NORDAC®

VECTOR
FREQUENCY INVERTER

OPERATING INSTRUCTIONS
SK1500/3CT – SK132000/3CT
SK2200/3VT – SK37000/3VT

NORD GEAR CORPORATION
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NORDAC *vector* frequency inverter

Safety and operating instructions for drive converters

in conformity with the low-voltage directive 73/23/EEC

1. General

Depending on their degree of protection during operation, frequency inverters may have live, non insulated, hot surfaces, as well as moving and/or rotating parts.

Serious personal injury and damage to property can occur with inappropriate removal of protective covers, or any improper use, incorrect installation or malfunction.

See documentation, for further information.

All operations serving staging, installation and commissioning as well as maintenance are to be carried out by skilled technical personnel (Observe IEC 364 or CENELEC HD 384 or DIN VDE 0100 and IEC 664 or DIN/VDE 0110 and national accident prevention rules!).

For the purposes of these basic safety instructions, “skilled technical personnel” means persons who are familiar with the installation, mounting, commissioning and operation of the product and have the qualifications needed for the performance of their functions.

2. Intended use

Frequency inverters are components designed for use in electrical installations or machinery.

When installed in machinery, commissioning of the frequency inverter (i.e. the starting of normal operation) is prohibited until the machinery has been proven to conform to the provisions of the directive 89/392/EEC (Machinery Safety Directive - MSD). Account is to be taken of EN 60204.

Commissioning (i.e. the starting of normal operation) is allowable only where conformity with the EMC directive (89/336/EEC) has been established.

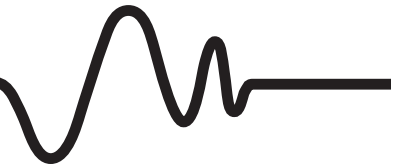
The frequency inverters meet the requirements of the low-voltage directive 73/23/EEC. They are subject to the harmonized standards of the series prEN 50178/DIN VDE 0160 in conjunction with EN 60439-1/ VDE 0660, part 500, and EN 60146/ VDE 0558.

The technical data as well as information concerning the supply conditions shall be taken from the rating plate and from the documentation and shall be strictly observed.

3. Transport, storage

The instructions for transport, storage and proper use shall be complied with.

The climatic conditions shall be in conformity with prEN 50178.



4. Installation

The installation and cooling of the frequency inverter shall be in accordance with the specifications in the pertinent documentation. The frequency inverter shall be protected against excessive strains. In particular, no components must be bent or isolating distances altered in the course of transportation or handling. No contact shall be made with electronic components and electrical contacts.

Frequency inverters contain electrostatic sensitive components and can be damaged through improper use. Electric components must not be mechanically damaged or destroyed (potential health risks).

5. Electrical connection

When working on live frequency inverters, the applicable national accident prevention rules (e.g. VBG 4) must be complied with.

The electrical installation shall be carried out in accordance with the relevant requirements (e.g. cross-sectional areas of conductors, fusing, ground connection). For further information, see documentation.

Instructions for the installation in accordance with EMC requirements, like shielding, grounding, location of filters and wiring, are contained in the frequency inverter documentation. Compliance is mandatory, and includes frequency inverters bearing CE markings. Observance of the limit values required by EMC law is the responsibility of the manufacturer of the installation or machine.

6. Operation

Installations which include frequency inverters shall be equipped with additional control and protective devices in accordance with the relevant applicable safety requirements, e.g. Act technical equipment, accident prevention rules etc. Changes to the frequency inverters by means of the operating software are admissible.

After disconnecting the frequency inverter from the voltage supply, live component parts and power terminals must not be touched because of possibly charged capacitors. In this respect, the corresponding signs and markings on the frequency inverter must be respected.

During operation, all covers and doors shall be kept closed.

7. Maintenance and servicing

The manufacturer's documentation shall be followed.

KEEP SAFETY INSTRUCTIONS IN A SAFE PLACE!

1 General

NORDAC *vector* frequency inverters are all-digital microprocessor-controlled voltage source dc link inverters designed to control the speed of three-phase motors. *Multiple control functions, optimized power characteristics, easy handling, compact design and high operational dependability* are the unique characteristics of these inverters.

NORDAC *vector* frequency inverters are available as VT (**V**ariable **T**orque) and CT (**C**onstant **T**orque) units. The VT type is particularly suitable for applications where a square load torque application is encountered, e.g. in fan or pump drives. The CT type lends itself to all other applications, especially to those in which a linear load torque is desirable (ref. section 14).

1.1 Delivery

Examine the unit **immediately** upon arrival/unpacking for shipping damage such as deformity or loose parts. In case of damage; promptly contact the shipping carrier and insure that the damage is documented and that proper forms are filled out for insurance and reimbursement.

Important! Undamaged packaging <u>also</u> needs to be examined!

1.2 Scope of delivery

Standard package:	IP 20 panel mounting unit Operating instructions Integrated clear text display Integrated brake-chopper RS 485 serial interface
Accessories available: (optional equipment)	IP 20 braking resistor AC line filter for a high level of radio interference suppression Interface converter RS 232 → RS 485 NORDCON software for parameter setting Incremental shaft encoder input for speed control *Posicon* positioning control add-on card Profibus connection assembly for Profibus - DP

Special version: Device with painted boards resistant to aggressive ambient air.
Consult factory for details

1.3 Safety and installation instructions

NORDAC *vector* frequency inverters are electrical equipment for application in industrial environments and are operated at voltages which may cause serious injuries or even death.

- Installation and any other work on the inverter shall be carried out by skilled and properly qualified technical personnel only. The operating instructions must be available to such personnel for installation and must be adhered to in every respect.

- The local, state, and federal regulations applicable to the installation of electrical systems as well as accident prevention regulations must be strictly observed.

- The inverter **still has high voltage up to 5 minutes** after disconnection from the AC line. Accordingly, the inverter covers must not be opened for at least 5 minutes after power has been switched off. Reattach all covers before switching the AC line voltage on again.

- Even when the motor has stopped (e.g. following electronic disable, or as a result of a jam situation, or a short circuit of the output terminals), the AC line terminals, motor terminals and terminals for the braking resistor **can have high voltage present.** A motor stop does not mean that the inverter is electrically isolated from the AC line.

- **CAUTION**, parts of the control board are at AC line voltage potential. Only the control terminals are isolated from the AC line voltage.

- **CAUTION**, certain parameter settings and configurations may cause the inverter to start up on its own when the AC line is switched on.

- The printed circuit boards carry highly sensitive MOS semiconductor components which are easily damaged by static electricity. Do not touch the conductive tracks or electronic components with your hands or metal objects. Only the screws of the terminal strips may be touched with insulated screw drivers while connecting the lines.

- The frequency inverter is designed solely for permanent connection and must not be operated without effective grounding as stipulated in the local regulations concerning high leakage currents (> 3.5 mA). VDE 0160 demands that either a second ground conductor be installed or that the ground conductor is 8 AWG.

- If local regulations do not allow direct current to exist in the fault current, conventional ground fault indicators will not provide sufficient protection.

- NORDAC *vector* frequency inverters are maintenance-free provided that they are properly operated in accordance with instructions. If the air is dust-laden, the cooling surfaces need to be regularly cleaned with compressed air.

The power section can still be live up to 5 minutes after disconnection from the AC line!
Inverter terminals, motor supply cables, and motor terminals can still be live !

Touching exposed or disconnected terminals, cables or parts of the inverter can lead to serious injuries or even death!

For the NORTH-AMERICAN market :

- The *vector* inverter is suitable for connection to a power supply system with a short circuit current of 5000 A (balanced to ground) provided that fuse protection as specified in section 15 is insured and that voltage will not exceed a maximum of 480V.
- Use copper wire for 140/167F (60/75°C) only.
- Use class 1 copper wire only.
- Suitable for use in an environment with a pollution degree not higher than 2
- Motor starting torque for “field connections”.

1.4 General Technical Data

Function	Range of values
Output frequency	0 Hz ... 999 Hz
Frequency resolution	0.1 Hz
Max. motor lead at the output	approx. 500 ft. (150m) without additional output choke, if standard cable is used
Ambient temperature	32ºF to 104ºF, (0°C to 40°C), air not containing any moisture or aggressive gases
Storage temperature	-4ºF to 158ºF, (-20°C to 70°C), in air free of moisture or aggressive gases
Air humidity	90% rel., no condensation
Installation altitude	up to 3300 ft., (1,000m) a.m.s.l. without loss of performance
Type of enclosure	IP 20 (alternatively: NEMA 1as an option)
Electrical protection	earth-fault- and short-circuit-proof, stable at no load, protected in case of AC line phase failure
Immunity to interference	IEC 801-2 /-4, severity level 4
R.I. suppression degree	in acc. with EN 55011, with optional AC line filter and properly connected
Approvals	UL and CSA for SK 1500/3 CT ... SK 11000/3 CT

2 Installation

The inverters require sufficient ventilation which is insured if the recommended minimum clearances above and below the units are observed. The values refer to a distance as measured from the upper edge towards any assemblies located above the inverters and correspondingly to a distance as measured from the lower edge towards any assemblies located below them. On a horizontal level no extra spacing will be required. The inverters can be installed one right beside the other.

Provide for the hot air rising from the inverters to be properly carried off

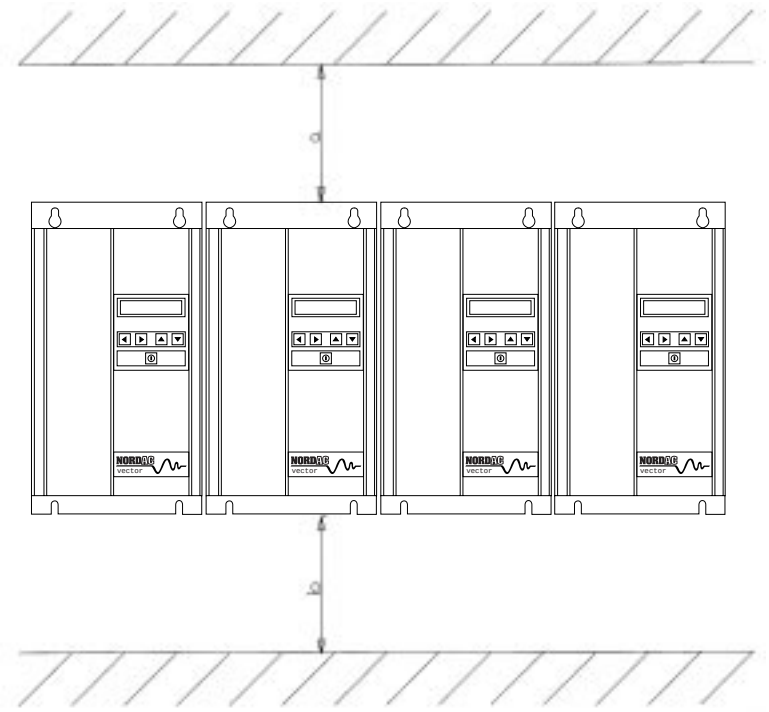


Fig. 1

above!

If several inverters are arranged one on top of the other, insure that the temperature of the air drawn in remains within the allowable limits 32˚ to 104˚F (0 to 40˚C)

Inverter type	Upward distance a	Downward distance b
SK 1500/3 CT to SK 11000/3 CT	5.2, (132)	5.2, (132)
SK 15000/3 CT and SK 22000/3 CT	6, (152)	6, (152)
SK 30000/3 CT and SK 75000/3 CT	8, (203)	8, (203)
SK 90000/3 CT to SK 132000/3 CT	10, (254)	10, (254)

All dimensions given also apply to VT Inverter types. Dimensions shown in inches,(mm)

3 Illustrated Dimensions

3.1 Frequency inverter dimensions

Version shown : IP 20

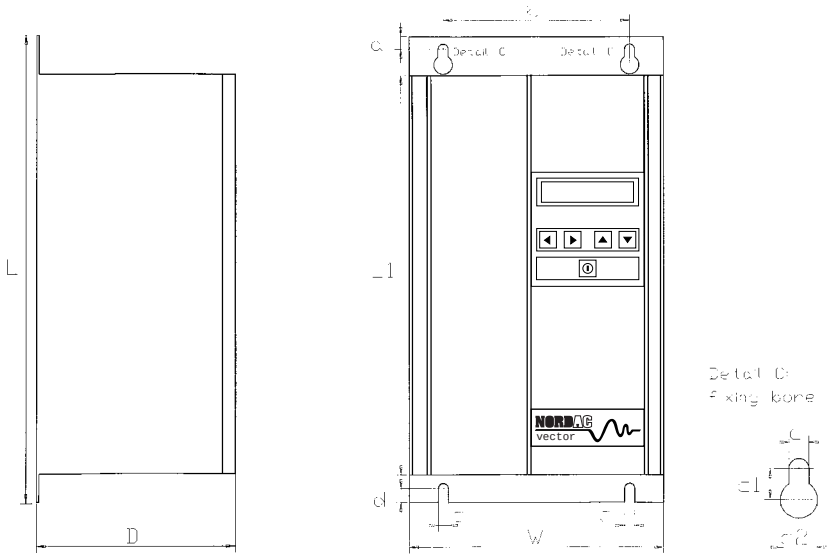


Fig. 2

Type	W	D	L	L1	a	b	c	c1	c2	d
SK 1500/3 CT SK 2200/3 CT SK 3000/3 CT	6.6 (168)	7.2 (184)	11.9 (301)	10.2 (258)	.315 (8)	4.724 (120)	.256 (6.5)	.394 (10)	.472 (12)	.354 (9)
SK 4000/3 CT SK 5500/3 CT	6.6 (168)	7.6 (193)	13.4 (341)	11.7 (298)	.315 (8)	4.724 (120)	.256 (6.5)	.394 (10)	.472 (12)	.354 (9)
SK 7500/3 CT SK 11000/3 CT	6.6 (168)	7.6 (194)	16.6 (421)	14.9 (378)	.315 (8)	4.724 (120)	.256 (6.5)	.394 (10)	.472 (12)	.354 (9)
SK 15000/3 CT SK 22000/3 CT	10.3 (261)	9.8 (248)	16.6 (421)	14.9 (378)	.315 (8)	8.268 (210)	.256 (6.5)	.394 (10)	.472 (12)	.354 (9)
SK 30000/3 CT SK 37000/3 CT	10.3 (261)	9.8 (248)	23.6 (599)	23.6 (556)	.315 (8)	8.268 (210)	.256 (6.5)	.394 (10)	.472 (12)	.354 (9)
SK 45000/3 CT SK 55000/3 CT	10.3 (261)	9.8 (248)	23.6 (599)	23.6 (556)	.315 (8)	8.268 (210)	.256 (6.5)	.394 (10)	.472 (12)	.354 (9)
SK 75000/3 CT	10.3 (261)	12.6 (321)	29.0 (736)	27.3 (693)	.315 (8)	8.268 (210)	.256 (6.5)	.394 (10)	.472 (12)	.354 (9)
SK 90000/3 CT SK 110000/3CT SK 132000/3CT	13.9 (352)	9.8 (248)	47.5 (1207)	45.5 (1156)	.315 (8)	5.591 (142)[1]	.256 (6.5)	.394 (10)	.472 (12)	.669 (17)
Technical design subject to change										dimensions in inches, (mm)

[1]Detail SK 90000/3 CT ... SK 132000/3 CT:

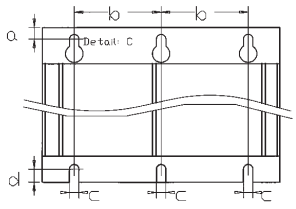


Fig. 3

4 Connection

The unit must be opened to make the electrical connections . The housing cover is attached to the housing by four screws. While working on the inverter be sure to adhere to the Safety and Installation Instructions (ref. section 1.3).

The connecting leads are fed into the unit from below and then connected to the power terminal strip. The cable entry plate can be detached to facilitate connection. It is secured with a screw. This plate must be reinstalled in order to maintain protection specifications.

Control, AC voltage and motor leads should be taken through separate openings. For strain relief, metal (PG) screwings can be inserted in the cable entry plate (AC voltage and motor connection up to 37kW). All supply conductors must be installed in accordance with the local regulations applicable to the installation of electrical systems.

In units ≥ 45kW, the power cables are installed without extra strain relief provisions (PG screwings, ref. section 4.2) in view of the fact that the connection terminals are located directly behind the openings in the cover plate.

As for units ≥ 45kW, the control lines should be held in position by means of the cable collars provided inside the unit.

For proper adherence to the current European Community directives supplementing the EMC law (as from 01.01.1996) an AC line filter recommended by the manufacturer of the inverter must be employed along with a shielding of the motor cables. Be sure also to connect the lines properly and to provide an effective ground connection using a midpoint conductor (ref. sections 1.3 and 10.1)

If the cable entry plate is used as a bonding plate for potential equalization, the cable shield has to be connected to the PE terminal in the inverter as well.

4.1 Power section SK 1500/3 CT to SK 132000/3 CT

Connection for AC voltage, braking resistor and motor:
- via screw-type terminal strips on the lower output stage board

Motor lead:
- approx. 500 ft. (150m) max. without additional measures if standard commercial cable is used.
- approx. 250 ft. (75 mm) max. if shielded cable is used.

4.1.1 Cable entry

SK 1500/3 CT to SK 11000/3 CT:

A total of 6 through holes sized PG 16 are provided of which 3 are intended to be used for control line and another 3 for power cable connection.

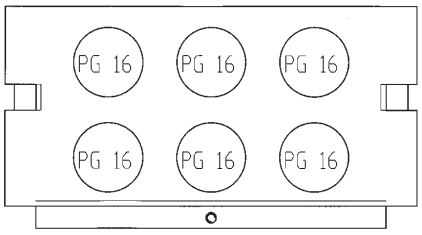


Fig. 4

Maximum wire gage:
- 12 AWG for SK 1500/3 CT to SK 7500/3 CT
- 8 AWG for SK 11000/3 CT

Types SK 15000/3 CT to SK 37000/3 CT:

Use a PG 36 screwing for AC input voltage connection, and a PG 29 screwing each to connect braking resistor and motor.

Maximum wire gage:
- 6 AWG (input) for SK 15000/3 CT and SK 22000/3 CT
- 8 AWG (output) for SK 15000/3 CT and SK 22000/3 CT
- 2 AWG for SK 30000/3 CT and SK 37000/3 CT

Types SK 45000/3 CT to SK 75000/3 CT:

AC input voltage and motor leads are fed through rectangular openings measuring approximately 1.0 in. (25 mm) x 3.3 in.(83 mm) each, while the braking resistor line is taken through a clearance approximately .7 in. (17.5 mm) x 1.8 in. (45 mm) wide. The connection terminals are located right behind those openings. The inverter housing does not allow for provision of strain relief accessories.

Maximum wire gage size:
- 1/0 AWG for SK 45000/3 CT and SK 75000/3 CT

Types SK 90000/3 CT to SK 13200/3 CT:

AC input voltage and motor leads are taken through 3 round openings (Ø 1.0 in., 25 mm) each while a total of 6 round openings (Ø .79 in., 20 mm) are provided for ground (PE) conductor and braking resistor connection. The connection terminals are located right behind those openings. The inverter housing is not equipped for providing strain relief on the wires.

Maximum wire gage size:
- 4/0 AWG for SK 90000/3 CT and SK 132000/3 CT

4.1.2 Electrical connection

*To be used as required

A safe motor protection against over temperature is only guaranteed with a motor temperature detector.

If a motor PTC resistor is used, the line routing should be different from that of the motor cable. It may even be advisable to provide a cable shielding.

Refer to section 15.2 for AC line fusing requirements.

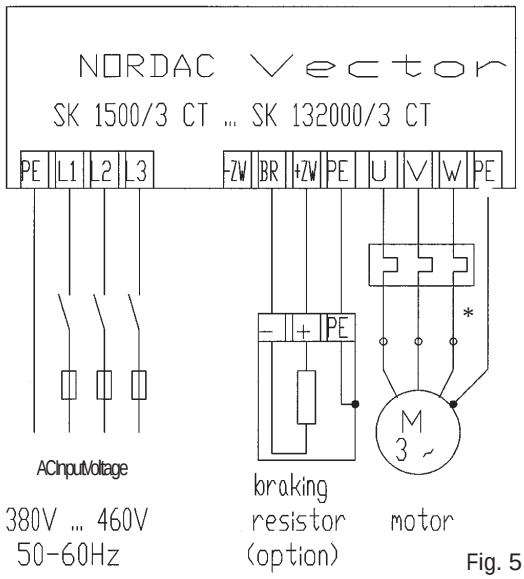


Fig. 5

4.2 Control section

Control wires to be connected to: → 29-pole control terminal strip, divided into 5 blocks

Selectable switch for the analog setpoint: → 2-pole DIP switch on the control board

Terminating resistance for RS485: →Jumper connects terminating resistor into circuit

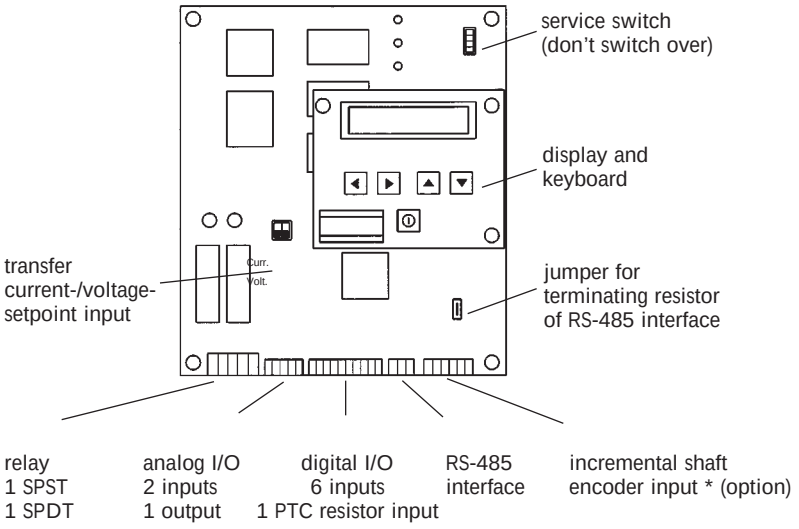


Fig. 6

*only if the optional incremental shaft encoder input has been provided! (ref. sec 7.2.5)

4.2.1 Cable entry

Types SK 1500/3 CT to SK 11000/3 CT:

A number of 6 openings sized PG 16 are provided to be used as required for entering control and power cables, with 3 openings for each type.

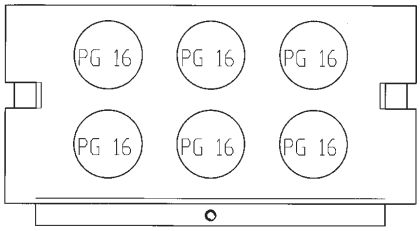


Fig. 7

Types SK 15000/3 CT to SK 132000/3 CT:

Three PG 16, one PG 11 and one PG 13.5-size screwings are provided to allow control line connection.

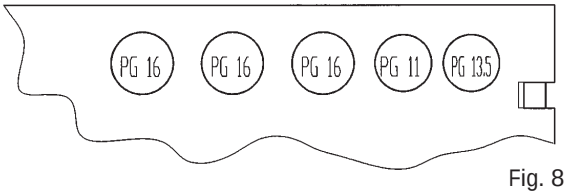


Fig. 8

4.2.2 Control terminal strip

Maximum connection wire gage size:
- 16 AWG for analog and digital in- and outputs
- 14 AWG for relay outputs

Cables:
- lay separately from AC input/motor leads and shield if necessary

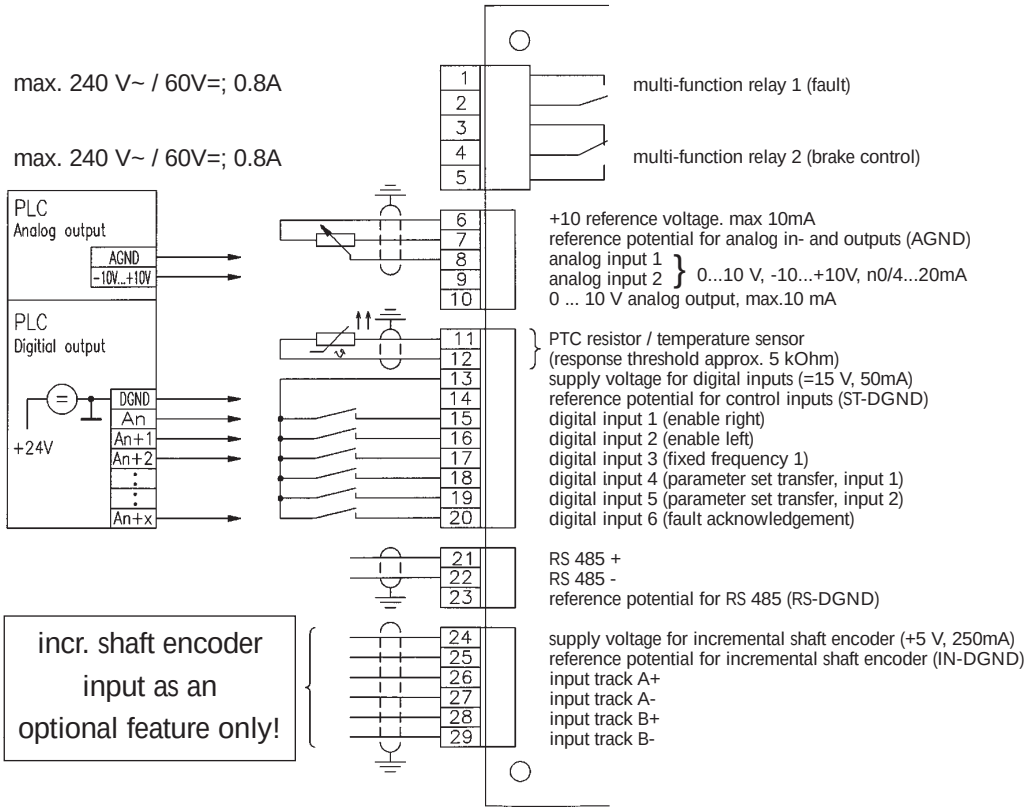
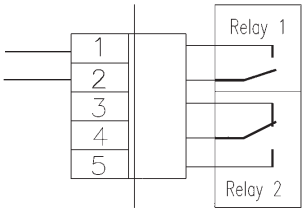
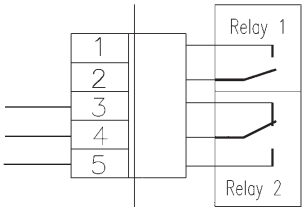
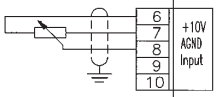
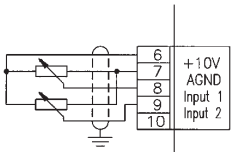
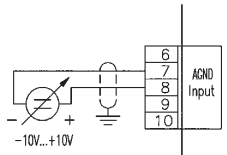
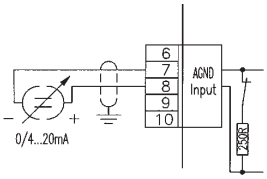


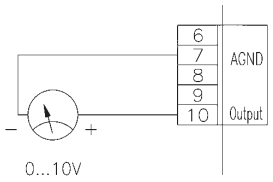
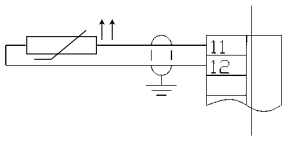
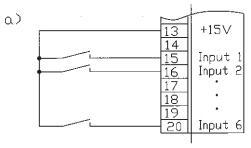
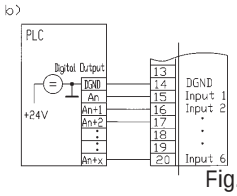
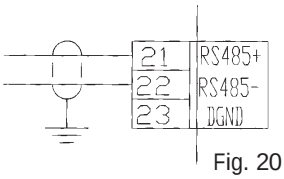
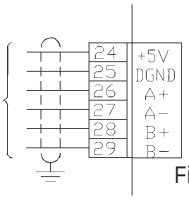
Fig. 9

The factory settings of the relay functions and digital inputs are shown in parentheses.

PLEASE NOTE: All grounds on the control card are internally connected, all GND terminals on the control card must be at <u>one</u> potential!

4.2.3 Control inputs

Terminal	Function/Comments	Data	Circuit/Suggested Circuit
1 2	**Relay 1**, make contact element Contact is open: • inverter is disconnected from the AC line voltage • inverter disturbance • programmed limiting value/ condition has been reached Contact is closed: • inverter is ready for operation • programmed limiting value has not been reached yet	max. 240 VAC/ 60 VDC@ 0.8 A terminals:14 AWG A 2 to 3 second delay of contact closure will result when power is first applied	 Fig. 10
3 4 5	**Relay 2**, changeover contact Contact 3-4 is closed: • non-operative position • inverter is disconnected from the AC line voltage Contact change-over, 4-5 is closed: • programmed limiting value/ condition has been reached		 Fig. 11
6 7 8 9	**Reference voltage** for analog inputs Power handling capacity: **Reference ground potential** for - analog in and outputs **Analog input 1** **Analog input 2** input impedance at voltage setpoint: current setpoint: a) with a setpoint potentiometer b) addition of two setpoints c) external analog voltage source d) external analog current source	+10 V max. 10 mA AGND 0...10 V, ±10 V 0/4...20 mA 0...10 V, ±10 V 0/4...20 mA approx. 40 kΩ approx. 250 Ω terminals:16 AWG R = 1 ... 10 kΩ 2 x R = 2 ... 10 kΩ ±10 V 0/4 ... 20 mA	a)  Fig. 12 b)  Fig. 13 c)  Fig. 14 d)  Fig. 15

Terminal	Function/Comments	Data	Circuit/Suggested Circuit
10	**Analog output** Power handling capacity: Analog voltage being put out corresponding to the output frequency*, the output current, the output voltage, the active power, the cos $\overline{\Phi}$, the motor torque* or the motor speed*	0 ... 10 V max. 10 mA terminals:16 AWG *depending on sign; possible: positive → 5-10 V negative → 0-5 V 1 kHz update	 Fig. 16
11 12	**Motor PTC resistor input** Response threshold: Separate the connecting cable from the AC line voltage and motor cables: if necessary a shielded cable should be used.	 approx. 5 kΩ terminals:16 AWG	 Fig. 17
13 14 15 16 17 18 19 20	**Power supply** for control inputs Load capacity: **Reference ground potential** for the control inputs **Control input 1** **Control input 2** **Control input 3** **Control input 4** **Control input 5** **Control input 6** Input impedance:	+15 V max. 50 mA low level:0...3V high level:13...30V positive logic terminals:16 AWG approx. 5.7 kΩ	 Fig. 18  Fig. 19
21 22 23	**Interface input** **RS 485 +** **RS 485 -** **Reference ground potential** for RS 485 interface Terminating resistance R ≈ 120Ω	 terminals:16 AWG (ref. sec. 4.3)	 Fig. 20
OPTION: Incremental shaft encoder input, RS 422			
24 25 26 27 28 29	**Power supply** **Reference potential for supply** **Input track A+** **Input track A-** **Input track B+** **Input track B-**	+5 V, max. 250 mA IN-DGND max. 250 kHz terminals:16 AWG (ref. sec. 7.2.5)	 Fig. 21
NOTE: The rotating field of the shaft encoder must be identical to that of the motor. If it isn't (e.g. in NORD motors with HG 660 transducer), tracks A+ and A- must be switched.			

PLEASE NOTE: All grounds on the control card are internally connected, all GND terminals on the control card must be at one potential!

5 Operation and Displays

General:
- Two-line liquid-crystal display with 16 digits in each line
- 5 keys for operation

5.1 Display

After AC line power up, the display will show the *inverter type* being used, e.g.

NORDAC *vector*
SK 2200/3 CT

Following enable, the display shows the major *operating data*, e.g.

P1 F/HZ U/V I/A
R 0.0 0 0.0

The display shows the menu parameter for as long as the relevant parameter is being adjusted, e.g.

Acceleration time
2.00s P1

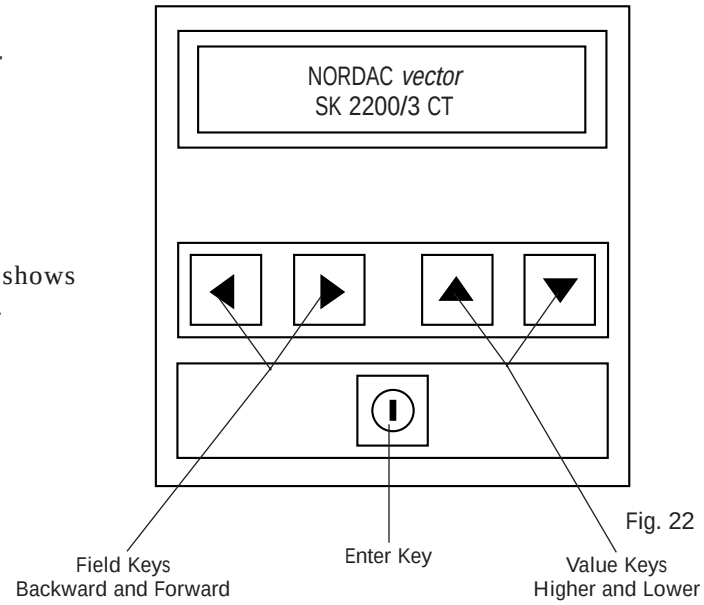


Fig. 22

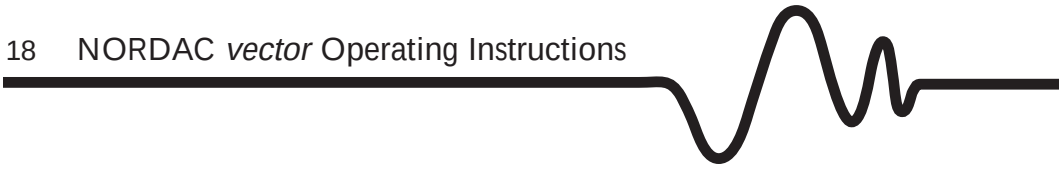
5.2 Keyboard

With the two "**field keys**" you can page forward and backward within the range of menu groups and menu parameters available for selection. When both keys are pressed simultaneously, the display will show the choice of menu groups, or when both keys are pressed simultaneously twice it will return to indicating either the inverter type or the operating data .

The "**enter key**" must be pressed to select the displayed menu group or to accept and store a parameter value within a menu that has been changed.

The values or contents of any menu parameter are changed with the two "**value keys**". Changes must be saved into memory by pressing the enter key, or else the previous value will be retained. Either the unit of measurement or a star symbol will be flashing to call attention to such changes which have not yet been confirmed by pressing the enter key. The factory default setting relating to a parameter can be reinstated by pressing the "value keys" at the same time.

Pushing the field key or value key once will make the contents change step by step. Holding down the field or value keys will make the contents change in a continuous fashion, until released. The longer the value keys are being pressed, the faster the display of the contents will change. In other words, holding the keys down will accelerate the rate at which different values or contents can be changed.



5.3 Relays

The output relay contacts which are integrated in the frequency inverter can be programmed for various functions. The desired function is selected with the higher value key. The lower value key is used to switch the selected function ON or OFF. The input is saved by pressing the enter key (ref. item 7.1.4 Control terminals, MFR1 or MFR2).

6 Starting-up

6.1 Parameter settings at system start-up

The NORDAC *vector* frequency inverter default settings are to operate a matching 4-pole standard motor with the inverters rated HP.

After turning on the AC input voltage begin by:

a) switching the electronic enable (connect control terminal 15 to a “high” signal, e.g. to control terminal 13,)

b) then apply an analog voltage setpoint between control terminals 7 and 8.

The following menu items are available while these settings are valid:

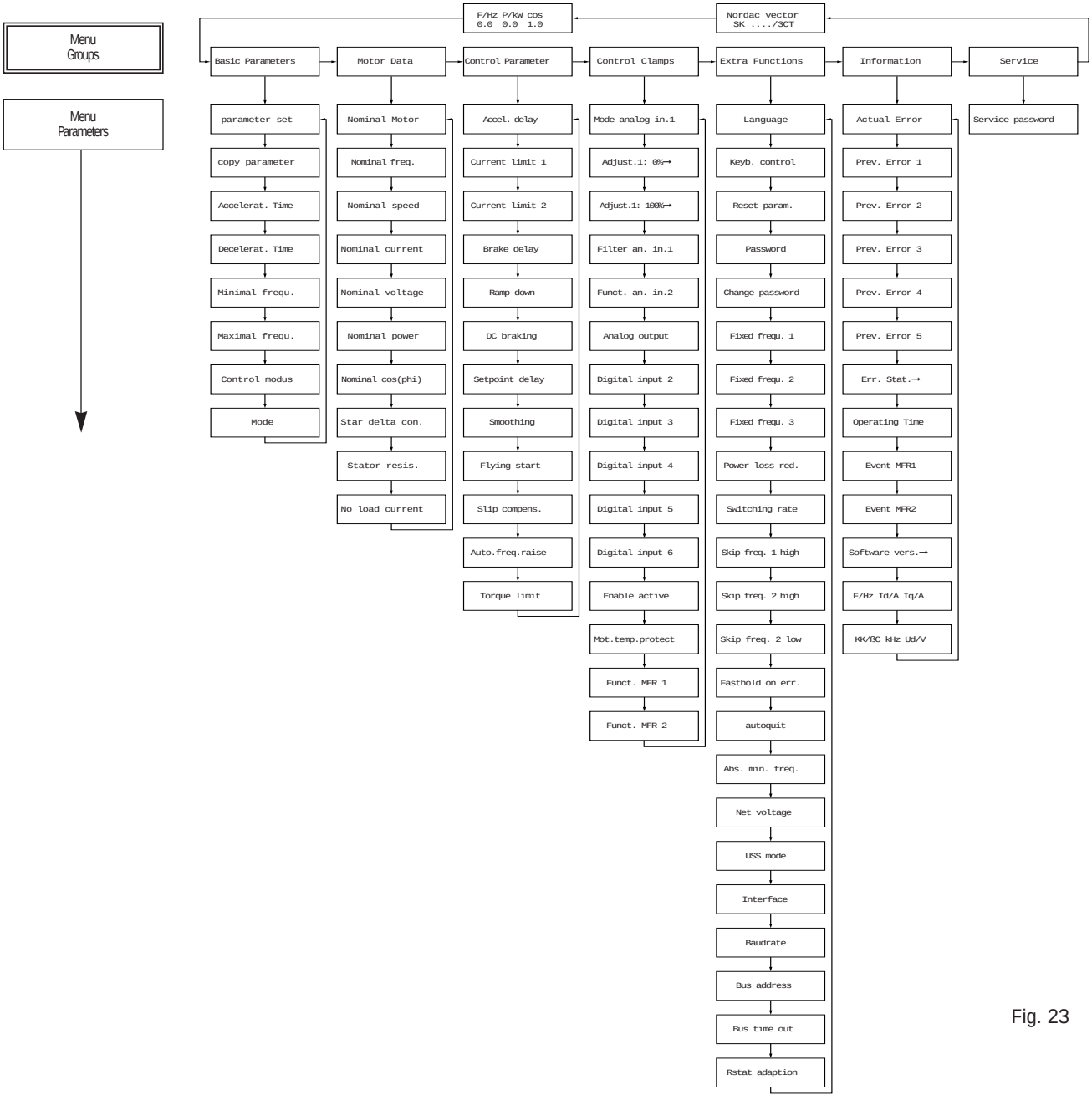


Fig. 23

The characteristic data of the motor used must be entered in the "**motor data**" menu group if it differs from the characteristics of the default motor (based on the inverter's rated output).

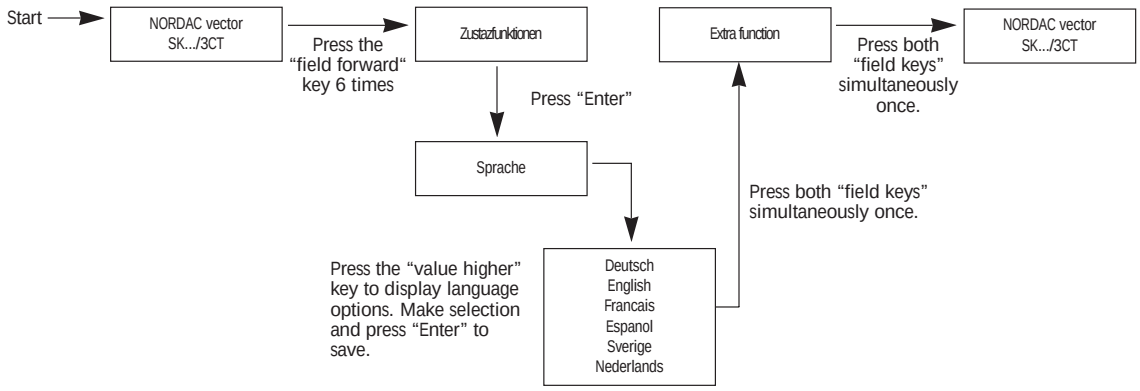
If the specific motor is a 4-pole three-phase AC standard type, it can be selected in the "standard motor" menu item on the basis of its rated power. All essential motor data is already preset.

If the motors differ from those mentioned above, read the nameplate data and enter it into the relevant menu items.

The inverter will measure the motors "**stator resistance**" automatically if you set the value of the respective menu item to "0" and press the "enter key". Make sure the motor is connected to the inverter before proceeding. For the measured value to be correctly interpreted, it is essential first to set the connection type of the motor (star or delta, Y or Δ). In the case of star, this is also commonly referred to as a wye connection.

6.2 Selecting the national language

The default communication for the inverter is German. To change the language to English, follow the instructions below:



7 Menu Groups and Menu Parameters

All *parameters* are logically arranged in the various **menu groups**. These *menu groups* are comprised of the following functions:

Basic parameters:	→ sufficient for standard applications. Represent basic inverter settings.
Motor data:	→ adjustment of the specific motor data. Important with regard to ISD current control. If a linear V/f characteristic is selected, only the standard motor information is displayed. In that case the parameters “V/f break point” and “Boost” included in the control parameters are relevant.
Control parameters:	→ control the voltage/frequency characteristic curve at the inverter output and the inverter action in the case of imminent overcurrent, overvoltage etc.
Control terminals:	→ determines the setpoint inputs, the analog output, the digital inputs and the relay functions.
Extra functions:	→ functions which are provided in addition to the fundamental inverter functions, for example; language, fixed frequencies, pulse frequencies or the RS485 interface
Information parameters:	→ indicates present and past disturbances, operating time and software version.
Service parameters:	→ used for final quality inspection. They are locked with a service-password and inaccessible to the user.

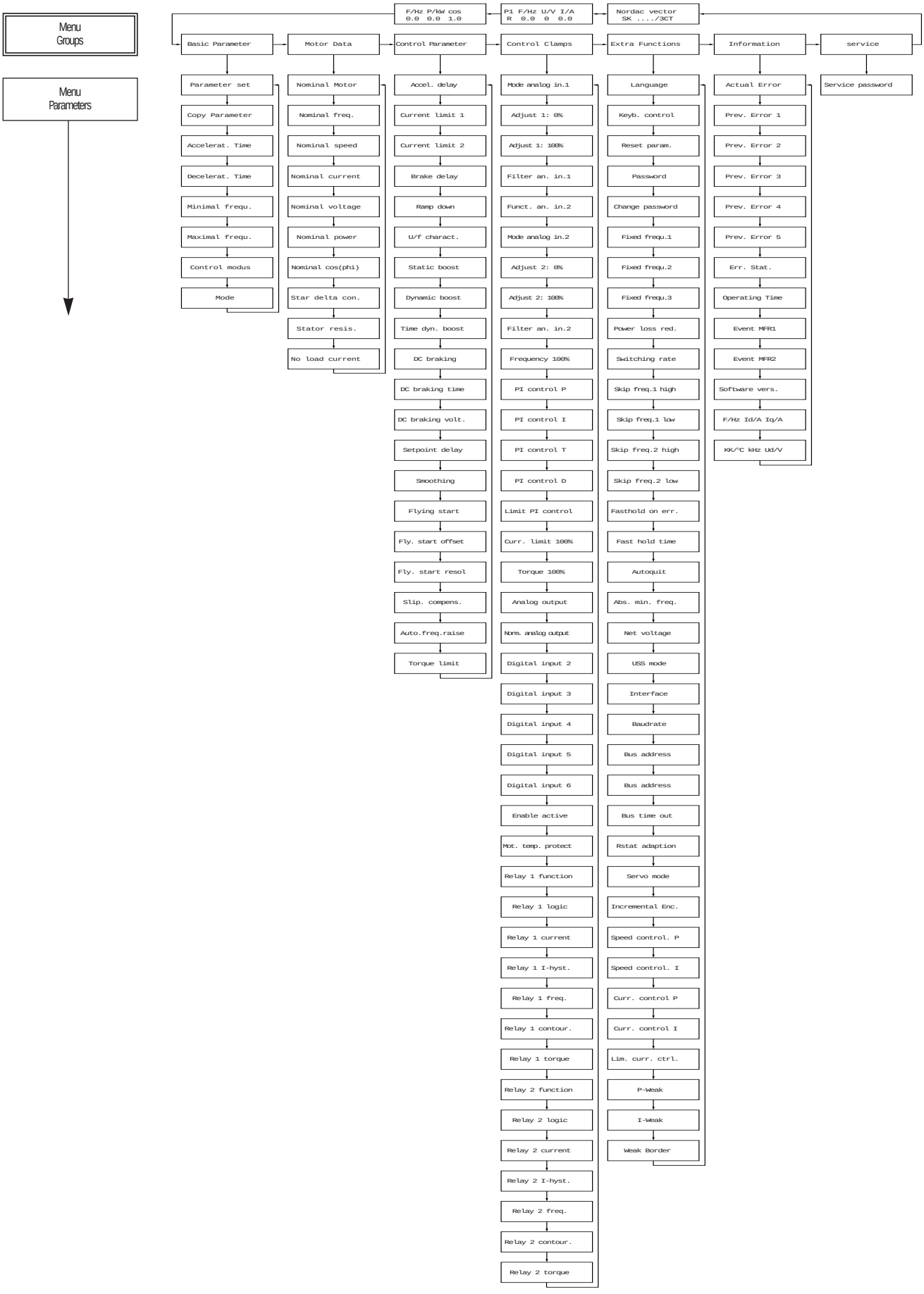

Menu Groups
Menu Parameters
F/Hz P/kW cos 0.0 0.0 1.0
P1 F/Hz U/V I/A R 0.0 0 0.0
Nordac vector SK ..../3CT
Basic Parameter
Motor Data
Control Parameter
Control Clamps
Extra Functions
Information
service
Parameter set
Copy Parameter
Accelerat. Time
Decelerat. Time
Minimal frequ.
Maximal frequ.
Control modus
Mode
Nominal Motor
Nominal freq.
Nominal speed
Nominal current
Nominal voltage
Nominal power
Nominal cos(phi)
Star delta con.
Stator resis.
No load current
Accel. delay
Current limit 1
Current limit 2
Brake delay
Ramp down
U/f charact.
Static boost
Dynamic boost
Time dyn. boost
DC braking
DC braking time
DC braking volt.
Setpoint delay
Smoothing
Flying start
Fly. start offset
Fly. start resol
Slip. compens.
Auto.freq.raise
Torque limit
Mode analog in.1
Adjust 1: 0%
Adjust 1: 100%
Filter an. in.1
Funct. an. in.2
Mode analog in.2
Adjust 2: 0%
Adjust 2: 100%
Filter an. in.2
Frequency 100%
PI control P
PI control I
PI control T
PI control D
Limit PI control
Curr. limit 100%
Torque 100%
Analog output
Norm. analog output
Digital input 2
Digital input 3
Digital input 4
Digital input 5
Digital input 6
Enable active
Mot. temp. protect
Relay 1 function
Relay 1 logic
Relay 1 current
Relay 1 I-hyst.
Relay 1 freq.
Relay 1 contour.
Relay 1 torque
Relay 2 function
Relay 2 logic
Relay 2 current
Relay 2 I-hyst.
Relay 2 freq.
Relay 2 contour.
Relay 2 torque
Language
Keyb. control
Reset param.
Password
Change password
Fixed frequ.1
Fixed frequ.2
Fixed frequ.3
Power loss red.
Switching rate
Skip freq.1 high
Skip freq.1 low
Skip freq.2 high
Skip freq.2 low
Fasthold on err.
Fast hold time
Autoquit
Abs. min. freq.
Net voltage
USS mode
Interface
Baudrate
Bus address
Bus address
Bus time out
Rstat adaption
Servo mode
Incremental Enc.
Speed control. P
Speed control. I
Curr. control P
Curr. control I
Lim. curr. ctrl.
P-Weak
I-Weak
Weak Border
Actual Error
Prev. Error 1
Prev. Error 2
Prev. Error 3
Prev. Error 4
Prev. Error 5
Err. Stat.
Operating Time
Event MFR1
Event MFR2
Software vers.
F/Hz Id/A Iq/A
kK/^C kHz Ud/V
Service password

Fig. 24

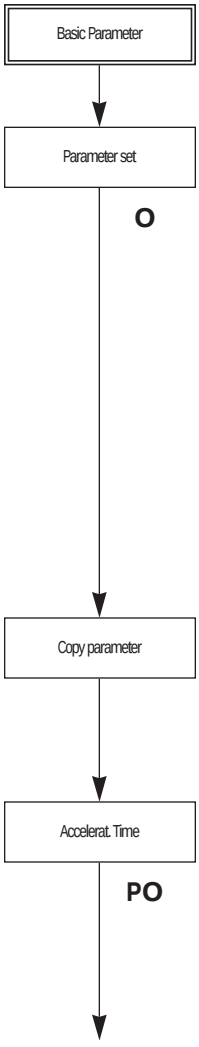
7.1 Menu parameters in tables

Individual menu parameters can be viewed by selecting the menu group and pressing the enter key. If both field keys (and) are pressed simultaneously, the display will return to the menu group ring structure and the operating value display (ref. sec 7).

Moving from one menu group to another is done using the field keys. To quit the ring structure of the menu groups the field keys are pressed simultaneously. **Values contained in any individual menu item are changed with the value keys** (Æ or) **and saved with the enter key.**

Below each menu group window in the outside page margin, menu items allowing for on-line changes are marked with an "O", while menu items correlated with parameter sets are marked with a "P". The "1 " symbol represents viewing of the menu items that are dependent on certain configurations. For instance the V/F corner frequency can be viewed only if the linear or square characteristic has been selected in the control mode.

All of the following information refers to figure 24 on page 22 and software version 4027 0001. Any software changes to the frequency inverter will be followed by an errata sheet attached to this instruction manual.



7.1.1 Basic Parameter

Parameter set

Manipulated parameter set. Up to 4 parameter sets can be programmed, and then activated via corresponding control inputs.

Range of values Resolution	Default Setting
1 ... 4	1

This parameter selects one of the 4 possible parameter sets which can be used to control various motors in succession. In that way, each of the motors can be operated fully exploiting its particular capacities under optimum operating conditions. Minimum waiting time is required when switching over to another parameter set.

Control terminals	Parameter input 1 DI4	Parameter input 2 DI5
parameter set 1	0	0
parameter set 2	1	0
parameter set 3	0	1
parameter set 4	1	1

(ref. sec. 4.2.2) 0 = open circuit

Copy parameter

Copy parameter set.
Complete parameter sets can be copied.

Range of values Resolution	Default Setting
1 ... 4, except parameter set currently being manipulated	2→1

Accelerat. time

Acceleration time is the time from 0 Hz to the set maximum frequency. The inverter will accelerate the frequency up to the preset value following a linear ramp.

Range of values Resolution	Default Setting
0.05 ... 1600 sec. 0.00 ... 1600 sec.-only with linear characteristic curve 0.05 sec.	*

The default settings marked * may vary according to the inverter type!

Basic Parameter (con't)

Decelerat. Time

PO

Minimal frequ.

PO

1

Maximal frequ.

PO

Control modus

P

Decelerat. time

Deceleration time is the time needed to reduce the set max. frequency to 0 Hz in accordance with a linear ramp.

Range of values Resolution	Default Setting
0.05 ... 1600 sec. 0.00 ... 1600 sec.-only with linear characteristic curve 0.05 sec.	*

Minimal frequ.

It is the frequency which is supplied by the inverter when the minimum setpoint is applied (corresponding to Adjust 1/2: 0% in the control clamps group). This setpoint can be for example. 0 V, 0 mA or 4 mA.

Range of values Resolution	Default Setting
0 ... maximum frequency 0.1 Hz	0.0 Hz

Minimum output frequency is not visible when selecting ±10 V for the setpoint input, and will be fixed at 0 Hz.

Maximal frequ.

Maximum output frequency is the frequency which is supplied by the inverter when the maximum setpoint is applied (corresponding to Adjust 1: 100% in the control clamps group.) This setpoint can be 10V or 20 mA for example.

Range of values Resolution	Default Setting
minimum frequency...999Hz 0.1 Hz	70.0 Hz

Note: By setting the servo mode to "ON" the possible maximum frequency is limited to twice the set rated motor frequency (motor data).

Control modus

Control mode is the mode, by which the frequency and the voltage are controlled at the inverter output in an open- or closed-loop procedure.

Range of values Resolution	Default Setting
• linear characteristic curve • square characteristic curve • automatic characteristic curve • ISD control	ISD control

Suitable for multi-motor drive or synchronous motors !

linear: Constant ratio between voltage and frequency up to the nominal working point. The starting torque is determined via the static and the dynamic boost.

square: Suitable for a square load torque, as e.g. in fan drives or pumps.

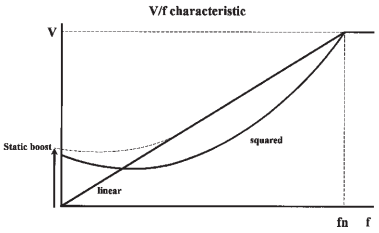
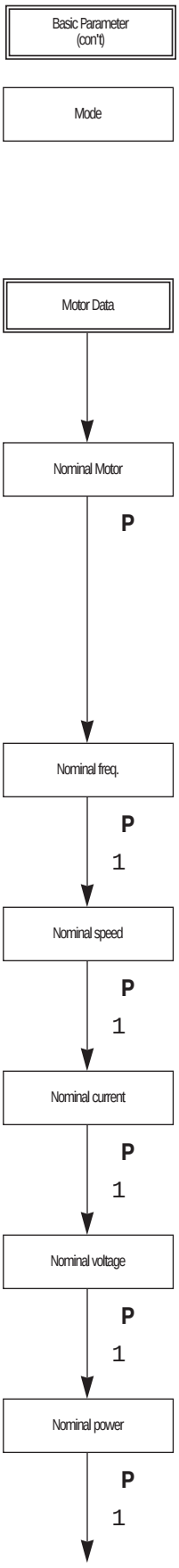


Fig. 25

Suitable for <u>one</u> three-phase asynchronous motor connected to <u>one</u> inverter !

automatic: The inverter calculates a linear output characteristic on the basis of the motor data which is suitable for simple applications only.

ISD regulation: The magnetic motor flux is constantly kept at the nominal value. This function is not suitable for multi-motor operation or synchronous motors.



Mode

Selection of this parameter is associated with a number of different factory settings regarding the digital control inputs and the analog setpoint input (ref. item 7.2.1 Mode).

Range of values Resolution	Default Setting
analog/motor potentiom.	analog

7.1.2 Motor data

Factory settings regarding this data refer to a 4-pole three-phase AC standard motor with rated inverter output. Data shown will not be displayed unless either ISD control or the automatic characteristic curve has been selected (except for the “standard motor” information).

Nominal Motor

When this setting is changed, the values of the three-phase AC standard motors concerned will be entered automatically for a voltage of 400V and a frequency of 50 Hz.

Range of values Resolution	Default Setting
0.37 kW...P_{NFU} + one frame size values of the 4-pole three-phase standard motors	P_{NFU} *

Even a “No motor” setting can be made! With that, the biasing period of the current controller is set to zero. Applicable only if the “linear characteristic”control mode has been selected.

Nominal freq.

Nominal frequency
Motor nameplate frequency rating.

Range of values Resolution	Default Setting
0 ... 999.0 Hz 1 Hz	50 Hz

Nominal speed

Motor nameplate speed.

Range of values Resolution	Default Setting
0 ... 30,000 rpm 1 rpm	*

Nominal current

Motor nameplate current.

Range of values Resolution	Default Setting
0 ... 1.5 I_{NFU} 0.1A	*

Nominal voltage

Motor nameplate voltage rating.
Ensure motor is properly wired for voltage input.

Range of values Resolution	Default Setting
0 ... 460 VAC 1 VAC	400 V

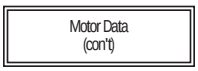
Nominal power

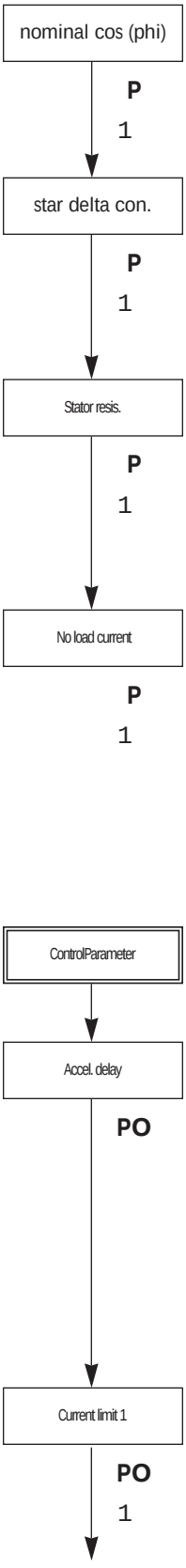
Motor nameplate power in kilowatts.

$$KW = \frac{746 \times HP}{1000}$$

Range of values Resolution	Default Setting
0 ... 1.5 P_{NFU} 0.01 kW	P_{NFU}*

The default settings marked * may vary according to the inverter type!





Nominal cos (PHI)

cos Φ (Motor Power Factor)

Range of values Resolution	Default Setting
0.5 ... 1.0 0.01	*

Star delta con.

Running connection.
Be absolutely sure to set this menu item correctly before the stator resistance is automatically calculated, because if the setting is not right, the result of stator resistance calculation won't be either and may cause an overcurrent fault.

Range of values Resolution	Default Setting
star/delta	

Stator resis.

Stator resistance.
0 = automatic calculation after the Enter key has been pressed. Insure correct setting of the motor's running connection.

Range of values Resolution	Default Setting
0 ... 40Ω depending on motor data 0.01Ω	*

The resistance stored will be that of one phase winding.

No load current

No-load motor current
This value is automatically calculated from the other motor data.

Range of values Resolution	Default Setting
0 ... $1_{N\ MOT}$ 0.1 A	*

If the cos Φ or the rated motor current is changed, the no-load current will also change.

For no-load current calculation the motor should be operated at a frequency a little lower than the rated frequency (e.g. 45 Hz). Read the result in the operating data display.

7.1.3 Control parameter

Accel. delay

Acceleration delay.
This function enables the drive to be accelerated without pushing the inverter current to a peak value.

Range of values Resolution	Default Setting
OFF/ON	ON

Two different current limits can be set. The 1st current limit prevents the output frequency from rising any further while the acceleration time is extended.

The 2nd current limit causes the output frequency to decrease. However, if the load is too large, the desired frequency may not be reached.

Current limit 1

Current limit 1 for the acceleration delay. Only when the acceleration delay is ON is a further frequency increase prevented.

Range of values Resolution	Default Setting
0 ... current limit 2 0.1 A	1.4 I_{NFU}

The default settings marked * may vary according to the inverter type!

ControlParameter (con't)

Current limit 2

PO

1

Brake delay

PO

Ramp down

PO

U/f charact.

PO

1

Static boost

PO

1

Current limit 2

Current limit 2 for the acceleration delay
Only when the acceleration delay is ON is the output frequency reduced.

Range of values Resolution	Default Setting
current limit 1 ... 1.5 I_{NFU} 0.1 A	1.5 I_{NFU}

Brake delay

Braking delay
With this function the electrical load on the required brake resistor is reduced (energy recovery from the motor!). The motor is decelerated within the set braking period. When the DC link voltage reaches the switching threshold of the braking delay value, the inverter interrupts the braking action. As soon as the DC link voltage drops again, deceleration of the motor goes on.

Range of values Resolution	Default Setting
OFF/ON	OFF

This function is applicable to the “normal” braking ramp and to quick braking. A braking resistor is required for this function!

CAUTION! This mode is not suitable for lifting gear applications.

Ramp down

OFF: At controller disable, the motor is <u>not</u> decelerated in accordance with a reference setpoint, instead the inverter switches off the final stage → the motor runs down.

Range of values Resolution	Default Setting
OFF/ON	ON

ON: The inverter uses the set deceleration ramp to arrest the motor.

U/f Charact.

Corner frequency
Only <u>with</u> linear or square characteristic curve (Ref. item 7.1.1 Control mode; basic parameters)

Range of values Resolution	Default Setting
20 ... 999 Hz 0.1 Hz	50 Hz

Having reached this frequency the inverter supplies the maximum possible output voltage. This value is equal to the AC line voltage.

Static boost

Only <u>with</u> linear or square characteristic curve (Ref. item 7.1.1 Control mode; basic parameters)

Range of values Resolution	Default Setting
OFF ... 100 V 0.1 V	*

In the lower range of the V/F-characteristic curve the voltage is boosted to provide the motor with a higher starting torque. Setting too high a boost value can lead to overcurrent.

f_n = v/f corner frequency

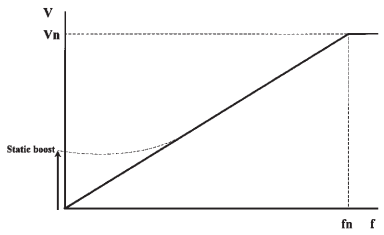


Fig. 26

The default settings marked * may vary according to the inverter type!

ControlParameter (con't)

Dynamic boost

PO 1

Time dyn. boost

PO 1

DC braking

PO

DC braking time

PO 1

DC braking volt.

PO 1

Dynamic boost

Range of values Resolution	Default Setting
OFF ... 120 V 0.1 V	OFF

Only with linear or square characteristic curve set in control modus.

Voltage boosting for a limited period of time, otherwise it is like the static boost. It is added to the static boost. Used to enable breakaway torque of a mechanical drive.

Time dyn. boost

Range of values Resolution	Default Setting
0.1 ... 20.0 sec. 0.1 sec.	0.1 sec.

Dynamic boost period.
Only with linear or square characteristic curve set in Control modus and with dynamic boost active.

Period of time for which the added dynamic boost will be effective. Only after controller has been enabled.

DC braking

Range of values Resolution	Default Setting
OFF / ON/ Immediately	OFF

DC braking only with ramp down ON.

With this function a direct voltage can be fed to the motor instead of a frequency. Along with a torque at the motor shaft a counter-torque is set up. **Do not use this function as a substitute for a mechanical brake.**

ON: When frequency drops below the absolute minimum (1.0 Hz) the inverter changes from frequency to direct current supply.

Immediately : When the controller enable is switched off, the inverter immediately changes from frequency to direct voltage. This setting will work no matter what value the output frequency is at that moment.

With direct current braking, no exact prediction of stopping time is possible, and no braking energy will be recovered from the motor. Braking energy is converted to heat in the rotor of the motor.

DC braking time

Range of values Resolution	Default Setting
1.0 ... 60.0 sec. 0.1 sec.	1.0 sec.

DC braking period only with DC braking set to ON or Immediately.

DC brake ON: The DC braking function is associated with a time limit.

DC brake immediately: Depending on the setpoint currently applicable (output frequency), braking will take all or only part of the time.

If controller enable is switched on again before this period is over, the inverter interrupts DC braking and starts again in accordance with the setpoint.

DC braking volt.

Range of values Resolution	Default Setting
0 ... 120 V 0.1 V	*

DC brake direct voltage only with DC braking set to ON or Immediately.

The value set for the direct voltage will affect current intensity during braking.

The default settings marked * may vary according to the inverter type!

ControlParameter (con't)

Setpoint delay

PO

Setpoint delay

Setpoint delay is a function controlling an electromagnetic brakes release and make time.

Range of values Resolution	Default Setting
OFF ... 10 sec. 0.05 sec.	OFF

Reaching the absolute minimum frequency value (1.0 Hz) set before the frequency inverter interrupts the frequency increase/decrease for the adjusted delay period. As a result there is time enough for the multifunction relay 2 (MFR 2, control terminals) to insure that brake control will cause the mechanical brake either to be released or engaged.

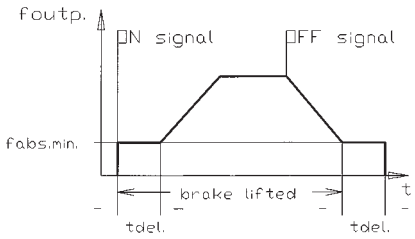


Fig. 27

The effect of this function is to prevent the motor from starting up against a brake while it is locked or, especially in hoisting gear drives ($f_{abs.min} \geq 2.0$ Hz), to prevent sagging of the load as a result of sudden stopping.

Smoothing

PO

Smoothing

e.g. to insure S shape of setpoint frequency curve.

Range of values Resolution	Default Setting
OFF ... 10 sec. 0.1 sec.	OFF

Where as normally the increase of frequency is linear all through the defined period of acceleration, a very smooth transition from a rest state to acceleration or deceleration (without jerking) is achieved using the ramp smoothing function.

Correspondingly, the acceleration or deceleration rate is slowly reduced towards reaching the final speed. The set acceleration and deceleration time is extended by the set smoothing period time.

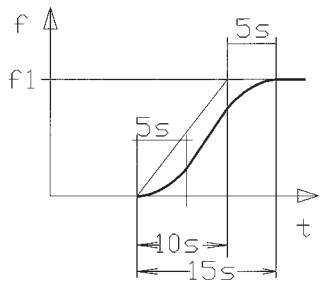


Fig. 28

The graph on the right shows acceleration set to 10 sec. and smoothing to 5 sec., which totals 15 seconds of combined acceleration time.

Flying start

P

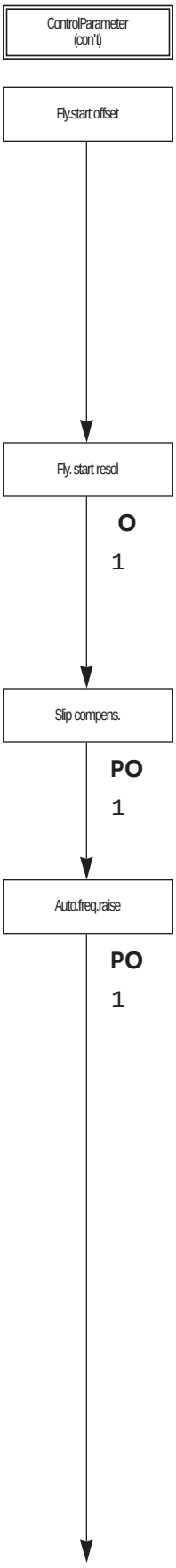
Flying start

e.g. used for fan drives.

Range of values Resolution	Default Setting
OFF / ON / after disconnection	OFF

This is a special feature insuring that the frequency inverter will measure the frequency of the rotating field in a running motor before starting to control its speed at exactly the measured frequency. Only then will it accelerate the motor up to the preset setpoint frequency, taking into account the direction of rotation of the motor.

For the search function to be executed within the "**after disconnection**" option, disconnection must not have been preceded by a braking ramp, e.g. after a fault message reset or with ramp down = OFF.



Flying start offset

Range of values Resolution	Default Setting
-10 V ... +10 V 1 Hz	0 Hz

Flying start offset only with flying start ON or after disconnection.

This adjustable offset is added to the frequency determined by the flying start function.

Experimental runs have shown that offsets between 2 and 4 Hz are recommended for high outputs (≥37 kW). We also recommend programming the acceleration delay to “ON”.

Too high an offset value will result in the inverter current quickly reaching the limit. If it is set too low, overvoltage or chopper operation will occur.

Fly. start resol

Range of values Resolution	Default Setting
0.2 ... 5.0 Hz 0.2 Hz	1.0 Hz

Flying start resolution only with flying start ON or after disconnection.

The resolution for searching the frequency range is adjustable.

Adjusting a finer resolution (smaller setting or increment) will prolong settling time.

Slip compens.

Range of values Resolution	Default Setting
OFF / ON	ON

Slip compensation only with automatic characteristic curve or ISD control.

The frequency inverter tries to hold speed constant by correcting the slip frequency. This function is dependent on the load current.

Auto.freq.raise

Range of values Resolution	Default Setting
OFF / ON	OFF

Automatic raising of frequency prevents excessive heating of the brake resistor during energy recovery (braking mode).

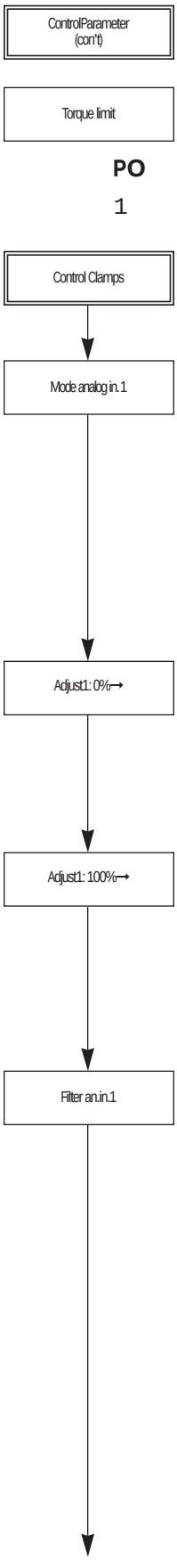
Excessive regenerative energy from a three-phase motor will result in an overvoltage fault by the inverter. This can be avoided by connecting a braking resistor to the terminals provided for that purpose. Due to the energy fed back to the loop, the resistor tends to grow hot. To prevent excessive heating (as sometimes happens where reciprocating motion is involved), the inverter is able to raise the output frequency, to the set maximum frequency (basic parameters) representing the upper limit. The frequency change follows the adjusted acceleration and deceleration ramps (basic parameters).

Because voltage is bound to rise very fast in the intermediate circuit of the inverter, connecting a braking resistor to the inverter is a must.

If the inverter is disabled, it will reduce the frequency within the set braking period!

CAUTION! This operating mode is not suitable for lifting gear functions.

Reciprocating and regenerative loads affecting the drive that are produced in every cycle, will result in frequent braking chopper operation.



Torque limit

Torque limiting.
Related to the motor torque; only <u>with</u> automatic characteristic curve or ISD control.

Range of values Resolution	Default Setting
OFF, 25 ... 400% 1%	OFF

7.1.4 Control Clamps

Mode an. in.1

Mode analog setpoint input 1.

±10V only <u>without</u> programming a digital input to “enable left” or “direction of rotation”. If ±10 V is selected, the minimum frequency is always set to 0 Hz.

Range of values Resolution	Default Setting
0 ... 10 V limited 0 ... 10 V -10 V ... +10 V 0 ... 20 mA 4 ... 20 mA OFF	0 ... 10 V limited

If “4...20 mA” has been selected, the inverter is disabled automatically (no output signal) should values decrease below 2 mA.

Adjust1: 0% →

Aligning the analog setpoint input 1: 0%.

Voltage or current value applied being stored as 0% value = minimum frequency.
The difference between Adjust 0% and Adjust 100% must be > 3.5V (>14 mA).

Range of values Resolution	Default Setting
	0 V or 0 mA

Adjust1: 100% →

Aligning the analog setpoint input 1: 100%.

Voltage or current value applied being stored as 100% value = maximum frequency.

The difference between Adjust 0% and Adjust 100% must be > 3.5V (>14 mA).

Range of values Resolution	Default Setting
	10 V or 20 mA

Filter an.in.1

Extra filter in setpoint input 1.

Low-pass filter against voltage peaks.
The response time is extended.

Range of values Resolution	Default Setting
OFF / ON	OFF

<u>Aligning the analog inputs</u>
Aligning inputs 1 and 2 as described above permits adjustment of the frequency inverter to any setpoint which is commonly used.

Control Clamps (con't)

E.g. 0 ... 10 V limited:
When the current drops below the setpoint aligned to 0%, the adjusted minimum frequency is supplied. This function is generally applicable to current setpoints (0/4...20 mA).

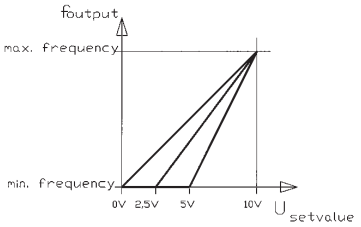


Fig. 29

E.g. 0 ... 10 V:
The diagrams show that a change of rotation can be brought about using 0...10V, with standstill e.g. when a potentiometer is in center position (5V).

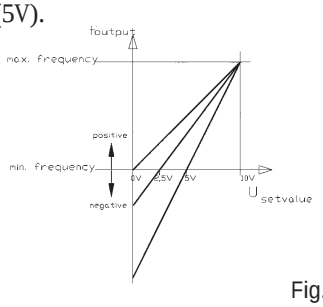


Fig. 30

PLEASE NOTE: If voltage exceeds the setpoint aligned to 100% (e.g. 9.3V instead of 10V) this will not set the max. frequency above its set value.

Funct. an. in.2

P

Funct. an. in.2

Function of the analog setpoint input 2.

Actual frequency value or PID controller is intended for analog speed control, ref. sec. 7.1.5 Extra functions, and sec. 7.2.5 Speed controller.

** only with "posicon" option

*** A torque limit cannot be set unless either the ISD or the automatic control mode has been selected (ref. sec. 7.1.1. Basic parameters)

Range of values Resolution	Default Setting
None addition to input 1 subtraction from input 1 actual frequency value current limit torque limit*** PID controller Positioning at maximum frequency**	None

Never set a torque limit < 20%, because it could result in erratic behavior of the drive!

Mode analog in.2

Mode an. in.2

Mode analog setpoint input 2.

±10V only without programming a digital input to "enable left" or "direction of rotation".If ±10 V is selected, the minimum frequency is always set to 0 Hz.

Range of values Resolution	Default Setting
0 ... 10 V limited 0 ... 10 V -10 V ... +10 V 0 ... 20 mA 4 ... 20 mA OFF	0 ... 10 V limited

If "4...20 mA" is selected, when values decrease below 2 mA, the inverter is disabled automatically (no output signal).

Adjust 2: 0% →

P

1

Adjust 2: 0% →

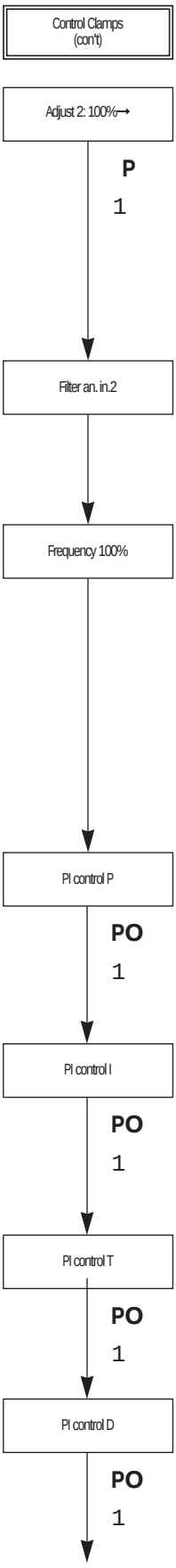
Aligning the analog setpoint input 2: 0%.

Voltage or current value applied being stored as 0% value = min. frequency.

Range of values Resolution	Default Setting
	0 V or 0 mA

The difference between Adjust 0% value and Adjust 100% value must be > 3.5V (> 14 mA).

Only with a function selection for input 2



Adjust 2: 100% →

Aligning setpoint input 2: 100%.

Voltage or current value applied stored as 100% value = max. frequency.

Range of values Resolution	Default Setting
	10 V or 20 mA

The difference between 0% aligned value and 100% aligned value must be > 3.5 V (> 14 mA).

Only <u>with</u> a function selection for input 2.

Filter an. in.2

Extra filter in setpoint input 2.

Low-pass filter against voltage peaks.
The response time is extended.

Range of values Resolution	Default Setting
OFF / ON	OFF

Frequency 100%

Frequency limit for Adjust 100% value input.

Only <u>with</u> one of the functions for analog input 2:

- addition
- subtraction
- actual frequency value
- PID controller
- maximum frequency during positioning

Range of values Resolution	Default Setting
0 ... 999 Hz 1 Hz	50 Hz

PI control P

P component of PI/PID controller.
Only <u>with</u> the function actual frequency value or PID controller.

Related to the differential frequency in Hz.

Range of values Resolution	Default Setting
0 ... 800% 1%	100%

PI controller I

I component of PI/PID controller.
Only <u>with</u> the function actual frequency value or PID controller.

As 1/time constant, like P component.

Range of values Resolution	Default Setting
0 ... 100%/ms 0.1%/ms	10%/ms

PI controller T

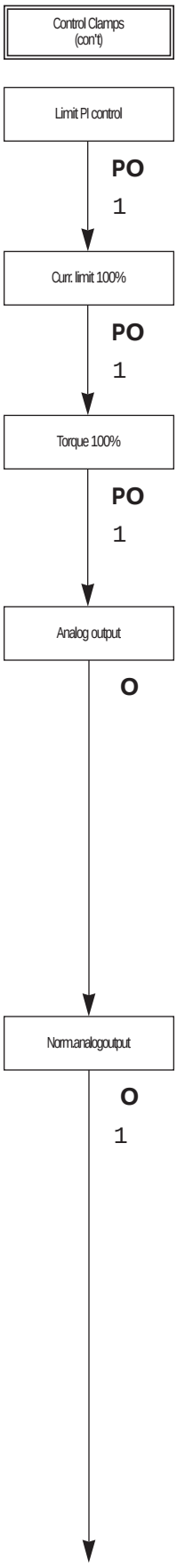
T component of PI controller.
Only <u>with</u> the function actual frequency value.

Range of values Resolution	Default Setting
2 ... 32000ms 1 ms	2 ms

PI controller D

D component of PI controller.
Only <u>with</u> the PID controller function as time constant.

Range of values Resolution	Default Setting
0 ... 400%/ms 0.1%/ms	0%/ms



Limit PI control

Value of maximum frequency sweep.
Only with function actual frequency value or PID controller.

Range of values Resolution	Default Setting
2 ... 999 Hz 0.1 Hz	10 Hz

Curr. limit 100%

Current limit for Adjust 100%, input 2.

Only with the function current limit.

Range of values Resolution	Default Setting
0 ... 2 I_{NFU} set currently being manipulated	1.5 I_{NFU}

Torque 100%

Torque limit for Adjust 100%, input 2.

Related to the nominal motor torque.

Only with the function torque limit.

Range of values Resolution	Default Setting
10 ... 400% 1%	100%

Analog output

Programming of the analog output.

***Setting a torque limit requires selection of the ISD or the automatic control mode.

Sign: The analog output allows for quantities positive or negative in sign, with 0 V to 5 V corresponding to negative values, e.g. -100% *** to 0% and 5 V to 10 V corresponding to positive values, 0% to 100% ***

Range of values Resolution	Default Setting
OFF output frequency output frequency with sign output current output voltage active power cos Φ torque*** torque*** with sign speed speed with sign	OFF

***The 100% value varies with normalization of the analog output.

Norm. analog output

Maximum value of the analog output.

The %-value indicated corresponds to 10 V of output voltage.

Only with a function of the analog output.

Range of values Resolution	Default Setting
10% ... 500 % of nominal value of the motor output 1%	100%

For a linear or square characteristic, the output frequency value is related to the set corner frequency (control parameters).

Control Clamps (con't)

Digital input 2

Digital input 2

Programming of digital input 2.

Representation of the permissible function.
***depends on the "Mode" selected in Basic parameters (ref. sec. 7.1.1/7.2.1 Mode).

Range of values Resolution	Default Setting
***	*** Enable left

Digital input 3

Digital input 3

Programming of digital input 3.

Representation of the permissible function.

***depends on the "Mode" selected in Basic parameters (ref. sec. 7.1.1/7.2.1 Mode).

Range of values Resolution	Default Setting
***	*** Fixed frequency 1

Digital input 4

Digital input 4

Programming of digital input 4.

Representation of the permissible function.

***depends on the "Mode" selected in Basic parameters (ref. sec. 7.1.1/7.1.2 Mode).

Range of values Resolution	Default Setting
***	*** Parameter input 1

Digital input 5

Digital input 5

Programming of digital input 5.

Representation of the permissible function.

*** depends on the "Mode" selected in Basic parameters (ref. sec. 7.1.1/7.1.2 Mode).

Range of values Resolution	Default Setting
***	*** Parameter input 2

Digital input 6

Digital input 6

Programming of digital input 6.

Representation of the permissible function.

*** depends on the "Mode" selected in Basic parameters (ref. sec. 7.1.1/7.1.2 Mode).

Range of values Resolution	Default Setting
***	*** Fault Recognition

Enable active

Enable active

Function of controller enable.

"Level" can be used for automatic restarting after switching on the AC line.

Range of values Resolution	Default Setting
Edge / Level	Edge

Mottemp.protect

Mot. temp. protect

Motor PTC resistor.

O

Monitoring the motor temperature with PTC thermistors or thermostats.

Range of values Resolution	Default Setting
OFF / ON	OFF

Control Clamps (con't)

Relay 1 function

PO

Relay 1 function

Programming of the multifunction relay 1.

Range of values Resolution		Default Setting
Current limit	(C)	
Frequency limit	(F)	
Brake control	(B)	
Temperature warning	(T)	
Overcurrent	(O)	
Acceleration delay	(A)	
Contouring error	(C)	Error
Slippage	(S)	
Torque limit	(T)	
Torque limit, regen.	(T)	
Setpoint reached	(S)	
Inactive error	(I)	
	(E)	

(the letters in brackets appear in the information parameters when the event they stand for has triggered the multifunction relay, ref. sec. 7.1.6)

Errors will always trip the relay. Clear text representation.

Acceleration delay only with acceleration delay = ON.

Contouring error only with speed controlling, ref. 7.1.5 Extra functions and 7.2.5 Speed controller.

Torque limit only with ISD control or automatic characteristic curve, choosing between powered or regenerative operation.

Although the multifunction relay 1 is permanently programmed for fault acknowledgement, other functions can be assigned to it as well. The contact opens as soon as an error occurs or a programmed limit value is reached. When the contact is closed (ready for operation!), the relay is in a rest position.

Page through the available functions with the *left* value key (ascending values) and switch to **ON** or **OFF** with the *right* value key (descending values). Any change must be validated with the Enter key .

If a number of functions have been selected there is a choice as to whether the conditional statements should be linked with AND or with OR .

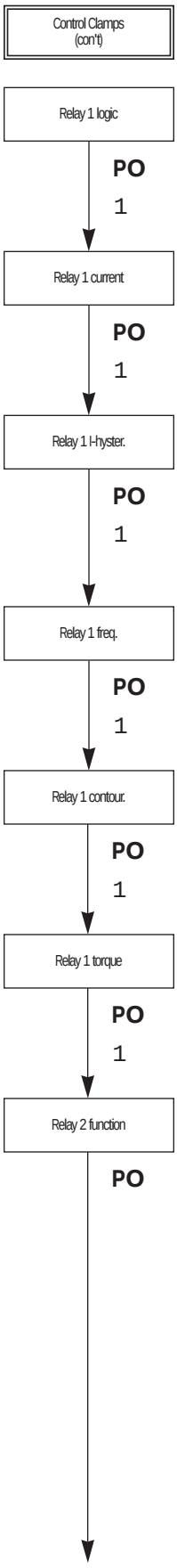
If a relay has been programmed to perform various functions, the function that has triggered the relay at a particular event can be read out in the information parameters.

Brake control: When the frequency value has decreased to the absolute minimum (ref. sec. 7.1.5 Extra functions), the relay contact closes, when it continues to drop, the contact opens. Although the fault signal is still active (applies to relay 1 only), it is no longer relevant after the frequency has dropped below the absolute minimum value.

Temperature warning: When the first temperature limit in the inverter is reached or the PTC resistor on the motor has triggered, the inverter reacts with a warning signal displayed on the inverter. The inverter will be disconnected when the second temperature limit has been reached or by the end of a 30 second period of motor over temperature.

Overcurrent: This warning indicates that the inverter's overcurrent range has been reached. The amount of time tolerated will depend on the current intensity. By the end of the permissible time the inverter is disconnected (ref. sec. 9.2).

Regenerative operation: The MFR signals regenerative operation, i.e. energy is being fed back by the motor. This means that the torque will be negative.



Relay 1 logic

Logical operators for the additional conditions for MFR 1.

Only with more than one function programmed.

Range of values Resolution	Default Setting
AND / OR	OR

Relay 1 current

Current limit MFR1.

Only if relay is programmed to respond to a current limit.

Range of values Resolution	Default Setting
0 ... 2 I_{NFU} 0.1 A	I_{NFU}

Relay 1 I-hyst.

Hysteresis current limit MFR1.

Only if programmed to respond to a current limit difference between operate point and release point of relay (indication of current).

Range of values Resolution	Default Setting
0 ... 20% 1%	10%

Relay 1 freq.

Frequency limit MFR1.

Only if programmed to respond to frequency limit.

Range of values Resolution	Default Setting
0 ... maximum frequency 0.1 Hz	50.5 Hz

Relay 1 contour.

Maximum contouring error MFR1.

Only if programmed to respond to contouring errors.

Range of values Resolution	Default Setting
0 ... 500 rpm 1 rpm	100 rpm

Relay 1 torque

Torque limit MFR1.

Only if programmed to respond to torque limit.

Range of values Resolution	Default Setting
0 ... 400% 1%	300%

Relay 2 function

Programming of the multifunction relay 2.

Represented in clear text.

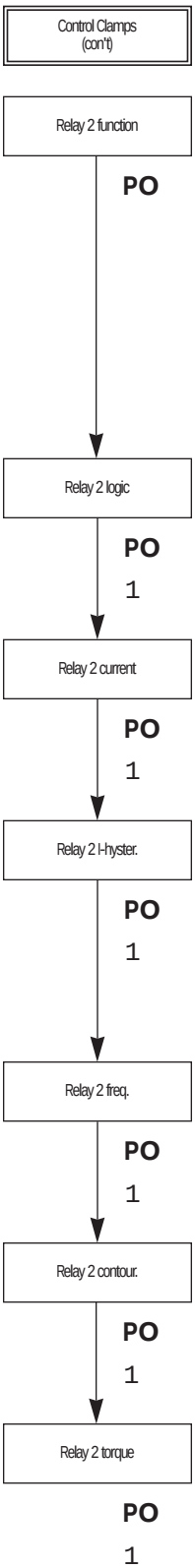
Acceleration delay only with acceleration delay = ON (control parameters).

Contouring error only with servo mode ON, ref. sec. 7.1.5 Extra functions and 7.2.5 Speed controller.

Torque limit only with ISD control or automatic characteristic curve; with alternatives powered or generative operation.

Range of values Resolution		Default Setting
Current limit	(C)	Brake contr.
Frequency limit	(F)	
Brake control	(B)	
Temperature warning	(T)	
Overcurrent	(O)	
Acceleration delay	(A)	
Coutouring error	(C)	
Slip	(S)	
Torque limit	(T)	
Torque limit, regen.	(T)	
Setpoint reached	(S)	
Inactive error	(I)	

The default settings marked * may vary according to the inverter type!



Mode of operation same as MFR 1, but without the permanently programmed fault signaling function.

Inactive error: An error which led to an inverter fault does not exist any more. When the stored fault message is reset, the drive is ready for operation.

Setpoint reached ($f \geq = f_s$:): indicates that the output frequency being currently supplied is = to the adjusted setpoint.

If a relay is programmed to perform several functions, the function that made the relay trip can be read out in the information parameters (represented by the letters in brackets).

Relay 2 logic

Logical operators for the conditions for MFR2.

Range of values Resolution	Default Setting
AND / OR	OR

Only <u>with</u> more than one function programmed.

Relay 2 current

Current limit MFR2.

Only if programmed to respond to current limit.

Range of values Resolution	Default Setting
0 ...2 I_{NFU} .,1 A	I_{NFU}

Relay 2 I-hyster.

Hysteresis current limit MFR2.

Only if programmed to respond to current limit.

Range of values Resolution	Default Setting
0 ... 20% 1%	10%

Difference between operate point and release point of relay (indication of current).

Relay 2 freq.

Frequency limit MFR2.

Only if programmed to respond to frequency limit.

Range of values Resolution	Default Setting
0 ... maximum frequency 0.1 Hz	50.5 Hz

Relay 2 contour.

Maximum contouring error MFR2.

Only if programmed to respond to contouring errors.

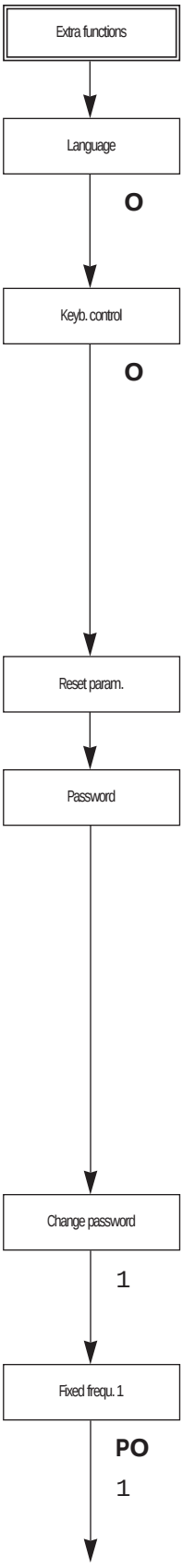
Range of values Resolution	Default Setting
0 ... 500 rpm 1 rpm	100 rpm

Relay 2 torque

Torque limit MFR2.

Only if programmed to respond to torque limit.

Range of values Resolution	Default Setting
0 ... 400% 1%	300%



7.1.5 Extra functions

Language

Range of values Resolution	Default Setting
German, English, French Spanish, Swedish, Dutch	

Keyboard control

With this function the inverter can be controlled via the integrated keyboard.

Range of values Resolution	Default Setting
OFF / ON	OFF

Value keys: will change the setpoint, also towards negative values.

Enter-key start / stop (must be in the initial power up screen to start and stop). If changing menu item parameters while running, always return to operating data screen to stop. (ref. sec. 5.1 Display).

By activating keyboard control (ON), all control functions executed via the control terminal strip are disabled (ref. sec. 7.2.2 Keyboard control).

Reset param.

Loading the default settings.
Use the Enter key to initiate loading.

Password

Protects the inverter settings from being changed by unauthorized persons.

Range of values Resolution	Default Setting
0 ... 9999 1	0

With the parameters “password” and “change password”, all of the parameters can be hidden.

A code word (any number between 0000 and 9999) will be required for this purpose which is stored in the “change password” parameter. However this parameter can neither be viewed nor changed unless the correct password was set in the “password” parameter!

If the two parameters do not agree, only parameters exclusively providing information such as operating data or error messages can still be viewed, whereas all the other parameters are no longer visible and hence not available for adjustment.

Change password

Changing the password.

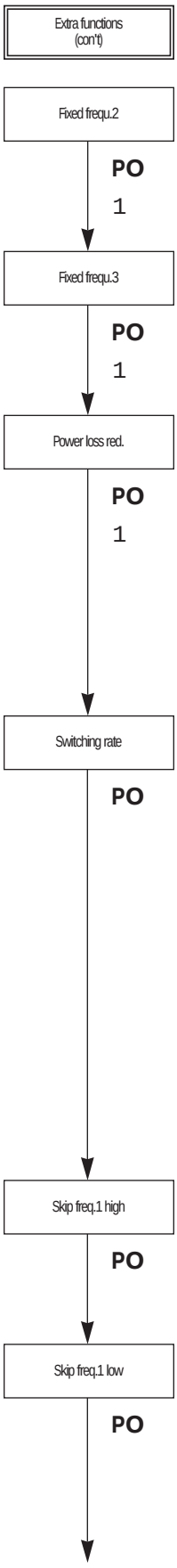
Range of values Resolution	Default Setting
0 ... 9999 1	0

Fixed frequ. 1

Fixed frequency 1.
Only with “analog” mode (ref. item 7.2.3 Fixed frequencies).

Range of values Resolution	Default Setting
± maximum frequency 0.1 Hz	10.0 Hz

The default settings marked * may vary according to the inverter type!



Fixed frequ .2

Fixed frequency 2.
Only with "analog" mode (ref. item 7.2.3 Fixed frequencies).

Range of values Resolution	Default Setting
± maximum frequency 0.1 Hz	20.0 Hz

Fixed frequ.3

Fixed frequency 3.
Only with "analog" mode (comp. item 7.2.3 Fixed frequencies).

Range of values Resolution	Default Setting
± maximum frequency 0.1 Hz	40.0 Hz

Power loss red.

Loss power reduction.

Only without servo mode ("Extra functions").

Range of values Resolution	Default Setting
OFF / ON	OFF

By activating this function the overcurrent limit of the inverter is reduced when a thermal limit is reached.

This functions intention is to insure that a disconnection of the inverter is delayed as far as possible or even prevented altogether because of an over temperature condition.

Switching rate

Switching frequency.
With a switching frequency of 16 kHz, thermal load on the inverter must be reduced. This can be achieved through intermittent operation or by keeping ambient temperature below the max. specification, or by avoiding full utilization of the admissible inverter current.

Range of values Resolution	Default Setting
2kHz/4kHz/8kHz/16kHz*	8kHz

When the inverter reaches a thermal limit value, control reduces the switching frequency automatically, to as low of a value as 2 kHz if necessary. As a consequence, the switching losses are diminished and inverter heating is limited or reduced.

After the temperature has dropped below the limit value, the system goes back to the initial switching frequency.

*Only inverters up to 37 kW allow for a 16 kHz setting!

Skip freq.1 high

Skip frequency 1 upper limit.
0 = OFF.

Range of values Resolution	Default Setting
lower limit 1 ... max. frequency 0.1 Hz	OFF

Skip freq.1 low

Skip frequency 1 lower limit.
0 = OFF.

Only with Skip freq.1 high = 0.1 Hz.

Range of values Resolution	Default Setting
upper limit 2 ... upper limit 1 0.1 Hz	OFF

Extra functions (con't)

No static frequency value can be set between the upper and lower limit. Frequency operates within this pre-defined range only during acceleration or deceleration periods.

Any setpoint equivalent to a frequency between these limit values would result in the output frequency being increased or decreased.

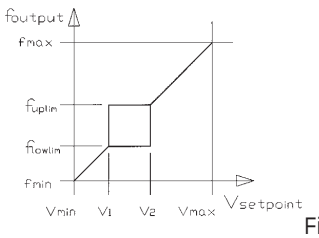


Fig. 31

Skip freq.2 high

PO

Skip freq.2 high

Skip frequency 2 upper limit.
0 = OFF.

Only with adjustment of Skip freq.1 high.

Range of values Resolution	Default Setting
lower limit 2 ... lower limit 1 0.1 Hz	OFF

Skip freq.2 low

PO

Skip freq.2 low

Skip frequency 2 lower limit.
0 = OFF.

Only with Skip freq.2 high = 0.1 Hz.

Range of values Resolution	Default Setting
0.1 ... upper limit 2 0.1 Hz	OFF

Fasthold on err.

P

Fasthold on err.

Quick stop at fault.

Range of values Resolution	Default Setting
OFF / ON	OFF

Fast hold time

P

1

Fast hold time

Only with "quick stop fault" ON.
As soon as the frequency inverter detects either a malfunction which would invariably bring on an inverter fault, or an AC voltage failure, it begins to decelerate the motor until it stops. For this action, the inverter may require the kinetic energy of the drive which is recovered to the DC link in the course of regenerative operation.

Range of values Resolution	Default Setting
0.05 ... 10 sec. 0.05 sec.	0.1 sec.

Therefore execution of this function will depend on the respective driving application and on the operating conditions prevalent at the time.

"Quick stop time" offers alternatives for setting the time in seconds during which output frequency is to be reduced by 50 Hz. This period is extended automatically in case of need.

This function only works in fault situations in which it is safe to let inverter operation go on for a short time!

Autoquit

Autoquit

Automatic acknowledgment.
Number of acknowledgments.

Range of values Resolution	Default Setting
OFF, 1 ...9, always (n•ack)	OFF

The inverter automatically acknowledges faults in the number set above, provided that the cause of the fault has been eliminated. Acknowledgments are executed after a delay of 10 seconds.

Following a disconnection from the AC line or a manual fault acknowledgment with the Enter key, the counter (value in brackets, max. 255) is reset to zero and the total number of acknowledgments are restored.

The default settings marked * may vary according to the inverter type!

Extra functions (con't)

Abs. min. freq.

O

Net voltage

USS mode

Abs. min. freq.

Absolute minimum frequency.
This menu item defines the lowest frequency the inverter is able to supply.

Range of values Resolution	Default Setting
0.1 ... 10.0 Hz 0.1 Hz	1.0 Hz

No output signal is supplied between 0 and the value set.

The value selected in this item defines the frequency at which the setpoint delay (ref. sec. 7.1.3 Control parameters) begins to be active. In hoisting gear brake control applications, the absolute minimum frequency must be ≥ to **2.0 Hz**. Only then will optimum efficiency of ISD control will be achieved.

Net voltage

AC line input voltage.
This parameter allows for a fixed setting of the maximum line voltage to be applied to the inverter.

Range of values Resolution	Default Setting
Auto, 304 ... 506 VAC 1 VAC	Auto

"Auto" → voltage is measured once immediately before the inverter signals "ready for operation".

Where major line voltage fluctuations are expected and where functions depending on line voltage are involved (such as braking chopper, braking delay or automatic frequency raising) a permanent setting should be initiated. For the inverter to yield optimum performance, a value as close to the maximum as possible should be established for this setting.

USS mode

Range of values Resolution		Default Setting
Slave	Master1	Slave
Master 2	Master 2	

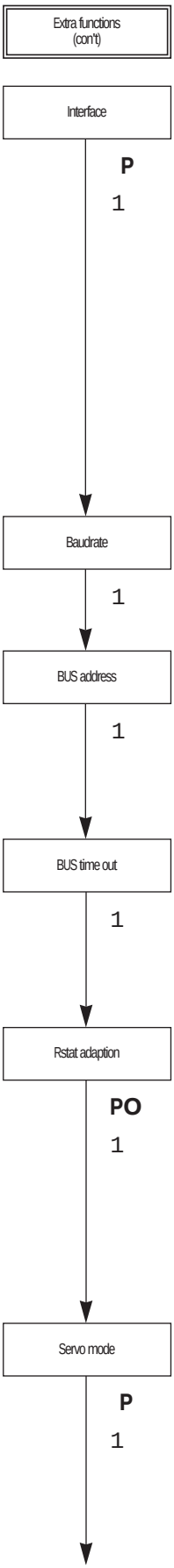
Slave: The inverter works as USS slave and can be controlled and programmed.

A "**Master function**" is selected whenever one inverter which is provided with an operating unit controls other inverters without operating unit. The recommended baud rate is 38400 baud. The slave to be controlled is selected via the "BUS address" (ref. sec. 7.2.4 USS mode).

Master 1: In this mode a slave can be remote-controlled via the keyboard and the control terminals of the master.

Master 2: All parameters of the master (slave address included) are transferred with the Enter key to a slave which is ready for operation.

Master 3: The control functions of the master inverter (digital inputs and analog setpoint) are transferred to the slave inverter(s).



Interface

Not with USS mode master 3.

Range of values Resolution		Default Setting
local BUS	setpoint 1 BUS BUS + setpoint 2	local

Local: Inverter is controlled via control terminal strip.

Set Value 1 BUS: Only one setpoint is transferred over the bus. Evaluation as with analog setpoint input 1. The digital inputs of the control terminals continue to be active "locally".

BUS: The inverter is controlled via the BUS (control word and setpoint 1). The analog setpoint input 2 continues to be active "locally".

BUS + Set Val. 2: As in "BUS", however with additionally a 2nd setpoint. It is evaluated in the same way as the analog setpoint input 2.

Baud rate

Transmission rate via the BUS (RS 485 interface).

Range of values Resolution	Default Setting
4800/9600/19200/38400 baud	9600 baud

BUS address

not with USS mode Master 3.

Range of values Resolution	Default Setting
0 ... 30 1	0

USS mode = slave: own address.

USS modes = master 1/2: address of the inverter being controlled.

BUS time out

Message down-time.

Range of values Resolution	Default Setting
0 ... 100 sec. 0.1 sec.	0

not with USS mode Master 2.

0 = no monitoring.

Rstat adaption

Cyclic stator resistance measurement.

Range of values Resolution	Default Setting
OFF / ON	OFF

Only <u>with</u> automatic or ISD control.

The stator resistance of the connected motor (ref. item 7.1.2 Motor data) is measured periodically once every minute, though only if the inverter is not enabled.

This function ensures that a change of the stator resistance due to an increase of motor temperature is compensated.

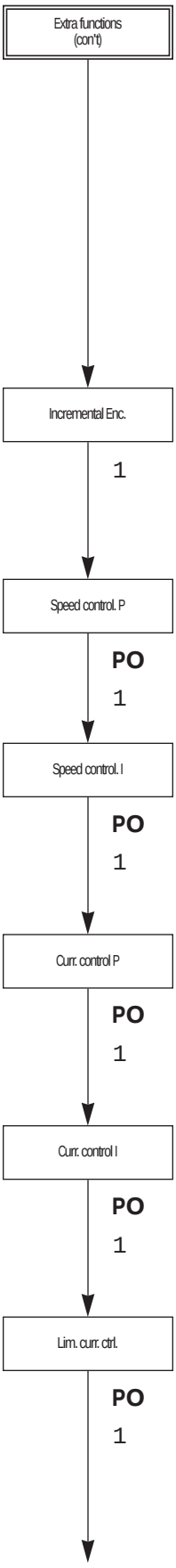
Servo mode

for motor speed control.

Range of values Resolution	Default Setting
OFF / ON (option)	OFF

Only <u>with</u> the incremental shaft encoder input option (ref. sec. 7.2.5 speed controller).

Can be used only if the **optional** incremental shaft encoder input is provided to permit and transmit the actual speed value picked up by an incremental shaft encoder to the encoder input. (ref. 4.2.3).



PLEASE NOTE:

1. The "servo" mode will limit the maximum possible frequency (Basic parameters) to twice the rated motor frequency (Motor data) set.

2. The "servo" mode will automatically activate an internal torque limit equal to 100% (of the rated motor size). The internal torque limit can be varied due to the effect of the adjustable torque limit.

3. The rotating field of the incremental encoder must be in accordance with that of the motor. If this is not the case (e.g. in NORD motors with encoder HG 660), the tracks A+ and A- must be interchanged.

Incremental Enc.

Encoder pulses/revolution setting.

Only with **optional** incremental shaft encoder input.

Range of values Resolution	Default Setting
500/512/1000/1024/2000/2048 4096/5000 pulses/revolution	4096

Speed control. P

P component of the speed controller.

Related to differential speed in rpm only with servo mode = ON.

Range of values Resolution	Default Setting
0 ... 800% 1%	100%

Speed control. I

I component of the speed controller.

As 1/time constant, same as P component.

Only with servo mode = ON.

Range of values Resolution	Default Setting
0 ... 800%/s 0.1%/s	10%/s

Curr. control P

P component of the current controller.

Related to differential speed in rpm.

Only with servo mode = ON.

Range of values Resolution	Default Setting
0 ... 800% 1%	150%

Curr. control I

I component of the current controller.

As 1/time constant, same as for P component.

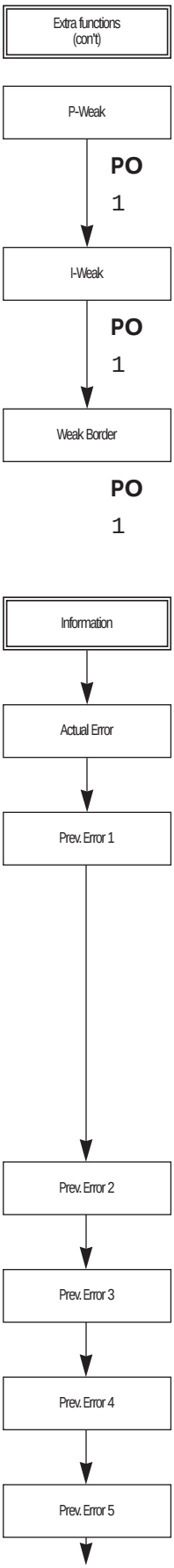
Only with servo mode = ON.

Range of values Resolution	Default Setting
0 ... 1000%/ms 0.1%/ms	30%/ms

Lim. curr. ctrl.

Only with servo mode = ON.

Range of values Resolution	Default Setting
0 ... 400 V 1 V	100 V



P-Weak
P component of field weakening controller.

Only <u>with</u> servo mode = ON 0 ... 400%.

Range of values Resolution	Default Setting
0 ... 400% 1%	50%

I-Weak
I component of field weakening controller.

Only <u>with</u> servo mode = ON.

Range of values Resolution	Default Setting
0 ... 100%/ms 0.1%/ms	10%/ms

Weak Border
Field weakening limit.

Only <u>with</u> servo mode = ON.

Range of values Resolution	Default Setting
0 ... 100% 1%	100%

7.1.6 Information parameters

Actual Error
New error(s).
Errors can be acknowledged with the Enter key or a digital input programmed for this job.

Prev. Error 1
The service condition of the inverter prevailing at the time when the last five error messages were generated is stored. The following information is captured in each case:

- set of parameters
- operating hours
- frequency
- DC link voltage
- current intensity
- inverter temperature

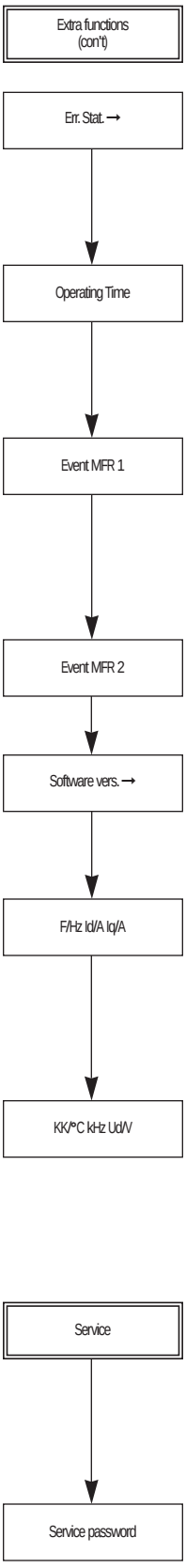
This information can be called with the value keys when the respective previous error is displayed.

Prev. Error 2
As in previous error 1.

Prev. Error 3
As in previous error 1.

Prev. Error 4
As in previous error 1.

Prev. Error 5
As in previous error 1.



Err. Stat. →
Error statistic.
Error no. = 0 ... max.

Paging with the value keys.

Operating Time
Working hour meter.

Range of values Resolution	Default Setting
Hours:minutes:seconds	

Recording of the operating time begins as soon as the frequency inverter is connected to AC line voltage and power applied to it.

Event MFR1
Display of the event that tripped the relay.

Range of values Resolution	Default Setting
The initial letter of the fault that triggered the relay is indicated. Comp. item 7.1.4	

Event MFR2
Display of the event that tripped the relay.

Software vers. →
All the parameters shown refer to software version 4027 0001.

Use the value keys to view the version number and date.

F/Hz Id/A Iq/A
Operating data display 1.

Display of current operational data picked up at the inverter output.

Range of values Resolution	Default Setting
F/Hz: Inverter output frequency in Hz Id/A; Field-producing current component in A Iq/A: Moment-producing current component in A	

KK/°C kHz Ud/V
Operating data display 2.

Display of current inverter data.

Range of values Resolution	Default Setting
KK/°C: Heat sink temperature in °C kHz: Current switching frequency in kHz Ud/V: Inverter DC link voltage in Vdc	

7.1.7 Service parameters

Apart from the first menu item, this category of parameters is not accessible to viewing unless the correct password has been entered.

These parameters are exclusively required for final quality inspection and not available to the user.

Service password

Range of values Resolution	Default Setting
0 ... 9999 1	

7.2 Menu item information

In this section, we will discuss some major menu groups and menu items in detail.

7.2.1 Operating mode (basic parameters)

The *operating mode* menu item in the basis parameters defines the extent to which the digital control inputs can be programmed and states the factory settings.

In the tables below, the functions users may set themselves are marked with an "*". An "o" marking identifies those which are factory-set.

Once adjusted the mode will always apply to all parameter sets - it is not possible to select different modes for the various parameter sets.

7.2.1.1 The "analog" operating mode

This operating mode allows for the implementation of standard applications, where a potentiometer or an external voltage source are used to fix an analog setpoint, and where no further presets are required.

As for the "quick stop" and "cut off voltage" functions, it should be remembered that these are low-active inputs. In order to operate the drive, which means that the "quick stop" or "cut off voltage" functions are not to be executed, either input must be at voltage (high) before the inverter can be enabled.

Function	DI1	DI2	DI3	DI4	DI5	DI6	active
No function		*	*	*	*	*	high
Enable (right)	o						edge/high
Enable (left)		o					edge/high
Sense of rotation		*					high
Fault acknowledgment		*	*	*	*	o	edge
Param. set change-over input 1				o			high
Param. set change-over input 2					o		high
Cut off voltage		*	*	*	*	*	low
Quick stop		*	*	*	*	*	low
Fixed frequency 1		*	o	*	*	*	high
Fixed frequency 2		*	*	*	*	*	high
Fixed frequency 3		*	*	*	*	*	high
Remote control		*	*	*	*	*	high

Note: **DI(n)** in the column headings refer to the 6 Digital Inputs (ref. sec. 4.2.2)

Sense of rotation: The sense of rotation is always determined by whether enable left (CCW) or enable right (CW) has been selected, or by the analog setpoint (±) respectively.

Remote control: With this function, inverter control can be shifted from the control terminal strip (digital inputs 1- 6) to the RS485 interface (BUS mode) and vice versa.

- Low → digital inputs 1 - 6
- High → RS 485, BUS mode

For remote control to work properly, the parameters relating to the RS 485 interface must be set correctly!

7.2.1.2 "Motor potentiometer" operating mode

A motor potentiometer function is primarily used for crane control systems. A two-step push-button is provided to enable the inverter and to increase the frequency. The extent to which the frequency may rise depends on the adjusted maximum value.

The first step of the push-button controls the inputs DI1 or DI2 (enable right or left), and the second step controls the increase *frequency function*.

If only the enabling function is activated (first step), frequency is maintained at a constant level or at least the set minimum frequency is supplied. If both inputs are opened, frequency decreases until standstill or until the first switching step is operated again.

Suggested circuit:

- S1 = enable right
- S2 = enable left
- S3 = reduce frequency
- S4 = increase frequency

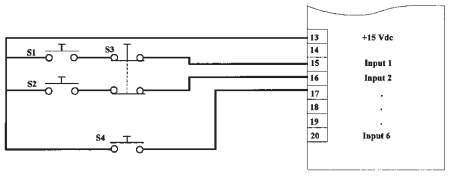


Fig. 32

Please note: Storage of the last output frequency set is not possible since the enable input is assigned the "reduce frequency" function as well!

Function	DI1	DI2	DI3	DI4	DI5	DI6	active
No function				*	*	*	high
Enable (right)	o						edge/high
Enable (left)		o					edge/high
Fault acknowledgment				*	*	o	edge
Param. set change-over input 1				o			high
Param. set change-over input 2					o		high
Cut off voltage				*	*	*	low
Quick stop				*	*	*	low
Increase frequency			o				high

7.2.1.3 Operating mode, general

- All options that have not been selected are regarded as being connected to logical zero, with no effect whatsoever on the performance of the inverter.
- DI1 is not programmable and always has the function "enable".
- If the function "enable left" is programmed, the function "enable" is interpreted as "enable right".

- The two functions, “sense of rotation” and “enable left”, exclude each other, i.e. only one of the two functions can be programmed.
- A Low/High edge is required for fault acknowledgment.
- If one switch of parameter sets is to be carried out by one digital input, the only input permitting this possibility is parameter set input 1, respectively for parameter sets 1 and 2 (DI4).
- If the “motor potentiometer” mode is set, DI2 and DI3 are permanently programmed.
- Even if control does not take place locally, the functions “cut off voltage” and “quick stop” are still available. Owing to this feature, an EMERGENCY STOP function can be provided even if the inverter is controlled via the RS485 interface using the USS protocol.

ATTENTION! Please observe all accident prevention regulations which govern your location!

7.2.2 Keyboard control (extra functions)

If the keyboard control feature is activated, direct intervention via the inverter keys is possible. The only way to change the control mode is to return to the standard operating value display. The start-stop function is assigned to the Enter key, and the setpoint (including the sense of rotation) to the value keys. Simultaneous operation of the value keys will set the setpoint to zero. If the frequency inverter is started via the Enter key, initial frequency is always 0 Hz, regardless of whether the minimum frequency was programmed to a value > 0 Hz. The frequency change always proceeds in accordance with the adjusted ramps (basic parameters) until the moment a limit value is reached. The control functions previously described which are insured via the control terminal strip cannot be used in this mode nor does the system accept an analog signal applied to the setpoint input. Any error messages that may have been generated can be acknowledged with the Enter key after the cause of the error has been eliminated. The various control jobs will always be executed in accordance with the parameter set selected in the menu item “manipulated parameter set” (Basic parameters).

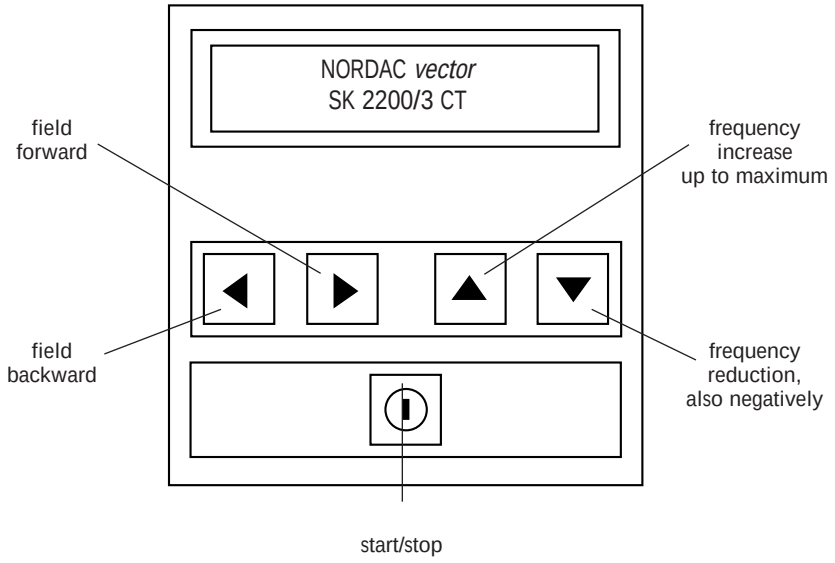
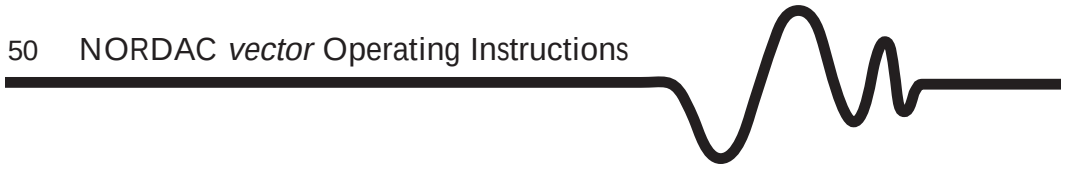


Fig. 33

Important note !
Starting the inverter with the Enter key (keyboard control) means that the Enter key, or else a Value key, must be used to stop it after returning to the operating value display !



7.2.3 Fixed frequencies

Fixed frequencies can be set and used provided that the “analog” mode has been selected in the operating mode menu item (Basic parameters). Then, the digital control inputs can be programmed to a total of 3 fixed frequencies.

The “Extra functions” menu group allows for setting the respective values of the individual fixed frequencies. Settings which are negative in sign are also admissible. A negative sign will result in the sense of rotation being reversed, starting from the control input (right/left) or in a subtraction being made from an analog setpoint.

Addition of the fixed frequencies may also produce a negative result and hence a reversal of the direction of rotation.

7.2.4 USS mode

The RS 485 interface permits communication with the frequency inverter based on the master-slave principle with the USS protocol (a universal interface protocol) serving as the access procedure. The inverter can be operated as either the master or the slave unit.

Please don't hesitate to contact us if you would like detailed information on the USS protocol.

Slave
This mode allows for the frequency inverter to be programmed and controlled via the serial bus. To enable control of the frequency inverter by way of the bus, the “interface” parameter must be set to “USS”. NORDCON operating software is available for communication with the inverter(s) if a PC is to be used as a master,.

Master
In the USS modes Master 1 or Master 2, other NORDAC *vector* frequency inverters can be operated via the RS 485 interface. These modes are intended primarily to put into operation inverters which are not equipped with an operating unit.

The recommended baud rate is 38400 baud. The inverters (system users) connected to the bus circuit are selected by means of the USS address.

If the Master fails to meet with a response at the contacted address, it automatically searches for another unit and reprograms this user to the baud rate and address of the previous one.

Master 1
In this mode a slave frequency inverter can be programmed and controlled via the keyboard, control terminals and display of the master inverter. When the slave is controlled using the control terminals of the master, the setting of the digital inputs must be identical, and the “interface” parameter in the slave inverter must be set to “USS”. Communication is terminated by switching off the USS mode.

Master 2
In this mode the parameter settings (of all parameter sets) are transmitted from the master to the slave. Only frequency inverters belonging to the same class of output capacities can be used for this mode.

Master 3
This mode is characterized by the fact that it is the control functions (analog setpoints and digital inputs) which are transmitted from the master inverter to the slave inverters connected -> synchronization control (pilot frequency).

7.2.5 Speed controller

The speed of the connected motor can be controlled in two different ways:

1. With an analog actual value signal, processed by the integrated PI or PID controller which is provided as standard.

2. Using an incremental shaft encoder attached to the motor, and the incremental shaft encoder input with PI control which is available as **optional** equipment.

7.2.5.1 Controlling the speed with an analog actual value

Analog input 2 is an analog actual value input provided for the purpose of controlling analog variables, as in speed control with tachometer feedback, pressure control with a pressure transducer, or tension control with a dancing roller.

a) PI Controller Setting the analog input 2 function: **Actual frequency value**

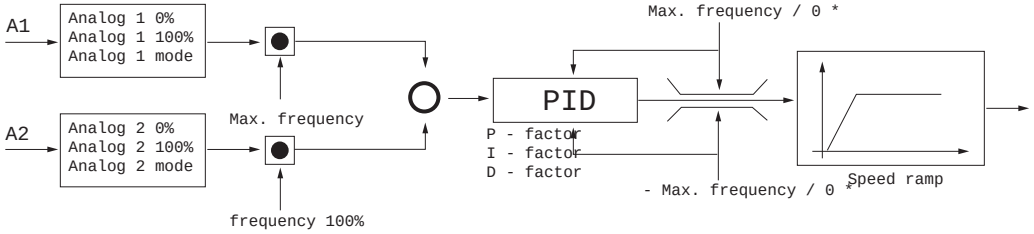
PI controller typically used to control dynamic processes, as in speed or dancing roller control.

The PI controller will allow for acceleration ramps only in a setpoint setting mode; it will not do so at the controller output.

b) PID Controller Setting the analog 2 input function: **PID Controller**

PID controller for control processes characterized by actual values changing at a slow rate, as e.g. pressure regulation.

The acceleration ramp is insured downstream of the PID controller in accordance with the maximum frequency and the acceleration period (Basic parameters).



Analog actual value signal: Use the DIP switch on the control board to choose between a current or a voltage actual value signal. The exact shape of the signal is specified in the setpoint input 2 mode parameter.

If the setting is **0..10V limited** or **0(4)..20 mA** and if the control offset is negative, the minimum output frequency will be 0 Hz, i.e. there will be no reversal of the rotational direction of the drive.

If the setting is **0..10 V** or **± 10 V**, the output frequency will be reversed if necessary when the control offset becomes negative, i.e. the rotational direction of the drive may change too.

Analog input 2 must be allocated either the "**actual frequency value**" or the "**PID controller**" function. Then go on by selecting any Adjust functions required (see above) and by setting the parameters relevant for the PI/PID controller as provided in the "control terminals" sub-menu.

Frequency 100%: At this point enter the frequency value the controller recognizes at 100% of the analog actual value (voltage or current respectively with 100% Adjust of analog input 2).

If the setpoint and the actual value differ with regard to normalization, there is the possibility of setting a ratio max. frequency/frequency 100% corresponding to the ratio setpoint value/actual value.

If the amounts of setpoint and actual value are equal, set the maximum frequency offered in the applicable parameter set.

PI controller P: Frequency jump in case of a control deviation, related to the control variance.

PI controller I: Frequency change/time, related to the control variance.

PI controller D: Frequency * time, related to the control variance, only with PID controller function.

Limit PI controller: maximum difference between output frequency and frequency setpoint (only with PI controller, actual frequency value)

Example: f_{max} (V_{set} =10V) = 70 Hz,

V_{set} = 5.0V, f_{set} = 35 Hz

limit PI controller = 10 Hz

Frequency will be limited within a range 25 to 45 Hz.

PI controller T: Attenuation time constant of the controller. The response time of the PI (T) controller is set. The attenuation time constant has an effect on both the setpoint and the actual value. The constant is not required for standard applications (only with PI controller, actual frequency value).

Starting-up: Speed control with DC voltage tachometer
Maximum actual value voltage must never exceed 10 V.

Control parameters default settings may not be adequate for operations. Whenever possible, improve their efficiency until they are optimum. Where heavy centrifugal masses are involved, as e.g. in revolving tables, it is advisable to reduce the I component even before the inverter is put into operation for the first time.

The best method is to optimize the initial transient process by evaluating the speed supplied by the analog output or by viewing the actual voltage value with an oscilloscope.

Starting-up: Pressure control

Connect the analog actual value signal (output of pressure sensor) to the analog input 2 of the inverter. Allocate the "**PID controller**" function to analog input 2.

Parameter default settings are indicated below:

Frequency 100%: maximum frequency in the parameter set being used

PI controller P: 10.0% (factory setting)

PI controller I: 1.00%/ms (factory setting)

Limit PI controller: 10 Hz (factory setting)

Proceed by optimizing drive control with the parameters PI controller P and PI controller I. Experience has shown that in pressure control, low I factors should be used.

7.2.5.2 Control with a digital actual value (Closed Loop Speed Control)

This type of control is superior in many respects to other techniques or uncontrolled systems.

- maximum torque even at standstill
- torque limit can be set with great accuracy
- no risk of the motor pulling out
- exact speeds and true running even at very low speeds down to “zero”

Digital actual value signal: Prior to start-up, connect the incremental shaft encoder, which is mounted to the motor, as indicated in the Instructions For Use (ref. sec. 4.2).

The rotating field orientation of the incremental encoder must be identical with that of the motor. If this is not the case (e.g. in NORD motors with HG 660 transducer), tracks A+ and A- must be interchanged.

The “Extra Functions” menu group includes the “**Servo Mode**” parameter (only with the CTD option). When this parameter has been programmed to “ON”, the display will show the parameters through which this type of control can be optimized.

Shaft encoder resolution: This is where to set the number of pulses/revolution of the incremental shaft encoder being used. Higher resolution (pulses/rev.) will enhance control response, especially when speeds are low. Normalization of the control parameters is such that any increase of the P or of the I component values will accelerate control response. They shouldn't rise to high though because this would result in excessive oscillations of the controller. If by way of contrast the said components are reduced, transient oscillation is smoothed but also prolonged in duration.

Speed controller P: Frequency jump on control deviation, related to control variance.

Speed controller I: Frequency change/time, related to control variance.

Current controller P: Frequency jump in case of control deviation, related to control offset.

Current controller I: Maximum voltage change that can be brought about by the current controller.

Field weakening controller: The field weakening controller controls the flux setpoint whenever frequencies are in the field weakening range, and thus determines the v/f (voltage/frequency) break point.

Starting-up: Speed control with incremental shaft encoder feedback

Factory settings will not be ideal for all applications, and therefore optimizing control parameters for your specific application will be required. For instance if large flywheel inertia's are involved as in rotary tables, lower the I-factor of the speed controller even before putting the inverter into operation.

As for the current controller parameters, further adjustment of the factory settings will rarely be necessary.

The transient process can best be optimized by evaluating the speed supplied by the analog output or by oscilloscoping the actual value voltage.

8 Settings after the first starting-up

We suggest that after start-up of the inverter for the first time you should record all relevant settings in the tables below. Remember that depending on parameter configuration some menu items (shaded) are not visually represented in the display. The tables show continuous lines without partitions for menu items which are independent of any particular parameter set having been selected.

8.1 Basic Parameter

Menu item	Factory setting	Parameter set 1	Parameter set 2	Parameter set 3	Parameter set 4
Accelerat. time	...s				
Decelerat. time	...s				
Minimal frequ.	0.0 Hz				
Maximal frequ.	70.0 Hz				
Control modus	ISD control				
Mode	analogue				

8.2 Motor Data

Menu item	Factory setting	Parameter set 1	Parameter set 2	Parameter set 3	Parameter set 4
Nominal Motor	...kW				
Nominal freq.	50 Hz				
Nominal speed	...rpm				
Nominal current	...A				
Nominal voltage	400 V				
Nominal power	...kW				
Nominal cos(PHI)	...				
Star delta con.	delta/star				
Stator resis.	...Ω				
No-load current	...A				

8.3 Control Parameter

Menu item	Factory setting	Parameter set 1	Parameter set 2	Parameter set 3	Parameter set 4
Accel. delay	On				
Current limit 1	...A				
Current limit 2	...A				
Brake delay	Off				
Ramp down	On				
U/f charact.	50 Hz				
Static boost	10.0 V				
Dynamic boost	0.0 V				
Time dyn. boost	0.0 s				
DC braking	Off				
DC braking time	1.0s				
DC braking volt.	...V				
Setpoint delay	0.0s				
Smoothing	0.0s				
Flying start	Off				
Fly. start offset	0 Hz				
Fly. start resol	1.0 Hz				
Slip compens.	On				
Auto.freq.raise	Off				
Torque limit	Off				

8.4 Control Clamps

Menu item	Factory setting	Parameter set 1	Parameter set 2	Parameter set 3	Parameter set 4
Mode analog in1	0..10 V				
Adjust 1: 0% →	.....V 0.00 V				
Adjust 1: 100% →	.....V 10.00 V				
Filter an. in. 1	Off				
Funct. an. in. 2	None				
Mode analog in.2	0..10 V				
Adjust 2: 0% →	.....V 0.00 V				
Adjust 2: 100% →	.....V 10.00 V				
Filter an. in.2	Off				
Frequency 100%	50 Hz				
PI controller P	100%				
PI controller I	10%/s				
PI controller T	2 ms				
PI controller D	0% ms				

Menu item	Factory setting	Parameter set 1	Parameter set 2	Parameter set 3	Parameter set 4
Limit PI control	10 Hz				
Curr. limit 100%	...A (1.5 I_{NFU})				
Torque 100%	100%				
Analog output	Off				
Norm. analog output	100%				
Digital input 2	enable left				
Digital input 3	fixed frequency 1				
Digital input 4	parameter set 1				
Digital input 5	parameter set 2				
Digital input 6	fault acknowledge				
Enable active	edge				
Mot. temp. protect.	Off				
Relay 1 functions	current: OFF frequency : OFF brake: OFF temp.: OFF overcurr.:OFF ramp-up:OFF contour:OFF slippage: OFF torque: OFF regen. torque: OFF FS = F : OFF inact. fault : OFF	fault	fault	fault	fault
Relay 1 logic	OR				
Relay 1 current	...A				
Relay 1 I-hyst.	10%				
Relay 1 freq.	50.5 Hz				
Relay 1 contour.	100 rpm				
Relay 1 torque	300%				
Relay 2 functions	current: OFF frequency: OFF brake: ON temp.: OFF overcurr.: OFF ramp up: OFF contour.: OFF torque limit: OFF Fs = F: OFF inact. fault: OFF				
Relay 2 logic	OR				
Relay 2 current	...A				
Relay 2 I-hyst.	10%				
Relay 2 freq.	50.5 Hz				
Relay 2 contour.	100 rpm				
Relay 2 torque	300%				

8.5 Extra functions

Menu item	Factory setting	Parameter set 1	Parameter set 2	Parameter set 3	Parameter set 4
Language	German				
Keyb. control	OFF				
Password	0				
Change password	0				
Fixed frequ. 1	10.0 Hz				
Fixed frequ. 2	20.0 Hz				
Fixed frequ. 3	40.0 Hz				
Power loss red.	OFF				
Switching rate	8 kHz				
Skip freq. 1 high	OFF				
Skip freq. 1 low	OFF				
Skip freq. 2 high	OFF				
Skip freq. 2 low	OFF				
Fasthold on err.	OFF				
Fast hold time	0.1 s				
Autoquit	0				
Abs. min. freq.	1.0 Hz				
Net voltage	autom.				
USS mode	slave				
Interface	local				
Baudrate	9600 baud				
BUS address	0				
BUS time out	0				
Rstat adaption	Off				
Servo mode	Off				
Incremental Enc.	4096 pulses/revol.				
Speed control. P	100%				
Speed control. I	10%/s				
Curr. control P	150%				
Curr. control I	30%/ms				
Lim. curr. ctrl.	100 V				
P-Weak	50%				
I-Weak	10%/ms				
Weak Border	100%				

9 Warnings and faults

The majority of the frequency inverter functions and operating data are constantly monitored and compared with limit values. On detecting a deviation, the inverter reacts by putting out a warning or a fault message.

This reaction is instantly represented in the display. As soon as the message goes out or starts to flash, the inverter is able to resume operation.

Warnings (W) → Provides information indicating that the inverter is operating near a limit value without the situation being critical enough to cause a fault, but could eventually do so if it grew worse.

Faults (F) → The inverter is switched off, the fault is indicated in the display. While the fault is being indicated it cannot be reset.

When the fault display starts to flash, the cause of the fault has ceased to exist and the error memory can be reset.

Reset is executed with the Enter key, by switching the AC line ON/OFF or with the automatic acknowledgment function.

Previous faults 1-5 : For the last five fault messages the inverter stores not only the fault itself but also the respective condition of the inverter at the moment the faults occurred. The following data are captured:

- Parameter set
- Operating hours
- Frequency
- DC link voltage
- Current
- Inverter temperature

These can be retrieved with the value keys when any of the previous faults are indicated. The previous faults are found in the information parameters.

Error statistic: For all fault messages that can possibly be generated, the number of their occurrence is registered and stored. This menu item is found in the information parameters. Any individual fault can be called with the value keys.

9.1 List of warnings and error messages included in the program

The following table lists all warnings and fault signals the system is able to produce. They are shown in clear text in the inverter's display:

Warnings (W) and faults (F)	Cause	What to do about it
Mains failure (W)	• Failure of all 3 AC line phases	• Check AC line voltage
Acceleration overcurrent (W)	• The acceleration ramp was delayed until **current limit 1** was reached, ref. Control parameters. • Frequency was reduced, **current limit 2** was reached, ref. Control parameters.	• Set a longer acceleration time • Reduce the loading of the drive • Raise current limits 1 and/or 2
Inverter over temperature (W/F) W=> temperature limit 1 F-> temperature limit 2	• Ambient temperature is too high • Inadequate ventilation, louvers are obstructed • Failure to install the unit in a vertical position	• Check/improve ventilation of the switch cubicle. • Check temperature of inverter environment, max. 104°F (40°C) • Follow installation/mounting instruction, item 2
Motor over temperature (W/F) W=> PTC resistor has triggered F=> sustained warning for > 30s	• The connected PTC resistor has triggered, the motor is overloaded • Control terminals 11 and 12 are not connected	• Improve cooling of the motor • Check whether motor size is right for the application • Connect PTC resistor or bridge control terminals • Switch function off → Extra functions
Overcurrent (I^2t monitoring) (W/F) W=> inverter is working in overcurrent range F=> inverter has been working in overcurrent range too long	• The internal overcurrent trip has responded, overcurrent must have been at least 1.2 times the rated inverter current • Inappropriate motor-inverter combination • Acceleration or deceleration period too short	• IDS control: check motor data Linear characteristic: check V/f break point and boost (Basic and control parameters) • Check configuration of the drive • Extend acceleration or braking time
Module overcurrent (F)	• Short circuit at the output • Earth fault at the output • Overcurrent • Over temperature	• Check motor cable/motor connection • Check braking chopper cable/connection • Check inverter/motor loads
Overvoltage (F)	• AC line voltage too high • Too much energy fed back by the motor • Braking time is too short • No braking resistor at all or braking resistor impedance too high	• Check AC line voltage and reduce if necessary • Check braking resistance value • Extend braking time • Check connection of the braking resistor

Warnings (W) and faults (F)	Cause	What to do about it
Undervoltage (F)	• AC voltage too low • AC line voltage interruption, during motor operation	• Please check AC line connection for supply of three phases and sufficient voltage level!
Phase failure (F)	• One of the AC input phases is having/has had an interruption • AC line voltage cycled ON/OFF too often in one hour (see section 9.5)	• Please check AC line connection for supply of three phases and sufficient voltage level! • use the enable right or left
Parameter loss (F)	• EEprom is defective • Noise pulses on the cables • New inverter type was set with DIP switch	• Reset fault signal • Repeat parameter setting!
USS time-out (F)	• Error in USS data transmission	• Check message downtime, extend if necessary • Switch off this monitoring feature when the NORDCON software is used
System errors 1-11 (F)	• Error in the internal program flow	• See section 9.4

9.2 Possible overcurrent (W/F)

The overcurrent monitoring relay trips when the internal I^2t limit value is exceeded. The limit value setting allows for 1.5 times the rated inverter current to be applied for 30 seconds. For reduced overcurrent values, additional time will be available while higher overcurrents are tolerated for a shorter period of time. When the overcurrent level time has been exceeded, overcurrent fault will occur.

9.3 Quick stop at major faults

Depending on the circumstances the quick stop function (ref. sec. 7.1.5 Extra functions) is usually activated when the following errors occur:

- inverter overtemperature
- motor overtemperature
- phase failure
- USS time-out
- mains failure

This function will decelerate the motor to a stop as quickly as possible provided that it is safe for the inverter operation to continue and that there is enough energy in the inverter to recover the energy from the load.

9.4 System errors 1-13

If any of the system errors occurs repeatedly you should get in touch with the supplier of the inverter.

In the majority of cases such errors are caused by interference with the program flow due to insufficient electromagnetic compatibility. System errors may also be the result of a component being defective.

To Insure full electromagnetic compatibility the recommendations mentioned in section 10.1 should be followed.

If the system accepts a reset of these signals, operation of the inverter can be continued.

9.5 Max. AC Line voltage switching cycles

SK 1500/3 CT ... SK11000/3 CT	250 times/hr.
SK 15000/3 CT ... SK 37000/3 CT	125 times/hr.
SK 45000/3 CT ... SK 132000/3 CT	50 times/hr.

10 EMC measures

10.1 Radio interference suppression level

If an AC line filter we have recommended is used and if shielded motor, brake resistor and AC line cables between filter and inverter are utilized, radio interference suppression in accordance with **EN 55011 resp. EN 50081 limit curve B** is ensured for inverters **up to 37 kW** provided that the switching frequency is **8 kHz** .

Radio interference suppression in accordance **with EN 55011 resp. EN 50081 limit curve A** is ensured for inverters **from 45 to 132 kW** at a pulse rate of **4 kHz** provided that an AC line filter we have recommended is used and that shielded motor, brake resistor and AC line cables are utilized between filter an inverter.

Connect the cable shield to ground on both sides. Where the shield meets the inverter, lay it on the metal front panel of the inverter using a PG brass screwing (inverters up to 37kW). In addition the cable shield must be connected to the inverter's PE terminal.

10.2 Noise immunity

Even if connecting and control cables are used without a shield, the frequency inverter is interference-proof up to **severity level 4 in accordance with IEC 801-2 and IEC 801-4**.

Shielding for noise immunity will only be required in cases where severity level 4 is inadequate.

Connect suppression filters across contactors, braking coils etc. or employ suitable AC line filters if necessary.

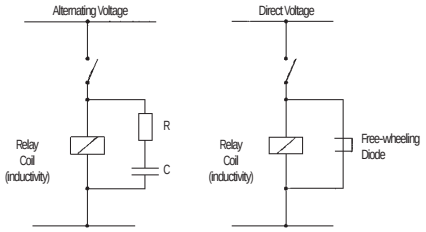
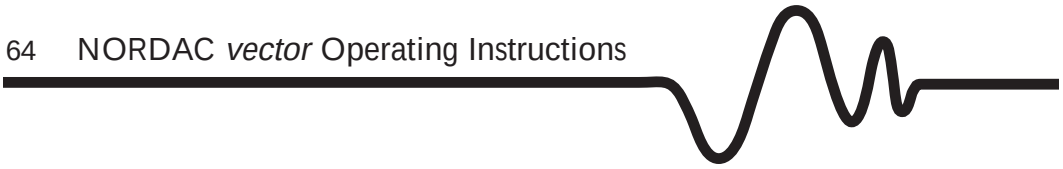


Fig. 34



11 CE marking

NORDAC *vector* frequency inverters are electrical equipment for application in industrial operations. They are designed to be used in machines for speed control of three-phase motors. Information and recommendations for installation are contained in the operating instructions.

NORDAC *vector* frequency inverters are CE-marked as stipulated by the European Low-Voltage Directives 73/23/EWG and 93/68/EWG. An EC-conformity statement can be issued if required.

Frequency inverters are not devices as defined in the EMC directives since they are exclusively produced as ancillary supply parts to be further processed by industry and craft and cannot be operated on their own.

Implementing the measures recommended in 10.1 meets the requirements for observance of the EMC directive 89/336/EWG. A manufacturer's statement can be issued if required.

12 Additional measures (OPTIONAL EQUIPMENT)

12.1 AC line filters

Various types of AC line filters are available for different rated currents to ensure that radio interference suppression levels are met as required.

Recommended AC line filters				
Inverter type	**Voltage**	**Power**	**AC line filter type**	**Filter current**
SK 1500/3 CT + SK 2200/3 CT	380 ... 460 V	1.5 / 2.2 kW	HFD 511 - 460 / 8	8 A
SK 3000/3 CT to SK 5500/3 CT	380 ... 460 V	3.0 / 5.5 kW	FS 3981 - 17 / 99	17 A
SK 7500/3 CT + SK 11000/3 CT	380 ... 460 V	7.5 / 11.0 kW	FS 3981 - 30 / 99	30 A
SK 15000/3 CT + SK 22000/3 CT	380 ... 460 V	15.0 / 22.0 kW	FS 3981 - 60 / 99	60 A
SK 30000/3 CT + SK 37000/3 CT	380 ... 460 V	30.0 / 37.0 kW	FS 3981 - 100 / 99	100 A
SK 45000/3 CT + SK 55000/3 CT	380 ... 460 V	45 / 55 kW	FN 258 - 130 / 35	130 A
SK 75000/3 CT	380 ... 460 V	75 kW	FN 258 - 180 / 40	180 A
SK 90000/3 CT + SK 110000/3 CT	380 ... 460 V	90 / 110 kW	FN 359 - 250 / 99	250 A
SK 132000/3 CT	380 ... 460 V	132 kW	FN 359 - 300 / 99	300 A

To order these filters, contact Nord Gear customer service.

12.2 Installation and dimensions of AC line filters

Make sure when installing the AC line filters that sufficient ventilation is available. A clearance of at least 2.4 in. (60 mm) should be maintained beside the ventilation grid!

Protect the filters against liquids, dust and aggressive gases!

The filters may be fixed on the wall in a vertical position or mounted on the floor in a horizontal position.

Optimum filter effectiveness is achieved by placing the filter as close to the inverter as possible.

AC line filters - Dimensions							
Filter type	**L**	**W**	**D**	**L1**	**W1**	**Attachment Ø**	**Output cable**
HDF 511 - 460/8	10 (255)	2 (50)	5 (126)	9.5 (240)	1 (25)	.26 (6.5)	11.8 , 4x14 AWG (300mm, 4x2.5^2)
FS 3981 - 17/99	12 (305)	2.2 (55)	5.6 (142)	11.4 (290)	1.2 (30)	.26 (6.5)	11.8, 4x14 AWG 300mm, 4x2.5^2
FS 3981 - 30/99	13.2 (355)	2.4 (60)	5.9 (150)	12.6 (320)	1.4 (35)	.26 (6.5)	15.6, 4x10 AWG 400mm, 4x6^2
FS 3981 - 60/99	13 (329)	3.2 (80)	8.7 (220)	12.4 (314)	2.2 (55)	.26 (6.5)	4 AWG 25mm^2 terminals
FS 3981 - 100/99	14.9 (379)	3.5 (90)	8.7 (220)	14.3 (364)	2.6 (65)	.26 (6.5)	1/0 AWG 50mm^2 terminals
FN 258 - 130/35	16.9 (429)	4.3 (110)	9.5 (240)	16.3 (414)	3.2 (80)	.26 (6.5)	1/0 AWG 50mm^2 terminals
FN 258 - 180/40	17.2 (438)	4.3 (110)	9.5 (240)	16.3 (413)	3.2 (80)	.26 (6.5)	4/0 AWG 95mm^2 terminals
FN 359 - 250/99	22.2 (564)	11.8 (300)	6.3 (160)	8.3 (210)	10.8 (275)	.26 (9)	Current bar
FN 359 - 300/99	22.2 (564)	11.8 (300)	6.3 (160)	8.3 (210)	10.8 (275)	.26 (9)	Current bar
All dimensions in in. (mm)							

HFD 511, FS 3981 and FN 258

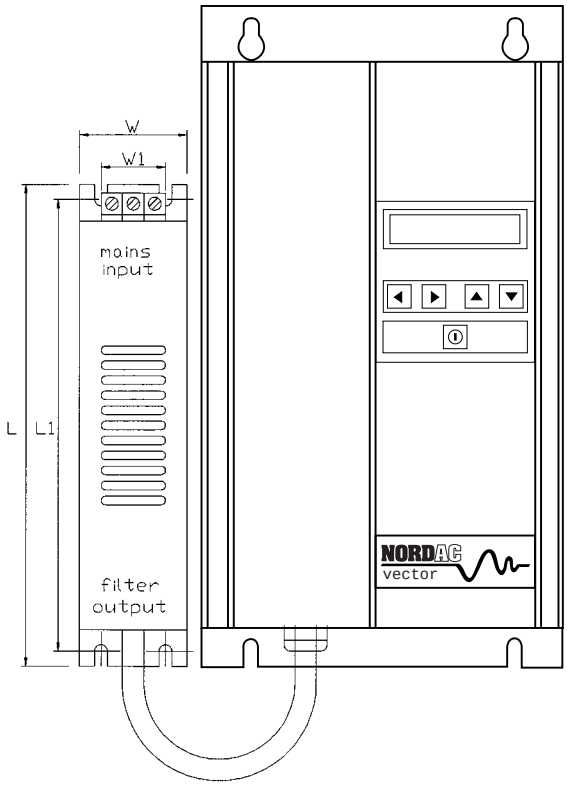


Fig. 35

FN 359

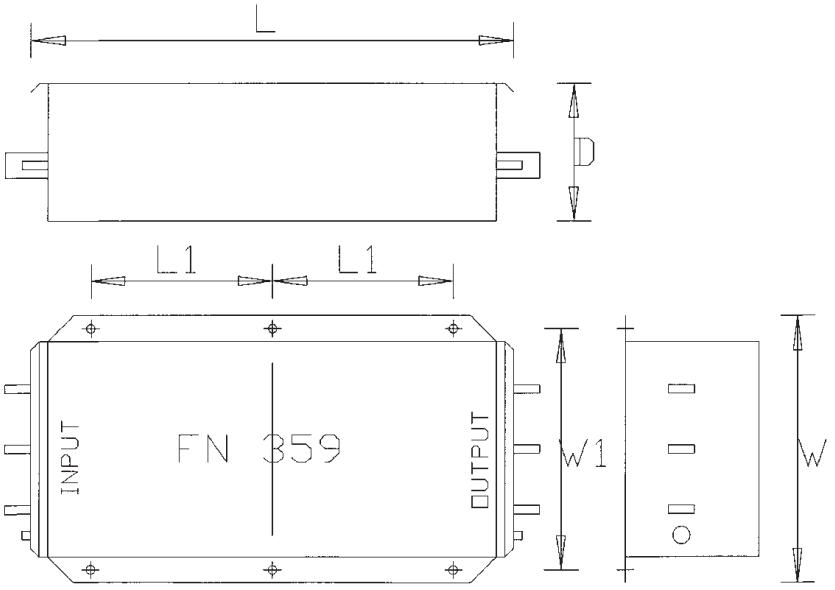


Fig. 36

12.3 Brake resistor data and dimensions

The table refers to construction type IP 20 * fastened with screws. For this resistor type a maximum percentage duty cycle of 3.4% with a cycle period of 120 sec. can be assumed. Larger duty cycles will require addition resistors.

Inverter types Covered	**Resistor** Resistance/Continuous rating	**L** Length	**W** Width	**D** Depth	**e**	**e1**	**Attach-ment Ø f**	**Connecting terminals**
SK 1500/3 CT... SK 3000/3 CT	120Ω/180W	3.9 (100)	2.6 (65)	8.7 (220)	3.5 (90)	1.8 45	.18 (4.5)	14 AWG (2.5mm^2)
SK 4000/3 CT... SK 5500/3 CT	60Ω/360W	3.9 (100)	6.7 (170)	8.7 (220)	3.5 (90)	4.1/5.9 105/150	.18 (4.5)	14 AWG (2.5mm^2)
SK 7500/3 CT... SK 11000/3 CT	40Ω/540W	3.9 (100)	6.7 (170)	8.7 (220)	3.5 (90)	4.1/5.9 105/150	.18 (4.5)	14 AWG (2.5mm^2)
SK 15000/3 CT... SK 22000/3 CT	18Ω/1600W*	7.3 (185)	23.1 (586)	4.7 (120)	20.7 (526)	5.9 150	.23 (5.8)	14 AWG (2.5mm^2)
SK 30000/3 CT... SK 37000/3 CT	12Ω/2000W*	10.8 (275)	19.1 (486)	4.7 (120)	16.8 (426)	9.5 240	.23 (5.8)	14 AWG (2.5mm^2)
SK 45000/3 CT... SK 55000/3 CT	8Ω/3000W*	19.3 (490)	11.6 (295)	10.2 (260)	10.6 (270)	15 380	.39,5x.51 (10, 5x13)	M6 Stud terminals
SK 90000/3 CT	4Ω/5500W*	19.3 (490)	15.6 (395)	10.2 (260)	14.6 (370)	15 380	.39, 5x.51 (10, 5x13)	M8 Stud terminals
SK 110000/3 CT... SK 132000/3 CT	3Ω/7500W*	19.3 (490)	23.4 (595)	10.2 (260)	22.4 (570)	15 380	.39, 5x.51 (10, 5x13)	M8 Stud terminals
All dimensions in in. (mm)								

Fig. 1: 120Ω - 40Ω

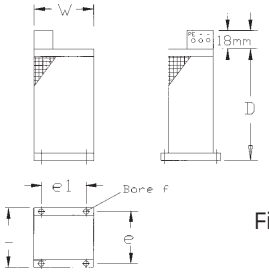


Fig. 37

Fig. 2: 18Ω - 12Ω

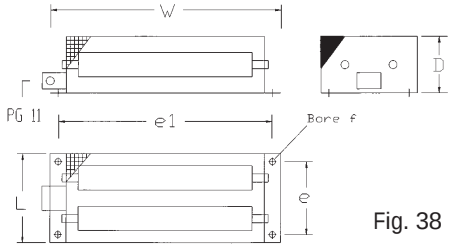


Fig. 38

Fig. 3: 8Ω - 3Ω

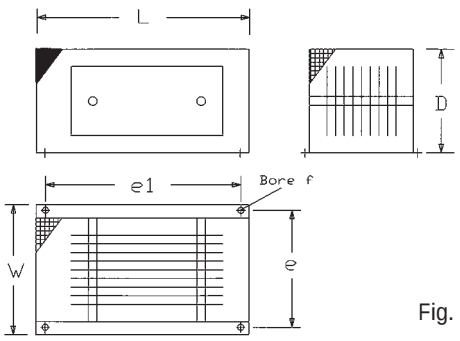


Fig. 39

12.4 Output chokes

If very long motor cables must be used, installation of an output choke may be necessary. With an output choke the cable capacitance developing with longer cable lengths can be compensated. Max. permissible cable length without a choke is 500 ft. (150 mm).

Too high a cable capacitance at the frequency inverter output may cause a module error or result in the generation of an overcurrent message.

Further inquiries should be addressed to our local distributor or manufacturer representative in your area, or our factory application engineering department.

12.5 Sine output filters

Sine filters can be employed for filtering the inverter output signal. In that case, shielding of the motor cables will not be necessary.

The inverter load is increased by approximately 10% if such a filter is used. Derate the system accordingly.

Further inquiries should be addressed to our local distributor or manufacturer representative in your area, or our factory application engineering department.

13 Maintenance and service information

NORDAC *vector* frequency inverters are maintenance-free if they are operated in accordance with instructions (ref. sec. 2.0) .

If the the frequency inverter is operated in an environment with very dusty air, the cooling surfaces must be cleaned with compressed air at regular intervals. If an enclosure is provided with air inlet filters, they too must be regularly cleaned or replaced.

When the inverter is in need of repair, contact your local distributor, manufacturer representative, or our factory repair department for assistance.

14 NORDAC *vector* for square load torque (VT)

In addition to the NORDAC *vector* frequency inverter type CT for applications with a constant load characteristic, another type series (VT) is available for square load characteristic curves.

To facilitate quick access to settings typically required in pump and fan applications, and to maximize ease and efficiency of operation, our engineers purposely dropped a few menu items and narrowed some setting ranges.

Yet control and operation of VT inverters are hardly any different as compared with the CT type series. The operating instructions are still applicable.

Apart from ISD control only the square V/f characteristic can be set as a control mode. Any overloading of the inverter is excluded as the output current is limited to the values indicated in the Technical data (ref. sec. 15.3). As for the switching frequency, only 2 or 4 kHz remain as options for selection.

While configuration of the digital control inputs provides for a fixed allocation of functions, the multifunction relays 1 and 2 still allow parameterization as they do in the CT-type inverters.

Fixed configuration of the control inputs		
Digital input 1	Control terminal 15	Enable right
Digital input 2	Control terminal 16	Enable left
Digital input 3	Control terminal 17	Fixed frequency 1
Digital input 4	Control terminal 18	Parameter set input 1
Digital input 5	Control terminal 19	Parameter set input 2
Digital input 6	Control terminal 20	Fault acknowledgement
same as in control terminal strip sec. 4.2.1 (in brackets)		

15 Technical data

15.1 Technical data, constant torque (CT→ Constant Torque)

Type SK ...	1500/3CT	2200/3CT	3000/3CT	4000/3CT	5500/3CT	7500/3CT
Max. rated power, **kW**	1.5	2.2	3.0	4.0	5.5	7.5
4 pole motor **HP**	2	3	4	5	7,5	10
Continuous output power **kVA** at 400V	2.8	3.8	4.9	6.7	8.6	11.3
Max. continuous output current **A**	4.0	5.5	7.1	9.7	12.4	16.3
Overload capacity	1.5 times the continuous output current for 30 seconds					
Output voltage	three-phase, 380 V -20% ... 460 V +10%					
Pulse frequency	2 kHz ... 16 kHz, no loss of performance up to 8 kHz					
Recomm. min. brake resistance Ω	120	120	120	60	60	40
Max. chopper current **A**	15	15	15	15	15	22
AC line voltage	three-phase, 380 V -20% ... 460 V +10%					
Inverter efficiency	approx. 97 %, at 8 kHz and related to the motor output					
Typ. nom. input current (appr.) **A**	6	8	11	13	17	21
Rec. AC line fusing (slow-blow) **A**	10	16	16	16	20	25
Max. wire gage **AWG**	12	12	12	12	12	12
Weight approx. **lb/kg**	10.6/4.8	11/5.0	11/5.0	13.9/6.3	14.3/6.5	17.6/8.0
Cooling with integrated fan	no	yes	yes	yes	yes	yes

Technical design subject to change

Type SK ...	**11000/3CT**	**15000/3CT**	**22000/3CT**	**30000/3CT**	**37000/3CT**
Max. rated power, **kW**	11.0	15.0	22.0	30.0	37.0
4 pole motor **HP**	15	20	30	40	50
Continuous output power **kVA** at 400V	16.8	22.2	31.5	41.5	49.2
Max. contin. output current **A**	24.3	32.0	45.5	60.0	71.0
Overload capacity	1.5 times the continuous output current for 30 seconds				
Output voltage	three-phase, 380 V -20% ... 460 V +10%				
Pulse frequency	2 kHz ... 16 kHz, no loss of performance up to 8 kHz				
Recomm. min. brake resistance Ω	40	18	18	12	12
Max. chopper current **A**	22	50	50	75	75
AC line voltage	three-phase, 380 V -20% ... 460 V +10%				
Inverter efficiency	approx. 97 %, at 8 kHz and related to the motor output				
Typ. nom. input current (appr.) **A**	30	42	56	75	93
Rec. AC line fusing (slow-blow) **A**	35	50	63	100	100
Max. wire gageb **AWG**	8	input: 6 output: 8	input: 6 output: 8	2	2
Weight approx. **lb/kg**	19.8/9.0	33/15	35.2/16	50.6/23	52.824
Cooling with integrated fan	yes	yes	yes	yes	yes

Type SK ...	**45000/3CT**	**55000/3CT**	**75000/3CT**	**90000/3CT**	**11000/3CT**	**13200/3CT**
Max. rated power, **kW**	45	55	75	90	110	132
4 pole motor **HP**	60	75	100	120	150	175
Continuous output power **kVA** at 400V	60	74	97	116	142	170
Max. continuous output current **A**	90	112	145	168	201	240
Overload capacity	1.5 times the continuous output current for 30 seconds					
Output voltage	three-phase, 380 V -20% ... 460 V +10%					
Pulse frequency	2 kHz ... 8 kHz, no loss of performance up to 4 kHz					
Recomm. min. brake resistance Ω	8	8	6	4	3	3
Max. chopper current **A**	100	100	150	200	240	240
AC line voltage	three-phase, 380 V -20% ... 460 V +10%					
Inverter efficiency	approx. 97 %, at 4 kHz and related to the motor output					
Typ. nom. input current (appr.) **A**	109	130	182	202	246	288
Rec. AC line fusing (slow-blow) **A**	125	160	200	250	300	300
Max. wire cross-section **AWG**	1/0	1/0	1/0	4/0	4/0	4/0
Weight approx. **lb/kg**	61.1/28	61.6/28	85.8/39	167/76	172/78	17680
Cooling with integrated fan	yes	yes	yes	yes	yes	yes

Technical design subject to change

15.2 Technical data, variable torque (VT→ Variable Torque)

Type SK ...	**2200/3VT**	**3000/3VT**	**4000/3VT**	**5500/3VT**	**7500/3VT**	**11000/3VT**	**15000/3VT**
Max. rated power, **kW**	2.2	3.0	4.0	5.5	7.5	11.0	15.0
4 pole motor **HP**	3	4	5	7.5	10	15	20
Continuous output power **kVA** at 400 V	3.8	4.9	6.7	8.6	11.3	16.8	20.4
Max. contin. output current **A**	5.5	7.1	9.7	12.4	16.3	24.3	29.5
Output voltage	three-phase, 380 V -20% ... 460 V +10%						
Pulse frequency	2 kHz or 4 kHz without loss of performance						
Rec. min. brake resistance Ω	120	120	60	60	40	40	40
Max. chopper current **A**	15	15	15	15	22	22	22
AC line voltage	Athree-phase, 380 V -20% ... 460 V +10%						
Inverter efficiency	approx. 97.5 %, at 4 kHz and related to the rated motor power						
Typ. nominal input current **A**	8	10	13	17	21	28	38
Rec. AC line fusing (slow-blow) **A**	10	16	20	20	25	35	50
Max. wire gage **AWG**	12	12	12	12	12	8	8
Weight approx. **lb/kg**	10.6/4.8	11/5.0	13.8/6.3	13.9/6.3	17.6/8.0	19.4/8.8	19.8/9.0
Dimensions same as SK...(see item 3.1)	1500/3 CT, 2200/3 CT		4000/3 CT, 5500/3 CT		7500/3 CT, 11000/3 CT		
Cooling with integrated fan	no	yes	yes	yes	yes	yes	yes

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Subsidiaries world wide:

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GmbHSchärdinger Str. 7
A - 4061 Pasching bei Linz

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