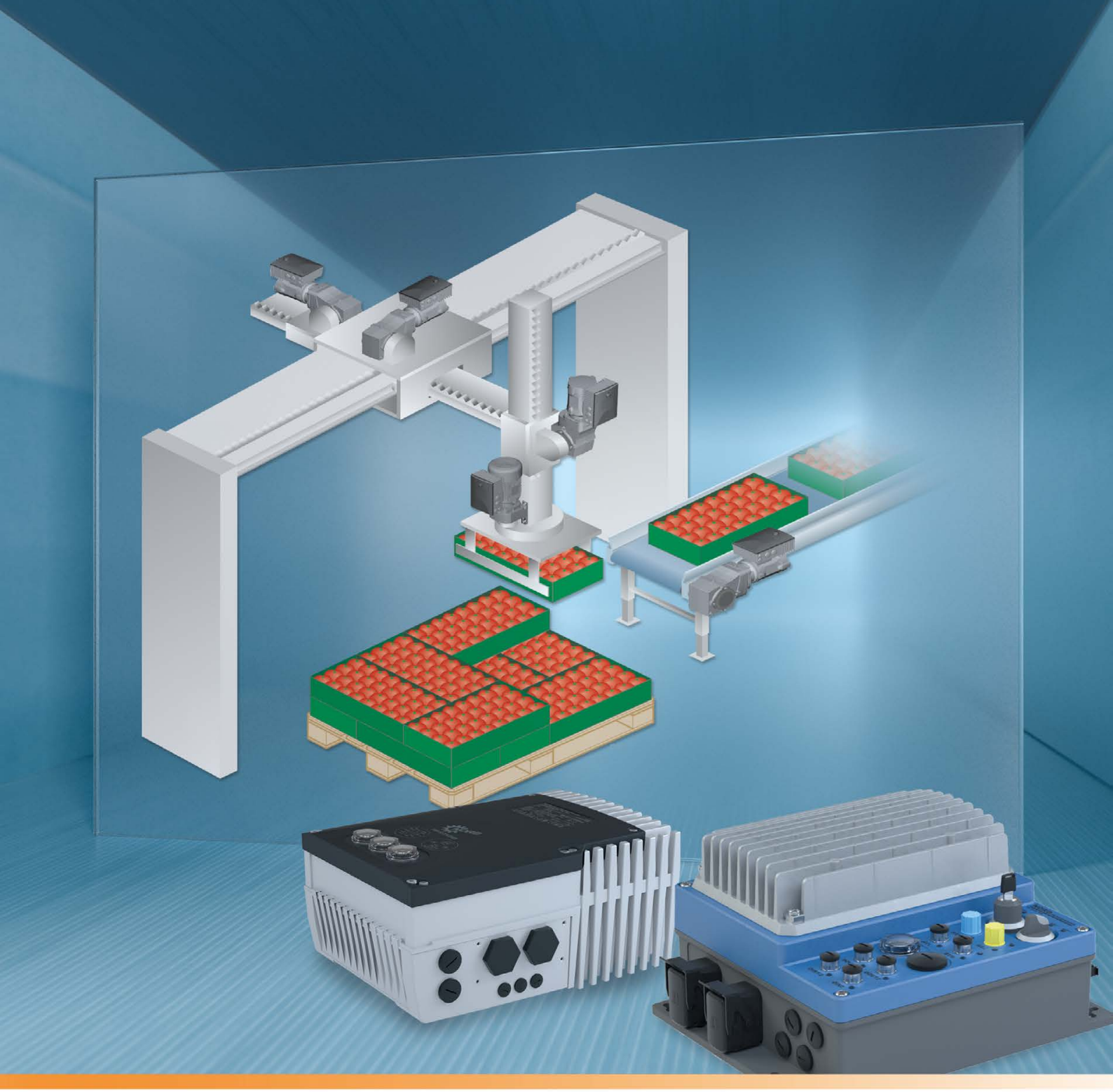
INTELLIGENT DRIVESYSTEMS, WORLDWIDE SERVICES



BU 0210 – en

POSICON positioning control

Supplementary manual for series SK 200E and SK 250E-FDS

NORD® DRIVESYSTEMS

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1 Introduction

1.1 General

1.1.1 Documentation

Name: **BU 0210**

Part number: **6072102**

Series: **POSICON for**

NORDAC FLEX and (SK 200E ... SK 235E)

NORDAC LINKseries frequency inverters (SK 250E ... SK 280E)

1.1.2 Document History

Edition Order number	Series	Version Software	Remarks
BU 0210, June 2009 **6072102**/ 2509	SK 205E … SK 235E	V 1.0 R0	First edition
BU 0210, November 2016 **6072102**/ 4816	SK 200E … SK 235E SK 250E-FDS … SK 280E-FDS	V 2.1 R1 V 1.0 R0	• Implementation of device types SK 200E, SK 210E, SK 220E and SK 230E • Implementation of SK 250E-FDS series with the SK 250E-FDS, SK 260E-FDS, SK 270E-FDS and SK 280E-FDS device types • “Flying saw“ technology function • “Remaining path positioning” technology function • Extension of static positions from 15 to 63 • Extensive revision
BU 0210, July 2017 **6072102**/ 3117	SK 200E … SK 235E SK 250E-FDS … SK 280E-FDS	V 2.1 R3 V 1.1 R2	• General corrections
BU 0210, April 2020 **6072102**/ 1620	SK 200E … SK 235E SK 250E-FDS … SK 280E-FDS	V 2.2 R0 V 1.3 R0	• General corrections

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 2.1 "Intended use".

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 2.2 "Selection and qualification of personnel".

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 SK 200E … SK 235E frequency inverters

In order to access the electrical connections, the SK 2xxE must be removed from the SK TI4-… connection unit (📖 Section).

One terminal block is provided for the power connections and one for the control connections.

The PE connections (device-earth) are inside the cast housing of the connecting unit on the base. A contact is available on the power terminal block for size 4.

The terminal strip assignments differ according to the version of the device. The correct assignment can be found on the inscription on the respective terminal or the terminal overview plan printed inside the device.

	Connecting terminals for
(1)	Power cable Motor cable Brake resistance lines
(2)	Control lines Electromechanical brake PTC (TF) of motor
(3)	PE

Control terminal details

Labelling, function

SH:	Function: Safe stop	DOUT:	Digital output
AS1+/-:	Integrated AS interface	24 V SH:	"Safe stop" input
24 V:	24 V DC control voltage	0 V SH:	"Safe stop" reference potential
10 V REF:	10 V DC reference voltage for AIN	AIN +/-	Analogue input
AGND:	Reference potential for analogue signals	SYS H/L:	System bus
GND:	Reference potential for digital signals	MB+/-:	Control of electro-mechanical brake
DIN:	Digital input	TF+/-:	Motor thermistor (PTC) connection

Connections depending on the development stage

Detailed information regarding **functional safety** (Safe Stop) can be found in supplementary manual BU0230. - www.nord.com -

Sizes 1 ... 3

SK 200E	**SK 210E** SH	**SK 220E** AS1	**SK 230E** SH+AS1	**Device type** **Labelling**	Pin		**SK 205E**	**SK 215E** SH	**SK 225E** AS1	**SK 235E** SH+AS1
24 V (output)				**43**	1	**44**	24 V (input)*			
AIN1+		ASI+		**14/84**	2	**44/84**	24 V (input)*		ASI+	
AIN2+				**16**	3	**40**	GND			
AGND		ASI-		**12/85**	4	**40/85**	GND		ASI-	
DIN1				**21**	5	**21**	DIN1			
DIN2				**22**	6	**22**	DIN2			
DIN3				**23**	7	**23**	DIN3			
DIN4	24 V SH	DIN4	24 V SH	**24/89**	8	**24/89**	DIN4	24 V SH	DIN4	24 V SH
GND	0V SH	GND	0V SH	**40/88**	9	**40/88**	GND	0V SH	GND	0V SH
DOUT1				**1**	10	**1**	DOUT1			
GND				**40**	11	**40**	GND			
SYS H				**77**	12	**77**	SYS H			
SYS L				**78**	13	**78**	SYS L			
10 V REF				**11**	14	**-**	---			
DOUT2				**3**	15	**79**	MB+			
GND				**40**	16	**80**	MB-			
TF+				**38**	17	**38**	TF+			
TF-				**39**	18	**39**	TF-			

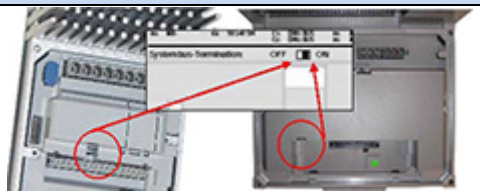
* when using the AS interface, terminal 44 provides an output voltage (26.5 V DC … 31.6 V DC, max. 60 mA). In this case, no voltage sources may be connected to this terminal!

Size 4

Device type		SK 200E	SK 210E (SH)	SK 220E (ASI)	SK 230E (SH+ASI)
Pin	**Labelling**				
1	**43**	24 V (output)			
2	**43**	24 V (output)			
3	**40**	GND			
4	**40**	GND			
5	**-/84**	/		ASI+	
6	**-/85**	/		ASI-	
7	**11**	10 V REF			
8	**14**	AIN1+			
9	**16**	AIN2+			
10	**12**	AGND			
11	**44**	24 V (input)			
12	**44**	24 V (input)			
13	**40**	GND			
14	**40**	GND			
15	**21**	DIN1			
16	**22**	DIN2			
17	**23**	DIN3			
18	**24/89**	DIN4	24 V SH	DIN4	24 V SH
19	**40/88**	GND	0V SH	GND	0V SH
20	**40**	GND			
21	**1**	DOUT1			
22	**40**	GND			
23	**3**	DOUT2			
24	**40**	GND			
25	**77**	SYS H			
26	**78**	SYS L			
27	**38**	TF+			
28	**39**	TF-			
Separate terminal block (2-pole):					
1	**79**	MB+			
2	**80**	MB+			

Meaning, Functions		Description / Technical data		
Terminal			Parameter	
No.	Designation	Meaning	No.	Function of factory setting
Digital inputs		Actuation of device via an external controller, switch or the like, connection of HTL transmitter (DIN2 and DIN3 only)		
		as per EN 61131-2, type 1 Low: 0-5 V (~ 9.5 kΩ) High: 15-30 V (~ 2.5 - 3.5 kΩ) *Scan time:* 1 ms *Reaction time:* 4 - 5 ms	*Input capacitance* 10 nF (DIN1, DIN 4) 1.2 nF (DIN 2, DIN 3) DIN 2 and DIN 3 double allocation Min.: 250 Hz, Max.: 205 kHz	
21	DIN1	Digital input 1	P420 [-01]	ON right
22	DIN2	Digital input 2	P420 [-02]	ON left
23	DIN3	Digital input 3	P420 [-03]	Fixed frequency 1 (→ P465[-01])
24	DIN4	Digital input 4	P420 [-04]	Fixed frequency 2 (→ P465[-02])
Control voltage source		Control voltage of device, e.g. for supplying accessories.		
		24 V DC ± 25 %, short circuit-proof	Maximum load 200 mA [1)]	
43	VO / 24V	Voltage output	-	-
40	GND / 0V	Reference potential GND	-	-

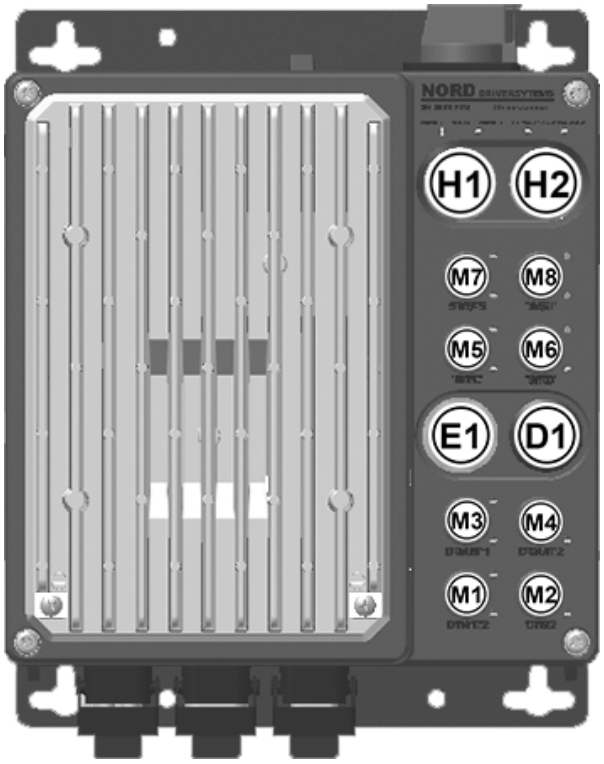
1) See "Total currents" information (🕮 Section)

System bus		NORD-specific bus system for communicating with other devices (e.g. smart option modules or frequency inverter)		
		Up to four frequency inverters (SK 2xxE, SK 1x0E) can be operated on a single system bus.	→ Address = 32 / 34 / 36 / 38	
77	SYS H	System bus+	P509/510	Control terminals / Auto
78	SYS L	System bus-	P514/515	250kBaud / Address 32_{dec}
System bus terminating resistance		Termination at the physical end of the bus system		
		If the device is supplied preassembled (e.g. equipped with customer unit SK CU4 / SK TU4) the terminating resistors on the device and the module are factory-set. If other devices are going to be incorporated in the system bus, the terminating resistors must be reset accordingly. **It must always be checked before commissioning that the terminating resistors have been correctly set (1x at beginning and 1x at end of system bus).**		
S2				Factory setting "OFF" (For deviating factory setting, see explanation above)

3.2 Connection to SK 250E-FDS … SK 280E-FDS frequency inverters

Electrical connections are made exclusively with plug connectors.

3.2.1.1 Control level



Position: front

The configuration and functions of the individual option slots are variable. They are directly influenced by the customer's specification, but are also indirectly dependent on the further features.

The meaning of the LEDs which are assigned for each option slot is also dependent.

D1 = Diagnostic opening
E1 = Status indicators (LEDs)
H1 = Control element 1
H2 = Control element 2
M1 =
… Signal connections
M8 =

3.2.1.2 Configuration of option slots on the control level

The option slots **M1** to **M8** are designed for M12 plug connectors. The configuration of the connections or functions for the individual option slots which are relevant for the frequency inverter is printed directly on the option slot.

Option slot	Option type		Function	Relevant parameters	Comments
M1	a	No option			
	b	Initiator 1 / 4	DIN1	P420[-01]	Not available if **M5 c** has zero track. Set the function of the zero track in **P420[-01]**.
			DIN4	P420[-04]	
M2	a	No option			
	b	Initiator 4	DIN4	P420[-04]	
M3	a	No option			
	b	Actuator 1 / 2	DOUT1	P434[-01]	
			DOUT2	P434[-02]	
M4	a	No option			
	b	Actuator 2	DOUT2	P434[-02]	
M5	a	No option			
	b	Initiator 2 / 3	DIN2	P420[-02]	
			DIN3	P420[-03]	
	c	HTL encoder [1]	HTL-A	P420[-02]	
			HTL-B	P420[-03]	
	d	System bus master	SYSM		
M6	a	No option			
	b	Initiator 3	DIN3	P420[-03]	only SK 250E-FDS / SK 270E-FDS
	c	Safe Stop	STO		only SK 260E-FDS / SK 280E-FDS
M7	a	No option			
	b	Initiator 6 / 7	AIN1 / DIN6	P400[-01] / P420[-06], P113	H1 / H2 only usable to a limited extent
			AIN2 / DIN7	P400[-02] / P420[-07], P113	
	c	System bus slave or absolute encoder	SYSS		
M8	a	No option			
	b	Initiator 7	AIN2 / DIN7	P400[-02] / P420[-07], P113	only SK 250E-FDS / SK 260E-FDS, H1 / H2 only usable to a limited extent
	c	24 V DC supply [2]	24VI		
	d	AS interface (“AUX“)	AUX		only SK 270E-FDS / SK 280E-FDS
	e	AS interface	ASI		
	f	AS interface (“AXS“)	AXS		

1) Encoder cable available on request If the encoder has a zero track, evaluation of the zero track is only via **DIN1**.

2) The DC control voltage can also be supplied via **M8 c** (AUX), **M8 f** (AXS) or the option slots **X1** or **Z1** … **Z4** of the connection level.

The control elements for the FI are located at the option slots **H1** and **H2**.

The various types of control elements can be selected. Depending on the combination which is selected, these have an effect on the function of the individual digital inputs. These functions are taken into account in the factory settings of the relevant parameters for the specific frequency inverter.

Version	Option slot H1 [1]		Option slot H2 [2]		Parameter function [3]		
	Type	Function	Type	Function	P420[-07]	P420[-06]	P420[-05]
0	-	/	-	/	{0}	{0}	{0}
1	I	L - A - R	-	/	{34}	{33}	{0}
2	I	L - A - R	IV	/ - Q	{34}	{33}	{12}
3	I	L - A - R	II	Sp1 - Sp2	{34}	{33}	{35}
4	II	A - H	-	/	{0}	{15}	{0}
5	II	A - H	II	Off - On	{0}	{37}	{33}
6	II	A - H	I	L - Off - R	{34}	{37}	{33}
7	II	A - H	II	Sp1 - Sp2	{0}	{33}	{12}
8	III	Q - A - H	-	/	{12}	{15}	{0}
9	III	Q - A - H	II	Off - On	{12}	{37}	{1}
10	III	Q - A - H	II	Sp1 - Sp2	{12}	{33}	{35}

Functions

A	Automatic mode enabled	**H**	Manual mode enabled	**L**	Manual mode enabled, left
R	Manual mode enabled, right	**Off**	Manual mode not enabled	**On**	Manual mode enabled
Sp1	Speed 1 (value from P113 [-01])	**Sp2**	Speed 2 (value from P113 [-02])	**Q**	Acknowledge fault

Operating option type	
I	Switch (left – centre – right), locking, switch or key switch version
II	Switch (centre – right), locking, switch or key switch version
III	Switch (left – centre – right), locking at centre and right, switch or key switch version
IV	Pushbutton

1) Influences the parameter functions of digital inputs DIN 6 / 7

2) Influences the parameter functions of digital inputs DIN 5 / 7

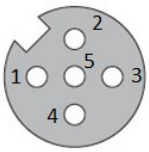
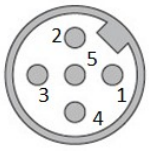
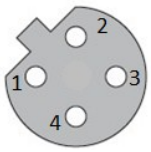
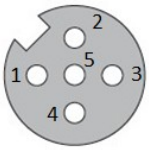
3) Variants for which the parameter functions are configured to the value {0} do not have a functional effect on the corresponding digital input. In such cases corresponding analog functions can be assigned via the relevant alternative analog inputs (see previous table).

Plug connections for M12 plug connectors

Depending on the function, 5-pin M12 surface mounted plug connectors with coloured sockets or plug inserts are installed. The colours reflect the functional assignment of the plug connector and therefore enable easy identification on the FI. The same applies for the colour coding of the cover caps.

The following plug connectors may be used on the device, depending on the customer's specification.

Option slots M1 to M8

Function	Plug connectors							Option slot	
	Contact diagram	Contact assignments							
		1	2	3	4	5		No.	Colour
DIN1 / DIN4	 Socket, A-coded	24 V	DIN4	GND	DIN1	PE		M1	black
DIN2 / DIN3		24 V	DIN3	GND	DIN2	PE		M5	black
DIN3		24 V		GND	DIN3	PE		M6	black
DIN4		24 V		GND	DIN4	PE		M2	black
DIN6 / DIN7		24 V	DIN7	GND	DIN6	PE		M7	black
DIN7		24 V		GND	DIN7	PE		M8	black
DOUT1 / DOUT2		24 V	DOUT2	GND	DOUT1	PE		M3	black
DOUT2		24 V		GND	DOUT2	PE		M4	black
AIN1 / AIN2		24 V	AIN2	GND	AIN1	+10 V Ref		M7	white
AIN2		24 V		GND	AIN2	+10 V Ref		M8	white
SYSM [1]			24 V	GND	CAN_H or SYS+	CAN_L or SYS-		M5	blue
STO [1]	 Plug connectors, A-coded			GND SH	24 V SH			M6	yellow
SYSS [1]				GND	CAN_H or SYS+	CAN_L or SYS-		M7	blue
24VI		24 V		GND				M8	black
ASI		ASI+		ASI-				M8	yellow
AUX		ASI+	GND	ASI-	24 V			M8	yellow
AXS		ASI+	GND	ASI-	24 V			M8	yellow
HTL [1]	 Socket, B-coded	24 V	Track B	GND	Track A			M5	black
HTL with zero track [1]	 Socket, A-coded	24 V	Track B	GND	Track A	Track -0		M5	black

1) The housing of the plug connector is internally wired to PE.

3.2.1.3 Control connection details

Meaning, Functions	Description / Technical data		
Contact (designation)	Meaning	Parameter No.	Function of factory setting
Digital inputs	Actuation of device via an external controller, switch or similar, connection of HTL transmitter (DIN2 and DIN3 only) The factory settings of digital inputs DIN5 to DIN7 depend on the configuration of option slots H1 and H2.		
	DIN1-5 according to EN 61131-2, type 1 Low: 0-5 V (~ 9.5 kΩ) High: 15-30 V (~ 2.5 - 3.5 kΩ) *Scan time:* 1 ms *Reaction time:* 4 - 5 ms	*Input capacitance* 10 nF (DIN1, DIN4, DIN5, DIN6, DIN7) 1.2 nF (DIN2, DIN3) *Limit frequency* (only DIN2 and DIN3) Min.: 250 Hz, Max.: 205 kHz	
DIN1	Digital input 1	P420 [-01]	No function
DIN2	Digital input 2	P420 [-02]	No function
DIN3	Digital input 3	P420 [-03]	No function
DIN4	Digital input 4	P420 [-04]	No function
DIN5	Digital input 5	P420 [-05]	(📖 Section "Configuration of option slots on the control level")
DIN6 / AIN1	Digital input 6	P420 [-06]	
DIN7 / AIN2	Digital input 7	P420 [-07]	

Notes for DIN6 and DIN7:
Digital inputs DIN6 and DIN7 depend directly on analogue inputs AIN1 and AIN2. This means that the digital functions can only be used if the analogue functions are disabled (corresponding to the factory setting).

Control voltage source	Control voltage from the inverter, e.g. as power supply for accessories		
	24 V DC ± 25 %, short circuit-proof	Maximum load [1]	
VO / 24V	Voltage output	-	-
GND / 0V	Reference potential GND	-	-

1) See "Total currents" information (📖 Section)

System bus	NORD-specific bus system for communicating with other devices (e.g. intelligent option modules or frequency inverters)		
	Up to four frequency inverters (SK 2xxE, SK 1x0E, SK 2xxE-FDS) can be operated on a single system bus.	→ Address = 32 / 34 / 36 / 38	
SYS H	System bus+	P509/510	Control terminals / Auto
SYS L	System bus-	P514/515	250kBaud / Address 32_{dec}

3.3 Encoders

3.3.1 CANopen absolute encoders

Absolute encoders are connected via the internal system bus 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.

3.3.1.1 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.0A00.2122.DG4404	8.5888.0400.2102.S014.K029	GXMMS.Z18
Part number	19551883 (AG7)	19551928 (AG9)	19551886 (AG4)	19556994 (AG6)
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. 33, baud rate 250k)	Adjustable (adr. 33, bd 250k)
Bus cover	Yes	No	Yes	Yes
Incremental encoder output	No	HTL/push-pull 2048 pulses	HTL/push-pull 2048 pulses	HTL/push-pull 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

3.3.1.2 Contact assignment for CANopen encoders (SK 200E … SK 235E)

Function	Assignment for SK 2xxE	
24 V supply	43 (/44)	24V (VO (/VI))
0 V supply	40	0V (GND)
System bus +	77	SYS H
System bus -	78	SYS L
Cable shield	Connect to the "PE" contact of the plug connector.	

3.3.1.3 Contact assignment for CANopen encoders (SK 250E-FDS … SK 280E-FDS)

Function	Assignment for SK 2xxE-FDS
24 V supply	24V (VO)
0 V supply	0V (GND)
System bus +	SYS H
System bus -	SYS L
Cable shield	Connect to the "PE" contact of the plug connector.

3.4 Colour and contact assignments for the incremental encoder (HTL)

Function	Wire colours for incremental encoders [1]	Assignment for SK 2xxE	
24V supply	brown / green	43 (/44)	24V (VO)
0V supply	white / green	40	0V (GND)
Track A	brown	22	DIN2
Track A inverse (A /)	green	--	
Track B	grey	23	DIN3
Track B inverse (B /)	pink	--	
Track 0	red	21	DIN1
Track 0 inverse	black	--	
Cable shield	Large-area connection to frequency inverter housing.		

1) The wire colours depend on the type of encoder and may differ. Please **note** the encoder **data sheet**!

Note the current consumption of the encoder (normally up to 150 mA) and the permissible load on the voltage source.

Only digital inputs DIN 2 and DIN 3 are in a position to process the signals of an HTL encoder. For the use of an encoder, parameters (P300) and/or (P600) must be activated according to requirements (speed feedback / servo mode or positioning).

Information — **DIN 2 and DIN 3 double allocation**

The digital inputs DIN2 and DIN3 are used for 2 different functions:

1. For digital functions which can be parameterised (e.g. “enable left”),
2. For evaluation of an incremental encoder.

Both functions are coupled by an "OR" link.

Evaluation of an incremental encoder is always activated. This means that if an incremental encoder is connected, it must be ensured that the digital functions are disabled (Parameter (P420 [-02] and [-03]) or via DIP switch).

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.

Information — **Encoder signal faults**

Wires that are not required (e.g. Track A inverse / B inverse) must be isolated.

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.

If the rotary encoder has a zero track, this must be connected to digital input 1 of the device. The zero track is read out by the frequency inverter if parameter P420 [-01] has been set to function "43".

3.5 Colour and contact assignments for the incremental encoder (HTL)

Function	Wire colours, for incremental encoders	Assignment for SK 2xxE-FDS
24V supply	brown / green	24V (VO)
0V supply	white / green	0V (GND)
Track A	brown	DIN2
Track A inverse (A /)	green	
Track B	grey	DIN3
Track B inverse (B /)	pink	
Track 0	red	(DIN1)
Track 0 inverse	black	
Cable shield	Connect to the "PE" contact of the plug connector.	

Note the current consumption of the encoder (normally up to 150 mA) and the permissible load on the voltage source.

For the use of an encoder, parameters (P300) or (P600) must be activated according to requirements (speed feedback / servo mode or positioning).

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 (P604 "Encoder type" without option “…+Save position”) or it has the value which was present on switch-off (P604 "Encoder type" 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]**)
U_n:	Negative speed ratio	(**P608 [-01]**)

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]** = 263

P608 [-01] = 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]** “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]** and **P608 [-01]** 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 20.

Reference runs

If the reference run is switched on, the drive moves according to the direction of its setpoint (*Enable right/left*, *+/- setpoint*). When reaching the reference point switch, the signal present at the digital input or the reference point of the BUS IO In bit reverses the direction. In this way, the reference switch is left again.

If the drive is already on the switch at the beginning of the reference run, the reference run is immediately started with the inverted direction of rotation.

After leaving the switch, the current position is set to the value set in the **P609** “*Offset Position*” parameter. If this value’s amount is not equal to “0”, the drive immediately moves to its new zero point. The drive remains at this point until the “*Reference run*” function is removed. If relative positioning (function 1) is selected in parameter **P610** the setpoint position is simultaneously set to the value 0.

Feedback from the frequency inverter for the completion of the reference run with adoption of a valid reference point can also 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 P604 "Encoder type" the setting “+ Save position” function 2 or 4) should be used. Otherwise, the actual values (position, reference point) are lost when the control voltage is switched off.

The reference 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 20.

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 1 or 5 ...).

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 [-02]**)
U_n:	Negative speed ratio	(**P608 [-02]**)

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 [-02]** =	263
	P608 [-02] =	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 [-02]** "*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 [-02]** and **P608 [-02]** 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 +/- 65000 (16 Bit) 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 1: 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 — **Alternative to P514 and P515**

As an alternative to setting via the parameters **P514** and **P515** the baud rate and the address can be set with the DIP switches of the frequency inverter (📖 BU 0200).

Information — **Use of an IO extension**

The address ranges 10 to 13 and 20 to 23 are occupied by the optional IO extension (e.g. SK TU4-IOE). If such modules are used in the bus system, these addresses can therefore not be used for the addressing of a CANopen absolute encoder.

4.2.2.2 Referencing an absolute encoder

Similarly to an incremental encoder, absolute encoders can be set to the value "0" or to the value which is set in parameter **P609 [-02]** "Offset Position" via the function "Reference point run" (📖 Section 4.2.1.1 "Reference run") and "Reset Position“ (📖 Section 4.2.1.2 "Reset position").

However, the precision of resetting the encoder position greatly depends on the actual speed of movement, the bus load, the baud rate and the type of encoder. Therefore it is urgently recommended that *absolute encoders are only reset when they are at a standstill*.

If both an incremental encoder and an absolute encoder are connected to the frequency inverter, both encoders are reset by performing the functions "Reference Point Run" or "Reset Position".

4.2.2.3 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 P604 one of the values 3, 4, 5 or 7 are set in the relevant parameters.

4.2.4 Linear or optimised path positioning method

The encoder used for positioning is activated via parameter **P604** "Encoder type". Here, a differentiation is made between normal measurement (for "linear" systems) and "path optimised" measurement (for circulating systems).

In the function "Optimum Path" the multi-turn resolution of the encoder for the overflow point can be additionally limited via parameter **P615** "Maximum Position". The multiturn resolution in rotations (1 rotation = 1,000 rev) is entered.

Select parameter **P601** "Actual position" to check the setting and function of the encoder.

Encoder type	Measuring method	
	Linear	Optimised path
Incremental encoder	0	3
Incremental encoder with saving of the position in the FI	2	4
CANopen absolute encoders (only for encoders approved by NORD (📖 Section 4.2.2.3 "Manual commissioning of the CANopen absolute encoder"))	1	5
CANopen absolute encoders for manual configuration (📖 Section)	6	7

Table 2: Parameter P604 encoder type selection

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 **P615** „*Maximum position*“.

Information

Overrun point in P615

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 [-02]** “*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]** “*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:

$\pm n_{max} = 0.5 * Ü_b / U_n$

n_{max}:	Number of motor revolution = Overflow point	**(P615)**
$Ü_b$:	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. absolute encoder: [-xx] = [-02]

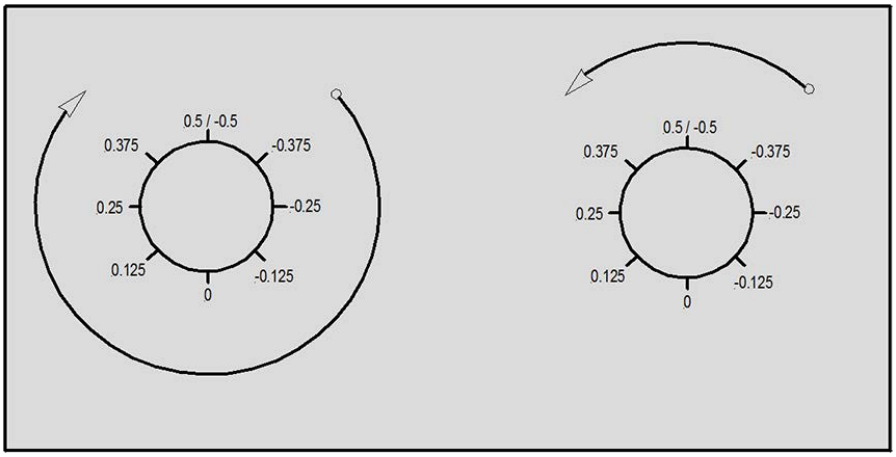
Example 1

The encoder, a absolute 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 [-02]	=	1
P608 [-02]	=	1
P615 =	=	0.5



Linear path Optimum path

Figure 1: Turntable positioning with a Singleturn application

Information

Parameterisation P615

In this case (singleturn application, encoder on the motor shaft) **P615** can remain in the factory setting (setting 0).

Example 2

The encoder, a absolute 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 [-02]	=	263
P608 [-02]	=	10
P615 =	=	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	**(P615)**
$Ü_b$:	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. absolute encoder: [-xx] = [-02]

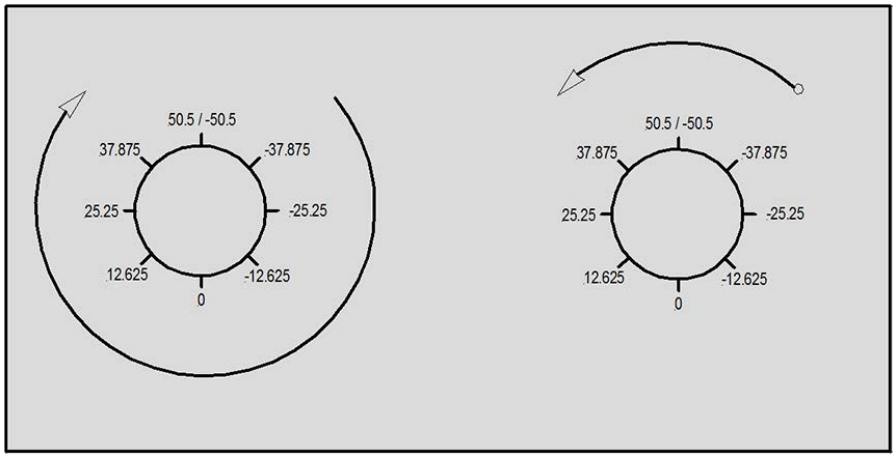
Example 1

The encoder, a absolute 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 [-02]	=	1
P608 [-02]	=	1
P615 =	=	50.5



Linear path Optimum path

Figure 2: Turntable positioning with a multiturn application

Example 2

The encoder, a absolute 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 [-02]	=	263
P608 [-02]	=	10
P615 =	=	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 20 “*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 20 “*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** [-03] the “Positive speed ratio” and **P608** [-03] 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 65000 (16 Bit) 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 the “path-optimised” function:

1. **Kübler encoders AG4** (part number 19551886): **2 x P615 * P607[3]/ P608[3] ≤ 1024**
2. **Kübler encoders AG9** (part number 19551928): **2 x P615 * P607[3]/ P608[3] ≤ 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.

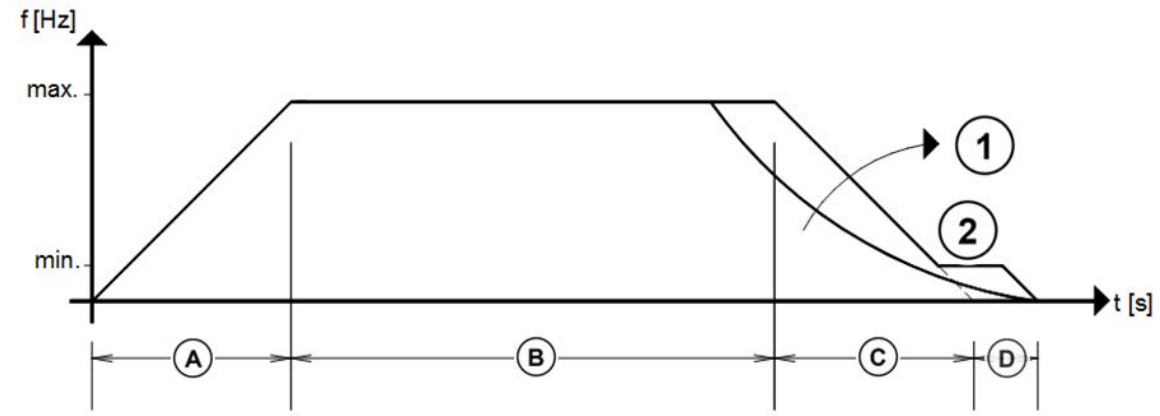
4.7 Position control: Function

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** = „OFF").

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 (system 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 system 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 system bus 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 **system bus** 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	1	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]	4	Main setpoint from system bus broadcast
P510 [-02]	4	Auxiliary setpoint from system bus 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]	2	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 25 "*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]	4	system bus Broadcast
P546	20	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 3: 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 system bus 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.

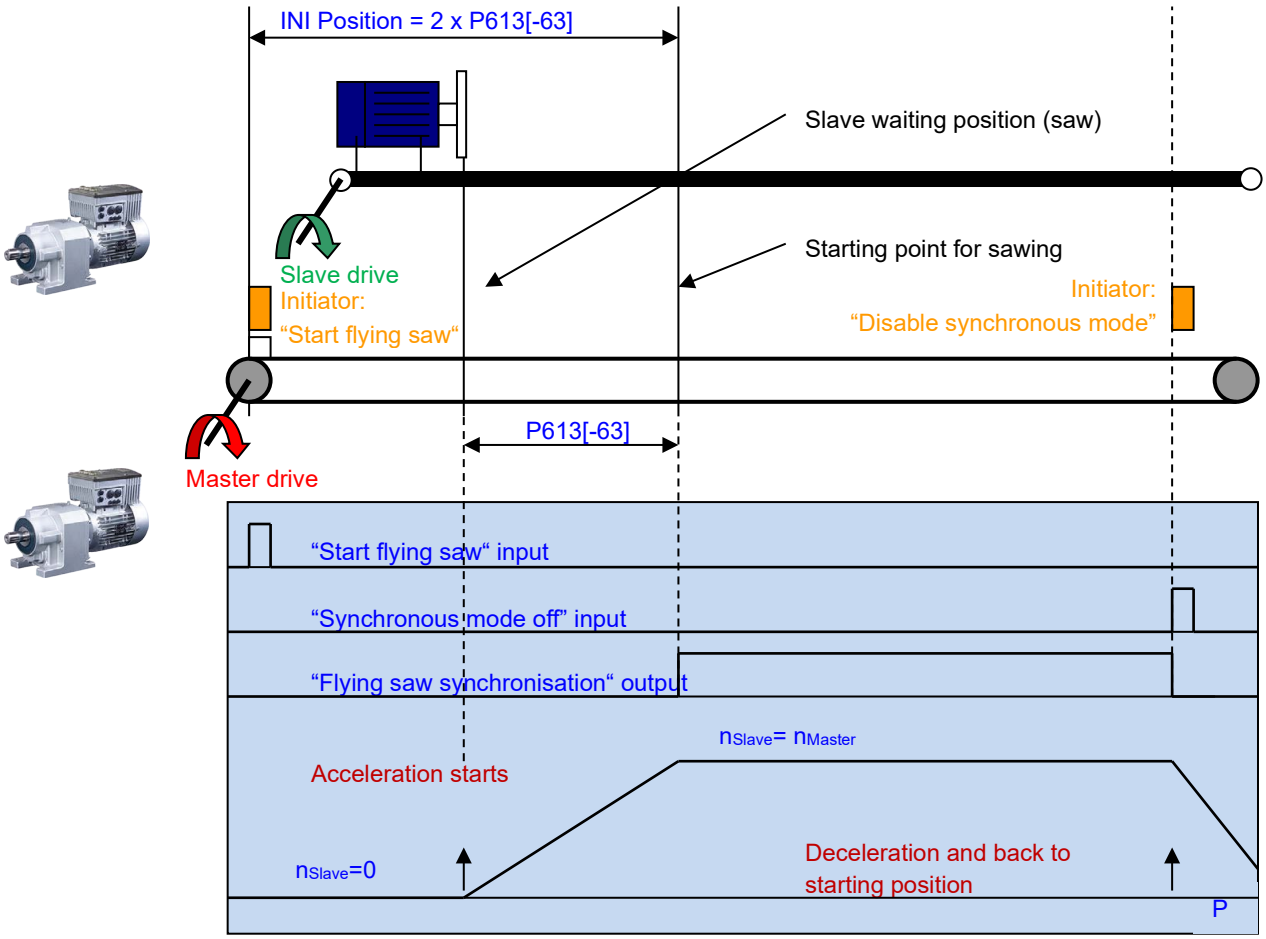


Figure 4: Flying Saw, example of principle

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.

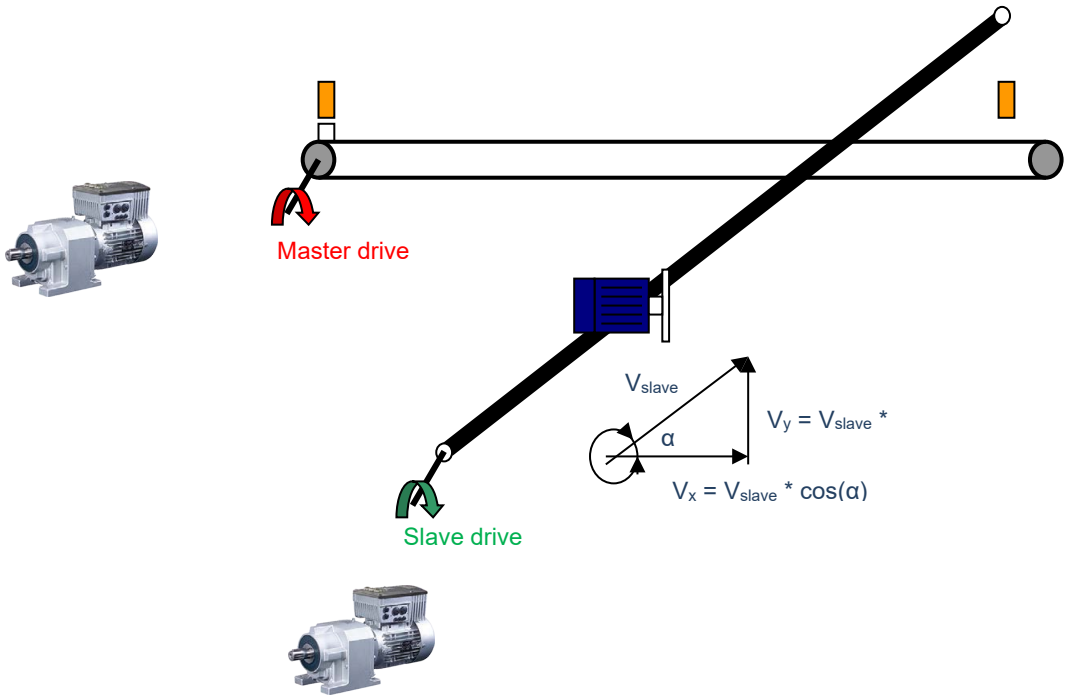


Figure 5: Flying Saw, diagonal saw

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 **P604 "Encoder type"**. 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”): $\lvert p_{ist}\rvert \geq p_{vergl}$ 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 4: Digital output messages for positioning function

5 Commissioning

When commissioning POSICON applications, it is recommended that a specific sequence is adhered to. The individual steps are described in the following.

Notes on special fault symptoms 🕮 Section 7 "Operating status messages".

Step 1: commissioning the axis without control

⚠ WARNING

Danger of injury due to unforeseen performance of functions

Unforeseen performances of functions may occur during commissioning.

For lifting gear, prior to switching on for the first time measures must be taken to prevent the load from falling.

Ensure that the Emergency Stop and safety circuits are functional!

After the input of all parameters the axis should first be commissioned without control of the position or speed.

- P300 "Servo Mode", setting 0 ("Off" or "VFC open-loop")
- P600 "Position control" setting 0 ("Off")

For lifting gear applications, when lifting loads with speed control, the parameter **P107** "Brake Application Time" and **P114** "Brake Release Time" should be optimised after setting the speed control.

Step 2: Commissioning the speed control

If no speed control is required or an incremental encoder is not available, this step can be skipped. Otherwise the Servo Mode must be switched on. For operation in Servo Mode, the exact motor data (parameter **P200** and following) and the correct encoder resolution / pulse number of the incremental encoder (parameter **P301**) must be parameterised.

If the motor only runs *at a slow speed* with a *high current consumption* after the Servo Mode is switched on, there is usually an error in the wiring or the parameterisation of the incremental encoder connection. The most frequent cause is an incorrect assignment of the direction of rotation of the motor to the counting direction of the encoder. Optimisation of the speed control is only carried out after commissioning of the position control, as the behaviour of the position control circuit can be influenced by changes to the speed control parameters.

Step 3: Commissioning the position control

After setting parameter **P604** "Encoder Type" and **P605** "Absolute Encoder" it must be checked whether the actual position is correctly detected. The actual position is shown in parameter **P601** "Actual Position". The value must be stable and become larger if the motor is switched on with rotation to the right enabled. If the value does not change when the axis is moved, the parameterisation and the encoder connection must be checked. The same applies if the displayed value for the actual position jumps although the axis has not moved.

After this a set position in the vicinity of the actual position should be parameterised. If after being enabled, the axis moves away form the position instead of towards it, the assignment between the direction of rotation of the motor and the direction of rotation of the encoder is incorrect. The sign for the speed ratio should then be changed.

If the detection of the actual position operates correctly, the position control can be optimised. In principle, with an increase of the P amplification the axis becomes "harder", i.e. the deviation from the set position becomes smaller than with smaller amplifications.

The size of the P amplification which is set in **P310** of the position control depends on the dynamic characteristics of the system as a whole. In principle: the greater the masses and the smaller the friction if the system, the greater is the tendency of the system to oscillate and the smaller is the maximum possible P amplification. To determine the critical value, the amplification is increased until the drive unit oscillates about the position (leaves the position and then approaches it again). The amplification should then be set to 0.5x to 0.7x this value.

For positioning applications with a subordinate speed control (**P300** "Servo Mode"), a setting which deviates from the standard setting of the speed control is usually to be recommended.

- **P310** "Speed Ctrl. P" = 100 % … 150 %
- **P311** "Speed Ctrl. I" = 3 %/ms … 5 %/ms

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 (BU0200 / BU0250).

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	Selection of the operating display of a ControlBox / SimpleBox with 7-segment display.
Setting values	

Value		Meaning
0	Actual frequency	Currently supplied output frequency
16	Position setpoint	Position setpoint
17	Actual position	Actual position
50	Actual position, incremental:	Actual position value of incremental encoder
51	Actual absolute position value or Actual CANopen actual position value	Actual position value of CANopen absolute encoder
52	Actual position difference	Actual difference between setpoint and actual position
53	Act. Pos. Diff. Abs/Inc	Actual position difference between absolute encoder and incremental encoder (see also **P631**)
54	Act. Pos. Diff. C/M	Actual position difference between the calculated and measured difference of an encoder (see also **P630**)

6.1.2 Speed control

P300	Servo mode	P
Description	Enabling of speed control with speed measurement using an incremental encoder. This leads to a very stable speed behaviour down to motor standstill.	
Note	Incremental encoder required	
Setting values		

Value		Meaning
0	Off = (VFC Open-Loop)	Speed control without encoder feedback
1	On (CFC closed-loop)	Speed control with encoder feedback
2	Obs (CFC open-loop)	Speed control without encoder feedback

P301	Encoder resolution
Description	Input of the pulse-count per rotation of the connected incremental encoder. If the direction of rotation of the encoder is not the same as the motor, this can be compensated by selecting the corresponding negative pulse numbers 8...0.16.
Note	Incremental encoder required
Setting values	

Value	Meaning	Value	Meaning
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
17 =	8192 pulses	16 =	- 8192 pulses

6.1.3 Control terminals

P400	Function Analog input			P
Arrays	[-01] … [-09]			
Scope of Application				
Description	Assignment of functions for the analogue input			
Setting values	**Value**		**Meaning**	
	0	Off	The input is not used.	
	25	Gear ratio factor	Gearing ratio. Setting of the speed ratio between the master and the slave	
	26	Set position	Within the limits of **P615** and **P616**, the set position can be specified via the analogue input. **P610** must be set to "Aux. setpoint source". In this case, monitoring of the position for minimum and maximum position is not performed.	

P418	Funct. Analog output			P
Arrays	[-01] … [-02]			
Scope of Application				
Description	Assignment of functions for the analogue output			
Setting values	**Value**		**Meaning**	
	0	Off	The output is not used.	
	29	Actual position	Within the limits of **P615** and **P616** the analogue output indicates the actual position.	

P420	Digital inputs
Arrays	[-01] … [-04]
Scope of Application	
Description	Assignment of functions for the digital input

Setting values

Value		Meaning	
0	Off	The input is not used.	
22	Reference point run	Start of reference point run (🕮 Section 4.2.1.1)	High
23	Reference point	Reference point reached (🕮 Section 4.2.1.1)	High
24	Teach-in	Start of Teach-in function (🕮 Section 4.4)	High
25	Quit – Teach-in	Saving of the actual position (🕮 Section 4.4)	Flank 0→1
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 of the actual position (🕮 Section 4.2.1.2)	Flank 0→1
62	Sync. Position array	Adoption of a preset position (🕮 Section 4.3)	Flank 0→1
63	Synchronous operation OFF	With function **P610** = 2 "Synchronous operation", synchronous operation is interrupted, however the drive unit remains in position control mode. The position setpoint (**P602**) of the master drive is reset with the 0→1 flank. The drive moves back to position "0" or to the position which is saved in the position offset (**P609**) and remains in this position.	High
		With function **P610** = 5 "Flying Saw", the slave returns 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. The position setpoint (**P602**) of the master drive is reset with the 0→1 flank.	Flank 0→1
64	Start Flying Saw	Start command for synchronisation of the slave drive with 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	Trig. remaining path	With function **P610** = 10 "Remaining path positioning" the drive unit switches to position control and moves for the parameterised "Remaining path". (🕮 Section 4.8)	Flank 0→1

P434	Digital output function			P
Arrays	[-01] … [-02]			
Scope of Application				
Description	Assignment of functions for the digital output			
Note	The parameters which are assigned to the output for standardisation (**P435**) or hysteresis **P436**) do not have any effect for the use of functions which are relevant to POSICON. In this case the hysteresis is set via parameter **P625**.			
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"

P480	Function BusIO In Bits	S
Arrays	[-01] … [-12]	
Description	Assignment of functions for Bus IO In Bits. The Bus IO In Bits are treated as digital inputs by the frequency inverter.	

Setting values

Value		Meaning	
0	Off	The input is not used.	
22	Reference point run	Start of reference point run (📖 Section 4.2.1.1)	High
23	Reference point	Reference point reached (📖 Section 4.2.1.1)	High
24	Teach-in	Start of Teach-in function (📖 Section 4.4)	High
25	Quit – Teach-in	Saving of the actual position (📖 Section 4.4)	Flank 0→1
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 of the actual position (📖 Section 4.2.1.2)	Flank 0→1
62	Sync. Position array	Adoption of a preset position (📖 Section 4.3)	Flank 0→1
63	Synchronous operation OFF	With function **P610** = 2 "Synchronous operation", synchronous operation is interrupted, however the drive unit remains in position control mode. The position setpoint (**P602**) of the master drive is reset with the 0→1 flank. The drive moves back to position "0" or to the position which is saved in the position offset (**P609**) and remains in this position.	High
		With function **P610** = 5 "Flying Saw", the slave returns 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. The position setpoint (**P602**) of the master drive is reset with the 0→1 flank.	Flank 0→1
64	Start Flying Saw	Start command for synchronisation of the slave drive with 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	Trig. remaining path	With function **P610** = 10 "Remaining path positioning" the drive unit switches to position control and moves for the parameterised "Remaining path". (📖 Section 4.8)	Flank 0→1

P481	Function BusIO Out Bits	S	
Arrays	[-01] … [-10]		
Description	Assignment of functions for Bus IO Out Bits. The Bus IO In Bits are treated as digital outputs by the frequency inverter.		

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	Leading function value	S	P
Arrays	[-01] … [-03]		
Description	Assignment of leading functions for the leading values of the master for a master/slave coupling.		
Note	With **P503** it must be specified via which bus system the guide value is to be sent to the slave.		

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

P503	Leading funct. output	S
Description	Specification on which bus system the master sends its control word and the leading values (**P502**) for the slaves which are connected to it	
Note	Relevant for master/slave applications on the master.	
	On the slave, parameters (**P509, P510, P546…**) are relevant for establishing communication.	

Setting values	Value	Meaning
	0 Off	No output of control word and leading values.
	1 CANopen (system bus)	Output of control word and leading values on the system bus (CANopen).
	2 System bus active	No output of control word and leading values, however via the ParameterBox or NORD CON, all participants which are set to ***System bus active*** are visible.
	3 CANopen+System bus active	Output of control word and leading values on the system bus (CANopen). Via the ParameterBox or NORD CON, all participants which are set to ***System bus active*** are visible.

P514	CAN bus baud rate
Description	Used to set the transfer rate (transfer speed) via the CANbus interface.
Note	All bus participants must have the same baud rate setting.

Setting values	Value	Meaning	Value	Meaning
	0 =	10 kBaud	4 =	125 kBaud
	1 =	20 kBaud	5 =	250 kBaud
	2 =	50 kBaud	6 =	500 kBaud
	3 =	100 kBaud	7 =	1 MBaud (no reliable operation, only use for test purposes!)

P515	CAN address
Setting range	0 … 255
Arrays	[-01] = Slave address, basic reception address for CAN + CANopen
	[-02] = Broadcast slave address, Broadcast – reception address for CANopen (Slave)
	[-03] = Master address, Broadcast – Transmission address for CANopen (Master)
Description	Setting for the CANbus address

P543	Bus actual value	S	P
Arrays	[-01] … -03		
Scope of Application			
Description	Assignment of a function for the selected actual value. This actual value is sent by the frequency inverter via the active bus system.		
Note	The output numeric values correspond to the number of encoder rotations per 1,000. Example: The display value 1246 corresponds to 1.246 rotations of the encoder.		

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	Func. bus setpoint	S	P
Arrays	[-01] … -03		
Scope of Application			
Description	In this parameter, a function is assigned to the delivered setpoints during bus control.		
Note	The output numeric values correspond to the number of encoder rotations per 1,000. Example: The display value 1246 corresponds to 1.246 rotations of the encoder.		

Setting values

Value		Meaning
0	Off	The bus setpoint is not used.
20	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
25	Gear ratio factor	Setting of the speed ratio between the master and the slave

P552	CAN master cycle	S	
Setting range	0 … 100		
Arrays	[-01] = CAN master function, cycle time system bus master function [-02] = CANopen abs. encoder, cycle time CANopen absolute encoder		
Factory setting	{ 0 }		
Description	Setting of the cycle time in the cycle time system bus master mode or to CANopen absolute encoders		
Note	With setting "0" a default value is used, which depends on the selected baud rate (P514). For details see 🕮 Section 4.2.2.1 "Additional settings: CANopen absolute encoders"		

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	Encoder type			S
Setting range	0 … 7			
Factory setting	{ 0 }			
Description	Selection of the encoder used for position detection (actual position value).			
Note	***Before activating*** *an absolute encoder via the parameter* ***P604*** *it is essential that the resolution of the absolute encoder is set in parameter* ***P605****. Also refer to note in* ***P605****.* For detailed information see 🕮 Section 4.2.4 "Linear or optimised path positioning method".			
Setting values	Value		Meaning	
	0	Incremental	Position detection with incremental encoders	
	1	CANopen absolute	Position detection with CANopen type absolute encoders, automatic configuration	
	2	Incr.+Save Pos.	Position detection with incremental encoder, with saving of position	
	3	Incremental absolute	Position detection with incremental encoder with emulation of a single-turn absolute encoder for path-optimised positioning	
	4	Incr.abs.+Save Pos.	... as for 3 with saving of position	
	5	CANopen path optimised	Position detection with CANopen type absolute encoder, for path-optimised positioning, automatic configuration	
	6	CANopen absolute, manual	Position detection with CANopen type absolute encoder, automatic configuration (🕮 Section 4.2.2.3 "Manual commissioning of the CANopen absolute encoder")	
	7	CANopen opt. path man.	... as for 6, for path optimised positioning	

P605	Absolute encoder	S
Setting range	0 ... 16 Bit	
Arrays	[-01] = Multi-turn resolution - number of possible encoder rotations [-02] = Single-turn resolution - resolution per encoder rotation	
Factory setting	{ all 10 }	
Description	Resolution setting of the absolute encoder.	
Note	If a single-turn encoder is used, the value "0" must be parameterised in Array [-01].	
	Before activation of the absolute encoder (**P604**) the resolution of the absolute encoder must be correctly set in **P605**. Otherwise, values which are 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] = Incremental encoder [-02] = Absolute encoder [-03] = Setpoint / actual value	
Factory setting	{ all 1 }	
Description	Setting the speed ratio (🕮 Section 4.5 "Speed ratio of setpoint and actual values")	
Note	Also note parameter **P608**.	

P608	Reduction ratio	S
Setting range	1 … 2 000 000	
Arrays	[-01] = Incremental encoder [-02] = Absolute encoder [-03] = Setpoint / actual value	
Factory setting	{ all 1 }	
Description	Setting the speed ratio (🕮 Section 4.5 "Speed ratio of setpoint and actual values")	
Note	Also note parameter **P607**.	

P609	Offset Position	S
Setting range	- 50000,000 … 50000,000 rev.	
Arrays	[-01] = Incremental encoder [-02] = Absolute encoder	
Factory setting	{ all 0 }	
Description	Offset setting for absolute and relative position specification.	

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
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
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
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.	

P615	Maximum position	S
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") **P604** parameter: If one of the "*Incremental absolute*", "*Incremental absolute with saving*" or "*… path-optimised*" has been set, the **P615** parameter performs the functions of a rotary axis' overflow point. The set value has to be a multiple of the 0.250 value.	
	• Positioning with incremental encoders If parameter **P604** is set to one of the functions "*Incremental* "0" or "*Incremental absolute*" the monitoring function is only active if the incremental encoder has been referenced. This means that referencing of the incremental encoder is necessary each time that the frequency inverter is switched on. In contrast, with setting "2" and "4" ("*Incremental … with saving of position*") the initial referencing after commissioning is sufficient in order to be able to use the function after switching on again.	
Setting values	0 = Monitoring is disabled	

P616	Minimum Position	S
Setting range	- 50000,000 … 50000,000 rev.	
Factory setting	{ 0 }	
Description	Setting of the lower setpoint limit of a permissible positioning range. The error message **E14.8** becomes active if the setpoint limit is exceeded.	
Note	• Round axes ("rotary table applications") If parameter **P604**: is set to one of the functions "*Incremental absolute*", "*Incremental absolute with saving*" or "*… path optimised*" parameter **P616** has no function. **SK 54xE:** This also applies for position detection with an HTL incremental encoder, i.e. if parameter **P604** is set to the function (0) "*Incremental*", **P618** is set to (1) and **P619** is set to (2) or (3). • Positioning with incremental encoders If parameter **P604** is set to one of the functions "*Incremental* "0" or "*Incremental absolute*" the monitoring function is only active if the incremental encoder has been referenced. This means that referencing of the incremental encoder is necessary each time that the frequency inverter is switched on. In contrast, with setting "2" and "4" ("*Incremental … with saving of position*") the initial referencing after commissioning is sufficient in order to be able to use the function after switching on again.	
Setting values	0 = Monitoring is disabled	

P625	Hysteresis output	S
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
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
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	Abs./Inc. slip error	S
Setting range	0.00 … 99.99 rev.	
Factory setting	{ 0 }	
Description	Permissible deviation of the measured positions between absolute encoder and incremental encoder. If the permissible deviation is exceeded error message **E14.6** is activated.	
Setting values	0 = Monitoring is disabled	

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

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

Display in the SimpleBox / ControlBox		Fault Text in the ParameterBox	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

Switch-on block messages

Display in the SimpleBox / ControlBox		Reason: Text in the ParameterBox	Cause • Remedy
Group	**Details in P700 [-03]**		
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.

8 Technical Data

The POSICON function essentially has the following technical data.

Encoder type		
	Incremental	HTL
	Absolute	CANopen
Number of positions		
	Absolute	63
	Relative	6
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

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 0200	Manual for Frequency Inverters NORDAC *FLEX* **SK 200E .. SK 235E**
BU 0250	Manual for field distributors NORDAC *LINK* **SK 250E-FDS .. SK 280E-FDS**
BU 0000	Manual for use of NORD CON software
BU 0040	Manual for use of NORD parameterisation units

Software

Software	Description
NORD CON	Parametrisation 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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