

# Electronic Products

## E 3000 GB





## NORDAC SK 500E/520E Frequency Inverter

The universal control device, small enough where space is limited, but technically as efficient as its "big brothers"

Due to its sensorless vectorial current type of control it is perfect e.g. for materials handling equipment or wherever else particularly high starting torques are required.

The upgraded version SK 520E allows for complex control tasks involving tachometer feedback (encoder) and extra control inputs to be implemented as well.

0.25 kW - 4.0 kW, 1/3 AC 200 V - 240 V

0.55 kW - 7.5 kW, 3 AC 380 V - 480 V

## NORDAC SK 700E Frequency Inverter

This device is particularly flexible when it comes to ever-changing demands.

Its modular construction means the functionality can be changed and adapted.

1.5 kW - 160 kW, 3 AC 380 V - 480 V



## NORDAC SK 1000E Servo Controller

The dynamic and intelligent drive by NORD

Wherever dynamic acceleration, and a high standstill torque combined with excellent precision are required, the SK 1000E is the best choice.

Equipped with an internal mini PLC and a field bus port, this type will solve even difficult drive problems in a reliable way.

1 - 10 kW, 3 AC 380 V - 480 V



## NORDAC *trio* SK 300E Motor Frequency Inverter

The ideal unit for decentralised solutions.

Communication via all common bus systems or the RS 485 interface, but also digital and analogue I/Os are available.

Replaceable modules make the device very flexible.

0.55 kW - 4 kW, 3 AC 380 V - 480 V



## NORDAC SK 750E Motor Plus Frequency Inverter

The ideal assembly for decentralized control of drives working in a higher output range.

Communication with any of the commonly used bus systems or via the RS 485 interface, as preferred by the user. Of course digital and analogue I/O's are provided as well.

By plugging in any of the variable equipment boxes, e.g. an operating module with display, the device is conveniently adapted to a variety of uses.

5.5 kW - 22 kW, 3 AC 380 - 480 V  
5.5 kW - 11 kW, 3 AC 200 - 240 V



## SK 140/150/160E Motor Starter, Soft Starter, Reverse Starter

The integral drive involving switching and protection functions.

**SK 140E:** Integrated electronic circuit breaker for ON / OFF switching

**SK 150E:** Soft starting ensured via integrated electronic phase-angle control.

**SK 160E:** Integrated power switches ensure ON / OFF switching and reversing operation.

Control and feedback via 24VDC control signals or a bus system.

0.25 kW - 3.0 / 4.0 kW, 3 AC 200 V - 480 V



Version shown with optional AS-Interface



## 1 Introduction

NORDAC frequency inverters supplement the gear motor range to make it a complete drive system.

NORD has been developing and manufacturing frequency inverters in accordance with specific market demands since 1986. NORD's previous experience with application categories and system commissioning are the basis of continuous and innovative product research and development.

NORDAC frequency inverters are characterised by easy handling, universal functionality and extremely convenient system start-up. The sensorless vector current control (ISD) system comprises extraordinary peak load allowance, excellent speed performance, and a high degree of robustness.

The uniform operating and parameter levels make for uniformity amongst the different frequency inverter series. In practice, this makes a very convenient operation.

They combine with the comprehensive range of gear motors to provide a compatible and economical drive system which can be used in any application:

e.g.

- pumps and fans
- materials-handling technology
- hoisting and lifting gear, cranes
- positioning applications
- warehouse and storage systems
- handling technology
- packaging machines
- textile machinery
- the beverage industry
- the automobile industry
- printing and paper processing
- airport technology

Competent application consultation, project and commissioning services are all part of the range of services Getriebbau NORD provides.

**Choose Getriebbau NORD as your partner for innovative drive technology.**



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## 2 Product characteristics

### 2.1 Frequency inverters for control cabinet installation

NORDAC frequency inverters for the respective demands can be selected from the following table for a great variety of driving applications.

More detailed information on the various type series is provided on the following pages.

Device series	NORDAC ...	<i>vector mc</i>	SK 500E/520E	SK 700E	SK 1000E
					
Features and functions		Frequency inverter	Frequency inverter	Frequency inverter	Servo controller
Performance range		0.25 ... 2.2 kW 1 AC 220...240 V	0.25 ... 4.0 kW 1/3 AC 200...240 V	-	-
Mains voltage		0.75 ... 3.0 kW 3 AC 380...460 V	0.55 ... 7.5 kW 3 AC 380...480 V	1.5 ... 160 kW 3 AC 380...480 V	1 ... 10 kW 3 AC 380...480 V
Max. overload capacity		200 %	200 %	200 %	200 %
Output frequency / speed		0...400 Hz	0...400 Hz	0...400 Hz	-6000...+6000 U/min
Mode of control		U/f Vector current control	U/f Vector current control	U/f Vector current control	Flux current control
Brake chopper		✓	✓	✓	✓
Internal line filter		✓	✓	✓ (up to 22kW)	✓
Tachometer feedback		-	✓ (SK 520E)	○	Resolver / Encoder
Torque control		✓	✓	✓	✓
Positioning module		-	-	○	✓
Digital inputs		4	5 / 7	○ max. 6	6
Analogue/digital outputs		2	2	○ max. 6	6
Analogue inputs		0...10 V 0/4...20mA (-10...+10 V optional)	0...10 V 0/4...20mA	○ 0...10 V -10...+10 V 0/4...20 mA	-10...+10 V
Parameter sets, number of		2	4	4	-
Motor temperature control		✓	✓	✓	✓
Licences		CE, UL, cUL	CE, UL	CE, UL, cUL	CE, UL, cUL
Ambient temperature		0...50°C	0...50°C	0...50°C	0...50°C
Storage temperature		-20...+60/70°C	-20...+60/70°C	-20...+60/70°C	-20...+60/70°C
Protection class		IP20	IP20	IP20	IP20
RS 485 interface (USS)		✓	✓	○ (✓ ≥ 30kW)	✓
Profibus		○	○	○	○
CAN bus		○	○	○	✓
CANopen		○	○	○	-
DeviceNet		○	○	○	-
InterBus		-	○	○	-
AS Interface		-	○	○	-
RS 232		○	✓	○ (✓ ≥ 30kW)	✓





✓ provided as standard

○ optional

## 2.2 Decentralised drive technology

NORDAC products, specially adapted to the motor, provide decentralised control technology with a variety of system benefits.

For more and detailed information read the relevant paragraphs on the following pages.

Device series	NORDAC...	<i>trio</i> SK 300E	<i>trio</i>	SK 750E	SK 140E / SK 150E / SK 160E
					
Features and functions		Motor Frequency inverter	Motor Frequency inverter	Motor Frequency inverter	Motor starter Soft starter Reversing starter
Performance range			0.25 ... 0.75 kW 1 AC 220...240 V	5.5 - 11 kW 3 AC 200 - 240 V	
Mains voltage		0.55 ... 4.0 kW 3 AC 380...480 V	0.37 ... 7.5 kW 3 AC 380...480 V	5.5 ... 22 kW 3 AC 380...480 V	0.25...3.0/4.0 kW 3 AC 200...480 V
Overload capacity		200 %	150 %	200%	depends on motor used
Output frequency		0...400 Hz	0...120 Hz	0...400 Hz	50 / 60 Hz
Mode of control		V/f Vector current control	U/f FCC flux current control	V/f Vector current control	Thyristor / phase angle control
Brake chopper		✓	○ (BG2)	✓	-
Internal line filter		✓ B1	✓ A1	✓ A1	✓ A1
Tachometer feedback		-	-	○	-
Torque control		✓	-	✓	-
Positioning module		-	-	○	-
Digital inputs		1 ✓ + 4 ○	3	○ max. 6	1 / 2
Outputs		1 ✓ + 1 ○	-	○ max. 6	1
Analogue inputs		○ 0...10 V 0/4...20mA	0...10 V 0/4...20 mA	○ 0...10 V -10...+10 V 0/4...20 mA	-
Parameter sets, number of		2	-	4	-
Motor temperature control		✓	✓	✓	✓
Licences		CE, UL, cUL	CE, UL, cUL	CE	CE
Ambient temperature		-10...+50°C	-10...+50°C	-10...+60°C	-10...+50°C
Storage temperature		-20...+60/70°C	-20...+60/70°C	-20...+60/70°C	-20...+60/70°C
Protection class		IP55 IP66 optional	IP55	IP54 IP65 water-cooled	IP55 IP66 as an option
RS 485 interface		✓	✓	✓	-
Profibus		○	○	○	-
CANbus		-	-	○	-
CANopen		○	-	○	-
DeviceNet		○	-	○	-
InterBus		○	-	○	-
AS Interface		○	-	○	○
RS 232		-	-	○	-

✓ provided as standard      ○ optional



### 3 Control cabinet frequency inverter

#### 3.1 NORDAC *vector mc*

##### 3.1.1 General information *vector mc*

NORDAC *vector mc* frequency inverters are microprocessor-controlled, voltage source frequency inverters designed to control the speed of three-phase current motors with an output range of 250W to 2.2kW (1 AC 220 ... 240V), and from 0.75kW to 3.0kW (3 AC 380 ... 460V).

Many different control options, optimised drive characteristics, simple operation, space-saving construction and high operational dependability are the distinctive features of these frequency inverters.

The sensorless vectorial current control system (ISD) enables the inverter to calculate, on the basis of a motor operation simulation program, how much the output voltage and frequency has to be modified for the desired motor speed to remain constant while load conditions are varying.



##### 3.1.2 Basic features *vector mc*

- ISD control provides a high starting torque.
- Slip compensation for precise motor speed regulation
- Easy installation, programming, and initialisation
- Two differently compact types of housing
- Can be mounted adjacent to each other without additional spacing
- Suited for an ambient temperature of up to 50°C
- Integrated line filter for EMC limit curve A
- Can be controlled via the serial RS 485 interface
- Automatic measurement of the stator resistance
- Two separate parameter sets which are switchable without interrupting the inverter-motor connection
- Specified setpoint using 0...10 volts, 0/4...20 mA (-10...+10 volts optional), fixed frequencies or bus
- Two programmable relay outputs
- Programmable direct current braking
- Integrated brake chopper for four-quadrant operation
- Adjustable ramp smoothing
- Scalable analogue output, 0...10 volts
- Detachable operating and display module
- Clear text display and data storage function
- Single phase *vector mc* also available for delivery as low leakage current version



### 3.1.3 Optional features vector mc

Option	Description	Data
Operating panel in plain language Parameter Box	Used to initialise, parameterise, configure and control the frequency inverter with full text instructions.	Will store 5 data records 6 languages / Help information Panel mounting
Various connecting cables	Cables to connect NORDAC <i>vector mc</i> , ParameterBox and PC.	Chap. 7.1 / 7.2
-10...+10 Volt setpoint card	Control using -10...+10 volts setpoint, with rotational direction detector Add-on board to be integrated in the frequency inverter.	-10...+10 volts
Brake resistors	When braking energy is recovered and fed back to the inverter, the integrated brake chopper will carry off excessive amounts to the external brake resistor.	Section 7.6
Input / output chokes	Required to reduce possible peaks in the supply current, or if very long motor cables are used	Chap. 7.7 / 7.8
(Additional) Line filters	Ensure radio interference suppression level B as per EN 55011.	Section 7.9
NEMA Kit	To improve protection against accidental contact with and around the connecting terminals, or when cable clamp screws are used.	Available in 2 sizes IP21
Frequency inverter type with low leakage current to earth	Available as single-phase version, SK 250/1 OFCT to SK 2200/1 OFCT. Must only be operated with a special additional line filter.	Leakage current < 3.5 mA, chap. 7.9.3

#### Technology boxes

Clipped on to the frequency inverter externally. They are used to control the frequency inverter or to display current operating values directly on the device.

Apart from being connected to custom interfaces, the variable technology boxes may also be used for bus access.



Option	Description	Data
ControlBox <i>mc</i>	Display enabling keyboard entry of parameter values and read-out of the current operating status. Clip-on fastening.	4 digits, 7 segments Will store 1 data record
RS 232 module	For parameterisation of the frequency inverter using a PC. Clip-on	Sub-D9
CANbus module	With this option the NORDAC <i>vector mc</i> can be controlled via the serial CAN bus port. For clip-on fastening.	Baud rate: 500 kBit/s Sub-D9
Profibus module	This option facilitates control of the NORDAC <i>vector mc</i> via the serial profibus port. For clip-on fastening.	Baud rate: 1.5 Mbaud Sub-D9
CANopen module	With this option the NORDAC <i>vector mc</i> can be controlled via the serial CAN bus port. For clip-on fastening.	Baud rate: 1 MBit/s Sub-D9
DeviceNet module	With this option the NORDAC <i>vector mc</i> can be controlled via the serial CAN bus port. For clip-on fastening.	Baud rate: 500 kBit/s 5 channel terminal connector



## 3.1.4 General data vector mc

Function	Specification		
Output frequency	0 ... 400 Hz		
Resolution	0.1 Hz		
Typical overload capacity	150 % for 30 s		
Protective measures against	Over-temperature overvoltage and undervoltage	Short-circuit, earth fault, overload, no-load running	
Regulation and control	Sensorless vector current control (ISD)	Regulation and control	
Analogue setpoint input / PID input	0 ... 10 V		
Analogue setpoint resolution	10 bits related to the measurement range		
Analogue output	0 .... Scalable between 0 and 10V		
Constancy of setpoint	analogue < 1 %    digital < 0.02 %		
Motor temperature control	PTC or bimetallic thermal circuit breaker		
Ramp periods	0 ... 99 s		
Control outputs	2 relays - 28 V DC / 230 V AC, 2 A		
Interface, optional	RS 485 (standard) RS 232	Profibus DP DeviceNet	CANbus CANopen
Efficiency of frequency inverter	approximately 95%		
Ambient temperature	0°C ... +40°C / +50°C (depending on operating mode) without condensation		
Storage and transport temperature	-20°C ... +60/70°C, 85% humidity of the air without condensation		
Long-term storage	Connect frequency inverters to the mains for 60 minutes at least once per year. Maintain this cycle throughout the storage period.		
Protection class	IP20		
Electrical isolation	Control terminals (digital inputs / outputs)		
Max. mounting height above zero	Up to 1000m: no impairment of the output 1000...4000m: impairment of the output 1%/ 100m (up to 2000m overvoltage cat. 3) 2000...4000m: only overvoltage category 2 is ensured, surge absorber to be used on the mains input		
Spell between two mains switch-on operations max.	60 sec for all devices in normal operation		
Licences	CE, UL, cUL		



### 3.1.5 Electrical data vector mc

#### 230-volt single-phase units

Unit type:	SK ... FCT	250/1	370/1	550/1	750/1	1100/1	1500/1	2200/1
Motor rated power (4-pole standard motor)	[kW]	0.25	0.37	0.55	0.75	1.1	1.5	2.2
	[hp]	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{3}{4}$	1	1½	2	3
Mains voltage		1 AC 230 V, ± 15 %, 47...63 Hz						
Nominal output current (rms)	[A]	1.7	1.9	2.6	3.6	5.0	6.3	8.6
Brake resistor (accessory part)		180Ω				82Ω		
Typ. input current (rms)	[A]	3.3	4.5	6.2	8.2	10	13	18
Ambient temperature		0°C ... +50°C (S1 duty cycle)			0°C ... +50°C (S3 duty cycle)			
Type of ventilation		Convection				Fan cooling		

#### 400-Volt three-phase units

Unit type:	SK ... FCT	750/3	1100/3	1500/3	2200/3	3000/3
Rated motor output (4-pole standard motor)	[kW]	0.75	1.1	1.5	2.2	3.0
	[hp]	1	1½	2	3	4
Mains voltage		3 AC 380 - 460 V, -20 %/+10 %, 47...63 Hz				
Nominal output current (rms)	[A]	2.2	3.0	3.7	5.5	7.0
Brake resistor (accessory part)		120Ω				
Typ. input current (rms)	[A]	3.1	4.2	5.2	7.7	9.8
Ambient temperature		0°C ... +40°C				
Type of ventilation		Fan cooling (thermostatically controlled)				

## 3.1.6 Dimensions vector mc

Frequency converter type	A	B	C	Weight
SK 250/1 FCT - 750/1 FCT	154	86	134	1.3
SK 1100/1 FCT - 2200/1 FCT	191	112	135	1.7
SK 750/3 FCT - 3000/3 FCT				
	all dimensions in [mm]			approx. [kg]



- Further data can be found in the product handbook BU 4100 at [www.nord.com](http://www.nord.com) -

## 3.2 NORDAC SK 500E/520E

### 3.2.1 SK 500/520E General information

The NORDAC SK 500E / 520E type series is the result of further developing and extending the NORD basic units which have long proven their sound and reliable performance. The devices of this upgraded series have a moderate space requirement while ensuring drive control at highest efficiency.

Provided with a no-sensor vectorial current control system, they will continuously optimize the ratio between output voltage and frequency on the basis of a program simulating typical operating conditions of three-phase asynchronous motors. Thus the motor speed is kept constant even while highest starting or overload torques are being produced.

Selecting an appropriate clip-on technology box from the choice of modules proposed by NORD provides for convenient customization.

Owing to the great variety of setting options available all types of three-phase motors can be connected. With a line filter integrated, outputs comprise a range from **0.25kW to 7.5kW**. The overload capacity of these devices is 200% for 3.5 secs or 150% for 60 secs respectively.







Many different control modes and options, optimized efficiency of driving, convenient operation, compact construction and high operational dependability are the most distinctive features of these frequency inverters.

### 3.2.2 SK 500/520E Principal features

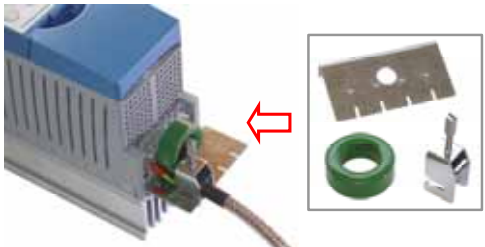
- As a result of ISD control, a high starting torque can be provided
- High precision of motor speed control owing to slip compensation
- Convenient installation, programming, and starting-up
- No clearance required for installation side by side
- Ambient temperatures up to 50°C allowed
- Integrated line filter for limit curve A1
- Allow for parameterization and control via serial RS 232 interface
- Stator resistance is measured, or motor data are identified automatically
- Four separate parameter sets which are switchable without interrupting the inverter-motor connection
- Setpoint setting via 0...10 volts, 0/4...20 mA, fixed frequencies or bus
- Two programmable relay outputs
- D.C. braking programmable
- Integrated brake chopper for 4-quadrant operation
- Adjustable ramp smoothing
- Analogue output scalable from 0 to 10 volts
- Detachable parameterization and display module
- Clear text display and data storage function



#### 3.2.3 SK 500/520E Connections

SK 500E		SK 520E	
	<ul style="list-style-type: none"> <li>2 analogue inputs 0...10V, 0/4...20mA</li> <li>1 analogue output 0...10V</li> <li>5 digital inputs 7.5...30V</li> </ul>		<ul style="list-style-type: none"> <li>2 analogue inputs 0...10V, 0/4...20mA</li> <li>1 analogue output 0...10V</li> <li>5 digital inputs 7.5...30V</li> </ul> <p><b>Plus with SK 520E:</b></p> <ul style="list-style-type: none"> <li>encoder input</li> <li>2 digital inputs 7.5...30V</li> <li>2 digital outputs 15V</li> <li>1 RS 485 (USS) to be connected to a port</li> </ul>
	<ul style="list-style-type: none"> <li>RS232/485 to RJ12 connector</li> <li>2 indicator relays (next to supply terminal)</li> </ul>		<ul style="list-style-type: none"> <li>RS232/485 to RJ12 connector</li> <li>2 indicator relays (next to supply terminal)</li> </ul> <p><b>Plus with SK 520E:</b></p> <ul style="list-style-type: none"> <li>2x CAN/CANopen to 2x RJ45 connector</li> </ul>

#### 3.2.4 SK 500/520E Optional equipment

Option	Description	Data
Various connecting cables	Cable to connect NORDAC SK 500E/520E with a PC.	Section 7.2
Brake resistors	To enable exploitation of the integrated brake chopper in applications with energy feedback loops	Section 7.6
Input / output chokes	To reduce mains current peaks, and when very long motor cables are used	Section 7.7 / 7.8
(Additional) Line filters	To raise the radio interference suppression level to B1 as per EN 55011.	In preparation
EMC kit	To ensure radio interference suppression level B1 as per EN55011, with short motor cable lengths not exceeding 5m.	

**Technology boxes**

... are snapped on to the inverter externally. They are used to control the inverter or to read out current operating values right on the device.

Apart from being connected to custom interfaces, the technology boxes may also be used to ensure access to a bus.



TechnologieBox- Optionen

Option	Description	Data
SimpleBox <b>SK CSX-0</b>	Used to start up, parameterise, configure and control the frequency inverter	4-digit, 7-segment LED display, single-button operation Mat. no. 275900095
ControlBox <b>SK TU3-CTR</b>	Used to start up, parameterise, configure and control the frequency inverter	4-digit, 7-segment LED display, keypad Mat. no. 275900090
ParameterBox <b>SK TU3-PAR</b>	Used to start up, parameterise, configure and control the frequency inverter	4-line LCD display, with a background lighting, keypad Mat. no. 275900100
Profibus module <b>SK TU3-PBR</b>	With this option the SK 500E / 520E can be controlled via the serial Profibus DP port.	Baud rate: 1.5 Mbaud Connector: Sub-D9 Mat. no. 275900030
Profibus module <b>SK TU3-PBR-24V</b>	With this option the SK 500E / 520E can be controlled via the serial Profibus DP port.	Baud rate: 12 Mbaud Connector: Sub-D9 ext. 24V DC voltage supply, 2-pole terminal Mat. no. 275900160
CANopen module <b>SK TU3-CAO</b>	With this option the SK 500E / 520E can be controlled via the serial CANbus port using the CANopen protocol	Baud rate: up to 1 Mbps Connector: Sub-D9 Mat. no. 275900075
DeviceNet module <b>SK TU3-DEV</b>	With this option the SK 500E / 520E can be controlled via the serial DeviceNet port using the DeviceNet protocol	Baud rate: 500 Kbps 5-pole screw-type terminals Mat. no. 275900085
InterBus module <b>SK TU3-IBS</b>	With this option the SK 500E / 520E can be controlled via the serial InterBus port.	Baud rate: 500 kbps (2Mbps) Connector: 2 x Sub-D9 Mat. no. 275900065
AS- Interface <b>SK TU3-AS1</b>	The actuator-sensor interface is a bus system covering the lower field bus level, for simple control tasks.	4 sensors / 2 actuators 5 / 8-pole screw-type terminals Mat. no. 275900170



## 3.2.5 General data SK 500/520E

Function	Specification
Output frequency	0.0 ... 400.0 Hz
Pulse frequency	3.0 ... 16.0 kHz, default setting = 6 kHz impairment of the output > 8 kHz with 230V device, > 6 kHz with 400V device
Typical overload capacity	150% for 60s, peak value 200 %
Protective measures against	Overtemperature in the frequency inverter      Short-circuit, earth fault, overload, Overvoltage and undervoltage                      no-load running
Regulation and control	sensorless vector current control (ISD)                      Regulation and control flux current control
Analogue setpoint input / PID input	0 ... 10 V
Analogue setpoint resolution	10 bits related to the measurement range
Analogue output	0 ... 10 V scalable (optional)
Setpoint consistency	analog < 1 %      digital < 0,02 %
Motor temperature monitoring	I <sup>2</sup> t motor (UL/cUL approved), PTC or bimetal thermal circuit breaker
Digital input	5 inputs 7.5...30V, cycle time = 1...2ms plus 2 inputs 7.5...30V, cycle time = 1...2ms with SK 520E
Control outputs	2 relays 28 V DC / 230 V AC, 2 A plus 2 digital outputs with SK 520E
Interface, optional	<u>Standard:</u> RS 485 (USS) <u>Option:</u> Profibus DP RS 232 (single slave)                      InterBus CANbus (with SK 520E)                      CANopen CANopen (with SK 520E)                      DeviceNet AS- Interface
Efficiency of frequency inverter	approximately 95%, according to frame size
Ambient temperature	0°C ... +40°C / +50°C (depending on mode of operation) without condensation
Storage and transport temperature	-20°C ... +60/70°C, max. 85% humidity of the air without condensation
Long-term storage	Connect frequency inverters to the mains for 60 minutes at least once per year. Maintain this cycle throughout the storage period.
Protection class	IP20
Electrical isolation	Control terminals (digital and analogue inputs)
Max. mounting height above zero	Up to 1000m: no impairment of the output 1000...4000m: impairment of the output 1%/ 100m (up to 2000m overvoltage cat. 3) 2000...4000m: only overvoltage category 2 is ensured, surge absorber to be used on the mains input
Spell between two mains switch-on operations max.	60 sec for all devices in normal operation
Licences	CE, UL





3.2.6 Electrical data SK 500/520E

230-volt single-phase / three-phase devices

Size 1					
Unit type:	SK 500E... SK 520E...	-250-323-A	-370-323-A	-550-323-A	-750-323-A
		Mat. no. 275410025 Mat. no. 275510025	Mat. no. 275410037 Mat. no. 275510037	Mat. no. 275410055 Mat. no. 275510055	Mat. no. 275410075 Mat. no. 275510075
Rated motor output (4-pole standard motor)	230V	0.25 kW	0.37 kW	0.55 kW	0.75 kW
	240V	1/3 hp	1/2 hp	3/4 hp	1 hp
Mains phases	Number of	1 / 3 AC			
Supply voltage		200 ... 240V, ± 10%, 47 ... 63 Hz			
Output voltage		3 AC 0 – supply voltage			
Rated output current	rms [A]	1.7	2.2	3.0	4.0
Brake resistor min.	Accessory	240 Ω	190 Ω	140 Ω	100 Ω
Typ. input current	1 / 3 AC rms [A]	3.7 / 2.4	4.8 / 3.1	6.5 / 4.2	8.7 / 5.6
Recommended mains fusing	1 / 3 AC slow [A]	10 / 10	10 / 10	16 / 10	16 / 10
Type of ventilation		free convection			
Weight	approx. [kg]	1.4			

Size 2 / 3						
Unit type:	SK 500E... SK 520E...	-111-323-A	-151-323-A	-221-323-A	-301-323-A	-401-323-A
		Mat. no. 275410110 Mat. no. 275510110	Mat. no. 275410150 Mat. no. 275510150	Mat. no. 275410220 Mat. no. 275510220	Mat. no. 275410300 Mat. no. 275510300	Mat. no. 275410400 Mat. no. 275510400
56 Rated motor output (4-pole standard motor)	230V	1.1 kW	1.5 kW	2.2 kW	3.0 kW	4.0 kW
	240V	1 1/2 hp	2 hp	3 hp	4 hp	5 hp
Mains phases	Number of	1 / 3 AC			3 AC	
Supply voltage		200 ... 240V, ± 10%, 47 ... 63 Hz				
Output voltage		3 AC 0 – supply voltage				
Rated output current	rms [A]	5.5	7.0	9.0	12.5	16.0
Brake resistor min.	Accessory	75 Ω	62 Ω	43 Ω	33 Ω	27 Ω
Typical input current	1 / 3 AC rms [A]	12.0 / 7.7	15.2 / 9.8	19.6 / 13.3	17.5	22.4
Recommended mains fusing	1 / 3 AC slow [A]	16 / 16	20 / 16	25 / 20	20	25
Type of ventilation		fan cooling, thermostatically controlled				
Weight	approx. [kg]	1.8			2.7	

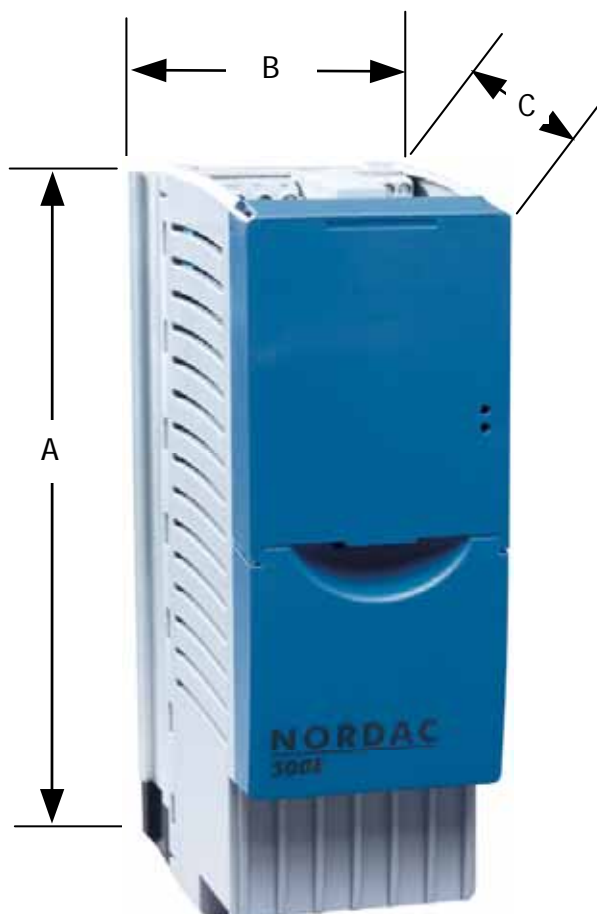
**400-volt three-phase devices**

Size 1 / 2						
Unit type:	SK 500E... SK 520E...	-550-340-A	-750-340-A	-111-340-A	-151-340-A	-221-340-A
		Mat. no. 275420055 Mat. no. 275520055	Mat. no. 275420075 Mat. no. 275520075	Mat. no. 275420110 Mat. no. 275520110	Mat. no. 275420150 Mat. no. 275520150	Mat. no. 275420220 Mat. no. 275520220
Rated motor output	400V	0.55 kW	0.75 kW	1.1 kW	1.5 kW	2.2 kW
(4-pole standard motor)	480V	¾ hp	1 hp	1½ hp	2 hp	3 hp
Mains phases	Number of	3 AC				
Supply voltage		380 ... 480V, -20% / +10%, 47 ... 63 Hz				
Output voltage		3 AC 0 – supply voltage				
Rated output current	rms [A]	1.7	2.3	3.1	4.0	5.5
Brake resistor min.	Accessory part	390 Ω	300 Ω	220 Ω	180 Ω	130 Ω
Typ. input current	rms [A]	2.4	3.2	4.3	5.6	7.7
Recommended mains fusing	slow [A]	10	10	10	10	10
Type of ventilation		free convection				fan, thermostatically controlled
Weight	approx. [kg]	1.4			1.8	

Size 3 / 4					
Unit type:	SK 500E... SK 520E...	-301-340-A	-401-340-A	-551-340-A	-751-340-A
		Mat. no. 275420300 Mat. no. 275520300	Mat. no. 275420400 Mat. no. 275520400	Mat. no. 275420550 Mat. no. 275520550	Mat. no. 275420750 Mat. no. 275520750
Rated motor output	400V	3.0 kW	4.0 kW	5.5 kW	7.5 kW
(4-pole standard motor)	480V	4 hp	5 hp	7½ hp	10 hp
Mains phases	Number of	3 AC			
Supply voltage		380 ... 480V, -20% / +10%, 47 ... 63 Hz			
Output voltage		3 AC 0 – supply voltage			
Rated output current	rms [A]	7.5	9.5	12.5	16.0
Brake resistor min.	Accessory part	91 Ω	75 Ω	56 Ω	43 Ω
Typ. input current	rms [A]	10.5	13.3	17.5	22.4
Recommended mains fusing	slow [A]	16	16	20	25
Type of ventilation		fan cooling, thermostatically controlled			
Weight	approx. [kg]	2.7			3.1

3.2.7 SK 500/520E Dimensions

Frequency inverter type	A	B	C	A mounting fixtures included	Weight
SK 5xxE-250- ... to SK 5xxE-750- ...	186	74	153	220	1.4
SK 5xxE-111- ... to SK 5xxE-221- ...	226	74	153	260	1.8
SK 5xxE-301- ... to SK 5xxE-401- ...	241	98	178	275	2.7
SK 5xxE-551- ... to SK 5xxE-751- ...	286	98	178	320	3.1
	all dimensions in [mm]				approx. [kg]



- Further data can be found in the product handbook BU 0500 at [www.nord.com](http://www.nord.com) -



### 3.3 NORDAC SK 700E

#### 3.3.1 General information SK 700E

The NORDAC **SK 700E** series is the result of resolute further development of proven NORD frequency inverter series. This series of devices is characterised by a high level of modularity with optimised control features.

##### Sensorless vector current control (ISD)

These devices are provided with non-sensor vector current control system which constantly ensures an optimised voltage-to-frequency ratio based on the simulated operation of a three-phase asynchronous motor.

This has the following significance for the drive: the highest level of start-up and overload torque at constant speed.

Owing to the huge variety of setting options these inverters are capable of controlling any three-phase motor on the market.

The output ranges from 1.5 kW to 160 kW (3 AC 380 ... 480 V).



##### Variable technology boxes, custom interfaces and special upgrades with no extra space requirement

Due to their modular construction with technology boxes which can be combined with one another in different ways, custom interfaces and special upgrades, the devices of this series can be adapted for any conceivable applications.

#### 3.3.2 Characteristics SK 700E

- A high level of starting torque (up to 400%) and non-sensor vector current control for precise regulation of the motor speed
- Variable configuration according to customer requirements using special technology boxes, custom interfaces, and special upgrades
- Easy installation, programming, and initialisation
- The great variety of setting options allow for adaptation for any commonly available three-phase motor. The data for operating NORD gear motors is preset.
- Space-saving installation in the control cabinet with bookshelf mounting
- Suitable for an ambient temperature up to 50°C (S3 duty cycle)
- Integrated line filter according to EMC- class A (up to 22kW)
- Automatic measurement of the stator resistance
- Four separate parameter sets which can be switched online
- Analogue PI / PID / process controller
- Programmable relay outputs
- Programmable direct current braking
- Integrated brake chopper for four-quadrant operation
- Adjustable ramp smoothing
- Scalable analogue output, 0...10 volts or 0/4...20 mA
- Detachable operating and display module (optional)
- Multilingual display in simple language and data storage function with parameter box (optional)
- Incremental shaft encoder feedback for high-precision speed control (optional)
- Integrated positioning control for exact positioning of the drive (optional)

### 3.3.3 Optional features SK 700E

Option	Data	Data
Variable equipment boxes (SK TU1-...)	Potentiometer, display or bus control – any of these are available as preferred by the customer	On the following pages
Customer interfaces (SK CU1-...)	Various interface configurations are available.	On the following pages
Special extensions (SK XU1-...)	Special functions such as digital speed control or positioning are easily implemented.	On the following pages
Various connecting cables	Cable to connect SK 700E with PC.	Section 7.2
Brake resistors (SK BR1-... / SK BR2-...)	For use of the brake chopper in application with energy feedback loops	Section 7.6
Input / output chokes (SK CI1-... / SK CO1-...)	To reduce peaks of the supply power, or if very long motor cables are used	Section 7.7 / 7.8
Additional line filters (SK LF1-... / HLD 110...)	For increased radio interference level A / B as per EN 55011	Section 7.9





#### Technology Boxes

Clipped on to the frequency inverter externally. They are used to control the frequency inverter or to display current operating values directly on the device.

Apart from being connected to custom interfaces, the variable technology boxes may also be used for bus access.



Option	Description	Data
ParameterBox <b>SK TU1-PAR</b>	Used to initialise, parameterise, configure and control the frequency inverter with full text instructions. Optional clip-on installation	6 languages Data set saving Help texts
ControlBox <b>SK TU1-CTR</b>	Like the parameter box but with a simplified display. Optional clip-on installation	4-digit, 7-segment LED display
PotentiometerBox <b>SK TU1-POT</b>	For direct control of the drive from the frequency converter. Optional clip-on installation	Potentiometer 0 to 100% ON / OFF / Reverse buttons
RS 232 <b>SK TU1-RS2</b>	These options facilitate control and parameterisation of the SK 700E via RS232/ Profibus DP/ CANbus/ CANopen/ DeviceNet/ InterBus (without serial port) / AS- Interface. Optional clip-on installation	Baud rate: up to 38400 Bit/s Connector: Sub-D9
Profibus module <b>SK TU1-PBR</b>		Baud rate: up to 1.5 MBit/s Connector: Sub-D9
Profibus module <b>SK TU1-PBR-24V</b>		Baud rate: up to 12 MBit/s Connector: Sub-D9 +24V DC
CAN bus module <b>SK TU1-CAN</b>		Baud rate: 500 kbit/s Connector: Sub-D9
CANopen <b>SK TU1-CAO</b>		Baud rate: up to 1 MBit/s Connector: Sub-D9
DeviceNet <b>SK TU1-DEV</b>		Baud rate: 500 kBit/s 5 channel screw plug
InterBus <b>SK TU1-IBS</b>		Baud rate: 500 kBit/s (optionally 2 MBit/s) Connector: 2x Sub-D9
AS Interface <b>SK TU1-AS1</b>		4 Sensors / 2 actuators 5 and 8 channel screw plug

## Customer Interfaces

Custom interfaces are optional insert modules. Their slots are found inside the frequency inverter housing. Having been plugged in they are identified by the frequency inverter automatically.

The cable connection is established using spring terminals. This makes the connection of devices very easy and convenient.



Option	Description	Data
Basic I/O <b>SK CU1-BSC</b>	Simplest custom interface for optimum adaptation to the application.	1 x multifunction relay 3 x digital inputs 1 x analogue input, 0...10V
Standard I/O <b>SK CU1-STD</b>	Upgraded functionality of control signals, including USS bus control.	2 x multifunction relays 4 x digital inputs 1 x analogue input, 0...10V, 0/4...20mA 1 x analogue outputs, 0...10V 1 x RS 485
Multi I/O <b>SK CU1-MLT</b>	Highest level of functionality through digital and analogue signal processing.	2 x multifunction relays 6 x digital inputs 1 x analogue input, 0...10V, 0/4...20mA 1 x analogue input, -10...+10 V 2 x analogue outputs, <b>0...10V</b>
Multi I/O <b>SK CU1-MLT-20mA</b>	Highest level of functionality through digital and analogue signal processing.	2 x multifunction relays 6 x digital inputs 1 x analogue input, 0...10V, 0/4...20mA 1 x analogue input, -10...+10 V 2 x analogue outputs, <b>0/4...20mA</b>
CAN bus <b>SK CU1-CAN-RJ</b>	This interface facilitates control of the NORDAC SK 700E via the serial CAN port.	1 x multifunction relay 5 x digital inputs 2 x RJ45 connectors CANbus
Profibus <b>SK CU1-PBR</b>	This interface facilitates control of the NORDAC SK 700E via the serial Profibus DP port.	1 x multifunction relays 1 x digital inputs 1 x Profibus

#### Extension Units

Extension units turn the standard frequency converter into a high-precision control device for reacting flexibly to all demands.

They can be used in the frequency inverter in addition to the custom interfaces.



Option	Description	Data
PosiCon <b>SK XU1-POS</b>	Positional and / or speed regulation A displacement calculation program ensures that positions are approached and held as set. Actual values measured using incremental and/or absolute encoders.	up to 252 positions 2 x multifunction relays 6 x digital inputs 1 x absolute encoder input, SSI 1 x incremental encoder input, 5V TTL
Encoder <b>SK XU1-ENC</b>	Facilitates high-precision speed control from standstill up to twice the nominal speed.	up to 250kHz 1 x digital inputs 1 x incremental encoder input, 5V TTL





3.3.4 General data SK 700E

Function	Specification		
Output frequency	0 ... 400 Hz		
Resolution	0.1 Hz		
Typical overload capacity	150% for 60s, peak value 200 %		
Protective measures against	Overtemperature in the frequency inverter Overvoltage and undervoltage	Short-circuit, earth fault, overload, no-load running	
Regulation and control	Sensorless vector current control (ISD) flux current control	Regulation and control	
Analogue setpoint input / PID input	0 .... 10 V (optional)		
Analogue setpoint resolution	10 bits related to the measurement range		
Analogue output	0 .... 10 V scalable (optional)		
Setpoint consistency	analogue < 1%    digital < 0.02%		
Motor temperature monitoring	PTC or bimetallic switch (optional)		
Ramp times	0 ... 99.99 s		
Control outputs	2 relays 28 V DC / 230 V AC, 2 A		
Interface, optional	RS 485 } > 22kW standard RS 232 }	Profibus DP CANbus CANopen	InterBus DeviceNet AS- Interface
Efficiency of frequency inverter	approximately 95%		
Ambient temperature	0°C ... +50°C (S3 duty cycle), 0°C ... +40°C (S1 duty cycle) without condensation		
Storage and transport temperature	-20°C ...+60/70°C, 85% humidity of the air max. without condensation		
Long-term storage	Connect frequency inverters to the mains for 60 minutes at least once per year. Maintain this cycle throughout the storage period.		
Protection class	IP20		
Electrical isolation	Control terminals (digital and analogue inputs)		
Max. mounting height above zero	Up to 1000m: no impairment of the output 1000...4000m: impairment of the output 1%/ 100m (up to 2000m overvoltage cat. 3) 2000...4000m: only overvoltage category 2 is ensured, surge absorber to be used on the mains input		
Spell between two mains switch-on operations max.	60 sec for all devices in normal operation		
Licences	CE, UL, cUL		



## 3.3.5 Electrical data SK 700E

Unit type:	SK 700E ....	-151-340-A	-221-340-A	-301-340-A	-401-340-A
Motor rated power (4-pole standard motor)	[kW]	1.5	2.2	3.0	4.0
	[hp]	2	3	4	5
Mains voltage		3 AC 380 - 480 V, -20 %/+10 %, 47...63 Hz			
Nominal output current (rms)	[A]	3.6	5.2	6.9	9.0
Recom. brake resistor (accessory part)		200 Ω		100 Ω	
Typ. input current (rms)	[A]	6	8	11	13
Ambient temperature		0°C ... +50°C (S3 duty cycle), 0°C ... +40°C (S1 duty cycle)			
Type of ventilation		Convection		Fan cooling (temperature-controlled)	

Unit type:	SK 700E ...	-551-340-A	-751-340-A	-112-340-A	152-340-A
Motor rated power (4-pole standard motor)	[kW]	5.5	7.5	11	15
	[hp]	7.5	10	15	20
Mains voltage		3 AC 380 - 480 V, -20%/+10%, 47...63 Hz			
Nominal output current (rms)	[A]	11.5	15.5	23	30
Recom. brake resistor (accessory part)		60 Ω		30 Ω	
Typ. input current (rms)	[A]	17	21	30	42
Ambient temperature		0°C ... +50°C (S3 duty cycle), 0°C ... +40°C (S1 duty cycle)			
Type of ventilation		Fan cooling (temperature-controlled)			

Unit type:	SK 700E ...	-182-340-A	-222-340-A	-302-340-O	-372-340-O
Motor rated power (4-pole standard motor)	[kW]	18.5	22.0	30.0	37.0
	[hp]	25	30	40	50
Mains voltage		3 AC 380 - 480 V, -20%/+10%, 47...63 Hz		3 AC 380 - 460 V, -20%/+10%, 47...63 Hz	
Nominal output current (rms)	[A]	35	45	57	68
Recom. brake resistor (accessory part)		22 Ω		12 Ω	
Typ. input current (rms)	[A]	50	56	70	88
Ambient temperature		0°C ... +50°C (S3 duty cycle), 0°C ... +40°C (S1 duty cycle)			
Type of ventilation		Fan cooling (temperature-controlled)		Fan cooling	



Unit type:	SK 700E ...	-452-340-O	-552-340-O	-752-340-O
Motor rated power (4-pole standard motor)	[kW]	45	55	75
	[hp]	60	75	100
Mains voltage		3 AC 380 - 460 V, -20%/+10%, 47...63 Hz		
Nominal output current (rms)	[A]	81	103	133
Recom. brake resistor (accessory part)		8 Ω		6 Ω
Typ. input current (rms)	[A]	105	125	172
Ambient temperature		0°C ... +50°C (S3 duty cycle), 0°C ... +40°C (S1 duty cycle)		
Type of ventilation		Fan cooling		

Unit type:	SK 700E ...	-902-340-O	-113-340-O	-133-340-O	*) -163-340-O-VT
Motor rated power (4-pole standard motor)	[kW]	90	110	132	160
	[hp]	125	150	180	220
Mains voltage		3 AC 380 - 460 V, -20%/+10%, 47...63 Hz			
Nominal output current (rms)	[A]	158	193	230	280
Recom. brake resistor (accessory part)		6 Ω		3 Ω	
Typ. input current (rms)	[A]	200	240	280	340
Ambient temperature		0°C ... +50°C (S3 duty cycle), 0°C ... +40°C (S1 duty cycle)			
Type of ventilation		Fan cooling			

\*) max. 125% overload

## 3.3.6 Dimensions SK 700E

Frequency converter type	A	B	C	Weight
SK 700E-151-340-A ... -401-340-A	281	123	219	4
SK 700E-551-340-A ... -751-340-A	331	123	219	5
SK 700E-112-340-A ... -152-340-A	386	167	255	9
SK 700E-182-340-A ... -222-340-A	431	201	268	12.5
SK 700E-302-340-O ... -372-340-O	599	263	263	24
SK 700E-452-340-O ... -552-340-O				28
SK 700E-752-340-O	736	263	336	40
SK 700E-902-340-O ... -163-340-O-VT	1207	354	263	80
	all dimensions in [mm]			approx. [kg]



- Further data can be found in the product handbook BU 0700 at [www.nord.com](http://www.nord.com) -

## 4 Servo controller

### 4.1 NORDAC SK 1000E

#### 4.1.1 General information SK 1000E

NORDAC **SK 1000E** servo controllers are designed using state-of-the-art fully digital DSP technology with field bus connection for torque, speed and positional control of asynchronous and synchronous motors.

This system has the highest level of dynamics and full motor torque even at zero speed.

Numerous implemented technological functions, e.g. *electronic gears*, *flying saw cam disc* and *winders* are all part of the standard.

An integrated PLC rounds off the range of this controller's functions.

The NORD SERV software included in the scope of delivery can be implemented intuitively and makes initialisation easy.

It contains the necessary motor / controller databases, an oscilloscope function and numerous other test options.

The input assistant makes programming the PLC, initialisation of the field bus connection and parameterisation of the technological functions easy

A cam disc editor makes it possible to input up to 4 cam profiles.



#### 4.1.2 Characteristics SK 1000E

- suitable for asynchronous, synchronous, torque and linear motors
- Encoder, resolver, absolute encoder- feedback possible
- Integrated line filter according EMC- curve A
- Integrated brake chopper, with external brake resistor
- Ramp generator / speed profile generator
- Incremental encoder emulation output
- Integrated PLC with input assistant for easy intuitive operation
- Integrated reference switch logic
- Integrated limit switch monitoring
- 100% CANopen with PDO data container and status machine.



### 4.1.3 Variants and options SK 1000E

Type	Description	Data
R (Resolver)	Feedback by resolver, 500 Kbps CANbus interface	12 bit resolution
E (Encoder)	Feedback by incremental encoder, 500 Kbps CANbus interface Addition of Hall component is recommended	Number of increments may be selected at discretion from 500 upwards Input frequency up to 5MHz
RT	Resolver, with integrated technology function	For technology functions see NORD servo applications brochure
ET	Encoder with integrated technology function	
RS	Resolver with optional 1Mbaud CAN and absolute encoder, and stepper motor interface	Absolute encoder up to 27bit, SSI external or integrated in motor
ES	Encoder with optional 1Mbaud CAN bus and absolute encoder, and stepper motor interface	
RST	Resolver with optional 1Mbaud CAN and absolute encoder, no stepping motor interface, with integrated technology function	
EST	Encoder with optional 1Mbaud CAN and absolute encoder, with integrated technology function	

### 4.1.4 Accessories SK 1000E

Accessories	Description	Data
NORD SERV	Operating and programming software	Windows 95, 98, ME, 2000, XP
Motor power cable	3, 10, 20 m length available from stock, other lengths available on request (oil-proof and suitable for use with drag-chains)	See NORD factory standard
Resolver encoder cable		
Incremental encoder cable		
Absolute encoder cable		
CANbus connecting cable	Sub-D9 cable	
RS 232 communication cable		
Profibus gateway	Four coupling of several SK 1000Es to one profibus network.	up to 12 Mbaud DP
External brake resistor	For applications with a high level of negative feed energy.	100-600 W continuous output 2-8 kW pulse output (see also chap. 7.6)
Additional external line filters	For use in residential environment only	category B (see also chap. 7.9)

## 4.1.5 General data SK 1000E

Function	Specification
Feedback Resolver	10-bit accuracy, 12-bit resolution, speed range +/- 22500 rpm (2 channel), 7Vrms
Feedback encoder / absolute encoder	Incremental encoder: 500 ... 5000 increments, TTL / RS422 Absolute encoder: 12 ... 27bit (single turn or multi turn), SSI
Protective measures against	Over-temperature of servo controller and motor      Short-circuit, earth fault, overload, no-load running Over and under-voltage
Regulation and control	Travelling profile, torque, speed and positional control (50µs / 100µs)
Setpoint input analogue	+/- 10V, resolution 12Bit, for speed, torque and override functions
Setpoint stability	16Bit calculation (e.g. 0.33rpm ... 6000rpm)
Motor temperature monitoring	KTY84
Digital control inputs	6 freely programmable inputs 10 ... 30V, e.g. by a PLC "plus" and "minus" limit switch, enable, referencing, motor temperature monitoring
Digital control outputs	1 relay 24V AC / 4A or 30V DC / 4A 6 freely programmable short-circuit resistant outputs, , 24V / 25mA (e.g. for a PLC)
Control and programming interfaces	RS 232 up to 56Kbaud      CANbus up to 1Mbaud RS 485 up to 56Kbaud      Profibus (optional) up to 12Mbaud
Interface	5MHz stepping motor interface (not to be combined with the optional SSI interface module, nor to be operated simultaneously with a second incremental encoder – the software will not allow it; NORD SERV does however facilitate switching between the two!) Second 5 MHz incremental encoder input, < 150mA is necessary for gear function (cannot be driven by the software simultaneously with stepping motor interface. NORD SERV does however facilitate switching between the two!)
Controller efficiency:	approximately 95%
Ambient temperature	0°C ... +40°C continuous operation without condensation
Storage and transport temperature	-20°C ... +60/70°C, 85% of air humidity max. without condensation
Long-term storage	Connect frequency inverters to the mains for 60 minutes at least once per year. Maintain this cycle throughout the storage period.
Protection class	IP20
Electrical isolation	Control terminals (digital and analogue inputs), CAN
Max. mounting height above zero	Up to 1000m: no impairment of the output 1000...4000m: output impaired by 1%/ 100m (up to 2000m overvoltage cat. 3) 2000...4000m: only overvoltage category 2 is ensured, mains input to be provided with an external overvoltage suppressor
Waiting time between two mains switch-on operations	60 sec for all devices under normal operating conditions
Licences	CE, UL, cUL

#### 4.1.6 Electrical data SK 1000E

Unit type:	SK 1000E-...	-101-340-A	-201-340-A	-301-340-A	-401-340-A	-501-340-A	-801-340-A	-102-340-A
Electrical output	[kW]	1	2	3	4	5	8	10
Mains voltage		3 AC 380 -480 V, -20%/+10%, 47...63 Hz						
Rated current (eff.) Long-term standstill	[A]	3.6	4.8	6.3	8.4	10.8	15	20
Peak current for 60 s (rms) Standstill	[A]	5.1	6.7	8.8	11.7	15.1	21	28
Peak current for 60 s > 1 Hz	[A]	7.2	9.5	12.4	16.6	21.4	30	40
Ambient temperature		0°C ... +40°C (continuous operation)						
Type of ventilation		Convection			Fan			

#### 4.1.7 Dimensions SK 1000E

Frequency converter type	A	B	C	Weight
SK 1000E-101-340-A ... -301-340-A	281	121	217	4
SK 1000E-401-340-A ... -501-340-A	331	121	217	5
SK 1000E-801-340-A ... -102-340-A	381	163	250	10
	all dimensions in [mm]			approx. [kg]



- Further data can be found in the product handbook BU 1000 at [www.nord.com](http://www.nord.com) -



## 5 Motor frequency inverter

### 5.1 NORDAC *trio* SK 300E

#### 5.1.1 General information

The **NORDAC *trio* SK 300E** is a combination of geared motor and highly functional frequency inverter with which process-oriented, decentralised unit concepts can easily be implemented.

The convenient construction of the frequency inverter makes for user-friendly operation. The “*electronic type plate*” saves all frequency inverter data on the motor so that it is not lost even when the motor is separated from the frequency inverter.

With its modular concept, the control components can be adapted to all types of application.



#### 5.1.2 SK 300E product characteristics

- High type of protection IP55 (according to the motor connected) or optionally IP66
- Integrated line filter according EMC- curve B1
- Optional potentiometer function for setting the frequency directly on the frequency inverter
- Separate modules with an adequate number of inputs and outputs for connection to controllers
- Integrated brake chopper for 4-quadrant operation
- Optional external brake resistor fitted to the device
- "Electronic type plate" ensures automatic saving of the frequency inverter data in the motor
- Universal, easily accessible connection unit for user-friendly usage
- Convenient parameterization with the technology unit provided for the purpose or via PC software

#### 5.1.3 Initialisation SK 300E

The frequency inverter can be parameterised and controlled using two alternative elements.

##### **NORDAC ControlBox**

(SK TU2-CTR)

Operating module with display to be directly snapped on to the SK 300E, for convenient parameter setting or control, presupposing an environment which is easily accessible (see also chap. 5.1.5)

##### **NORDAC ParameterBox**

(SK PAR-2H)

Handy operating device with a display and a keypad for direct parameterisation and control of the frequency inverter on site.

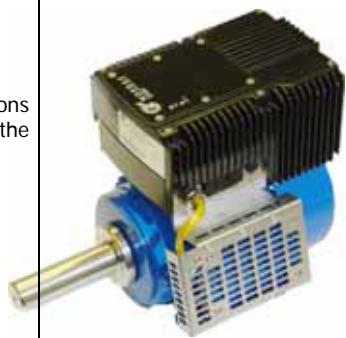
(see also chap. 7.1)

##### **NORD CON Software**

Easy-to-use software for simple parameterisation, operation and control of the frequency inverter from a PC.

(see also chap. 7.3)

### 5.1.4 Options available for the SK 300E

Option	Description	Data
Technology boxes (SK TU2-...)	Potentiometer, display or bus control, this module type will accomplish any of these tasks	On the following pages
Custom interfaces (SK CU2-...)	Various interface configurations are provided.	On the following pages
ParameterBox <b>SK PAR-2H / SK PAR-2E</b>	External handy operating device with a display and a keypad for starting up and parameterizing the inverter, and for servicing purposes. The unit allows for reading up to 5 data records into memory.	Section 7.1
Various connecting cables	Cables to connect the SK 300E with the ParameterBox and a PC.	Sections 7.1 / 7.2
Brake resistor <b>SK BR3-100/120-TI 0/1</b>	<p>For exploitation of the integrated brake chopper in applications providing for excessive energy to be recovered and fed back to the inverter</p> <p>Item no. 275140010, 120Ω / 100W</p>	

### 5.1.5 SK 300E control options

The **NORDAC trio SK 300E** is extendable through modular construction. While the device is provided with various control components from the start, it may further be extended by

adding any of the technology boxes or custom interfaces available and featuring inputs and outputs or bus ports in the required number.

Standard	Description	Data
Basic equipment	All of the essential functions are ensured even in the basic version of the device.	<ul style="list-style-type: none"> <li>1 brake control feature</li> <li>1 multi-function relay</li> <li>1 digital input</li> <li>RS 485 interface via M12 circular connector</li> </ul>

**Technology Boxes**

Technology boxes are plugged into or screwed onto the frequency inverter from the outside. They are used to control the frequency inverter manually or using a bus system.

The bus is connected using a 5 channel M12 system connector / screw terminals (Profibus).



Technology boxes		
ControlBox <b>SK TU2-CTR</b>	A control panel with display, for parameterization and to read out the operating values.	4-digit, 7-segment LED display
Switch / potentiometer <b>SK TU2-POT</b>	For direct control of the frequency inverter without additional installation or setting.	On – R – Off – On – L Setpoint 0 ... 100 %
Profibus I/O <b>SK TU2-PBR</b>	These options facilitate control and parameterisation of the SK 300E via Profibus DP.	1 Profibus interface 2x 5 pin M12 system connector
Profibus I/O <b>SK TU2-PBR-KL</b>	These options facilitate control and parameterisation of the SK 300E via Profibus DP.	1 Profibus interface 8 pin terminals / SUB-D9 connector
Profibus I/O <b>SK TU2-PBR-24V</b>	These options facilitate control and parameterisation of the SK 300E via Profibus DP. The external 24V voltage makes sure the bus subscriber remains in the network even if the frequency inverter's supply voltage is switched off.	1 Profibus interface 2x 5 pin M12 system connectors 1 external 24 V power supply
CANopen <b>SK TU2-CAO</b>	This interface facilitates control and parameterisation of the SK 700E via the serial CANopen port.	1 CANopen interface 1x 5 pin M12 system connector
DeviceNet <b>SK TU2-DEV</b>	This interface facilitates control and parameterisation of the SK 700E via the serial DeviceNet port.	1 DeviceNet interface 2x 5 pin M12 system connectors
InterBus <b>SK TU2-IBS</b>	This interface facilitates control and parameterisation of the SK 700E via the serial InterBus port.	1 InterBus interface 2x 5 pin M12 system connectors 1 external 24 V power supply
AS Interface <b>SK TU2-AS1</b>	This interface facilitates the control of sensors and actuators. In addition, the SK 300E can be parameterised via the AS interface.	2x 5 pin M12 system socket for actuators and sensors 2x 5 pin system connector for AS interface circuit and 24V auxiliary voltage



### Customer Interfaces

Custom interfaces are optional plug-in modules for adding control functions to the standard package. Their slot is situated inside the connection unit. Once inserted, they are identified by the frequency inverter automatically.

The cable connection is established using screw terminals. This makes the connection of devices very easy and convenient.



Custom interfaces (additional to the standard)		
Basic I/O <b>SK CU2-BSC</b>	The basic custom interface offers a minimum of functions for simple control tasks.	3 digital inputs 1 analogue input 0...10V
Standard I/O <b>SK CU2-STD</b>	With the standard interface, the SK 300E provides sufficient functions for most applications.	4 digital inputs 2 analogue inputs 0...10V, 0/4...20mA 1 output analogue/digital



### 5.1.6 General data SK 300E

Function	Specification
Output frequency	0.0 ... 400.0 Hz
Rated overload capacity	150 % for 30 s, peak value 200 %
Protective measures against	Overheating in the frequency inverter / motor                      over / under voltage short-circuit, ground fault    overload, no-load running
Local setpoint setting possible	Optional potentiometer function
Analogue setpoint input / PI input	0 ... 10 V, 0/4 ... 20 mA
Analogue setpoint resolution	10-bit related to measuring range, (setpoint consistency: analogue < 1%, digital < 0.02%)
Motor temperature monitoring	I <sup>2</sup> t monitoring,          PTC input (PTC resistor on motor)
Control outputs	1 Relay 24V DC 500 mA / optional 1 analogue output 0...10 V
Efficiency of frequency inverter	approximately 95%
Ambient temperature	-10°C ... +50°C without condensation
Storage / shipping temperature	-20°C ... +60/70°C, humidity of the air 85% max., without condensation
Long-term storage	Connect frequency inverters to the mains for 60 minutes at least once per year. Maintain this cycle throughout the storage period.
Protection type	IP55 (depending on the motor being used), optional IP66
Electrical isolation	Control terminals (digital inputs / outputs)
Climatic conditions	Class 3K3 as per EN 60721-3-3
Max. mounting height above zero	Up to 1000m with no reduction in performance 1000...4000m:    output impaired by 1%/ 100m (up to 2000m overvoltage cat. 3) 2000...4000m:    only overvoltage category 2 is ensured, mains input to be provided with an external surge absorber
Waiting spell between 2 mains-switch-on operations	60 secs for all devices in normal operating duty
Licences	CE, UL, cUL

### 5.1.7 Electrical data SK 300E

Unit type:	SK 300E ...	-550-340-B	-750-340-B	-111-340-B	-151-340-B	-221-340-B	-301-340-B	-401-340-B
Motor rated power	[kW]	0.55	0.75	1.1	1.5	2.2	3.0	4.0
	[hp]	0.75	1	1.5	2	3	4	5
Mains voltage	3 AC 380 - 480 V, ±10 %, 47 ... 63 Hz					3 AC 380 - 480 V, ±10 %, 47 ... 63 Hz		
Nominal output current (rms)		1.6	2.2	3.0	3.7	5.5	7.0	9.2
Typ. input current (rms)		2.5	3.1	4.2	5.2	7.7	9.8	12.9
Brake resistor	120 Ω					120 Ω		82 Ω
Type of ventilation	Convection					Convection		

## 5.1.8 Dimensions trio SK 300E

Motor type	Motor output [kW]	Size	g1	m	p	Weight (frequency inverter only)
80 S/4	0.55	FS1	188.5	214	156	4.0
80 L/2, /4	1.1 / 0.75					
80 L/40	1.1					
90 S/2, /4, /6	1.5 / 1.1 / 0.75		193.5			
90 L/4, /6	1.5 / 1.1		211.5			
100 L/6	1.5					
100L/4	2.2	FS2	233.5	282	196	8.4
100L/40	3.0		247			
112M/4	4.0					
			all dimensions in [mm]			approx. [kg]



- Further data can be found in the product handbook BU 0300 at [www.nord.com](http://www.nord.com) -

## 5.2 NORDAC *trio*

### 5.2.1 General information

The **NORDAC *trio*** is a combination of motor, gearbox, and frequency inverter in one unit thus providing a solution for decentralised drive applications and an alternative to mechanical variable speed gears.

The frequency inverter in the terminal box is available in two sizes, with outputs between 0.25 kW and 7.5 kW.

The basic type is provided with 3 digital inputs and one analogue input for control purposes.



### 5.2.2 Characteristics

- High protection class (IP55)
- Integrated line filter according to EMC curve A
- Integrated inputs and outputs to link the unit to other control systems
- Integrated potentiometer for direct speed adjustment on the frequency inverter
- Optional Profibus access module
- Integrated USS interface
- Control of a mechanical brake

### 5.2.3 Optional features

Option	Description	Data
CBV clear text operating panel	Used to initialise, parameterise, configure and control the frequency inverter with full text instructions.	7 languages, help texts 10 saveable data sets Switch panel installation SUB-D9
TR/2 operating cable	Connecting cable between NORDAC <i>trio</i> and CBV clear text control panel	Length: 3 m Sub-D9 on system circular connector
Brake relay (BG2 only)	Optional mechanical brake control for motor. The optional module is housed inside a raised cover (50 mm).	Brake voltage: 180 V DC
Brake module (BG2 only)	Brake chopper and resistor, plus relay for mechanical motor brake control. The optional module is housed inside a raised cover (90 mm).	Continuous brake rating: 350 W Pulse power: 7.0 kW Brake voltage: 180 V DC
Profibus module	This option facilitates control of the NORDAC <i>trio</i> via the serial Profibus DP port. This optional module is screwed on to the side of the frequency inverter housing.	Baud rate: 12 Mbaud Bus connection via terminals



### 5.2.4 General data

Function	Specification
Output frequency	0 ... 140 Hz
Resolution	0.05 Hz
Rated overload capacity	150% for 60 s
Protective measures against	Overheating on the frequency inverter / motor short-circuit, ground fault
Local setpoint setting possible	Built-in potentiometer
Analogue setpoint input / PI input	0 / 2 ... 10V 0 / 4 ... 20mA
Analogue setpoint resolution	10-bit
Setpoint consistency	analogue < 1%    digital < 0.02%
Motor temperature monitoring	I <sup>2</sup> t monitoring,    PTC input (PTC resistor on motor)
Ramp times	0 ... 650 s
Control outputs	1 relay DC 30V / 1A
Serial interface	RS485 (provided as standard), Profibus DP (optional)
Efficiency of frequency inverter	approximately 95%
Ambient temperature	-10°C ... +40°C without condensation
Storage / shipping temperature	-20°C ... +60/70°C, max. 85% humidity without condensation
Protection type	IP55
Protective insulation	Double insulation or else shielding of the internal wiring
Licences	CE, UL, cUL



## 5.2.5 Electrical data

### 1 AC 208 - 240 V supply voltage

Unit type:	SK ... TR	250/1	370/1	550/1	750/1
Motor rated power	[kW]	0.25	0.37	0.55	0.75
	[hp]	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{3}{4}$	1
Mains voltage		1 AC 208 - 240 V, $\pm 10\%$ , 47 ... 63 Hz			
Nominal output current (rms)	[A]	1.4	1.9	2.6	3.6
Typ. input current (rms)	[A]	3.2	4.6	6.2	8.2
Type of ventilation		Convection			

### 3 AC 380 -480 V supply voltage

Unit type:	SK ... TR	370/3	550/3	750/3	1100/3	1500/31
Motor rated power	[kW]	0.37	0.55	0.75	1.1	1.5
	[hp]	$\frac{1}{2}$	$\frac{3}{4}$	1	1.5	2
Mains voltage		3 AC 380 - 480 V, $\pm 10\%$ , 47 ... 63 Hz				
Nominal output current (rms)	[A]	1.1	1.5	2.1	2.8	3.6
Typ. input current (rms)	[A]	2.2	2.8	3.7	4.9	5.9
Type of ventilation		Convection				

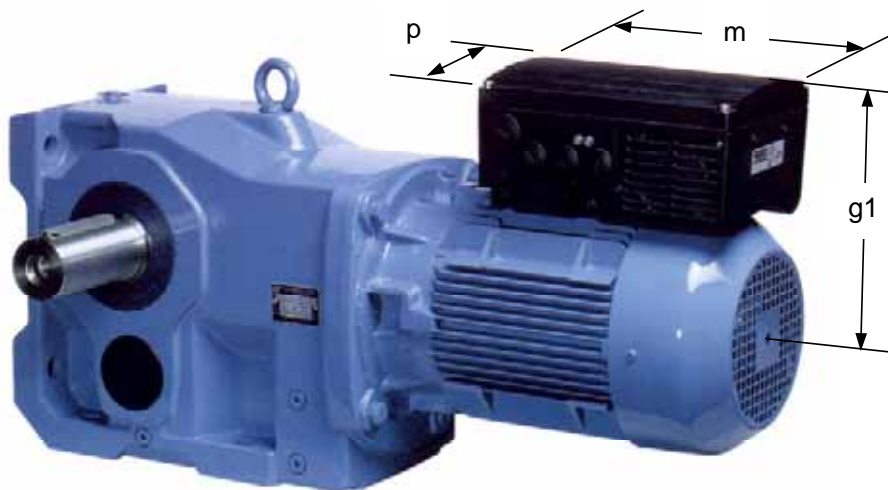
### 3 AC 380 -480 V supply voltage

Unit type:	SK ... TR	1500/3	2200/3	3000/3	4000/3	5500/3	7500/3
Motor rated power	[kW]	1.5	2.2	3.0	4.0	5.5	7.5
	[hp]	2	3	4	5.5	7.5	10
Mains voltage		3 AC 380 - 480 V, $\pm 10\%$ , 47 ... 63 Hz					
Nominal output current (rms)	[A]	3.6	5.2	6.9	8.3	11.4	14.8
Typ. input current (rms)	[A]	3.5	4.7	6.4	10.0	12.2	16.0
Type of ventilation		Convection					



5.2.6 Dimensions

Motor type	Frame size	g1	m	p	Weight (frequency inverter only)
71 S + L/4	FS1	208	160	121	3.5
80 S + L/4		200			
90 S + L/4		205			
80 S + L/4	FS2	212	242.2	171	5.6
90 S + L/4		217			
100 L/4 + 40		228			
112 M/4		238			
132 M + S/4		257			
all dimensions in [mm]					approx. [kg]



- Further data can be found in the product handbook BU 6010 at [www.nord.com](http://www.nord.com) -

## 5.3 NORDAC SK 750E

### 5.3.1 General information

The NORDAC **SK 750E** series is the result of resolute further development of proven NORD SK 700E frequency inverter series. This series of devices is characterized by a high level of modularity with optimized control features.

What makes them different is the substantially higher degree of protection and the option of being mounted right on a three-phase motor, in other words their suitability for decentralized configurations.

#### Vectorial current control without a sensor (ISD)

These devices are provided with a non-sensor vector current control system which constantly ensures an optimised voltage-to-frequency ratio based on a program which simulates typical operating conditions of a three-phase asynchronous motor.

As a result highest starting-up and overload torques are available to the drive while the desired motor speed remains constant. Owing to the huge variety of setting options these inverters are capable of controlling any three-phase motor on the market.



Outputs range from 5.5 kW to 22 kW (3 AC 200...240V to 11kW or 3 AC 380...480V to 22kW).

#### Variable technology boxes, custom interfaces and special upgrades with no extra space requirement

Due to their modular construction with technology boxes, custom interfaces and special upgrades which can be combined with one another in different ways, the devices of this series can be adapted for any conceivable applications.

### 5.3.2 SK 750E Characteristic features

- A high level of starting torque (up to 400%) and precise regulation of the motor speed due to a non-sensor vector current mode of control
- Variable configuration according to customer requirements using special technology boxes, custom interfaces, and special upgrades (optional equipment)
- Easy installation, programming, and system start-up
- The great variety of setting options allows for adaptation to any commonly available three-phase motor. The data for operating NORD geared motors is preset in the factory.
- High protection class for distributed installation, even directly on a three-phase asynchronous motor.
- Ambient temperatures up to 60°C allowed (S3 operation)
- Integrated line filter to ensure EMC class A1
- Automatic measurement of the stator resistance
- Four separate parameter sets which can be switched while inverter and motor remain connected
- Analogue PI / PID process controller (optional)
- Programmable relay outputs (optional)
- Programmable direct current braking
- Integrated brake chopper for 4-quadrant operation
- Adjustable ramp smoothing
- Scalable analogue output, 0...10 volts or 0/4...20 mA (optional)
- Detachable operating and display modules (optional)
- Multilingual display in plain language and data storage function, with ParameterBox (optional)
- Incremental shaft encoder feedback for high-precision speed control (optional)
- Integrated positioning control for precise positioning of the driven equipment (optional)

### 5.3.3 SK 750E Optional equipment

Option	Description	Data
Technology boxes (SK TU2-...)	Potentiometer, display or bus control, this module type will accomplish any of these tasks (identical with SK 300E modules).	On the following pages
Custom interfaces (SK CU1-...)	Various interface configurations can be implemented (identical with SK 700E modules).	On the following pages
Special upgrades (SK XU1-...)	Providing special functions such as digital speed control or positioning reliably and conveniently (identical with SK 700E modules).	On the following pages
ParameterBox SK PAR-2H / SK PAR-2E	External handy operating device with a display and a keypad for starting up and parameterizing the inverter, and for servicing purposes. Will accommodate up to 5 data records in its memory.	Section 7.1
Various connecting cables	Cables to connect SK 750E, ParameterBox and PC.	Section 7.1 / 7.2



### Technology Boxes

Technology boxes are plugged into or screwed onto the frequency inverter from the outside. They are used to control the frequency inverter manually or via a bus system.

The bus is connected using a 5 channel M12 system connector / screw terminals (Profibus).



Technology boxes		
ControlBox <b>SK TU2-CTR</b>	Module providing for operation and display. Suitable for system start-up and to read out operating values. (to be plugged into the left slot exclusively)	4-digit, 7-segment display
Switch / potentiometer <b>SK TU2-POT</b>	For direct control of the frequency inverter without additional installation or setting. (to be plugged into the left slot exclusively)	On – R – Off – On – L Setpoint 0 ... 100 %
Profibus I/O <b>SK TU2-PBR</b>	These options facilitate control and parameterisation of the SK 750E via Profibus DP.	1 Profibus interface 2x 5 pin M12 system connector
Profibus I/O <b>SK TU2-PBR-KL</b>	These options facilitate control and parameterisation of the SK 750E via Profibus DP.	1 Profibus interface 8 pin terminals / SUB-D9 connector
Profibus I/O <b>SK TU2-PBR-24V</b>	These options facilitate control and parameterisation of the SK 750E via Profibus DP. The external 24V voltage makes sure the bus subscriber remains in the network even if the frequency inverter's supply voltage is switched off.	1 Profibus interface 2x 5 pin M12 system connectors 1 external 24 V power supply
CANopen <b>SK TU2-CAO</b>	This interface facilitates control and parameterisation of the SK 750E via the serial CANopen port.	1 CANopen interface 1x 5 pin M12 system connector
DeviceNet <b>SK TU2-DEV</b>	This interface facilitates control and parameterisation of the SK 700E via the serial DeviceNet port.	1 DeviceNet interface 2x 5 pin M12 system connectors
InterBus <b>SK TU2-IBS</b>	This interface facilitates control and parameterisation of the SK 750E via the serial InterBus port.	1 InterBus interface 2x 5 pin M12 system connectors 1 external 24 V power supply
AS Interface <b>SK TU2-AS1</b>	This interface facilitates the control of sensors and actuators. In addition, the SK 750E can be parameterised via the AS interface.	2x 5 pin M12 system socket for actuators and sensors 2x 5 pin system connector for AS interface circuit and 24V auxiliary voltage

### Custom interfaces

Custom interfaces are optional insert modules. Their slots are found inside the frequency inverter housing. Once plugged in they are identified by the inverter automatically.

With spring terminals being provided for cable connection, the devices are most conveniently connected in no time at all.



Option	Description	Data
Basic I/O <b>SK CU1-BSC</b>	Simplest custom interface for optimal adaptation to the application.	1 x multifunction relay 3 x digital inputs 1 x analogue input, 0...10V
Standard I/O <b>SK CU1-STD</b>	Upgraded functionality of control signals including USS bus control.	2 x multifunction relays 4 x digital inputs 1 x analogue input, 0...10V, 0/4...20mA 1 x analogue output, 0...10V 1 x RS 485
Multi I/O <b>SK CU1-MLT</b>	Highest level of functionality through digital and analogue signal processing. Analogue voltage output.	2 x multifunction relays 6 x digital inputs 2 x analogue inputs, -10...+10 V, 0/4...20mA 2 x analogue outputs, <b>0...10V</b>
Multi I/O <b>SK CU1-MLT-20mA</b>	Highest level of functionality through digital and analogue signal processing. Analogue current output.	2 x multifunction relays 6 x digital inputs 2 x analogue inputs, -10...+10 V, 0/4...20mA 2 x analogue outputs, <b>0/4...20mA</b>
CANbus <b>SK CU1-CAN-RJ</b>	This interface enables control of the NORDAC SK 750E via the serial CAN port.	1 x multifunction relay 5 x digital inputs 2 x RJ45 CANbus connectors
Profibus <b>SK CU1-PBR</b>	This interface enables control of the NORDAC SK 750E via the serial Profibus DP port.	1 x multifunction relay 1 x digital input 1 x Profibus

**Special extension units**

Special extension units will turn a standard frequency inverter into a high-precision control device which will respond effectively to any requirements associated with an application.

They can be used in the frequency inverter in addition to the custom interfaces.



Option	Description	Data
PosiCon <b>SK XU1-POS</b>	Position and / or speed control Programmed positions are approached and held on the basis of displacement calculation. The actual values are collected by an incremental and/or an absolute value encoder.	Up to 252 positions programmable 2 x multifunction relays 6 x digital inputs 1 x absolute value encoder input, SSI 1 x incremental encoder input, 5V TTL
Encoder <b>SK XU1-ENC</b>	For high-precision speed control from zero speed to twice the nominal speed.	Up to 250kHz 1 x digital input 1 x incremental encoder input, 5V TTL



## 5.3.4 General data SK 750E

Function	Specification
Output frequency	0 ... 400 Hz
Rated overload capacity	150% for 60s, peak value 200%
Protective measures against	Overheating in the frequency inverter / motor      over / under voltage short-circuit, ground fault                                      overload, no-load running
Regulation and control	Sensorless vector current control (ISD)                      Regulation and control flux current control
Analogue setpoint input / PI input	0 ... 10V, 0/4 ... 20mA
Analogue setpoint resolution	10-bit related to the measuring range
Analogue output	Scalable between 0 .... 10 V (optional)
Setpoint stability	analogue < 1%      digital < 0.02%
Motor temperature monitoring	I <sup>2</sup> t monitoring,      PTC input (PTC resistor on motor)
Ramp times	0 ... 320 s
Control outputs	2 relays 230V AC / 28V DC , 2A (optional)
Interface, optional	RS 485      standard (M12)                      Profibus DP                      InterBus CANbus                      CANopen                      DeviceNet AS- Interface
Efficiency of frequency inverter	approximately 95%
Ambient temperature	-10°C ... +50°C without condensation
Storage / shipping temperature	-20°C ... +60/70°C, 85% humidity of the air max. without condensation
Long-term storage	Connect frequency inverters to the mains for 60 minutes at least once per year. Maintain this cycle throughout the storage period.
Protection type	IP54 air cooled version, IP65 water cooled version, depending on the motor being used
Climatic conditions	Class 3K3 as per EN 60721-3-3
Electrical isolation	Control terminals (digital inputs / outputs)
Max. mounting height above zero	Up to 1000m: no impairment of the output 1000...4000m: output impaired by 1%/ 100m (up to 2000m overvoltage cat. 3) 2000...4000m: only overvoltage category 2 is ensured, an external surge absorber should be provided to the mains input
Waiting spell between 2 mains-switch-on operations	60 secs for all devices in normal operating duty
Licences	CE





5.3.5 Electrical data SK 750E

230V unit type:	SK 750E ...	-551-323-A	-751-323-A	-921-323-A	-112-323-A
Motor rated power (4-pole type)	200V [kW]	5.5	7.5	9.2	11
	240V [hp]	7.5	10	12.5	15
Mains voltage	3 AC 200 - 240 V, +/-10%, 47...63 Hz				
Nominal output current (rms)	[A]	23	30	35	45
Recomm. brake resistor (accessory part)		33 Ω	25 Ω	20 Ω	15 Ω
Typ. input current (rms)	[A]	30	40	50	60
Ambient temperature	0°C ... +60°C (S3 duty cycle), 0°C ... +50°C (S1 duty cycle)				
Type of ventilation	fan cooling (thermostatically controlled) or water cooling				

400V Unit type:	SK 750E ...	-551-340-A	-751-340-A	-112-340-A	-152-340-A	-182-340-A	-222-340-A
Motor rated power (4-pole type)	400V [kW]	5.5	7.5	11.0	15.0	18.5	22.0
	460..480V [hp]	7.5	10	15	20	25	30
Mains voltage	3 AC 380 - 480 V, -20%/+10%, 47...63 Hz						
Nominal output current (rms)	[A]	11.5	15.5	23	30	35	45
Recomm. brake resistor (accessory part)		40 Ω	33 Ω	33 Ω	25 Ω	20 Ω	15 Ω
Typ. input current (rms)	[A]	17	21	30	40	50	60
Ambient temperature	0°C ... +60°C (S3 duty cycle), 0°C ... +50°C (S1 duty cycle)						
Type of ventilation	fan cooling (thermostatically controlled) or with water cooling						

## 5.3.6 Dimensions SK 750E

Frequency converter type	A	B	C	Weight
SK 750E-551-323-A to ... -751-323-A	414	255	237.5	18
SK 750E-551-340-A to ... -152-340-A			165 *	
SK 750E-921-323-A to ... -112-323-A	472	305	253	23
SK 750E-182-340-A to ... -222-340-A			180 *	
	all dimensions in [mm] *) with water cooling			approx. [kg]



- Further data can be found in the product handbook BU 0750 at [www.nord.com](http://www.nord.com) -

## 6 Decentralised motor starter

The NORDAC SK 1xxE product series comprises components for flexible solution of decentralised drive applications. Intelligent assembly groups for controlling motors are upgraded in a modular way with variable connection options, I/O modules and various bus connections.

A high level of standardisation simplifies the planning and implementation of even decentralised applications. In particular installation, clear arrangement and initialisation are made more convenient and efficient.

NORDAC SK 1xxE components are integrated into the motor or can be used near to the motor.

The motor frequency inverters described in chapter 5 also belong to the group of drive components which can be used for decentralised applications.



### System benefits:

- Integration of intelligence in motor terminal boxes
- High type of protection IP55 (according to the motor connected) or optionally IP66
- Thermistor-type motor protection
- Simple upgrade for all NORD motors
- Integrated brake management
- Various industrial system connectors for simple installation
- Robust and highly EMC compatible

### Convenient and efficient:

- Simple installation and conversion
- Problem-free replacement within the product group
  - Intelligent high-value frequency inverter
  - Motor starter
  - Soft starter
  - Reverse starter
- Digital control or control using various bus systems
- Status LED for quick test and diagnosis option
- Simple initialisation without service tools

## 6.1 NORDAC SK 140E

### Electronic motor starter

#### 6.1.1 General information

NORDAC **SK 140E** is an electronic switch for one rotational direction integrated into the motor terminal box with integrated thermistor-type motor protection for a motor output of 0.25 kW to 3kW.

No other components are required in the control cabinet for switching and monitoring the drive.

Thus NORDAC SK 140E is the solution for many decentralised drive applications which does not compromise safety.



#### 6.1.2 Characteristics

- Wear-free motor start and stop in one rotational direction
- Wide-ranging input voltage
- Control and acknowledgement via 24 V DC control signals
- Can be controlled via all commonly used field buses
- Semi-conductor indicator output
- Operating status display / integrated LEDs for fault diagnosis
- Temperature monitoring for motor
- Integrated rectifier for direct brake control (optional) = **Brake management**
- Up to 1000 switch operations per hour
- Interference suppression EMC limit class A

## 6.2 NORDAC SK 150E

### Electronic soft starter

#### 6.2.1 General information

NORDAC **SK 150E** is a soft start device for one rotational direction integrated into the motor terminal box with integrated thermistor-type motor protection for a motor output of 0.25 kW to 4kW.

No other components are required in the control cabinet for switching and monitoring the drive.

Thus NORDAC SK 150E is the solution for many decentralised drive applications which does not compromise safety.



Figure of AS interface option

#### 6.2.2 Characteristics

- Rotary coding switch for simple setting of ramp times (times of 0 to 60s)
- Wide-ranging input voltage
- Control and acknowledgement via 24 V DC control signals
- Can be controlled via all commonly used field buses
- Operating status display / integrated LEDs for fault diagnosis
- Temperature monitoring for motor
- Integrated rectifier for direct brake control (optional) = **Brake management**
- Up to 500 switch operations per hour
- Interference suppression EMC limit class A

### 6.3 NORDAC SK 160E

#### Electronic reverse starter

#### 6.3.1 General information

NORDAC **SK 160E** is an electronic switch for both directions integrated into the motor terminal box with integrated thermistor-type motor protection for a motor output of 0.25 kW to 4kW.

No other components are required in the control cabinet for switching and monitoring the drive.

Thus NORDAC SK 160E is the solution for many decentralised drive applications which does not compromise safety.



#### 6.3.2 Characteristics

- wear-free motor start-up and stoppage in **both** rotational directions
- Wide-ranging input voltage
- Control and acknowledgement via 24 V DC control signals
- Can be controlled via all commonly used field buses
- Semi-conductor indicator output
- Operating status display / integrated LEDs for fault diagnosis
- Rotary coding switch for simple setting of the locking time.
- Temperature monitoring for motor
- integrated rectifier for direct brake control (optional) = **Brake management**
- up to 1000 switch operations per hour
- Interference suppression EMC limit class A

### 6.4 Optional circular plug connector M12 on SK 1xxE

If M12 system cables are used (e.g. to connect a field bus module), the NORDAC SK 1xxE can be fitted with an optional M12 installation connector.

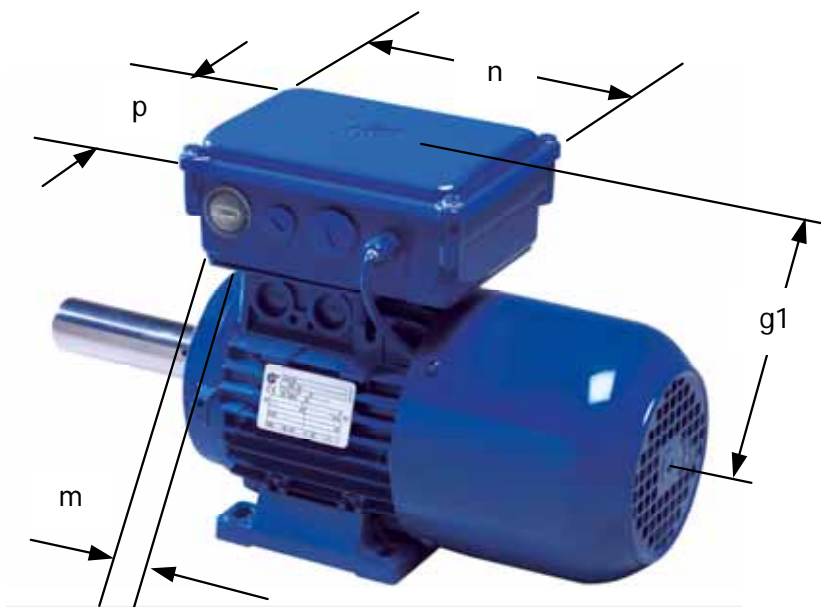


## 6.5 SK 1xxE general data

Function	Specification
Mains voltage	SK xxx-1- <b>O</b> 3~ 200...480 V, ±10%, 50/60 Hz      without brake control SK xxx-1- <b>BSG2</b> 3~ 380...480 V, ±10%, 50/60 Hz      with brake control
Operating current	0.5 ... 9 A
Motor output	<b>SK 140E:</b> 0.25 ... 3 kW (at 400 V) <b>SK 150E / SK 160E:</b> 0.25 ... 4 kW (at 400 V)
Brake voltage	depending on mains voltage (180V DC at 400V~ / 205V DC at 480V~), max. 0.5 A
Ext. control voltage	24 V DC (15 ... 30 V), 50 mA (without AS-Interface option)
Control input	15 ... 30 V, approximately 2 mA
Control output	15 ... 30 V, max. 50 mA, short-circuit resistant
Motor temperature monitoring	PTC or bimetallic switch, evaluation on mains potential
Interface	24 V DC      M12 connector (optional)      AS-Interface (optional)
Electrical isolation	Control logic (digital input) against supply voltage
Ambient temperature	-10°C ... +50°C, without condensation
Storage and transport temperature	-20°C ... +60/70°C, 85% of air humidity max. without condensation
Protection type	IP55 (depending on the motor used), IP66 as an option
Climatic conditions	Class 3K3 as per EN 60721-3-3
Max. mounting height above zero	up to 1,000 m with no reduction in performance > 1000 m: 5 % reduction in performance per 1000 m, up to a max. of 3000 m
Max. permitted frequency of switching	<b>SK 140E / SK 160E:</b> 1000 switches per hour, without start-up difficulty <b>SK 150E:</b> 500 switches per hour, without start-up difficulty
EMC	Interference suppression rating A1, suitable for industrial area
Licences	CE

## 6.6 SK 1xxE dimensions

Motor size	SK 140E				SK 150E / SK 160E			
	Weight without motor approximately 0.7kg				Weight without motor approx. 1.4kg			
	g1	m	n	p	g1	m	n	p
BG 63	158	9	153	108	167	- 8	185	139
BG 71	167	17			176	0		
BG 80	159	26			169	9		
BG 90	164	30			174	14		
BG 100	175	36			185	19		
BG 112	-	-	-	-	195	32		
	all dimensions in [mm]				all dimensions in [mm]			



- Further data can be found in the product handbook BU 0100 at [www.nord.com](http://www.nord.com) -



## 7 Accessories and optional features

### 7.1 NORDAC ParameterBox

*SK PAR-2H and SK PAR-2E*

#### 7.1.1 General information

The **ParameterBox** facilitates control, display of operating parameters and parameterisation of NORDAC frequency inverters.

It is available as a hand-held device = SK PAR-2H or installed version = SK PAR-2E (e.g. for installation in the control cabinet door). Thus it is easy to parameterise and operate up to 5 frequency inverters.

For documentation and storage of parameter settings the data sets of up to 5 inverters can be stored. Later on, the ParameterBox can be connected to a PC to read the parameter setting using the NORD CON software.



#### 7.1.2 Characteristics

- Illuminated, high resolution LCD graphics display with several lines
- 6 operating languages available for selection
- Central unit for up to 5 frequency inverters connected to a network via RS 485
- 5 complete frequency inverter datasets can be stored in the memory, loaded, and edited
- Connection to a standard PC interface (with RS232 / RS485 converter, chap. 7.2) for communication with the NORD CON software
- Parameter configuration "online" or "offline"
- Display of various operating parameters as a list or large-screen display
- Protection level IP66 if installed in the control cabinet door
- Standardisation of individual operating parameters to enable the display of specific system data
- Direct control of frequency inverter



7.1.3 Connection operations for the ParameterBox

ParameterBox type	Connecting cable Module	Module	NORDAC ... frequency inverter
<b>SK PAR-2H</b> Mat. No. 078910100 Cable length 3m 	Direct to system connector		 trio SK 300E SK 750E
	 <p>connecting cable: M12 socket → wires</p> <p>M12 So/wires Mat. No. 078910200</p>	Direct to connection terminals (RS485)	 vector mc
	 <p>SK CU1-STD</p>	 SK 700E	
	 <p>connecting cable: M12 socket → SUB-D</p> <p>M12 So/Sub-D9 Mat. No. 078910210</p>	 SK IC1-232/485 Mat. No. 276970020 + USB / 5V adapter Mat. No. 078910220	 PC / Laptop  NORD CON Software
<b>SK PAR-2E</b> Mat. No. 078910110  	Flexible shielded signal line 4 x 0,75 mm <sup>2</sup>	Direct to connection terminals (RS485)	 trio SK 300E
		Direct to connection terminals (RS485)	 vector mc
		 <p>SK CU1-STD</p>	 SK 700E
		 SK 750E	

## 7.2 NORDAC SK IC1-232/485

*Interface converter RS485 / RS232*

### General information

The **SK IC1-232/485** interface converter is a converter of signals from RS485 to RS232. This converter is used for connecting a PC or laptop to a NORDAC frequency inverter.

The appropriate connecting cable is required for the respective NORDAC frequency inverter in order to establish the connection between the frequency converter and the interface converter (see overview). The converter is plugged in directly to the RS232 interface of the PC/laptop with its SUB-D9 socket. An LED shows when the converter is live



with +5V supply voltage. The converter can be supplied with power from the respective frequency inverter or the PC (USB interface).

### Setting the Baud rate



The Baud rate can be set using a combination of 3 DIP switches with a range of 4800 to 38400 bit/s and must be adjusted to the setting of the frequency inverter.

### Accessories, external 5V supply cable



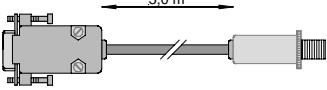
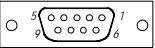




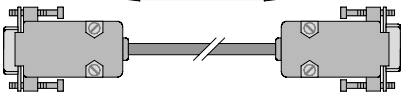






A supply voltage of +5V is required for connecting the ParameterBox / *p-box* to a PC/laptop when using the interface converter. It can be established using an additional connecting cable. The cable is connected to the USB interface of the PC/laptop.

When using the interface converter on the frequency inverter, it takes its supply voltage directly from the frequency inverter and does not need to be supplied with voltage externally.





Connection options

PC / Laptop	Interface converter / connecting cable / optional module	Frequency Inverter
	<p>SK IC1-232/485 Mat. No. 76970020</p>  <p>Connecting cable 300E 3.0 m Mat. No. 78910060</p>  <p>RS 232 2 = RXD 3 = TXD 5 = GND</p>  <p>RS 485 1 = RS 485+ 5 = GND 4 = RS 485- 6 = +5V</p> 	<p>trio SK 300E</p>  <p>SK 750E</p> 
<p>NORD CON Software Mat. no. 6099985</p> 	<p>RS232 connecting cable 2.0 m</p>  <p>In this case, an interface converter is not required as an RS232 input is provided!!!</p> <p>Optional module of the frequency inverter: <i>vector mc</i>: RS232 <i>mc</i></p>  <p>SK 700E: SK TU1-RS2</p>  <p>RJ12 adapter cable to SUB-D9 Length 3m, assignment RS 232 (Rx/D, Tx/D, GND)</p>  <p>Mat. no. 278910240</p>	<p><i>vector mc</i></p>  <p>SK 700E</p>  <p>SK 500E/520E: RJ12 standard</p> 

### 7.3 NORD CON Software

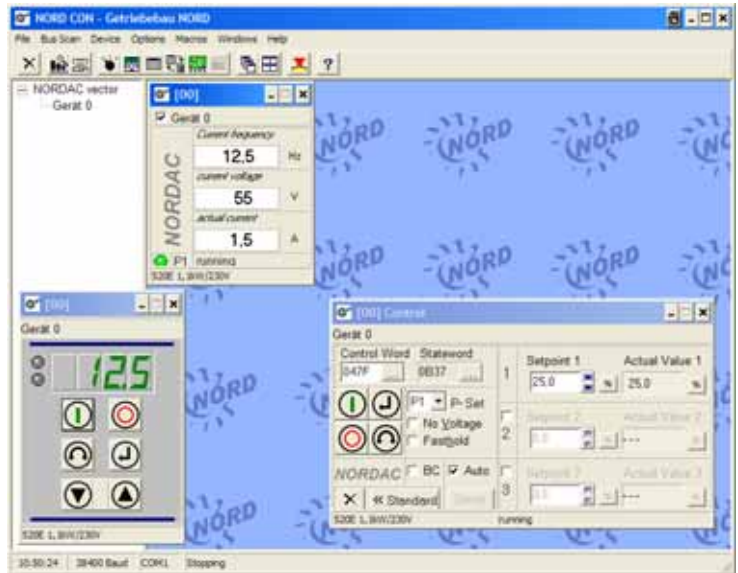
#### 7.3.1 General information

NORD CON is the PC program for controlling and parameterising NORDAC frequency inverters made by the Getriebebau NORD company.

The software can be installed on all computers with operating systems Windows 95, 98, NT, 2000, ME, XP.

NORD CON can be used to address up to **31 frequency inverters** at once via the device's own RS485 interface.

The connection is made using an interface converter (RS 232 - RS 485) connected to the serial PC interface.



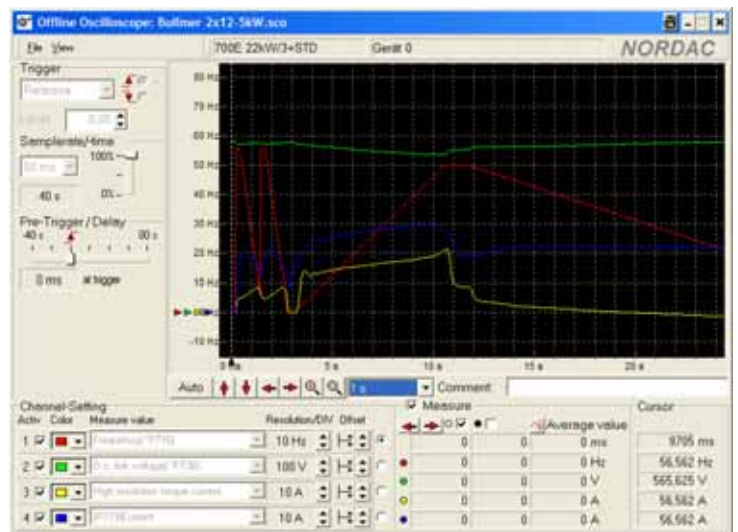
#### 7.3.2 Characteristics

- For creating, documenting and saving frequency inverter parameter settings
- Control of the connected frequency inverters
- Monitoring of connected frequency inverters
- Oscilloscope function
- Definition of macros for test process sequences
- Remote control of connected frequency inverters

#### 7.3.3 Oscilloscope function

The function required for recording can be selected from various channel settings. A total of 4 channels are available and are scalable in both time and range of values.

The graphs can be saved and archived, then opened up at a later time.



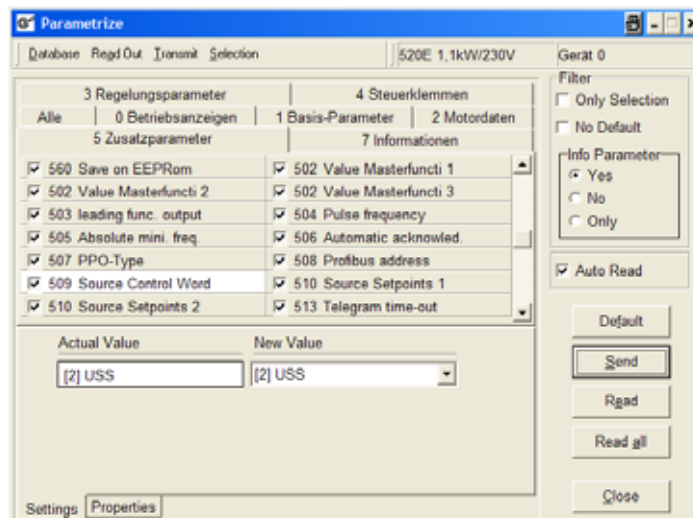


### 7.3.4 Parameterisation, overview

With NORD CON, all of the parameters of the connected frequency inverter can be read, changed, saved, or printed out for documentation.

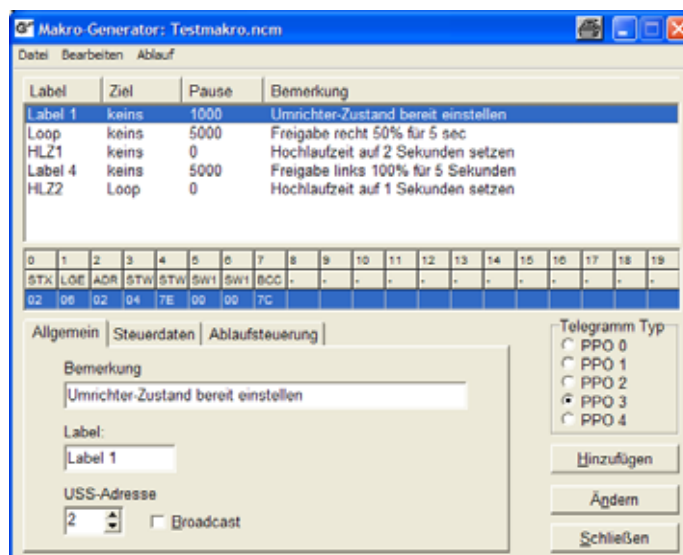
Each parameter has been assigned a parameter name and a unique parameter number with which it can be accessed. This makes handling extremely easy.

Furthermore, the parameter characteristics are provided and it is possible to narrow down the displayed parameters.



### 7.3.5 Macros, overview

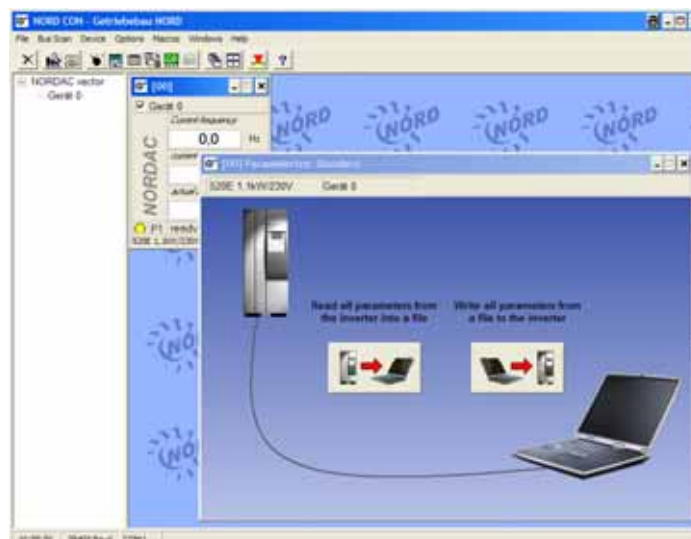
Macros can be used to create simple process sequences. This can be very useful for instance for testing during initialisation.



### 7.3.6 Archiving datasets

Entire frequency inverter datasets can be downloaded and archived direct on the PC.

Datasets already on the PC can also be transferred directly onto a connected frequency inverter.



## 7.4 NORD SERV Software

### 7.4.1 General information

NORD SERV is a PC program for creating, documenting, and saving the servo parameter settings and runs with Windows operating systems 95, 98, NT, 2000, ME and XP.

NORD SERV can be used for simultaneous addressing of up to 16 servo controllers via the device's own RS485 interface.



### 7.4.2 Parameter management and transfer

The NORD SERV program has a motor/controller database with datasets which have already been optimised in advance for simple handling. In most cases it is therefore not necessary to optimise the controller in the servo

frequency inverter. The integrated input assistants provide the user with suggested parameter settings. Only the datasets relevant to the connected servo motor are shown.

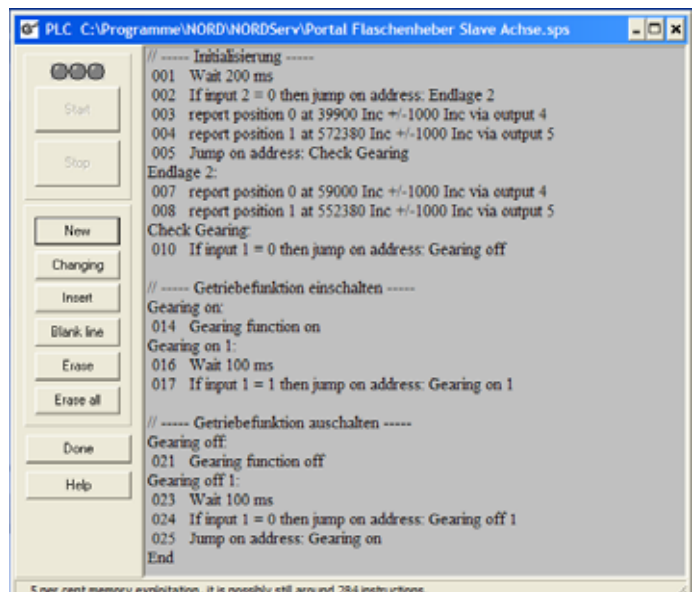
### 7.4.3 Initialisation and trouble shooting

NORD SERV can be used to control initialisation of the servo controller on the system, switch it on and drive it in all modes (torque, speed and position mode). It is also possible to observe the progress of controlled variables, e.g. torque,

speed and position in NORD SERV and to display them in the oscilloscope function which is equipped with comprehensive trigger aids.

### 7.4.4 Programming the drive PLC

The PLC included in the servo controller is programmed and tested using NORD SERV. Programming can be carried out online or offline in a very user-friendly way using templates in which the respective command parameters are entered or selected. The types of command range from simple marker operations and driving instructions to commands which send messages on the CAN field bus.

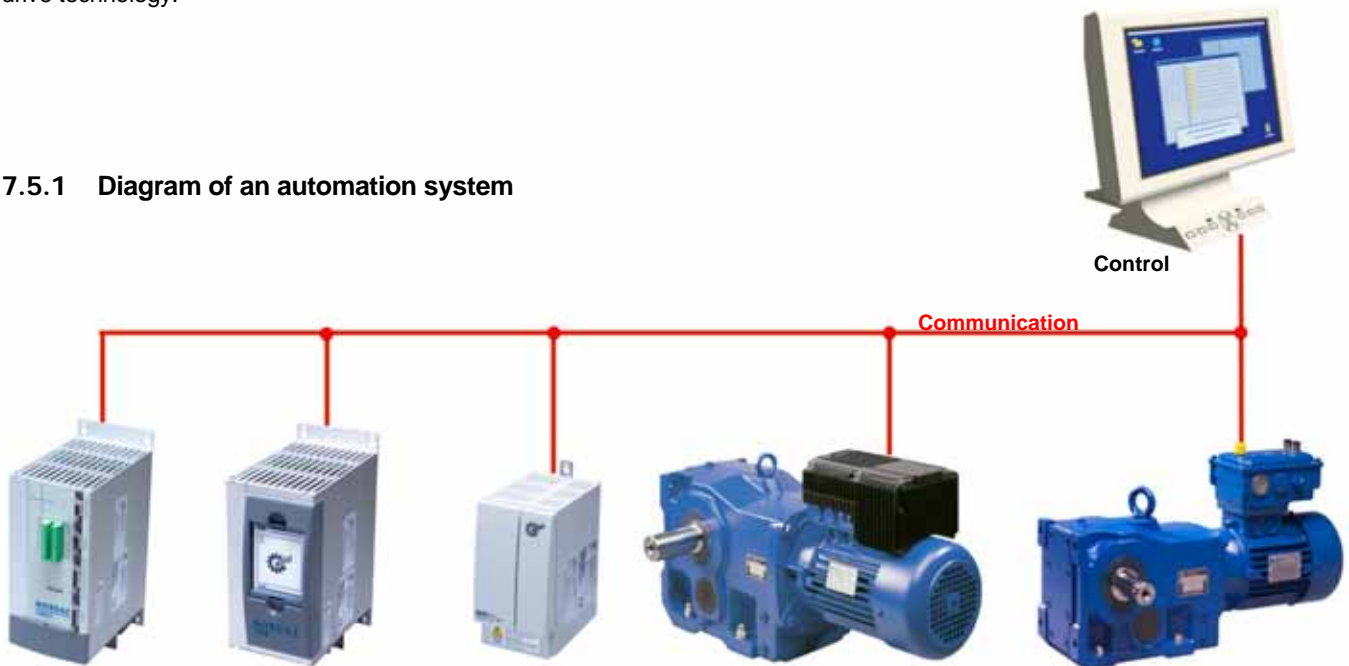


## 7.5 Communication

For All common bus systems for connecting automation systems are available for Getriebebau NORD's electronic drive technology.

Simplified control and diagnostics options are just two of the advantages over normal installation.

### 7.5.1 Diagram of an automation system



### 7.5.2 Profibus

Profibus can be used to facilitate data exchange between numerous different automation devices. PLC's, PC's, operating and monitoring devices can all communicate via one uniform bus in serial bit mode. PROFIBUS DP is primarily used for communication between sensor and actuator where system response needs to be very fast. PROFIBUS DP is a suitable alternative to expensive 24-volt parallel signal transmission and transmission of measured values.



This type of PROFIBUS which is optimised to speed is used for instance for operating frequency inverters on automation devices.

Data exchange is subject to DIN 19245 parts 1 and 2 and upgrades specific to the application in part 3 of this standard. As part of European field bus standardisation, the PROFIBUS is being integrated into the European field bus standard EN 50170.

#### Characteristic:

- Electrically isolated bus interface
- 12 Mbit/s transfer rate
- Problem-free connection to the frequency inverter via a Sub-D9 connector or plug contact
- Status display with 2 LEDs (technology box)
- Problem-free programming of all frequency inverter parameters
- Control of the output frequency via the Profibus connection
- Transfer of setpoint positions with NORDAC SK 700E/750E with PosiCon option
- Transfer of the current frequency inverter status during operation
- Up to 126 frequency inverters on one bus



### 7.5.3 CANbus

## CAN

The CAN bus facilitates the implementation of high-performance automation systems with distributed intelligence. CAN is based on linear topology. Using repeaters, branch-like topologies are possible. Solutions based on light wave conductors as well as double wire lines can be used. The collision and fault detection function which is integrated in the CAN log ensures a high level of bus usage and data security.

Bus access rights are not issued from a higher-level control unit (multi-master capability) but are issued by way of priority (identifier of the message).

A maximum Baud rate of 1 Mbit/s possible depending on the extent of the bus system. The data width per telegram is limited to a maximum of 8 bytes.

#### Characteristic:

- Electrically isolated bus interface
- Standard transfer rates of 10 kBits/s to 1 Mbit/s
- Connection to the inverter via a 9 channel Sub-D connector or plug contact
- The device is parameterised and controlled in accordance with CAN specifications 2.0A and 2.0B
- Transfer of setpoint positions with SK 700E/750E with PosiCon option
- Transfer of the current frequency inverter status during operation
- Up to 512 frequency inverters on one bus
- Terminating resistor may be connected into the circuit if required

### 7.5.4 AS- Interface



The AS- interface (generally referred to as ASI) has been developed as a simple bus system for universal use with products from all manufacturers in order to provide an interface to the simple sensors and actuators in the field. The term interface also denotes that this bus system cannot replace the classic field buses but is merely an interface to the simple command links at the lowest field bus level.

#### Characteristics:

- Single-master system
- Standard slave (max. 31 slaves)
- 4 sensors and 2 actuators
- Complete specification 2.1 profile 7.4.0
- Binary 4E / 4A data processing with two-directional string transfer

### 7.5.5 USS- protocol

## USS

The USS protocol defines an access process according to the master-slave principle for communication via a serial bus. It also includes point-to-point connection as a subset. One master and up to 31 slaves can be connected to the bus. RS485 and RS232 interfaces (PC communication) are provided for physical connection of the bus.

#### Characteristics:

- Master- slave access method
- Single-master system
- A maximum of 32 subscribers (max. 31 slaves )
- Operation with variable or fixed telegram lengths
- Simple and safe telegram frame



### 7.5.6 CANopen

**CANopen** is an open communications profile for diverse industrial automation systems. It is based on the CAN bus system (Controller-Area-Network). CANopen was specified by the international CAN-in-Automation (CiA) organisation and defines the communication mechanisms (process data, parameterisation, monitoring etc.) via CAN bus. Thus CANopen can be used to facilitate data exchange between devices from different manufacturers. The communication profile is defined in CiA standard DS-301.

Alongside the communication profile, CANopen defines device profiles for the most important types of device used in industrial automation technology, e.g. digital and analogue I/Os, drives etc.

#### Characteristics:

- Electrically isolated bus interface
- Standard transfer rates up to 1 Mbit/s
- Problem-free connection to the frequency inverter using a 9-channel Sub-D connector
- Status display with 4 LEDs
- Optional 24V supply
- Programming of all frequency inverter parameters using CANopen
- Supports DS-301 communications profile and DS-402 drive profile
- Dynamical mapping (4 TPDOs und 4 RPDOs)
- Heartbeat and node guarding
- Up to 127 devices on a single bus

### 7.5.7 DeviceNet

**DeviceNet** is an open communications profile for diverse industrial automation systems. It is based on the CAN bus system (Controller-Area-Network) which was developed by Bosch and describes the layers 1 (physical layer) and 2 (data transfer) of the OSI reference model (ISO 11898). DeviceNet was specified by the international *Open DeviceNet Vendor Association, Inc. (ODVA)* organisation and defines the communication mechanisms (process data, parameterisation, monitoring etc.) via the CAN bus. Thus DeviceNet can be used to facilitate data exchange between devices from different manufacturers. The communication profile is defined in the *DeviceNet Specification*.

Alongside the communication profile, DeviceNet defines device profiles for the most important types of device used in industrial automation technology, e.g. digital and analogue I/Os, drives etc.

#### Characteristics:

- Electrically isolated bus interface
- Standard transfer rates up to 500 kbit/s
- Problem-free connection to the frequency inverter using a 5-channel open style connector
- Status display with 4 LEDs
- 24V bus driver supply
- Programming of all frequency inverter parameters using DeviceNet
- Supports the communication profile DeviceNet Specification Release 2.0 and drive profile AC Drive.
- Group 2 only slave (supports predefined master/slave connection S)

### 7.5.8 InterBus

The InterBus is a very efficient bus system which works according to the special master-slave access method, also referred to as the summation frame protocol. The InterBus topology is that of a ring network with go-and-return lines which pass through each terminal in succession.



This ensures full duplex operation.

The subscribers are addressed automatically depending on their respective physical position within the system. The interface conforms to the German standards **DIN 19258** and **DIN 19245 Part 2**.

#### Characteristics:

- Electrically isolated bus interface
- Master- slave access method
- Summation frame protocol for stable cycle time
- Bus length: 400m (between two remote bus subscribers), total length 13km
- Transfer rate of 500kBit/s, or an optional 2Mbit/s
- Settable DRIVECOM 21 profile
- Processing of parameter data via PCP
- External 24V supply for continuous bus operation without interruptions
- 9 channel Sub-D connector for remote bus connection
- A maximum of 85 NORDAC frequency inverters
- Status display with 5 InterBus status LEDs, plus a two-colour operation LED

## 7.6 Brake resistors

### 7.6.1 Brake resistors for the Trio SK 300E

For detailed information regarding the brake resistor which can be fitted to the SK 300E see Section 5.1.4, Options for the SK 300E.



### 7.6.2 vector mc brake resistors

Brake resistors can be fitted as a substructure component. Overall space requirement is thus reduced.

Different sizes are available. The specified resistance values are electrically adapted to standard applications.

Frequency inverter type	Resistor IP20	Cont. rating	*) Approximate pulse power	A	B	C
SK 250/1 FCT - SK 750/1 FCT	180 Ω Mat. No. 278998180	50 W	0.8 kW	190	82	30
SK 1100/1 FCT - SK 2200/1 FCT	82 Ω Mat. No. 278998082	100 W	1.7 kW	224	108	30
SK 750/3 FCT - SK 3000/3 FCT	120 Ω Mat. No. 278998120	180 W	4.0 kW			
*) Pulse power with a maximum CDF of 4% and cycle of 120s (370/700Vdc)				all dimensions in [mm]		



**7.6.3 Brake resistors SK 500E / 520E**

Frequency inverter type SK 500E ... SK 520E ...	Resistor type IP40/IP20	Resistor	Cont. rating	*) Approximate pulse power	A	B	C
... -250-323-A - ... -370-323-A	<b>SK BR4</b> -240/100 Mat. no. 275991110	240 Ω	100 W	1.0 kW	230 **	88 **	175 **
... -550-323-A - ... -750-323-A	<b>SK BR4</b> -150/100 Mat. no. 275991115	150 Ω	100 W	1.0 kW			
... -111-323-A - ... -221-323-A	<b>SK BR4</b> - 75/200 Mat. no. 275991120	75 Ω	200 W	4.0 kW			
... -301-323-A - ... -401-323-A	<b>SK BR2</b> - 35/400-C Mat. no. 278282045	35 Ω	400 W	6.0 kW	170	100	240
... -550-340-A - ... -750-340-A	<b>SK BR4</b> -400/100 Mat. no. 275991210	400 Ω	100 W	0.75 kW	270 **	88 **	175 **
... -111-340-A - ... -221-340-A	<b>SK BR4</b> -220/200 Mat. no. 275991220	220 Ω	200 W	4.0 kW			
... -301-340-A - ... -401-340-A	<b>SK BR2</b> -100/400-C Mat. no. 278282040	100 Ω	400 W	6.0 kW	170	100	240
... -551-340-A - ... -751-340-A	<b>SK BR2</b> - 60/600-C Mat. no. 278282060	60 Ω	600 W	7.5 kW	350	92	120
*) once within 120s max.					all dimensions in [mm] **) total for BR and inverter		



SK BR4-... frame size 1 (IP40)



SK BR4-... frame size 2 (IP40)



SK BR2-... frame size 3 (IP20)



SK BR2-... frame size 4 (IP20)

#### 7.6.4 SK 700E/1000E brake resistors

The brake resistor can be fitted flat below or on one edge next to the frequency inverter. Overall space requirement is thus reduced.

Different sizes are available for inverter outputs of up to 7.5 kW.

The specified resistance values are electrically adapted to standard applications.

Higher outputs are available on request or can be taken from the list "Standard brake resistors" (chap. 7.7.3).

Frequency inverter type SK 700E ... SK 1000E...	Resistor type IP20	Resistor	Cont. rating	*) Approximate pulse power	A	B	C
...-101-340-A - ...-301-340-A	SK BR1-200/100-F Mat. no. 278281010	200 $\Omega$	100 W	2.4 kW	281	121	48
	SK BR1-200/300-F Mat. no. 278281030	200 $\Omega$	300 W	2.4 kW			
...-401-340-A	SK BR1-100/400-F Mat. no. 278281040	100 $\Omega$	400 W	4.8 kW			
...-551-340-A - ...-751-340-A	SK BR1-60/600-F Mat. no. 278281060	60 $\Omega$	600 W	8.2 kW	331	121	48
*) The specified pulse power varies according to the application type, maximum cyclic duration factor 5% / 120s (700VDC).					all dimensions in [mm]		



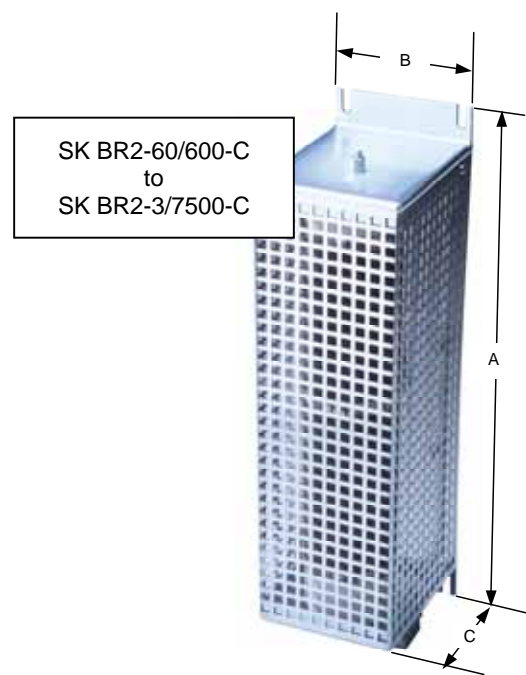
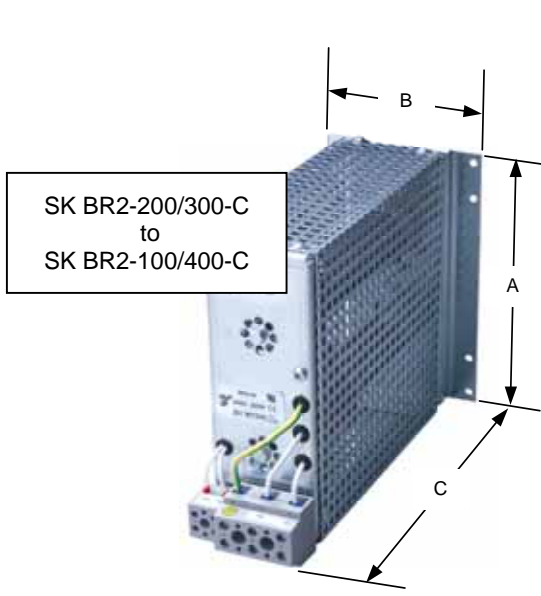
### 7.6.5 Standard brake resistors

These brake resistors are for universal use. The resistor elements are integrated into a grill housing and have to be connected to the respective frequency inverter via a separate connection line.

A shielded line which is as short as possible should be used for this purpose.

These resistors need to be protected against heavy soiling and high levels of moisture.

Frequency inverter power	Resistor type IP20	Resistor	Cont. rating	*) Approximate pulse power	A	B	C
1.5 ... 2.2 kW	<b>SK BR2-200/300-C</b> Mat. no. 278282030	200 Ω	300 W	2.4 kW	170	100	240
3.0 ... 4.0 kW	<b>SK BR2-100/400-C</b> Mat. no. 278282040	100 Ω	400 W	4.8 kW			
5.5 ... 7.5 kW	<b>SK BR2-60/600-C</b> Mat. no. 278282060	60 Ω	600 W	8.2 kW	350	92	120
11 ... 15 kW	<b>SK BR2-30/1500-C</b> Mat. no. 278282150	30 Ω	1500 W	16 kW	560	185	120
18.5 ... 22 kW	<b>SK BR2-22/2200-C</b> Mat. no. 278282220	22 Ω	2200 W	22 kW	460	270	120
30 ... 37 kW	<b>SK BR2-12/4000-C</b> Mat. no. 278282400	12 Ω	4000 W	41 kW	560	270	240
45 ... 55 kW	<b>SK BR2-8/6000-C</b> Mat. no. 278282600	8 Ω	6000 W	61 kW	470	600	300
75 ... 90 kW	<b>SK BR2-6/7500-C</b> Mat. no. 278282750	6 Ω	7500 W	82 kW	570	600	300
110 ... 160 kW	<b>SK BR2-3/7500-C</b> Mat. no. 278282753	3 Ω	7500 W	164 kW			
*) permitted, depending on application, max. 5% CDF / 120s (700VDC)					all dimensions in [mm]		



## 7.7 Input chokes

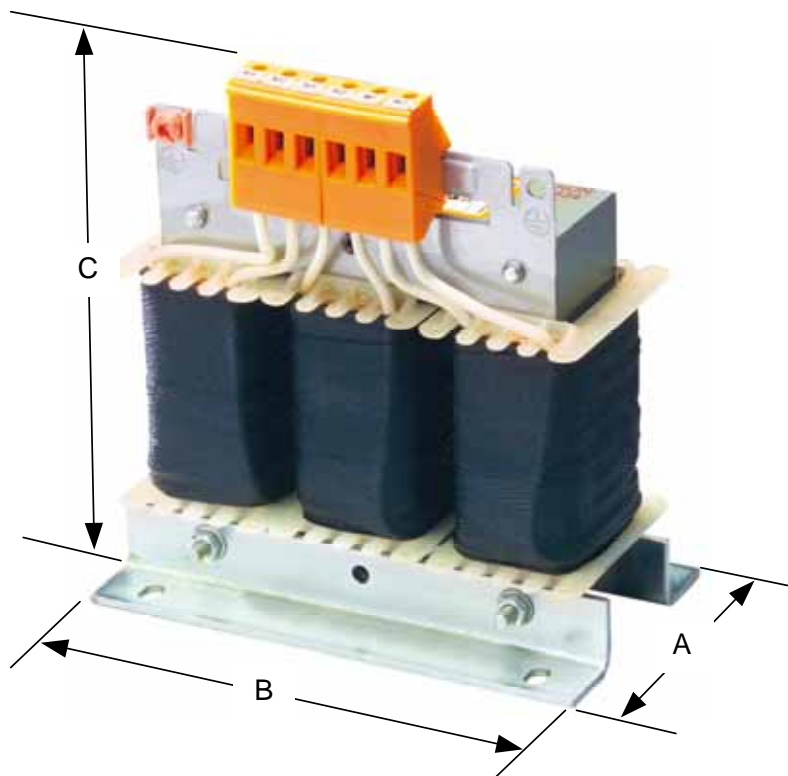
### 7.7.1 General information

All chokes have an IP20 protection rating. Chokes are designed to reduce dangerous mains current peaks.

Their use also significantly reduces reverse transfer to the mains and the harmonic content of the current is reduced to a minimum. The use of an input choke is recommended whenever the frequency inverter power exceeds 45kW.

For some drive systems it may be necessary to use input chokes. This also enhances protection of the device and EMC.

The tables below show which types of input chokes are used as standard with the various frequency inverter types.





## 7.7.2 Assignment of input chokes to frequency inverters

NORDAC vector mc, SK 500E/520E						
Frequency inverter type (Power)	Input choke 1 x 220 - 240 V			A	B	C
	Type IP20	Continuous current	Inductance			
0.25 ... 0.75 kW	SK CI1-230/8-C B 9907167	8 A	2 x 1.0 mH	65	78	98
1.1 ... 2.2 kW	SK CI1-230/20-C B 9907168	20 A	2 x 0.4 mH	81	96	118
						all dimensions in [mm]

NORDAC SK 500E/520E, SK 700E						
Frequency inverter type (Power)	Input choke 3 x 200 - 240 V			A	B	C
	Type IP20	Continuous current	Inductance			
0.25 ... 0.75 kW	SK CI1-460/6-C	6 A	3 x 4.88 mH	71	125	140
1.1 ... 1.5 kW	SK CI1-460/11-C	11 A	3 x 2.93 mH	84	155	160
2.2 ... 3.0 kW	SK CI1-460/20-C	20 A	3 x 1.47 mH	98	190	191
4.0 kW	SK CI1-460/40-C	40 A	3 x 0.73 mH	118	190	191
						all dimensions in [mm]

NORDAC vector mc, SK 500E/520E, SK 700E, SK 1000E						
Frequency inverter type (Power)	Input choke 3 x 380 - 480 V			A	B	C
	Type	Continuous current	Inductance			
0.75 ... 2.2 kW	SK CI1-460/6-C	6 A	3 x 4.88 mH	71	125	140
3.0 ... 4.0 kW	SK CI1-460/11-C	11 A	3 x 2.93 mH	84	155	160
5.5 ... 7.5 kW	SK CI1-460/20-C	20 A	3 x 1.47 mH	98	190	191
11 ... 18.5 kW	SK CI1-460/40-C	40 A	3 x 0.73 mH	118	190	191
22 ... 30 kW	SK CI1-460/70-C	70 A	3 x 0.47 mH	124	230	290
37 ... 45 kW	SK CI1-460/100-C	100 A	3 x 0.29 mH	148	230	290
55 ... 75 kW	SK CI1-460/160-C	160 A	3 x 0.18 mH	170	299	360
90 ... 132 kW	SK CI1-460/280-C	280 A	3 x 0.10 mH	190	290	270
160 kW	SK CI1-460/350-C	350 A	3 x 0.084 mH	190	300	270
						all dimensions in [mm]

## 7.8 Output chokes

### 7.8.1 General information

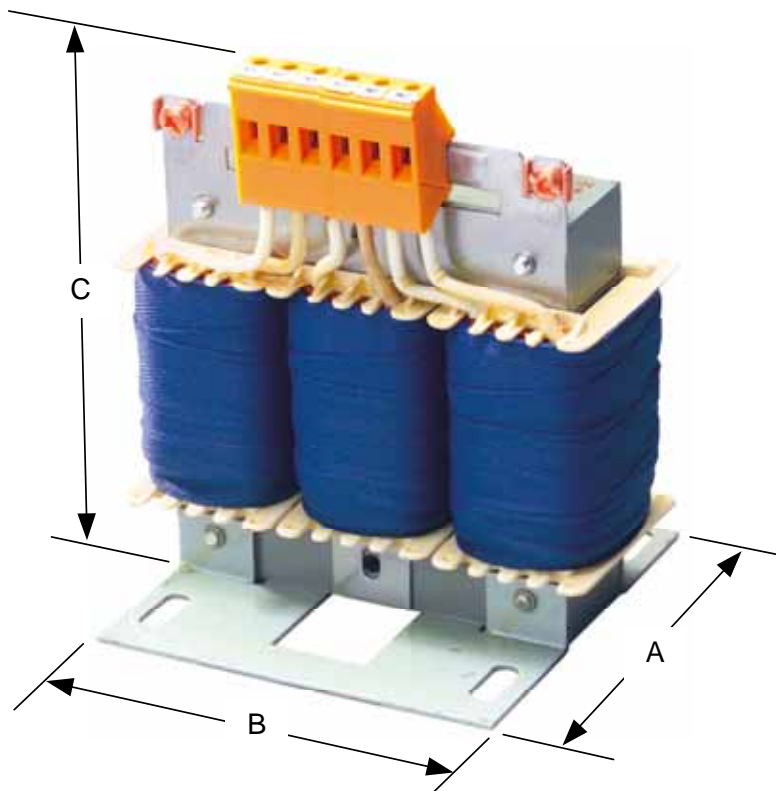
The following tables show which output chokes are used as standard with which types of frequency inverter.

For large motor cables (cable capacitance) it is often necessary to use additional output chokes at the inverter output.

This has a positive effect on device protection and the EMC properties.

The output chokes specified in the tables are rated for a frequency inverter pulse frequency of 3 to 6kHz and an output frequency of 0 to 120Hz.

All chokes have an IP20 protection rating.



**7.8.2 Assignment of output chokes**

<b>NORDAC vector mc, SK 500E/520E</b>						
Frequency inverter type	Output choke 3 x 200 – 240 V			A	B	C
	Type IP20	Continuous current	Inductance			
0.25 ... 0.75 kW (in the process of being discontinued)	SK CO1-460/4-C (B 9907166)	4 A (9 A)	3 x 3.5 mH (3 x 0.4 mH)	104 (46)	125 (95)	140 (118)
1.1 ... 2.2 kW	SK CO1-460/9-C	9.5 A	3 x 2.5 mH	105	155	160
3.0 ... 4.0 kW	SK CO1-460/17-C	17 A	3 x 1.2 mH	97	190	180
						all dimensions in [mm]

<b>NORDAC vector mc, SK 700E, SK 1000E</b>						
Frequency inverter type (Power)	Output choke 3 x 380 - 480V			A	B	C
	Type IP20	Continuous current	Inductance			
0.75 ... 1.5 kW	SK CO1-460/4-C	4 A	3 x 3.5 mH	104	125	140
2.2 ... 4.0 kW	SK CO1-460/9-C	9.5 A	3 x 2.5 mH	105	155	160
5.5 ... 7.5 kW	SK CO1-460/17-C	17 A	3 x 1.2 mH	97	190	180
11 ... 15 kW	SK CO1-460/33-C	33 A	3 x 0.6 mH	107	190	180
18 ... 30 kW	SK CO1-460/60-C	60 A	3 x 0.33 mH	140	230	290
37 ... 45 kW	SK CO1-460/90-C	90 A	3 x 0.22 mH	140	300	315
55 ... 90 kW	SK CO1-460/170-C	170 A	3 x 0.13 mH	185	360	452
110 / 132 kW	SK CO1-460/240-C	240 A	3 x 0.07 mH	215	360	472
160 kW	SK CO1-460/330-C	330 A	3 x 0.03 mH	200	300	270
						all dimensions in [mm]
<b>NORDAC SK 500E/520E</b>						
0.55 ... 4.0 kW	SK CO1-460/9-C	9.5 A	3 x 2.5 mH	105	155	160
5.5 ... 7.5 kW	SK CO1-460/17-C	17 A	3 x 1.2 mH	97	190	180
						all dimensions in [mm]



## 7.9 Line filters

### 7.9.1 General information

As of January 1996, all electrical facilities with an intrinsic, independent function marketed exclusively for use with certain individual devices must comply with the EEC

directive EEC/89/336. There are three different ways for manufacturers to display compliance with this directive:

#### 1. EG- declaration of conformity

This is a declaration from the manufacturer stating that the requirements in the applicable European standards for the electrical environment of the equipment have been met. Only those standards which are published in the Official Journal of the European Community can be cited in the manufacturer declaration.

#### 2. Technical documentation

Technical documentation can be produced which describes the EMC characteristics of the device. This documentation must be approved by a '*competent authority*' which is in turn appointed by the European government authority in charge. This makes it possible to use standards that are still being prepared.

#### 3. EG type test certificate

This method applies for radio transmitters only (not applicable to frequency inverters!).

### 7.9.2 EMC operation classes

A number of EMC operation classes may be relevant for electrical installations. With regard to frequency inverters,

additional factors such as switching frequency and cable lengths must be taken into account:

**Class 1: General, for industrial environment (EN68100-3)**

**Class 2: interference-free, for industrial environment (EN50081-2, EN50082-2)**

**Class 3: interference-free, for residential areas, commercial areas and light industrial environments (EN50081-1, EN50082-1)**

The tables below help with the selection of the appropriate line filters to ensure compliance with the EMC classes

mentioned above. All line filters are of protection type IP 20.

### 7.9.3 Line filters – vector mc

NORDAC <i>vector mc</i>						
Device type	without additional line filter	with additional line filter	Line filter type IP20	A	B	C
SK 250/1 FCT ... SK 750/1 FCT	class 2	class 3	HFE 141-230/9	188	87	44
SK 1100/1 FCT ... SK 2200/1 FCT	class 2	class 3	HFE 141-230/18	228	112	44
SK 750/3 FCT ... SK 3000/3 FCT	class 2	class 3	HFD 141-400/10			
<i>vector mc</i> , with low leakage current to earth						
SK 250/1 OFCT ... SK 750/1 OFCT	This frequency inverter must <u>not</u> be operated without a line filter!!	class 3	HFE 341-230/9	188	87	44
SK 1100/1 OFCT ... SK 2200/1 OFCT		class 3	HFE 341-230/18	228	112	44
				all dimensions in [mm]		



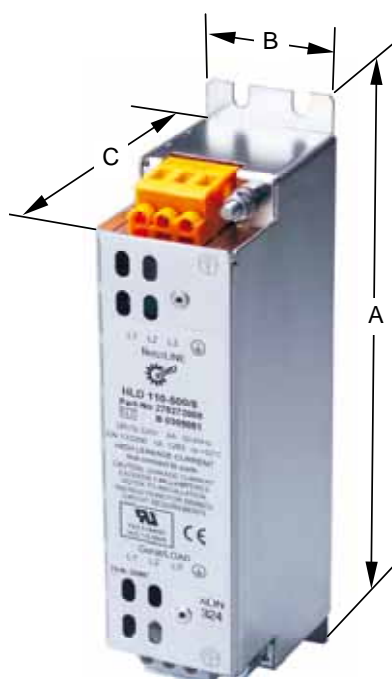
## 7.9.4 Line filters – SK 700E / SK 1000E

NORDAC SK 700E 1.5 ... 22kW - suitable for substructure installation -						
Device type	without additional line filter	with additional line filter	Line filter type IP20	A	B	C
...-151-340-A to ...-401-340-A	class 2	class 3	SK LF1-460/14-F	281	121	48
...-551-340-A to ...-751-340-A	class 2	class 3	SK LF1-460/24-F	331	121	58
...-112-340-A to ...-152-340-A	class 2	class 3	SK LF1-460/45-F	386	165	73
...-182-340-A to ...-222-340-A	class 2	class 3	SK LF1-460/66-F	431	201	83
NORDAC SK 1000E - suitable for substructure installation -						
...-101-340-A to ...-301-340-A	class 2	class 3	SK LF1-460/14-F	281	121	48
...-401-340-A to ...-501-340-A	class 2	class 3	SK LF1-460/24-F	331	121	58
...-801-340-A to ...-102-340-A	class 2	class 3	SK LF1-460/45-F	386	165	73
				all dimensions in [mm]		



## 7.9.5 Line filters UL / cUL – SK 700E

UL / cUL line filters for NORDAC SK 700E 1.5 ... 110kW						
Device type SK 700E ...	without additional line filter	with additional line filter	Line filter type	A	B	C
...-151-340-A to ...-221-340-A	class 2	class 3	HLD 110-500/8	190	45	75
...-301-340-A to ...-551-340-A	class 2	class 3	HLD 110-500/16	250	45	75
...-751-340-A to ...-112-340-A	class 2	class 3	HLD 110-500/30	270	55	95
...-152-340-A	class 2	class 3	HLD 110-500/42	310	55	95
...-182-340-A	class 2	class 3	HLD 110-500/55	250	85	95
...-222-340-A to ...-302-340-O	class 2 / class 1	class 3 / class 2	HLD 110-500/75	270	85	135
...-372-340-O	class 1	class 2	HLD 110-500/100	270	95	150
...-452-340-O to ...-552-340-O	class 1	class 2	HLD 110-500/130			
...-752-340-O	class 1	class 2	HLD 110-500/180	380	130	181
...-902-340-O to ...-113-340-O	class 1	class 2	HLD 110-500/250	450	155	220
				all dimensions in [mm]		



7.9.6 Line filters – SK 700E 132/160kW

Line filters for NORDAC SK 700E 132/160kW						
Device type SK 700E ...	without additional line filter	with additional line filter	Line filter type IP00	A	B	C
...-133-340-O	class 1	class 2	HLD 103-500/300	564	300	160
...-163-340-O	class 1	class 2	HLD 103-500/400			
				all dimensions in [mm]		





## 7.10 Incremental encoder

The NORDAC SK 700E/750E inverter series has an optional incremental encoder evaluation function. This is necessary when a very constant motor speed which is not affected by the load is required.

The SK 1000E servo controller can operate both servo motors and DS asynchronous motors.

The encoder will not work reliably unless the shielded motor cable and the encoder cable are laid separately. In addition, an output choke should be fitted to the frequency inverter output to reduce noise emissions.

To ensure faultless operation of the incremental encoder, it must be fitted to the motor shaft correctly aligned and as secure a fit as possible. In some special cases the encoder may also be fitted externally.



### 7.10.1 Incremental encoder types

Encoder type	Supply voltage	Output signal	Number of increments per revolution
1	5V ± 10%	TTL / RS 422	500 ... 5000
2	10 ... 30V	HTL / push-pull	
3	10 ... 30V	TTL / RS 422	

The SK 700E/750E frequency inverter can be supplemented with the *encoder extension module* (SK XU1-ENC) or *posicon extension module* (SK XU1-POS). It must be noted that these options are capable of evaluating an 5V TTL signal ⇒ type 1.

The accuracy of speed regulation or positioning increases with the number of increments of the encoder. 1024 (standard), 2048 and 4096 increments per revolution are

usual. The limit frequency of the encoder must be taken into consideration. This usually stands at 200kHz. Mathematically, the resultant maximum speed (e.g. for an encoder with 2048 increments) stands at 6,000 rpm<sup>-1</sup>. When the encoder is connected to external controllers, the permitted input frequency may restrict the number of increments of the encoder. The maximum number of increments can be calculated as follows:

$$\text{max. Increments} = \frac{\text{max. input frequency [Hz]} \cdot 60}{\text{Revolutions [1/min]}}$$

An optional encoder terminal box can be delivered as an alternative to the free connecting cable

(variable length). In this case, the terminal box is positioned on the van cover of the motor.



## 8 Application and projecting instructions

### 8.1 Brake resistors

#### 8.1.1 General information

While a loaded motor is decelerated, excess energy is fed back to the inverter and stored in the DC link capacitors.

This leads to an increase in voltage in the DC link which switches off the frequency inverter if the value is too high. At the same time, the fault message „overvoltage“ (device protection) is issued. If a brake resistor is installed on the frequency inverter, the integrated brake chopper (standard/optional) conducts the excess energy away to the external brake resistor .

The brake resistors listed here are designed for standard use and for typical braking processes.

The lower the resistance value, the higher is the maximum braking power. The resistors can be overloaded for short periods. However this maximum power is not for continuous operation.

Further advice and designs for special application requirements are available on request.

#### 8.1.2 Criteria for selection

Choosing the right brake resistor depends on 3 criteria: the **intensity** of the braking action (maximum power), the **duration** of the braking process (cycle) and the **frequency** of the braking process (cycle time).

Braking intensity includes the drive energy, i.e. the mass and speed of the load.

##### Resistance:

The resistance required is derived from the intensity of braking. The potential braking power depends on the DC link voltage and the resistance value. The braking power is equal to the pulse power.

##### Pulse power:

Brake resistors for use on frequency inverters have to satisfy certain criteria. These include pulse stability because of the DC link current which may go up to 800VDC (typically 700VDC) and the short switch times of the chopper transistor.

##### Continuous rating:

The number of braking operations per unit of time (cycle) determines the continuous resistor rating required. Our standard resistors are designed for short-time duty, i.e. for applications where deceleration takes only a short time and is followed by a waiting period or a period during which the equipment travels at constant speed.

Hoisting and lifting gear usually requires special brake resistors as energy is continuously fed back into the circuit each time a lowering motion is carried out. The result is a

resistance value with a considerably higher continuous rating.

### 8.1.3 Brake resistor rating

The effectiveness of the system is of considerable significance to the choice of brake resistors. Whenever the load is accelerated, the drive must generate the acceleration torque in addition to the load torque. The opposite applies for deceleration. The effectiveness of the system reduces the total braking torque required.

For hoisting and lifting gear, the different performance when raising and lowering must be taken into consideration.

- A *lifting action* always requires motor operation (static + dynamic torque). The higher the efficiency of the system the higher the required motor power.
- A *lowering action* mostly involves regenerative operation (static + dynamic torque, pay attention to indications). The higher the efficiency of the system the lower the regenerative energy

This regenerative power is relevant when determining the brake resistor required on the frequency inverter.



#### Example: LIFTING GEAR on frequency inverter

##### Load data, specifications

Mass (empty when empty)	$m_0 = 320\text{kg}$
Mass (weight of load)	$m_L = 625\text{kg}$
max. speed	$v = 0.7\text{m/s} \Rightarrow 42\text{m/min}$
Acceleration	$t_B = 0.7\text{sec} \Rightarrow a_B = 1\text{m/s}^2$

*The load is lifted by a non-reeved metal rope..*

Lifting height, average	$s_H = 7.5\text{m}$
Diameter of rope drum	$d = 106\text{mm}$
$\Rightarrow$ Output speed	$n_2 = 126\text{rpm}$
at an output frequency of	$f_{\text{max}} = 70\text{Hz}$
$\Rightarrow$ Motor speed	$n_1 = 1900\text{rpm}$

Interval between each travelling motion = 10.0s

##### Drive calculated according to AAP\*

SK 42-132M/40 Bre100 +	SK 700E-112-340-A
$P_{\text{NM}} = 9.2\text{kW}$	$P_{\text{NFU}} = 11\text{kW}$
$n_{2N} = 96 \frac{1}{\text{min}}$ at ...	$f_{\text{max}} = \text{approx. } 70\text{Hz}$
$T_N = 60.6\text{Nm}$	

$$J_{\text{MOT}} = 0.0354\text{kgm}^2$$

External mass moment of inertia:

$$J_x = 91.2 \cdot m \cdot \left(\frac{v}{n}\right)^2$$

$$J_x = 91.2 \cdot 945\text{kg} \cdot \left(\frac{0.7\text{m/s}}{1900\frac{1}{\text{min}}}\right)^2 = 0.0117\text{kgm}^2$$

\*) AAP = NORD Drive Design Program  
(Antriebs-Auslegungs-Programm)



**Lifting: Calculation of the static / the dynamic power / the torque**

**Lifting (static) positive speed**

$$P_{\text{stat}} = \frac{m \cdot g \cdot v}{1000 \cdot \eta} = \frac{945 \text{ kg} \cdot 9.81 \text{ m/s}^2 \cdot 0.7 \text{ m/s}}{1000 \cdot 0.8} = 8.11 \text{ kW}$$

$$M_{\text{stat}} = \frac{P \cdot 9550}{n_M} = \frac{8.11 \text{ kW} \cdot 9550}{1900 \text{ 1/min}} = 40.76 \text{ Nm}$$

**Lifting + acceleration**

$$M_{\text{stat+dyn}} = M_{\text{stat}} + \frac{\left( J_M + \frac{J_X}{\eta} \right) \cdot n_M}{9.55 \cdot t_B} = 40.76 \text{ Nm} + \frac{\left( 0.0354 \text{ kgm}^2 + \frac{0.0117 \text{ kgm}^2}{0.8} \right) \cdot 1900 \text{ 1/min}}{9.55 \cdot 0.7 \text{ s}} = 54.98 \text{ Nm}$$

**Lifting - deceleration**

$$M_{\text{stat-dyn}} = 40.76 \text{ Nm} - \frac{\left( 0.0354 \text{ kgm}^2 + \frac{0.0117 \text{ kgm}^2}{0.8} \right) \cdot 1900 \text{ 1/min}}{9.55 \cdot 0.7 \text{ s}} = 26.54 \text{ Nm}$$

All of the torques are positive, hence the power is positive in each case, too.

This means that no brake resistor will be required!

### Lowering: Calculation of the static / the dynamic power / the torque

#### Lowering (static) negative rate

$$P_{\text{stat}} = \frac{m \cdot g \cdot v}{1000 \cdot \eta} = \frac{945 \text{ kg} \cdot 9.81 \text{ m/s}^2 \cdot -0.7 \text{ m/s}}{1000 \cdot \frac{1}{0.8}} = -5.19 \text{ kW}$$

$$M_{\text{stat}} = \frac{P \cdot 9550}{n_M} = \frac{-5.19 \text{ kW} \cdot 9550}{-1900 \text{ 1/min}} = 26.09 \text{ Nm}$$

#### Lowering - acceleration

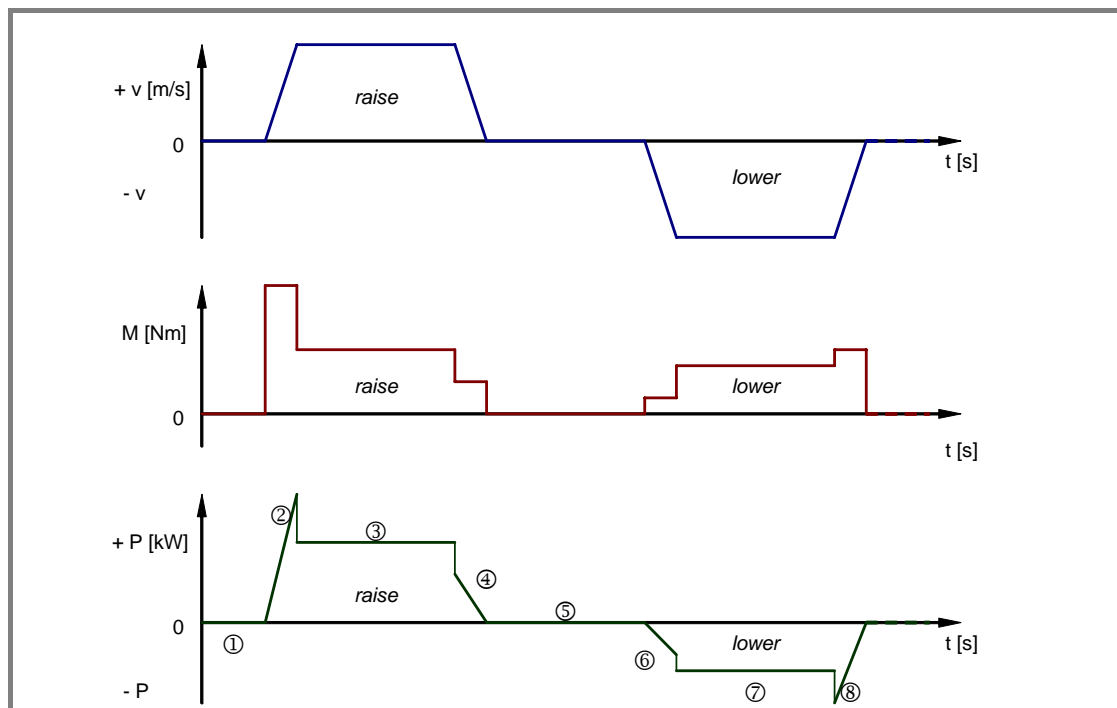
$$M_{\text{stat-dyn}} = M_{\text{stat}} - \frac{\left( J_M + \frac{J_X}{\eta} \right) \cdot n_M}{9.55 \cdot t_B} = 26.09 \text{ Nm} - \frac{\left( 0.0354 \text{ kgm}^2 + \frac{0.0117 \text{ kgm}^2}{\frac{1}{0.8}} \right) \cdot 1900 \text{ 1/min}}{9.55 \cdot 0.7 \text{ s}} = 13.37 \text{ Nm}$$

#### Lowering + deceleration

$$M_{\text{stat+dyn}} = 26.09 \text{ Nm} + \frac{\left( 0.0354 \text{ kgm}^2 + \frac{0.0117 \text{ kgm}^2}{\frac{1}{0.8}} \right) \cdot 1900 \text{ 1/min}}{9.55 \cdot 0.7 \text{ s}} = 38.81 \text{ Nm}$$

Calculations result in braking torques only, so the powers are negative. Consequently, a brake resistor must be used!

### Travelling cycle in this application





### Peak braking power

The peak braking power is reached at ⑧ :

$$P_{Br8} = \frac{M_{stat+dyn} \cdot n_M}{9550} = \frac{38.81Nm \cdot 19001/min}{9550} = 7.72kW$$

### Resistance value

The selected resistance value determines the minimum peak power that can be ensured involving the DC link voltage:

$$R_{Br} \leq \frac{(U_{UZW})^2}{|P_{Br8}|} \leq \frac{(700Vdc)^2}{7720W} \leq 63\Omega$$

Note: The voltage  $V_{ZW}$  (DC. link voltage) may vary according to the frequency inverter type.  
The typical amount with 1 AC 230V devices is 370VDC.

### Continuous rating

The required nominal power of the brake resistor (continuous rating) depends on the frequency and duration of the individual braking operations taking place within a 120-second cycle.

The intervals marked 2, 3 and 4 are disregarded however because during these stages the driving power comes from the motor exclusively.

① to ⑤ are not relevant, no braking power.

⑥ Braking power during *downward acceleration*

$$P_{Br6} = \frac{M_{stat-dyn} \cdot n_M}{9550} = \frac{13.37Nm \cdot 19001/min}{9550} = 2.66kW$$

⑦ Braking power during constant *downward travelling*

$$P_{Br7} = \frac{M_{stat} \cdot n_M}{9550} = \frac{26.09Nm \cdot 19001/min}{9550} = 5.19kW$$

⑧ Braking power during *downward deceleration*

$$P_{Br8} = \frac{M_{stat+dyn} \cdot n_M}{9550} = \frac{38.81Nm \cdot 19001/min}{9550} = 7.72kW$$

Of the power values calculated for the acceleration or deceleration stages only 50% are taken into account as the power depends on the speed.

$$P_{Br1-8} = \frac{\frac{P_{Br6} \cdot t_{Br6}}{2} + P_{Br7} \cdot t_{Br7} + \frac{P_{Br8} \cdot t_{Br8}}{2}}{t_{ges}} = \frac{\frac{2.66kW}{2} \cdot 0.7s + 5.19 \cdot 10s + \frac{7.72kW}{2} \cdot 0.7s}{42.8s} = 1.30kW$$

The brake resistor to be selected should have the following key data:

$$R_{Br} \leq 63\Omega, \quad P_{peak} = 7.72kW, \quad P_{cont} = 1.30kW$$

*CDF=cyclic duration factor*

$$CDF = \frac{11.4s}{42.8s} \cdot 100\% = \frac{32.0s}{120.0s} \cdot 100\% = 26.6\%$$

Based on the calculated data an enquiry should be made for a brake resistor.

The example calculation can be applied to other drive situations with slight variations.

Please contact your local NORD representative or distributing agent with any further questions.





## 8.2 50, 87, 100Hz U/f- characteristic

The use of frequency inverters significantly increases the range of uses for three-phase motors and gear motors and their range of speed settings

and output options in comparison to simple mains operation.

We would like to present and answer some important questions

e.g. **lowest possible frequency or speed,**  
**frequency increase at 50Hz,**  
**output increase of three-phase motors through 87Hz characteristic,**  
**extended speed range through 100Hz characteristic,**

which contribute to the optimum application of frequency inverter drives.

The standard three-phase asynchronous motor can principally be operated within a range of 0 rpm to double the nominal speed. The maximum speed is determined by mechanical limits only.

Due to inconsistent progression of torque and thermal limits the adjusting range has to be reduced / restricted depending on the application.

### 8.2.1 Smallest possible frequency / speed

At low speeds, the cooling of the motor using its own fan is inevitably reduced considerably. As a consequence, the motor's typical thermal power loss is no longer sufficiently conducted away and in continuous operation, overheating may occur. When operating at nominal torque, this area starts at speeds  $< \frac{1}{2}$  nominal speed ( $\Rightarrow$  25Hz).

Use of an external fan is one remedy which can eradicate the problem fully. Continuous operation is then possible at the lowest possible speeds ( $\Rightarrow$  2 - 5Hz slip frequency).

Alternatively, a bigger motor has to be selected.

The drive is then operated more within its limits. The increased size of the motor also results in a lower loss of power with additionally increased thermal reserves.

It is generally advisable to equip each speed controlled drive with temperature sensors which are evaluated by the frequency inverter. This ensures the thermal protection of the motor.



### 8.2.2 Design according to the 50 Hz characteristic curve

#### Adjusting range 1 : 10

Standard AC motors are designed for a certain nominal operation point (e.g.400V/50Hz). Up to this nominal frequency, the drive can be loaded with its nominal torque. Above the nominal frequency, the available torque is reduced as the voltage is no

longer increased at a higher frequency and the magnetic flux is reduced. This range is referred to as the field weakening range.

The physical prerequisites for stable torque are:

$$\begin{array}{ccccc}
 M = \text{constant} & \Rightarrow & \Phi = \text{constant} & \Rightarrow & V/f = \text{constant} \\
 \text{Torque} & & \text{magnetic flux} & & \text{Voltage/frequency}
 \end{array}$$

The condition  $V/f = \text{constant}$  can only be achieved by the frequency inverter up to the nominal operation point ( $V_{\text{nominal}}/f_{\text{nominal}} = \text{constant}$ ). A further increase in voltage above the mains voltage is technically

impossible. A further increase in frequency in the field weakening range thus leads to a reduction in torque.

The torque is reduced by the ratio

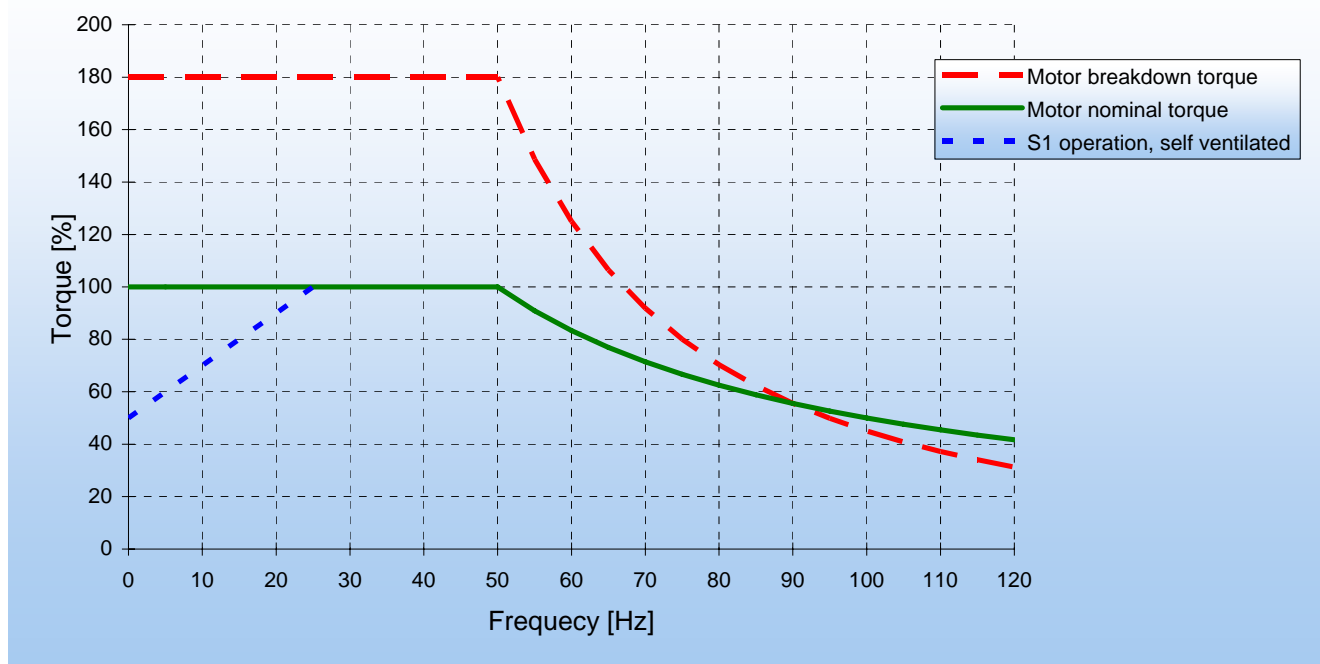
$$1/x \Rightarrow \frac{M_{AB}}{M_{\text{nominal}}} = \frac{f_{\text{nominal}}}{f_{AB}}$$

... minus other additional losses due to increased frequency.

Example: 1.4 times the nominal frequency = 70Hz

$$M_{(70\text{Hz})} = \frac{f_{\text{nominal}}}{f_{ab}} \cdot M_{\text{nominal}} = \frac{50\text{Hz}}{70\text{Hz}} \cdot M_{\text{nominal}} = 71\% \cdot M_{\text{nominal}}$$

The correlations are defined in the following **50Hz characteristic curve**:



### Summary:

An increased adjusting area is achieved by selecting the bigger motor so that the thermal limit and the reduction in torque in the field weakening range are not exceeded. The thermal limit only applies in **continuous operation**. For **short-term operation**, the usual start-up and overload torque values are available on the frequency inverter.

This must be taken into account if applications do not require stable torque across the entire adjusting range.

Centrifugal pumps and fans for instance have a quadratically increasing torque characteristic which favours operation at lower speeds.



### 8.2.3 Design according to the 87Hz characteristic curve

#### *Adjusting range 1 : 17*

For the 87Hz characteristic curve, the same thermal restrictions apply at lower speeds as with the 50Hz

design. However, the field weakening range does not begin until above the cut-off frequency of 87Hz.

This type of operation is possible if the following conditions are taken into account:

- The motor must be switched for 3~230V voltage, i.e. with motors 230/400V → delta connection-
- The frequency inverter must have an operating volume of 3~400V and the output current must at least be equal to the delta current of the motor.
- The higher maximum motor speeds may make it necessary to determine the reduction of the gears again.

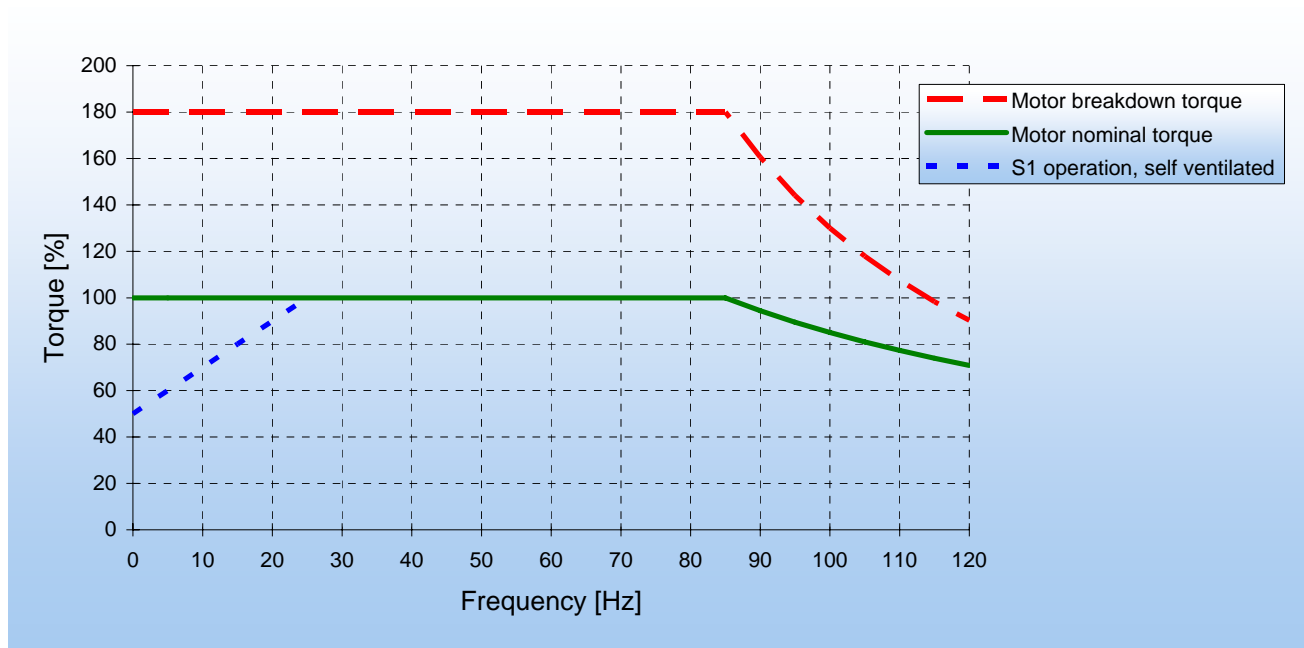
#### **Note**

With this configuration - 230V/50Hz motor on a frequency inverter with 400V – the nominal operation point stands at 230V/50Hz and an extended operation point at 400V/87Hz. Due to the increase of the operation point from 50Hz to 87Hz with constant

torque, the motor output power increases to the same extent by a factor of  $\sqrt{3} = 1.73$ .

Operation of the 230V motor with 400V is not at all critical as the motor windings are designed for test voltages > 2000V.

The correlations are defined in the following **87Hz characteristic curve**:



### Summary:

The advantage of this variant is an increase of the motor output through the increase of speed with constant torque and thus a larger adjusting range. It is important to note that the nominal torque of the motor does not increase. In particular the

performance remains unchanged in the range from 0 to 50Hz. The usual adjusting range is 1 : 17 or greater.



### 8.2.4 Design according to the 100Hz characteristic curve

#### *Adjusting range 1 : 20*

For the 100Hz characteristic curve, the same thermal restrictions apply at lower speeds as with the 50Hz and 87Hz design. However, the field weakening range does not begin until above the

100Hz point. This leads to a further expansion of the speed adjusting range.

This type of operation is possible if the following conditions are taken into account:

- The motor must be switched for 3~230V voltage, i.e. with motors 230/400V → delta connection-
- New motor data for 100Hz have to be calculated. → Getriebebau NORD
- The frequency inverter must have an operating voltage of 400V.
- The frequency inverter output must be one standard level above that of the motor.
- The higher maximum motor speeds may make it necessary to determine the reduction of the gears again.

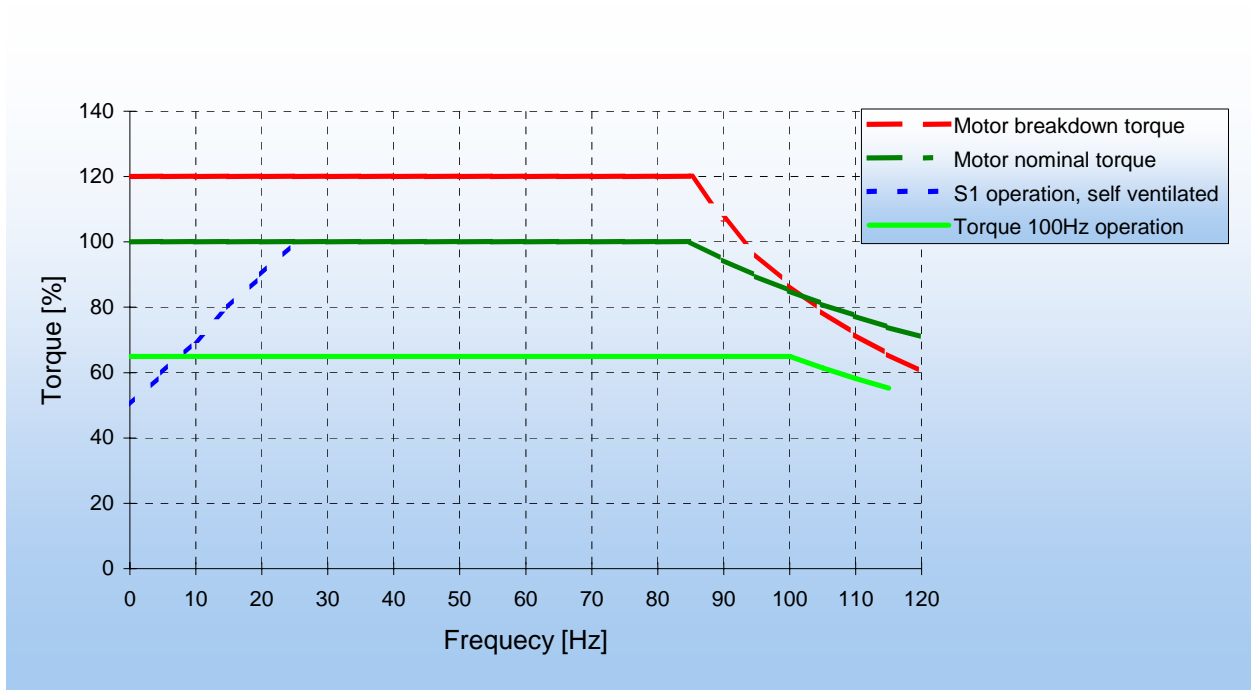
#### **Note**

With this configuration the nominal operating point of the standard asynchronous motor stands at 400V/100Hz. This is made possible by re-calculation of the motor data on our premises.

The resultant torque is available over the entire adjusting range (5...100Hz) and is a little below the standard value for the respective size of motor.

The reduction in the drive torque is between 30 and 40% depending on the size of the motor which is however compensated by the higher gear reduction with the same drive speed.

The correlations are defined in the following **100Hz characteristic curve**:



**Summary:**

The advantages of this variant are the greater speed adjusting range and the low level thermal sensitivity of the three-phase motor even at the lowest speeds. This is achieved as the motor is not operated at its

thermal output limit but still works on the vector controlled frequency inverter with accurately matched motor data.



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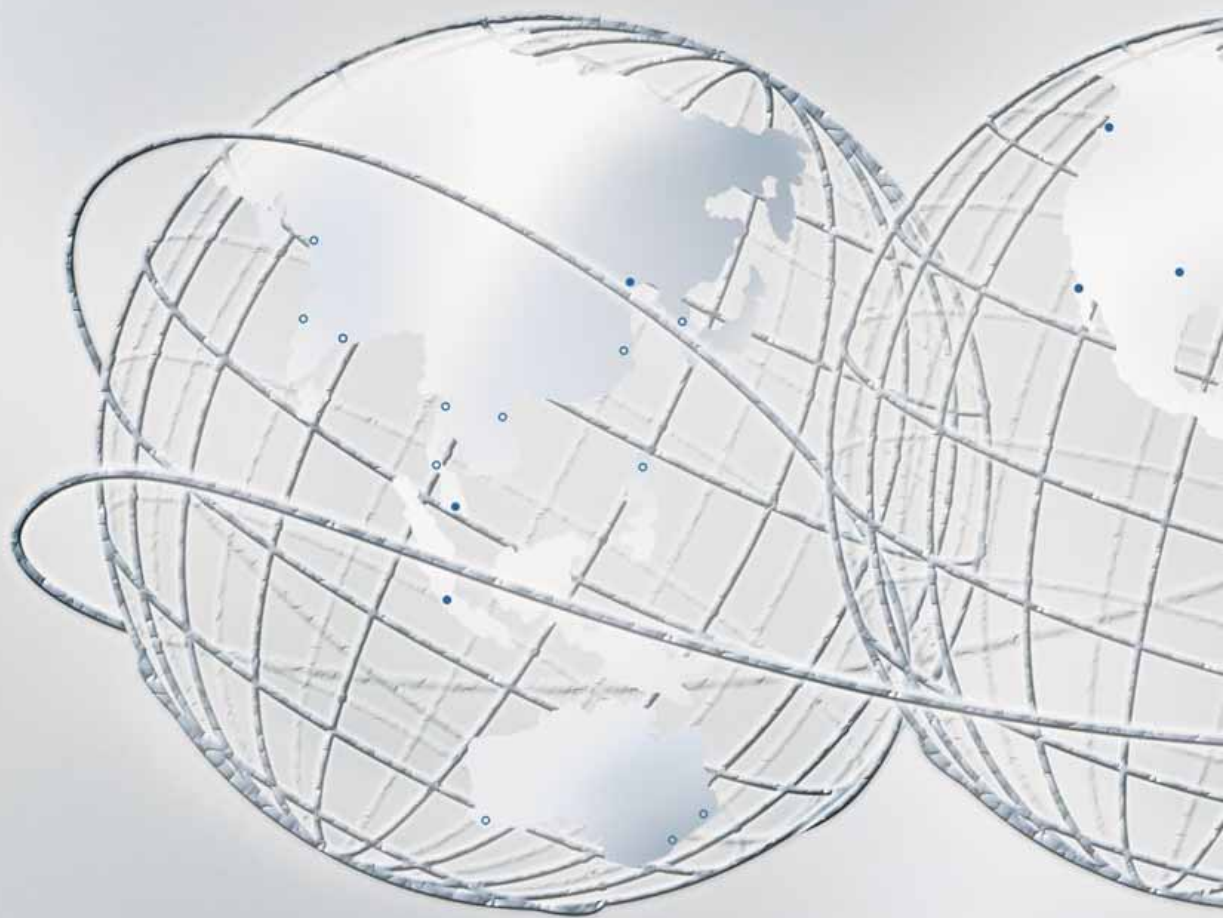
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