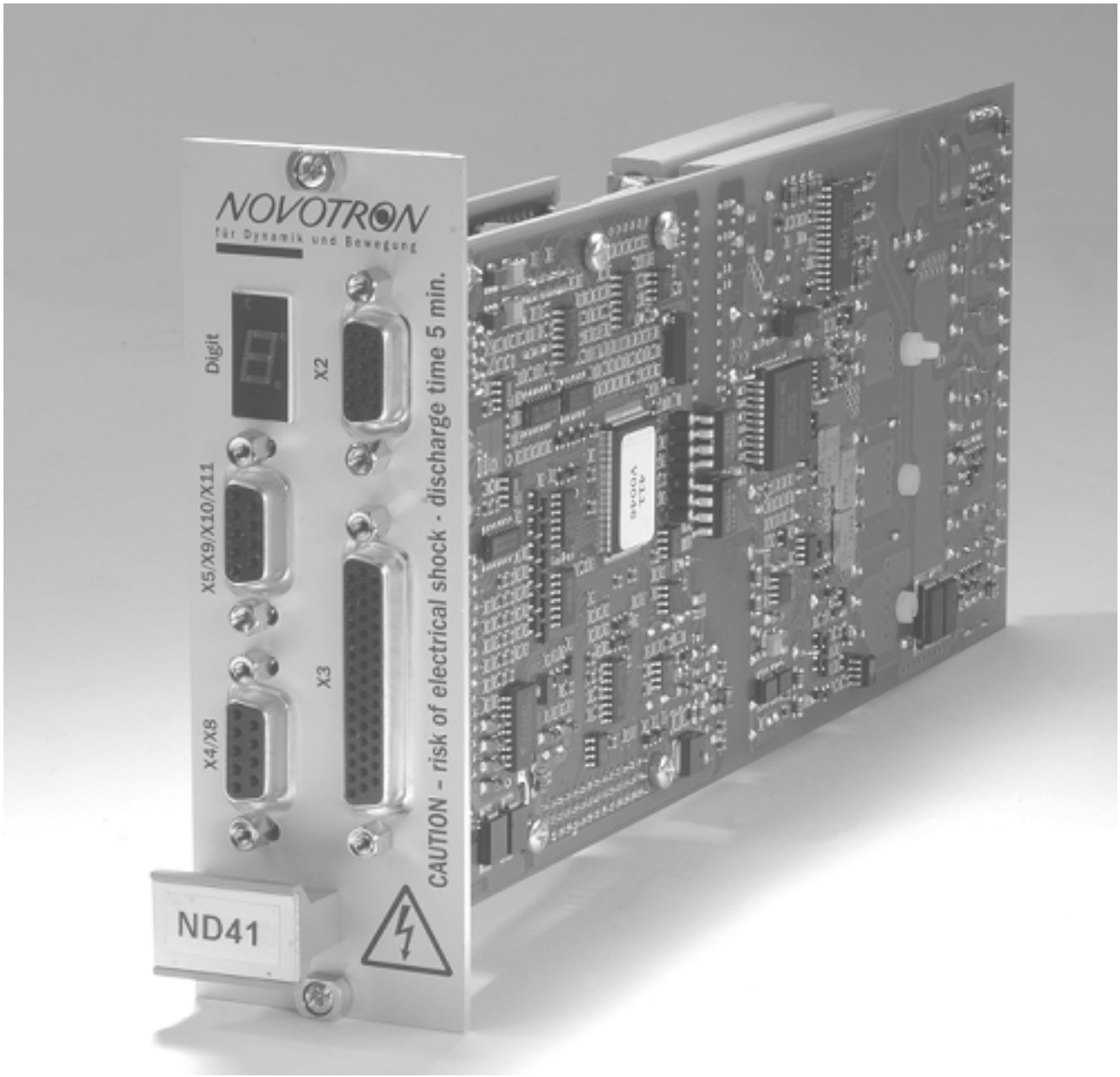
NOVOTRON
Future in Drives

Manual For Servo Amplifier

NOVODRIVE ND40

Basic Device



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1 Contents

2 General Information

2.1 Customer Service

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2.2 List of Abbreviations

Abbreviation	Meaning	Abbreviation	Meaning
VAC	AC voltage	VDC	DC voltage
RO	Read Only	RW	Readable and Writeable
WO	Write Only	BCD	binary coded decimal

2.3 Symbols

Warning or important information.

Noncompliance may lead to trouble in operation or to property damage.

Hazard that may lead to

- damage of life or health of user or other persons, or
- major property damage.

2.4 Trademarks

“EnDat” is a registered trademark of DR. JOHANNES HEIDENHAIN GmbH.

“Windows” is a registered trademark of Microsoft Corporation.

“COMBICON”, “MICRO COMBICON” and “POWER COMBICON” are product names of Phoenix Contact.

“LÜTZE SUPERFLEX®” is a registered trademark of Friedrich Lütze GmbH & Co. KG.

2.5 User Manual Structure

Volume 1 Basic Device

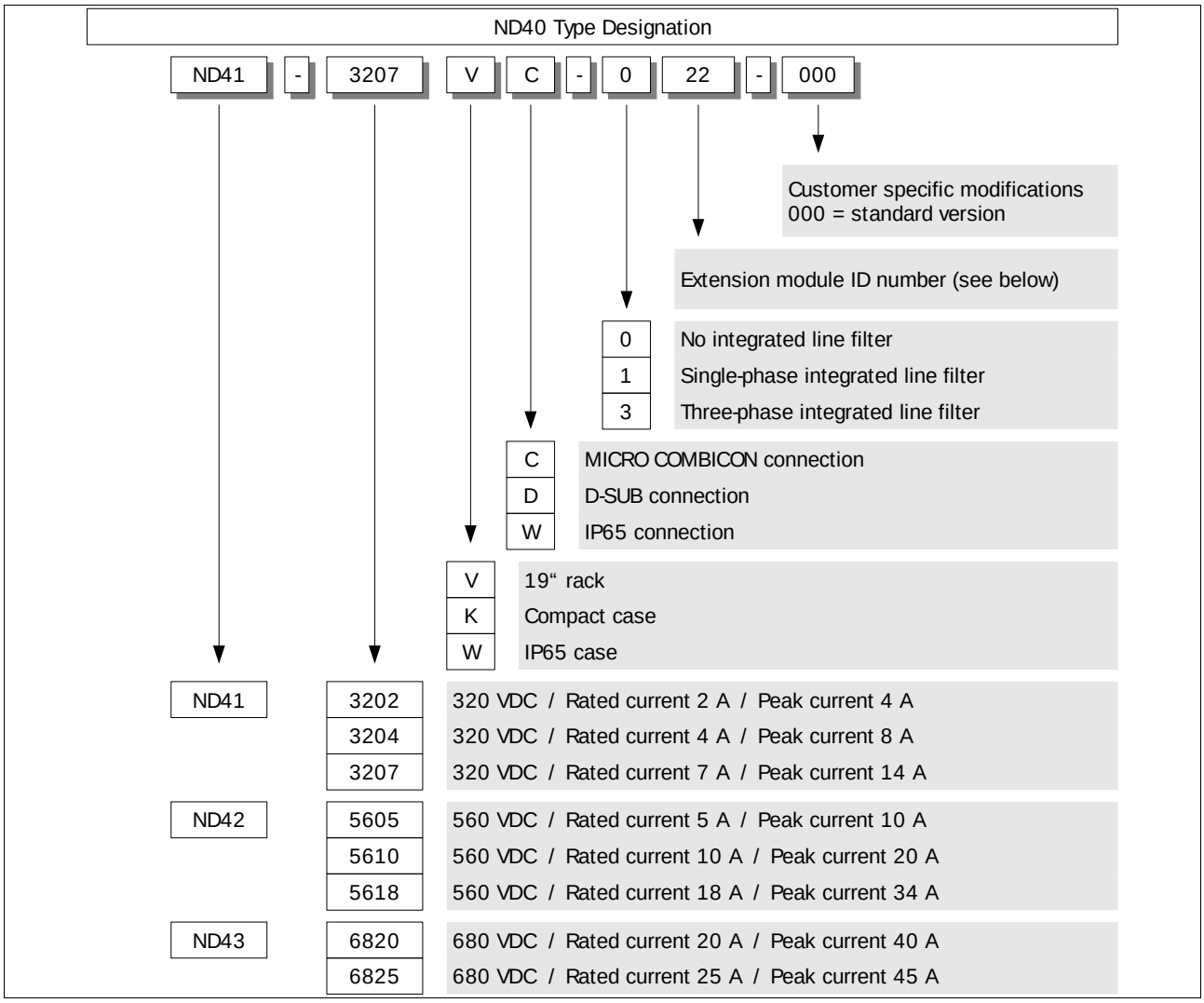
Volume 2 Software Reference

Volume 3 Extension Modules

Volume 4 initiation (setup)

2.6 Ordering Designations

2.6.1 Type Designation



2.6.2 Extension Modules Designations

ID number	Meaning
11	NOVOBUS + CAN-NOVOTRON
12	NOVOBUS + CAN-NOVOTRON galvanically isolated
21	NOVOBUS + PROFIBUS (obsolete)
22	NOVOBUS + EnDat 2.2 (obsolete)
23	NOVOBUS + PROFIBUS + EnDat 2.2 (obsolete)
31	NOVOBUS + PROFIBUS
32	NOVOBUS + EnDat 2.2
33	NOVOBUS + PROFIBUS + EnDat 2.2
34	NOVOBUS + CANopen
35	NOVOBUS + CANopen + EnDat 2.2

2.6.3 Software Bus Options

For customer specific modification NOVODRIVE can be delivered with preset bus system parameters. Regardless of the parameter set loaded, this allows a control unit to build up communication with NOVODRIVE and do the configuration without needing to set the bus address over a PC before.

Bus Option = 0 (standard option)

Customer specific parameters are not changed upon reset.

Bus Options = 1...4

Bus options for CAN-NOVOTRON. The data rate is preset to 1 MBit/s. All CAN Identifiers are defined by the states of the digital inputs GPIn9...14. The four options differ regarding their numbers of process data identifiers activated.

Bus Option = 5

Bus option for extension modules featuring PROFIBUS or CANopen. For PROFIBUS, the bus address is defined by the states of the digital inputs GPIn9...14. For CANopen, all CAN Identifiers are set according to the CANopen standard, with the Node-ID defined by the states of the digital inputs GPIn9...14.

Bus-Option = 7

Bus option for the connection of an external controller of the EPIS company.

	Value	**Example**
GPIn9	1	1
GPIn10	2	0
GPIn11	4	0
GPIn12	8	1
GPIn13	16	1
GPIn14	32	1
Bus address		= 57 (1 + 8 + 16 + 32)

States of digital inputs GPIn9...14:

24 V → 0

0 V → 1

2.6.4 Scope of Delivery for standard NOVODRIVE

Compact case version

- Connector set 'Power Connection ND41/42/43' with Power connector, Connector for motor temperature sensor (for ND42 only) and Ring core
- Shield connection clamp SK14 (ND41) or SK20 (ND42) by Phoenix Contact
- Integrated line filter single-phase (ND41) or three-phase (ND42-5605, ND42-5610 and ND43)
- Integrated forced ventilation
- Connector set 'MICRO COMBICON ND40' or 'D-SUB ND40'

19“ version1

- Connector set 'Power Connection NDxx' with Power connector, Connector for motor temperature sensor (for ND42 only) and Ring core
- Connector set 'MICRO COMBICON ND40' or 'D-SUB ND40'

No line filter integrated. Please provide for an external line filter.

Accessories

You may order additional connector sets and ring cores for assembly and installation of the devices.

Order number	Product	Scope of delivery / Characteristics
105212	Connector set 'MICRO COMBICON ND40'	1 x HD D-SUB, 15-pole, male (incl. hood) 1 x D-SUB, 9-pole, male (incl. hood) 1 x D-SUB, 9-pole, female (incl. hood) 1 x MICRO COMBICON, 8-pole female 1 x MICRO COMBICON, 12-pole female 1 x connector 'bus termination'
105213	Connector set 'D-SUB ND40'	1 x HD D-SUB, 44-pole, male (incl. hood) 1 x HD D-SUB, 15-pole, male (incl. hood) 1 x D-SUB, 9-pole, male (incl. hood) 1 x D-SUB, 9-pole, female (incl. hood) 1 x connector 'bus termination'
105214	Connector set 'Power Connection ND41'	1 x COMBICON, 16-pole female 1 x ring core (order number 100950)
105215	Connector set 'Power Connection ND42' (ND42-5605 and ND42-5610)	1 x COMBICON, 12-pole, female 1 x COMBICON, 2-pole, male 1 x ring core (order number 100950)
105468	Connector set 'Power Connection ND42-5618'	1 x POWER COMBICON, 12-pole, female 1 x COMBICON, 2-pole, male 1 x ring core (order number 100950)
105216	Connector set 'Power Connection ND43'	1 x POWER Connector, 6-pole, female 1 x POWER Connector, 3-pole, female 1 x ring core (order number 100950)
100950	Ring core	Ring core Material:N30 Version: R25/10 AL: 4600 nH
102719	serial cable for “NOVOBUS” to the computer	1 x serial cable 9poles 2m

3 Safety Information

NOVODRIVE works with hazardous voltage!

Line voltage is present at power inputs, motor connectors, brake choppers, DC link circuits, and the motor temperature sensor input. Connectors carrying hazardous voltage are X1, X6, and X7.

3.1 Intended Usage

Devices of the ND40 series are state-of-the-art servo converters for driving brushless servo motors and linear motors featuring an appropriate position sensor.

NOVODRIVE servo converters are components to be installed in electric machines. A NOVODRIVE servo converter may only be put into operation as such an integrated component.

Safe and trouble free operation

Safe and trouble free operation is possible only by correct interplay of NOVODRIVE with:

- motor and position sensor,
- in combination with correct wiring, and
- appropriate parametrization.

An erroneous parametrization or wiring or defect may accelerate the motor uncontrolled and hazardous.

Using NOVODRIVE servo converters for any other purpose may lead to property damage or damage to users and other persons.

NOVODRIVE servo converters may be installed and put into operation only if in technically perfect condition, if used in compliance with the intended usage described above, and if users are aware of risks and hazards that may occur when working with the devices.

Machinery Directive

According to the 2006/42/EG Machinery Directive, machinery manufacturers have to make an appropriate risk assessment for the specific machinery, and they have to take appropriate action in order to prevent damage to persons or property when working with the machinery.

Machinery manufacturers and/or operators are responsible for sticking to applicable guidelines for safe operation and prevention of accidents.

Ambient Conditions

NOVODRIVE servo converters may not be used in explosion-prone areas or in medical areas or other areas classified hazardous.

3.2 General Safety Instructions

Before you install and put into operation a NOVODRIVE servo converter, read this User Manual fully and carefully. Inappropriate handling of NOVODRIVE servo converters may lead to damage to persons or property. Make sure you take notice of the technical specifications and connecting conditions (check type plate and this User Manual).

Transportation and Storage

To transport and store NOVODRIVE servo converters, use the original packaging only.

Repairs and Modifications

Do not dismantle and/or modify NOVODRIVE servo converters.

If a NOVODRIVE servo converter needs repair or modification, this may be done by skilled personnel of NOVOTRON GmbH only.

Working at the motor or axis

Do not work on running gear until NOVODRIVE has been disconnected from the power supply system and NOVODRIVE's capacitors' are fully discharged.

Provide for sufficient protection, as a defect in NOVODRIVE, in the feedback system or wiring may speed up the drive enormously within fractions of a second, leading to uncontrolled movements and very high acceleration of the motor.

3.3 Connection

Only skilled personnel may install, put into operation, and maintain NOVODRIVE servo converters. Skilled personnel are persons familiar with the requirements to assemble, install, put into operation, and work with the product. Such persons need to take notice of and comply with the following norms and guidelines:

- IEC 364 / CENELEC HD 384 or DIN VDE 0100,
- IEC-Report 664 or DIN VDE 0110,
- national directives for accident prevention.

Grounding

Make sure NOVODRIVE's compact case or 19“ rack, as the case may be, is grounded before the line voltage is switched on (→ section 5.3.1).

Wiring

Always check the wiring before you power up NOVODRIVE. Check

- if all connections are correct and all terminal clamps are tight,
- if grounding / shielding is correct,
- if connectors are locked against getting loose.

Do not pull any (i.e. also low-voltage) energized plug connectors, as this may destroy the electronics. Make sure no voltage carrying parts can be accidentally touched. Cables carrying line

voltage must have double or reinforced insulation between wire and surface. Use appropriate sleeves for wire ends.

Fuse Protection

Make sure NOVODRIVE is equipped with an appropriate and correctly connected fuse protection.

Emergency Shutdown / Emergency Stop

Provide for an emergency shutdown / emergency stop by which the motor can be brought to a standstill at any time (see section 6 Emergency Shutdown / Emergency Stop).

3.4 Operation

Discharge Time

NOVODRIVE contains capacitors which keep on carrying hazardous operating voltage for some time after line voltage has been switched off.

Therefore, after disconnecting NOVODRIVE from line voltage wait at least five minutes before you touch any voltage carrying parts (e.g. pins) or loosen connections. As a safety measure, repeatedly measure the DC link voltage and wait until it is below 40 V.

Electric Shock Protection

A moving motor can produce hazardous voltage also if line voltage is switched off.

Therefore, the discharge time of the capacitors does not start until the motor has stopped.

Power On/Off

Do not switch on and off line voltage of NOVODRIVE frequently in short time, as this may lead to an overload of NOVODRIVE's inrush current limitation, which could destroy the inrush current limiter. Therefore, always wait at least one minute before switching NOVODRIVE on again after you switched it off.

Sequence for Switching On/Off

If you want to switch on NOVODRIVE, first switch on the power supply unit providing the 24 VDC supply voltage for the low-voltage part, and then switch on line voltage for the power part. If you want to switch off NOVODRIVE, proceed vice versa.

4 Technical Specifications

4.1 Applicable Norms

Low Voltage Directive (LVD)

If installed and wired correctly, all NOVODRIVE servo converters comply with the Low Voltage Directive (LVD) 2006/95/EG with regard to the following norms:

EN 50178:1997

Protection class according to EN 60529:1991

Compact case version	IP20
19“ version	Protection class determined by 19“ rack.

Electromagnetic Compatibility Directive (EMC Directive)

If installed and wired correctly, all NOVODRIVE servo converters comply with the EMC Directive 2004/108/EG with regard to the following norms:

EN 61 800-3:2004

NOVODRIVE's integrated line filter is designed for a maximum motor line length of 10 m. If you work with a longer motor line, an external line filter may be needed.

Connect NOVODRIVE to industrial power supply systems only. If you want to connect NOVODIVE to the public grid, further measures are necessary to comply with EN 61000-3-2.

Noise emission

NOVODRIVE is a Class A device. If used in residential environments, this product may cause high-frequency noise which might require additional measures for noise suppression.

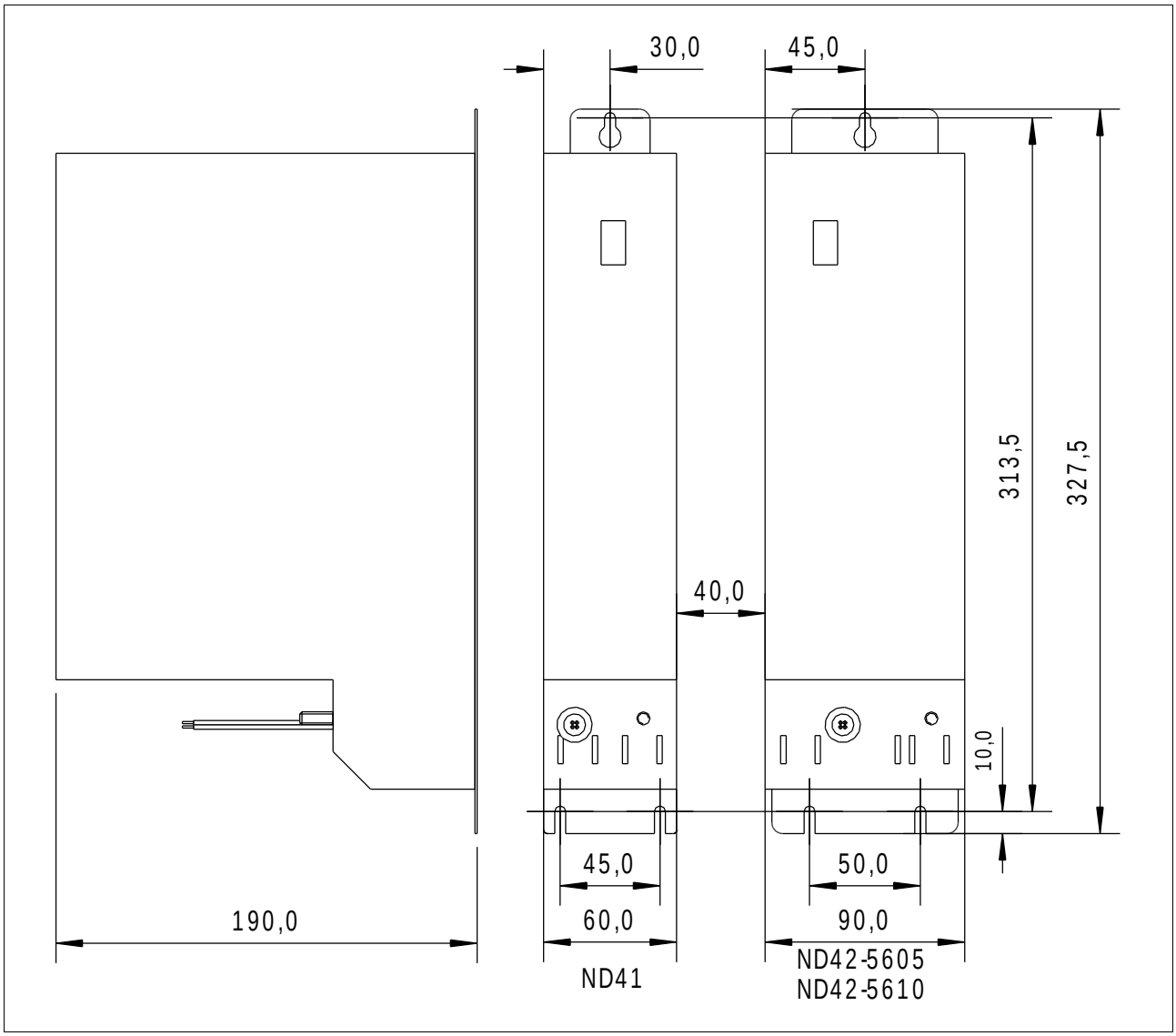
4.2 Installation

Necessary tools:

- screw driver 4 mm
- screw driver 3 mm
- open-end wrench 10 mm
- stripping tool

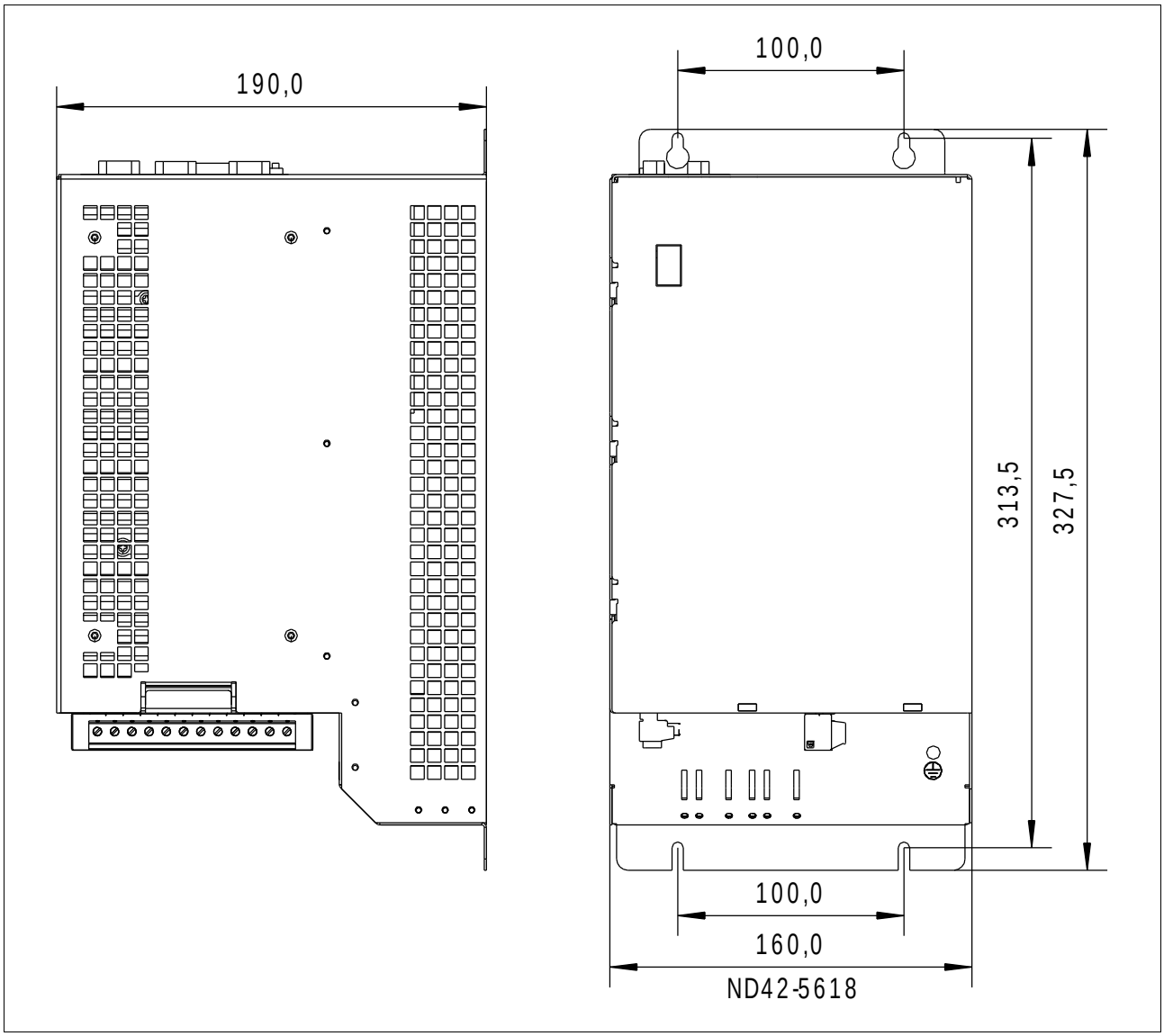
4.2.1 Compact case

Dimensional drawing



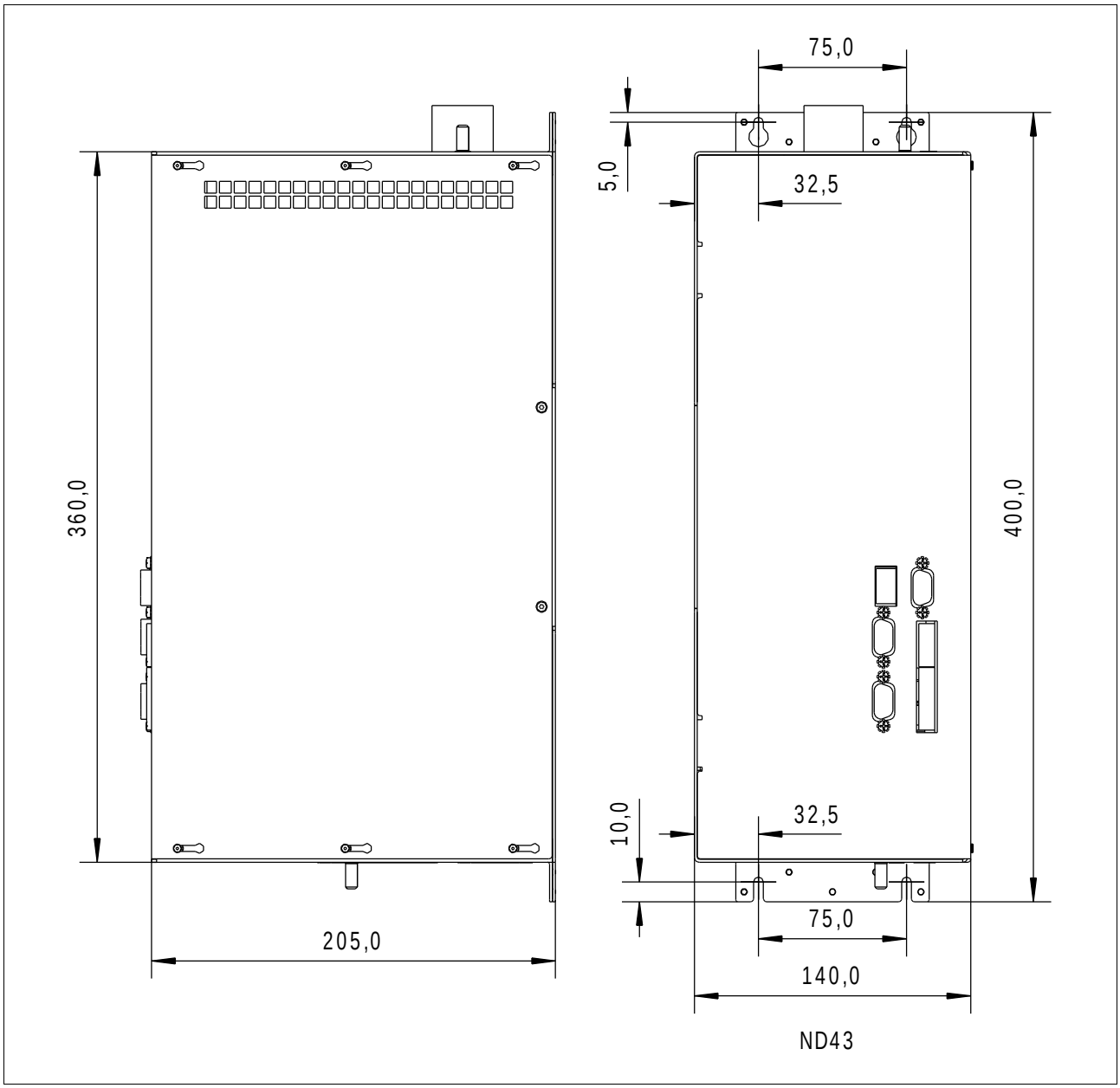
All figures in [mm]

Attachment screws: M4 cylinder-head screws with washers and toothed lock washer.



All figures in [mm]

Attachment screws: M4 cylinder-head screws with washers and toothed lock washer.

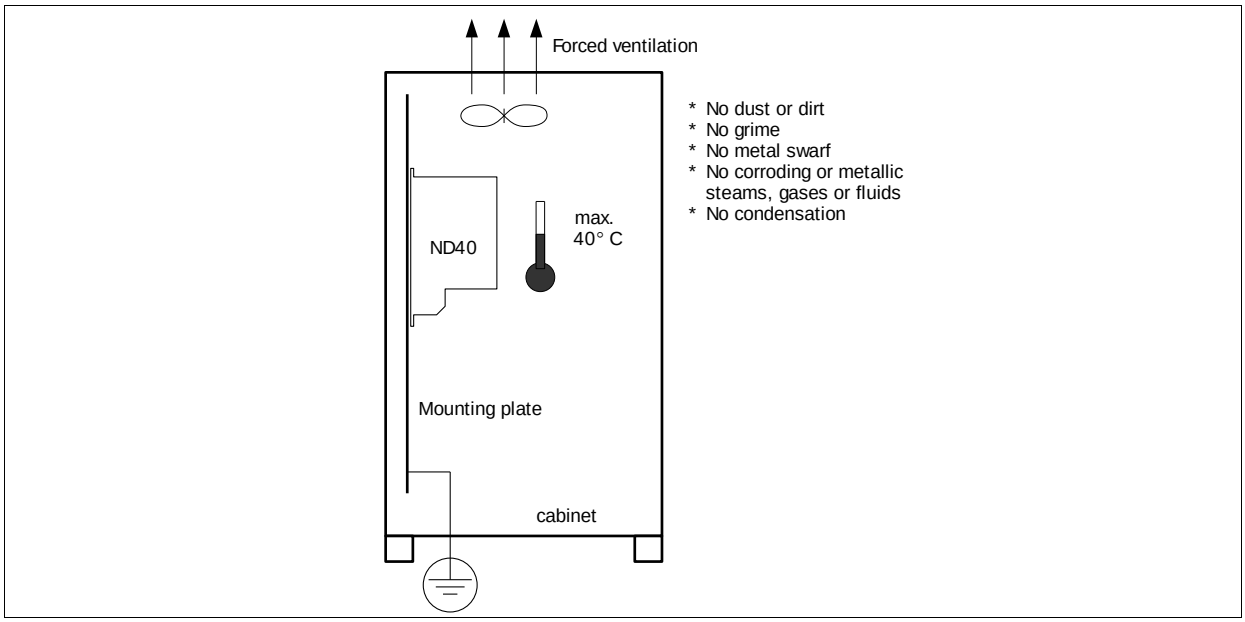


All figures in [mm]

Attachment screws: M4 cylinder-head screws with washers and toothed lock washer.

Important information

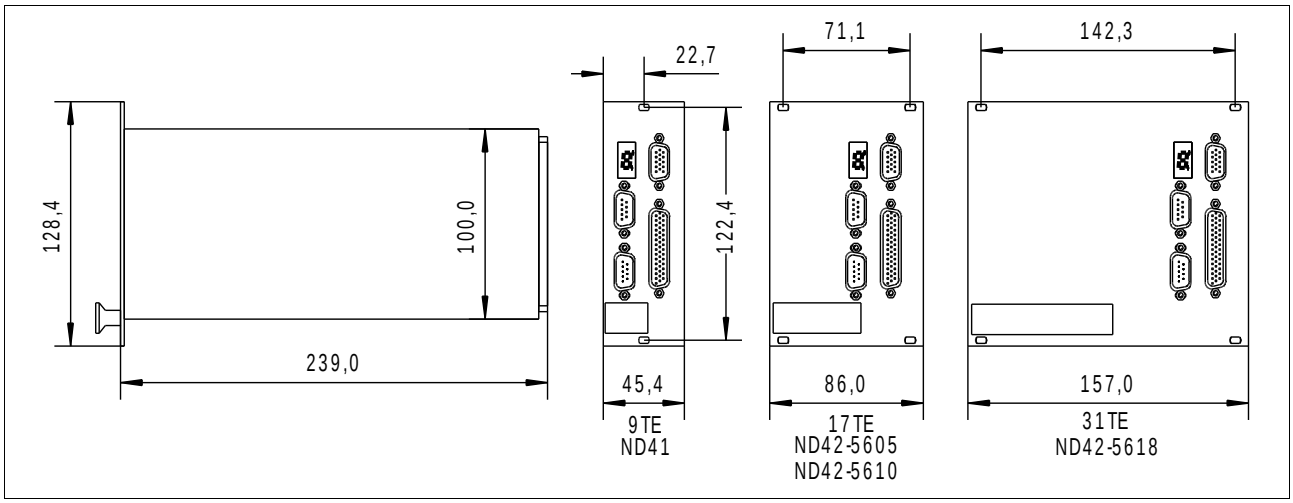
- The compact case must be mounted into a protected switchgear cabinet.
- Make sure ambient conditions in the switchgear cabinet comply with specifications given in section 4.2.3.
- The compact case must be grounded.
- The power connection area of the compact case must be protected against accidental contact.
- Connector X6 (only for ND42) always carries line voltage. For protection against accidental contact, X6 must always be plugged, even if no cable is connected to the plug.
- The mounting position of the compact case is vertical.



- Make sure enough cooling air is always available. To provide for enough space between the case and other devices, leave at least 20 mm clearance to the left and to the right of the case. If more than one compact case is to be mounted, leave at least 40 mm clearance between the cases so that enough cooling air can be taken in.
- Make sure there is a air convection in the cabinet.
- Do not use NOVODRIVE in areas classified hazardous.

4.2.2 19“ rack

Dimensional drawing



All figures in [mm]

Important information (in addition to the information given for the compact case)

- 19 “NOVODRIVE only ND41 and ND42.
- While transport and storage the NOVODRIVE must be protected by ESD package.
- While installation and removal of NOVODRIVE, it must be paid attention to ESD handling because electrical units can be touched.
- The 19" rack must be grounded. The cross section of protective earth must be chosen in respect to cross section of mains.
- As the 19" version of NOVODRIVE comes without casing, it offers no protection against hazardous body currents. Therefore make sure both the top side and the bottom side of the 19" rack are covered in such a way that no parts of NOVODRIVE can accidentally be touched.
- The connection area on the backside of the 19" rack must be protected against accidental contact.

Creepage and clearance distances

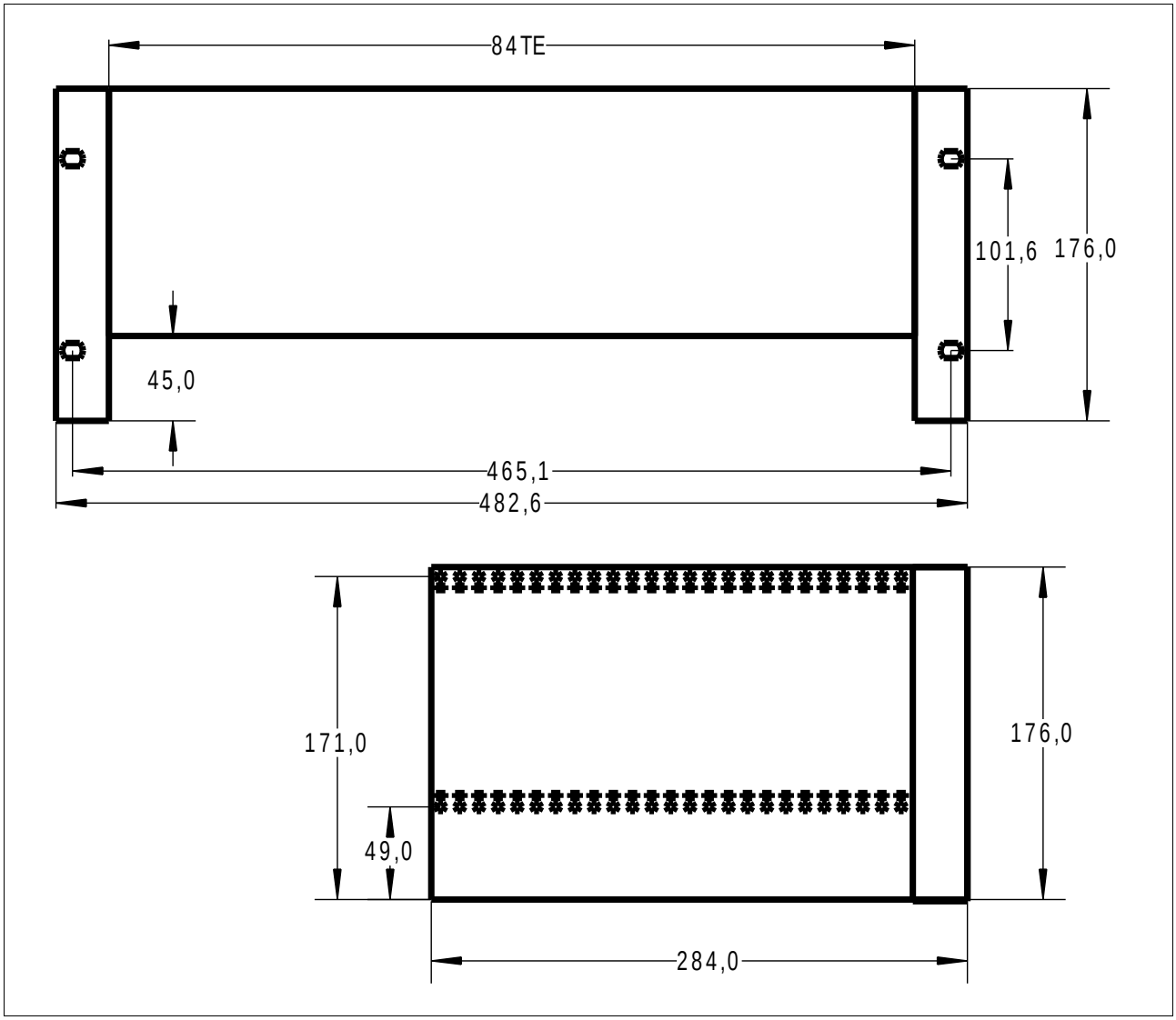
For the compliance of creepage and clearance distances with EN50178:1997 inside the 19” frame the constructor is responsible.

- The 19” guide rails must be made of insulating material. They must offer sufficient creepage and clearance distances between NOVODRIVE's printed circuit boards and the 19" rack.
- The heatsink of ND41 should be considered as life part. He should never grounded by mounting on an other part.

- Between all NOVODRIVE and/or other 19” devices should remain a sufficient clearance. Especial on the right side of ND41 (see above 19” front side) there should be after inserting in the 19” rack a sufficient air gap to other parts.
- Pulling out NOVODRIVE from the 19” rack and inserting NOVODRIVE into the 19” rack may be done only if no voltage is present (wait until capacitors are fully discharged!) and may be done only by skilled personnel.
- For operation of the 19“ version, forced ventilation is necessary. Such forced ventilation must affect NOVODRIVE's whole cross section. If forced ventilation is missing, this may lead to reduction in performance and reduction of lifespan of NOVODRIVE.

Type	ND41	ND42-5605 / 5610	ND42-5618
Air quantity recommended	30...40 m³/h	80...100 m³/h	160...200 m³/h

Rack dimension



4.2.3 Ambient conditions

Operation

Surge voltage category according to EN 50178 Sect. 5.2.16	III
Pollution Degree according to EN 50178 Sect. 5.2.15.2	2
Climate class according to EN 50178 Sect. 6.1 Temperature Relative air humidity	Type B +5 degree Celsius ... +45 degree Celsius 5 % ... 85 %
Condensation or icing	Not permissible
Pollution according to EN 50178 Sect. 6.1.3	NOVODRIVE may not be exposed to dust, dirt, grime, metal swarf, corroding or metallic steams, gases or fluids. Forced ventilation must be done over filters, if need be. Avoid any condensation. If condensation still occurs, make sure any humidity is removed by a heater before power-on.
Operating restrictions	Starting from a height of 1000 m over sea level reduces due to the decreased heat dissipation the power output NOVODRIVE. Starting from a height of 2000 m over sea level the NOVODRIVE may be only operated with reduced operating voltage.

Storage and transport

Climate class according to EN 50178 Sect. 6.1 Temperature Relative air humidity	Type D -25 degree Celsius ... +55 degree Celsius 5 % ... 95 %

4.2.4 Weight

	Compact case	**19“**
ND41	2,4kg	0,6kg
ND42	3,4kg	1,2kg
ND42-5618	2,4kg	3,4kg
ND43	11,2kg	---

4.3 Electrics

4.3.1 Low-voltage part

The supply voltage for NOVODRIVE's low-voltage part must be generated by an external, regulated power supply unit. The supply voltage must be grounded.

Voltage	24 V = ±10 %
Current consumption 19“ version [fuse]	1,0 A [2 A]
Compact case version [fuse]	1,5 A [2 A]

To ensure safe power-on of NOVODRIVE, the power supply unit must be capable of temporarily supplying double the amount of current indicated in the table.

4.3.2 Power part

Mains voltage

The mains voltage connection may take place only at TN or TT network with grounded neutral point. If a asymmetrically grounded network is used an insulating transformer is necessary. In case of using of a separation or a series transformer the neutral point must be grounded on the secondary side.

Error current (→ EN 61800-5-1:2003)

The NOVODRIVE can cause a direct current in protective earth conductor. Where for protection in case of direct or indirect contact a residual-current-protection (RCD) is used, on power supply side only a RCD type B is permissible.

Device type	ND41-3202	ND41-3204	ND41-3207
Line voltage single-phase	230 V~ ±10 %		
Line voltage three-phase (phase/line-line voltage)[1]	130/230 V~ ±10 %		
Input frequency	50/60 Hz		
Rated output power	0,7 kVA	1,4 kVA	2,5 kVA
Fuse protection single-phase fuse inert [2]	10 A		
Fuse protection three-phase fuse inert [2]	3 x 10 A		
Minimum cross-section of feed lines (copper)	1,5 mm²		
Minimum cross-section of ground connection (copper)	2,5 mm²		

1 The series transformator must have a grounded natural point

2 The fuse rating of NOVODRIVE is based on the maximum capability of the internal rectifier.

Maximum inrush current	160 A

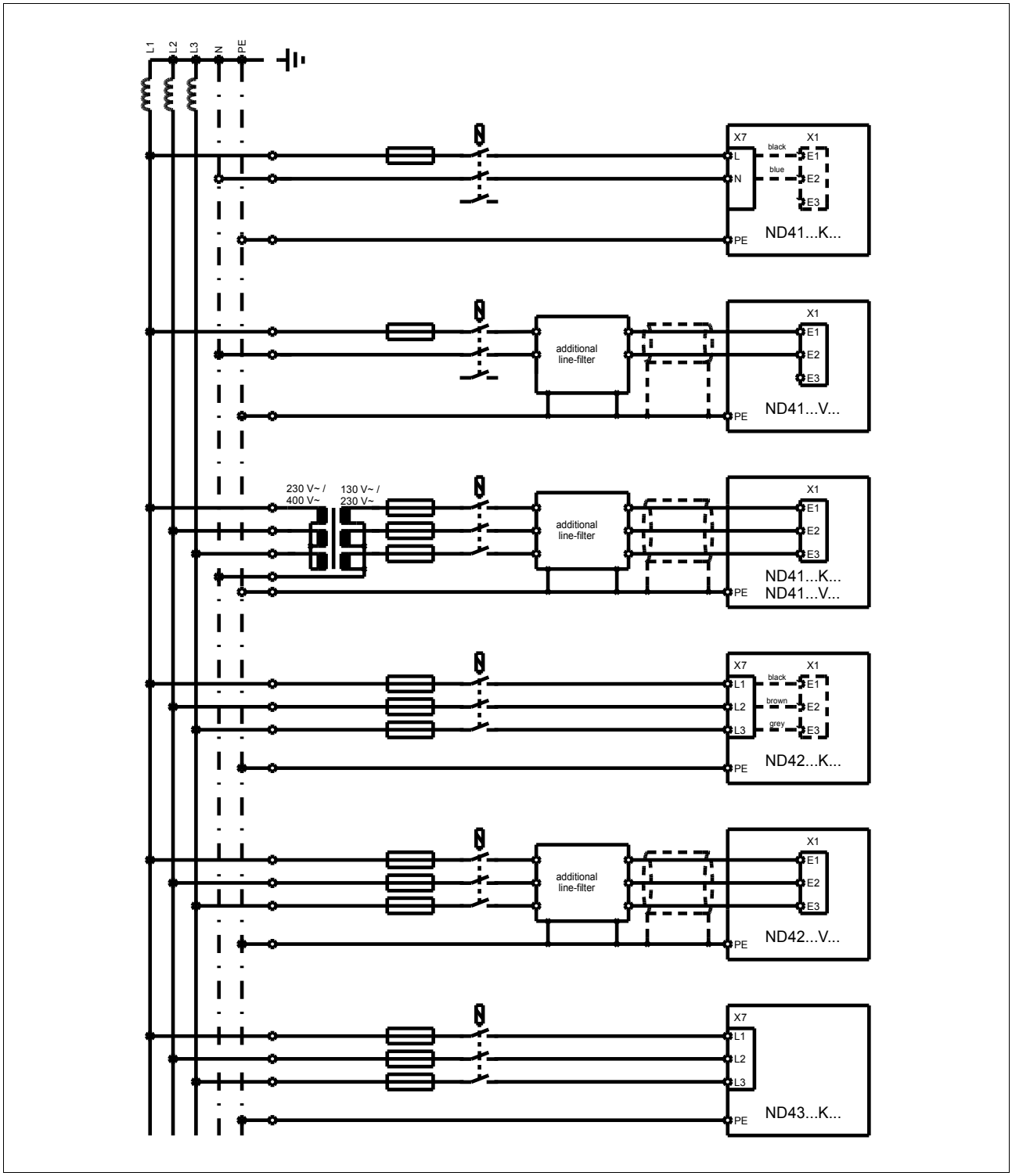
Device type	ND42-5605	ND42-5610	ND42-5618
Line voltage three-phase (phase/line-line voltage)	230 / 400 V~ ±10 %		
Input frequency	50/60 Hz		
Rated output power	3,3 kVA	6,5 kVA	12,3 kVA
Fuse protection three-phase fuse inert ²	3 x 16 A		3 x 20 A
Minimum cross-section of feed lines (copper)	2,5 mm²		4,0 mm²
Minimum cross-section of ground connection (copper)	2,5 mm²		4,0 mm²
Maximum inrush current	5 A		10 A

Device type	ND43-6820	ND43-6825
Line voltage three-phase (phase/line-line voltage)	230...280 / 400...480 V~ ±10 %	
Input frequency	50/60 Hz	
Rated output power	15,6 kVA	19,6kVA
Fuse protection three-phase fuse inert ²	3 x 25 A	
Minimum cross-section of feed lines (copper)	6,0 mm²	
Minimum cross-section of ground connection (copper)	6,0 mm²	
Maximum inrush current	10 A	

Three-phase connection of ND41

In case of three-phase connection of ND41, phase voltage may not exceed 130 V per phase, otherwise NOVODRIVE gets severely damaged.

Overview of electrical supply - variants



4.3.3 Connection of DC voltage links

Connection of DC voltage links

Before using connectors Z+ and Z- consult the manufacturer.

External buffer capacitors

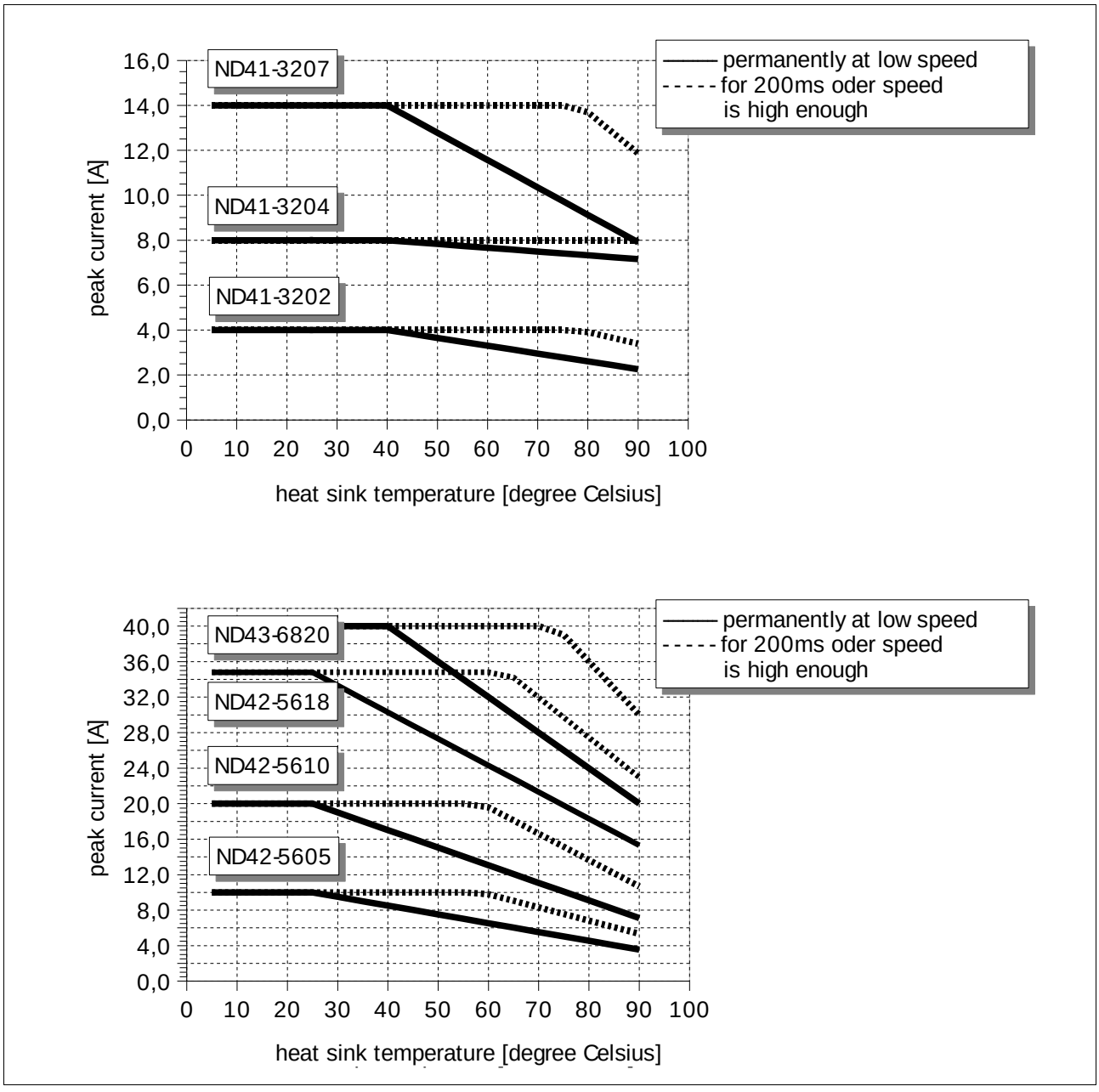
The connectors of DC link voltage Z+ and Z- are not adequate for direct connection of external buffer capacitors!

4.3.4 Peak current

NOVODRIVE's output capacity is limited by several factors:

- the peak current of the specific application (→ Input Variable 'CurrentPeak1Limit'),
- the maximum permissible motor peak current (→ Parameter 'CurrentPeak2Limit'),
- the i²t current limitation, which limits the peak current when the I²t limit value (→ Parameter 'I2tLimit') is reached,
- the heat sink temperature (see below), with the maximum permissible peak current being dependent on the temperature and the drive's state.

The output current is limited to the smallest value of all factors.



4.3.5 DC link and inverter

Device type	ND41-3202	ND41-3204	ND41-3207
DC link voltage at rated supply voltage	320 V=		
Cut-off threshold at overvoltage in DC link	430 V= ±5 %		
Cut-off threshold at undervoltage in DC link	30 V=±5 %		
Rated motor current	2,0 A	4,0 A	7,0 A
Maximum motor current	4,0 A	8,0 A	14,0 A
Inverter pulse frequency	19,5 kHz	9,8 kHz	
Unaffected slope at motor outputs	typ. 3 kV/µs		
Rated voltage of motor outputs	300 V~		
Voltage drop at rated current	~10 V	~15 V	~20 V
Inverter power dissipation at rated current	40 W	50 W	60 W
DC link capacity	360 µF	480 µF	

Device type	ND42-5605	ND42-5610	ND42-5618
DC link voltage at rated supply voltage	560 V=		
Cut-off threshold at overvoltage in DC link	720 V= ±5 %		
Cut-off threshold at undervoltage in DC link	180 V=±5 %		
Rated motor current	5,0 A	10,0 A	18,0 A
Maximum motor current	10,0 A	20,0 A	34,0 A
Inverter pulse frequency	9,8 kHz	4,9 kHz	4,9 kHz
Unaffected slope at motor outputs	typ. 6 kV/µs		
Rated voltage of motor outputs	500 V~		
Voltage drop at rated current	~10 V		
Inverter power dissipation at rated current	100 W	130 W	260 W
DC link capacity	300 µF		675 µF

Device type	ND43-6820	ND43-6825
DC link voltage at rated supply voltage	680 V=	
Cut-off threshold at overvoltage in DC link	864 V= ±5 %	
Cut-off threshold at undervoltage in DC link	200 V=±5 %	
Rated motor current	20,0 A	25,0 A
Maximum motor current	40,0 A	45,0 A
Inverter pulse frequency	4,9 kHz	
Unaffected slope at motor outputs	typ. 8 kV/µs	
Rated voltage of motor outputs	600 V~	
Voltage drop at rated current	~10 V	
Inverter power dissipation at rated current	260 W	
DC link capacity	720 µF	

4.3.6 Brake chopper

The integrated brake chopper resistor can be activated over connector X1 by means of a wire jumper. If the integrated resistor's power rating is not sufficient, you may connect an external resistor to X1.

The braking energy is always electronically monitored by NOVODRIVE. If a certain limit value, which can be altered, is exceeded, an error is generated (→ Parameter 'BrPowerBoundary', or setup software 'Limit Values / Brake Chopper').

		ND41		ND42		ND43
	Device type	3202	3204 3207	5605 5610	5618	6820 6825
Integrated resistor	**Continuous power dissipation (at forced**	68 W	130 W	130 W	150 W	150 W
	Maximum braking energy	200 Ws	400 Ws	400 Ws	600 Ws	600 Ws
	Resistance	50 Ohm	25 Ohm	25 Ohm	17 Ohm	17 Ohm
External resistor	**Continuous power dissipation**	< 0,5 kW	< 2,0 kW	< 5,0 kW	< 5,0 kW	< 5,0 kW
	Maximum braking energy	Determined by power rating of external resistor				
	Resistance	50 Ohm	25 Ohm	33 Ohm	18...33 Ohm	18...33 Ohm
Both	**Voltage threshold**	375...415 V	375...415 V	670...700 V	670...700 V	806...840 V
	Pulse power in resistor	3,5 kW	6,8 kW	14,8 kW	28,8 kW	41,5 kW

Maximum braking energy

The average maximum braking energy is given in the line saying 'Continuous power dissipation' in the table above. A braking process may never feed back more energy than indicated in the line saying 'Maximum braking energy'.

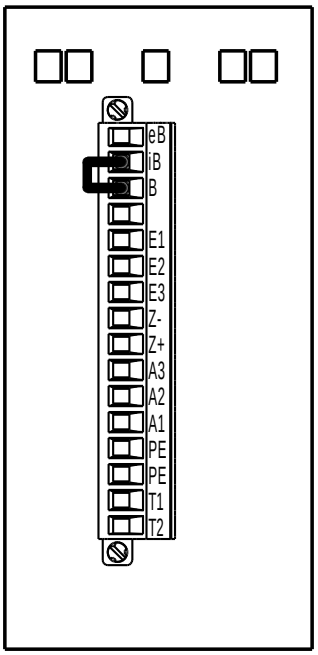
At a given braking energy, the repetition rate for braking processes can be determined by the following formula:

$$\text{min. repetition rate}[sec] = \frac{\text{braking energy}[J]}{\text{continuous power dissipation brake resistor}[W]}$$

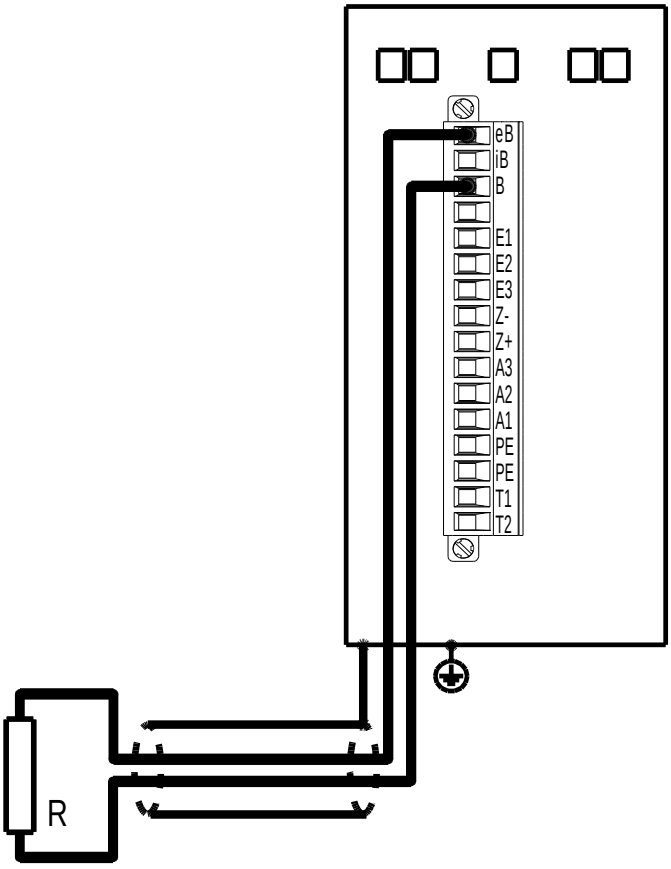
External brake chopper resistor

When selecting an external resistor, be aware of the fact that in the worst case the resistor terminals must bear 400 VDC (ND41) or 900 V (ND42/ND43), respectively. Always make sure the resistor can not cause fire or endanger electric safety due to overheating or flying sparks.

Internal brake chopper resistor



External brake chopper resistor



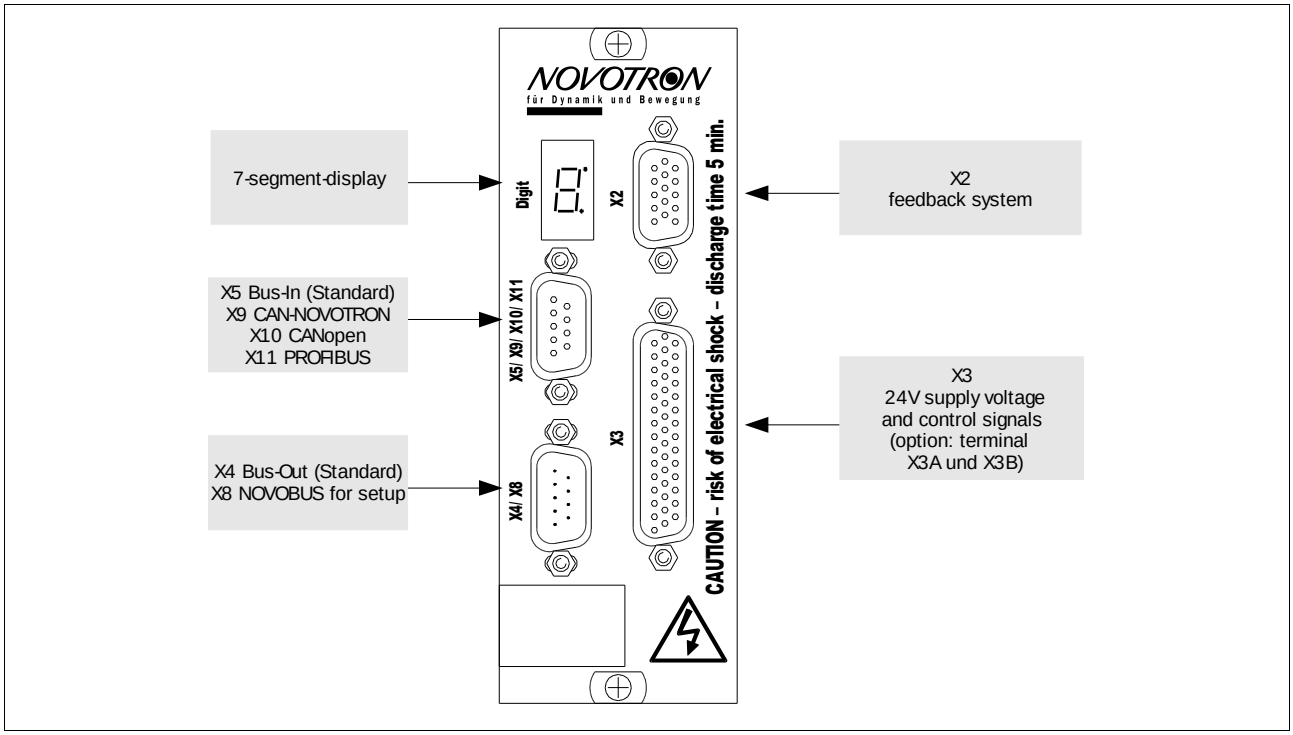
External brake chopper resistor

The length of the cable leading to the external brake chopper resistor may not exceed 3 m. If the cable is longer than 0,5 m, it must be shielded.

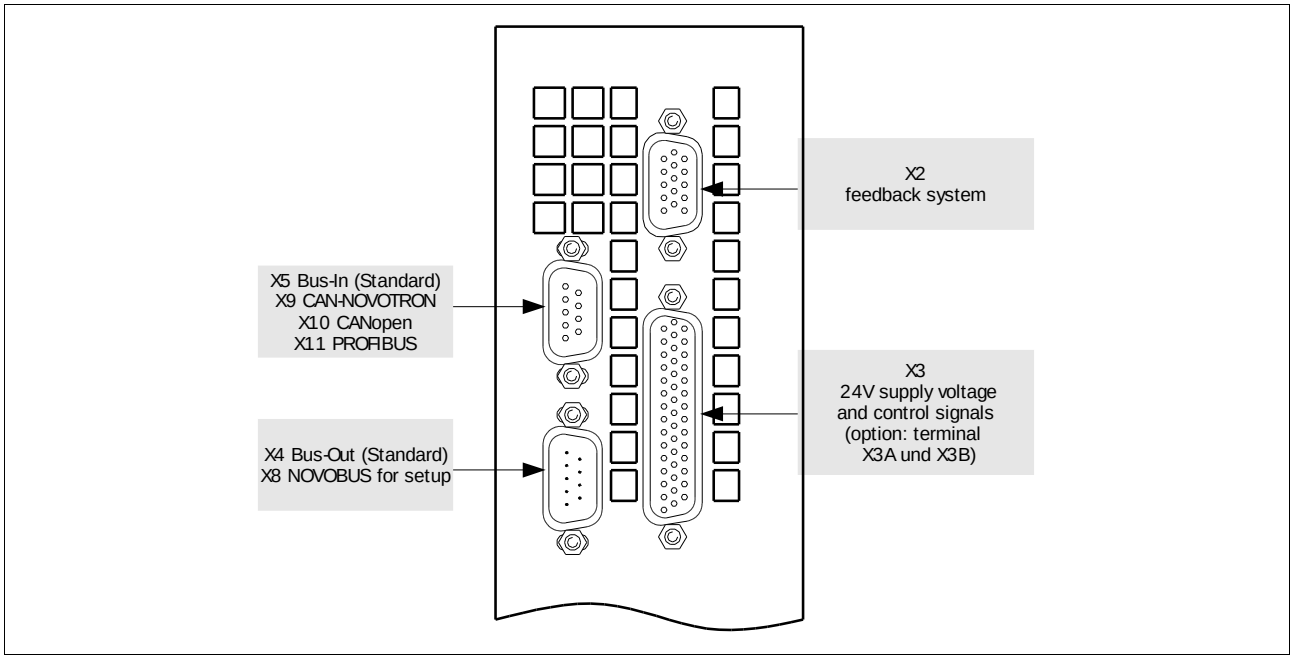
5 Connectors

5.1 Low-Voltage Part

19“ version



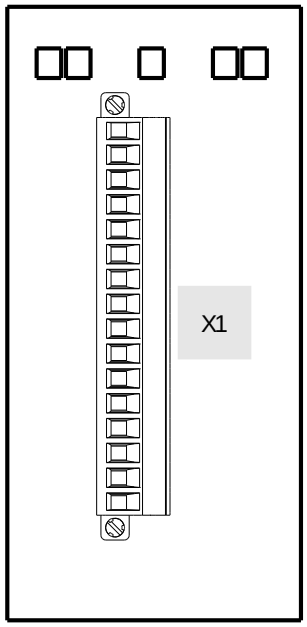
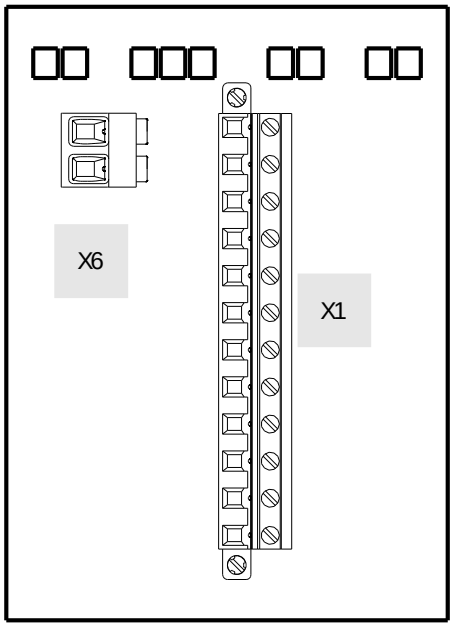
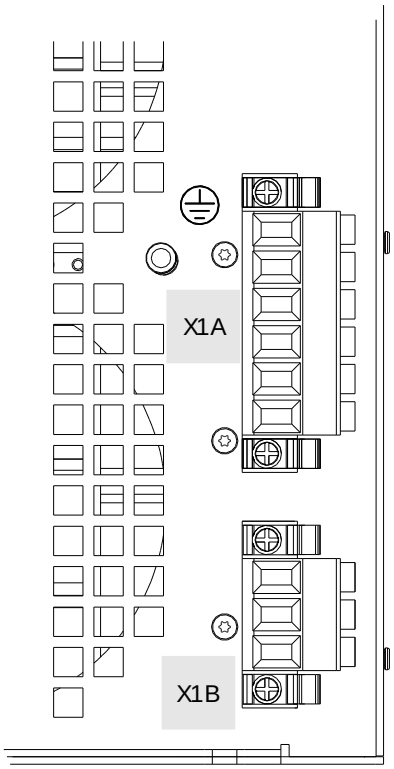
Compact case version



Compact case versions have the 7-segment display on the front side.

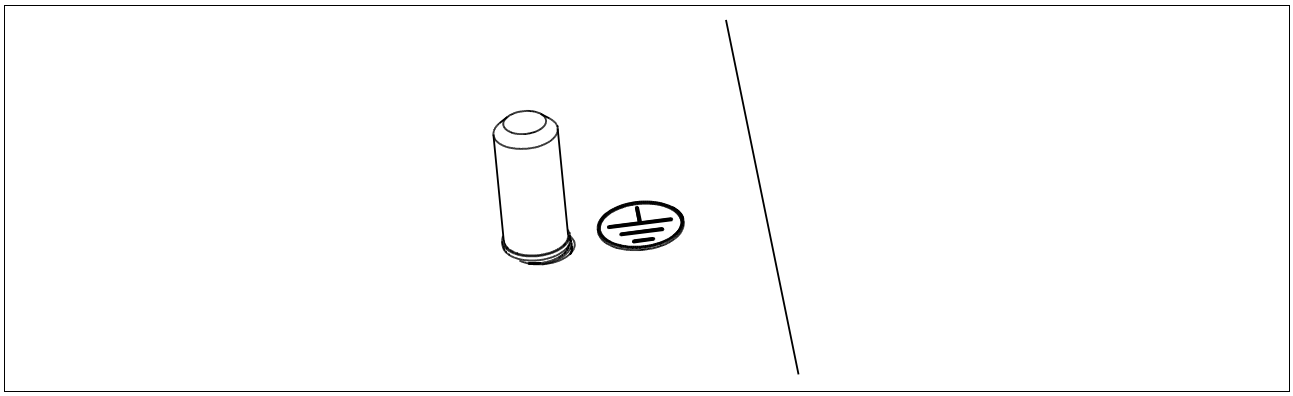
5.2 Power Part

Connectors are the same for 19“ version and compact case version.

ND41	ND42	ND43 (only compact case)
		 (cut-out of chassis)

5.3 Pin Assignment

5.3.1 Protective earthing



Radially connect to the compact case's earthing bolt the lines to

- the switchgear cabinet's earth conductor,
- NOVODRIVE's X1, Pin PE (keep line as short as possible in order to achieve best possible interference suppression),
- the integrated line filter's earth conductor.

When using the 19“ version, use a 19“ backplate with earthing bolt and connect the bolt the same way as described above.

Protective earthing

Protective earthing is required for both the compact case and the 19“ rack.

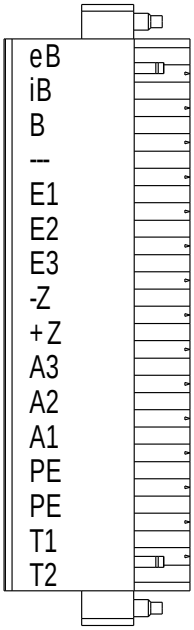
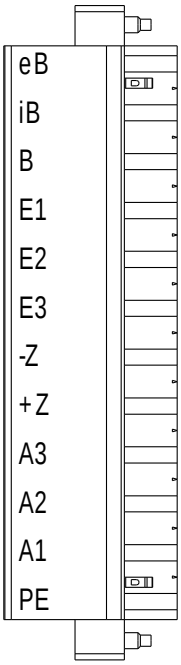
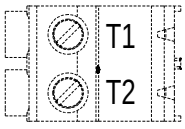
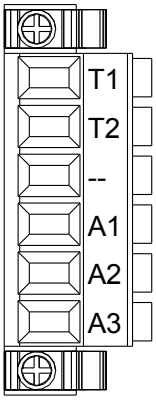
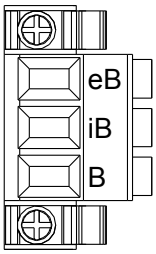
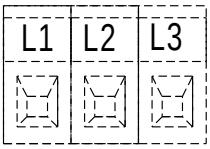
Leakage Current

Due to the integrated line filter, leakage current > AC 3,5 mA may occur during operation. According to EN50178:1997 Sect. 5.3.2.1, applications with leakage current AC 3,5 mA need a fixed installation, with one of the following requirements being fulfilled:
* earth conductor cross-section at least 10 mm² Cu.,
* earth conductor monitoring by a device providing for automatic switch-off in case of error,
* connection of a second earth conductor.

5.3.2 X1 – Power

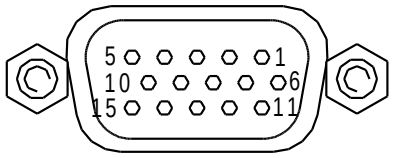
Connection of mains → section 4.3.2

Connection motor → section 4.4

ND41	ND42	ND43
ND41-3202, ND41-3204 and ND42-3207: MSTB 2,5-16-STF-5,08	ND42-5605 and ND42-5610: Front-GMSTB 2,5-12-STF-7,62 ND42-5618: PC4/12-ST-7,62 GIC2,5HCV/2-ST-7,62	ND43-68xx: BVZ 7,62HP 06SF SN (X1A) BVZ 7,62HP 03SF SN (X1B)
 (X1)	 (X1)  (see x6)	 (X1A)  (X1B)  (see X7)
tightening torque 0,5 ... 0,6 Nm	tightening torque 0,5 ... 0,6 Nm	tightening torque 0,5 ... 0,6 Nm

Pin	Function
eB	External brake chopper (not short-circuit proof)
iB	Internal brake chopper (not short-circuit proof)
B	Brake chopper + (not short-circuit proof, identical with Z+)
---	Not connected
E1	Line phase L1
E2	Line phase L2
E3	Line phase L3
Z-	DC link – (not short-circuit proof)
Z+	DC link + (not short-circuit proof)
A3	Output motor phase A3 (short-circuit proof)
A2	Output motor phase A2 (short-circuit proof)
A1	Output motor phase A1 (short-circuit proof)
PE (2x)	Interference suppression /protective earth
T1	Motor temperature sensor (PTC or opening contact; caution: not potential-free but carrying line voltage; not short-circuit proof)
T2	Motor temperature sensor (PTC or opening contact; caution: not potential-free, but carrying line voltage; not short-circuit proof)

5.3.3 X2 – Position sensor



15-pole HD D-SUB female connector with UNC thread.

Pin	Function	Motor temperature sensor	Resolver	Hall sensors	Encoder digital and analog	Commutation track	EnDat 2.2
1	GND	T-	-	GND	GND	GND	GND
2	connenction for PTC or break contact element	T+	-	-	-	-	-
3	incremental signal A input RS422 / 1 Vss	-	-	-	A+	-	-
4	incremental signal A input RS422 / 1 Vss	-	-	-	A-	-	-
5	GND	GND	R2	GND	GND		
6	zero reference mark input RS485	-	-	-	N+	-	Data+
7	power supply 5 V±10% 200 mA	VCC	-	VCC	VCC		
8	Resolver reference signal 5Veff AC Output	-	R1	-	-	-	-
9	Resolver Sinus input RS485 / 3 Vss	-	S2	V	-	C-	-
10	Resolver Sinus input RS485 / 3 Vss	-	S4	W	-	C+	-
11	incremental signal B input RS422 / 1 Vss	-	-	-	B+	-	-
12	incremental signal B input RS422 / 1 Vss	-	-	-	B-	-	-
13	zero reference mark input RS485	-	-	-	N-	-	Data-
14	Resolver Cosinus input RS485 / 3 Vss	-	S3	/U	-	D-	Clock-
15	Resolver Cosinus Input RS485 / 3 Vss	-	S1	U	-	D+	Clock+

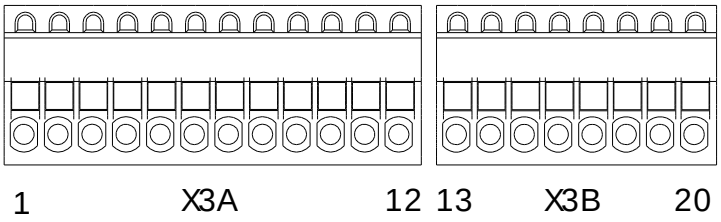
Motor temperature sensor

Connect a motor temperature sensor to X2 only if the sensor and the cables have double or reinforced isolation against the motor winding.

5.3.4 X3 – Control signals

Max. length of cable: 30 m

X3A / X3B – MICRO COMBICON

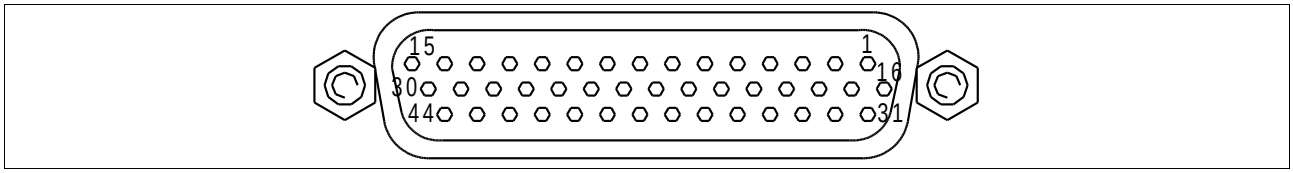


X3A Phoenix Contact MICRO COMBICON FK-MC 0,5/12-ST-2,5

X3B Phoenix Contact MICRO COMBICON FK-MC 0,5/8-ST-2,5

Connector	Pin	Function	
X3A	1	control voltage 0 V	→ Section 4.3.1 „Electrics“
X3A	2	control voltage 24 V	
X3A	3	BTB2 (ready to operate relay)	→ Section 11.2 „Digital outputs“
X3A	4	BTB1 (ready to operate relay)	
X3A	5	MB2 (Motor brake relay)	
X3A	6	MB1 (Motor brake relay)	
X3A	7	GPIn6 (function input)	→ Section 11.1 „Digital inputs“
X3A	8	GPIn5 (Reference switch)	
X3A	9	GPIn4 (positive limit switch)	
X3A	10	GPIn3 (negative limit switch)	
X3A	11	GPIn2 (setpoint enable)	
X3A	12	GPIn1 (inverter enable)	
X3B	13	EncOut N--	→ Section 11.6 „Encoder output“
X3B	14	EncOut N+	
X3B	15	EncOut B--	
X3B	16	EncOut B+	
X3B	17	EncOut A--	
X3B	18	EncOut A+	
X3B	19	AnalogInput--	→ Section 11.4 „Analog input“
X3B	20	AnalogInput+	

X3 – D-SUB



44-pole HD D-SUB female connector with UNC thread.

Pin	Function	Pin	Function	Pin	Function
1	Count A-- (counter input)	16	Count A+ (counter input)	31	Internally used
2	Count B-- (counter input)	17	Count B+ (counter input)	32	Internally used
3	EncOut A-- (encoder output)	18	EncOut A+ (encoder output)	33	Internally used
4	EncOut B-- (encoder output)	19	EncOut B+ (encoder output)	34	Internally used
5	EncOut N-- (encoder output)	20	EncOut N+ (encoder output)		
6	/SyncIn (cycle synchronisation)	21	SyncIn	35	AnalogIn+
7	/SyncOut	22	SyncOut	36	AnalogIn--
8	GPIn3 (neg. limit switch)	23	GPIn2 (Setpoint Enable)	37	GPIn1 (Inverter Enable)
9	GPIn6 (function input)	24	GPIn5 (homing switch)	38	GPIn4 (pos. limit switch)
10	GPIn11	25	GPIn10	39	GPIn9 (delete Error)
11	GPIn14	26	GPIn13	40	GPIn12
12	GPO11	27	GPO10	41	GPO9
13	-	28	-	42	GPO12
14	MB2 (motor brake)	29	MB1 (motor brake)	43	Control voltage 24 V
15	BTB2 (ready to operate)	30	BTB1 (ready to operate)	44	Control voltage 0 V

- The counter input can be used for the step/direction presetting or as encoder input (→ section 11.5 „input counter“).
- encoder output → section 11.6 „encoder output“
- controller cycle syncronisation → section 11.7 „controller cycle syncronisation“
- digital inputs „GPIn1“...“GPIn14“ → section 11.1 „digital inputs“
- digital outputs „GPO9“ ... „GPO12“ → section 11.2 „digital outputs“
- ready to operate outputs „BTB1“ and „BTB2“ will be closed in state „ready to operate“ by a semi-conductor relay (→ section 8 „state machine“ and section 11.2 „digital outputs“).
- Outputs „MB1“ and „MB2“ for controlling motor brake will be closed in active state by a semi-conductor relay (→ section 8 „state machine“ and section 11.2 „digital outputs“).

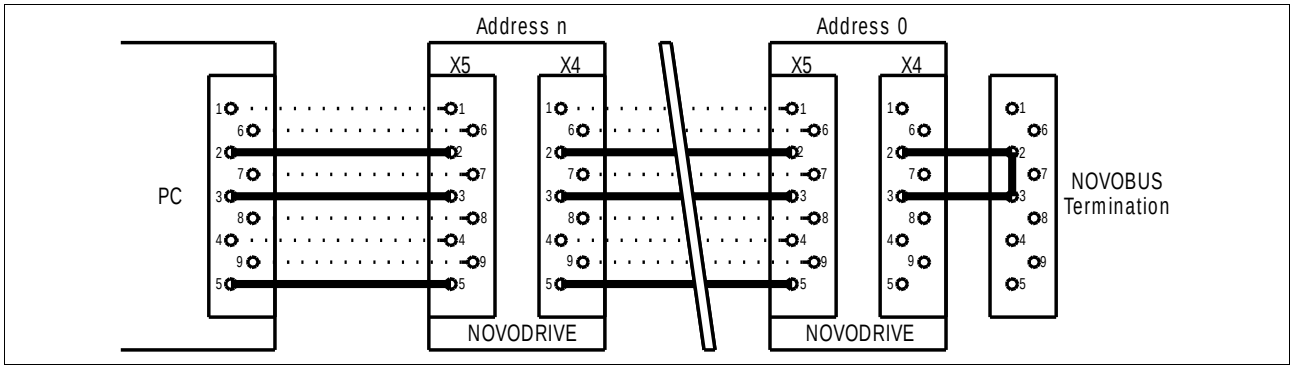
5.3.5 Bus connection standard (X4 and X5)

Type Designation	Position X4	Position X5
ND4x-xxxxxx-x11-xxx	→ Connector X4	→ Connector X5
ND4x-xxxxxx-x12-xxx	→ Connector X4	→ Connector X5

Wiring of NOVOBUS / terminating plug

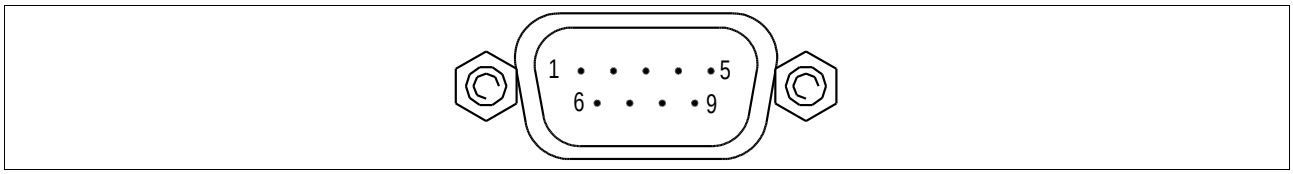
For the connection to a computer a normal serial cable can be used (no null-modem cable).

Use only screened cables!



No connection without a terminating plug.

X4 – NOVOBUS Bus-Out



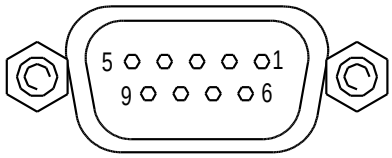
9-pole D-SUB male connector with UNC thread.

Pins 2, 3 and 5 comply with RS-232.

Pins 1, 8 and 9 comply with CAN 2.0 A and B according to ISO 11898.

Pin	Function
1	CAN-NOVOTRON GND (only with option: potential-free)
2	NOVOBUS RS-232 return line
3	NOVOBUS RS-232 Tx
4	Not connected
5	NOVOBUS RS-232 GND / CAN-NOVOTRON GND
6	Not connected
7	Not connected
8	CAN-NOVOTRON L (option: potential-free)
9	CAN-NOVOTRON H (option: potential-free)

X5 – NOVOBUS Bus-In



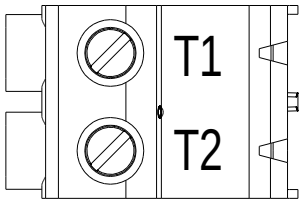
9-pole D-SUB female connector with UNC thread.

Pins 2, 3 and 5 comply with RS-232.

Pins 1, 8 and 9 comply with CAN 2.0 A and B according to ISO 11898.

Pin	Function
1	CAN-NOVOTRON GND (only with option: potential-free)
2	NOVOBUS RS-232 return line
3	NOVOBUS RS-232 Rx
4	Not connected
5	NOVOBUS RS-232 GND / CAN-NOVOTRON GND
6	Not connected
7	Not connected
8	CAN-NOVOTRON L (option: potential-free)
9	CAN-NOVOTRON H (option: potential-free)

5.3.6 X6 – Motor temperature sensor (for ND42 only)



400 V: Phoenix Contact COMBICON GIC 2,5 HCV/ 2-ST-7,62

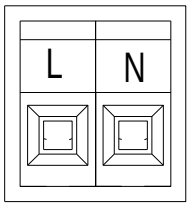
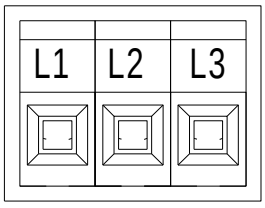
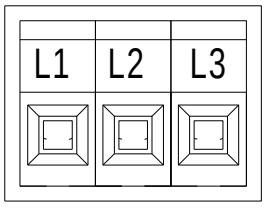
Pin	Function
T1	Motor temperature sensor (PTC or opening contact)
T2	Motor temperature sensor (PTC or opening contact)

Connector X6

Connector X6 always carries line voltage. Therefore, do not ground. Use only wiring with basic insulation for mains voltage.
If the motor temperature sensor is connected to X6, it must only have basic isolation against the motor winding, whereas in case of connection to X2 double or reinforced isolation is required.

5.3.7 X7 – Integrated line filter (compact case version only)

In the compact case version, X7 is used for connecting the integrated line filter with line voltage. The line filter's output wires leave the compact case above X7. They must be connected to X1 as follows:

Single-phase connection (ND41)	Three-phase connection (ND42)	Three-phase connection (ND43)
		
X1.E1 – black or brown X1.E2 – blue PE bolt – green/yellow	X1.E1 – black X1.E2 – brown X1.E3 – gray or blue PE bolt – green/yellow	

5.3.8 Bus connection with extension module (X8, X9, X10, X11)

Type Designation	Position X4 replaced by	Position X5 replaced by
ND4x-xxxxxx-x21-xxx	→ Connector X8	→ Connector X10 (PROFIBUS)
ND4x-xxxxxx-x22-xxx	→ Connector X8	→ Connector X9 (CAN-NOVOTRON)
ND4x-xxxxxx-x23-xxx	→ Connector X8	→ Connector X10 (PROFIBUS)
ND4x-xxxxxx-x31-xxx	→ Connector X8	→ Connector X10 (PROFIBUS)
ND4x-xxxxxx-x32-xxx	→ Connector X8	→ Connector X9 (CAN-NOVOTRON)
ND4x-xxxxxx-x33-xxx	→ Connector X8	→ Connector X10 (PROFIBUS)
ND4x-xxxxxx-x34-xxx	→ Connector X8	→ Connector X11 (CANopen)
ND4x-xxxxxx-x35-xxx	→ Connector X8	→ Connector X11 (CANopen)

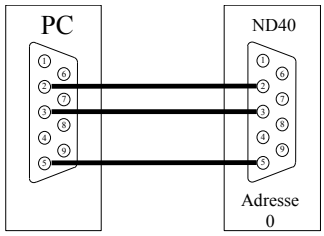
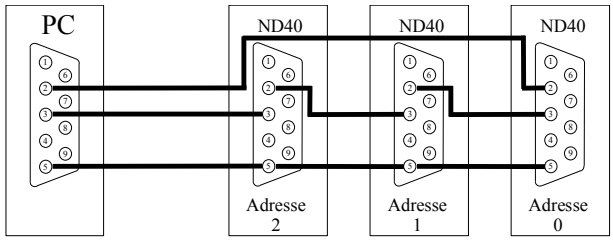
Wiring of NOVOBUS

X8 is used as a service interface for setup by PC. In contrast to X4 and X5, daisy-chaining with other NOVODRIVEs is only possible by using a customized cable. A terminating plug is not required.

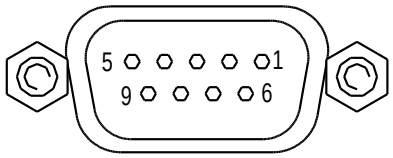
For the connection to a computer a normal serial cable can be used (no null-modem cable).

Use only shielded cables!

Connection variants for X8

Connection PC with one NOVODRIVE	Connection PC with several NOVODRIVEs
	

X8 – NOVOBUS



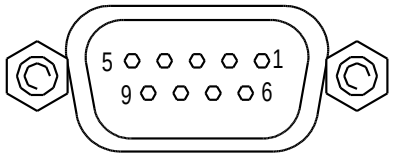
9-pole D-SUB female connector with UNC thread.

Pins 2, 3 and 5 comply with RS-232.

Pins 1, 8 and 9 comply with CAN 2.0 A and B according to ISO 11898.

Pin	Function
1	Not connected
2	NOVOBUS RS-232 Tx
3	NOVOBUS RS-232 Rx
4	Not connected
5	NOVOBUS GND / CAN-NOVOTRON GND
6	Not connected
7	Not connected
8	CAN-NOVOTRON L
9	CAN-NOVOTRON H

5.3.9 X9 – CAN-NOVOTRON

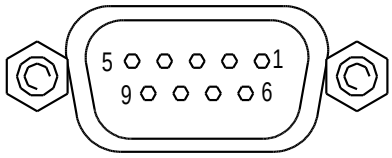


9-pole D-SUB female connector with UNC thread.

Pins 8 and 9 comply with CAN 2.0 A and B according to ISO 11898.

Pin	Function
1	Not connected
2	Not connected
3	Not connected
4	Not connected
5	Not connected
6	Not connected
7	Not connected
8	CAN-NOVOTRON L
9	CAN-NOVOTRON H

5.3.10 X10 – PROFIBUS



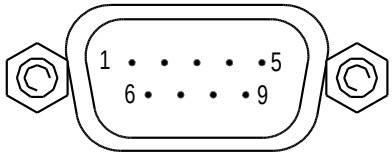
9-pole D-SUB female connector with UNC thread.

All pins comply with RS-485 / EN 50170.

Pin assignment complies with EN 50170.

Pin	Function
1	Shield
2	Not connected
3	RxD/TxD (Receive/Transmit Plus)
4	CNTR-Plus (Direction Control Plus)
5	DGND (ground)
6	VP (+5 V)
7	Not connected
8	RxD/TxD (Receive/Transmit Minus)
9	Not connected

5.3.11 X11 – CANopen



9-pole D-SUB male connector with UNC thread.

All pins comply with CAN 2.0 A and B according to ISO 11898.

Pin assignment complies with CiA DS102-1.

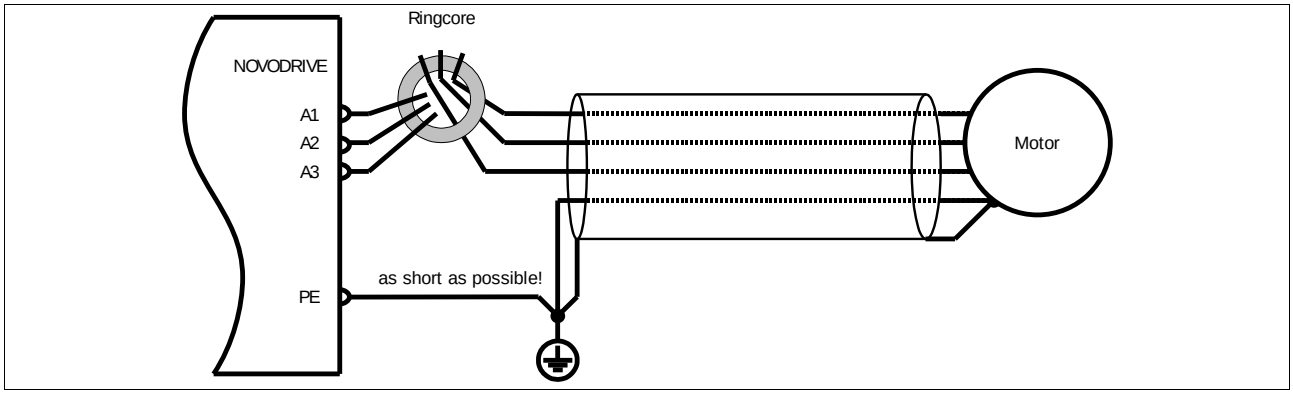
Pin	Beschreibung
1	Not connected
2	CANopen CAN_L
3	CANopen CAN_GND
4	Not connected
5	CANopen CAN_SHLD (option)
6	CANopen GND (option)
7	CANopen CAN_H
8	Not connected
9	CANopen CAN_V+ (option)

5.4 Connection to motor

Motor cable

Connect the motor to X1 using a shielded cable. Because of the physical effects of a pulse wide modulated (pwm) signal with several 100 Vs produce the inverter outputs A1, A2 and A3 significant disturbs if wiring is not done accurate.

Motor cable



For the connection of inverter outputs A1, A2 and A3 and the protective earth is a shielded four-wire cable necessary. Between the inverter output A1, A2 and A3 and the shielded part of the motor cable all three wires must be wound one time through a ring core.

Cable characteristics

The motor cable must be suitable for use with DNC-motors or servo motors.

Parameter	Value
Rated voltage U0 / U	min. 600 V / 1000 V
Cable cross section	NOVODRIVE dependant: → section 4.3 „Electrics“

By NOVOTRON used and tested cable:

- LÜTZE SUPERFLEX® PLUS M (C) PUR SERVO 0,6/1kV

Cable shield

The cable shield must be clamped to the compact case or 19” backside. Use for this cable shield ground clamp SK14 (ND41) or SK20 (ND42) of Phoenix Contact.

A special case is ND43. Because of the stiffness of the motor cable, the cable shield should be screwed with a clamp to the mounting plate nearby connector X1A at the the compact case.

On motor side the cable shield should be clamped against the motor connector.

Forbidden practices

The effect of a cable shield can be degraded by applying forbidden practices:
→ To twist the end of the cable shield to a long wire and connect the end of wire to ground (pigtail wire). The pigtail wire has a high impedance and prevents high frequency grounding.
→ To connect several shields of several different cables like motor cable, feedback cable, or other control cable. Noise and spikes will be transmitted to other parts of the wiring instead to earth.

Maximum length of motor cable

Length of motor cable	Compact case	19“ Rack
$\leqslant 10\,\mathrm{m}$	Internal line filter[3]	Additionally line filter
$> 10\,\mathrm{m}$ [4]	Internal line filter with additionally measures	Additionally line filter
$> 40\,\mathrm{m}$	Please consult manufacturer	

The choose of a proper line filter depends on the current and cable length to motor. Especially an important factor is the loss in the frequency range 150 kHz...5 MHz. The loss in this part should be exceed 50...60 dB dependent from line length.

Motor Holding Brake

The wires to the holding brake should for reasons of electrical safety and EMC **not packed together** with the inverter outputs A1, A2 and A3 in one cable. Especially in long cables the wires to the motor holding brake can catch noise and spikes by capacity coupling, which can disturb other devices.

However, in the majority cases the motor manufacturer pack both wires in one connector. In this case, consider some rules:

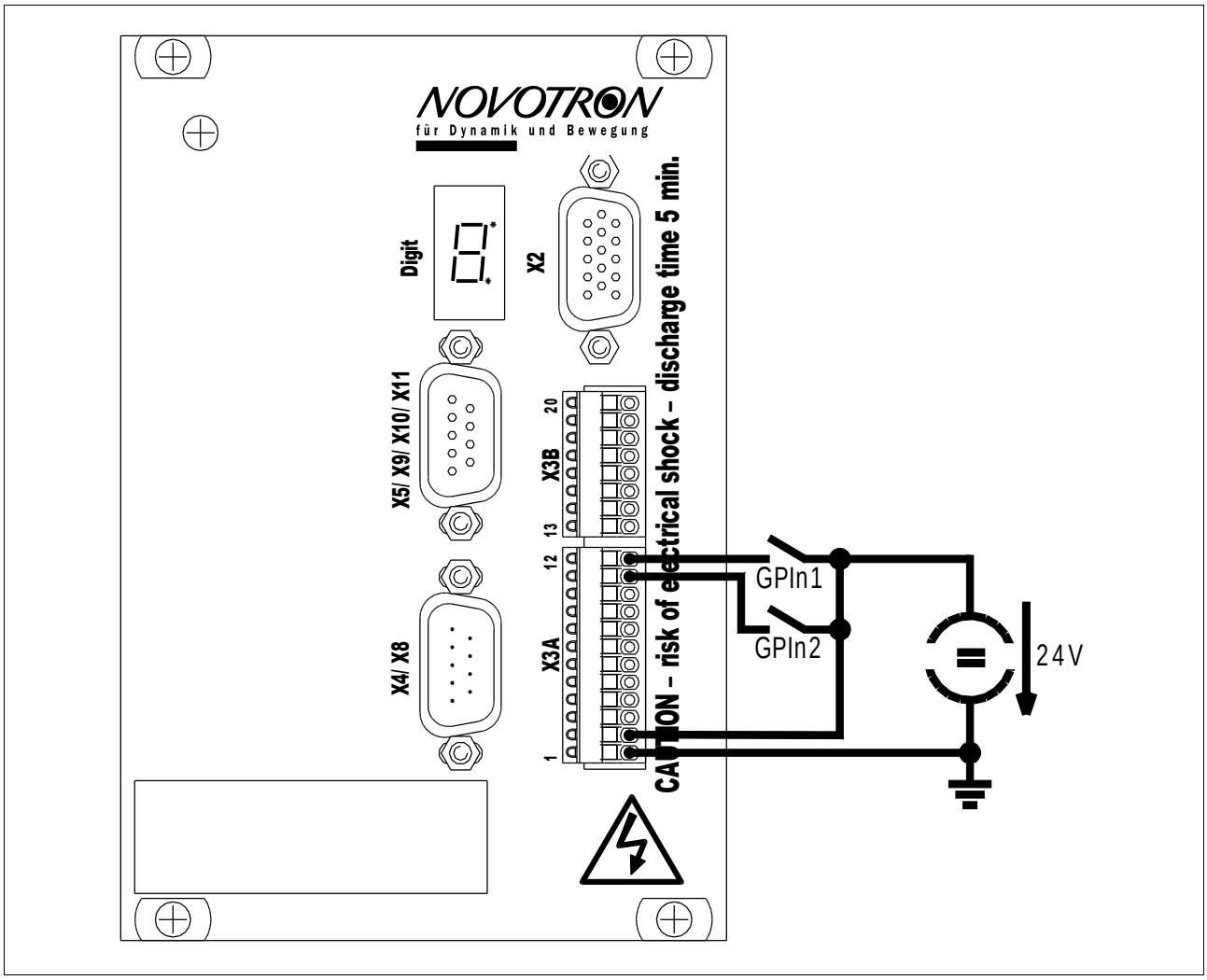
- the wires of the holding brake should have a double insulation to the wires from inverter, and
- the wires of the holding brake should have a separate shield inside the cable, and
- the wires of the holding brake were wound several times to a ring core before connecting to other parts of the 24 VDC wiring.

3 Compliance with limits of class A (EN61800-3).

4 When using longer motor cables, line capacity should be as small as possible. See also application note: 16-400-013D-00 „AppNote Motorleitung 10m u.m.“.

5.5 Examples for Connection

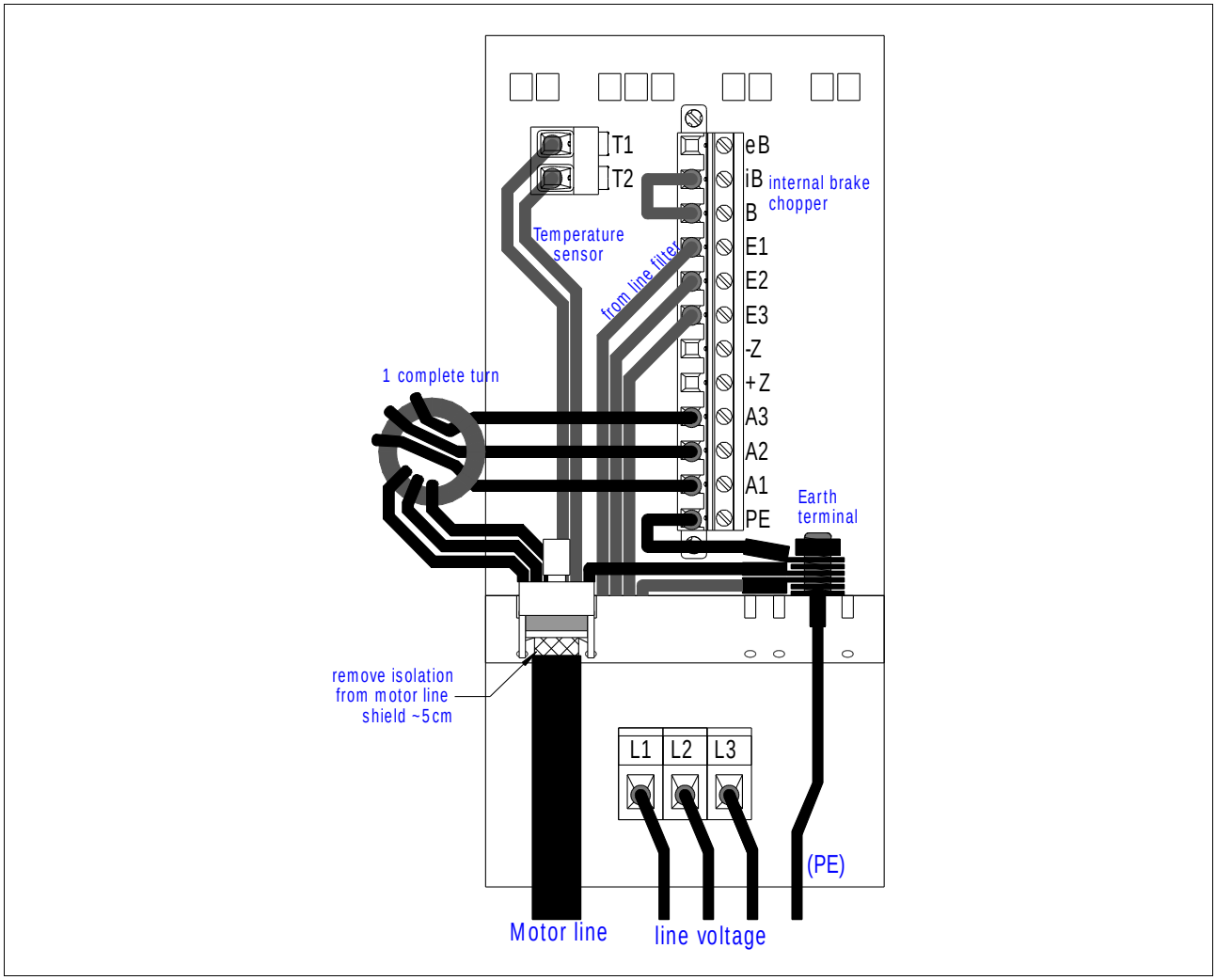
5.5.1 Low-Voltage Part (ND42 MICRO COMBICON)



Minimum connections:

- 24-V supply voltage (grounded),
- two switchable signal lines for Inverter Enable/Disable and Setpoint Enable/Disable (GPIn1 and GPIn2).

5.5.2 Power Part (ND42 compact case version)

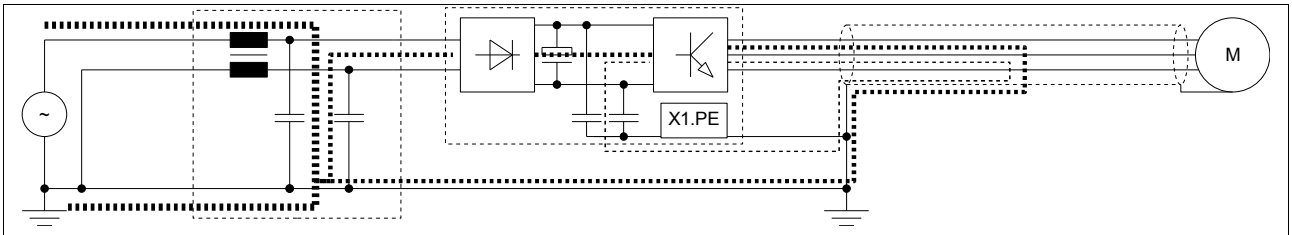


Important notes:

- Mount compact case on a mounting plate (grounded).
- Connect line voltage (single-/three-phase) to X7 (line filter).
- Connect output of three-phase line filter to Pins E1, E2 and E3 of X1, or output of single-phase line filter to Pins E1 and E2 of X1, as the case may be.
- Remove shield of motor line wires on a length of 16 cm. Make sure the wires are led through the ring core by at least one complete turn. Then connect them to Pins A1, A2 and A3 of X1 (be aware of phase assignment as specified in motor connection plan).
- Remove 5 cm isolation from motor line shield. Press shield to compact case using a shield connection clamp.
- Connect connectors of motor temperature sensor to T1 and T2.
- Connect earth lines of line voltage, line filter, motor, and X1 to the earth terminal of the case by means of cable shoe M6.
- Connect a bridge to Pins B and iB of X1 for using the integrated brake chopper resistor.

5.6 Mains Filter

Basic Information



thick line left - low-leakage current via the mains filter
mid line center/right - high-frequency leakage current to the mains filter
thin line right - high-frequency leakage current to the NOVODRIVE

The output of a servo controller is clocked with a PWM frequency of 5 … 20 kHz and depending on the mains voltage with voltage ranges from 320 VDC or 560 VDC. The wires in the motor cable and the motor windings have a parasitic capacitance to the cable shield and the motor box to the ground. The combination of all these causes, especially in the motor cable runs off a high-frequency leakage current from the DC bus to ground.

Without further steps, the high-frequency circuit would be closed only for long ways of the motor cable again and cause the current considerable electromagnetic interference in the environment. To prevent this, the mains filter to the circuit needs a hand as close as possible close to the intermediate circuit again and also block the power supply for high-frequency currents.

It does not matter if the servo is connected to single-phase or three-phase. All phases L1, L2 and L3 (three-phase connection) or L and N (single-phase connection) follow the same high-frequency leakage current and need to be guided through the mesh filter.

Actions

Some of the high-frequency leakage currents are reduced by NOVODRIVE contained in Y2 capacitors. But this is not sufficient for complete suppression.

The high-frequency noise at the rectifier input of the servo amplifier is in the frequency range from 100 kHz ... 1 MHz of the harmonics of the PWM, frequency range between 500 kHz and 3 MHz are from the leakage current of the motor cable. Therefore is important in the selection of the mains filter if the motor is built right next to the NOVODRIVE or is connected via a 50 m long cable.

A mains filter for drive systems must in any case have the following properties:

- Chokes in the power supply must be available. These are usually current-compensated, so they do not go with the smaller size and the expected flows into saturation.
- Between the chokes and the rectifier input of the inverter must be sufficiently large Y2 - Capacitors may be connected to earth. They are necessary, but are also the reason for the high leakage currents in drive systems.
- The mains filter in the frequency range from 100 kHz to 3 MHz must have a very good attenuation (dimension 70 .. 100 dBm).

The built-in compact housing mains filters are designed for a motor cable length of up to 10 m.

For other connection options specify the information given above guidelines for the selection of a mains filter. Proof of compliance with EMC limit values, however, provide only one measurement at the installation.

6 Emergency Shutdown / Emergency Stop

Hazard caused by moving parts!

Moving parts may be a hazard for persons or may damage property. That is why the machine NOVODRIVE is built in has to be equipped with an emergency stop capable of bringing the machine to a stop as quickly as possible.

Hazard caused by coasting/freewheeling motor after emergency shutdown!

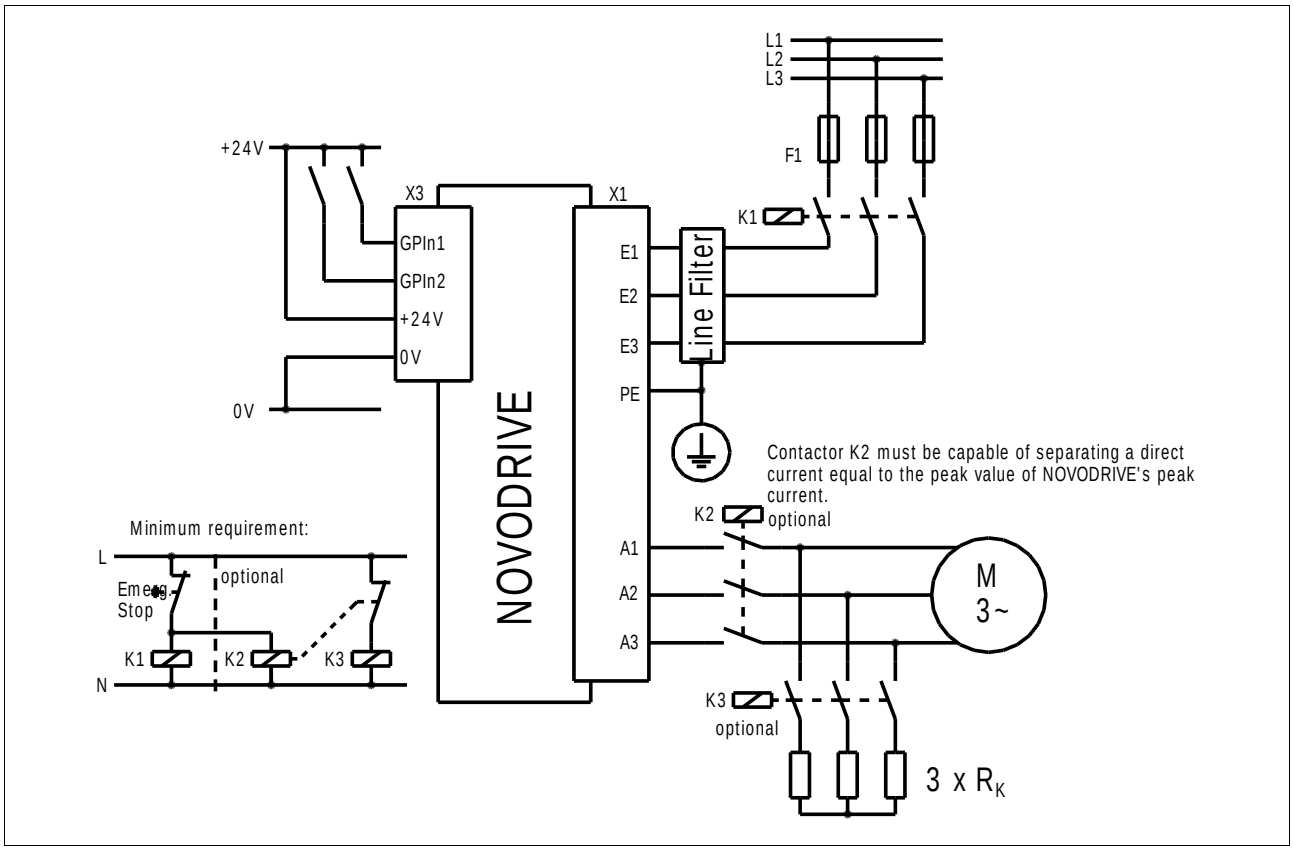
After the supply voltage has been switched off, a motor may keep running for some time.

Hazard caused by electric shock!

Before you start any working on NOVODRIVE or the motor, provide for all-pole disconnection of NOVODRIVE from the power supply system. Disabling NOVODRIVE is **not** sufficient, because a semiconductor device is no safety circuit interruption!

6.1 Wiring Plan

Please note: Not all components shown in the drawing might be necessary for every application.



6.2 Concepts

There are various possibilities to stop a drive in an emergency case.

Hazard caused by moving parts	Hazard caused by electric shock / body current
All-pole disconnection of NOVODRIVE from power supply system	All-pole disconnection of NOVODRIVE from power supply system
Resistor braking	
Controlled braking	

Which concept may be the right one depends on applicable safety regulations and possible hazards of the machine.

6.2.1 All-pole disconnection of NOVODRIVE from power supply system

Principle

NOVODRIVE is disconnected from the power supply system by means of contactor K1.

Sequence of events

- Via contactor K1, NOVODRIVE is disconnected from the power supply system.
- If the motor was running before power disconnection, it will slow down until it stops.
- NOVODRIVE reports an 'Undervoltage' error.
- After the motor has come to a stop, the DC link circuit will start to discharge. After approx. five minutes, both NOVODRIVE and the motor are free from hazardous voltage.

We recommend to maintain the 24-V supply voltage for the low-voltage part of NOVODRIVE, as it does not produce any danger. If you switch off supply voltage, all state information will get lost, i.e. reinitialization of NOVODRIVE and – depending on the application – new homing will become necessary prior to restart.

6.2.2 Resistor Braking

Principle

By short-circuiting the motor windings over brake resistors (using contactors K2 and K3) the motor is slowed down until it stops, independent of NOVODRIVE.

Sequence of events

- Disable inverter (e.g. by setting digital input GPIn1 to 0 V).
- Open contactor K2 to disconnect the motor from NOVODRIVE and close contactor K3 to initiate the braking process.
- The motor is slowed down until it stops.

Dimensioning of brake resistors

To achieve maximum braking effectiveness and to prevent the motor from being damaged, the resistors R_K must be dimensioned correctly.

$$R_K = \frac{maximum\,speed\,[rpm] \cdot voltage\,gradient\,of\,motor\,[\frac{V}{rpm}]}{\sqrt{3} \cdot peak\,current\,of\,motor\,[A]}$$

or

$$R_K = \frac{DC\,link\,voltage\,[V]}{\sqrt{6} \cdot peak\,current\,of\,motor\,[A]}$$

When dimensioning the brake resistors R_K with regard to peak pulse power, take into consideration the application specific kinetic energy that could occur in the most extreme case.

Braking energy

The braking resistors must be able to take up sextuple of rotation energy at rated speed of the motor.

6.2.3 Controlled braking

Principle

Upon Setpoint Disable the motor gets decelerated by NOVODRIVE. After the motor has come to a stop, NOVODRIVE or the motor can be disconnected from line voltage.

Sequence of events

- Upon Setpoint Disable (e.g. by setting digital input GPIn2 to 0 V) the process of controlled braking of the motor is initiated over the parameterized stop ramp (→ setup software 'Limit Values/Ramps').

24-V supply voltage and Inverter Enable

To allow for controlled braking, do not switch off the 24-V supply voltage for the low-voltage part of NOVODRIVE and do not disable inverter.

- In addition, you may disconnect NOVODRIVE from line voltage by means of contactor K1 in order to prevent a restart of the motor.
- Upon expiry of the deceleration time, disable inverter (e.g. by setting GPIn1 to 0 V).
- Upon expiry of the deceleration time, the motor can be disconnected from NOVODRIVE by means of contactor K2. After NOVODRIVE has been disconnected form line voltage, the DC link may continue to carry enough energy for several minutes to restart the motor. Whether contactor K2 is necessary depends on the machine (e.g. high friction is braking the motor). If you are not sure, test the behavior of the machine.

Calculation of deceleration time

Rotary motor	$Deceleration\,time\,[ms] = \frac{max.\,speed\,[rpm]}{StopRamp\,[\frac{rpm}{ms}]}$
Linear motor	$Deceleration\,time\,[ms] = \frac{max.\,speed\,[m/s]}{StopRamp\,[\frac{m/s}{ms}]}$

If the calculated value for deceleration time is not reached, the motor will run down at residual speed until it stops. Therefore we recommend to increase the value for deceleration time to 120 %.

Restrictions

Applicability and effectiveness of the concept of controlled braking is determined by several factors:

- NOVODRIVE's parameter settings (particularly motor, current control, speed control, and position control parameters) must be correct.
- If you work with an Operating Mode featuring position control and if a position tracking error has occurred before emergency stop, the braking process will be delayed until the position tracking error is reduced by the position controller. A position tracking error may occur due to mechanic disturbance (blockage), for example.
- If the feedback system is defective, controlled braking is not possible.

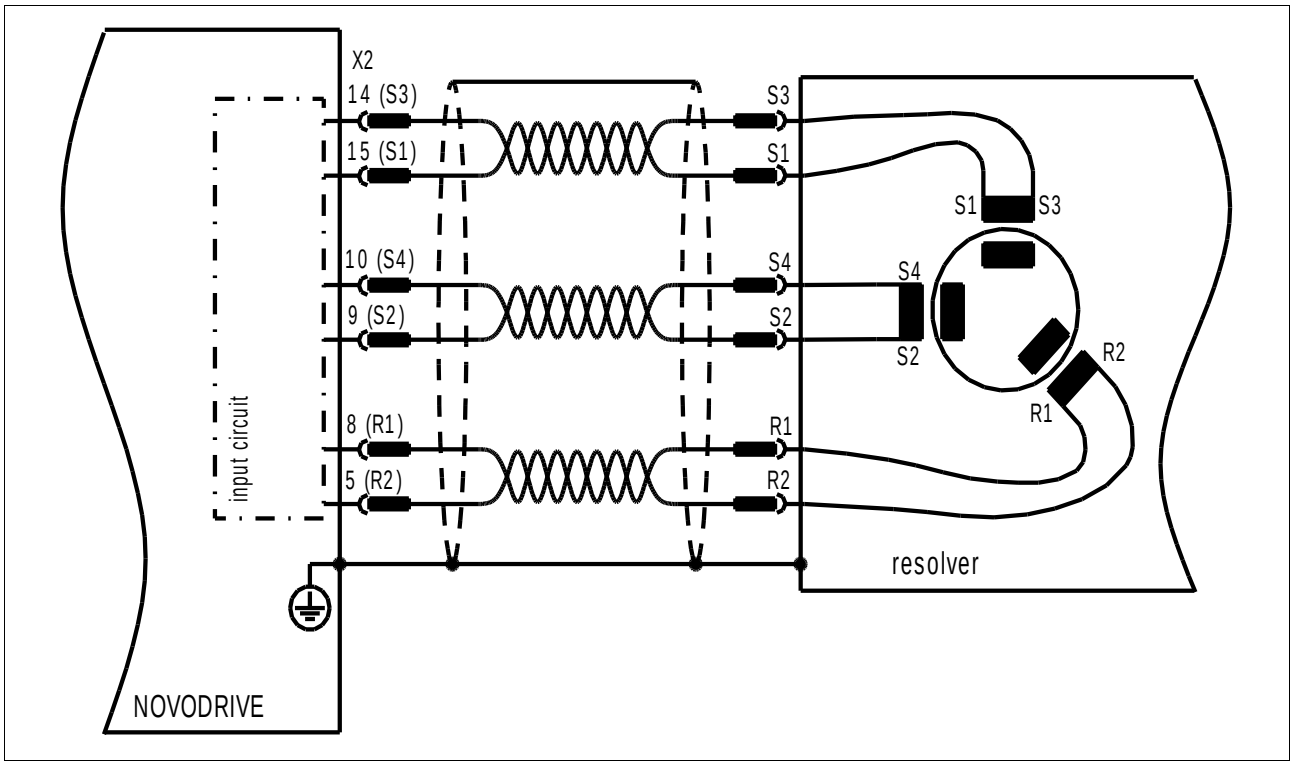
7 Feedback Systems

All NOVODRIVEs of the ND40 series support the following types of feedback systems:

- resolvers,
- sine wave encoders and linear encoders feat. up to 1024-fold interpolation,
- absolute feedback systems with EnDat 2.2[5] interface by HEIDENHAIN,
- at customer's demand: absolute feedback systems with SSI.

7.1 Interfaces

7.1.1 Resolver



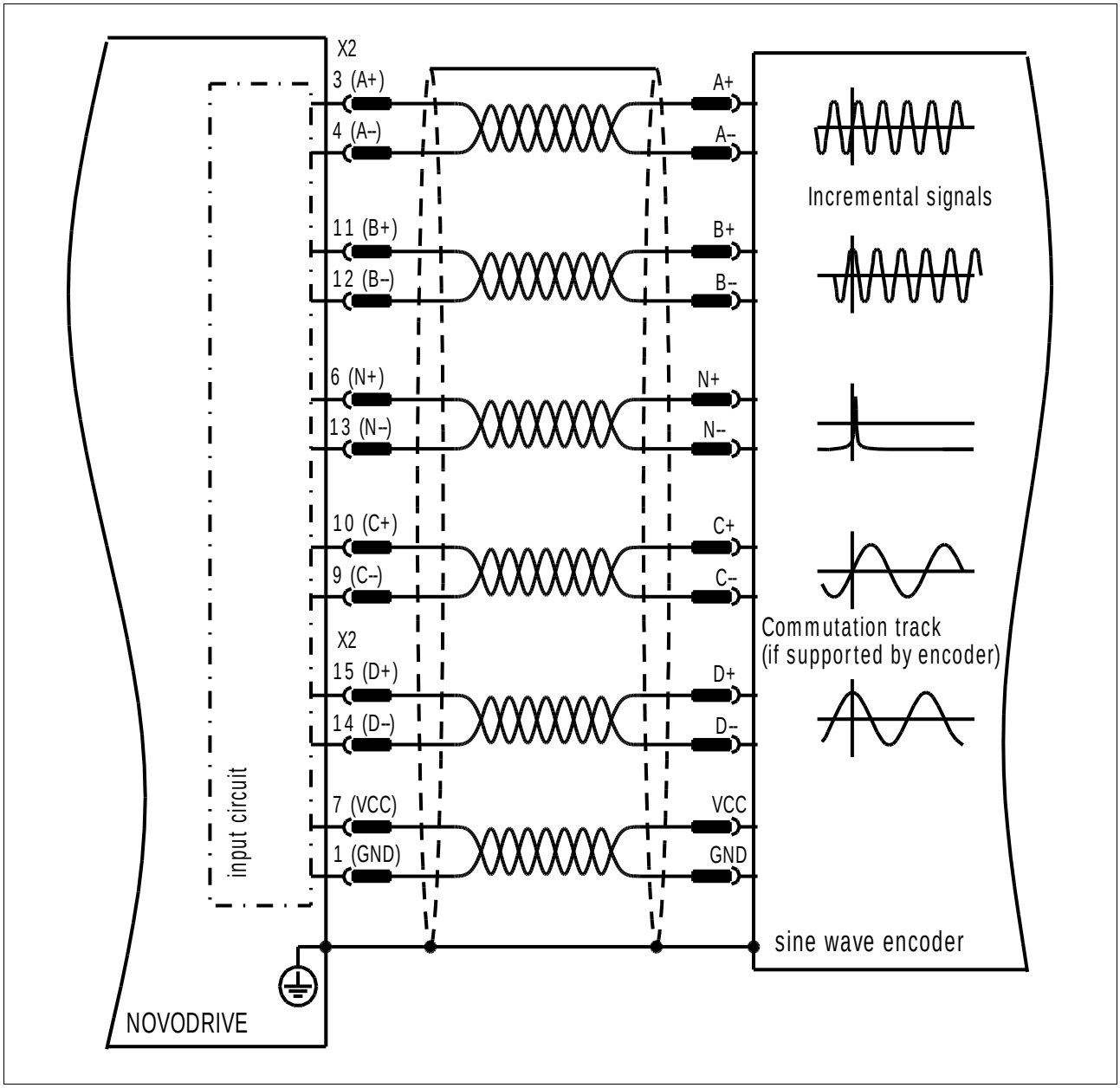
characteristics (e.g. Litton JSSBH-21-P4):

- type: transmitter
- transformation ratio: 2 : 1
- input signal: 5 V eff / 10 kHz
- standard number of poles of resolver: 2. You may use resolvers with other numbers of poles, but if you do so make sure you maintain a certain ratio of the number of resolver poles and the number of motor poles, according to the formula:

$$\textit{Number of motor poles} = V \cdot \textit{Number of resolver poles; with } V = 1,2,3,4,5,\ldots$$

5 EnDat is a registered trademark of DR. JOHANNES HEIDENHAIN GmbH.

7.1.2 Sine wave encoder



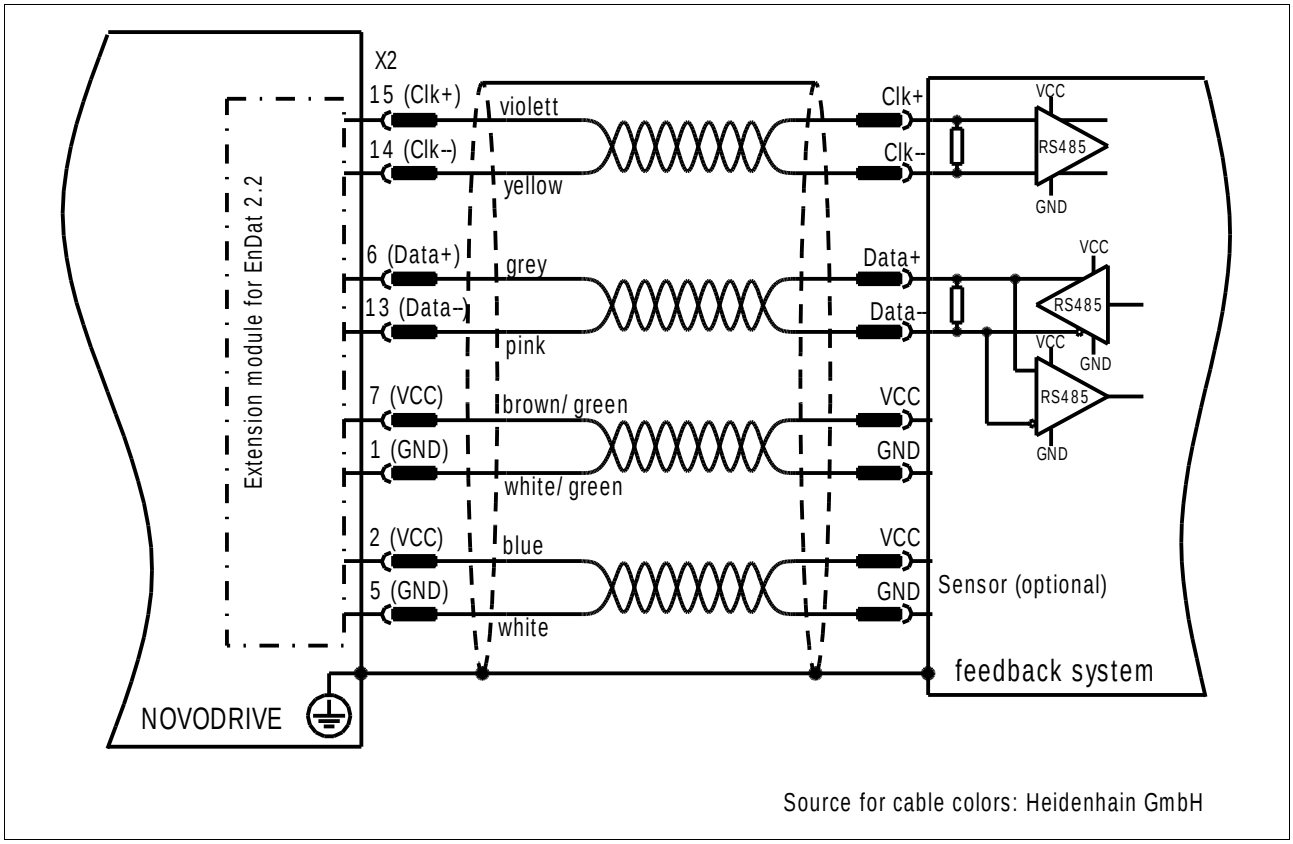
Technical specifications (e.g. HEIDENHAIN ERN 1387):

- supply voltage: 5 V ±10 %
- incremental signals A+, A--, B+, B--: RS-422 (no interpolation) or 1 Vss (with interpolation)
- zero-point marker N+, N--: RS-422 (no interpolation) or 1 Vss (with interpolation). Decoding of zero-point markers according to:

  zero pulse marker activ = (A+ >> A--) AND (B+ >> B--) AND (N+ >> N--)

- commutation track C+, C--, D+, D-- : 1 Vss (if supported by feedback system)

7.1.3 EnDat 2.2



Decoding of signals of EnDat 2.2 absolute feedback systems requires the use of an extension module featuring an EnDat 2.2 interface.

Use EnDat 2.2 cables by Heidenhain only.

7.2 Supported Rotary Feedback Systems

The following table gives an overview of all rotary feedback systems currently supported by the setup software.

Feel free to ask for parameters that allow working with other feedback systems.

Name	System characteristics	Resolution	Speed ranges	Additional information
Resolver	---	Standard resolution (16 bit/rev)	0...3000 rpm 0...6000 rpm 0...12000 rpm	2 poles (other numbers of poles available at request)
Sine wave encoder	Incremental track: 2048 periods/rev	Standard resolution (16 bit/rev)	0...3000 rpm 0...6000 rpm 0...12000 rpm	Sine wave encoder without commutation track. Upon Inverter Enable, the commutation position is determined automatically by the AutoKomm function. (other periods/rev available at request)
ERN1387	Incremental track: 2048 periods/rev Commutation track: 1 period/rev	Standard resolution (16 bit/rev)	0...3000 rpm 0...6000 rpm 0...12000 rpm	Sine wave encoder with commutation track by Heidenhain
ECN1325	---	Standard resolution (16 bit/rev)	0...3000 rpm 0...6000 rpm 0...12000 rpm	Absolute feedback system single-turn with EnDat 2.2 interface by Heidenhain
		Enhanced resolution (20 bit/rev)	0...2500 rpm 0...5000 rpm	
		Maximum resolution (25 bit/rev)	0...450 rpm	
EQN1337	---	Standard resolution (16 bit/rev)	0...3000 rpm 0...6000 rpm 0...12000 rpm	Absolute feedback system multi-turn with EnDat 2.2 interface by Heidenhain
		Enhanced resolution (20 bit/rev)	0...2500 rpm 0...5000 rpm	
		Maximum resolution (25 bit/rev)	0...450 rpm	

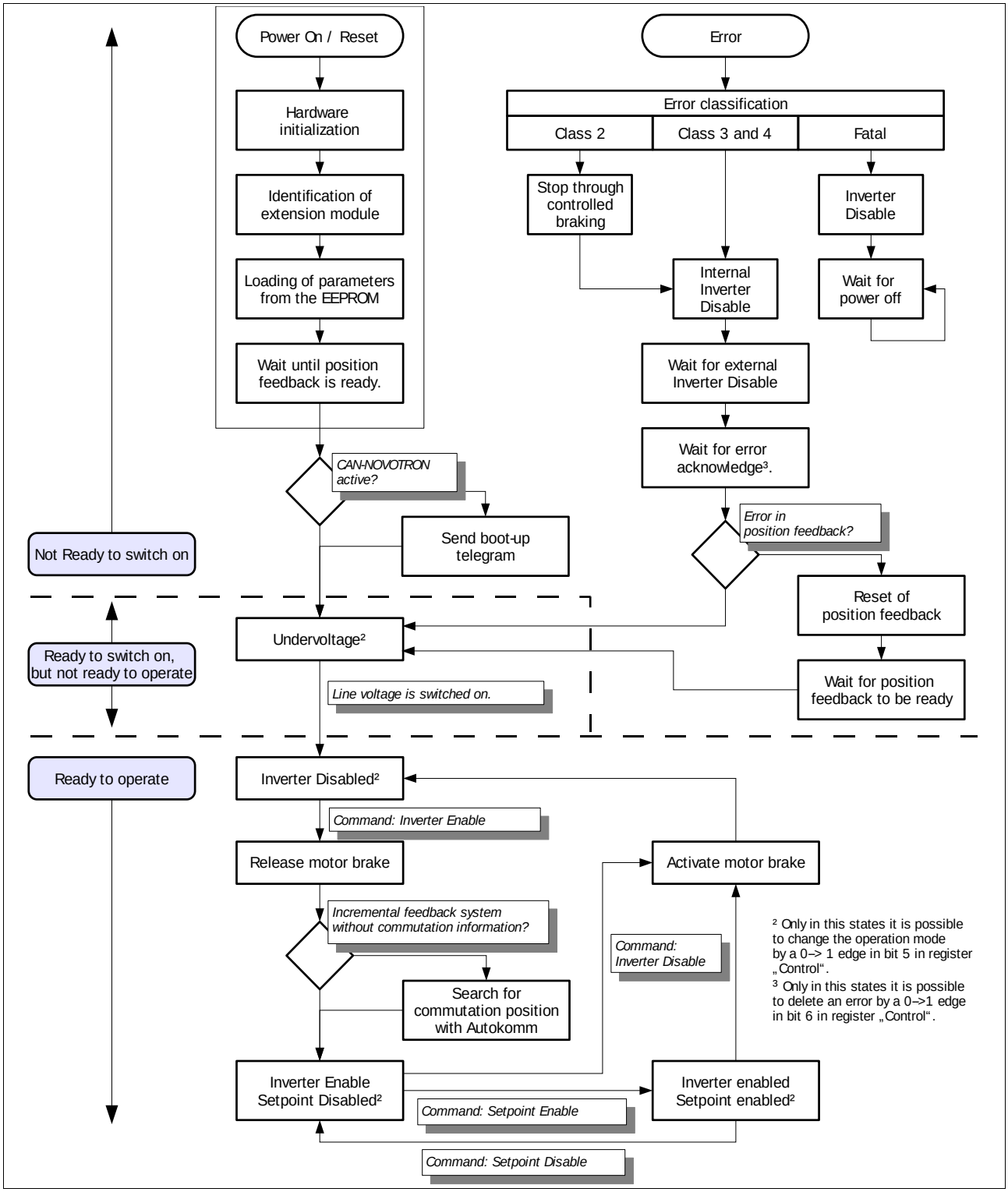
7.3 Supported Linear Feedback Systems

The following table gives an overview of all linear feedback systems currently supported by the setup software.

Feel free to ask for parameters that allow working with other feedback devices.

Name	System characteristics	Resolution	Speed ranges	Additional information
LH100	0,5 mm/period	1024-fold interpolation	0...5 m/s 0...3 m/s	magnetic linear feedback system by Siko
LH100	1,0 mm/period	1024-fold interpolation	0...5 m/s 0...3 m/s	magnetic linear feedback system by Siko
RGH22D (5 um)	5 µm/period	No interpolation (RS-422)	0...5 m/s	optical linear feedback system by Renishaw
RGH22B (20 um)	20 µm/period	1024-fold interpolation	0...5 m/s	optical linear feedback system by Renishaw
LC483	10 nm	10 nm	0...2 m/s	linear absolute feedback system with EnDat 2.2 interface by Heidenhain

8 NOVODRIVE State Machine



9 NOVODRIVE Registers

NOVODRIVE offers a large number of registers for configuration of NOVODRIVE and for working with the Job Control. Registers can be divided into three categories:

- System Settings: default values, which cannot be altered;
- Parameters: for configuration of NOVODRIVE; contain permanent information and should be saved in the EEPROM;
- Variables: for Job execution; contain temporary information.

Data storage

All parameters, jobs, and the error history can be permanently stored in the EEPROM. While the error history is always saved automatically, parameters and jobs must be saved to the EEPROM by command.

Archiving of parameter sets

Each parameter set must be archived! Without the original parameter set it might be very difficult to put a machine into operation after a servo converter has been exchanged. Archiving of parameter sets can be done over the PC using the setup software. Archiving of parameter sets must be done separately for each machine component and after each alteration. Use file names which allow for unambiguous assignment to machine axes.

Invalid values

NOVODRIVE provides for constant checking of all values set. If invalid values or reserved values are identified, NOVODRIVE reports Error 106, 107, 108, 109, 450, 451, 452 or 453. In case of Error 453, you will be informed about the address of the register containing an invalid value in Register 'ErrorInfo0' or on the 'General/Troubleshooting' page of the setup software. For all other errors, the address of the register set wrongly is shown by the error code.

Reserved bits and registers

Reserved bits and registers are always set to '0'. Do not alter this value, otherwise you will face severe problems with later software versions.

9.1 List of Registers

9.1.1 Basic information

Decimal address	Category	Size		Name	Function
100	System	INT32	RO	NovodriveType	ASCII string incl. device type (e.g. 'ND41')
101	System	INT16	RO	RatedVoltage	Rated voltage of NOVODRIVE in V_{eff}
102	System	INT16	RO	RatedCurrent	Rated current of NOVODRIVE in A_{eff}
103	System	INT16	RO	XRamAvailableSegments	Size of XRAM in 256 bytes
104	System	INT32	RO	SerialNumber	Serial number of NOVODRIVE as a decimal value (e.g. 'ND41-10120': 4110120)
105	System	INT32	RO	HardwareCode	ASCII string code of hardware (e.g. '0100')
106	System	INT32	RO	SoftwareVersion	ASCII string of software version (e.g. '0102')
107	System	INT16	RO	Modification	Modification ID number of NOVODRIVE as a decimal value
108	System	INT32	RO	ExtModuleType	Hexadecimal ID number of extension module
109	System	INT16	RO	BusOption	→ Software bus options
110	System	INT32	RO	ClockActiveHours	Operation time counter; hours of active time
111	System	INT32	RO	ClockLifeTimeHr	Operation time counter; hours of life time
112	System	INT8	RO	ClockActiveMinutes	Operation time counter; minutes of active time
113	System	INT8	RO	ClockLifeTimeMin	Operation time counter; minutes of life time
114	System	INT32	RO	CiaVendorId	Manufacturer ID CiA
115	System	INT32	RO	PnoId	Manufacturer ID PNO
116	System	INT32	RO	TechFuncFlags1	Bit fields with supported technology functions
117	System	INT32	RO	TechFuncFlags2	
120	Parameter	INT16	RW	SpeedScaleUnit	Information for scaling of input and output values over a bus module in SI units (not CAN-NOVOTRON)
121	Parameter	INT32	RW	SpeedScale	
122	Parameter	INT16	RW	PositionScaleUnit	
123	Parameter	INT32	RW	PositionScale	
124	Parameter	INT16	RW	RampScaleUnit	
125	Parameter	INT32	RW	RampScale	
126	Parameter	INT16	RW	CurrentScaleUnit	

Decimal address	Category	Size		Name	Function
127	Parameter	INT32	RW	CurrentScale	
128	Parameter	INT32	RW	GearFactor	
129	Parameter	INT32	RW	BallScrewPitch	
150	Variable	INT32	RW	ParamControl	Control register for loading and saving of parameters and jobs

9.1.2 Input Variables/Parameters for Operating Modes and I/O hardware

Decimal address	Category	Size		Name	Function
200	Variable	INT8	RW	Control	Control register; software interface for controlling NOVODRIVE's basic functions
201	Parameter	INT8	RW	OperationMode	Operating Mode selection
202	Variable	INT16	RW	DigitalSetpoint	Speed setpoint
203	Parameter	INT16	RW	CurrentPeakLimit1	Application dependent current limitation
204	Parameter	INT16	RW	PositioningSpeed	Obsolete → Operating Mode #32
205	Variable	INT32	RW	TargetPosition	Target position
206	Parameter	INT16	RW	AccelerateLimit	Acceleration ramp
207	Parameter	INT16	RW	DecelerateLimit	Deceleration ramp
208	Variable	INT16	RW	GPO	State of digital outputs
209	Variable	INT16	RW	AsInput	Input signals of Job Control
248	Variable	INT16	RW	DataInput16	General input variables
249	Variable	INT32	RW	DataInput32	

9.1.3 Output Variables for Operating Modes and I/O hardware

Decimal address	Category	Size		Name	Function
250	Variable	INT8	RO	Status	Contains Bits 8...15 of Register 'Status16'
251	Variable	INT16	RO	Status16	Status indication; accommodates the complete spectrum of NOVODRIVE's states
252	Variable	INT16	RO	ErrorCode	Error code in BCD
253	Variable	INT32	RO	SysTime1ms	System clock [1,024 ms]
254	Variable	INT32	RO	PositionActual1	Actual position
255	Variable	INT32	RO	PositionActual1High	Overflow counter of actual position

Decimal address	Category	Size		Name	Function
256	Variable	INT16	RO	SpeedSetpoint1	Speed setpoint
257	Variable	INT16	RO	SpeedSetpoint2	Speed setpoint from position controller
258	Variable	INT16	RO	SpeedActual	Actual speed for display
259	Variable	INT16	RO	SpeedActualFiltered	Actual speed for speed controlling
260	Variable	INT16	RO	CurrentSetpoint	Current setpoint
261	Variable	INT16	RO	VoltageSetpoint	Voltage setpoint
262	Variable	INT16	RO	GPIn	State of digital inputs
263	Variable	INT16	RO	EncInputCounter	Counter value of counter input
264	Variable	INT16	RO	AnalogInput	State of analog input
265	Variable	INT8	RO	ActualOperationMode	Actual operating mode
266	Variable	INT16	RO	StepDisplay	Step display for Technology Functions
267	Variable	INT32	RO	PositionSetpoint	Position setpoint of position controller
268	Variable	INT16	RO	AsOutput	Output signals of Job Control
269	Variable	INT16	RO	SpeedSetpointFiltered	Speed setpoint from speed controller
298	Variable	INT16	RO	DataOutput16	General output variables
299	Variable	INT32	RO	DataOutput32	

9.1.4 Parameters for motor settings, system functions and Technology Functions

Decimal address	Category	Size		Name	Function
300	Variable	INT8	RO	----	Reserved
301	Parameter	INT8	RW	TechHandler	→ Technology Functions
302	Parameter	INT8	RW	---	Reserved
303	Parameter	INT16	RW	EnableDelay	Internal delay time of Inverter Enable [ms]
304	Parameter	INT8	RW	PdoHandler	→ Parameter 'PdoHandler'
305	Parameter	INT8	RW	FeedbackSystem	→ Feedback system
306	Parameter	INT8	RW	ScFactor	
307	Parameter	INT8	RW	SyncControl	→ Controller Cycles Synchronization
308	Parameter	INT8	RW	LimitSwControl	→ Limit switch
309	Parameter	INT32	RW	LimitSwPosHigh	
310	Parameter	INT32	RW	LimitSwPosLow	
311	Parameter	INT16	RW	ErrorConfig	→ Error treatment
312	Parameter	INT16	RW	ErrorStopTime	
313	Parameter	INT16	RW	StopRampLimit	

Decimal address	Category	Size		Name	Function
314	Parameter	INT16	RW	SpeedLimit	Limit values for
315	Parameter	INT16	RW	SpeedBoundary	- actual speed and speed setpoint
316	Parameter	INT16	RW	SpeedTrackingBoundary	- deviation of actual speed and speed setpoint
317	Parameter	INT32	RW	PosTrackingBoundary	- deviation of actual position and position setpoint
318	Parameter	INT16	RW	BrPowerBoundary	→ Brake chopper
319	Parameter	INT8	RW	McMotorPoles	Commutation of motor
320	Parameter	INT32	RW	McPoleDistance	
321	Parameter	INT16	RW	McFactor	
322	Parameter	INT16	RW	McAngleOffset	
323	Parameter	INT16	RW	McDivisor	
324	Parameter	INT8	RW	MotorTempControl	→ Motor temperature monitoring
325	Parameter	INT8	RW	MotorTempBoundary	
326	Parameter	INT8	RW	MbSetTime	Delay times for motor brake activation/deactivation
327	Parameter	INT8	RW	MbReleaseTime	with regard to Inverter Enable/Disable
328	Parameter	INT8	RW	FanControl	→ Fan monitoring in compact case version
329	Parameter	INT16	RW	FeedbackInformation	→ Feedback system
330	Parameter	INT8	RW	EncInterpolationBits	
331	Parameter	INT32	RW	EncAnalogOffset	
332	Parameter	INT16	RW	----	Reserved
333	Parameter	INT16	RW	CurrentPeakLimit2	Maximum permissible peak current of motor
334	Parameter	INT16	RW	I2tBoundary	I^2t limit value of motor (→ Error 315)
335	Parameter	INT16	RW	I2tLimit	I^2t limit value of motor for current limiting
336	Parameter	INT8	RW	I2tFilter	Time constant for calculation of I^2t value
337	Parameter	INT8	RW	CcKp	Active parameter set for current controller
338	Parameter	INT8	RW	CcKi	
339	Parameter	INT8	RW	CcEmk0	
340	Parameter	INT16	RW	CcRippleComp	
341	Parameter	INT8	RW	CcPhasePrecontrol	
342	Parameter	INT16	RW	ScKp	Active parameter set for speed controller
343	Parameter	INT16	RW	ScKi	
344	Parameter	INT16	RW	ScKd	
345	Parameter	INT16	RW	ScKf	
346	Parameter	INT8	RW	ScActualFilter	
347	Parameter	INT8	RW	ScSetpointFilter	
348	Parameter	INT16	RW	PcKp	Active parameter set for position controller
349	Parameter	INT16	RW	PcKd	
350	Parameter	INT16	RW	SetpointScale	→ Operating Modes #48 and #50

Decimal address	Category	Size		Name	Function
351	Parameter	INT8	RW	AnalogInputControl	→ Analog input
352	Parameter	INT16	RW	AnalogInputScale	
353	Parameter	INT16	RW	AnalogInputOffset	
354	Parameter	INT8	RW	EncInputControl	→ Counter input
355	Parameter	INT8	RW	EncInputPreControl	
356	Parameter	INT32	RW	EncInputFactor	
357	Parameter	INT16	RW	EncOutputResolution	→ Encoder output
358	Parameter	INT16	RW	TestRevSpeed	→ Operating Modes #1 and #2 (Reversing)
359	Parameter	INT32	RW	TestRevPosHigh	
360	Parameter	INT32	RW	TestRevPosLow	
361	Parameter	INT32	RW	DistanceBoundary	Distance limitation for various Operating Modes
362	Parameter	INT16	RW	EncCounterMask	→ Feedback system
364	Parameter	INT16	RW	BlockedCurrent	→ Operating Mode #15 (Scan for Blocking)
365	Parameter	INT32	RW	HomePosition	Obsolete; → Operating Mode #10
366	Parameter	INT32	RW	HomePositionMask	→ Operating Modes Annex A (Set Position)
367	Parameter	INT32	RW	----	Reserved
368	Parameter	INT32	RO	PositionOffset	Postion offset to zero point of feedback system
369	Parameter	INT16	RW	PositioningWindow	→ Operating Modes Annex B (In Position)
370	Parameter	INT16	RW	SpeedWindow	→ Operating Modes Annex C (In Speed)
371	Parameter	INT16	RW	CanBcr	→ CAN-NOVOTRON; data rate
372	Parameter	INT8	RW	CanNodeId	→ CAN-NOVOTRON;
373	Parameter	INT32	RW	CanNmtId	data channel identifiers
374	Parameter	INT32	RW	CanSyncId	
375	Parameter	INT32	RW	CanTimeStamp	
376	Parameter	INT32	RW	CanEmergencyId	
377	Parameter	INT32	RW	CanPdo1TxId	
378	Parameter	INT32	RW	CanPdo1RxId	
379	Parameter	INT32	RW	CanPdo2TxId	
380	Parameter	INT32	RW	CanPdo2RxId	
381	Parameter	INT32	RW	CanSdoTxId	
382	Parameter	INT32	RW	CanSdoRxId	
383	Parameter	INT32	RW	CanNmtErrControlId	
384	Variable	INT16	RO	----	Reserved
385	Variable	INT16	RO	----	Reserved
386	Variable	INT16	RO	----	Reserved
387	Parameter	INT16	RW	BusCycleTimeMin	→ CAN-NOVOTRON: limit values for
388	Parameter	INT16	RW	BusCycleTimeMax	cycle time of process data channel

Decimal address	Category	Size		Name	Function
389	Variable	INT16	RO	----	Reserved
390	Parameter	INT16	RW	FiCycle	→ Operating Mode #59 (Fine Interpolation)
391	Parameter	INT32	RW	CANopenBaudrate	→ CANopen: baud rate of extension module
392	Parameter	INT8	RW	ExtModuleBusAddress	PROFIBUS address / CANopen Node-ID of extension module
393	Variable	INT16	RO	----	Reserved
:	:	:	:	:	
399	Variable	INT16	RO	----	
400	Parameter	INT16	RW	PdoTByte[0]	→ CAN-NOVOTRON:
401	Parameter	INT16	RW	PdoTByte[1]	Mapping parameters for
:	:	:	:	:	process data exchange by means of
415	Parameter	INT16	RW	PdoTByte[15]	sync telegrams
416	Parameter	INT16	RW	PdoRByte[0]	
417	Parameter	INT16	RW	PdoRByte[1]	
:	:	:	:	:	
431	Parameter	INT16	RW	PdoRByte[15]	
432	Variable	INT16	RO	---	Reserved
:	:	:	:	:	
439	Variable	INT16	RO	---	
440	Parameter	INT32	RW	UserParam[0]	Registers for free use
441	Parameter	INT32	RW	UserParam[1]	to save user specific information;
442	Parameter	INT32	RW	UserParam[2]	these registers are not used by NOVODRIVE
443	Parameter	INT32	RW	UserParam[3]	
444	Parameter	INT32	RW	UserParam[4]	
445	Parameter	INT32	RW	UserParam[5]	
446	Parameter	INT32	RW	UserParam[6]	
447	Parameter	INT32	RW	UserParam[7]	
448	Parameter	INT32	RW	UserParam[8]	
449	Parameter	INT32	RW	UserParam[9]	
450	Parameter	INT16	RW	CsScKp0	Alternative parameter set 0 for
451	Parameter	INT16	RW	CsScKi0	speed controller and position controller
452	Parameter	INT16	RW	CsScKd0	
453	Parameter	INT16	RW	CsScKf0	
454	Parameter	INT16	RW	CsPCKp0	
455	Parameter	INT16	RW	CsPCKd0	
456	Parameter	INT16	RW	CsScKp1	Alternative parameter set 1 for
457	Parameter	INT16	RW	CsScKi1	speed controller and position controller

Decimal address	Category	Size		Name	Function
458	Parameter	INT16	RW	CsScKd1	
459	Parameter	INT16	RW	CsScKf1	
460	Parameter	INT16	RW	CsPCKp1	
461	Parameter	INT16	RW	CsPCKd1	
462	Parameter	INT16	RW	CsScKp2	Alternative parameter set 2 for speed controller and position controller
463	Parameter	INT16	RW	CsScKi2	
464	Parameter	INT16	RW	CsScKd2	
465	Parameter	INT16	RW	CsScKf2	
466	Parameter	INT16	RW	CsPCKp2	
467	Parameter	INT16	RW	CsPCKd2	
468	Parameter	INT16	RW	CsScKp3	Alternative parameter set 3 for speed controller and position controller
469	Parameter	INT16	RW	CsScKi3	
470	Parameter	INT16	RW	CsScKd3	
471	Parameter	INT16	RW	CsScKf3	
472	Parameter	INT16	RW	CsPCKp3	
473	Parameter	INT16	RW	CsPCKd3	
474	Parameter	INT8	RW	CsCcEmk0	Alternative parameter set 0 for current controller
475	Parameter	INT8	RW	CsCcKi0	
476	Parameter	INT8	RW	CsCcKp0	
477	Parameter	INT8	RW	CsCcEmk1	Alternative parameter set 1 for current controller
478	Parameter	INT8	RW	CsCcKi1	
479	Parameter	INT8	RW	CsCcKp1	
480	Variable	INT16	RO	----	Reserved
481	Parameter	INT16	RW	FCVH	→ Compensation of static friction
482	Parameter	INT16	RW	FCVL	
483	Parameter	INT16	RW	FCMP	
484	Parameter	INT16	RW	AkPhiPoGain	Parameters for automatic search of commutation position
485	Parameter	INT16	RW	AkCurrentGain	
486	Parameter	INT16	RW	AkSpeed	
487	Parameter	INT16	RW	StatusEventMask	→ Event Monitoring
488	Parameter	INT16	RW	InPosTimeConst	→ Operating Modes Annex B (In Position)
489	Parameter	INT16	RW	AsDefSpeed	→ Job Control: various default values for programmable jobs
490	Parameter	INT16	RW	AsDefAccLim	
491	Parameter	INT16	RW	AsDefDecLim	
492	Parameter	INT32	RW	AsAnInCorrFactor	→ Operating Mode #44
493	Parameter	INT16	RW	ResolvCorrection1	Reserved
494	Parameter	INT16	RW	ResolvCorrection2	

Decimal address	Category	Size		Name	Function
495	Parameter	INT16	RW	ResolvCorrection3	
496	Parameter	INT16	RW	ResolvCorrection4	
497	Parameter	INT16	RW	FieldAttCurrent	→ Field attenuation
498	Parameter	INT16	RW	FieldAttSpeedLow	
499	Parameter	INT16	RW	FieldAttSpeedHigh	

9.1.5 State variables

Decimal address	Category	Size		Name	Function
550	Variable	INT16	RO	SyncStatus	→ Controller cycles synchronization
551	Variable	INT16	RO	SpeedTrackingError	Speed tracking error
552	Variable	INT32	RO	PosTrackingError	Position tracking error
553	Variable	INT32	RW	PosTrackingMemory	Record of max. position tracking error
554	Variable	INT32	RO	----	Reserved
555	Variable	INT16	RO	CurrentPeakLimit0	Actual max. permissible peak current
556	Variable	INT16	RO	I2tActual	Actual I²t current value
557	Variable	INT16	RO	ResolverAngle	Angle and signal levels
558	Variable	INT8	RO	ResolverSinus	at resolver connectors
559	Variable	INT8	RO	ResolverCosinus	
560	Variable	INT16	RO	EncSignalA	Signal levels
561	Variable	INT16	RO	EncSignalB	at sine wave encoder connectors
562	Variable	INT8	RO	PhaseCurrActualA1	Actual setpoint and actual phase currents A1...A2;
563	Variable	INT8	RO	PhaseCurrActualA2	scaling hardware dependent
564	Variable	INT8	RO	PhaseCurrSetpointA1	
565	Variable	INT8	RO	PhaseCurrSetpointA2	
566	Variable	INT8	RO	PhaseVoltageA1	Actual voltage of motor phases A1...A3;
567	Variable	INT8	RO	PhaseVoltageA2	scaling hardware dependent
568	Variable	INT8	RO	PhaseVoltageA3	
569	Variable	INT8	RO	DcBusVoltage	DC link voltage; hardware dependent
570	Variable	INT16	RO	BrPowerFiltered	→ Brake chopper; calculated power dissipation
571	Variable	INT8	RO	HeatsinkTemp	Heat sink temperature
572	Variable	INT8	RO	MotorTempFiltered	Resistance value of motor temperature sensor [58,8 Ohm/incr.]
573	Variable	INT16	RW	TiPtr	→ Operating Modes #48 and #50

Decimal address	Category	Size		Name	Function
574	Variable	INT16	RW	XRamPtr	
575	Variable	INT16	RO	---	Reserved
576	Variable	INT16	RO	---	Reserved
577	Variable	INT16	RO	---	Reserved
578	Variable	INT16	RW	TracePtr	→ Operating Modes #48 and #50
579	Variable	INT8	RO	ActualOperationMode	Obsolete; identical with Address 265
580	Variable	INT32	RO	ErrorInfo0	→ Error information;
581	Variable	INT32	RO	ErrorInfo1	additional information in case of error
582	Variable	INT32	RO	RippleCompensation	Reserved
583	Variable	INT32	RO	AllControl	Output of speed controller
584	Variable	INT32	RO	PositionSetpoint	Internal position setpoint of position controller
585	Variable	INT16	RW	EPSaddress	→ Extension module; feedback system
586	Variable	INT16	RW	EPSdata	
587	Variable	INT32	RO	FrictionCompValue	→ Compensation of static friction
588	Variable	INT16	RO	ExtModuleState	→ Extension module; internal state
589	Variable	INT16	RW	I2tActualMemory	Record of Variable 556 'I2tActual'
590	Variable	INT32	RO	PdoMappingState	→ CAN-NOVOTRON
591	Variable	INT16	RW	Status16Memory	Record of Variable 251 'Status16'
592	Variable	INT32	RO	ExtPosRawData	→ Extension module; feedback system
593	Variable	INT16	RO	ApparentCurrent	→ Field attenuation
594	Variable	INT16	RO	I2T100ms	
595	Variable	INT16	RO	I2T100msApparent	

9.1.6 Error history variables

Decimal address	Category	Size		Name	Function
600	Variable	INT8	RO	ErrorPtr	→ Error history; pointer to the last error
601	Variable	INT32	RO	Error [0]	Ring buffer of error history
602	Variable	INT32	RO	Error [1]	
:	:	:	:	:	
632	Variable	INT32	RO	Error [31]	
633	Variable	INT16	RW	EhInfoPtr	→ Error history;
634	Variable	INT16	RO	EhInfoCursor	Query of error information by cursor
635	Variable	INT16	RO	EhInfoError	
636	Variable	INT16	RO	EhInfoHour	

Decimal address	Category	Size		Name	Function
637	Variable	INT32	RO	EhInfo0	
638	Variable	INT32	RO	EhInfo1	
639	Variable	INT16	RO	---	Reserved

9.1.7 Extension Module with EnDat 2.2 Feedback System

Decimal address	Category	Size		Name	Function
640	Variable	INT16	RO	EpParam[00]	→ Extension module; information on feedback system connected to extension module
641	Variable	INT16	RO	EpParam[01]	
:	:	:	:	:	
671	Variable	INT16	RO	EpParam[31]	

9.1.8 Oscilloscope variables

Decimal address	Category	Size		Name	Function
680	Variable	INT8	RW	ScopeControl	→ Oscilloscope functions
681	Variable	INT8	RO	ScopeStatus	
682	Variable	INT16	RW	ScopeTimer	
683	Variable	INT16	RW	ScopeSignal1	
684	Variable	INT16	RW	ScopeSignal2	
685	Variable	INT16	RW	ScopeSignal3	
686	Variable	INT16	RW	ScopeSignal4	
687	Variable	INT16	RW	ScopeTriggerSignal	
688	Variable	INT8	RW	ScopeTriggerBit	
689	Variable	INT8	RW	ScopeTriggerLevel	
690	Variable	INT8	RW	ScopeDelay	
691	Variable	INT16	RO	ScopeDataPointer	
700	Variable	INT32	RO	Scope Data [0]	Recorded oscilloscope data
701	Variable	INT32	RO	Scope Data [1]	
:	:	:	:	:	
827	Variable	INT32	RO	Scope Data [127]	
828	Variable	INT16	RO	---	Reserved
829	Variable	INT16	RO	---	Reserved

9.1.9 X-RAM variables

The X-RAM is word-organized and can be read and written only by the X-commands of NOVOBUS and CAN-NOVOTRON.

Interpolation Buffer

The usage of the interpolation buffer is outlined in the description of Operating Modes #48 and #50 in the Software Reference User Manual. The interpolation buffer is cleared after each power-off and reset.

Decimal Address	Category	Size		Name	Function
0	Variable	INT16	RW	XRAM_0	Interpolation Buffer Word 0
1	Variable	INT16	RW	XRAM_1	Interpolation Buffer Word 1
:	:	:	:	:	:
4095	Variable	INT16	RW	XRAM_4095	Interpolation Buffer Word 4095

Job memory

The job memory is used for storage of programmable jobs. Like the parameters, it can be saved in the EEPROM.

Decimal Address	Category	Size		Name	Function
8192	Variable	INT16	RW	XRAM_8192	Job memory Word 0
8193	Variable	INT16	RW	XRAM_8193	Job memory Word 1
:	:	:	:	:	:
9211	Variable	INT16	RW	XRAM_9211	Job memory Word 1023

9.2 The 'ParamControl' Register

The 'ParamControl' register controls the loading and saving of parameters and jobs from and to the EEPROM. It is also possible to reset all parameters to factory settings.

For reasons of operating safety, loading parameters from the EEPROM and saving parameters to the EEPROM can be done only in disabled state. By this it is ensured that the motor does not run with inconsistent or invalid data.

Address	Name	Function
150	ParamControl	Control register for loading and saving of parameters and jobs

After a value has been written into the register, wait until the register shows 'DONE' or 'FAIL'.

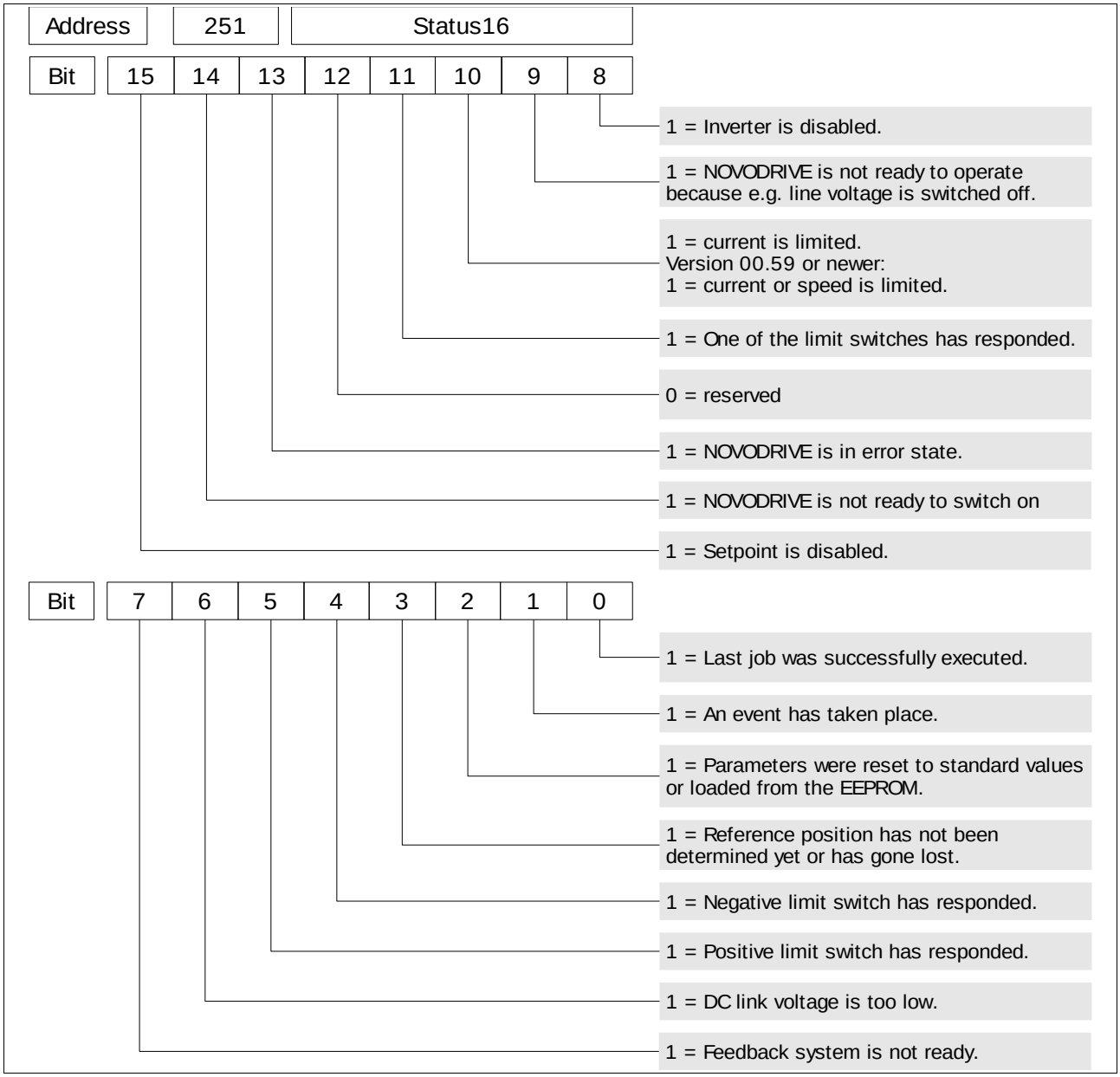
Hexadecimal value	ASCII equivalent	Function
0x4C4F4144	LOAD	Loading of parameters and jobs from the EEPROM (is done automatically upon reset)
0x53415645	SAVE	Saving (permanent) of parameters and jobs to the EEPROM. Please note that a saving process may take up to 30 seconds.
0x46414354	FACT	Reset of parameters to factory settings
0x444F4E45	DONE	Content of register after successful execution
0x4641494C	FAIL	Content of register after fault

Upon power-up or reset, do not write into 'ParamControl' until NOVODRIVE is ready to be switched on ('Undervoltage' state), as the register is internally used by NOVODRIVE before that point.

9.3 The 'Status16' Register

The 'Status16' register accommodates the complete spectrum of NOVODRIVE's states.

The 'Status' register (Address 250) is available for reasons of compatibility with NOVODRIVE ND30. It contains Bits 8...15 of 'Status16'.



Please note

Upon power-up or in case of an error in the feedback system (Error Class 4), Bit 3 is set to '1'.

Upon successful execution of Operating Modes #9, #10, #11, #12, #14 and #15, Bit 3 is set to '0'.

9.4 Status Memory and Events

All events indicated in 'Status16' are being recorded in 'Status16Memory'. Every time a bit is set to '1' in 'Status16', this event will be documented permanently in 'Status16Memory'.

'Status16Memory' can be cleared by writing '0' into it.

To avoid a time consuming query of register 'Status16Memory', selected Bits can be monitored. Selection of Bits is made over Parameter 'StatusEventMask'. Each Bit that is set in 'StatusEventMask' activates the monitoring of the respective Bit in 'Status16Memory'. If at least one of the Bits monitored is set, this will be indicated in Bit 1 of 'Status16'.

Address	Name	Function
251	Status16	Status indication; accommodates the complete spectrum of NOVODRIVE's states
487	StatusEventMask	Bit mask for event monitoring
591	Status16Memory	Record of 'Status16'

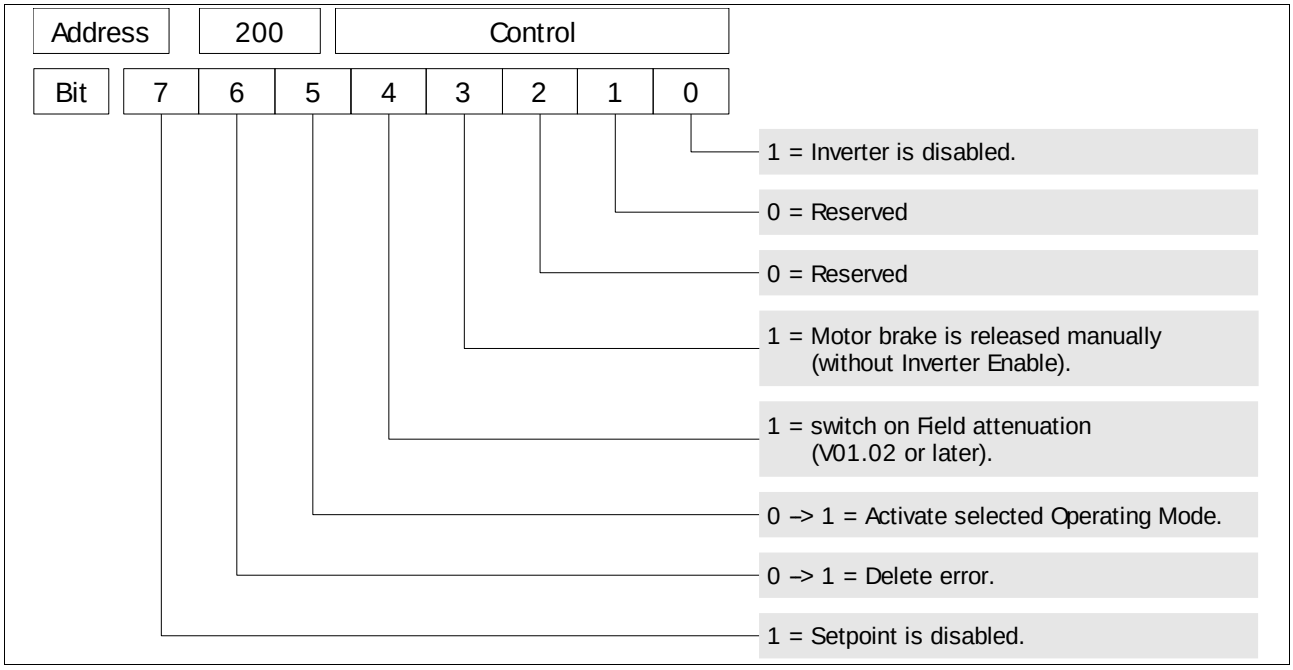
Example

You want to monitor the current limit bit.

Step	Register	Content	Description
1	StatusEventMask	0000 0100 0000 0000	Set event mask to 0x0400
2	Status16Memory	0000 0000 0000 0000	Delete event memory
3		...	
4	Status16	xxxx x1xx xxxx xx0x	For a short time Bit 10 shows current is limited
5	Status16	xxxx x0xx xxxx xx0x	Current limiting ended
6	Status16Memory	0000 0100 0000 0000	Register 'Status16Memory' has recorded Bit 10
7	Status16	xxxx x0xx xxxx xx1x	Bit 1 shows an event has taken place

9.5 The 'Control' Register

The 'Control' Register is the software interface for controlling NOVODRIVE's basic functions.



Example

Description	Binary value	Hexadecimal value
Upon power-up the Register's value is	1000 0001	0x81
Disable inverter and setpoint	1000 0001	0x81
Enable inverter, setpoint remains disabled	1000 0000	0x80
Activate selected Operating Mode (inverter remains enabled, setpoint remains disabled)	1100 0000	0xC0
Activate selected Operating Mode (inverter and setpoint remain enabled)	0100 0000	0x40
Enable inverter and setpoint	0000 0000	0x00
Delete error (inverter and setpoint disabled)	1100 0001	0xC1

9.6 Inverter Enable/Disable and Setpoint Enable/Disable

The NOVODRIVE functions

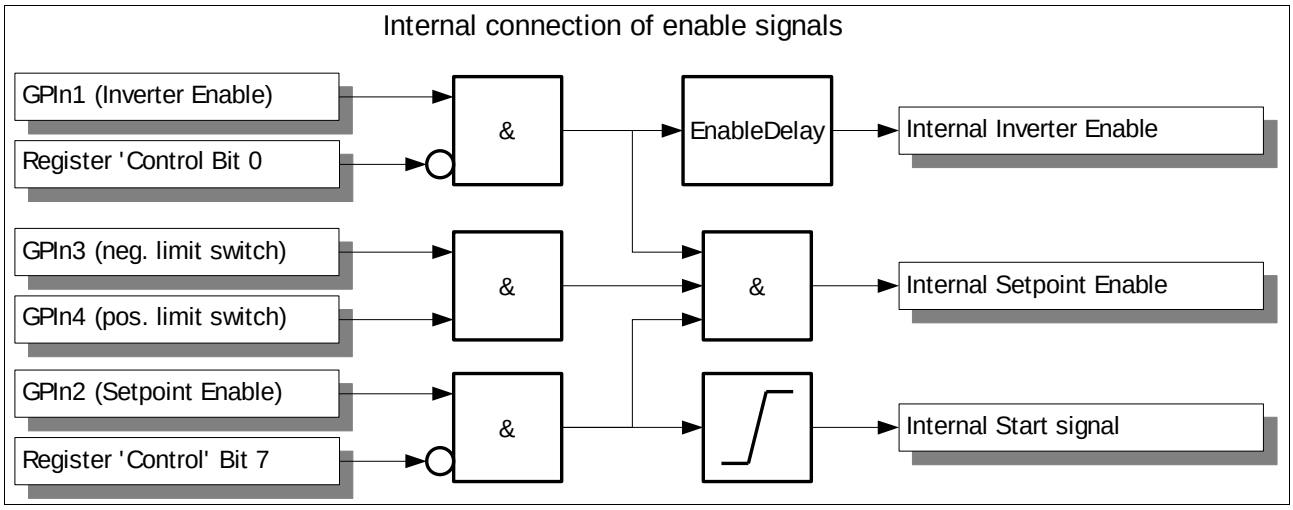
- Inverter Enable/Disable
- Setpoint Enable/Disable

are controlled by digital inputs GPIn1 and GPIn2 and by the 'Control' Register (Bit 0 and Bit 7).

The NOVODRIVE functions

- Activate Selected Operating Mode
- Delete Error

can only be controlled by the 'Control' Register (Bit 5 and Bit 6).



Inverter Enable delay

Inverter Enable can be internally delayed by Parameter 'EnableDelay'. This allows to switch GPIn1 and line voltage with the same signal. In this case, 'EnableDelay' should be set to 1 sec. This will ensure that the DC link is fully charged before the motor starts to move. Otherwise the inrush current limiter may be damaged.

Address	Name	Function
303	EnableDelay	Internal delay of Inverter Enable. The scaling is 1 incr. = 1 ms. We recommend a delay of 1000 incr. = 1 sec.

9.7 The 'PdoHandler' Register

The 'PdoHandler' Register specifies how and by what NOVODRIVE is controlled. This setting can be made on the 'IO/Control' page of the setup software.

Address	Name	Function
304	PdoHandler	See list below

Mode list

Value	Mode	Description
0	Setup software	NOVODRIVE is controlled by NOVOBUS (e.g. via the setup software) or by the CAN-NOVOTRON service channel. After setting digital inputs GPIn1 (Inverter Enable) and GPIn2 (Setpoint Enable) to 24 V, control of NOVODRIVE is done by writing into Register 'Control' or writing into the process data inputs.
1	Digital inputs	NOVODRIVE is controlled over the digital inputs. The 'Control' register is manipulated over GPIn1 (Inverter Enable), GPIn2(Setpoint Enable) and GPIn9 (Delete Error). By this, simple applications like, for example, analog setpoint setting and encoder feedback, can be set up without any bus connection. Version 01.04 or newer: GPO9=Status16.Bit0, GPO10=Status16.Bit10
2	Technology Function 1: job control via digital inputs	NOVODRIVE is controlled over the digital inputs. All GPIns and GPOs are connected to the job control's inputs and outputs. The 'Job Control' Technology Function must be switched on separately.
3	-	Reserved for extensions.
4	CAN-NOVOTRON: interpolation buffer	Same as '0', but additionally the CAN-NOVOTRON data exchange with interpolation buffer for Operating Modes #48 and #50 is running.
5	Technology Function 8	Same as '2'. However, the 'Control' register is manipulated over GPIn1 (Inverter Enable) and GPIn9 (Delete Error). Unlike with '2', Bits 'Setpoint Enable' and 'Activate Selected Operating Mode' are controlled internally by Technology Function 8. Technology Function 8 must be switched on separately.
6...15	-	Reserved for extensions.
16	Extension module Setup software	NOVODRIVE is controlled by setup software. A PLC, which is connected via PROFIBUS / CANopen, cannot set any value but gets all actual data. This mode is useful for first setup and debugging.
17	Extension module Drive Profile	NOVODRIVE is controlled by Drive Profile via PROFIBUS / CANopen.
18	Extension module Job Control	NOVODRIVE is controlled by Job Control via PROFIBUS / CANopen.
19...31	-	Reserved for extensions.
32	CAN-NOVOTRON: process data with synchonization	Same as '0', but additionally the CAN-NOVOTRON process data exchange with synchronization is running. NOVODRIVE then works as a CAN-NOVOTRON slave.
33...255	-	Reserved for extensions.

10 Scaling of Actual Values and Setpoints

The scaling of values for current, speed and position is dependent on the device type or variant, the feedback system connected, and various parameters.

For reasons of increased processing speed, NOVODRIVE always works with increments. The same thing applies for data transmission over NOVOBUS and CAN-NOVOTRON.

By contrast, for the setup software and the extension modules for bus systems (PROFIBUS, CANopen) it is possible to set and display process data in SI units.

10.1 Increment Scaling in NOVODRIVE

> The information given in this sub-section is only relevant if you work with NOVODRIVE's registers. You may view actual values on page 'Motor / Scales Information' of the setup software.

Position

Resolver	$\frac{increments}{rotation} = 2^{16}$
Sine wave encoder	$\frac{increments}{rotation} = \frac{impulse}{rotation} \cdot 2^{Register\ \mathbf{EncInterpolationsBits}}$
Incremental linear encoder systems	$\frac{distance\,[mm]}{increment} = \frac{pulse\ length\ of\ linear\ encoder\,[mm]}{2^{Register\ \mathbf{EncInterpolationsBits}}}$
EnDat 2.2 Absolute rotary feedback system	$\frac{increments}{revolution} = 2^{(\frac{number\ of\ bits}{rotation} - Register\ \mathbf{EncInterpolationsBits})}$
EnDat 2.2 Absolute linear feedback system	$\frac{distance\,[mm]}{increment} = 2^{Register\ \mathbf{EncInterpolationsBits}} \cdot messure\,unit\,[mm/inc.]$

Speed

Rotary	$\frac{speed\,[rpm]}{increment} = 585937{,}5 \cdot \frac{resolution\ of\ position\,[\frac{rotation}{inc.}]}{Register\ \mathbf{ScFactor}}$
Linear	$\frac{speed\,[m/s]}{increment} = 9{,}765625 \cdot \frac{resolution\ of\ position\,[\frac{mm}{Ink.}]}{Register\ \mathbf{ScFactor}}$

Speed ramps

Rotary	$\frac{ramp\,[\frac{rpm}{ms}]}{[increment]} = 0{,}038147 \cdot resolution\ of\ speed\,[rpm]$
Linear	$\frac{ramp\,[\frac{m}{s^2}]}{[increment]} = 38{,}147 \cdot resolution\ of\ speed\,[m/s]$

R.m.s. current (torque setpoint, limit values, I²t monitoring etc.)

The scaling of r.m.s current is dependent on NOVODRIVE's rated current.

	Percentage	Decimal value	Hexadecimal value
Rated current	100 %	14848	0x3A00
Peak current	200 %	29696	0x7400

Phase current (Registers 'PhaseCurrActualA1', 'PhaseCurrActualA2' etc.)

The scaling of phase current is dependent on NOVODRIVE's rated current.

	Percentage	Decimal value	Hexadecimal value
Rated current	100 %	48	0x30
Peak current	200 %	96	0x60

DC link voltage

The scaling of DC link voltage is dependent on NOVODRIVE's rated voltage.

Conversion factors for current and voltage

Scaling of NOVODRIVE Typ	r.m.s. current	phase current	DC-Link Voltage	Rated voltage
ND41-3202	0,135 mA/Incr.	58,9 mA/Incr.	1,78 VDC/Incr.	230 VAC
ND41-3204	0,269 mA/Incr.	117,9 mA/Incr.	1,78 VDC/Incr.	230 VAC
ND41-3207	0,470 mA/Incr.	206,2 mA/Incr.	1,78 VDC/Incr.	230 VAC
ND42-5605	0,337 mA/Incr.	147,3 mA/Incr.	4,0 VDC/Incr.	400 VAC
ND42-5610	0,673 mA/Incr.	294,6 mA/Incr.	4,0 VDC/Incr.	400 VAC
ND42-5618	1,210 mA/Incr.	530,0 mA/Incr.	4,0 VDC/Inkr.	400 VAC
ND43-6820	1,347 mA/Incr.	589,0 mA/Incr.	4,0 VDC/Incr.	480 VAC
ND43-6825	1,683 mA/Incr.	737,0 mA/ Incr.	4,0 VDC/Incr.	480 VAC

Examples for rotary feedback systems

Feedback system	Speed range 0...3000 rpm	Speed range 0...6000 rpm	Speed range 0...12000 rpm
Resolver with 16 bit/rev. or ERN1387 with 16 bit/rev	Position: 1 Incr. = 1/65536 rev. Speed: 1 Incr. = 0,11175 rpm Ramps: 1 Incr. = 0,004263 rpm/ms	Position: 1 Incr. = 1/65536 rev. Speed: 1 Incr. = 0,2235 rpm Ramps: 1 Incr. = 0,008526 rpm/ms	Position: 1 Incr. = 1/65536 rev. Speed: 1 Incr. = 0,1118 rpm Ramps: 1 Incr. = 0,004263 rpm/ms

10.2 SI Scaling

For the setup software and the extension modules for bus systems it is possible to set and display process data in SI units.

Scaled data exchange via the SDO channel is not possible, as the conversion is not done in NOVODRIVE itself. To determine the conversion factors, a number of settings must be done in the setup software, referring to

- the feedback system used (→ setup software page 'General / Scaling/Scales and Units'),
- the gear or the ball screw spindle (if applicable) (→ setup software 'General / Scaling / Gear Factor'),
- the number format desired (→ setup software page 'General / Scaling / Scales and Units').

Number format for position when using a rotary drive

Decimal places	0	1	2	3
In increments	########,	-	-	-
In degrees	########,	########,#	######,##	#####,###
In revolutions	########,	########,#	######,##	#####,###

Number format for position when using a linear drive / rotary drive with ball screw spindle

Decimal places	0	1	2	3
In increments	########,	-	-	-
In µm	########,	########,#	######,##	#####,###
In mm	########,	########,#	######,##	-
In m	########,	########,#	######,##	-

Number format for speed when using a rotary drive

Decimal places	0	1	2	3
In increments	########,	-	-	-
In percent	########,	########,#	-	-
In degrees/sec	########,	########,#	######,##	#####,###
In revolutions/sec	########,	########,#	######,##	#####,###
In revolutions/min	########,	########,#	######,##	#####,###

Number format for speed when using a linear drive

Decimal places	0	1	2	3
In increments	########,	-	-	-
In percent	########,	########,#	-	-
In mm/sec	########,	########,#	######,##	#####,###
In m/sec	########,	########,#	######,##	-

Number format for speed when using a rotary drive with ball screw spindle

Decimal places	0	1	2	3
In increments	########,	-	-	-
In percent	########,	########,#	-	-
In degrees/sec	########,	########,#	######,##	#####,###
In revolutions/sec	########,	########,#	######,##	#####,###
In revolutions/min	########,	########,#	######,##	#####,###
In mm/sec	########,	########,#	######,##	#####,###
In m/sec	########,	########,#	######,##	-

Number format for speed ramps when using a rotary drive

Decimal places	0	1	2	3
In increments	########,	-	-	-
In percent	########,	########,#	-	-
In degrees/sec^2	########,	########,#	######,##	#####,###
In revolutions/sec^2	########,	########,#	######,##	#####,###
In revolutions/min/ms	########,	########,#	######,##	#####,###

Number format for speed ramps when using a linear drive

Decimal places	0	1	2	3
In increments	########,	-	-	-
In percent	########,	########,#	-	-
In mm/sec^2	########,	########,#	######,##	#####,###
In m/sec^2	########,	########,#	######,##	-

Number format for speed ramps when using a rotary drive with ball screw spindle

Decimal places	0	1	2	3
In increments	########,	-	-	-
In percent	########,	########,#	-	-
In degrees/sec^2	########,	########,#	######,##	#####,###
In revolutions/sec^2	########,	########,#	######,##	#####,###
In revolutions/min/ms	########,	########,#	######,##	#####,###
In mm/sec^2	########,	########,#	######,##	#####,###
In m/sec^2	########,	########,#	######,##	-

Number format for r.m.s. current

Decimal places	0	1	2	3
In increments	########,	-	-	-
In percent	########,	########,#	-	-
In A	########,	########,#	######,##	#####,###

Example

Specification:

You want to set and display the value for position in [mm] with one decimal place.

Format selection:

'#####.# mm' is selected.

Result:

Via PROFIBUS the position value is transmitted as:

23,1 mm ≅ 0000231dez ≅ 0x0000 00E7

The setup software displays the value as '23,1 mm'.

11 Hardware Inputs and Outputs

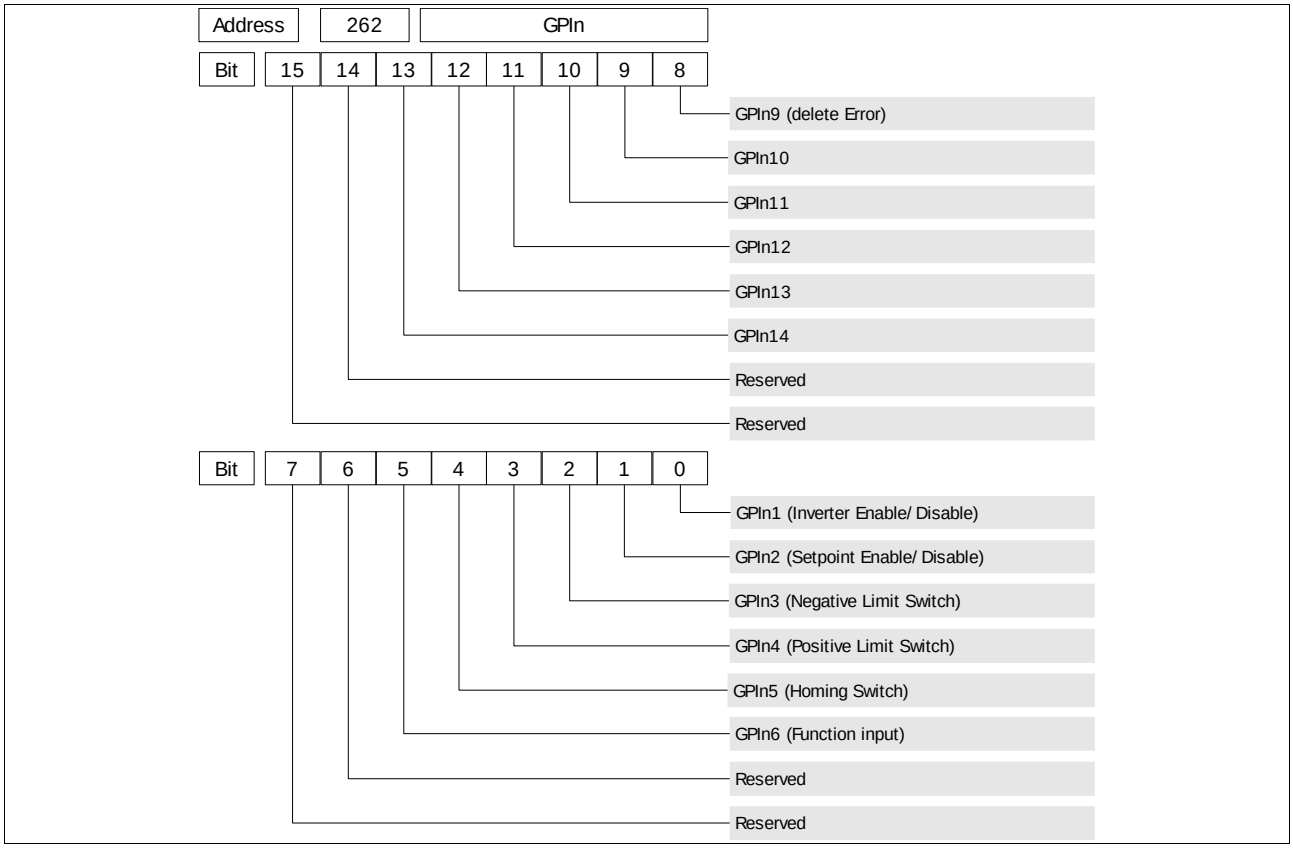
11.1 Digital Inputs

Connector X3 (X3A/X3B) offers twelve (six) digital inputs. The states of the digital inputs can be read in the 'GPIn' Register.

Low level	< 6 V	State '1'
High level	> 21 V	State '0'
Max. permissible voltage	30 V	
Debouncing with a time constant of	100 µs	
Internal impedance		10 kOhm

The functions of GPIn1...GPIn6 are set by default, while GPIn9... GPIn14 can be used for various purposes:

- for selection of jobs by the Job Control,
- for setting the bus address for PROFIBUS and CANopen in extension module or CAN-NOVOTRON (→ software bus options),
- as additional digital inputs, which can be read by the control unit via bus system.



11.2 Digital Outputs

Connector X3 offers six digital outputs. The digital outputs “BTB1” / “BTB2” and “MB1” / “MB2” are semiconductor relays with a load capacity of 24 V / 200 mA. They are controlled internally.

State '0': relay contact open

State '1': relay contact closed

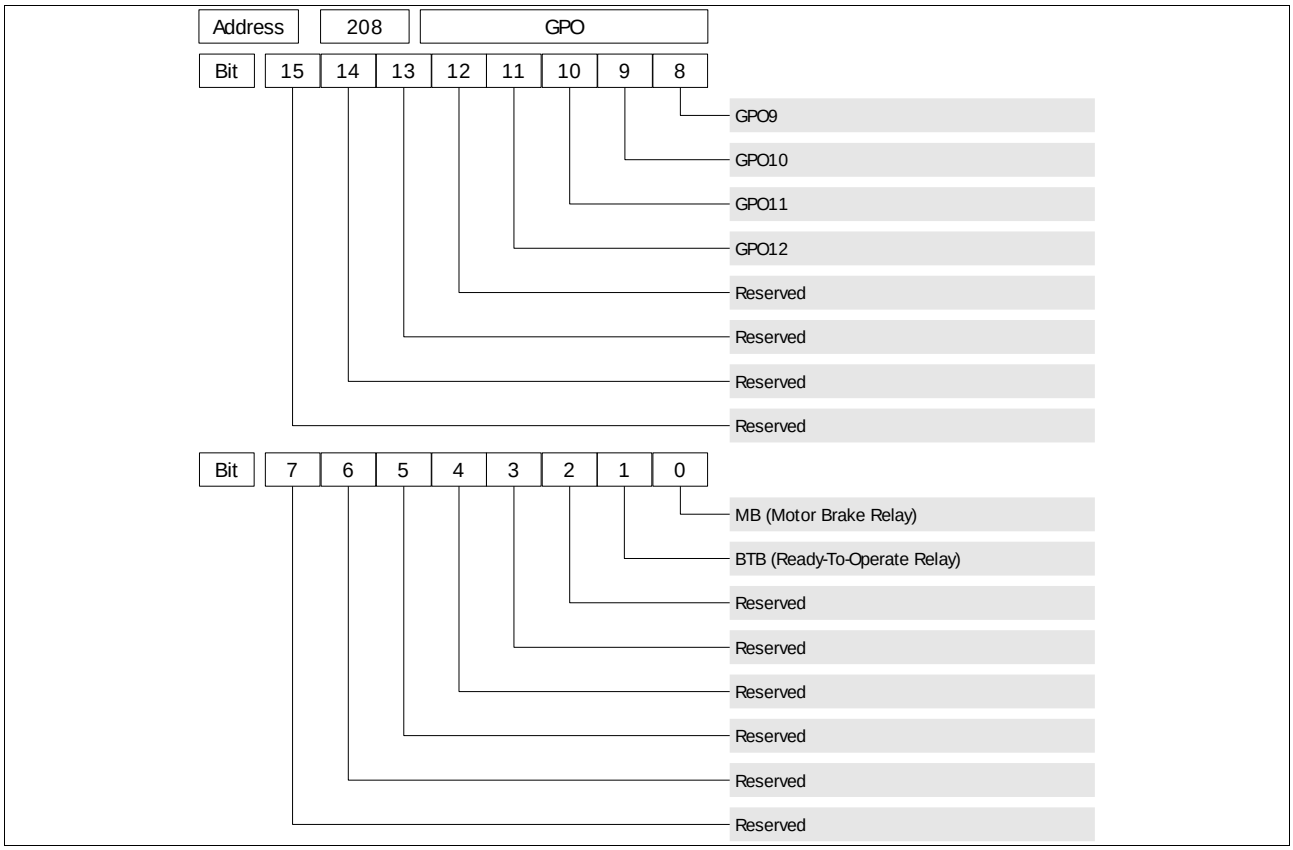
GPO9...GPO12 switch to 24 V and have a load capacity of 100 mA. They can be set by writing into the 'GPO' Register.

State '0': high-impedance output

State '1' +24 V output

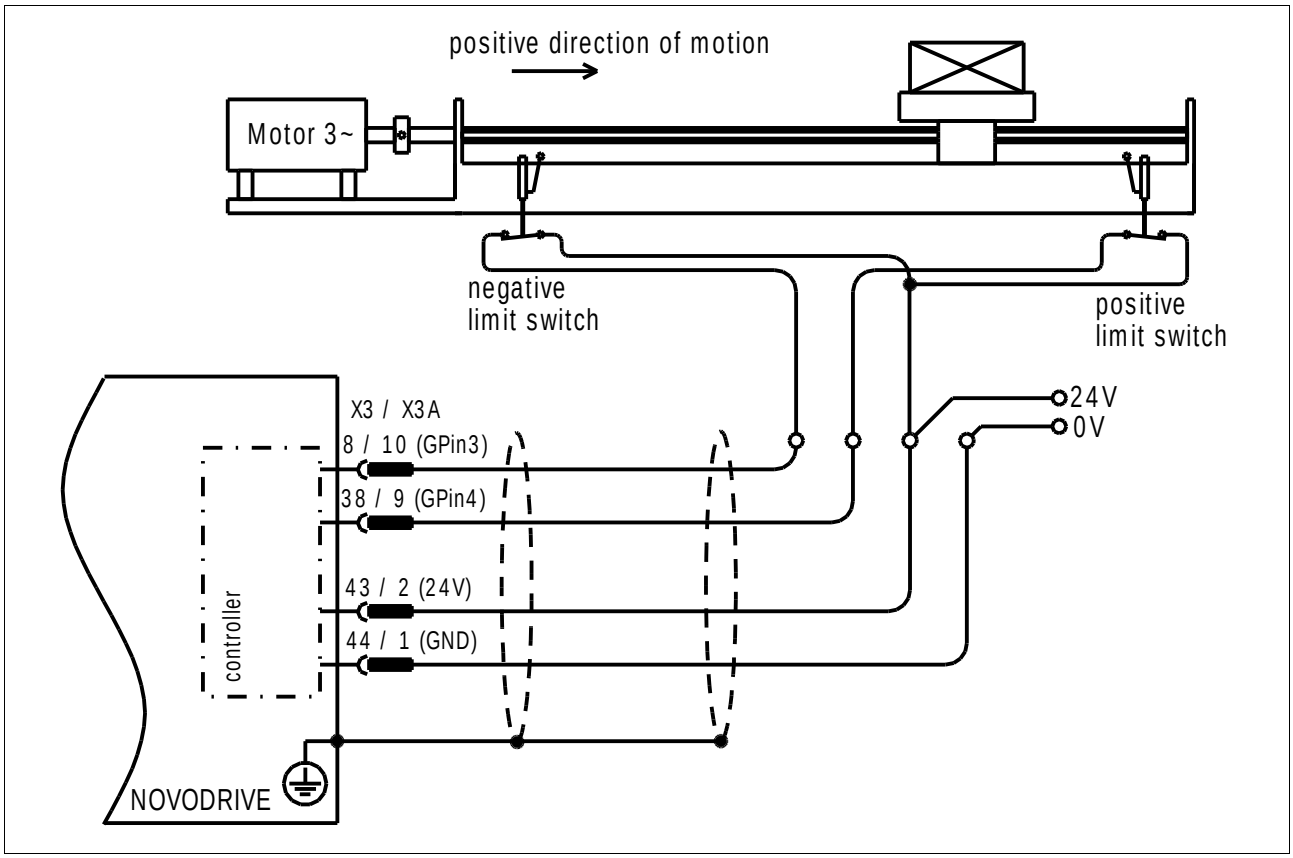
The functions of “BTB” and “MB” are set internal, while GPO9...GPO12 can be used for various purposes:

- as signal outputs for the Job Control,
- as additional digital outputs, which can be set by the control unit via bus system.



11.3 Limit Switches

Hardware limit switches



You can choose the reaction to a response of the hardware limit switches:

- no reaction,
- controlled braking of the motor by means of the deceleration ramp: the limit switch position can be left again by moving towards the opposite direction; if both limit switches are open, Error 314 (Class 2) will be generated,
- generation of Error 310 or Error 311 (Class 3): the motor runs down until it stops; if both limit switches are opened, Error 314 (Class 2) will be generated.

Software limit switches

Prerequisites for using software limit switches

Software limit switches can function only if homing has been done or if an absolute feedback system is used. This will be indicated by the value '0' in Bit 3 of the 'Status16' Register.

Upon power-up, Bit 3 of the 'Status16' Register is set to '1'. Upon successful execution of one of the Operating Modes #9, #11, #12, #14 or #15, Bit 3 is reset to '0'. If an error (Class 4) occurs, Bit 3 will be set to '1' again and the software limit switches will be deactivated again.

You can choose the reaction to a response of the software limit switches:

- no reaction,
- controlled braking of the motor by means of the deceleration ramp: the limit switch position can be left again by moving towards the opposite direction; if both limit switch positions are swaped, Error 318 (Class 2) will be generated,
- generation of Error 316 or Error 317 (Class 3): the motor runs down until it stops; if both limit switch positions are swaped,, Error 318 (Class 2) will be generated.

Registers

Address	Name	Function
308	LimitSwControl	Hardware limit switch: `xxxx 0000` no reaction `xxxx 0001` controlled braking by means of the deceleration ramp `xxxx 0010` generation of Error 310 or 311 Software limit switch: `0000 xxxx` no reaction `0001 xxxx` controlled braking by means of the deceleration ramp `0010 xxxx` generation of Error 316 or 317
309	LimitSwPosHigh	Position of positive software limit switch
310	LimitSwPosLow	Position of negative software limit switch

Error codes

Error code	Description
E 3 1 0	Positive hardware limit switch has responded
E 3 1 1	Negative hardware limit switch has responded
E 3 1 2	Software and hardware limit switches mutually block each other
E 3 1 4	Both hardware limit switches have responded
E 3 1 6	Positive software limit switch has responded
E 3 1 7	Negative software limit switch has responded
E 3 1 8	Both software limit switches have responded

11.4 Analog Input

Description

NOVODRIVE offers an analog ±10 V input, whose resolution and conversion time can be chosen.

The analog input can be used

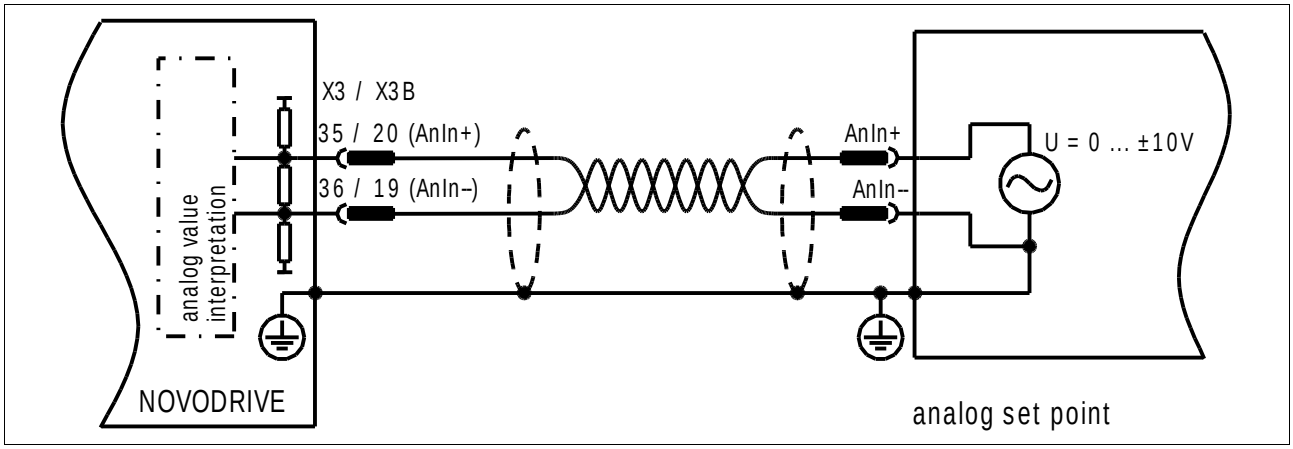
- for speed setpoint setting (Operating Modes #18, #19 and #20),
- for speed override in the Job Control,
- for data logging by readout via bus system.

Registers

Address	Name	Function
264	AnalogInput	Voltage scaling at resolution: 16/14 bit ±11,6 V 1,0 V = -2825 increments 10 bit ±9,6 V 1,0 V = +3413 increments
351	AnalogInputControl	Selection of resolution and conversion time: 0 = 16 Bit / 3,2 ms 1 = 14 Bit / 0,8 ms 2 = 10 Bit / 102,4 µs Please note: Any changes require a reset to become effective.
352	AnalogInputScale	Used by Operating Modes #18, #19 and #20 for scaling of speed setpoint (100 % = 256)
353	AnalogInputOffset	Offset correction (scaling same as with 'AnalogInput')

Hardware I/O

The analog input is on connector X3 and X3B, respectively.



Error codes

The analog input does not generate any errors.

11.5 Input Counter

Description

NOVODRIVE has a input counter, which can be used as a quadrature counter or as a step/direction counter. Using the input counter, you may

- emulate a step motor's behavior,
- build an electronic gear,
- run synchronous shafts, or
- for data logging by readout via bus system.

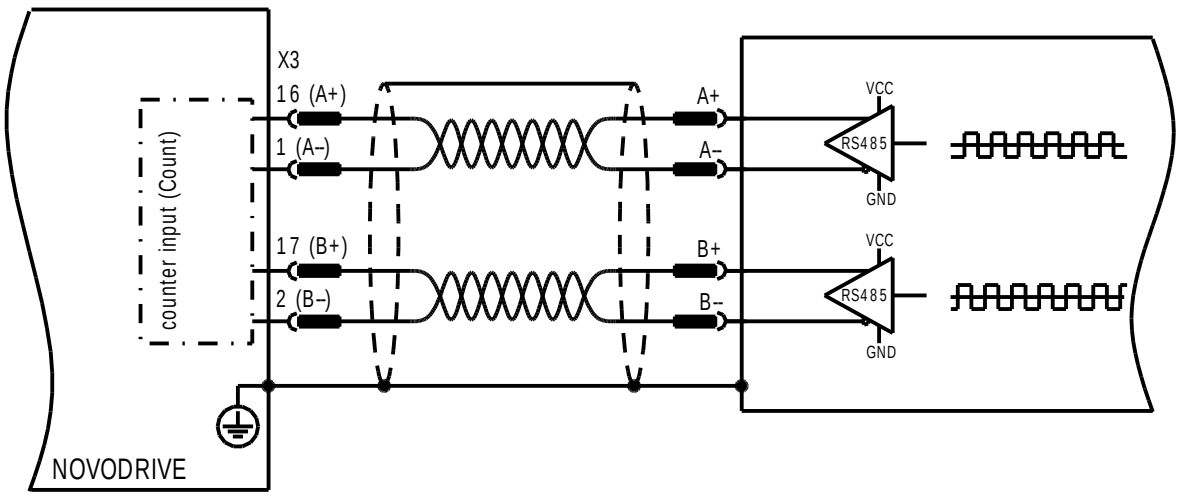
Please note: The first three functions are activated by the respective Operating Mode.

Registers

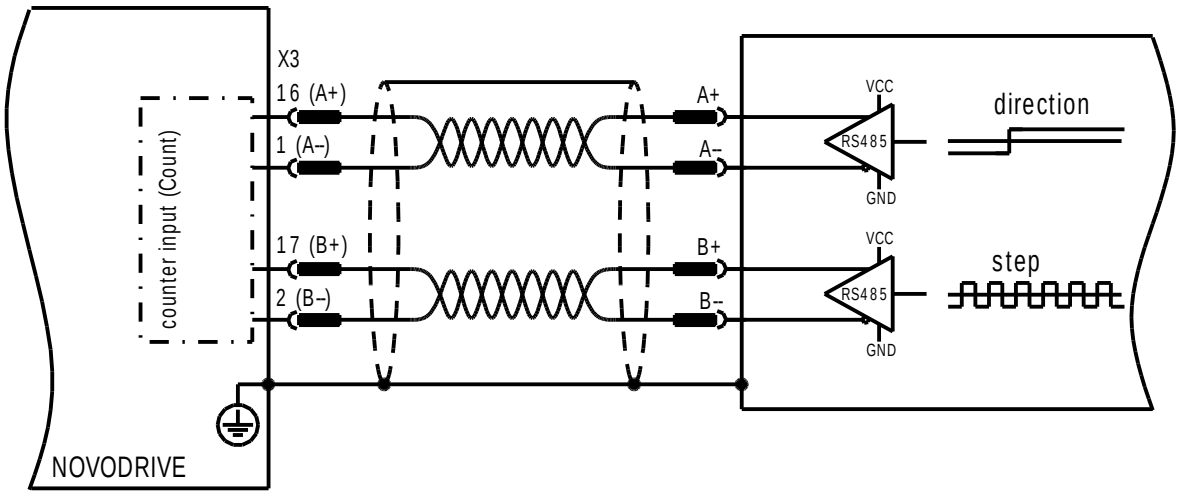
Address	Name	Function
263	EncInputCounter	Counter value, resolution 16384 pulses / revolution
354	EncInputControl	Parameter for configuration of counter Bit 0: 0 = quadrature counter (A/B signals) 1 = step/direction counter

Hardware I/O

The input counter is on connector X3. Signal levels must comply with RS-422 (5 V). For connecting 24 V signals you need a resistor circuit. The inputs are internally connected to 120 Ohm terminal resistors. The maximum input frequency is 2 MHz.



Connection of quadrature counter



Connection of step/direction counter

Error codes

The input counter does not generate any errors.

11.6 Encoder Output

Description

If a resolver is used for position feedback, the resolver position can be transmitted to a control unit via incremental signals.

This is useful for e.g. position control by an external control unit.

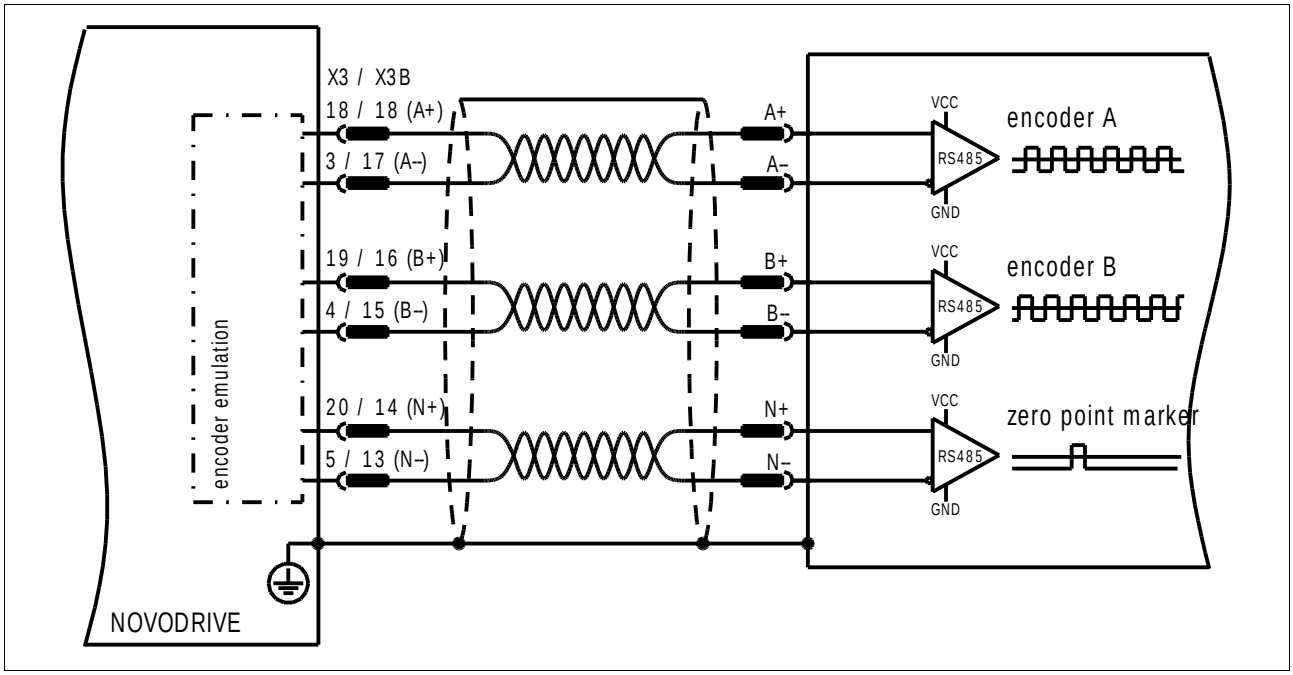
Registers

Address	Name	Function
357	EncOutputResolution	1...1024 periods per revolution of resolver

Hardware I/O

The encoder output is on connector X3. Signal levels must comply with RS-422 (5 V). The maximum output frequency is 156,2 kHz.

Tracks A and B are translated by 90 degrees. The zero-point marker is set to '1' at the resolver zero point, if A and B = 1.



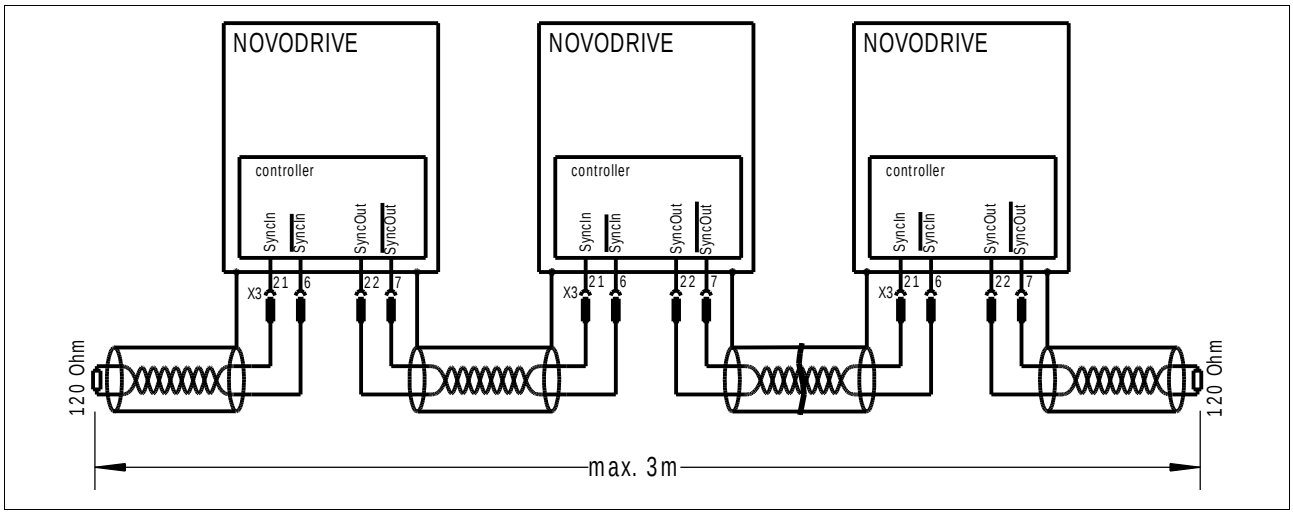
Error codes

The encoder output does not generate any errors.

11.7 Controller Cycles Synchronization

Description

Using this function you may synchronize the controller cycles of several NOVODRIVEs from the ND40 series. This is necessary, for example, for synchronous execution of Operating Modes #48 ... #50. To do so, connect the SyncIn pins and the SyncOut pins of X3.



Within the chain of NOVODRIVEs connected to each other, one NOVODRIVE must be configured as a master, while the other NOVODRIVEs must be configured as slaves. Upon power-up, the slaves will synchronize their controller cycles according to the master.

During the time the inverter is enabled, the slaves will check synchronicity. If deviations occur, an error is generated.

Registers

Address	Name	Function
307	SyncControl	Parameter for configuration of controller cycles synchronization Value: 165 dec Configuration as a slave Value: 90 dec Configuration as a master
550	SyncStatus	Time of interception of synchron signal in relation to controller cycle. The ideal value is 350 dec.

Hardware I/O

The function uses the SyncIn and SyncOut pins on connector X3.

The wiring can be controlled by means of an oscilloscope. Between both lines there must be a square wave with a cycle time of 102,4 µs and a duty cycle of ~30:70.

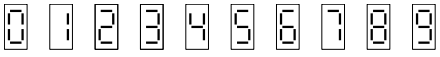
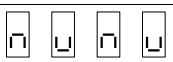
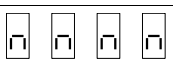
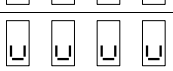
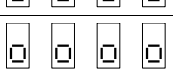
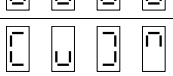
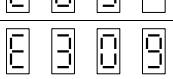
Error codes

Code number	Description
E 3 2 0	Controller cycle is not synchronous with master. Error checking is done only if inverter is enabled.

12 Error Messages

12.1 Display

For correct operation, the text on the display should flash every three seconds. If the text is displayed without flashing, the software is not running.

7-segment display	Description
	NOVODRIVE in Reset state.
	Test during Reset.
	Loading of parameters from the EEPROM.
	Configuration of CAN-NOVOTRON.
	Waiting for the ready signal from extension module.
	NOVODRIVE in disabled state (Inverter Disable and Setpoint Disable).
	NOVODRIVE in stop state (Inverter Enable and Setpoint Disable).
	NOVODRIVE in start state (Inverter Enable and Setpoint Enable).
	Error 309 has been generated.

Please note: Some processes usually happen very fast, so that only single characters are displayed (e.g. 'L' for 'L o a d').

12.2 Registers

If an error is generated, Bit 13 of 'Status16' is set to '1'. If this happens, NOVODRIVE is not ready-to-operate anymore. All errors that occurred are being saved in the error history, which can be read out via the setup software.

Address	Name	Function
252	ErrorCode	Error code
580	ErrorInfo0	Additional information
581	ErrorInfo1	

12.3 Reaction to Errors

Errors are divided into five classes, differing with regard to the required reaction to an error.

Class 1 (Warning)

Register 'ErrorCode' is set, but error handling is not started. After 60 seconds the register 'ErrorCode' will be deleted. The setup software shows a warning code.

Class 2

The motor gets linearly decelerated according to the speed ramp value specified in the 'StopRampLimit' Register. Upon expiry of the time limit specified in the 'ErrorStopTime' Register, the inverter gets disabled (this time interval starts the moment the error occurs). If the specified time is not long enough, the motor coasts freely. We recommend a value which is 120 % larger than calculated stop time.

Rotatory motor	$stop\,time[ms] = \frac{highest\,speed[rpm]}{stop\,ramp[\frac{rpm}{ms}]}$ or
Linear motor	$stop\,time[ms] = \frac{highest\,speed[m/s]}{stop\,ramp[\frac{m/s}{ms}]}$

Class 3

The inverter gets disabled immediately, i.e. the moment the error occurs. The motor runs down until it stops.

Class 4

The inverter gets disabled immediately, i.e. the moment the error occurs. The motor runs down until it stops. Since the feedback system has reported an error, the home position has gone lost. Bit 3 of 'Status16' is set to '1'.

Class 5 (Fatal Error)

The inverter gets disabled immediately, i.e. the moment the error occurs. The motor runs down until it stops. Since the error generated is a Fatal Error, it can only be eliminated by switching off NOVODRIVE.

12.4 Error Acknowledge

Errors of Classes 2, 3 and 4 can be acknowledged by disabling the inverter and setting Bit 6 of 'Control' to '1'. If the inverter is not disabled before setting Bit 6, NOVODRIVE will remain in the 'Waiting for Inverter Disable' state. After the error has been acknowledged (while NOVODRIVE is connected to line voltage), NOVODRIVE is ready-to-operate again.

Errors of Class 1 need not be acknowledged.

Errors of Class 5 can only be acknowledged by disconnecting NOVODRIVE from the 24 V supply voltage (provided it is no permanent error).

12.5 List of Errors

Code hex	Code dec	Display	Class	Description
0x001	1	E 0 0 1	FATAL	Internal error
0x002	2	E 0 0 2	FATAL	
0x003	3	E 0 0 3	FATAL	
0x100	256	E 1 0 0	FATAL	
0x104	260	E 1 0 4	2	Invalid value in Register 'DataInput16' (Operating Mode #70).
0x105	261	E 1 0 5	3	Invalid value in Register 'TechHandler'. Or: Selected function is not available.
0x106	262	E 1 0 6	3	Invalid value in Register 'PdoHandler'.
0x107	263	E 1 0 7	4	Invalid value in Register 'Feedback System'.
0x108	264	E 1 0 8	3	Invalid value in Register 'OperationMode'.
0x109	265	E 1 0 9	Obsolet	Invalid value in Register 'Call102A'.
0x110	272	E 1 1 0	WARNING or 2	At least one of the heat sink temperature sensors is defective or shows a value below 0 degree Celcius. Error occurs after three warnings within one second.
0x111	273	E 1 1 1	FATAL	Current measuring in motor phase A1 does not work.
0x112	274	E 1 1 2	FATAL	Current measuring in motor phase A2 does not work.
0x120	288	E 1 2 0	2	Not possible to save parameters to the EEPROM while inverter is enabled.
0x121	289	E 1 2 1	3	System data in the EEPROM could not be written.
0x122	290	E 1 2 2	3	System data in the EEPROM could not be read.
0x123	291	E 1 2 3	3	Operation time counter in the EEPROM could not be written.
0x124	292	E 1 2 4	3	Operation time counter in the EEPROM could not be read.
0x125	293	E 1 2 5	3	Error history in the EEPROM could not be written.
0x126	294	E 1 2 6	3	Error history in the EEPROM could not be read.
0x127	295	E 1 2 7	3	Parameter area 1 in the EEPROM could not be written.
0x128	296	E 1 2 8	3	Parameter area 1 in the EEPROM could not be read.
0x129	297	E 1 2 9	3	Parameter area 2 in the EEPROM could not be written.
0x130	304	E 1 3 0	3	Parameter area 2 in the EEPROM could not be read.
0x131	305	-	WARNING	Invalid value in Register 'ParamControl'.

Code hex	Code dec	Display	Class	Description
0x132	306	-	WARNING	Not possible to write into the system parameters in the EEPROM without certain rights.
0x133	307	E 1 3 3	FATAL	Formating of the EEPROM has failed.
0x134	308	E 1 3 4	FATAL	Not possible to format the EEPROM without certain rights.
0x135	309	E 1 3 5	3	Job memory in the EEPROM could not be written.
0x136	310	E 1 3 6	3	Job memory in the EEPROM could not be read.
0x137	311	E 1 3 7	3	Area 6 in the EEPROM could not be written.
0x138	312	E 1 3 8	3	Area 6 in the EEPROM could not be read.
0x142	322	E 1 4 2	FATAL	Check sum error with regard to system parameters in the EEPROM. Send in NOVODRIVE for repair.
0x143	323	E 1 4 3	FATAL	Check sum error with regard to parameter set. Transfer and save a new parameter set to NOVODRIVE. Then restart NOVODRIVE.
0x144	324	E 1 4 4	FATAL	Check sum error in the Job Control memory. Transfer and save the job(s) again to NOVODRIVE. Then restart NOVODRIVE.
0x306	774	E 3 0 6	3	Only at field attenuation: Heat sink too hot to keep up field attenuation or the limitation of peak/effective current is lower adjusted than the field attenuation current.
0x307	775	-	WARNING	Error of power driver circuit, inverter is disabled.
0x307	775	E 3 0 7	3	Short circuit at power output A1, A2 or A3.
0x308	776	E 3 0 8	3	Overcurrent (current controller does not work adequately).
0x309	777	E 3 0 9	4	Signal levels of resolver are below 50 % of expected value.
0x310	784	E 3 1 0	3	Positive hardware limit switch has responded.
0x311	785	E 3 1 1	3	Negative hardware limit switch has responded.
0x312	786	E 3 1 2	3	Software and hardware limit switches mutually block each other.
0x314	788	E 3 1 4	3	Both hardware limit switches have responded.
0x315	789	E 3 1 5	2	R.m.s. current monitoring has responded.
0x316	790	E 3 1 6	2	Positive software limit switch has responded.
0x317	791	E 3 1 7	2	Negative software limit switch has responded.
0x318	792	E 3 1 8	2	Both software limit switches have responded.
0x320	800	E 3 2 0	2	Inverter is enabled and controller cycle syncronization is configured as slave and synchronization does not work.
0x400	1024	E 4 0 0	WARNING or 2	At least one of the heat sink temperature sensors reports excess temperature. Error occurs after three warnings within one second.
0x401	1025	E 4 0 1	2	Resistance limit value of motor temperature sensor exceeded. Motor temperature is too high.

Code hex	Code dec	Display	Class	Description
0x402	1026	E 4 0 2	WARNING or 2	Monitoring of internal fan is active and fan does not draw current, i.e. it is defective. (→ setup software site „General/Error handling“).
0x450	1104	E 4 5 0	2	A reserved parameter is set to a value other than '0'. The parameter's address is given in the 'ErrorInfo0' Register.
0x451	1105	E 4 5 1	2	Register 'AccelerateLimit' or Register 'DecelerateLimit' is set to '0'.
0x452	1106	E 4 5 2	2	Register 'ExtModuleBusAddress' is set to '0'.
0x453	1107	E 4 5 3	2	One of the Parameters is set to an invalid value. The parameter's address is given in the 'ErrorInfo0' Register.
0x454	1108	E 4 5 4	2	A non-existent Register of the extension module was addressed.
0x501	1281	-	WARNING	NOVOBUS error.
0x504	1284	-	WARNING	
0x505	1285	-	WARNING	NOVOBUS error: invalid command.
0x506	1286	-	WARNING	NOVOBUS error: invalid Register address.
0x507	1287	-	WARNING	NOVOBUS error: invalid check sum.
0x511	1297	E 5 1 1	3	A reset command was received while inverter is still enabled.
0x512	1298	E 5 1 2	3	Inverter Enable set although NOVODRIVE is not yet ready-to-operate.
0x514	1300	E 5 1 4	3	Attempt to read or write the feedback system memory while inverter is still enabled.
0x515	1301	-	WARNING	CAN-NOVOTRON protocol error: invalid command in service message.
0x516	1302	-	WARNING	CAN-NOVOTRON protocol error: invalid register address in service message.
0x517	1303	-	WARNING	CAN-NOVOTRON protocol error: invalid check sum in service message.
0x518	1304	E 5 1 8	2	CAN-NOVOTRON: The next synchronization message was received too soon (→ Register BusCycleTimeMin').
0x519	1305	E 5 1 9	2	CAN-NOVOTRON: The next synchronization message was received too late (→ Register 'BusCycleTimeMax'). Before stopping process data exchange with sync message set register “PDoHandler” to 0 or 1. Otherwise the error 519 appears immediately again.
0x520	1312	-	WARNING	CAN-NOVOTRON: Not possible to use sync messages for process data exchange when Register 'BusCycleTimeMax' is set to '0'.
0x521	1313	E 5 2 1	2	CAN-NOVOTRON: Length of messages for process data inputs (setpoints) is other than 8 byte.
0x522	1314	E 5 2 2	2	Attempt to use an inappropriate Variable for process data exchange. Example: A read-only Variable was mapped to an input.

Code hex	Code dec	Display	Class	Description
0x523	1315	E 5 2 3	2	CAN-Bus: A CAN message was overwritten by a successor, before it could be handled. A error message is generated only if bit 3 (process data) or bit 4 (service data) in register “ErrorConfig” is set. Typically the error is caused by hurting protocol rules. On the other hand the CAN specification allows multiple transmission of messages.
0x550	1360	E 5 5 0	FATAL	Time-out during reset of CAN-Controller.
0x551	1361	E 5 5 1	2	CAN-NOVOTRON: Attempt to alter the process data configuration while inverter is still enabled.
0x600	1536	E 6 0 0	2	Distance set in Register 'DistanceBoundary' reached without finding a marker.
0x601	1537	E 6 0 1	2	Use of operation mode in this configuration is senseless e. g. if you start the operation mode 14 and no sine wave encoder was attached/connected.
0x604	1540	-	WARNING	S-ramp:The accelerate or decelerate limit will be ignored for numerical reasons.
0x610	1552	E 6 1 0	2	Operating Mode #48: Overrun error at interpolation buffer. Drive ran faster than data was downloaded.
0x621	1569	E 6 2 1	FATAL	Self-test of internal interface to extension module canceled due to an error.
0x622	1570	E 6 2 2	FATAL	Invalid ID code of extension module.
0x623	1571	E 6 2 3	3	This NOVODRIVE does not support the feedback system you work with (wrong extension module).
0x624	1572	E 6 2 4	4	Internal error with regard to position feedback in the extension module.
0x625	1573	E 6 2 5	4	General error with regard to position feedback in the extension module. Within next 100 ms error cause will be checked and error code changed.
0x626	1574	E 6 2 6	4	Extension module gets no response from feedback system.
0x627	1575	E 6 2 7	4	Internal software error with regard to position feedback in the extension module.
0x628	1576	E 6 2 8	4	This type of feedback system is not supported.
0x629	1577	E 6 2 9	4	EnDat 2.2: Feedback system reports internal error (error bit 1).
0x630	1584	E 6 3 0	4	EnDat 2.2: Check sum error during request of position data.
0x631	1585	E 6 3 1	4	EnDat 2.2: Error Type 1
0x632	1586	E 6 3 2	4	EnDat 2.2: Error Type 2
0x633	1587	E 6 3 3	4	EnDat 2.2: Inconsistent data received.
0x634	1588	E 6 3 4	4	Internal hardware error with regard to position feedback in the extension module.
0x635	1589	E 6 3 5	4	EnDat 2.2: Spikes in data line.
0x636	1590	E 6 3 6	FATAL	Internal error in extension module for buses.
0x637	1591	E 6 3 7	OBSOLETE	

Code hex	Code dec	Display	Class	Description
0x638	1592	E 6 3 8	FATAL	
0x639	1593	E 6 3 9	3	
0x640	1600	E 6 4 0	3	
0x641	1601	E 6 4 1	3	
0x650	1616	E 6 5 0	2	Several Operating Modes generate this error if it was not possible to execute the job.
0x661	1633	-	1 or WARNING	The extension module displays an error by PROFIBUS / CANopen if NOVODRIVE is in query mode. The basic device shows a warning.
0x0680	1664	E 6 8 0	5	Internal error of extension module.
0x0681	1665	E 6 8 1	5	Invalid PROFIBUS address. Selected address is displayed in Register 'ErrorInfo1'.
0x700	1792	E 7 0 0	3	Value for position tracking error higher than set in Register 'PositionTrackingBoundary'. Either acceleration was too high or a mechanical blockade is present.
0x701	1793	E 7 0 1	3	Value for speed tracking error higher than set in Register 'SpeedTrackingBoundary'. Either acceleration was too high or a mechanical blockade is present.
0x702	1794	E 7 0 2	OBSOLETE	Value for acceleration higher than set in Register 'RampBoundary'.
0x705	1797	E 7 0 5	3	Value for speed higher than set in Register 'SpeedBoundary'.
0x706	1798	E 7 0 6	4	Signal levels of sine wave encoder lower than 50 % of expected value. Or: Internal error during evaluation of sine wave encoder signals.
0x707	1799	E 7 0 7	4	A counting error at sine wave encoder input (X2) has been detected. • The feedback system was interfered. The wiring, grounding and shielding must be controlled. • The signal inputs for the zero marker are not connected and the monitoring must be switched off (→ start-up software side 'General/Error handling'). • The feedback system does not send a clear zero marker (e.g. Renishaw RGH22). The monitoring must be switched off (→ start-up software side 'General/Error handling').
0x803	2051	E 8 0 3	FATAL	Internal software error.
0x804	2052	E 8 0 4	FATAL	
0x805	2053	E 8 0 5	FATAL	
0x806	2054	E 8 0 6	FATAL	
0x807	2055	E 8 0 7	FATAL	
0x808	2056	E 8 0 8	FATAL	
0x900	2304	E 9 0 0	3	Internal error.
0x901	2305	E 9 0 1	3	

Code hex	Code dec	Display	Class	Description
0x902	2306	E 9 0 2	3	
0x906	2310	E 9 0 6	3	
0x907	2311	E 9 0 7	3	
0x908	2312	-	WARNING	
0x909	2313	E 9 0 9	FATAL	
0x910	2320	E 9 1 0	FATAL	
0x911	2321	E 9 1 1	FATAL	
0x912	2322	E 9 1 2	FATAL	
0x913	2323	E 9 1 3	FATAL	
0x914	2324	E 9 1 4	FATAL	
0x915	2325	E 9 1 5	FATAL	
0x970	2416	E 9 7 0	3	Brake chopper resistor is not connected, defective or brake chopper resistance is not correct (→ section 4.3.6).
0x971	2417	E 9 7 1	3	The braking energy is too high. • The value in Register 'BrakePowerBoundary' does not comply with the brake chopper's power of the connected ballast resistor (→ start-up software side „Limit Values/Brake chopper“). • The brake resistor is dimensioned too small, and a larger external brake resistor must be connected (→ section 4.3.6).
0x976	2422	E 9 7 6	3	Undervoltage in DC link after Inverter was enabled. • The mains voltage was not yet connected. • The parameter 'MainsVoltage' was adjusted too high(→ start-up software side 'General/Mains Voltage'). • The fuses of mains voltage are defective.
0x977	2423	E 9 7 7	3	There is an overflow in calculation of speed setpoint. It is impossible to follow the external setpoint because e.g. in step/direction mode there have been too many steps in short time.
0x978	2424	E 9 7 8	3	Current controller incapable of controlling the motor current, either because motor cable is broken or because the motor inductivity is extremely high. In the latter case, the monitoring can be switched off. (→ start-up software side 'General/Error handling').
0x979	2425	E 9 7 9	3	Surge voltage in DC link • The NOVODRIVE was attached to a too high mains voltage. • The parameter 'MainsVoltage' is adjusted too low (→ start-up software side 'General/Mains Voltage'). • If an error occures only by braking the motor, the braking resistor is not connected.
0xEE2	3810	E O F F	3	An emergency off was initiated. The motor trundle off.
0xEE3	3811	S T O P	3	An emergency stop was initiated. The motor stops with stop ramp and switch off inverter after the expiration of „ErrorStopTime“.