is entered in **P613** [-01] or [-02] the bus setpoint represents the relative remaining path.

Once the target position has been reached, the drive remains in this position.

A new pulse at the input with the function "*Trigger remaining path*" triggers the function again. The drive then moves a further remaining path. For this it is irrelevant whether the drive is stationary at its target position or is still moving.

The following options are available to start a new remaining path positioning process (start in setpoint mode):

- Stop the drive (remove enable) and enable the drive again, or
- Trigger digital-In function 62 "*Sync. position array*" (via digital input **P420**…, or BUS IO In bit **P480**)

The status message "*Position reached*" is only displayed after remaining path positioning is complete. During constant movement at the setpoint frequency the status message "*Position reached*" is disabled.

The accuracy of remaining path positioning depends on the jitter of the response time, the speed and the initiator which is used. The jitter of the response time of a digital input is typically 1 … 2 ms. The positioning error therefore corresponds to the distance which is travelled with the present speed during the jitter time.

Remaining path positioning is always performed with a linear ramp. S-ramps which have been set do not have any effect. If a position limit is enabled (**P615** / **P616**), this is taken into account in the constant movement.

4.9 Synchronisation control

A prerequisite for position or synchronisation control is that all of the devices involved communicate with each other via a common bus (CANopen / CAN bus). The master FI transmits its “*actual position*” and „*actual setpoint speed after the frequency ramp*” to the slave FIs. The slave FIs use the speed as the lead and make the remaining adjustments via the position controller. The transfer time for the actual speed and position from the master to the slave FIs creates an angle or position offset which is proportional to the speed of movement.

ΔP = n[rpm] / 60 * Cycle time [ms] / 1000

A speed of 1500 rpm and a transfer time of approx. 5 ms results in an offset of 0.125 rotations or 45°. This offset is partly adjusted for by corresponding compensation by the slave drive. However, a jitter (fluctuation) of the cycle time remains, which cannot be compensated. In the selected case an angular error of approx. 9° remains. This only applies if a CANopen / CAN bus connection with a baud rate of at least 100 kBaud is used to couple the two drives. Coupling with a lower baud rate increases the deviation considerably and is therefore not recommended.

Coupling the drives via CANopen also enables the use of CANopen absolute encoders. However, there must be no more than five slave frequency inverters in this network. This is the only way to ensure that the bus load remains less than 50 % and therefore a deterministic behaviour remains ensured.

4.9.1 Communication settings

Establishment of communication between the Master and Slave **CANopen** requires the following settings.

Master frequency inverter

Parameters	Value	Meaning
P502 [-01]	20	Setpoint frequency after frequency ramp [1)]
P502 [-02]	15	Actual position increment High word [2)]
P502 [-03]	10	Actual position increment Low word [2)]
P503	3	CANopen
P505	0	0.0 Hz
P514	5	250 kBaud (at least 100 kBaud must be set)
P515 [-03]	$P515_{Slave}$ [-02]	Broadcast Master address

1) If enabling is not transmitted from the master to the slave, i.e. the slave is only enabled in one direction, but the master rotates in both directions, instead of **"***Setpoint frequency after frequency ramp***" "***20***"** the function "*Actual frequency without slip master value***" "***21***"** must be used.

2) The actual position must be transferred to the slave(s) as increments in the setting. Otherwise the number of transmission time errors increases.

Slave frequency inverter

Parameters	Value	Meaning
P510 [-01]	10	Main setpoint from CANopen broadcast
P510 [-02]	10	Auxiliary setpoint from CANopen broadcast
P505	0	0.0 Hz
P514	$P514_{Master}$	Setting according to the value in the Master
P515 [-02]	$P515_{Master}$ [-03]	Broadcast slave address
P546 [-01]	4	Frequency addition [1)]
P546 [-02]	24	Setpoint position increment High word
P546 [-03]	23	Setpoint position increment Low word
P600	1 or 2	Position control ON [2)]
P610	2	Synchronous running

1) The "*Frequency addition*"setting is necessary in order to optimise the calculation of the speed and minimise control deviations relative to the master. However, this greatly restricts the ability of catching up any position deviations relative to the master at maximum speed.

2) Both settings are possible; in synchronous mode, positioning is always performed with the maximum possible frequency.

Establishment of communication between the Master and Slave via the **CAN-Bus** is also possible and requires the following settings.

Master frequency inverter

Parameters	Value	Meaning
P502 [-01]	20	Setpoint frequency after frequency ramp [1]
P502 [-02]	15	Actual position increment High word [2]
P502 [-03]	10	Actual position increment Low word [2]
P503	2	CAN
P505	0	0.0 Hz
P514	5	250 kBaud (at least 100 kBaud must be set)
P515 [-01]	0	Address 0 (📖 Section “Monitoring functions – Master switch-off“)

1) If enabling is not transmitted from the master to the slave, i.e. the slave is only enabled in one direction, but the master rotates in both directions, instead of **“***Setpoint frequency after frequency ramp***” “***20***”** the function ”*Actual frequency without slip master value***” “***21***”** must be used.

2) The actual position must be transferred to the slave(s) as increments in the setting. Otherwise the number of transmission time errors increases.

Slave frequency inverter

Parameters	Value	Meaning
P510 [-01]	9	Main setpoint from CAN broadcast
P510 [-02]	9	Auxiliary setpoint from CAN broadcast
P505	0	0.0 Hz
P514	$P514_{Master}$	Setting according to the value in the Master
P515 [-01]	128	Address 128 (📖 Section “Monitoring functions – Master switch-off“)
P546 [-01]	4	Frequency addition [1]
P546 [-02]	24	Setpoint position increment High word
P546 [-03]	23	Setpoint position increment Low word
P600	1 or 2	Position control ON [2]
P610	2	Synchronous running

1) The “*Frequency addition*“setting is necessary in order to optimise the calculation of the speed and minimise control deviations relative to the master. However, this greatly restricts the ability of catching up any position deviations relative to the master at maximum speed.

2) Both settings are possible; in synchronous mode, positioning is always performed with the maximum possible frequency.

4.9.2 Ramp time and maximum frequency settings on the slave

In order for the slave to be able to perform the control, the ramp times should be selected somewhat smaller than for the master and the maximum frequency should be selected somewhat higher.

Slave frequency inverter

Parameter	Value
P102	0.5 .. 0,95 * $P102_{Master}$
P103	0.5 .. 0,95 * $P103_{Master}$
P105	1.05 .. 1.5 * $P102_{Master}$
P410	0
P411	$P105_{Master}$

4.9.3 Speed and position controller settings

1. Set the speed (P300 et seq.) and position controller (P600 et seq.) *independently* in all FIs.
2. Start "*Synchronisation*" position control.

The controller settings greatly depend on the drive characteristics, the drive task and the load conditions. Therefore they cannot be planned in advance and must be performed and optimised experimentally on the system.

In principle, tighter controller settings usually obtain better dynamic results. However, a rather moderate setting of the *I-component* in the *speed controller* is advisable for optimum position control.

The speed controller should be set for a slight overshoot. This results in a *P-component* which is as high as possible (until noises occur at low speeds) and a rather moderate *I-component.*

The torque limit and the selected ramps must be set so that the drive can always follow the ramp.

Information

Controller settings

Detailed information for setting and optimising speed and position controllers can be found on our website www.nord.com in the application guide AG 0100 and AG 0101.

4.9.4 Compensation of a speed ratio between master and slave

Setting a fixed speed ratio

A speed ratio between the master and the slave can be taken into account by setting a fixed speed ratio with the parameters **P607** "*Positive speed ratio*" and **P608** "*Negative speed ratio*".

The speed ratio is entered in the arrays of the encoder which is not used.

N_{Slave} = P607 [-xx] / P608 [-xx] * N_{Master}

$P105_{Slave}$ = P607 [-xx] / P608 [-xx] * N_{Master} * 1.05 … 1.5

Setting a variable speed ratio

With the use of an analogue input the speed ratio between the Master and the slave can be continuously varied between -200% and a +200% of the speed of the Master.

For this, the relevant analogue input (**P400**…) must be set to function 47 "*Gearing speed ratio*". With the adjustment of the analogue input (**P402**… / **P403**…) this is scaled according to the existing requirements. Negative values change the direction of rotation.

It is possible to change the speed ratio "online", i.e. during operation. However, it must be noted that during adjustment the position slip error may have considerably larger values than during normal synchronous movement. The reason for this is the necessary adjustment to the new speed and may need to be taken into account by changing the permissible slip error (in parameter **P630** "*Pos. slip error*").

4.9.5 Monitoring functions

4.9.5.1 Achievable accuracy of position monitoring

The deviation between the master and the slave can be monitored with the status message "*Position reached*" (e.g.: **P434**, setting 21) from the slave. The achievable accuracy of this message and therefore the offset between the master and the slave drive depends on several factors. In addition to the settings of the speed and position controller, the control system, i.e. the drive and the mechanics of the system also play as decisive role.

However, the minimum value of the achievable accuracy is governed by the type of transmission. An offset of 0.1 rotations must always be expected. In practice, a value greater than 0.25 motor rotations should be planned for. The message "*Position reached*" disappears if the value which is set in **P625** "*Output hysteresis*" is exceeded or the difference between the lead and the actual speed exceeds 2 Hz + **P104** "*Minimum frequency*"". The minimum frequency of the slave can be determined from the following equation.

P104 = 0.25 ... 1,0 * (**P625** [Rotation] * 4.0 Hz * **P611** [%]) – 2 Hz

For a permissible deviation of one rotation and a value of 5% in **P611** „*Position controller P*" this results in a speed component of the position controller of 20 Hz. If **P104** is set to considerably lower values, the status message is determined by the excess speed of the slave and not by the maximum position deviation. This applies to an even greater extent for shorter slave ramp times.

4.9.5.2 Master shut-down on slave error or position slip error

With a master/slave coupling, errors of the master are automatically treated by transfer of the position to the slave. In case of an error in the master, a synchronisation malfunction is therefore ruled out as long as the communication is intact. The slave continues to control according to the position of the master.

If the slave cannot follow the specified position of the master or the slave goes into an error state, appropriate information and a response by the master are necessary. This can either be performed by a higher level control system or by establishing a second communication relationship between the slave and the master. For this, the slave frequency encoder sends the master the bit "*Position reached*" and/or "*Error*" as a Bus IO bit. The master can use this signal, e.g. to trigger a quick stop or to change to the "*Error*" state and shut down.

Example

- A fault occurs in the slave The FI switches to the "*Error*" state. As a result, the master switches directly to the "*Error*" state.
- The slave cannot follow the master due to a mechanical blockage. The parameterised slip error limit is exceeded, i.e. the status message "*Position reached*" disappears on the slave. The master stops. The master can only be re-enabled if the slave is within the specified tolerance again.

The following settings are necessary to set up the required second communication channel.

Master frequency inverter

Parameters	Value	Meaning
P426	$P103_{Master}$	Deceleration time on slave fault
P460	0	Watchdog time = 0 → "Customer error"
P480 [-01]	18	Watchdog
P480 [-02]	11	Quick stop
P510 [-02]	10	CANopen Broadcast
P546	17	Bus IO bit

Slave frequency inverter

Parameters	Value	Meaning
P481 [-01]	7	Fault
P481 [-02]	21	Position reached
P502 [-01]	12	Bus IO OUT bits 0-7
P502 [-02]	15	Actual position increment High word [1)]
P502 [-03]	10	Actual position increment Low word [1)]

1) Parameterisation optional. Parameterisation is not required for monitoring.

In addition, the CAN addresses of the devices must be selected so that they cannot be sent with the same identifier. The identifier to which the CAN master function is set depends on the CAN address which is set (**P515** [-01]).

P515 CAN Address	Broadcast Identifier	Addressed slave FIs
0 … 127	1032	0 – 255
128, 136, 144, 152, …, 240, 248	1024	0 – 31
129, 137, 145, 153, …, 241, 249	1025	32 – 63
130, 138, 146, 154, …, 242, 250	1026	64 – 95
131, 139, 147, 155, …, 243, 251	1027	96 – 127
132, 140, 148, 156, …, 244, 252	1028	128 – 159
133, 141, 149, 157, …, 245, 253	1029	160 – 191
134, 142, 150, 158, …, 246, 254	1030	192 – 223
135, 143, 151, 159, …, 247, 255	1031	224 – 255

Table 8: Address allocation

Example

$P515_{Master}$ = 1
$P515_{Slave}$ = 128

Communication between the master and the slave must be monitored in both directions with a timeout (**P513**).

In case of coupling via CANopen the broadcast transmitting and receiving addresses are set separately with the array parameter **P515** (🕮 Section 4.9.1 "Communication settings").

Information

Address "0"

It is recommended that as low a value as possible is used for selection of the address. A low address sets a higher priority. This optimises communication between the master and the slave and therefore the synchronisation characteristics of the drive.

However, for CANopen, the address “0” is reserved for certain special uses. To prevent overlaps and possible malfunctions, the address = should not be used.

4.9.5.3 Slip error monitoring on the slave

A further option for slip error monitoring on the slave can be implemented with parameter **P630** “*Pos. slip error*”. For this, with *active synchronisation* and *enabled FI* the specified and the actual position are compared. If the slave is not enabled, the position of the master may deviate from slave position without a corresponding error message.

4.9.6 Slave axis reference run in a synchronous application

Position detection with **absolute encoders** typically does not require a reference run. Therefore this is always preferable for systems in which no discrepancy, i.e. no position deviation may occur, e.g. for gantry hoist systems.

If **incremental encoders** are used for position detection, the axes (master and slave) must be referenced occasionally (🕮 Section 4.2.1.1 "Reference run").

If the master and slave are *not discrepant* from each other, i.e all axes are operating synchronously, the entire system is referenced. I.e. the slave must be in active synchronisation with the master (synchronisation enabled). The reference run should then be performed in the following steps via an external control unit (all steps with a minimum time offset of 20 ms):

1. Move entire system to reference point
2. Remove master enabling
3. Remove slave enabling
4. Perform “Reset position” on the master (**P601**$_{Master}$ = 0, **P602**$_{Slave}$ switches over)
5. Perform “Reset position” on the slave (**P602**$_{Slave}$ = 0, **P601**$_{Slave}$ = 0)

If there is a *discrepancy* between the master and the slave, i.e. the drives are not operating with synchronous positioning, the slave must be referenced independently from the master. Here, care must be taken that in synchronous mode the slave receives its setpoint speed as a lead value from the master. If the master is not running, it sends the value “0” as the specified speed for the slave. The slave can therefore not perform a reference run. Additional settings must be made on the slave in order to provide it with a corresponding setpoint speed for the reference run. For this, an additional parameter set (e.g. Parameter set 2) must be used. It should be noted that firstly *all* settings in this parameter set, e.g. the motor data from the 1st parameter set must be adopted. After this, in the *2nd parameter set* the necessary parameters for the slave reference run must be adjusted.

1. Specify the speed for the reference run (F_{ref})

   F_{ref} = F_{min} (**P104**) = F_{max} (**P105**) ≠ 0 (e.g. enter the value 5 (= 5 Hz) in each)

2. Disable frequency addition (**P546** “Bus setpoint function)

To start the slave reference run the relevant parameter set (in this example parameter set 2) must be activated.

The slave must always be referenced after the master.

Synchronous systems in which the master and slave cannot be operated independently require an individual strategy in the event that a discrepancy has occurred.

With incremental position detection, the actual position value is not suitable for determination of the discrepancy.

4.9.7 Offset switching in synchronous operation

In addition to the position setpoint, which can be transmitted from the master to the slave device via the CAN bus, a relative position offset can be added to the slave via the "increment array". With each 0 → 1 flank at the relevant input, the position setpoint value can be offset by the value which is set in parameter P613 "Position" [-01]...[-06].

The offset cannot be transferred directly via a field bus with a "process data word". For this, appropriately parameterised digital inputs of Bus IO In Bits must be used.

4.9.8 Flying saw (extended synchronisation function)

A special case of synchronisation is the „*Flying saw*" mode (**P610**, setting 5). In addition to synchronous control, the slave drive is able to switch to a drive which is already running, i.e. to synchronise its movement with the master. Use of a rotary encoder as the master encoder is not possible in this case. An appropriate frequency inverter must be used as the master.

On the slave, the technology function "*Flying saw*" is controlled with three digital functions (**P420** or **P480**). The drive must be enabled for this.

- **Digital In function 64: "Start Flying saw"**

  The enabled drive is in the waiting position. The "sawing process" is started with a 0 → 1 flank at the input. The input "disable synchronous mode" must not be set.
  The drive accelerates to the position which is set in parameter **P613** [-63]. The acceleration time is calculated so that when the target position is reached, the reference speed of the master drive (e.g. conveyor belt) is also reached. Regardless of the speed of the master, the acceleration path always remains constant, to that the point at which synchronous movement begins is always at the same position. This is the point at which the actual synchronous phase begins.
  A status message (setting 27) is provided, which can be parameterised via a digital output (**P434**) or a Bus IO Out bit (**P481**). This message indicates that the synchronisation phase has been successfully completed and the the slave drive is synchronised with the master This signal can be used for example to start the actual work process (e.g. "lower saw" or "start sawing process").

- **Digital In function "63": "Synchronous mode off"**

  Synchronous mode is maintained until a 0 →1 flank is detected at the input "Synchronous mode off". The sawing process is complete and the saw drive (slave) moves back to position "0". The reference point can be set at will by means of an offset (**P609**). The next process can only be started when "position zero" has been reached. With the 0→1 flank from "Synchronous mode off" the position setpoint (**P602**) of the lead drive (master) is reset.

- **Digital In function "77": "Stop Flying Saw"**

  Synchronous mode is maintained until a 0 →1 flank is detected at the input "Stop flying saw". The sawing process is complete, however the saw drive does not move back to position "0", but rather stops. After a further flank at input "64" "Start flying saw" the slave drive again begins to synchronise with the master.

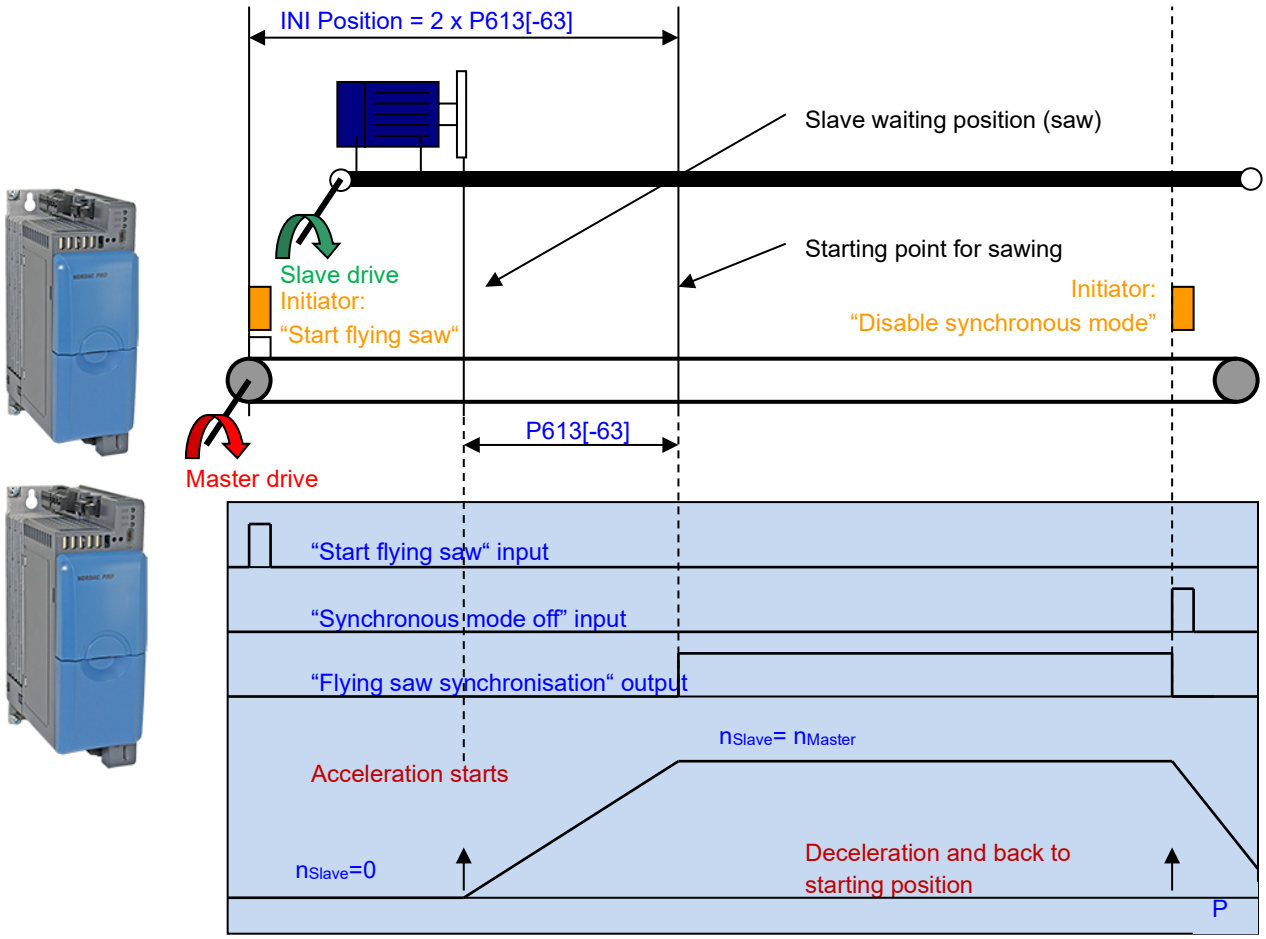


Figure 4: Flying Saw, example of principle

4.9.8.1 Determination of acceleration distance and initiator position

The distance of the initiator from the point at which the sawing process is to begin corresponds to double the value of the acceleration distance for the saw drive (slave). During the acceleration process the belt drive (master) travels double the distance in comparison with the saw drive (slave).

The corresponding speed ratios between the drives and the gear unit factors must be taken account for calculation of the initiator position. The minimum acceleration distance must be entered in **P613** [-63].

Calculation of minimum acceleration path

$$P613\ [-63] > 0{,}5 * n_{Slave\_max} * T_{Acceleration\ Time}$$

$$T_{Acceleration\ Time} = P102 * F_{Slave\_max} / P105$$

$$n_{Slave\_max} = F_{Slave\_max} / \text{Number of pole pairs}$$

$$P608\ [-xx] / P607\ [-xx] = (R_{Gear\ Unit\ Slave} * D_{Master}) / (R_{Gear\ Unit\ Master} * D_{Slave})$$

$$\Delta P_{INI} = 2 * P613\ [-63] * \pi * D_{Slave} / R_{Gear\ Unit\ Slave}$$

n	=	Speed [rps]
D	=	Time [s]
F	=	Frequency [Hz]
R	=	Speed ratio
D	=	Gear unit output diameter
ΔP_{INI}	=	Minimum distance from initiator

If the acceleration distance which is set is smaller than that which is necessary, error message *E13.5* "*Flying saw acceleration*" is activated. It is also checked whether the prefix for the acceleration travel matches the prefix for the master speed. If this is not the case, error message *E13.6* "*Flying saw value false*" is issued after activation of the start command.

4.9.8.2 Diagonal saw

A special case of the “flying saw” is the diagonal saw. With this, there is no differentiation between the slave and the processing axis. The axis which is to be synchronised moves at a definite angle(e.g. 30°) transverse to the material. The movement therefore comprises a longitudinal and a transverse vector. Because of this, the angle must also be taken into account for the speed ratio between the master and the slave.

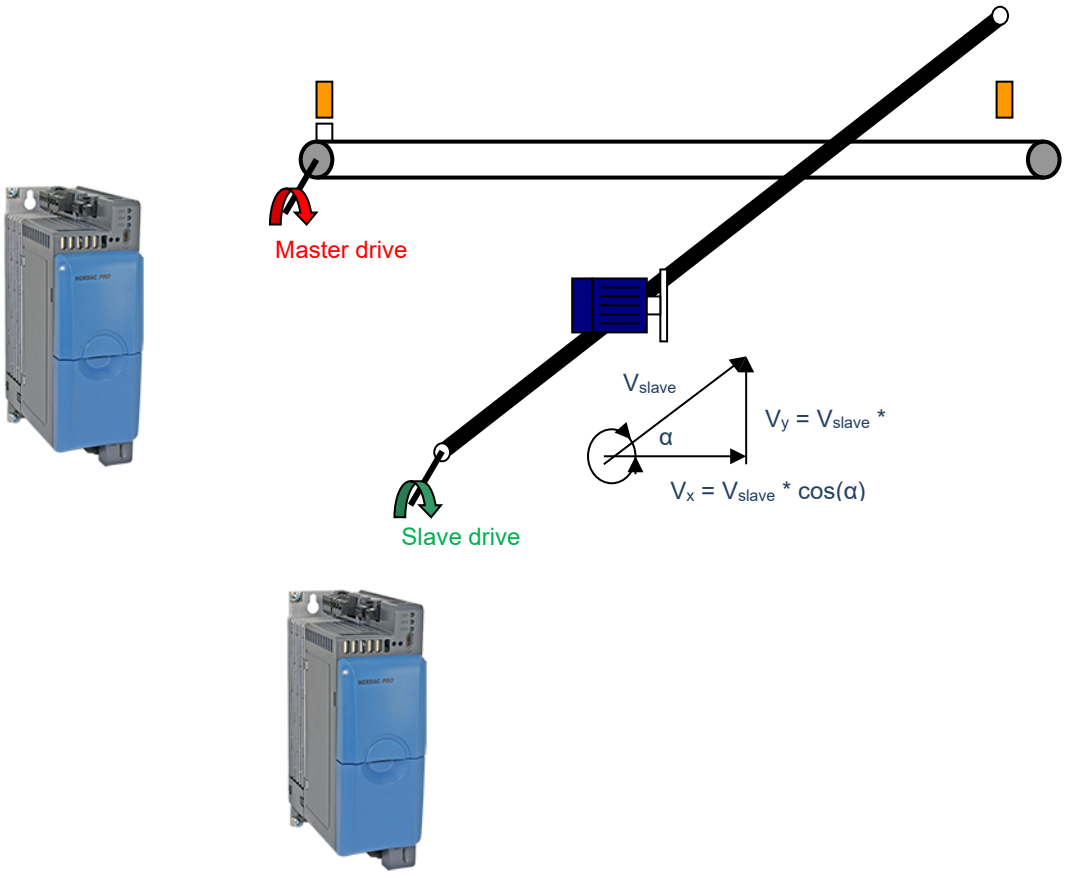


Figure 5: Flying Saw, diagonal saw

Speed ratio calculation for diagonal saw

$$P608\ [-xx] / P607\ [-xx] = (R_{Gear\ Unit\ Slave} * D_{Master}) / (R_{Gear\ Unit\ Master} * D_{Slave}) * \cos(\alpha)$$

α	=	Angle of slave movement relative to master movement [°]
R	=	Speed ratio
D	=	Gear unit output diameter

With the diagonal saw the saw feed is proportional to the belt speed. The saw feed and the belt speed can therefore not be selected independently from each other (as long as the angle is kept constant). With a “normal” flying saw the saw feed is controlled via a separate axis independent of the belt or movement speed.

Regardless of the setting in parameter **P600** “flying saw” is always executed with linear ramps and a speed of movement with maximum frequency. Therefore: The return movement of the saw is always performed with the set maximum frequency, which in general corresponds to the maximum speed during synchronous movement.

4.10 Output messages

The frequency inverter provides various status messages for the positioning function. These can be output physically (e.g. via digital output **P434**…) or alternatively as a Bus IO Out bit (**P481**). To use the Bus IO Out bit, one of the bus actual values (**P543**…) must be set to "Bus I/O In Bits 0-7".

Information

Availability of status messages

The status messages are also available if the position control is not enabled (**P600** = Setting “disabled”).

Function (Setting)	Description
Reference (20)	The message is active if a valid reference point is available. The signal switches off when a reference run is started. The signal state when the power supply is switched on depends on the setting in **P619 "Incremental mode"**. For settings for incremental encoders *with save position* and for absolute encoders the signal state after switch-on is “active (High)”, otherwise “Low”.
Position reached (21)	With this function the frequency inverter signals that the specified position has been reached. The message is active if the deviation between the specified and the actual position is smaller than the value set in parameter **P625** “*Output hysteresis*“ and the actual frequency is lower than the frequency which is parameterised in parameter **P104** “*Minimum frequency*” + 2 Hz In synchronous mode, the condition is not the frequency which is parameterised in **P104** but rather the setpoint frequency.
Comparison position (22)	This message is active if the actual position is greater or equal to parameter **P626** “*Output comparison position*“. The signal switches off again when the actual position is smaller than **P626** minus hysteresis (**P625**). The prefix is taken into account. Output signal 0 → 1 (“High”): $p_{ist} \geq p_{vergl}$ Output signal 1 → 0 („low“): $p_{ist} < p_{vergl} - p_{hyst}$
Comparison position value (23)	This function corresponds to function 22 “*Comparison position*”, with the difference that the actual position is treated as an absolute value (without prefix). Output signal 0 → 1 (“High”): $\lvert p_{ist}\rvert \geq \lvert p_{vergl}\rvert$ Output signal 1 → 0 (“Low”): $\lvert p_{ist}\rvert < \lvert p_{vergl}\rvert - p_{hyst}$
Position array value (24)	This message is active if a position which is parameterised in parameter **P613** has been reached or overrun. This function is always available regardless of the setting in **P610**.
Comparison position reached (25)	This message is active if the amount of the difference between the actual position and the value parameterised in parameter **P626** “*Comparison position output*” is smaller than the value set in parameter **P625** “*Output hysteresis* “ Output signal 0 → 1 (“High”): $\lvert p_{vergl.} - p_{ist}\rvert < p_{hyst}$
Comparison position value reached (26)	This message is active if the amount of the difference between the actual position and the value parameterised in parameter **P626** “*Comparison position output*” is smaller than the value set in parameter **P625** “*Output hysteresis* “ Output signal 0 → 1 (“High”): $\lvert(\lvert p_{vergl}\rvert - \lvert p_{ist}\rvert)\rvert < p_{hyst}$
Flying Saw synchronisation (27)	This message is active if the slave drive has completed the start phase in the function “*Flying saw*” and is synchronised with the master axis, taking the “*Output hysteresis*“ set in **P625** into account.

Table 9: Digital output messages for positioning function

5 Commissioning

1. Connect encoder
2. Commission the encoder by changing the parameters. For this, make the necessary settings for each axis in the relevant parameter set.

Step		Interface / position measurement system (encoder)					
		Incremental		Absolute	Universal		
		HTL	TTL	CANopen	SIN/COS	SSI/ BISS	Endat/ Hiperface
1	Contact assignment	P420 [-01] … [-06]	P420 [-05] DIN5 TTL Zero track	–	–		
2	Selection of the position measurement system	P604					
3	Resolution	P301 [-02]	P301 [-01]	P605 [-01, -02]	P301 [-03]	P605 [-03, -04]	
4	Position detection Linear / Modulo	P619 [-02]	P619 [-01]	P621 [-01]	P619 [-03]	P621 [-02]	
5	Additional settings	–	–	P514, P515 [-1]	–	P617, (P622)	–
6	Speed ratio Speed ratio	P607 [-02]	P607 [-01]	P607 [-04]	P607 [-03]	P607 [-05]	
	Speed reduction ratio	P608 [-02]	P608 [-01]	P608 [-04]	P608 [-03]	P608 [-05]	
8	Check the direction of rotation, resolution and speed ratio	P660 [-02], P583	P660 [-01], P583	P660 [-04], P583	P660 [-03], P583	P660 [-05], P583	
8	Setpoint processing (source and type)	P610					
9	Overflow point (only for modulo)	P620 [-02]	P620 [-01]	P620 [-04]	P620 [-03]	-	-
10	Reference the encoder	P420 [-XX] = 22, 23, 31, 32, 61; P623 = XX; (P624 [-XX] = XX)					
11	Define the offset	P609 [-02]	P609 [-01]	P609 [-04]	P609 [-03]	P609 [-05]	
12	Define the limits	P612 / P615 / P616					
13	Define the target position	P613					
14	Define the reference point run	P623 / P624					
15	Monitoring etc.	P625, P626, P630 et seq.					

6 Parameters

The following only lists the specific parameters and display and setting options for the **POSICON** technology function. For a detailed overview of all available parameters, please refer to the frequency inverter manual (BU0600).

6.1 Description of parameters

P000 (parameter number)	**Operating display** (parameter name)		**xx** [1]	**S**	**P**
Setting range (or display range)	Display of typical display format (e.g. (bin = binary) of possible setting range and number of decimal places	**Other applicable parameters:**	List of other directly related parameters		
Arrays	[-01]	If parameters have a substructure in several arrays, this is shown here.			
Factory setting	{ 0 }	Typical default setting of parameters in the as-delivered condition of the FI, or to which it is set after carrying out "Restore factory settings" (see parameter P523).			
Scope of Application	List of variants for which this parameter applies. If the parameter is generally valid, i.e. for the entire model series, this line is omitted.				
Description	Description, function, meaning and similar for this parameter.				
Note	Additional notes about this parameter				
Setting values (or display values)	List of possible settings with description of their respective functions				

1) xx = Other codes

Figure 6: Explanation of parameter description

Information

Unused lines of information are not listed.

Notes / Explanations

Code	Designation	Meaning
S	Supervisor parameter	The parameter can only be displayed and changed if the relevant supervisor code has been set (see parameter **P003**).
P	Depending on the parameter set	The parameter provides various setting options which depend on the selected parameter set.

6.1.1 Operating displays

P001	Selection of display value		
Description	ControlBox operating display selection		
Setting values	**Value**	**Meaning**	
	0	Actual frequency	Present supplied output frequency
	16	Position setpoint	Setpoint position
	17	Actual position	Present actual position (actual position)
	50	TTL actual position	Actual position from TTL incremental encoder
	51	CANopen actual position	Actual position from CANopen absolute encoder
	52	Act. pos. diff.	Actual position difference between setpoint and actual position
	53	Act. pos. diff. Abs/Inc	Actual position difference between absolute and incremental encoder (see also **P631**)
	54	Act. pos. diff. Cal./Meas.	Actual position difference between the calculated and measured value of an encoder (see also **P630**)
	55	Pos. act. Univ. encoder	Actual position from universal encoder
	56	HTL actual position	Actual position from HTL incremental encoder
	57	Actual position Sin/Cos	Actual position from Sin/Cos encoder
	58	Reserved	

6.1.2 Speed control

P301	Encoder resolution		
Setting range	0 … 27		
Arrays	[-01] = TTL	[-02] = HTL	[-03] = Sin/Cos
Factory setting	{ 6 }	{ 3 }	{ 3 }
Description	"*Encoder resolution*". Input of the pulse count per rotation of the connected encoder. If the direction of rotation of the encoder is not the same as the FI, (depending on installation and wiring), this can be compensated by selecting the corresponding negative pulse numbers.		
Note	P301 is also significant for position control via incremental encoders. If an incremental encoder is used for positioning (P604=1), the setting of the pulse number is made here (see supplementary POSICON manual).		
Setting values	**Value**	**Value**	
	0	500 pulses	8	-500 pulses
	1	512 pulses	9	-512 pulses
	2	1000 pulses	10	-1000 pulses
	3	1024 pulses	11	-1024 pulses
	4	2000 pulses	12	-2000 pulses
	5	2048 pulses	13	-2048 pulses
	6	4096 pulses	14	-4096 pulses
	7	5000 pulses	15	-5000 pulses
			16	-8192 pulses
	17	8192 pulses		
	18	16 pulses	23	-16 pulses
	19	32 pulses	24	-32 pulses
	20	64 pulses	25	-64 pulses
	21	128 pulses	26	-128 pulses
	22	256 pulses	27	-256 pulses

6.1.3 Control terminals

P400	Analog input function		P
Setting range	0 … 58		
Arrays	[-01] = Analog input 1	Analog input 1 (AI1) integrated into the FI	
	[-02] = Analog input 2	Analog input 2 (AI2) integrated into the FI	
	[-03] = Ext. analog input 1	*"External analog input 1"*. Analog input 1 of the first IO extension	
	[-04] = Ext. analog input 2	*"External analog input 2"*. Analog input 2 of the first IO extension	
	[-05] = Ext. A. in.1 2.IOE	*"External analog input 1 of the 2nd IOE"*. Analog input 1 of the second I/O extension	
	[-06] = Ext. A. in.1 2.IOE	*"External analog input 2 of the 2nd IOE"*. Analog input 2 of the second I/O extension	
	[-07] = Reserved		
	[-08] = Reserved		
	[-09] = Clock input 1		
Scope of Application	**[-01] … [-02] SK 500P and higher**		
	[-03] … [-09] SK 530P and higher		
Factory setting	[-01] = { 1 } All other { 0 }		
Description	"*analog input function*". Assignment of analogue functions to internal analogue inputs or the analogue inputs of optional modules.		
Note	The analogue inputs of the frequency inverter (analog inputs 1 and 2) can alternatively be parameterised to digital functions (see P420 [-13] or [-14]). To avoid misinterpretation of the signals, the analogue functions can then be connected to the relevant inputs (P400 [-01] or [-02])		

Setting values

Value		Description
0	Off	Input not used
47	Gear ratio factor	Gearing speed ratio factor Sets the speed ratio between master and slave
58	Setpoint position	Within the limits of **P615** and **P616**, the set position can be specified via the analogue input. **P610** must be set to “auxiliary setpoint”. In this case position monitoring for minimum and maximum position is not performed.

P418	Analog output function		P
Setting range	0 ... 60		
Arrays	[-01] = Analog output 1	Analogue output (AO) integrated into the FI	
	[-02] = Reserved		
	[-03] = First IOE	*"External analog output of first IOE".* Analogue output of the first IO extension	
	[-04] = Second IOE	*"External analog output of second IOE":* analogue output of the second IO extension	
Scope of Application	**[-01] SK 500P and higher**		
	[-02] … [-04] SK 530P and higher		
Factory setting	All { 0 }		
Description	"*Analog output function*".(max. load: 5 mA analogue, 20 mA digital)**:** An analogue voltage (0 ... +10 Volt) can be obtained at the control terminals (max. 5 mA). Various functions are available, whereby: 0 Volt analogue voltage always corresponds to 0 % of the selected value. 10 V analogue voltage always corresponds to the nominal values for the motor (unless otherwise stated) multiplied by the P419 scaling factor, e.g.: $\Rightarrow 10\,\mathrm{V} = \frac{\text{Motor rating value} \cdot \text{P419}}{100\,\%}$		
Setting values	**Value**	**Description**	

0	Off	Output not used
29	Actual position	Within the limits of **P615** and **P616** the analogue output signals the actual position.
34	Reference	Digital functions, see parameter **P434** for explanations
35	Position reached	
36	Comparison position	
37	Comparison position value	
38	Position array value	
39	Comparison position reached	
40	Comparison position value reached	

P420	Digital inputs				
Setting range	0 … 84				
Arrays	[-01] = Digital input 1	Digital input 1 (DI1) integrated into the FI			
	[-02] = Digital input 2	Digital input 2 (DI2) integrated into the FI			
	[-03] = Digital input 3	Digital input 3 (DI3) integrated into the FI			
	[-04] = Digital input 4	Digital input 4 (DI4) integrated into the FI			
	[-05] = Digital input 5	Digital input 5 (DI5) integrated into the FI			
	[-06] = Digital input 6	Digital input 6 (DI6) integrated into the FI			
	[-07] = Digital input 7	Digital input 1 (DIO1) integrated into SK CU5			
	[-08] = Digital input 8	Digital input 2 (DIO2) integrated into SK CU5			
	[-09] = Digital input 9	Digital input 3 (DIO3) integrated into SK CU5			
	[-10] = Digital input 10	Digital input 4 (DIO4) integrated into SK CU5			
	[-11] = Reserved				
	[-12] = Reserved				
	[-13] = Digital function analog1	Analogue input 1 (AI1) (digital function) integrated into the FI			
	[-14] = Digital function analog2	Analogue input 2 (AI2) (digital function) integrated into the FI			
Scope of Application	**[-01] … [-05] SK 500P and higher**				
	[-06] … [-12] SK 530P and higher				
	[-13] … [-14] SK 500P and higher				
Factory setting	[-01] = { 1 }	[-02] = { 2 }	[-03] = { 8 }	[-04] = { 4 }	All other { 0 }
Description	"*Digital input functions*". Up to 14 inputs which can be freely programmed with digital functions are available.				
Note	Analogue inputs 1 and 2 of the FI do not comply with EN61131-2 (Type 1 digital inputs)				
	Alternatively, digital inputs 7… 10 can also be used as digital outputs 3… 6 (see P434). For these inputs/outputs it is recommended to parameterise either an input or an output function. However, if an input function and an output function are parameterised, a High signal from the output function will result in activation of the input function. This IO connection is hence used as a kind of "flag".				
Setting values	**Value**	**Description**	**Signal**		

0	Off	Input not used	
22	Reference run	Start reference run (📖 Section 4.2.1.1)	High
23	Reference point	Reference point reached (📖 Section 4.2.1.1)	High
24	Teach - In	Start Teach-in function (📖 Section 4.4)	High
25	Quit Teach-in	Save the actual position (📖 Section 4.4)	Flank 0→1
31	Disable right running [1]	Blocks the "*Enable right/left*" via a digital input or Bus control. Does not depend on the actual direction of rotation of the motor (e.g. following negated setpoint).	Low
32	Disable left running [1]		Low
55	Bit 0 PosArr / Inc	Bit 0 Position array / Position increment array (📖 Section 4.3))	High
56	Bit 1 PosArr / Inc	Bit 1 Position array / Position increment array (📖 Section 4.3)	High
57	Bit 2 PosArr / Inc	Bit 2 Position array / Position increment array (📖 Section 4.3))	High
58	Bit 3 PosArr / Inc	Bit 3 Position array / Position increment array (📖 Section 4.3)	High
59	Bit 4 PosArr / Inc	Bit 4 Position array / Position increment array (📖 Section 4.3)	High
60	Bit 5 PosArr / Inc	Bit 5 Position array / Position increment array (📖 Section 4.3)	High
61	Reset position	Reset the actual position (📖 Section 4.2.1.2)	Flank 0→1
62	Sync. position array	Adoption of a preselected position (📖 Section 4.3)	Flank 0→1
63	Synchronous mode off	With function **P610** = 2 “Synchronous mode” the synchronous mode is interrupted, but the drive remains under position control. With the 0→1 flank the position setpoint (**P602**) of the lead drive is reset. The drive moves back to position “0” or to the position saved in the position offset (**P609**) and remains there.	High
		With function **P610** = 5 “flying saw” the slave moves back to its starting position and remains there until the next “Start flying saw” command. A new start command is only accepted if the slave has reached its starting position. With the 0→1 flank the position setpoint (**P602**) of the lead drive is reset.	Flank 0→1
64	Start flying saw	Start command for the slave drive to synchronise to the master. (📖 Section 4.9.8)	Flank 0→1
77	Stop Flying Saw	The “flying saw” function is interrupted. (📖 Section 4.9.8)	Flank 0→1
78	Remaining path trigger	With function **P610** = 10 “Remaining path positioning” the drive switches to position control and travels the parameterised “remaining path”. (📖 Section 4.8)	Flank 0→1
1. Also effective for BUS control (e.g. RS-232, RS-485, CANbus, CANopen, …)			

P434	Digital output function		P
Setting range	0 … 59		
Arrays	[-01] = Binary output.1 / MFR1	Multi-function relay 1 (K1) integrated into the FI	
	[-02] = Binary output.2 / MFR2	Multi-function relay 2 (K2) integrated into the FI	
	[-03] = Digital output 1	Digital output 1 (DO1) integrated into the FI	
	[-04] = Digital output 2	Digital output 2 (DO2) integrated into the FI	
	[-05] = Digital output 3	Digital output 1 (DIO1) integrated into SK CU5	
	[-06] = Digital output 4	Digital output 2 (DIO2) integrated into SK CU5	
	[-07] = Digital output 5	Digital output 3 (DIO3) integrated into SK CU5	
	[-08] = Digital output 6	Digital output 4 (DIO4) integrated into SK CU5	
	[-09] = Digital function analog1	Digital output 1 (AO1) (digital function) integrated into the FI	
	[-10] = Reserved		
Scope of Application	**[-01] … [-02] SK 500P and higher**		
	[-03] … [-08] SK 530P and higher		
	[-09] … [-10] SK 500P and higher		
Factory setting	[-01] = { 1 } [-02] = { 7 } All other { 0 }		
Description	"*Digital output function*". Up to 10 outputs (2 of which are relays) are available. These can be freely programmed with digital functions. These can be seen in the following table.		
Note	With settings 3 to 5 and 11 the two relays (K1, K2) work with 10 % hysteresis, i.e. the relay contact closes (setting 11: opens) on reaching the limiting value and opens (setting 11: closes) if a 10 % lower value is undershot. This behaviour can be inverted with a negative value in P435.		
	Alternatively, digital outputs 3… 6 can also be used as digital inputs 7… 10 (see P420). For these inputs/outputs it is recommended to parameterise either an input or an output function. However, if an input function and an output function are parameterised, a High signal from the output function will result in activation of the input function. This IO connection is hence used as a kind of "flag".		

Setting values

Value		Description	Signal
0	Off	Output not used	
20	Reference	Reference point available / has been saved	
21	Position reached	The specified position has been reached	
22	Comparison position	Position value in **P626** reached	
23	Comparison position value	Position value (amount) in **P626** reached (without consideration of prefix)	
24	Position array value	A value set in **P613** has been reached or exceeded.	
25	Comparison position reached	Comparison position reached, as for function 22, however with consideration of **P625**	
26	Comparison position value reached	Comparison position value reached, as for function 23, however with consideration of **P625**	
27	Flying saw synchronisation	The slave drive has completed the starting phase of the “flying saw” function and is now synchronised with the master axis.	

Note: For detailed information about output messages, please refer to 📖 Section 4.10 "Output messages"

P480	Bus IO In Bits function				S
Setting range	0 … 82				
Arrays	[-01] = Bus / 2nd IOE Dig In1	In Bit 0 … 3 via Bus or digital input 1 … 4 of the 2nd IO extension			
	[-02] = Bus / 2nd IOE Dig In2				
	[-03] = Bus / 2nd IOE Dig In3				
	[-04] = Bus / 2nd IOE Dig In4				
	[-05] = Bus / 1st IOE Dig In1	In Bit 4 … 7 via Bus or digital output 1 … 4 of the 1st IO extension			
	[-06] = Bus / 1st IOE Dig In2				
	[-07] = Bus / 1st IOE Dig In3				
	[-08] = Bus / 1st IOE Dig In4				
	[-09] = Flag 1	See "Use of flags" at the end of the description of parameter P481			
	[-10] = Flag 2				
	[-11] = Bit 8 Bus control word	Assignment of a function for Bit 8 or 9 of the control word			
	[-12] = Bit 9 Bus control word				
Factory setting	[-01] = { 1 }	[-02] = { 2 }	[-03] = { 4 }	[-04] = { 5 }	All other { 0 }
Description	"*Bus IO In Bits function* ". The Bus I/O In Bits are perceived as digital inputs P420. They can be set to the same functions. In order to use this function, one of the bus setpoints P546 must be set to "Bus I/O In Bits 0-7". The required function must then be assigned to the relevant bit.				
Note	For the possible functions of the Bus In Bits, please refer to the table of digital input functions. Function 14 "Remote control" is not possible.				

0	Off	Input not used	
22	Reference run	Start reference run (📖 Section 4.2.1.1)	High
23	Reference point	Reference point reached (📖 Section 4.2.1.1)	High
24	Teach - In	Start Teach-in function (📖 Section 4.4)	High
25	Quit Teach-in	Save the actual position (📖 Section 4.4)	Flank 0→1
31	Disable right running [1]	Blocks the "*Enable right/left*" via a digital input or Bus control. Does not depend on the actual direction of rotation of the motor (e.g. following negated setpoint).	Low
32	Disable left running [1]		Low
55	Bit 0 PosArr / Inc	Bit 0 Position array / Position increment array (📖 Section 4.3))	High
56	Bit 1 PosArr / Inc	Bit 1 Position array / Position increment array (📖 Section 4.3)	High
57	Bit 2 PosArr / Inc	Bit 2 Position array / Position increment array (📖 Section 4.3))	High
58	Bit 3 PosArr / Inc	Bit 3 Position array / Position increment array (📖 Section 4.3)	High
59	Bit 4 PosArr / Inc	Bit 4 Position array / Position increment array (📖 Section 4.3)	High
60	Bit 5 PosArr / Inc	Bit 5 Position array / Position increment array (📖 Section 4.3)	High
61	Reset position	Reset the actual position (📖 Section 4.2.1.2)	Flank 0→1
62	Sync. position array	Adoption of a preselected position (📖 Section 4.3)	Flank 0→1
63	Synchronous mode off	With function **P610** = 2 “Synchronous mode” the synchronous mode is interrupted, but the drive remains under position control. With the 0→1 flank the position setpoint (**P602**) of the lead drive is reset. The drive moves back to position “0” or to the position saved in the position offset (**P609**) and remains there.	High
		With function **P610** = 5 “flying saw” the slave moves back to its starting position and remains there until the next “Start flying saw” command. A new start command is only accepted if the slave has reached its starting position. With the 0→1 flank the position setpoint (**P602**) of the lead drive is reset.	Flank 0→1
64	Start flying saw	Start command for the slave drive to synchronise to the master. (📖 Section 4.9.8)	Flank 0→1
77	Stop Flying Saw	The “flying saw” function is interrupted. (📖 Section 4.9.8)	Flank 0→1
78	Remaining path trigger	With function **P610** = 10 “Remaining path positioning” the drive switches to position control and travels the parameterised “remaining path”. (📖 Section 4.8)	Flank 0→1
1. Also effective for BUS control (e.g. RS-232, RS-485, CANbus, CANopen, …)			

P481	Function BusIO Out bits		S	
Arrays	[-01] … [-18]			
Description	Assignment of functions for Bus IO Out bits. The frequency inverter treats the Bus IO Out bits as digital outputs.			
Setting values	**Value**	**Meaning**		
	0	Off	Output not used	
	20	Reference	Reference point available / has been saved	
	21	Position reached	The specified position has been reached	
	22	Comparison position	Position value in **P626** reached	
	23	Comparison position value	Position value (amount) in **P626** reached (without consideration of prefix)	
	24	Position array value	A value set in **P613** has been reached or exceeded.	
	25	Comparison position reached	Comparison position reached, as for function 22, however with consideration of **P625**	
	26	Comparison position value reached	Comparison position value reached, as for function 23, however with consideration of **P625**	
	27	Flying saw synchronisation	The slave drive has completed the starting phase of the “flying saw” function and is now synchronised with the master axis.	

Note: For detailed information about output messages, please refer to 🕮 Section 4.10 "Output messages"

6.1.4 Additional parameters

P502	Master function value				S	P
Setting range	0 … 57					
Arrays	[-01] = Master value 1	[-02] = Master value 2	[-02] = Master value 3			
	[-04] = Master value 4	[-05] = Master value 5				
Factory setting	all { 0 }					
Description	Selection of master values of a Master for output to a bus system (see P503). These master values are assigned to the slave via P546.					
Note	For details regarding the processing of setpoints and actual values, please refer to 🕮 Section 4.3 "Setpoint specification".					
Setting values	**Value**	**Meaning**	**Value**	**Meaning**	**Value**	**Meaning**

0	Off	The guide value is not used.
6	Actual position Low word	Lower 16-bit value of the set position (absolute position) of the frequency inverter
7	Set position Low word	Lower 16-bit value of the set position (absolute position) of the frequency inverter
10	Actual position Inc.Low word	Lower 16-bit value of the actual position (relative position) of the frequency inverter
11	Set pos. Inc.Low word	Lower 16-bit value of the set position (relative position) of the frequency inverter
13	Actual position High word	Upper 16-bit value of the actual position (absolute position) of the frequency inverter
14	Set position High word	Upper 16-bit value of the set position (absolute position) of the frequency inverter
15	Actual position inc. High word	Upper 16-bit value of the actual position (relative position) of the frequency inverter
16	Setpoint pos. inc. High word	Upper 16-bit value of the set position (relative position) of the frequency inverter

P503	Master function output	S
Setting range	0 … 5	
Factory setting	{ 0 }	
Description	For master-slave applications this parameter specifies on which bus system the master transmits the control word and the master values P502 for the slave. On the slave, parameters P509, P510, P546 define the source from which the slave obtains the control word and the master values from the master and how these are to be processed by the slave.	

Setting values

Value		Meaning
0	Off	No output of control word and master values.
1	USS	Output of control word and master values to USS
2	CAN	Output of control words and master values to CAN (up to 250kBaud).
3	CANopen	Output of control words and master values to CANopen.
4	System bus active	Output of control word and master values on CAN open via the ParameterBox or NORDCON, however all participants which are set to "System bus active" are visible via the ParameterBox or NORDCON.
5	CANopen + System bus active	Output of control word and master values on CAN open via the ParameterBox or NORDCON; all participants which are set on the System bus active are visible.

P514	CAN baud rate
Setting range	0 … 7
Factory setting	{ 5 }
Description	Used to set the transfer rate (transfer speed) via the CAN bus interface. All bus participants must be set to the same baud rate.

Setting values

Value	Meaning	Value	Meaning	Value	Meaning
0	10 kBaud	3	100 kBaud	6	500 kBaud
1	20 kBaud	4	125 kBaud	7	1 MBaud * (for test purposes only)
2	50 kBaud	5	250 kBaud		
*) Reliable operation cannot be guaranteed					

P515	CAN address	
Setting range	0 … 255	
Arrays	[-01] = Slave address	Receipt address for CAN and CANopen system bus
	[-02] = Broadcast slave address	Broadcast receipt address for CANopen system bus (slave)
	[-03] = Master address	Broadcast transmission address for CANopen system bus (Master)
Factory setting	All { 50 }	
Description	Setting of the basic CANbus address for CAN and CANopen.	
Note	If several frequency inverters are to communicate with each other via the system bus, the addresses must be set as follows: FI 1 = 32, FI 2 = 34 … .	

P543	Bus actual value			S	P
Setting range	0 … 57				
Arrays	[-01] = Actual bus value 1	[-02] = Actual bus value 2	[-03] = Actual bus value 3		
	[-04] = Actual bus value 4	[-05] = Actual bus value 5			
Factory setting	[-01] = { 1 }	[-02] = { 4 }	[-03] = { 9 }	[-04] = { 0 }	[-05] = { 0 }
Description	Setting of the return values for bus control.				
Setting values	Value / Meaning				

0	Off	The guide value is not used.
6	Actual position Low word	Lower 16-bit value of the set position (absolute position) of the frequency inverter
7	Set position Low word	Lower 16-bit value of the set position (absolute position) of the frequency inverter
10	Actual position Inc.Low word	Lower 16-bit value of the actual position (relative position) of the frequency inverter
11	Set pos. Inc.Low word	Lower 16-bit value of the set position (relative position) of the frequency inverter
13	Actual position High word	Upper 16-bit value of the actual position (absolute position) of the frequency inverter
14	Set position High word	Upper 16-bit value of the set position (absolute position) of the frequency inverter
15	Actual position inc. High word	Upper 16-bit value of the actual position (relative position) of the frequency inverter
16	Setpoint pos. inc. High word	Upper 16-bit value of the set position (relative position) of the frequency inverter

P546	Funct. Bus set point			S	P
Setting range	0 … 57				
Arrays	[-01] = Bus set point 1	[-02] = Bus set point 2	[-03] = Bus set point 3		
	[-04] = Bus set point 4	[-05] = Bus set point 5			
Factory setting	[-01] = { 1 }	All other { 0 }			
Description	Assignment of a function to a bus set point value.				
Setting values	Value				

0	Off	The bus setpoint is not used.
17	BusIO Out Bits 0-7	BusIO Out Bits 0-7 of the frequency inverter
21	Set position Low word	Lower 16-bit value of the set position (absolute position) of the frequency inverter
22	Setpoint pos. High word	Upper 16-bit value of the set position (absolute position) of the frequency inverter
23	Setpoint pos. Inc.Low word	Lower 16-bit value of the set position (relative position) of the frequency inverter
24	Setpoint pos. inc. High word	Upper 16-bit value of the set position (relative position) of the frequency inverter
47	Gear ratio factor	Setting of the speed ratio between the master and the slave

P552	CAN master cycle		S
Setting range	0 … 100 ms		
Arrays	[-01] =	CAN master function, CAN master cycle 1	
	[-02] =	CANopen absolute encoder, CANopen absolute encoder, CAN master cycle 2	
Factory setting	all { 0 }		
Description	In this parameter, the cycle time for the CAN/CANopen master mode and the CANopen encoder is set (see P503/514/515). Depending on the baud rate which is set, there are different minimum values for the actual cycle time:		

Baud rate	Minimum value t_z	Default CAN Master	Default CANopen Abs.
10 kBaud	10 ms	50 ms	20 ms
20 kBaud	10 ms	25 ms	20 ms
50 kBaud	5 ms	10 ms	10 ms
100 kBaud	2 ms	5 ms	5 ms
125 kBaud	2 ms	5 ms	5 ms
250 kBaud	1 ms	5 ms	2 ms
500 kBaud	1 ms	5 ms	2 ms
1000 kBaud	1 ms	5 ms	2 ms

Note	The range of values which can be set is between 0 and 100ms. With the setting 0 “Auto” the default value (see table) is used. In this setting the monitoring function for the CANopen absolute encoder is no longer triggered at 50 ms but rather at 150 ms.

P583	Motor phase sequence		S	P
Setting range	0 ... 22			
Factory setting	{ 0 }			
Description	The motor phase control sequence (U – V – W) can be changed with this parameter. This enables the direction of rotation of the motor to be changed without changing the motor connections.			
Note	If there is a voltage on the output terminals (U – V – W) (e.g. on enabling) the parameter setting or the parameter set may be changed by setting parameter **P583**. Otherwise the frequency inverter switches off with error message **E016.2**.			
Setting values	**Value**	**Meaning**		

0	Normal	No change
1	Inverted	*"Invert motor phase sequence"* The direction of rotation of the motor is changed. The counting direction of the encoder for speed detection (if present) remains unchanged.
2	Inverted by encoder	As for setting 1, however in addition the counting direction of the encoder is also changed.

6.1.5 Positioning

P600	Position control		S	P
Setting range	0 … 4			
Factory setting	{ 0 }			
Description	Enabling the position control.			
Note	Details 🕮 Section 4.6.1 "Position control: Positioning variants (P600)"			
Setting values	Value	Meaning		
	0	Off	Positioning control is disabled	
	1	Lin. Ramp (max. freq.)	Position control is active with a linear ramp and maximum frequency	
	2	Lin.ramp(setp.freq.)	Position control is active with a linear ramp and setpoint frequency	
	3	S-ramp (max. freq.)	Position control is active with an S ramp and maximum frequency	
	4	S-ramp (set freq.)	Position control is active with an S ramp and setpoint frequency	

P601	Actual position
Display range	- 50000,000 … 50000,000 rev.
Description	Display of the actual position.

P602	Actual setpoint position
Display range	- 50000,000 … 50000,000 rev.
Description	Display of the actual setpoint position.

P603	Act. position diff.	S
Display range	- 50000,000 … 50000,000 rev.	
Description	Display of the actual difference between the set position and the actual position.	

P604	Position measurement system		S	P
Setting range	0 … 8			
Factory setting	SK 500P / SK 510P	= { 0 }		
	SK 530P / SK 550P	= { 1 }		
Description	Selection of the encoder used to detect the position (actual position).			
Note	Only one multiturn encoder (setting 4 – 7) may be parameterised simultaneously in one of the 4 parameter sets. Otherwise the frequency inverter goes into fault state (**E25.5**).			
	Before activating an absolute encoder via parameter **P604** it is essential to set the resolution of the absolute encoder in parameter **P605**. Also refer to the information in **P605**.			
Setting values	Value	Meaning		
	0	TTL incremental [1]	Position detection with incremental encoder (TTL)	
	1	HTL incremental	Position detection with incremental encoder (HTL)	
	2	Sin/Cos incremental [2]	Position detection with incremental encoder (Sin/Cos)	
	3	CANopen	Position detection with absolute encoder (CANopen)	
	4	SSI [2]	Position detection with absolute encoder (SSI)	
	5	BISS [2]	Position detection with absolute encoder (BISS)	
	6	Hiperface [2]	Position detection with absolute encoder (Hiperface)	
	7	Endat [2]	Position detection with absolute encoder (Endat)	
	5	Reserved		

[1] SK 530P and higher

[2] Only with option SK CU5-MLT

P605	Absolute encoder		S
Setting range	0 … 24 Bit		
Arrays	[-01] = CANopen Multiturn	Number of possible encoder rotations of a CANopen absolute encoder.	
	[-02] = CANopen Singleturn	Resolution per rotation of the CANopen absolute encoder.	
	[-03] = Universal Multiturn	Number of possible encoder rotations of an absolute encoder which is connected to the universal encoder interface.	
	[-04] = Universal Singleturn	Number of possible encoder rotations of an absolute encoder which is connected to the universal encoder interface.	
Factory setting	[-01], [-02] = { 10 }	[-03] = { 12 }	[-04] = { 13 }
Description	Setting the resolution of the absolute encoder.		
Note	If a singleturn encoder is used, the value "0" must be parameterised accordingly in Array [-01] or [-03].		
	Before activating the absolute encoder (**P604**) the resolution of the absolute encoder must be correctly set in **P605**. Otherwise, the values entered in parameter **P605** may be transferred to the absolute encoder.		

Setting values

Conversion of encoder resolution (Bit value → decimal value):

Setting [Bit]	0	1	2	3	4	5	6	7	8	9	10	11	12	…
Resolution	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	…

Example

– Absolute encoder with 12-bit single-turn resolution:
  P605 [-01] = 0
  P605 [-02] = 12

– Absolute encoder with 24-bit resolution, of which 12-bit single-turn resolution:
  P605 [-01] = 12
  P605 [-02] = 12

P607	Speed ratio	S
Setting range	- 2 000 000 … 2 000 000	
Arrays	[-01] = TTL encoder [-02] = HTL encoder [-03] = Sin/Cos encoder [-04] = CANopen encoder [-05] = Universal encoder, (SSI, BISS, EnDat and Hiperface) [-06] = Reserved [-07] = Setpoint/actual values [-08] = Synchronous running	
Factory setting	{ all 1 }	
Description	Speed ratio setting, see 4.5 "Speed ratio of setpoint and actual values".	
Note	If the encoder is not mounted on the motor shaft, the speed ratio (i) between the motor shaft and the drive shaft on which the encoder is mounted must be stated. Only integer values can be entered. Because of the speed ratio must be divided into a positive speed ratio (**P607**) and a negative speed ratio (**P608**). E.g. i=3.5 = 35 /10 → **P607 = 35**, **P608 = 10**	

P608	Reduction ratio	S
Setting range	1 … 2 000 000	
Arrays	[-01] = TTL encoder [-02] = HTL encoder [-03] = Sin/Cos encoder [-04] = CANopen encoder [-05] = Universal encoder, (SSI, BISS, EnDat and Hiperface) [-06] = Reserved [-07] = Setpoint/actual values [-08] = Synchronous running	
Factory setting	{ all 1 }	
Description	Speed ratio setting, see 4.5 "Speed ratio of setpoint and actual values".	
Note	If the encoder is not mounted on the motor shaft, the speed ratio (i) between the motor shaft and the drive shaft on which the encoder is mounted must be stated. Only integer values can be entered. Because of the speed ratio must be divided into a positive speed ratio (**P607**) and a negative speed ratio (**P608**). E.g. i=3.5 = 35 /10 → **P607 = 35**, P608 = 10	

P609	Offset Position	S
Setting range	- 50000,000 … 50000,000 rev.	
Arrays	[-01] = TTL encoder [-02] = HTL encoder [-03] = Sin/Cos encoder [-04] = CANopen encoder [-05] = Universal encoder, (SSI, BISS, EnDat and Hiperface) [-06] = Reserved	
Factory setting	{ all 0 }	
Description	Set-up of an offset for defining an absolute and a relative position setpoint.	

P610	Setpoint Mode	S
Setting range	0 … 10	
Factory setting	{ 0 }	
Description	Specification of setpoint position (type and source)	
Note	For detailed information see 🕮 Section 4.3 "Setpoint specification", 4.9 "Synchronisation control".	

Setting values

Value		Meaning
0	Position Array	Specification of absolute position [1]
1	Pos. Inc. Array	Specification of relative position [1]
2	Synchronous operation	Position specification from master drive unit (note **P509**) [2]
3	Bus	… as for 0, via bus (note **P509**)
4	Bus Increment	… as for 1, via bus (note **P509**)
5	Flying saw	… as for 2, however extended with the "Flying Saw" function [2]
6	Auxiliary setpoint source	… as for 0, within the limits of P615 and P616 via analogue signal (P400 set to "Setpoint position" function)
7	Relative position increment	… as for 1, in this case the movement increment relates to the current actual position – accordingly, the setpoint position is extended by the required increment relative to the current actual position.
8	Relative bus increment	… as for 7, via bus (note **P509**)
9	*Reserved*	
10	Remaining path position	Position specification for "Residual path positioning" mode (🕮 Section 4.8)

1) Any setpoint from the bus (note**P509**, **P546**…) is added!

2) Any programmed position increment via the digital inputs or Bus IO Bits is added!

P611	Position controller P	S	P
Setting range	0.1 … 100.0 %		
Factory setting	{ 5 }		
Description	Adjustment of the proportional amplification P (P amplification) of the position control. The rigidity of the axis when at a standstill increases with increasing values of P.		
Note	• Values which are too large cause overshooting. • Values which are too low cause imprecise positioning.		

P612	Target window size	S	P
Setting range	0.0 … 100.0 rev.		
Factory setting	{ 0 }		
Description	Slow running at the end of the positioning process can be achieved through the size of the target window. The target window corresponds to the starting point for slow running.		
Note	Within the target window or during slow running the speed is specified by parameter **P104** (minimum frequency) and not by the maximum or setpoint frequency. With **P104 = 0** slow running is carried out with 2 Hz.		

P613	Position	S	P *
Setting range	- 50000,000 … 50000,000 rev.		
Arrays	[-01] = Position 1, position array element 1 or position increment array element 1 [-02] = Position 2, position array element 2 or position increment array element 2 … … [-06] = Position 6, position array element 6 or position increment array element 6 [-07] = Position 7, position array element 7 … … [-63] = Position 63, position array element 63		
Factory setting	{ all 0 }		
Description	Setting of various position setpoints which can be selected via digital inputs or a field bus.		
Note	• All arrays (position array Element 1 … 63) are available for positioning with absolute setpoint positions) (see **P610**). • The first 6 arrays (position array Element 1 … 6) are available for positioning with relative setpoint positions) (see **P610**). With each change of signal from "0" to "1" at the relevant digital input, the value allocated to the digital input is added to the position setpoint value. This also applies to control via the bus.		

	This parameter *depends on the parameter set*. Therefore *4 times the number* of relative (24) or absolute positions (252) are available.

P615	Maximum position	S	P
Setting range	- 50000,000 … 50000,000 rev.		
Factory setting	{ 0 }		
Description	Setting of the upper setpoint limit for a permissible positioning range. If the setpoint limit is exceeded error message **E14.7** is activated.		
Note	• Rotary axes ("Turntable applications") Parameter **P619**: With the setting **P619 = 2** "*Modulo Pos*" or **P619 = 3** "*Save Modulo Pos*" parameter **P615** has no function.		
	• Positioning with incremental encoder Parameter **P619**: With the setting **P619 = 0** "*Normal*" or **P619 = 1** "*Save position*" the monitoring function is only active for referenced incremental encoders. I.e. referencing of the incremental encoder is necessary every time the frequency encoder is switched on. In contrast, with setting **619 = 1** "*Save position"* the initial referencing on commissioning is sufficient to be able to use the function when the frequency inverter is switched on again. • With the setting **P610 = 6** "*Auxiliary setpoint source*" monitoring is always deactivated.		
Setting values	0 = Monitoring is disabled		

P616	Minimum position	S	P
Setting range	- 50000,000 … 50000,000 rev.		
Factory setting	{ 0 }		
Description	Setting of the lower setpoint limit for a permissible positioning range. If the setpoint limit is undershot error message **E14.8** is activated.		
Note	• Rotary axes ("Turntable applications") Parameter **P619**: if one of the functions "*Modulo Pos*“ { 2 } or "*Save Modulo Pos*" { 3 } has been set, parameter **P616** has no function.		
	• Positioning with incremental encoder Parameter **P619**: With the setting **P619 = 0** "*Normal*“ or **P619 = 1** "*Save position*" the monitoring function is only active for referenced incremental encoders. I.e. referencing of the incremental encoder is necessary every time the frequency encoder is switched on. In contrast, with setting **619 = 1** "*Save position"* the initial referencing on commissioning is sufficient to be able to use the function when the frequency inverter is switched on again. • With the setting **P610 = 6** "*Auxiliary setpoint source*" monitoring is always deactivated.		
Setting values	0 = Monitoring is disabled		

P617	SSI type encoders	S	
Setting range	000 … 111 (binary)		
Factory setting	{ 010 }		
Description	Protocol settings for SSI encoders		
Setting values	**Bit**	**Meaning**	
	0 Power Fail Bit.	This bit is activated if the transfer protocol contains a Power Fail Bit (PFB). If the PFB changes to the value 1, error message **E 25.4** is triggered.	
	1 Gray=1/Binary=0	Data format for position communication	
	2 Multiply-Transmit	The encoder supports the communication variant "*Multiple Transmit*", which is used to increase the reliability of communication by transmitting the data 2x in mirrored form.	

P619	Incremental mode	S	
Setting range	0 … 3		
Arrays	[-01] = TTL encoder [-02] = HTL encoder [-03] = Sin/Cos encoder		
Factory setting	{ all 0 }		
Description	Selection of the mode for detection of position (actual position) with an incremental encoder.		
Setting values	**Value**	**Meaning**	
	0 Normal	Position detection with the selected incremental encoder	
	1 Save position	… as for 0, with saving of the position	
	2 Modulo Pos	... as for 0 with emulation of a singleturn absolute encoder for optimum path positioning	
	3 Save Modulo Pos	… as for 2, with saving of the position	

P620	Absolute encoder range	S
Setting range	0 … 50000,000 rev.	
Arrays	[-01] = TTL encoder [-02] = HTL encoder [-03] = Sin/Cos encoder [-04] = CANopen encoder	
Factory setting	{ all 0 }	
Description	*"Absolute encoder range"*, Definition of the overflow point for the rotary axis / turntable positioning function (number of rotations until encoder overflow).	
Note	Only relevant if **P619** is in setting (2) or (3), or in the case of a CANopen application, if **P621** is in setting (1).	
Setting values	0 = A value range of ± 0,5 rev. (0.5 rotations) is assumed.	

P621	Absolute encoder mode	S
Setting range	0 … 1	
Arrays	[-01] = CANopen encoder [-02] = Universal encoder [-03] = Reserved	
Factory setting	{ all 0 }	
Description	*"Absolute encoder mode"*Selection of the mode for detection of position (actual position) with an incremental encoder.	

Setting values	**Value**	**Meaning**
	0 Normal	Linear position detection with selected absolute encoder
	1 Modulo Pos	Position detection for path optimised positioning (rotary axes / turntable applications)

P622	Shift SSI Position	S
Setting range	0 … 7	
Factory setting	{ 0 }	
Description	With SSI encoders the position is typically transmitted with the first bit. However, there are some SSI encoders where transmission of the position is made with other bits. This parameter defines an offset in order to conceal the surplus bits.	

Setting values	**Value**	**Meaning**
	0	No offset
	1 ... 7	Telegram offset of 1 (… 7) Bit

P623	Reference run type	S	P
Setting range	0 … 34		
Factory setting	{ 15 }		
Description	*"Reference run type"*, selection of a variant for the reference run.		

Setting values	Value		Meaning
	0	No ref. run	No reference run
	1	DS402 Method 17	Reference run according to CANopen Drive Profile DS402 "homing method 17 … 30"
	2	DS402 Method 18	
	…	…	
	14	DS402 Method 30	
	15	Nord Method 1	Once the reference point has been reached, the drive reverses. When the reference point switch is left (negative flank), this is adopted as the reference point. The reference point is therefore typically in the side of the reference point switch on which the reference point run started. Note: If the reference point switch is passed over (switch too narrow, speed too high), this is also taken as the reference point when leaving the reference point switch (negative flank). The reference point is therefore not on the side of the reference point switch from which the reference point run was started.
	16	Nord Method 2	As for 15, however passing over the reference point switch does not result in adoption as the reference point. A negative flank only results in adoption as the reference point after reversal has been completed. The reference point is therefore definitely on the side of the reference point switch from which the reference point run was started.
	17	Nord Method 3	If the reference point switch is passed over during the reference point run (positive flank → negative flank) the drive adopts the average value of both positions and sets this as the reference point. The drive reverses and therefore stops at the reference point which has been thus determined.
	18	DS402 Method 1	Reference run according to CANopen Drive Profile DS402 "homing method 1 … 14"
	…	…	
	31	DS402 Method 14	
	32	Nord Zero track 1	As for 15, however with synchronisation with the zero track.
	33	Nord Zero track 2	As for 16, however with synchronisation with the zero track.
	34	Nord Zero track 3	As for 17, however with synchronisation with the zero track.

P624	Reference run frequency		S	P
Setting range	0 … 399.0 Hz			
Arrays	[-01] =	Search for switch	The set frequency is used as the specified frequency up to the reference switch (initiator).	
	[-02] =	Search for reference point	The set frequency is used as the specified frequency up to the reference point.	
Factory setting	{ all 0 }			
Description	*"Reference run frequency"*, Specification of the speed for the reference run.			

Setting values	Value		Meaning
	0		The value from the setpoint source is used
	1…	399.0	Frequency value for the reference run

P625	Hysteresis output	S	P
Setting range	0.00...99.99 rev		
Factory setting	{ 1 }		
Description	Difference between switch-on and switch-off point to prevent oscillation of the output signal.		
Note	Relevant for POSICON output messages. Parameter **P436** … or **P483** … accordingly have no effect. (🕮 Section 4.10 "Output messages")		

P626	Comparative position output	S	P
Setting range	- 50000.000 … 50000.000 rev.		
Factory setting	{ 0 }		
Description	Comparative position for digital output messages.		
Note	Relevant for POSICON output messages. (🕮 Section 4.10 "Output messages")		

P630	Position slip error	S	P
Setting range	0.00...99.99 rev		
Factory setting	{ 0 }		
Description	Permissible deviation between the estimated and actual position. The error message **E14.5** becomes active if the permissible deviation is exceeded. As soon as a target position is reached, the estimated position is set to the current actual position.		
Note	The estimated position is determined from the calculated position, which results on the basis of the actual speed.		
Setting values	0 = Monitoring is disabled		

P631	2nd encoder slip error	S	P
Setting range	0.00 … 99,99 rev.		
Factory setting	{ 0 }		
Description	*"2nd encoder slip error"*, permissible deviation of the measured position between the two encoders which are selected in parameter P632. If the permissible deviation is exceeded error message **E14.6** is activated.		
Setting values	0 = Monitoring is disabled		

P632	Slip error source	S	P
Setting range	0 … 5		
Arrays	[-01] = Encoder 1 [-02] = Encoder 2		
Factory setting	SK 500P / SK 510P: [-01] = { 1 }, [-02] = { 3 } SK 530P / SK 550P: [-01] = { 0 }, [-02] = { 3 }		
Description	Selection of the encoder to be compared according to **P631**.		

Setting values

Value		Meaning
0	TTL incremental [1]	Incremental encoder (TTL)
1	HTL incremental	Incremental encoder (HTL)
2	Sin/Cos incremental [2]	Incremental encoder (Sin/Cos)
3	CANopen	Absolute encoder (CANopen)
4	Universal [2]	Absolute encoder via universal encoder interface (SSI, BISS, Hiperface or EnDat)
5	Reserved	

[1] SK 530P and higher

[2] Only with option SK CU5-MLT

P633	Slip error delay	S	P
Setting range	0 ... 99.99 s		
Arrays	[-01] = Slip error position (P630) [-02] = Slip error 2nd Encoder (**P631**)		
Factory setting	{ all 0 }		
Description	"*Slip error delay*", delay of slip error monitoring after enabling.		

P640	Unit of pos. value	S
Setting range	0 … 9	
Factory setting	{ 0 }	
Description	Assignment of a measurement unit for the position values.	
Note	For details see 🕮 Section 4.5 "Speed ratio of setpoint and actual values"	

Setting values

Value		Meaning
0	rev	Rotations
1	°	Degrees
2	rad	Radians
3	mm	Millimetres
4	cm	Centimetres
5	dm	Decimetres
6	m	Metres
7	in	Inch
8	ft	Feet
9	(no unit)	No unit

P650	Univ. encoder status	S
Display range	-32768 … 32767	
Arrays	[-01] = Actual error, encoder error code [-02] = Actual warning, encoder warning code [-03] = Signal quality, the number of communication errors which have occurred since the last initialisation.	
Description	Status of a connected universal encoder	
Note	In case of error, **Hiperface-** and **EnDat-** encoders issue a specific code which can be displayed in the arrays [-01] or [-02]. The cause of the message can be found in the documentation for the encoder. In case of error, **BISS** encoders only issue the value 1 which can be displayed in the arrays [-01] or [-02].	

P651	SinCos voltage	S
Display range	-5.00 … 5.00 V	
Arrays	[-01] = Track A (SIN) [-02] = Track B (COS)	
Description	Display of signal voltage (SIN/COS encoder)	

P660	Position encoder	S
Display range	- 50000,000 … 50000,000 rev.	
Arrays	[-01] = TTL encoder [-02] = HTL encoder [-03] = Sin/Cos encoder [-04] = CANopen encoder [-05] = Universal encoder [-06] = Reserved	
Description	Displays the current position measured by the respective rotary encoder.	
Note	The function of parameter **P660** is comparable with the function of parameter **P601.** However the actual positions of all connected encoders can be read out from the arrays of parameter **P660**.	

6.1.6 Information

P700	Actual operating status	
Display range	0.0 … 99.9	
Arrays	[-01] = Actual error	Indicates the presently active (unacknowledged) fault.
	[-02] = Actual warning	Indicates a present warning message.
	[-03] = Reason for switch-on inhibit	Indicates the reason for active switch-on inhibit.
	[-04] = Extended actual error (DS402)	Displays the present active error according to DS402 terminology.
Description	Messages (coded) for the actual operating status of the frequency inverter such as faults, warnings or the cause of a switch-on inhibit (see Section 7 "Operating status messages").	
Note	Display of bus-level error messages is in decimal integer format. The displayed value must be divided by 10 in order to correspond with the correct format. Example: Display: 20 → Error number: 2.0	
	The error number range from 50.0 to 99.9 displays messages from any extension modules. The meaning of these numbers is explained in the relevant documentation for the extension module.	

P701	Last fault
Display range	0.0 … 99.9
Arrays	[-01] … [-10]
Description	"*Last fault 1 … 10*". This parameter stores the last 10 faults (see 7 "Operating status messages").

7 Operating status messages

The majority of functions and operating data of the frequency inverter are continuously monitored and simultaneously compared with limit values. If a deviation is detected, the frequency inverter responds with a warning or an error message.

For basic information about this, please refer to the frequency inverter operating instructions.

All errors or reasons which result in a switch-on block of the frequency inverter and which are associated with POSICON functionality are listed below.

7.1 Messages

Error messages

Control panel display		Fault Text	Cause • Remedy
Group	**Details in P700 [-01]/ P701**		
E013	**13.0**	**Encoder error**	No signal from encoder • Check 5 V sensor if present. • Check supply voltage of encoder.
	13.1	**Speed slip error** "Speed slip error"	The slip speed error limit was reached. • Increase value in P327
	13.2	**Shut-down monitoring**	The slip error shut down monitoring was triggered; the motor could not follow the setpoint. • Check motor data P201-P209! (important for current controllers) • Check motor circuit • Check encoder settings P300 and following • Increase value for torque limit in P112 • Increase value for current limit in P536 • Check deceleration time P103 and extend if necessary
	13.3	**"Rotation direction" slip error** "Rotation direction slip error"	• Unexpected direction of rotation of the encoder.
	13.5	**Flying saw acceleration** "Flying Saw acceleration"	The acceleration value set in P613 [-63] is too low.
	13.6	**Incorrect Flying Saw value** “Flying saw value incorrect”	The prefix of the acceleration path (P613 [-63]) does not match the prefix of the master drive.
	13.8	**Right end position**	The right limit switch was reached during the reference run although this is not permitted,
	13.9	**Left end position**	The left limit switch was reached during the reference run although this is not permitted,

E014	**14.2**	**Reference point Error**	The reference point run was cancelled without a reference point being found. • Check the reference point switch and the control unit
	14.4	**Absolute encoder error**	Absolute encoder defective or connection faulty (Error message is only possible with positioning enabled) • Check absolute encoder and wiring • Check the parameterisation in the frequency inverter • Five seconds after switching on the frequency inverter there is no contact with the encoder • The encoder does not respond to an SDO command from the frequency inverter • The parameters set in the frequency inverter do not correspond to the possibilities for the encoder (e.g. resolution in parameter P605) • The frequency inverter does not receive a position value over a period of 50ms
	14.5	**Pos. diff. Speed**	Change of position and speed do not match • Check the position detection and the setting in P630
	14.6	**Diff.betw.Abs. & Inc.**	Difference between absolute and incremental encoders • Check the position detection and the setting in P631 • Position change for the absolute and incremental encoders do not match • Check the speed ratio or reduction ratio and offset of both encoders in P607 … P609.
	14.7	**Max. Pos. Exceeded**	Maximum position has been exceeded • Check the specified setpoint and the control setting in P615
	14.8	**Min. Pos. Undershot**	Minimum position undershot • Check the setpoint setting in P616

E025	**25.0**	**Hiper. Abs./Inc error** “Hiperface absolute/incremental error”	The Hiperface encoder monitoring detects errors in the comparison of data between incrementally calculated and absolute signals. • Poor cable shielding • Sin/Cos signals are not connected or are defective. Check **P709 [-09] and [-10]**.
	25.1	**Uni. enc. comm.** *“Universal encoder communication”*	Universal encoder interface communication error (CRC checksum error) • Poor cable shielding • Incorrect encoder resolution (BISS, SSI) • SSI does not support Multiply Transmit (**P617**)
	25.2	**No corresp. uni. enc.** “No corresponding universal encoder”	No connection to the selected universal encoder. • The encoder or data cable are not connected correctly • No power supply to the encoder • Encoder incorrectly set, check **P604**
	25.3	**Uni. enc. res.** *“Universal encoder resolution”*	The set universal encoder does not match the resolution sent by the encoder. • Check P605.
	25.4	**Uni. enc. error** *“Universal encoder error”*	The universal encoder reports an internal error to the frequency inverter. • Re-start encoder.

E025	**25.5**	**Uni. encoder parameter**	Two different multiturn encoder types have been parameterised. • Only identical multiturn encoders may be used. Use and parameterisation of two different multiturn encoders (P604 [-04] to [-07]) in the 4 parameter sets results in an error.

Information

Check of signal quality

P650 [-03] counts the communication errors to the universal encoder since switch-on. A high value may indicate that the encoder cable is poorly shielded.

A communication error does not necessarily result in a fault. An error message is only triggered if several consecutive communications have failed.

Switch-on block message, “not ready”

Control panel display		Reason	Cause
Group	Details in P700 [-03]	Text	• Remedy
I014	**14.4**	**Absolute encoder error**	Absolute encoder defective or communication interrupted • Check absolute encoder and wiring • Check the parameterisation in the frequency inverter • Five seconds after switching on the frequency inverter there is no contact with the encoder • The encoder does not respond to an SDO command from the frequency inverter • The parameters set in the frequency inverter do not correspond to the possibilities for the encoder (e.g. resolution in parameter P605) • The frequency inverter does not receive a position value over a period of 50ms

1) Indication of operating mode (message) on the *ParameterBox* or virtual operating unit of the *NORD CON-Software*: **"Not ready"**

7.2 FAQ operational problems

Typical operating errors and sources of error in connection with positioning and speed control are listed below. It is recommended that the same sequence as for commissioning is used for troubleshooting. Accordingly, it should first be checked whether the affected axis is running without control. After this, the speed and position controllers should be tested.

7.2.1 Operation with speed feedback, without position control

Symptom	Cause
• Motor only rotates slowly • Motor runs unevenly	• Incorrect assignment of the direction of rotation of the motor to the counting direction of the incremental encoder – Change the sign in P301 • Incorrect incremental encoder type (no RS422 outputs) • Encoder cable interrupted – Check the voltage difference of track A and B with **P709** • Encoder voltage supply missing • Incorrect pulse number parameterised – Check the resolution in P301 • Incorrect motor parameters – Check P200 et seq. • Encoder track missing
• With active speed feedback (servo mode enabled) the motor runs correctly, but runs unevenly at low speeds • Overcurrent switch-off at higher speeds	• Incremental encoder incorrectly mounted • Interference in encoder signals
• Overcurrent switch-off when braking	• For field weakening operation in servo mode, the torque limit must not exceed 200 %

7.2.2 Operation with active position control

Symptom	Cause
• Target position exceeded	• Position control P amplification considerably too large – Check P611 • Speed controller (servo mode) not optimally set – Set I amplification to approx. 3 % / ms, – Set P amplification to approx. 120 %
• Drive oscillates at the target position	• Position control P amplification considerably too large – Check P611
• Drive moves in the wrong direction (away from the setpoint position)	• The direction of rotation of the absolute encoder does not match the direction of rotation of the motor – Parameterise a negative value for the speed ratio (**P607**)
• Drive unit sags away after enabling is removed (lifting gear)	• Setpoint delay missing (control parameter) • For servo mode = "Off" the control must be locked immediately by the event "End Point Reached"

7.2.3 Position control with incremental encoders

Symptom	Cause
• Position drifts away	• Interference pulse in the encoder cable
• No reproducible precision when approaching the position,	• At all speeds – Interference pulse in the encoder cable • Only at high speed (n > 1000 rpm) – Pulse number of the encoder too large in association with the length of the encoder cable → pulse frequency too high – Encoder not mounted correctly / loose

7.2.4 Position control with absolute encoders

Symptom	Cause
• Actual position value always runs to the same value and then no longer changes	• Encoder connection faulty
• Position not always found at the same place, axis sometimes jumps backwards and forwards.	• Axis stiff • Axis jams • Encoder not mounted correctly / loose
• Position value jumps or does not match the number of revolutions of the encoder	• Encoder defective Check the absolute encoder: – Remove the encoder – Set the speed ration and reduction to "1" (P607, P608) – Manually rotate the encoder shaft. The displayed position must match the number of revolutions of the encoder, otherwise the encoder has a malfunction.

7.2.5 Other encoder errors (universal encoder interface)

Circumstances	Cause
• Hiperface encoder After enabling, the frequency inverter goes into fault state with error E25.0	• Sin/Cos signals not connected correctly – The voltage signal can be checked with **P651**.
• SSI encoders	
The position jumps to the value 0 too early.	Multiply Transmit (OFF), PBF (OFF). Coding is binary • The resolution is set too low.
The position does not count evenly up or down, but jumps.	Multiply Transmit (OFF), PBF (OFF). • Position coding (Gray, Binary) is set incorrectly. • Resolution is set incorrectly, especially with the coding type Gray.
The position jumps with a power of 2.	Multiply Transmit (OFF), PBF (OFF). Coding is binary • The resolution is set too low.
Continuously occurring Multiply Transmit error.	• Encoder does not support Multiply Transmit
• BISS encoders	
Communication error although the encoder has been connected correctly.	• Resolution set incorrectly
Communication error after enable.	• Resolution set incorrectly
Speed ratio present although none has been set.	• Resolution set incorrectly
• The universal encoder reports an internal error or a warning.	• If the encoder reports and internal error, the cause must be determined from the reason which is entered in **P650** [-01], using the documentation from the encoder manufacturer. An internal warning is not critical for positioning and can be obtained from parameter **P650** [-02] • A BISS encoder only signals a **1** as the cause of a warning or error. Such a message means that a warning or error has occurred since the last initialisation. If the message does not disappear, the power supply to the encoder must be disconnected for 1 minute to reset the message. • Frequent errors or warnings after long and error-free operation indicate that the encoder will soon fail!

8 Technical Data

The POSICON function essentially has the following technical data.

Encoder type		
	Incremental	SK 5xxP: HTL; ab SK 53xP: TTL; SK CU5-MLT: SIN/COS
	Absolute	SK 5xxP: CANopen; SK CU5-MLT: SSI, BISS, EnDat, Hiperface
Number of positions		
	Absolute	252
	Relative	24
Measurement detection resolution		1/1000 position
Functionalities		• Absolute positioning • Relative positioning • Residual path positioning • Rotary table positioning / module axes (path optimised) • Reference point run • Reset position • Position synchronisation (Master - Slave) – Flying Saw – Diagonal Saw
Setpoint specification		• Digital inputs • Bus IO In Bits • Analogue inputs • Bus setpoints
Status messages		• Setpoint / Actual position and position deviations • Operating status – Position reached – Reference point available – …
Types of acceleration		• With maximum speed • With fixed or variable speed setpoint .... each optionally with "S ramp" (ramp smoothing)
Monitoring		• Communication – To encoder – Between Master and Slave • Operating characteristics – Target window / permissible positioning range (min/ max. position) – Slip error ~ Calculated value in comparison with the actual encoder value ~ Measured value between two encoders

Note:	Only the encoder for the active parameter set is monitored.
Position detection	• Sequential position detection for up to 4 axes with different encoders is possible. • With correct parameterisation the position of all connected encoders is detected. Via the integrated PLC of the frequency inverter the positions can be transmitted to a higher level PLC and used for monitoring (e.g. standstill monitoring of inactive drive axes).

9 Appendix

9.1 Service and commissioning information

In case of problems, e.g. during commissioning, please contact our Service department:

☎ +49 4532 289-2125

Our Service department is available 24/7 and can help you best if you have the following information about the device and its accessories to hand:

- Type designation,
- Serial number,
- Firmware version

9.2 Documents and software

Documents and software can be downloaded from our website www.nord.com .

Other applicable documents and further information

documentation	Contents
BU 0600	Manual for frequency inverter NORDAC *PRO* **SK 500P**
BU 0000	Manual for use of NORDCON software
BU 0040	Manual for use of NORD ParameterBoxes

Software

Software	Description
NORDCON	Parameterisation and diagnostic software

9.3 Keyword Index

- **Absolute encoder, single-turn** — Rotary encoder, which outputs coded information for each measurement step within a rotation. The data is retained even after a power failure. The data continues to be recorded even without power.
- **Absolute encoder, multiturn** — ... as for absolute single-turn encoder, however, the number of rotations are additionally recorded.
- **Baud rate** — The transmission rate for serial interfaces in bits per second
- **Binary code** — The designation for a code in which messages are communicated by "0" and "1" signals.
- **Bit / Byte** — A bit (binary digit) is the smallest unit of information in the binary system. A byte has 8 bits.
- **Broadcast** — In a network, all slave participants are addressed simultaneously by the master.
- **CAN-Bus** — CAN = (Controller Area Network)
  Designates a multi-master bus system with two-conductor cable. Its operation is orientated to events or messages. At present, standard CAN protocols are specified under CANopen.
- **CANopen** — Designates a communications protocol based on CAN
- **Encoder** — Electrical or opto-mechanical device for detecting rotary movements. A differentiation is made between absolute encoders and incremental encoders.
- **Incremental encoder** — Encoders which output an electrical pulse (High/Low) for each measurement step.
- **Jitter** — Designates a slight fluctuation in precision in the transmission pulse, or the variation in the transmission time of data packages.
- **Multiple-turn encoder** — See "Absolute encoder, multiturn"
- **Precision** — Deviation between the actual and the measured position.
- **Pulse number** — A number of light/dark segments are applied to a glass pulse disk. These segments are scanned by a light beam in the encoder and therefore determine the possible resolution of a rotary encoder.
- **Reset position** — Function for setting a zero point (or offset) at any position of the resolution range of an encoder without mechanical adjustment.
- **Resolution (encoder resolution)** — For single-turn rotary encoders, the resolution indicates the number of measurement steps per rotation.
  For multi-turn rotary encoders the resolution indicates the number of measurement steps per rotation multiplied by the number of rotations.
- **Single-turn encoder** — See "Absolute encoder, single-turn"
- **Total resolution** — See Resolution

9.4 Abbreviations

- **Abs.** Absolute
- **AIN** Analogue input
- **AOUT** Analogue output
- **DIN** Digital input
- **DOUT** Digital output
- **FI** Frequency inverter
- **GND** Ground
- **Inc** Incremental
- **IO** IN / OUT (Input / Output)
- **P** Parameter set dependant parameter, i.e. a parameter which can be assigned with different functions of values in each of the 4 parameter sets of the frequency inverter.
- **Pos** Position
- **S** Supervisor parameter, i.e. a parameter which is only visible if the correct Supervisor Code is entered in parameter **P003**.

Key word index

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