# DME 230 / 400

## Connection and Commissioning

for servo drives series
- BN6773
- BN6783
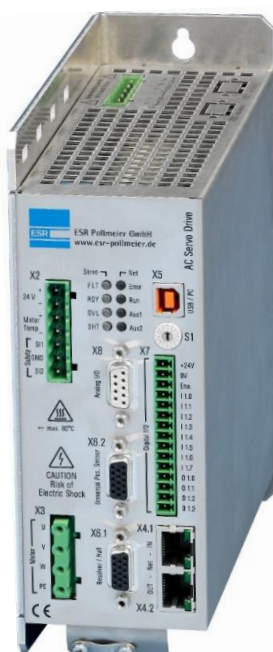
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**AMETEK®**
PRECISION MOTION CONTROL

# Technische Dokumentation
# Technical Documentation

**Servo Drives New Generation**

**Digital Servo Drives
for Direct Mains Connection**

# BN 677x and BN 678x
# Connection and Commissioning

**Operating Instructions 6770.202, V 2.0**

These operating instructions apply to
• Servo Drives New Generation, compact design, with integrated safety system
  – BN 6771 to BN 6774 with built-in power supply unit for single-phase AC power connection
  – BN 6781 to BN 6787 with built-in power supply unit for three-phase power connection
• Operation via personal computer with SPP Windows software
• Access to device functions via communication interfaces
These operating instructions are applicable together with
• Operating Instructions 6710.201 (Functions and Parameters)*
• Operating Instructions 6745.205 (CANopen® Interface)
• Operating Instructions 6745.232 (EtherCAT Interface)
• Operating Instructions 6745.236 (Ethernet Interface)
• Operating Instructions 6770.237 (Profinet Interface)
• Operating Instructions 6710.207 (SPP Windows Command and Commissioning Software)*
and other operating instructions.

* Available in the help function of SPP Windows and per download

| 2013-08-01 V 1.0, KS | New on the basis of the German version |
|---|---|
| 2014-04-30 V 1.1, MH | Value range for current consumption of motor position sensor; added connector assignment and notes for BiSS encoders; connector assignment of incremental encoder with square-wave signals changed; minor corrections |
| 2015-03-25 V 1.2, KS/MH | Rewritten in .hmxz format on the basis of V 1.1; max. continuous braking power (external) updated; table in section Analog Outputs Actual1, Actual 2 updated; electrical specifications updated, holding brake updated; safety system updated (STO); figure Connection Example and Internal Circuitry updated |
| 2016-04-18 V 2.0, KS | Low Voltage Directive and EMC Directive updated; Profinet interface added; new EC Declaration of Conformity; manufacturer's declaration added; technical specifications updated; hint to ESD added in section Installation and Connection Instructions; section Mains Connection updated; section Preconditions for Commissioning and Connection Instructions updated; section Use for the Intended Purpose updated; minor corrections |

# Contents

# 1   Preliminary Remarks

## 1.1   About this Description

These Operating Instructions 6770.202 explain connection and commissioning of the Servo Drives New Generation with built-in power supply unit for direct connection to 230 V AC or 3 × 400/480 V three-phase current.

They are applicable together with

- Operating Instructions 6710.201
  - Functions and Parameters (available in the SPP Windows help function and per download)

As well as, depending on the equipment,

- Operating Instructions 6745.205
  - CANopen® Interface (supplied with the optional CANopen® interface)
- Operating Instructions 6745.232
  - EtherCAT Interface (supplied with the optional EtherCAT interface)
- Operating Instructions 6745.236
  - Ethernet Interface (supplied with the optional Ethernet interface)
- Operating Instructions 6770.237
  - Profinet Interface (supplied with the optional Profinet interface)
- Operating Instructions 6710.231
  - Part Program (Positioning Control) (available in the SPP Windows help function and per download, for option B2 or higher)
- Operating Instructions 6710.207
  - SPP Windows Command and Commissioning Software (available in the SPP Windows help function and per download)

(?) For the commissioning of the functions described in these operating instructions, a PC with command and commissioning software SPP Windows or SPP Windows light is required. Please make sure that this requirement is met and the above-mentioned operating instructions are available.

## 1.2     Drive System Packages

The servo drive system packages consist of:

- the AC servo motor with built-in resolver, absolute encoder (single- or multi-turn, protocols EnDat, Hiperface, or BiSS), or incremental encoder (sine/cosine 1 Vpp with commutation track or square-wave signals RS 422) as motor position sensor and

- the digital servo drive with built-in power supply unit and integrated safety system.

These operating instructions describe

- the servo drives,

- the connection, and

- the commissioning.

The series described here includes servo drives

- in 3 different sizes,

- for 2 different supply voltages (230 V or 3 × 400/480 V),

- for 7 different rated currents (0.8 $A_{rms}$ to 32 $A_{rms}$)

- with different equipment (options).

## 1.3     Accessories

For the ESR servo drive system packages,

- motor supply cables (power) and encoder connection cables,

- ready-assembled cables,

- connector sets,

- shunt resistors, as well as

- various software components

are available which are described in separate data sheets.

- For information on connection cables, ready-assembled cables, connector sets, and shunt resistors, see data sheet 8817.201 Accessories for Servo Drive Systems.

- For information on the software components, see data sheet 6710.260 Software for Servo Drive Systems.

# 2   Safety Instructions

## 2.1     Type of Instructions

The warnings and hints in the margin must be observed by all means:

- **Danger** to health and life due to electrical shock or motion of the drive. When disconnecting the device from the mains, wait until the DC-bus capacitors have discharged before carrying out the measure described.

- **Caution**: Noncompliance violates the safety regulations or statutory provisions and can lead to personal injury or material damage.

- The CE marking requires compliance with the **EMC limits** for the first and second environment according to EN 61800-3 regarding emission and immunity. The instructions marked with this symbol must be observed by all means. Otherwise, the facility in which the drive is operated has to be checked for compliance with the EMC limits at the customer's own responsibility.

- When using the servo drives in the North American market, **pay attention to** the hints related to these signs.

- **Check**: Prior to commissioning and in case of failures or problems, check these items first.

- **Tip**, useful hint.

## 2.2     Qualified Personnel

The servo drives work with dangerous voltages. Contact with voltage-carrying parts can damage your health seriously.

Therefore, only trained, qualified personnel with knowledge in the fields of

- automation systems,

- handling of dangerous voltages,

- standards and regulations such as

  – until 2016-04-19 EMC Directive 2004/108/EC,
  – from 2016-04-20 on EMC Directive 2014/30/EC, published on 2014-03-29 in the Official Journal of the European Communities L96/79-106,
  – until 2016-04-19 Low Voltage Directive 2006/95/EC,
  – from 2016-04-20 on Low Voltage Directive 2014/35/EC, published on 2014-03-29 in the Official Journal of the European Communities L96/357-374,
  – Machinery Directive (2006/42/EC),
  – VDE regulations (such as DIN VDE 0100, DIN EN 60204, DIN EN 61800-5-1),
  – safety rules

may

- install,

- commission,

- maintain, and

- service

these devices.

They have to read these operating instructions carefully in advance and observe the safety instructions permanently while working.

## 2.3    Use for the Intended Purpose

The servo drives have been developed, manufactured, tested, and documented in accordance with the relevant standards. If used for the intended purpose, the devices do not cause any danger to persons, domestic or farm animals, or goods. Use for the intended purpose requires that the device is only used the way described here, and that the safety regulations mentioned are observed.

When using the devices, use for the intended purpose includes compliance with the relevant regulations with respect to safety (machinery directive) and electromagnetic compatibility (EMC directive).

At the end of its service life, dispose of the device according to the regulations to be applied then.

ESR Pollmeier GmbH does not accept any liability for direct or indirect damage resulting from an abuse of the devices.

## 2.4    Protective Earthing

Due to the leakage currents of the built-in RFI filter, the protective earth conductor, in accordance with DIN EN 61800-5-1, must

- either be routed double or

- have a cable cross-section of at least 10 mm$^2$ Cu.

Operation via earth-leakage circuit breaker should be avoided because of the leakage currents of the RFI filter. Please, also consider that the typical triggering level of an earth-leakage circuit breaker is around 70%.

For size 1 servo drives (BN 6771 to BN 6774) type AC earth-leakage circuit breakers are not permitted because of the pulsating direct current floating in case of an earth fault. With the permitted type A and B earth-leakage circuit breakers, trigger faults may occur due to inrush peak currents when switching on the mains.

For size 2 and 3 servo drives (BN 6781 to BN 6787) type A and AC earth-leakage circuit breakers are not permitted because of the direct current floating in case of an earth fault. Only type B earth-leakage circuit breakers may be used.

However, even with those trigger faults may occur due to inrush peak currents when switching on the mains.

Therefore, use only earth-leakage circuit breakers with short-term delay and observe the leakage current stated in the technical specifications.

## 2.5   Lines/Cables

UL/CSA  For wiring, use copper wires suitable for at least 60/75 ºC or 75 ºC, only.

Use class 1 wire only.

## 2.6   UL/CSA Conformity

UL/CSA  The servo drives described in these operating instructions meet the requirements

• according to UL for the USA

• according to CSA for Canada

The certification is in preparation.

## 2.7   Mains Connection

UL/CSA  The BN 677x servo drives are suitable for use on a circuit capable of delivering not more than 5 kA rms symmetrical amperes, 230 VAC maximum when protected by (JDDZ) cartride fuses, nonrenewable (series ATQR10, class CC by Mersen, formerly Ferraz Shawmut), see section Line-Side Fuses, Cable Cross-Sections, and Lengths [17].

The BN 677x servo drives may be operated on a solidly grounded wye source only.

UL/CSA  The BN 678x servo drives are suitable for operation in mains with a short-circuit current not higher than 5 kA rms symmetrical amperes, 3 × 480 VAC maximum when protected by (JDDZ) cartride fuses, nonrenewable (series ATQR10, class CC by Mersen, formerly Ferraz Shawmut), see section Line-Side Fuses, Cable Cross-Sections, and Lengths [17].

The BN 678x servo drives may be operated directly with three-phase TN or TT mains with earthed neutral point. They must not be operated with unearthed mains.

Operation of the BN 678x servo drives with asymmetric mains (earthed external conductor) is not permitted unless the maximum voltage to earth is <300 V. In North American mains, this corresponds to 480 V Y / 277 V Δ.

If not used in the North-American market, operation in mains with a short-circuit current higher than 5 kA, these are especially low-resistance industrial mains, is permitted, as well. In this case, a line choke must be installed as a protection against mains voltage interferences due to overvoltage, voltage fluctuations, and voltage imbalance

• to protect the input rectifier

- to reduce mains system perturbations

- to improve the efficiency factor

- to extend the service life of the DC-bus capacitors

Use three-phase line chokes with a short-circuit voltage of 4% (corresponds to $U_K = 4$). We recommend one triple choke per device.

## 2.8    Hazard Warnings

Due to their design and connection system, the servo drives may be operated

- in a closed housing (control cabinet), pollution degree 2

- with a fixed mains connection, only

Do not insert objects (screwdrivers, wires, etc.) through the ventilation holes into the inside of the device.

Before connecting or disconnecting a connector

- switch off the mains voltage.

The charging capacitor of the power supply unit maintains the voltage after switch-off. Before working at device

- BN 6771 to BN 6774 and BN 6781 to BN 6783 wait for at least 2 minutes

- BN 6785 and BN 6787 wait for at least 5 minutes

after having switched off.

Depending on drive utilization and ambient temperature, the housing may reach a temperature of up to 80 °C.

Electronic devices are generally not fail-safe. The user has to make sure that

- the drive is switched to a safe state in case of a breakdown of the device.

The STO function works with a safe pulse inhibitor and does not create a galvanic isolation. It cannot replace the emergency-stop function.

In case of a breakdown of the drive's power circuit, voltage may exist at the motor connection although the STO function was triggered. Using that voltage, the motor may carry out movements of up to 60º (for motors with 3 pole pairs).

## 2.9    CE Marking

The servo drives described in these operating instructions meet the requirements of

- EMC Directive (until 2016-04-19: 2004/108/EC, from 2016-04-20 on: 2014/30/EC, published on 2014-03-29 in the Official Journal of the European Communities  L96/79-106) and

- Low Voltage Directive (until 2016-04-19: 2006/95/EC, from 2016-04-20 on: 2014/35/EC, published on 2014-03-29 in the Official Journal of the European Communities  L96/357-374)

**EMC** Thus, they conform to the current EC regulations and have a CE marking. The CE marking is only valid if

- all installation and connection instructions of these operating instructions have been observed exactly and

- the requirements marked with the EMC symbol have been met.

If this is not possible, you must have checked the facility in which the drives are operated for compliance with the EMC limits on your own responsibility.

**EMC** Devices with -S1 option are not equipped with a RFI filter. The CE marking of these devices is only valid if, in addition to the above-mentioned requirements, the servo drive is operated with an external RFI filter. Further information is available on request.

⚠ This is a category C2 product according to EN 61800-3. Installation and commissioning of the servo drive may be carried out by qualified personnel, only. Operation of this device can cause radio interferences in the residential environment ("first environment") which might require appropriate action. In this case, please contact us.

## 2.10   Preconditions for Commissioning

In addition to the low voltage and EMC directives applicable to the servo drive, machinery directive 2006/42/EC applies, as well. Thus, it is also applicable to the final product, the machine in which the servo drive is operated. That means it must be fulfilled by the machine manufacturer.

⚠ Commissioning is prohibited until the requirements of the machinery directive have been met. Prior to commissioning, all required protection measures must be installed and functioning.

TIP For a risk analysis of the drive, also consider hazards due to critical speeds, torsion, and short-term torques.

# 3　Description of the Device

## 3.1　Type Code

The type code clearly identifies drives equipped in a certain way. It is also applicable to device variants not described in these Operating Instructions. For further details on the equipment, please see section Modular Equipment [30].

**Example:** **BN 6774-5243-B2-RA-A2-F7-K1-S0**

**74**

**Mains connection and DC-bus voltages**
Mains connection 230 V~ (320 V DC-bus voltage):
71　output current 0.8 $A_{rms}$ (size 1)
72　output current 2 $A_{rms}$ (size 1)
73　output current 4 $A_{rms}$ (size 1)
74　output current 6 $A_{rms}$ (size 1)

Mains connection 3×400/480 V (560 V DC-bus voltage):
81　output current 2 $A_{rms}$ (size 2)
82　output current 4 $A_{rms}$ (size 2)
83　output current 8 $A_{rms}$ (size 2)
85　output current 16 $A_{rms}$ (size 3)
87　output current 32 $A_{rms}$ (size 3)

**5243**

**Assembly code**
Internal coding of ESR, given for various feature combinations. Statement of the assembly code is not required if all other features unequal zero are stated and the customer-specific equipment is described. For above-mentioned example, "BN 6774-B2-RA-A2-F7-K1" would be sufficient.

**B2**

**Operating modes**
B1　command mode with torque, speed, or position control (standard);
　　　setting via communication interface
B2　as B1, additionally program mode with position control, 500 blocks

**RA**

**Motor position sensor**
RA　Universal interface for
　　　– resolver
　　　– absolute encoder, single- and multi-turn, protocols EnDat, Hiperface, BiSS (others on request)
　　　– incremental encoder (sine/cosine 1 Vpp or square-wave signals RS 422), with or without commutation track / hall sensor
RB　Hall sensor (analog, 1 Vpp)

**A2**

**Digital and analog inputs/outputs**
A1　8 digital inputs, 4 digital outputs (24 V); 2 analog inputs (±10 V), 2 analog outputs (±5 V)
A2　8 digital inputs, 4 digital outputs (24 V); no analog inputs/outputs

**F7**

**Fieldbus connection**
F2　CANopen®
F7　EtherCAT
F8　Ethernet TCP/IP communication (protocols Modbus/TCP, ESR protocol; others on request)
F9　Profinet IO (Profinet IRT and others on request)

ZL1

**Additional interface**
ZG1　incremental encoder output 5 V, push-pull signals RS 422
ZL1　input encoder signals 5 V, push-pull signals RS 422
ZL4　additional interface for external absolute encoder (fully digital; EnDat 2.2, Hiperface DSL 4-wire, or BiSS)
ZF1　additional USB interface for connecting a PC
ZF2　additional CAN interface for the connection of additional peripheral devices
ZF8　additional COM interface for serial Modbus (RS 232/RS 422/RS 485, protocols RTU, ASCII)
ZK　additional interface, customer-specific

**K1**

**Safety system**
K1　integrated safety system, safe torque-off (STO) (standard)

**S0**

**Special equipment**
S0　not available (standard)
S1　without built-in RFI filter (size 3)
S2　with sub-assembled fan (size 1)

SK　customer-specific
SL　for operation with linear motors

# 3.2 Technical Specifications

## 3.2.1 Electrical Specifications

| Servo Drive | BN 6771 | BN 6772 | BN 6773 | BN 6774 [1] |
|---|---|---|---|---|
| **Mains input** | | | | |
| Rated supply voltage | 230 V AC ±10%, 50 .. 60 Hz | | | |
| Rated input current | 1.2 A | 3 A | 6 A | 9 A |
| Rated DC-bus voltage | 320 V DC | | | |
| Permissible supply voltage | 85 .. 253 V AC (corresponds to 115 .. 340 V DC-bus voltage) | | | |
| Switch-in threshold DC-bus | > 110 V DC | | | |
| Shutdown threshold overvoltage | < 90 V DC / > 430 V DC | | | |
| Maximum mains inrush peak current | approx. 3 A | | | |
| Integration time of the $I^2t$ circuit for max. peak current | approx. 1.2 s (servo operation) / approx. 0.12 s (blocked drive) | | | |
| Leakage current (EMC filter) | 10 mA, depending on operating mode and motor cable length [2] | | | |
| **Motor output** | earth-fault proof, short-circuit proof | | | |
| Rated power | 0.25 kW | 0.6 kW | 1.2 kW | 1.8 kW |
| Switching frequency of power circuit | 8 or 16 kHz, can be parameterized via the motor data | | | |
| Maximum continuous current (rms) | 0.8 A | 2 A | 4 A | 6 A |
| Max. peak current for 1.2 s (crest value) | 3.4 A | 8.5 A | 17 A | 25.5 A |
| Power dissipation at rated conditions [3]          at 8 kHz | 24 W | 34 W | 52 W | 73 W |
|                                                     at 16 kHz | 25 W | 37 W | 58 W | 81 W |
| **Shunt circuit** | overload-proof, short-circuit proof | | | |
| Max. continuous braking power (internal) | 30 W internal / 2000 W external | | | |
| Pulse braking power | 2.5 kW (1% switch-on duration, 160 ms) | | | |
| Switch-in threshold shunt resistor | dynamic, DC-bus voltage +20% | | | |
| Shutdown threshold shunt resistor | dynamic, DC-bus voltage +15% | | | |
| Usable shunt resistor (external) | 27 .. 200 Ω | 27 .. 120 Ω | 27 .. 68 Ω | 27 .. 36 Ω |
| **Control supply** | protected against polarity reversal, int. overload protection | | | |
| Control supply voltage | 24 V DC ±20% (PELV) | | | |
| Max. inrush peak current | approx. 1 A | | | |
| Max. interruption time | 10 ms without drive reset | | | |
| Current consumption at 24 V [4] | 330 mA | | | |
| Additional current consumption of the motor position sensor | +30 .. +120 mA | | | |

[1] Drive BN 6774 (6 A device) may be operated up to a loading of 70% without restrictions. For a higher loading, the device must be installed next to a control cabinet fan or equipped with sub-assembled fan option S2. Another option to minimize a heating up in case of a loading > 70% is to select power circuit switching frequency 8 kHz.

[2] Touch current according to IEC 60990

[3] According to EN 50598-2, incl. losses of the control supply voltage

[4] For full load, without supply of input SI1 and SI2, without connected consumers and other options. For the additional current consumption of the motor position sensor, see the table in section Position Sensor Connection 27. All values ±10%.

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| Servo Drive | | BN 6781 | BN 6782 | BN 6783 | BN 6785 | BN 6787 |
|---|---|---|---|---|---|---|
| **Mains input** | | | | | | |
| Rated supply voltage | | 3 × 400 .. 480 V AC ±10%, 50 .. 60 Hz | | | | |
| Rated input current | | 2 A | 4 A | 8 A | 16 A | 32 A |
| Rated DC-bus voltage | | 560 .. 680 V DC | | | | |
| Permissible supply voltage | | 90 .. 528 V AC (corresponds to 125 .. 740 V DC-bus voltage) | | | | |
| Switch-in threshold DC-bus | | > 120 V DC | | | | |
| Shutdown threshold overvoltage | | 850 V DC | | | | |
| Max. mains inrush peak current | at 3 × 400 V | ≈ 6 A | | | ≈ 9 A | ≈ 18 A |
| | at 3 × 480 V | ≈ 7 A | | | ≈ 11 A | ≈ 22 A |
| Integration time of the I²t circuit with max. peak current | | approx. 3 s (servo operation) / approx. 0.3 s (blocked drive) | | | | |
| Leakage current (EMC filter), dep. on operating mode and line length [1] | | < 9 mA | | | | |
| **Motor output** | | earth-fault proof, short-circuit proof | | | | |
| Rated power | | 1 kW | 2 kW | 4 kW | 8 kW | 16 kW |
| Switching frequency of power circuit | | 8 or 16 kHz, can be parameterized via the motor data | | | | |
| Max. continuous current (rms) | at 8 kHz | 2 A | 4 A | 8 A | 16 A | 32 A |
| | at 16 kHz | 2 A | 4 A | 6 A | 16 A | 16 A |
| Max. peak current (crest value) | at 8 kHz | 5.5 A | 11 A | 22 A | 45 A | 90 A |
| | at 16 kHz | 5.5 A | 11 A | 16 A | 45 A | 45 A |
| Power dissipation at rated conditions [2] | at 8 kHz | 78 W | 109 W | 208 W | 363 W | 639 W |
| | at 16 kHz | 120 W | 165 W | 241 W | 563 W | 563 W |
| **Shunt circuit** | | overload-proof, short-circuit proof | | | | |
| Max. continuous braking power (int.) | | 45 W | | | 80 W | 160 W |
| Max. continuous braking power (ext.) | | 2000 W | | | 10,000 W | |
| Pulse braking power, internal (1% switch-on duration, 1 s) | | 4.5 kW | | | 8 kW | 16 kW |
| Switch-in threshold shunt resistor | | dynamic, DC-bus voltage +20% | | | | |
| Shutdown threshold shunt resistor | | dynamic, DC-bus voltage +15% | | | | |
| Usable shunt resistor (external) | | 62 .. 220 Ω | 62 .. 120 Ω | 62 .. 70 Ω | 20 .. 70 Ω | 20 .. 50 Ω |
| **Control supply** | | protected against polarity reversal, int. overload protection | | | | |
| Control supply voltage | | 24 V DC ±20% (PELV) | | | | |
| Max. inrush peak current | | approx. 1 A | | | | |
| Max. interruption time | | 10 ms without drive reset | | | | |
| Current consumption at 24 V [3] | | 330 mA | | | 500 mA | |
| Additional current consumption of the motor position sensor | | +30 .. +120 mA | | | | |
| Add. current consumption fan operation | | +120 mA | | | +350 mA | |

[1]  Touch current according to IEC 60990
[2]   According to EN 50598-2, incl. losses of the control supply voltage
[3]  For full load, without supply of input SI1 and SI2, without connected consumers and other options. For the additional current consumption of the motor position sensor, see the table in section Position Sensor Connection 27 . All values ±10%.

## 3.2.2 Line-Side Fuses, Cable Cross-Sections, and Lengths

| Servo Drive | BN 6771 | BN 6772 | BN 6773 | BN 6774 |
|---|---|---|---|---|
| Line-side fuse mains [1] | 4 A | 6 A | 10 A | 10 A |
| or motor-protective circuit breaker | 2 A | 4 A | 7 A | 10 A |
| **Mains supply cable** | shield not necessary | | | |
| Minimum cable cross-section | $1.5 \; mm^2$ copper | | | |
| **Motor supply cable** | shielded | | | |
| Minimum cable cross-section | $1.5 \; mm^2$ copper | | | |
| Maximum length without motor choke | 15 m | | | |
| Maximum length with motor choke BN 3845.2258 | 25 m | | | |
| Maximum length with motor choke BN 3857.2311 | 40 m | | | |
| **Connection external shunt resistor** | shielded | | | |
| Cable cross-section | $1.5 \; mm^2$ copper | | | |
| **Connection cable encoder** | shielded, twisted pair | | | |
| Cable cross-section resolver | $0.25 \; mm^2$ | | | |
| Cable cross-section others | depending on the encoder type | | | |

| Servo Drive | BN 6781 | BN 6782 | BN 6783 | BN 6785 | BN 6787 |
|---|---|---|---|---|---|
| Line-side fuse mains [1] | 6 A | 6 A | 10 A | 20 A | 35 A |
| or motor-protective circuit breaker | 3 A | 5 A | 9 A | 18 A | 34 A |
| **Mains supply cable** | shield not necessary | | | | |
| Minimum cable cross-section | $1.5 \; mm^2$ | | | $2.5 \; mm^2$ | $6 \; mm^2$ [2] |
| **Motor supply cable** | shielded | | | | |
| Minimum cable cross-section | $1.5 \; mm^2$ | | | $2.5 \; mm^2$ | $6 \; mm^2$ [2] |
| Maximum length | 25 m | | | | |
| **Connection external shunt resistor** | shielded | | | | |
| Cable cross-section | $1.5 \; mm^2$ | | | $2.5 \; mm^2$ | |
| **Connection cable encoder** | shielded, twisted pair | | | | |
| Cable cross-section resolver | $0.25 \; mm^2$ | | | | |
| Cable cross-section others | depending on the encoder type | | | | |

[1] Use type gL line-side fuses or an automatic circuit breaker with tripping characteristic "C" switching off all poles.

**UL/CSA** For UL/CSA use class CC cartridge fuses, only. For information on the circuit, see section Mains Connection [11].

[2] Lines with a cross-section of $4 \; mm^2$ may be used if the ambient temperature does not exceed 40 ºC or the utilization of the servo drive is not higher than 80%. Please, observe the regulations of VDE 0100, VDE 0113, and EN 60204-1.

Cables available from ESR are described in detail in data sheet 8817.201.

### 3.2.3    Mounting, Dimensions, and Weight

| Servo Drive | | BN 6771 | BN 6772 | BN 6773 | BN 6774 |
|---|---|---|---|---|---|
| Mounting method | | in control cabinet only, vertical wall mounting | | | |
| Min. mounting spacing above/below | | 80 mm | | | |
| Mounting spacing right/left | | 10 mm | | | |
| Width | | 70 mm | | | |
| Height | without sub-assembled fan | 195 mm | | | |
| | with sub-assembled fan | 210 mm | | | |
| Depth without connectors | | 200 mm | | | |
| Weight | | 1.6 kg | | | |

| Servo Drive | BN 6781 | BN 6782 | BN 6783 | BN 6785 | BN 6787 |
|---|---|---|---|---|---|
| Mounting method | in control cabinet only, vertical wall mounting | | | | |
| Min. mounting spacing above/below | 80 mm | | | | |
| Mounting spacing right/left | 10 mm | | | | |
| Width | 70 mm | | | 188 mm | |
| Height | 275 mm | | | 275 mm | |
| Depth without connectors | 220 mm | | | 227 mm | |
| Weight | 2.8 kg | | | 10.0 kg | |

The following figures show the mounting dimensions of the Servo Drives New Generation.
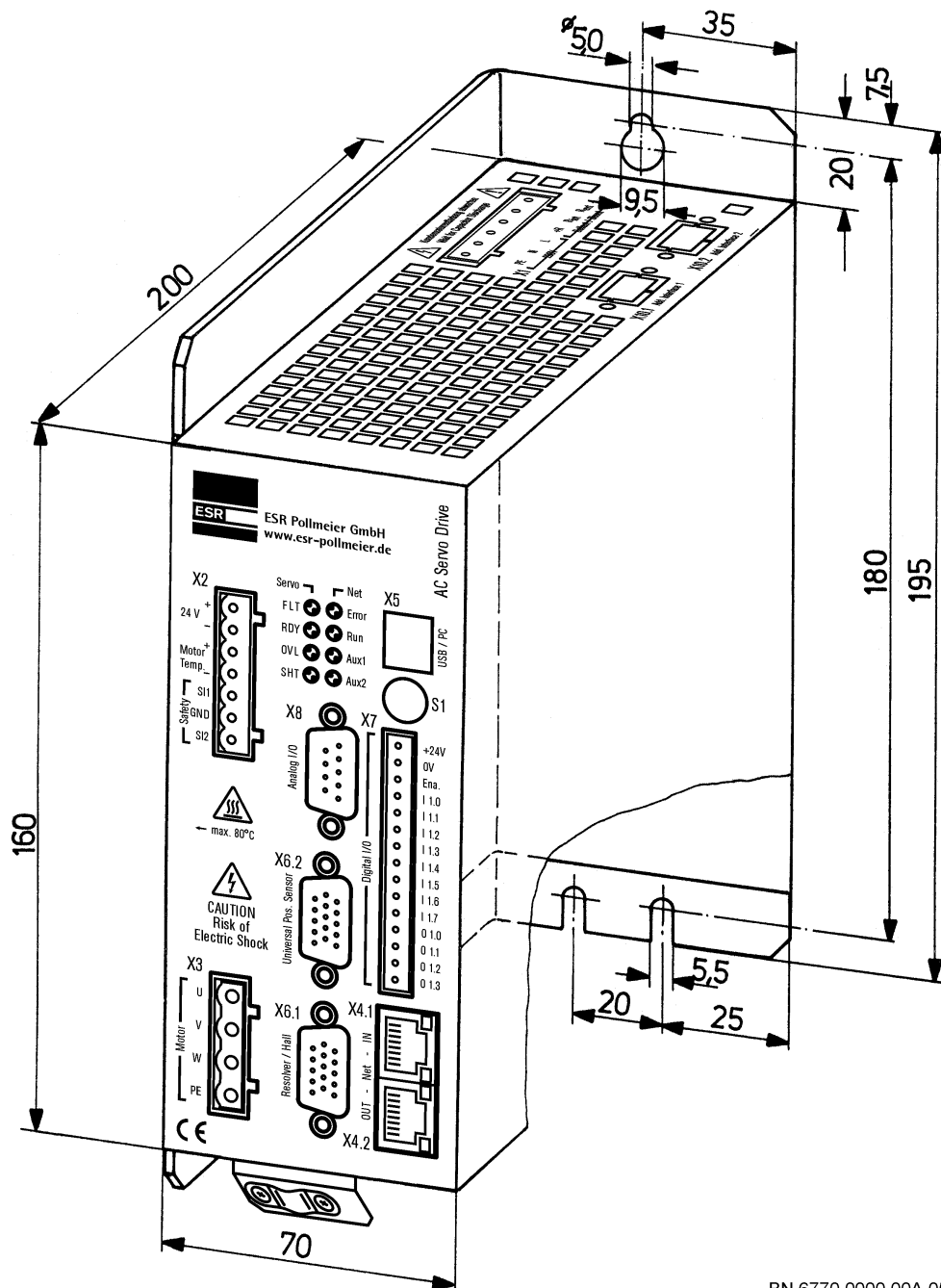
BN 6770.0000.00A.050

Figure 1: Mounting Dimensions, Location of Connectors BN 6771 to BN 6774
(size 1, 230 V, 0.8 .. 6 A rated current)
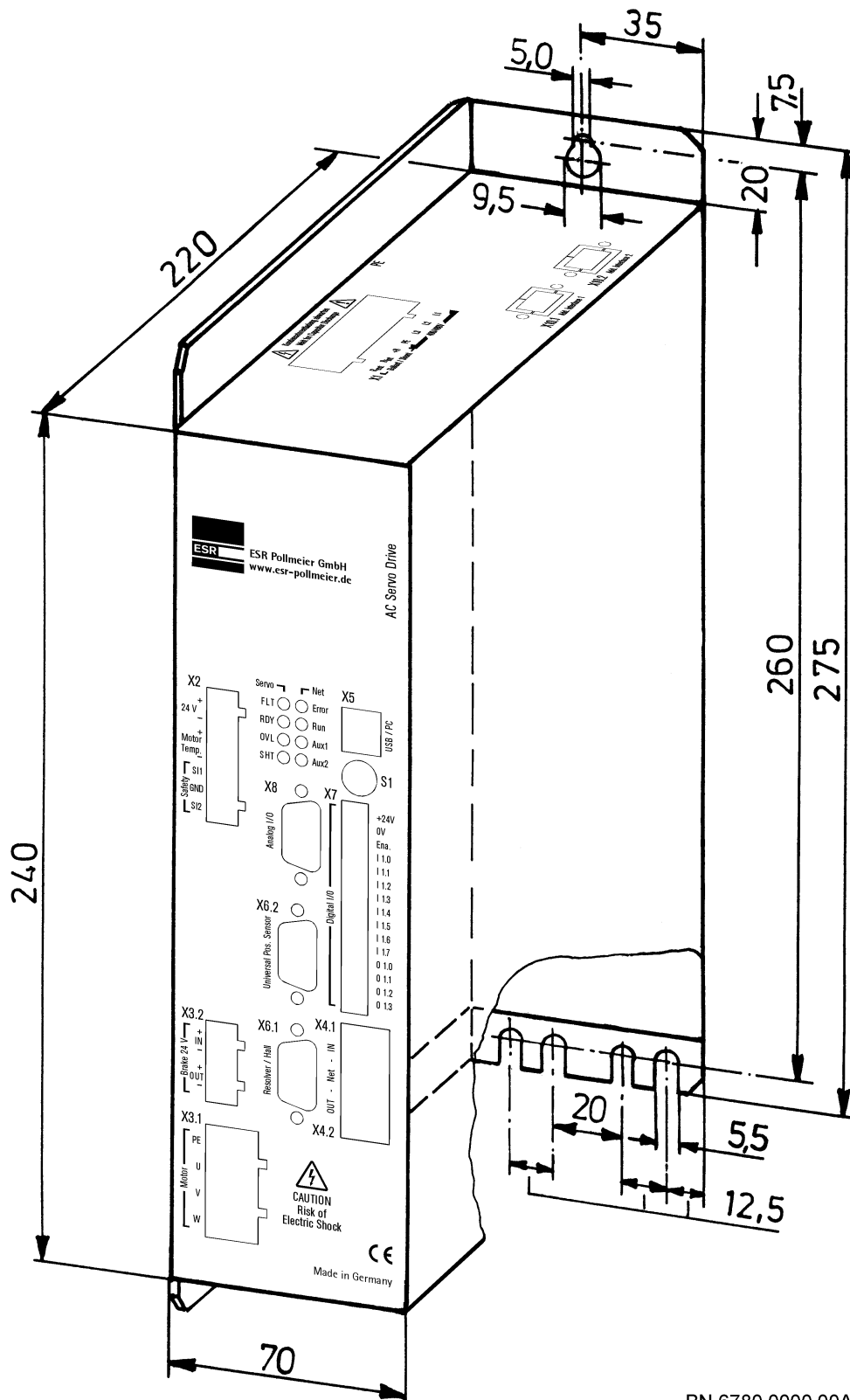
BN 6780.0000.00A.050

Figure 2: Mounting Dimensions, Location of Connectors BN 6781 to BN 6783
(size 2, 3 × 400/480 V, 2 .. 8 A rated current)
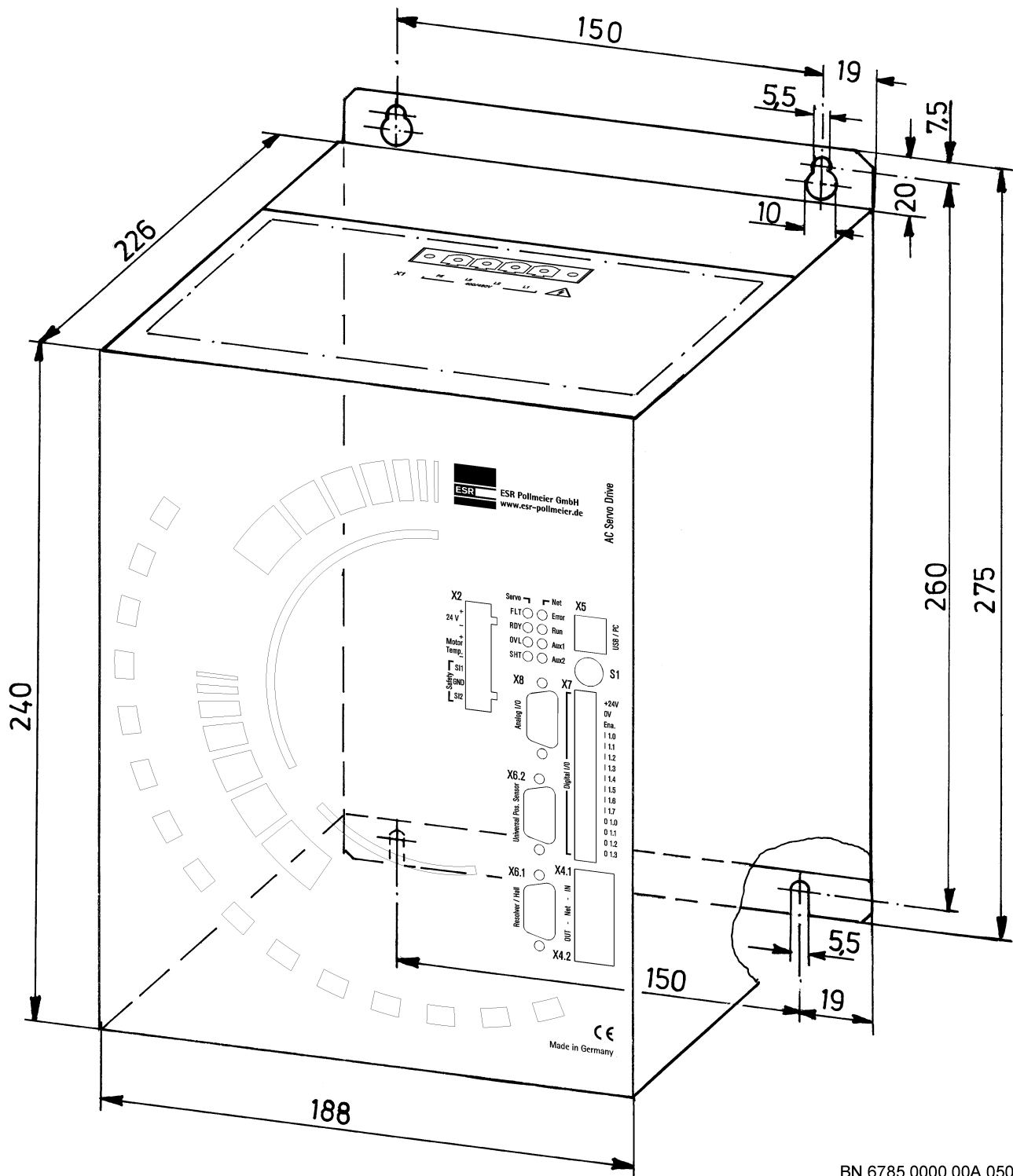
BN 6785.0000.00A.050

Figure 3: Mounting Dimensions, Location of Connectors BN 6785 and BN 6787
(size 3, 3 × 400/480 V, 16 .. 32 A rated current)

## 3.2.4    Environmental Conditions

The devices must not be installed in areas exposed to frequent impacts or excessive vibrations.

| Servo Drive | All BN 677x and BN 678x |
|---|---|
| Degree of protection | IP 20 according to EN 60529 |
| Protection class | I according to VDE 0106 |
| Degree of pollution | 2 according to EN 61800-5-1 |
| Overvoltage category | III according to EN  61800-5-1 |
| Mounting height (without current derating) | ≤ 1000 m above sea level |
| Mounting height (with current derating) | ≤ 2000 m above sea level (–1.5% per 100 m above 1000 m) |
| Vibration resistance | tested at 10 Hz to 58 Hz with amplitude 0.075 mm<br>tested at 58 Hz to 150 Hz with acceleration 10 m/s$^2$ |
| Shock resistance | tested with 15 g within 11 ms |
| Climatic category acc. to DIN EN 50178 | operation: 3K3, storage: 1K4, transport: 2K3 |
| Permissible ambient temperature [1] | operation: +5..+40 ºC , storage:  –25..+55 ºC,<br>transport: +25..+70 ºC |
| Permissible relative humidity | operation: 5 .. 85%, storage: 5 .. 95%, transport: 5 .. 95% |
| Compliance with EMC limits according to EN 61800-3 [2] | emission: first and second environment<br>immunity: first and second environment |

[1]    At the stated ambient temperature, drive BN 6774 (6 A device) may be operated up to a loading of 70% without restrictions. For a higher loading, the device must be installed next to a control cabinet fan or equipped with sub-assembled fan option S2.

[2]    Please note the hints for "limited availability" in section CE Marking 12 .

## 3.2.5   Digital and Analog Inputs and Outputs, Interfaces

| Servo Drive | All BN 677x and BN 678x |
|---|---|
| **Digital I/O** | opto-isolated, switching towards positive (PLC-compatible) |
| Voltage supply from outside | 24 V DC at "+24 V I/O", "0 V I/O" (18 .. 32 V DC PELV) |
| Digital inputs | 8, freely configurable |
| – voltage level | 0 .. 5 V for "0" ("low") / 12 .. 30 V for "1" ("high") |
| – input current at 24 V | 7.5 mA |
| Digital outputs | 4, freely configurable, short-circuit proof |
| – permissible load current | max. 250 mA |
| Max. permissible line length | 30 m (unlimited in case of shielded cabling) |
| **Brake** (only BN 6781 to BN 6783) | short-circuit proof, protected against reverse polarity voltage |
| External voltage supply | 24 V ±20% |
| Max. permissible line length for voltage supply | 30 m (unlimited in case of shielded cabling) |
| Permissible load current | max. 2 A |
| **Analog I/O** | only with option -A1 |
| Auxiliary voltage outputs | +15 V and –15 V, ±4% |
| Loading capacity of auxiliary voltages | 10 mA each (via PTC 125 Ω), short-circuit proof |
| Analog inputs | 2 differential inputs, freely configurable |
| – assignment | e. g. "setpoint speed", "torque limitation" |
| – voltage range | ±10 V |
| – input resistance | 20 kΩ |
| – resolution | 12 Bit |
| Analog outputs | 2, freely configurable, short-circuit proof |
| – assignment | "speed", "current" (default setting) |
| – voltage range | ±5 V |
| – resolution | 10 Bit |

| Servo Drive | | BN 677x, BN 6781 .. BN 6783 | BN 6785, BN 6787 |
|---|---|---|---|
| **Safety function** | | STO (Safe Torque Off) | |
| DIN EN ISO 13849-1 | | PL e / category 4 | |
| DIN EN 61800-5-2 | | SIL 3 | |
| PFH | | $2.0 \times 10^{-10}$ h$^{-1}$ | |
| Safety inputs | | two-channel | |
| Input voltage | | 24 V ±20% (PELV) | |
| Input current | power circuit 8 kHz | 95 mA per channel | 150 mA per channel |
| | power circuit 16 kHz | 100 mA per channel | 200 mA per channel |
| Permiss. test intervals with OSSD signals | | ≤ 1 ms | |
| Permiss. delay between redundant signals | | 1 s | |
| Response time STO at 24 V | power circuit on | 4 ms | 15 ms |
| | power circuit off | 80 ms | 400 ms |
| Max. permissible line length | | 30 m (unlimited in case of shielded cabling) | |

| Servo Drive | All BN 677x and BN 678x |
|---|---|
| **Other interfaces** | |
| Motor position sensor | Resolver (standard), absolute encoder single- or multi-turn (EnDat, Hiperface, or BiSS) or incremental encoder (sine/cosine 1 Vpp with commutation track or square-wave signals RS 422) |
| Motor temperature sensor | Temperature switch opening in case of overtemperature, PTC, 2.5 kΩ at switch-off temperature, or KTY 84/KTY 83 for temperature measurement and monitoring |
| USB interface | USB 2.0 for use with shielded USB cables ("USB certified") |
| Field bus interface | CANopen® according to CANopen® CiA 402, EtherCAT according to ETG and CANopen® standards, Ethernet or Profinet; all of them acc. to DRIVECOM profile 22 |
| Output encoder signals (optional) | 5 V push-pull (RS 422) potential-free |
| Input encoder signals (optional) | 5 V push-pull (RS 422), voltage supply for encoder, no potential separation |
| Serial interface (optional) | COM1 (RS 232C) not galvanically isolated, max. 115,200 Baud |

### 3.2.6    Control and Operating Modes

| Servo Drive | All BN 677x and BN 678x |
|---|---|
| Cycle time current control loop | 62.5 µs |
| Cycle time speed control loop | 62.5 µs |
| Cycle time position control loop | 1 ms |
| Operating modes | |
| – command mode (standard) | with torque, speed, or position control (standard) |
| – program mode (option) | with positioning control, 500 blocks (option) |
| Axis synchronization (standard) | electronic gearing, interpolated position mode, and three more cyclic synchronous operating modes (standard) |
| Ramp functions | linear, $\sin^2$, standardized laws of motion |

## 3.3    Design

### 3.3.1    General Information

The Servo Drives New Generation are manufactured in a compact design for being screwed on a mounting plate. They have a metal housing.

All connections are plugged at the front, at the top, or at the bottom. LEDs and coding switch of the fieldbus interface are located at the front panel of the servo drives.

The Servo Drives New Generation BN 678x are equipped with one or more fans supplied internally by the control supply voltage. For BN 677x, this is only possible with special equipment S2. The fans do not run continually, they are switched depending on the temperature. Additionally, they are switched on for approx. 1 minute when the shunt resistor was activated.

### 3.3.2    Mains Connection

A switch-off or a breakdown of the voltage supply in the mains connection does not cause the servo drive to report a fault or to leave axis state "operation enabled".

An interrupted movement will be continued as soon as the voltage supply has been restored. In case this behavior is not desired, measures have to be taken by the controller side to prevent a restart.

#### 3.3.2.1    Mains Connection Size 1

UL/CSA  The BN 677x servo drives are suitable for use on a circuit capable of delivering not more than 5 kA rms symmetrical amperes, 230 VAC maximum when protected by (JDDZ) cartride fuses, nonrenewable (series ATQR10, class CC by Mersen, formerly Ferraz Shawmut), see section Line-Side Fuses, Cable Cross Sections, and Lengths [17] for rating.

The servo drives may be operated on a solidly grounded wye source only.

For connection to mains with higher short-circuit current, please see the notes in section Mains Connection [11].

Single-phase connection to 230 V TN mains is used as mains connection, this corresponds to 320 V DC-bus. Lower mains voltages are permitted (see Technical Specifications [15]) resulting in a correspondingly reduced DC-bus voltage (e. g. 90 V AC for 125 V DC in the DC-bus).

If an isolating transformer is used for voltage reduction, the secondary side has to be earthed. Autotransformers are permitted.

For upstream earth-leakage circuit breakers installed for safety reasons, please see the notes in section Protective Earthing [10]. A type AC earth-leakage circuit breaker is not permitted because of the pulsating direct current floating in case of an earth fault.

Connector X1 for mains connection is described in section Mains Connection [35]. For connecting the servo drive to the mains, see section Mains Connection [68].

### 3.3.2.2    Mains Connection Size 2 and 3

UL/CSA

The BN 678x servo drives are suitable for operation in mains with a short-circuit current not higher than 5 kA rms symmetrical amperes, 3 × 480 VAC maximum when protected by (JDDZ) cartride fuses, nonrenewable (series ATQR10, class CC by Mersen, formerly Ferraz Shawmut), see section Line-Side Fuses, Cable Cross Sections, and Lengths [17] for rating.

For connection to mains with higher short-circuit current, please see the notes in section Mains Connection [11].

Three-phase connection to 400 .. 480 V AC is used as mains connection, this corresponds to 560 .. 680 V DC-bus. Lower mains voltages are permitted (see Technical Specifications [15]) resulting in a correspondingly reduced DC-bus voltage (e. g. 90 V AC for 125 V DC in the DC-bus). Anyway, observe the safety notes of section Mains Connection [11].

If a mains transformer is used for the reduced voltage, the neutral point of the transformer has to be earthed. Autotransformers are permitted.

For upstream earth-leakage circuit breakers installed for safety reasons, please see the notes in section Protective Earthing [10]. Type A and AC earth-leakage circuit breakers are not permitted because of the pulsating direct current floating in case of an earth fault.

Connector X1 for mains connection is described in section Mains Connection [35]. For connecting the drive to the mains, see section Mains Connection [68].

## 3.3.3    Motor Connection

TIP

To provide the required voltages and currents for the motor, the DC-bus voltage is switched on and off at regular intervals. The frequency results from the selected switching frequency. The Servo Drives New Generation can be operated at 8 kHz or 16 kHz. The switching frequency can be selected when loading the motor parameters.

TIP

The switching frequency for highly dynamic drives should be high, i. e. 16 kHz. Such a switching frequency is above the hearing threshold level of the human

ear. The servo drive will heat up slightly more when being operated at 16 kHz compared to 8 kHz.

TIP  If high dynamics is not required and/or the servo drive has to emit as little heat loss as possible, it can be operated at 8 kHz. In this case, you can hear a 8 kHz noise which will certainly not be disturbing in a machine shop with a common noise level. The motor will heat up slightly more when being operated at 8 kHz compared to 16 kHz.

### 3.3.4    Position Sensor Connection

The Servo Drives New Generation support servo motors with different  types of position sensors. The universal interface can be configured by the user for:

- resolvers

- absolute encoders single- and multi-turn, protocols EnDat 2.1 and 2.2, Hiperface, Hiperface DSL 4-wire, and BiSS C

- incremental encoders (sine/cosine 1 Vpp with commutation track or square-wave signals RS 422)

The position is determined in the position sensor

- incrementally with incremental encoders with sine/cosine or square-wave signals.

   The absolute position information is listed in a software counter in the servo drive. For positioning modes, the home position has to be determined after each switch-off and switch-on of the control supply voltage in order to determine the absolute position of the axis.

- within one revolution with resolver and single-turn absolute encoders

   For multiple revolutions, it is listed in a software counter in the servo drive. That means: for positioning modes, the home position has to be determined after each switch-off and switch-on of the control supply voltage in order to determine the absolute position of the axis.

- for 4096 revolutions with multi-turn absolute encoders:

   The position is read out from the encoder after each switch-off and switch-on of the control supply voltage so that going to home position is not required.

**Resolvers** are used as standard motor position sensor. The resolver input is dimensioned for the standard servo drive-type single pole-pair resolvers with a transformation ratio of 1 : 0.5.

The excitation voltage is 7 $V_{rms}$ (short-circuit proof) at an excitation frequency of 8 kHz.

Position sensors with a higher resolution are intended for applications in which at least one of the following criteria must be met:

- high accuracy

- low speed ripple

- absolute position sensing (absolute encoders in multi-turn design)

Two types of absolute encoders (with protocols such as **EnDat**, **Hiperface**, or **BiSS**) are available:

- Single-turn design: similar to the resolver, the position is sensed within one revolution of the encoder.

- Multi-turn design: the position is sensed for 4096 revolutions in the encoder.

  Note: The travel distance of multi-turn encoders must not exceed 4096 revolutions of the motor. Thus, endless axes cannot be realized with multi-turn-type encoders. With the resolution per revolution the entire positioning range results in 4096 × 65536 = 268,435,456 (= $2^{28}$) steps.

The **high-resolution incremental encoder** passes a reference signal once per revolution.

Before passing the reference signal for the first time, the position information of the rotor is determined using a second track (Z1 track). Prior to that, the position information is still inaccurate (see footnote of the following table).

Once the reference signal has been passed, the position is determined using the incremental signals, and the position information reaches the high accuracy stated in the following table.

As an alternative, **incremental encoders with square-wave signals** (RS 422, 5 V push-pull signals) can be used.

| Encoder System | Resolver | Sincos (Hiperface)-Encoder | | EnDat Encoder | | High-Resolution Incremental Encoder | Incremental Encoder (square-wave signals) |
|---|---|---|---|---|---|---|---|
| | | Single-turn | Multi-turn | Single-turn | Multi-turn | | |
| Measuring principle | magnetical | optical | | magn. (16, 32) opt. (512, 2048) | | optical | various |
| Mechanically permissible speed [1] | 10,000 rpm | 12,000 rpm | | | | | |
| Revolutions measured, absolute | 1 | 1 | 4,096 | 1 | 4,096 | 1 | 1 |
| Max. resolution (software, steps per revolution) | 65,536 | 8,192 × number of sine periods per revolution | | | | | 4 × line number |
| System accuracy [2] (angle, dep. on sine periods or line number) | ±15' [3] | ±80" (128) ±45" (1024) | | ±480" (16) ±280" (32) ±60" (512) ±20" (2048) | | ±60" (512) [4] ±20" (2048) [4] | ±64" (1024) ±32" (2048) ±16" (4096) |
| Endless axes possible | yes | yes | no | yes | no | yes | yes |
| Limit frequency input filter | 32 kHz | 230 kHz | | 420 kHz | | 420 kHz | – |
| Additional current consumption of the drive [5] | +30 mA | +50 mA | | +120 mA | | +80 mA | +80 mA |

[1]  Higher speeds on request, please observe frequencies at the motor position sensor input.

[2]  At 6,000 r.p.m.

[3]  Prerequisite: resolver has an accuracy of at least ±10'.

[4]  Before having passed the reference signal for the first time, the position accuracy is ±5°. After the first revolution of the rotor, at the latest, the stated accuracy will be reached.

[5]  From the control voltage supply, at 24 V and full load; also see the table in section Technical Specifications [15]. All values ±10%.

The current consumption from the control voltage supply of the servo drive depends on the motor position sensor used. Observe the values for current consumption in the table.

Connector X6 for connecting the motor position sensor is described in section [Motor Position Sensor (X6.1 and X6.2)](#)[41]. For connecting a motor position sensor, see section [Connection of the Motor Position Sensor](#)[76].

### 3.3.5 Controlling a Holding Brake (size 2, only)

For the direct connection of a holding brake, the Servo Drives New Generation BN 6781 to BN 6783 are equipped with a switching output switching the supplied 24 V to the brake and opening it that way.

The 24 V supply can be switched off externally in case of an emergency stop.

The output driver is protected against reverse polarity voltage by the brake inductance and against short circuit.

### 3.3.6 Safety System

A wear-free electronic conception of safety function STO (safe torque off according to EN 61800-5-2) developed by ESR is used in the Servo Drives New Generation.

For that, the control energy for the upper and lower power circuit bridge leg is supplied separately via safety inputs SI1 and SI2. If at least one of the two voltages is switched off, current cannot flow any longer into the motor winding. This pulse inhibitor does not create a galvanic isolation.

Due to the two-channel design (SIL 3 according to DIN EN 61800-5-2 and PL e / category 4 according to DIN EN ISO 13849-1), an evaluation of the switch-off is not required on the controller side. If required, extensive diagnostics options are available for the controller.

If STO is activated, the motor cannot build up a torque and may run out freely. For ensuring that the drive is fixed, e. g. in case of a Z axis, the motor must be equipped with a brake.

The STO function cannot replace the emergency-stop function if a galvanic isolation is required for emergency-stop.

After the safety inputs have been switched on, operation must be enabled (via the "Ena." (Enable) input or the corresponding command via fieldbus communication).

### 3.3.7 LEDs

On the front panel, there are LEDs displaying certain operating states of the servo drive ("Servo") and the states of the fieldbus interface ("Net").

The LEDs for the operating states of the servo drive have the following meaning:

| Designation | Color | Display |
|---|---|---|
| FLT (Fault) | red | Lit or flashing when the servo drive indicates a fault. The fault is stored (state "fault"), the cause of the fault can be read out in the PC as "fault code" (see Operating Instructions 6710.201 "Functions and Parameters").<br><br>Continuous illumination indicates a drive fault, flashing a programming or parameterization error. |
| RDY (Ready) | green | Lit when the power circuit is ready (state "operation enabled" **and** the bus voltage is in the permissible range).<br><br>If the axis is not in state "operation enabled", the LED flashes at long intervals with short breaks in case the bus voltage is **available**.<br><br>If the bus voltage is **not available**, it flashes at short intervals with long breaks. |
| OVL (Overload) | yellow | Lit when temporarily switched from peak current to continuous current in the event of an overload. |
| SHT (Shunt) | yellow | Lit when the shunt circuit is switched on to receive the energy returned when the motor is braked. |

For further information on the LEDs for displaying the states of the fieldbus module, please see the following sections:

- section CANopen® (X4.1/F2 and X4.2/F2) [49] for CANopen®
- section EtherCAT (X4.1/F7 and X4.2/F7) [50] for EtherCAT
- section Ethernet (X4.2/F8) [50] for Ethernet
- section Profinet (X4.1/F9 and X4.2/F9) [51] for Profinet

### 3.3.8 Coding Switch

At the moment, the coding switch on the front panel does not have a function yet.

## 3.4 Modular Equipment

This section describes the various options of the servo drives. It is based on the type code.

The options are basic characteristics, they have to be stated with the order. Retrofitting on site is not possible.

The connector assignment is described in section Assignment of Connectors [34], the connection directions can be found in section Installation and Connection Instructions [62].

### 3.4.1 Operating Modes (Options Bx)

Depending on the equipment, the Servo Drives New Generation permit the following operating modes:

- Command mode (options B1 or higher) with torque, speed, or position control

  for direct control of axis motions via single commands of a higher-level controller (PLC, PC).

- Program mode with positioning control, 500 blocks (options B2 or higher)

  for running special programs, so-called part programs, on the servo drive. With these part programs, motion sequences can be executed independent of a higher-level controller.

The desired operating mode can be selected from the possible operating modes via software, the fieldbus interfaces (variable access), or by means of appropriate programming in the part program.

For further information on the different operating modes and the application of them, please see Operating Instructions 6710.201 "Functions and Parameters".

For information on the part program, please see Operating Instructions 6710.231 "Part Program".

## 3.4.2 Fieldbus

All parameters of the servo drives can be accessed via the fieldbus interface. The following are available:

- CANopen® (option F2)
- EtherCAT (option F7)
- Ethernet TCP/IP (Modbus/TCP, ESR protocol) (option F8)
- Profinet IO (option F9)

Due to the fact that from the beginning, the software of the servo drives has been developed for use with a fieldbus, all interfaces access the same parameters, USB interfaces of the servo drive systems included.

## 3.4.3 Output Encoder Signals (Option ZG1)

Via output encoder signals, the position of the driven axis can be transmitted to higher-level controllers in the form of incremental encoder signals (incremental encoder simulation).

The resolution of the encoder signals and the function of the index pulse depend on the motor position sensor used:

- Motor position sensor resolver as position sensor:
  - The resolution of the encoder signals can be set between 50 and 1024 pulses per revolution by means of the machine data.
  - The index pulse is given once per motor revolution; the position of the index pulse can be shifted by means of the machine data.
  - The position sensed by the resolver serves as setpoint for a software control loop, the regulated quantity is the frequency of the encoder signals. At low values, feedforward via speed leads to additional short pulses at output encoder signals. These pulses will be corrected automatically with inverted pulses by the software control.
- Motor position sensor absolute encoder with sine/cosine tracks as position sensor:

– Depending on the number of sine periods of the motor position sensor, the resolution of the encoder signals is 16, 32, 128, 512, 1024, or 2048 pulses per revolution.

– The index pulse is not given.

• High-resolution incremental encoder with index pulse as position sensor:

– Depending on the number of sine periods of the position sensor, the resolution of the encoder signals is 512 or 2048 pulses per revolution.

– The index pulse is given once per motor revolution.

• Incremental encoder with square-wave signals RS 422 as position sensor:

– The encoder signals resolution corresponds to the resolution of the position sensor.

– The index pulse is given once per motor revolution.

Output encoder signals can currently not be used in case an absolute encoder without sine/cosine tracks (fully digital) is used as position sensor.

The current consumption from the control voltage supply of the drive increases by approximately 10 mA.

The output is opto-isolated. Therefore, it must be supplied with voltage by the receiver side.

Connector X10/ZG1 for output encoder signals is described in section Output Encoder Signals (Option X10/ZG1) [31]) [52] beschrieben. For connecting the encoder signals, see section Connection Encoder Input or Output [79].

### 3.4.4    Input Encoder Signals (Option ZL1)

Input encoder signals can be used for axis coupling (synchronization, electronic gearing), the connection of an external position sensor, or pilot frequency setting. The encoder signals can be processed either as incremental encoder or as pulse/direction signals. The maximum permissible signal frequency is 200 kHz, higher frequencies only after consultation with ESR. The minimum signal frequency that can be processed by the software is 250 Hz.

The current consumption from the control voltage supply of the drive increases by the current for the external position sensor if supplied via input encoder signals.

This input is not opto-isolated.

Connector X10/ZL1 for input encoder signals is described in section Input Encoder Signals (X10/ZL1, optional) [53]. For connecting the encoder signals, see section Connection Encoder Input or Output [79].

### 3.4.5    Additional Interface for External Absolute Encoder (Fully Digital, Option ZL4)

This additional interface can be used for connecting an external position sensor with EnDat, Hiperface-DSL, or BiSS interface. In this case, only the digital signals of the encoder are evaluated.

Connector X10/ZL4 for the additional EnDat interface is described in section [Additional Interface for External Absolute Encoder (X10/ZL4, optional)](54). For connecting the encoder cable, see section [Connection External Absolute Encoder](79).

### 3.4.6    Additional USB Interface (Option ZF1)

The additional USB interface is suitable for connecting a PC.

Connector X10/ZF1 for the additional USB interface is described in section [USB Interface for PC (X5 or X10/ZF1)](48). For connecting the USB cable, see section [Connection of a PC](73).

### 3.4.7    Additional CAN Interface (Option ZF2)

The additional CAN interface can be used for connecting peripheral devices the user would like to access via the field bus interface of the servo drive. The servo drive acts as field bus coupler between the CAN bus of the periphery and the field bus system of the customer (CANopen®, EtherCAT, Ethernet, or Profinet).

TIP    This interface is particularly designed for connecting safety controller BN 5599 so that the status of the controller can be queried comfortably via the existing field bus. Due to the direct connection to the back wall bus of the safety controller, an additional field bus component for the controller is not required.

Connector X10/ZF2 for the additional CAN interface is described in section [Additional CAN Interface (X10/ZF2, optional)](55). For connecting the CAN cable, see section [Connecting Other Peripheral Devices](82).

### 3.4.8    COM Interface for Modbus (Option ZF8)

All parameters of the servo drive system can be accessed via this serial interface with the serial Modbus protocol (RS 232, RS 485, or RS 422). Among others, this interface can be used for connecting an operating terminal, e. g. in drive system solutions in which the program sequence is stored in the internal positioning control of the servo drive (see section [Writing and Testing Part Programs](82)). The Modbus interface can also be used for connecting controllers with serial interface.

Connector X10/ZF8 for the serial interface is described in section [Additional Serial Interface for Modbus (X10/ZF8, optional)](55). For connecting the serial cable, see section [Connecting Other Peripheral Devices](82).

# 4    Assignment of Connectors

This section describes the assignment of the connectors. The connection instructions can be found in section <u>Installation and Connection Instructions</u> [62]. For information on the equipment, see section <u>Modular Equipment</u> [30].

TIP    Design and pin assignment of the connectors may vary depending on the equipment of the device, for example for connector X10 depending on the selected option ZG..., ZL..., or ZF... Therefore, in these operating instructions the designation of the connector (e. g. X10) is supplemented by the designation of the option (e. g. X10/ZG1) to which the specified assignment applies.

## 4.1    Mains Connection and Shunt Resistor (X1)

BN 6771 to BN 6774 (size 1, 230 V, 0.8 .. 6 A rated current): 6-pin Combicon connector X1 (RM 7.5):

| Pin | Designation | Assignment |
|-----|-------------|------------|
| PE | PE | Mains protective earth conductor |
| N | N | Mains neutral |
| L | L | Mains phase |
| 5 | +R | Either connect external shunt resistor between $R_{ext}$ and +R or install jumper from $R_{int}$ to +R. (Standard: with jumper installed by the manufacturer) |
| 6 | $R_{int}$ | |
| 7 | $R_{ext}$ | |

UL/CSA    Tighten the screwing terminals of the connector with a tightening torque of 0.5 Nm (4.5 Lb·in).

BN 6781 to BN 6783 (size 2, 3 × 400/480 V, 2 .. 8 A rated current): 7-pin Power Combicon connector X1 (RM 7.62) on the top side of the device:

| Pin | Designation | Assignment |
|-----|-------------|------------|
| L1 | L1 | Mains phase 1 |
| L2 | L2 | Mains phase 2 |
| L3 | L3 | Mains phase 3 |
| PE | PE | Mains protective earth conductor |
| 5 | +R | Either connect external shunt resistor between $R_{ext}$ and +R or install jumper from $R_{int}$ to +R. (Standard: with jumper installed by the manufacturer.) |
| 6 | $R_{int}$ | |
| 7 | $R_{ext}$ | |

UL/CSA    Tighten the screwing terminals of the connector with a tightening torque of 0.5 Nm (4.5 Lb·in).

BN 6785 and BN 6787 (size 3, 3 × 400/480 V, 16 .. 32 A rated current): 4-pin Power Combicon connector X1 (RM 10.16) on the top side of the device:

| Pin | Designation | Assignment |
|-----|-------------|------------|
| L1 | L1 | Mains phase 1 |
| L2 | L2 | Mains phase 2 |
| L3 | L3 | Mains phase 3 |
| PE | PE | Mains protective earth conductor |

**UL/CSA** Tighten the screwing terminals of the connector with a tightening torque of 1.8 Nm (16 Lb·in).

The shunt resistor connection of these devices is located at connector X9, see section DC-Bus Coupling (X9) [36]

.

## 4.1.1    Mains Connection

A 6-pin (BN 6771 to BN 6774), 7-pin (BN 6781 to BN 6783), or 4-pin (BN 6785 and BN 6787) connector must be used for connections at connector X1 in order to prevent contact with live parts.

To limit the inrush current, the DC-bus is charged via the shunt resistor (internal or external, see next section). After exceeding the threshold value of 85 V AC, the current limitation will be switched off with a delay of 1 s using a power relay.

If the shunt resistor fails or has not been connected because

• the jumper for the internal shunt resistor has not been set,

• the external shunt resistor is missing, or

• the internal overload fuse has blown,

the DC-bus cannot be charged (LED "RDY" flashes at short intervals with long breaks even if the power circuit is enabled, however, a fault is **not** reported). In this case, establish the connection to the internal or external shunt resistor or contact ESR.

When the mains voltage is switched off, the surge current limitation will be activated immediately. The device can be switched on again directly, without delay.

For connecting the drive to the mains, see section Mains Connection [68]. Recommended line-side fuse and cable cross-sections are listed in the table in section Line-Side Fuses, Cable Cross-Sections, and Lengths [17].

## 4.1.2    Shunt Resistor

The servo drive is equipped with a shunt resistor that takes up energy returned by the motor.

The built-in PTC shunt resistor protects itself against overload by its resistance characteristics. In case of an overload, the DC-bus voltage continues to rise

and switches the device to fault after the overvoltage threshold has been exceeded.

Additionally, a software monitoring calculating the current utilization of the internal or external shunt resistor and switching to fault in case of overload is installed.

(?)    Operation of the device as brake regulator in which the motor mainly has to work against an external torque in braking operation requires an external shunt resistor dimensioned for the appropriate power. The internal resistor is not sufficient for that.

The resistor value for the external shunt resistor can be taken from the table in section Electrical Specifications [15]. The loading capacity must be dimensioned according to the required braking power.

UL/CSA    The external shunt resistor must be equipped with a thermo switch opening in case of an overload.

⚠    This switch is not designed for the load current, it must be integrated in the control circuit of the mains contactor.

The connector for the external shunt resistor is short-circuit proof. A short circuit in the shunt circuit leads to a switch-off and a corresponding fault message.

⚠    Connector +R for the external shunt resistor is not earth-fault proof. An earth fault at this connector triggers the pre-fuse of the device and can destroy the internal mains rectifier.

For connecting an external shunt resistor, the jumper for the internal resistor has to be removed. For further details, see section Shunt Resistor [69].

A description of the shunt resistors together with technical specifications can be found in data sheet 8817.201.

## 4.2    DC-Bus Coupling (X9, size 2 and 3, only)

BN 6781 to BN 6783 (size 2, 3 × 400/480 V, 2 .. 8 A rated current): 2-pin Power Combicon connector X9 (RM 7.62) on the bottom side of the device:

| Pin | Designation | Assignment |
|-----|-------------|------------|
| 1   | +DC         | DC-bus coupling |
| 2   | –DC         | |

BN 6785 and BN 6787 (size 3, 3 × 400/480 V, 16 .. 32 A rated current): 5-pin Power Combicon connector X9 (RM 10.16) on the bottom side of the device:

| Pin | Designation | Assignment |
|-----|-------------|------------|
| 1 | –DC | DC-bus coupling |
| 2 | +DC | |
| 3 | +R | Either connect external shunt resistor between $R_{ext}$ and +R or install jumper from $R_{int}$ to +R. (Standard: with jumper installed by the manufacturer.) |
| 4 | $R_{int}$ | |
| 5 | $R_{ext}$ | |

For the description of the shunt resistor connection, see section Shunt Resistor [69].

### 4.2.1    DC-Bus Coupling

With the Servo Drives New Generation, the DC-bus voltage of several devices can be connected. This permits e. g. the use of the braking energy of one axis for accelerating another axis. This function can also be used for test stand applications in which one motor powers and the other one brakes in a defined way. In this case, only the loss energy is taken from the mains.

For establishing a DC-bus coupling of several devices, see section DC-Bus Coupling [69].

## 4.3    Control Supply Voltage, Motor Temperature Sensor, Safety System (X2)

7-pin Combicon connector X2 (RM 5):

| Pin | Designation | | Assignment |
|-----|-------------|---|------------|
| 1 | 24 V | + | Control supply voltage +24 V DC |
| 2 | | – | Control supply voltage 0 V |
| 3 | Motor-Temp. | + | Motor temperature sensor * |
| 4 | | – | |
| 5 | Safety | SI1 | Safety system |
| 6 | | GND | |
| 7 | | SI2 | |

\* This input is connected in parallel internally with the corresponding pins of connector X6.

The internal circuit of connector X2 and an example of a connection are shown in the following figure.
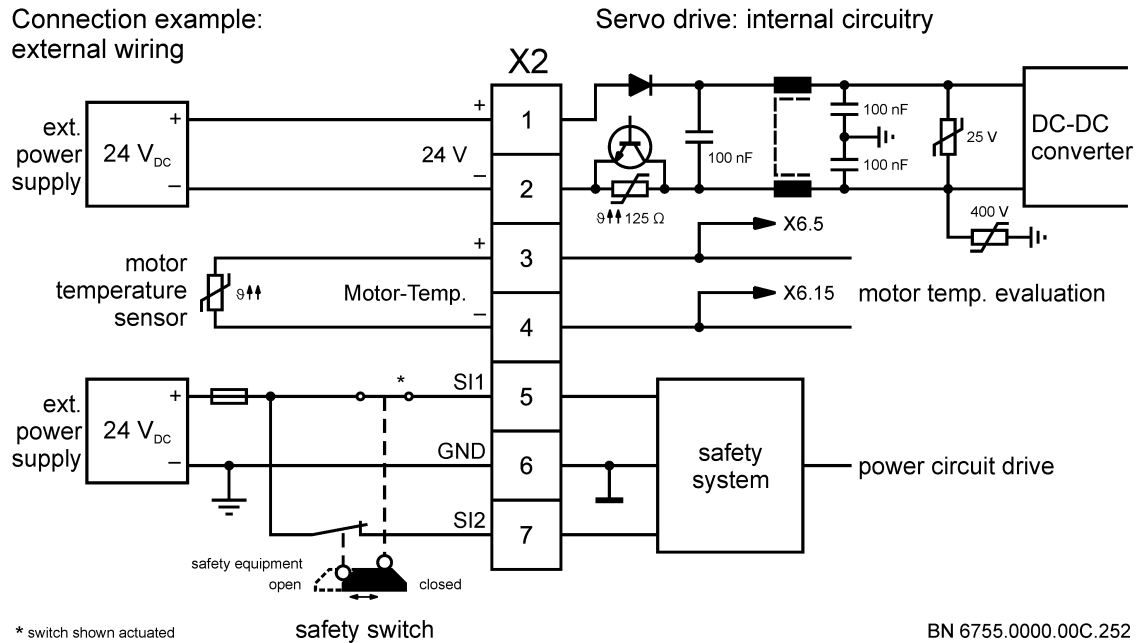
Figure 4: X2, Connection Example and Internal Circuitry

## 4.3.1   Control Supply Voltage

The control supply voltage of +24 V DC PELV (Protective Extra Low Voltage) powers the electronics of the drive; inside the drive, it is converted into voltages of +5 V, +15 V and −15 V via DC/DC converters. The control supply voltage is potential-free towards the drive.

The control supply voltage input is protected against polarity reversal.

The surge current when switching on is limited by an electronic circuit. After that, the current consumption increases for a short period of time until the DC/DC converter has started. For technical specifications, see section Electrical Specifications [15].

For connecting the control supply voltage, see section Connection of Control Supply Voltage +24 V and Safety System [73].

## 4.3.2   Motor Temperature Sensor

UL/CSA

The motor must be equipped with a temperature sensor permitting a monitoring of the motor temperature by the drive. The $I^2t$ monitoring by the software alone is not sufficient.

As temperature sensors, the following can be used:

- a thermo switch opening in the event of overheating,

- a PTC resistor increasing its value to more than 2.5 kΩ in the event of over-heating, or

- type KTY-84-130 and KTY-83-110 sensors (others on request) which also permit a temperature measurement; the temperature to be monitored is set individually via the motor parameterization.

The insulation of the temperature sensor within the motor and the wiring to-wards the motor winding must be designed according to the regulations for pro-tective separation.

The motor temperature sensor is usually routed via the motor supply cable (power) and connected via Combicon connector X2 to avoid a coupling of mo-tor temperature line interferences to the sensitive encoder lines.

For resolvers or incremental encoders with square-wave signals, a connection via input X6.1 or X6.2 is possible without problems. With absolute encoders or high-resolution incremental encoders, the motor temperature sensor can be connected to X6.2 as well, however, this should be done in special cases, only.

**(?)** If the motor does not have a temperature sensor, the pins must be jumpered at one of the connectors. Otherwise, the drive would constantly report a "motor overtemperature" fault.

### 4.3.3 Safety System

A safety signal 24 V (PELV) has to be supplied to inputs SI1 and SI2 each. The voltage source for the control supply voltage can be used for that, as well. The negative pole of this voltage source must be earthed and switched to GND.

The separated safety levels of the two-channel safety wiring (safety switch, sa-fety limit switch, etc.) represent a redundant system ensuring that safety functi-on STO is maintained in case of a safety channel breakdown. Please, note that the safety switch must be an opener-closer combination with a forced break contact in the opener circuit. The supply lines must be laid separately. Accor-ding to DIN EN ISO 13849-1 (category 4), safety switches must not be casca-ded.

A safety switching device, e. g. PNOZe1p by Pilz, with transistor outputs can be connected, as well. This device additionally monitors the safety wiring within the control cabinet for earth fault and short-circuits across input contacts using so-called OSSD signals (Output Signal Switching Device).

The states of inputs SI1 and SI2 as well as the safety system can be read out by a controller using logical input I 3. For further information, see Operating In-structions 6710.201 "Functions and Parameters".

**(?)** If the STO function is not required, these inputs have to be supplied with 24 V (PELV) each for operating the power circuit.

## 4.4    Motor (X3 or X3.1)

BN 6771 to BN 6774 (size 1, 230 V, 0,8 .. 6 A rated current): 4-pin Combicon connector X3 (RM 7.62):

| Pin | Designation | Assignment |
|---|---|---|
| U | Motor U | motor connection U |
| V | Motor V | motor connection V |
| W | Motor W | motor connection W |
| PE | PE | PE of the motor connection cable (protective earthing) |
| Shield terminal clamp | | connect the cable shield of the motor supply cable using the terminal clamp |

UL/CSA   Tighten the screwing terminals of the connector with a tightening torque of 0.5 Nm (4.5 Lb·in).

The motor connection is earth-fault proof and short-circuit proof.

BN 6781 to BN 6783 (size 2, 3 × 400/480 V, 2 .. 8 A rated current): 4-pin Power Combicon connector X3.1 (RM 7.62):

BN 6785 and BN 6787 (size 3, 3 × 400/480 V, 16 .. 32 A rated current): 4-pin Power Combicon connector X3.1 (RM 10.16 with shield connection):

| Pin | Designation | Assignment |
|---|---|---|
| PE | PE | PE of the motor connection cable (protective earthing) |
| U | Motor U | motor connection U |
| V | Motor V | motor connection V |
| W | Motor W | motor connection W |
| Shield terminal clamp | | connect the cable shield of the motor supply cable using the terminal clamp |

UL/CSA   Tighten the screwing terminals of the connector with a tightening torque of 0.8 Nm (7.08 Lb·in) (size 2) or 1.8 Nm (16 Lb·in) (size 3).

The motor connection is earth-fault proof and short-circuit proof.

The AC servo motors with permanent magnets in the rotor (synchronous servo motors) supplied by ESR can be connected. Other motors should only be used after consultation with ESR.

For connecting the motor to the servo drive, see section Motor Connection (Power) [71]. Recommended cable cross-sections are listed in the table in section Line-Side Fuses, Cable Cross-Sections, and Lengths [17].

## 4.5    Holding Brake (X3.2, size 2, only)

4-pin Combicon connector X3.2 (RM 5):

| Pin | Designation | | | Assignment | |
|-----|-------------|---|---|------------|---|
| 1 | Brake 24 V | IN | + | +24 V DC | Supply voltage for driving the brake |
| 2 | | | − | 0 V DC | |
| 3 | | OUT | + | +24 V | Output for brake |
| 4 | | | **−** | 0V | |

The 24 V supplied for driving the holding brake are switched internally via an electronic circuit which is protected against reverse polarity voltage by the brake inductance and against short circuit.

The 24 V brake circuit is isolated galvanically from the internal driver circuit.

Pay attention to the correct polarity of supplied voltage and brake!

The 24 V supply can be switched off externally in case of an emergency stop.

For connecting a holding brake to the servo drive, see section Connection of the Holding Brake [72].

## 4.6    Motor Position Sensor (X6.1 and X6.2)

The Servo Drives New Generation are equipped with a universal interface for connecting a motor position sensor which can be configured for different kinds of position sensors by the user. It consists of two connectors X6.1 "Resolver/Hall" and X6.2 "Universal Pos. Sensor". The following sections describe the pin assignments valid for use with the stated motor position sensor.

Do not connect the motor position sensor until having made sure that the motor position sensor interface is parameterized correctly! Otherwise, the motor position sensor may be damaged or destroyed!

## 4.6.1    Input Resolver (X6.1)

15-pin D sub female connector X6.1 (high-density), assignment for parameterization for resolver:

| Pin | Assignment Resolver |
|------|---------------------|
| 1 | Excitation + (R2) |
| 2 | Excitation – (R1) |
| 3 | – |
| 4 | – |
| 5 | Motor temperature sensor +, connected in parallel internally with the corresponding pin "Motor Temp +" of Combicon connector X2 |
| 6 | Sine + (S4) |
| 7 | Sine – (S2) |
| 8 | – |
| 9 | – |
| 10 | – |
| 11 | Cosine + (S3) |
| 12 | Cosine – (S1) |
| 13 | – |
| 14 | – |
| 15 | Motor temperature sensor –, connected in parallel internally with the corresponding pin "Motor Temp. –" of Combicon connector X2 |
| Housg. | Connect cable shield via the D sub housing |

The resolver input is designed for the standard servo drive-type single pole-pair resolvers with a transformation ratio of 1 : 0.5.

The motors with resolver supplied by ESR are equipped with matching resolvers. Other resolvers can only be installed after consultation with ESR. The adaptation of the control to other resolver signals can only be carried out by ESR at extra charge.

For the differences between the types of motor position sensors, please see section Position Sensor Connection [27].

For connecting the resolver see sections Connection of the Motor Position Sensor [76] and Connection of a Resolver [76].

If the motor does not have a temperature sensor, the pins must be jumpered at one of the connectors. Otherwise, the drive would constantly report a "motor overtemperature" fault.

For connecting a motor temperature sensor, please see section Connection of the Motor Temperature Sensor [75].

## 4.6.2    Input EnDat Absolute Encoder (X6.2)

15-pin D sub female connector X6.2 (high-density), assignment for parameterization for EnDat absolute encoder:

| Pin | Assignment EnDat Absolute Encoder |
|-----|------------------------------------|
| 1 | – |
| 2 | – |
| 3 | CLOCK– |
| 4 | CLOCK+ |
| 5 | Motor temperature sensor +, connected in parallel internally with the corresponding pin "Motor Temp +" of Combicon connector X2* |
| 6 | B+ |
| 7 | B– |
| 8 | DATA+ |
| 9 | DATA– |
| 10 | +5 V          supply voltage for EnDat encoder |
| 11 | A+ |
| 12 | A– |
| 13 | +5 V |
| 14 | 0 V |
| 15 | 0 V for supply voltage EnDat encoder and motor temperature sensor –* |
| Housg. | Connect cable shield via the D sub housing |

Pins 3/4: digital-serial clock signals RS 485, 5 V push-pull
Pins 6/7: incremental signals 1 $V_{pp}$ (if available)
Pins 8/9: digital-serial data RS 485, 5 V push-pull
Pins 11/12: incremental signals 1 $V_{pp}$ (if available)
Pins 13/14: input measuring lead for regulating the supply voltage for the EnDat encoder

\*    The motor temperature sensor is usually routed via the motor supply cable (power) and connected via Combicon connector X2 to avoid a coupling of motor temperature line interferences to the sensitive encoder lines.

The EnDat encoder input is designed for EnDat encoder EQN 1325 or ECN 1313 produced by Heidenhain. Motors with these encoders are available from ESR.

To keep the supply voltage of the encoder at constant 5 V, it is fed back to the servo drive via the measuring lead and the output voltage is re-adjusted in the range between 5 V and 8 V. If the measuring lead is not connected correctly, the encoder can permanently receive the highest voltage which may damage the encoder.

For the differences between the types of motor position sensors, please see section Position Sensor Connection [27].

For connecting an EnDat encoder, see sections Connection of the Motor Position Sensor [76] and Connection of an EnDat Absolute Encoder [76].

For connecting a motor temperature sensor, please see section Connection of the Motor Temperature Sensor [75].

### 4.6.3   Input Hiperface Absolute Encoder (X6.2)

15-pin D sub female connector X6.2 (high-density), assignment for parameterization for Hiperface absolute encoder:

| Pin | Assignment Hiperface Absolute Encoder |
|---|---|
| 1 | – |
| 2 | – |
| 3 | +485 — digital-serial clock signals RS 485, 5 V push-pull |
| 4 | –485 |
| 5 | Motor temperature sensor +, connected in parallel internally with the corresponding pin "Motor Temp +" of Combicon connector X2* |
| 6 | SIN — incremental signals 1 $V_{pp}$ |
| 7 | REFSIN |
| 8 | – |
| 9 | – |
| 10 | +8 V |
| 11 | COS — incremental signals 1 $V_{pp}$ |
| 12 | REFCOS |
| 13 | – |
| 14 | – |
| 15 | 0 V and motor temperature sensor –* |
| Housg. | Connect cable shield via the D sub |

\*   The motor temperature sensor is usually routed via the motor supply cable (power) and connected via Combicon connector X2 to avoid a coupling of motor temperature line interferences to the sensitive encoder lines.

Input Hiperface absolute encoder is designed for Sincos encoders with Hiperface protocol produced by Stegmann. Motors with these encoders are available from ESR.

In case the motor position sensor interface is parameterized for Hiperface absolute encoders, make sure that you do not connect another motor position sensor! Otherwise, the motor position sensor may be damaged or destroyed by the higher voltage!

For the differences between the types of motor position sensors, please see section Position Sensor Connection [27].

For connecting the Hiperface absolute encoder see sections Connection of the Motor Position Sensor [76] and Connection of a Hiperface Absolute Encoder [77].

For connecting a motor temperature sensor, please see section Connection of the Motor Temperature Sensor [75].

## 4.6.4  Input BiSS Absolute Encoder (X6.2)

15-pin D sub female connector X6.2 (high-density), assignment for parameterization for BiSS absolute encoder:

| Pin | Assignment BiSS Absolute Encoder |
|---|---|
| 1 | – |
| 2 | – |
| 3 | MA– / C– |
| 4 | MA+ / C+ — digital-serial clock signals RS 485, 5 V push-pull |
| 5 | Motor temperature sensor +, connected in parallel internally with the corresponding pin "Motor Temp +" of Combicon connector X2* |
| 6 | B+ |
| 7 | B– — incremental signals 1 $V_{pp}$ (if available) |
| 8 | SL+ / D+ |
| 9 | SL– / D– — digital-serial data RS 485, 5 V push-pull |
| 10 | V+      +5 V supply voltage for BiSS encoder |
| 11 | A+ |
| 12 | A– — incremental signals 1 $V_{pp}$ (if available) |
| 13 | +5 $V_{sens}$ |
| 14 | 0 $V_{sens}$ — input measuring lead for regulating the supply voltage for the BiSS encoder (if available) |
| 15 | 0 V for supply voltage BiSS encoder and motor temperature sensor –* |
| Housing | Connect cable shield via the D sub housing |

\*    The motor temperature sensor is usually routed via the motor supply cable (power) and connected via Combicon connector X2 to avoid a coupling of motor temperature line interferences to the sensitive encoder lines.

The BiSS encoder input is designed for BiSS encoders of various manufacturers. Motors with these encoders are available from ESR.

To keep the supply voltage of the encoder at constant 5 V, the encoder may be equipped with a measuring lead for feed back to the servo drive which re-adjusts the output voltage in the range between 5 V and 8 V. If the measuring lead is not connected correctly, the encoder can permanently receive the highest voltage which may damage the encoder. Pins 13 and 14 of encoders without measuring lead can remain open or can be jumpered at the motor end of the encoder cable.

For the differences between the types of motor position sensors, please see section Position Sensor Connection [27].

For connecting a BiSS encoder, see sections Connection of the Motor Position Sensor [76] and Connection of a BiSS Absolute Encoder [77].

For connecting a motor temperature sensor, please see section Connection of the Motor Temperature Sensor [75].

## 4.6.5 Input High-Resolution Incremental Encoder (X6.2)

15-pin D sub female connector X6.2 (high-density), assignment for parameterization for high-resolution incremental encoder:

| Pin | Assignment High-Resolution Incremental Encoder |
|---|---|
| 1 | R+ |
| 2 | R– reference signal RS 422, 5 V push-pull |
| 3 | D+ |
| 4 | D– Z1 track 1 $V_{pp}$ |
| 5 | Motor temperature sensor +, connected in parallel internally with the corresponding pin "Motor Temp +" of Combicon connector X2* |
| 6 | B+ |
| 7 | B– incremental signals 1 $V_{pp}$ |
| 8 | C+ |
| 9 | C– Z1 track 1 $V_{pp}$ |
| 10 | +5 V    supply voltage for incremental encoder |
| 11 | A+ |
| 12 | A– incremental signals 1 $V_{pp}$ |
| 13 | +5 V    input measuring lead for regulating the supply voltage for the incremental encoder |
| 14 | 0 V |
| 15 | 0 V for supply voltage incremental encoder and motor temperature sensor –* |
| Housg. | Connect cable shield via the D sub housing |

\* The motor temperature sensor is usually routed via the motor supply cable (power) and connected via Combicon connector X2 to avoid a coupling of motor temperature line interferences to the sensitive encoder lines.

The high-resolution incremental encoder input is designed for incremental encoder ERN 1185 or ERN 1387 produced by Heidenhain. Motors with this position sensor are available from ESR.

To keep the supply voltage of the encoder at constant 5 V, it is fed back to the drive via the measuring lead and the output voltage is re-adjusted in the range between 5 V and 8 V. If the measuring lead is not connected correctly, the encoder can permanently receive the highest voltage which may damage the encoder.

For the differences between the types of motor position sensors, please see section Position Sensor Connection [27].

For connecting the high-resolution incremental encoder see sections Connection of the Motor Position Sensor [76] und Connection of a High-Resolution Incremental Encoder [77].

For connecting a motor temperature sensor, please see section Connection of the Motor Temperature Sensor [75].

### 4.6.6    Input Incremental Encoder Square-Wave Signals (X6.2)

15-pin D sub female connector X6.2 (high-density), assignment for parameterization for incremental encoder with square-wave signals:

| Pin | Assignment Incremental Encoder with Square-Wave Signals |
|---|---|
| 1 | Ua0+ (index pulse +) — RS 422, 5 V push-pull |
| 2 | Ua0– (index pulse –) |
| 3 | Ua1+ (channel A +) — Incremental signals RS 422, 5 V push-pull |
| 4 | Ua1– (channel A –) |
| 5 | Motor temperature sensor +, connected in parallel internally with the corresponding pin "Motor Temp +" of Combicon connector X2 * |
| 6 | – |
| 7 | – |
| 8 | Ua2+ (channel B +) — Incremental signals RS 422, 5 V push-pull |
| 9 | Ua2– (channel B –) |
| 10 | +Up                              +5 V supply voltage incremental encoder |
| 11 | – |
| 12 | – |
| 13 | (reserved) |
| 14 | (reserved) |
| 15 | –Up                              0 V for supply voltage incremental encoder and motor temperature sensor – * |
| Housg. | Connect cable shield via D sub housing |

\*    The motor temperature sensor is usually routed via the motor supply cable (power) and connected via Combicon connector X2 to avoid a coupling of motor temperature line interferences to the sensitive encoder lines.

The incremental encoder square-wave signals input is designed for commercial incremental encoders with square-wave signals (RS 422, 5 V push-pull signals).

For the differences between the types of motor position sensors, please see section Position Sensor Connection [27].

If the motor does not have a temperature sensor, the pins must be jumpered at one of the connectors. Otherwise, the drive would constantly report a "motor overtemperature" fault.

For connecting the incremental encoder with square-wave signals, see sections Connection of the Motor Position Sensor [76] and Connection of an Incremental Encoder (Square-Wave Signals RS 422) [77].

For connecting a motor temperature sensor, please see section Connection of the Motor Temperature Sensor [75].

### 4.6.7    Input Hall Sensor (X6.1)

Description in preparation.

## 4.7    USB Interface for PC (X5 or X10/ZF1)

The USB interface consists of a type B USB female connector (USB 2.0) at the front side of the device (X5) and optionally an additional type B USB female connector (USB 2.0) at the top side of the device (X10/ZF1).

Pin assignment and signal levels correspond to USB 2.0 standard.

The USB interface is isolated galvanically from the drive.

This interface is provided for the parameterization of the servo drive and the transmission of part programs during commissioning.

For a permanent connection between drive and PC via this interface, servo drive housing and PC must be connected with a potential equalization cable according to section Potential Equalization Cables [67].

The USB female connector is designed for higher insertion and withdrawal forces so that the cable does not slip out so easily.

For the USB connection, exclusively use shielded USB cables with the "USB certified" marking as otherwise the communication can be disrupted. In case of communication problems, do not connect the USB cable at the USB interface of the front side of the PC but at one of the USB interfaces of the mainboard at the rear side of the PC.

A suitable USB cable, 3 m long, for connecting the USB interface with a PC is included in the scope of delivery of command and commissioning software SPP Windows.

For connecting a PC, see section Connection of a PC [73].

## 4.8    Fieldbus Interface (X4.1 and X4.2)

The fieldbus interface consists of two RJ 45 connectors located at the front side of the device:

X4.1 Net-IN:     RJ 45 connector at the front panel

X4.2 Net-OUT:  RJ 45 connector at the front panel

In the following sections, the connector assignments are described the way they apply to the corresponding fieldbus (option -F...).

## 4.8.1    CANopen® (X4.1/F2 and X4.2/F2)

| Pin | Signal | Assignment |
|-----|--------|------------|
| 1 | CAN_H | bus line (dominant high) |
| 2 | CAN_L | bus line (dominant low) |
| 3 | CAN_GND | ground / 0 V |
| 4 | – | reserved |
| 5 | – | reserved |
| 6 | CAN_SHLD | shield connection for special applications (to be used after consultation with the manufacturer, only) |
| 7 | CAN_GND | ground / 0 V (option) |
| 8 | – | not assigned |
| Housg. | Shield | connect cable shield via the housing of the connector; use standard CAT5 cables |

The two RJ 45 connectors are assigned according to CANopen® Cabling and Connector Pin Assignment DR 303-1. The signals correspond to standard ISO 11898. A galvanic isolation exists between bus connection and CAN controller.

TIP    With the CAN In and CAN Out connectors, the device can be connected to the bus without T connectors and stub lines.

**Bus Lines**

?    Max. permissible line lengths (total of all bus lines):

| Transmission rate kBit/s | 1000 | 500 | 125 | 50 |
|--------------------------|------|-----|-----|-----|
| Max. bus length in m | 40 | 100 | 500 | 1000 |

?    Cables corresponding to ISO 11989 part 2 must be used.

**LEDs**

On the front panel of the Servo Drives New Generation, below marking "Net", the LEDs Error, Run, Aux1, and Aux2 are located. These LEDs display the states of the CANopen® interface (communication).

LED Error (red) displays the state of the send and receive monitoring of the CAN controller of the servo drive:

- off:                  OK (CAN term: error active)
- flashing 0.5 Hz:      warning (CAN term: error passive)

     sending or receiving faults have occurred frequently, device and bus run on

- on:                   fault (CAN term: bus off)

     sending or receiving faults have occurred too many times, device separated from the bus

LED Run (green) displays the state in the NMT node state diagram:

- flashing 2 Hz:        pre-operational
- on:                   operational

Aux1 and Aux2 are currently not used.

The bus address is set by the software.

For detailed information on option F2 CANopen® Interface, see Operating Instructions 6745.205 "CANopen® Interface".

## 4.8.2    EtherCAT (X4.1/F7 and X4.2/F7)

Connector assignment and signal levels correspond to Ethernet standard IEEE 802.3. A galvanic isolation exists between bus connection and controller.

**LEDs**

On the front panel of the Servo Drives New Generation, below marking "Net", the LEDs Error, Run, Aux1, and Aux2 are located. These LEDs display the states of the EtherCAT interface (communication).

LED Error (red) displays errors such as watchdog timeout and unsolicited state changes:

- off:                     no error
- flickering:              booting error, INIT State
- blinking:                general configuration error
- single flash:            unsolicited state change
- double flash:            application watchdog timeout
- on:                      PDI watchdog timeout

LED Run (green) displays the status of the EtherCAT state machine:

- off:                     the device is in state INIT
- blinking:                pre-operational
- single flash:            safe-operational
- on:                      operational

Aux1 and Aux2 are currently not used.

The bus address is set automatically by the master.

For detailed information on option F7 EtherCAT interface see Operating Instructions 6745.232 "EtherCAT Interface".

## 4.8.3    Ethernet (X4.1/F8)

The Ethernet interface consists of a RJ 45 connector Net-IN (X4.1/F8) at the front panel of the device. In the Ethernet version of the device, connector X4.2 must not be used!

Connector assignment and signal levels correspond to Ethernet standard IEEE 802.3. A galvanic isolation exists between bus connection and controller.

Supported interface standards and transmission rates:

- 10 BaseT / 100 BaseT

Supported protocols:

- Modbus TCP, Profibus emulation, ESR

Due to the wiring with standard Ethernet, a termination of the first or last bus participant is not required.

**LEDs**

On the front panel of the Servo Drives New Generation, below marking "Net", the LEDs Error, Run, Aux1, and Aux2 are located. These LEDs display the states of the Ethernet interface (communication).

LED Run (green) displays the status of the Ethernet state machine:

- off: TCP configuration missing

- blinking: waiting for TCP connection

- on: at least one TCP connection active

The Error LED is not used for Ethernet, Aux1 and Aux2 are currently not used.

For detailed information on option F8 Ethernet interface, see Operating Instructions 6745.236 "Ethernet Interface".

## 4.8.4 Profinet (X4.1/F9 and X4.2/F9)

Connector assignment and signal levels correspond to Ethernet standard IEEE 802.3. A galvanic isolation exists between bus connection and controller.

**LEDs**

On the front panel of the Servo Drives New Generation, below marking "Net", the LEDs Error, Run, Aux1, and Aux2 are located. These LEDs display the states of the Profinet interface (communication).

The bus LEDs of the servo drives are used for displaying internal states of the Profinet stack. Some internal states are output via different flash codes.

**LED Error (red)**

| Status | Flash Sequence | Description |
|---|---|---|
| NO-ERROR | Off | No error |
| DOUBLE_ADDRESS_ERROR | Flashing 2×, then 1 s off | Address conflict detected. Network communication might be disturbed. |
| HARDWARE_ERROR | Flashing 3×, then 1 s off | Possible causes are incorrect access to the MAC or interrupted data flow. |
| APPL_WATCHDOG_EXPIRED | Flashing 1×shortly, then 1 s off | Application watchdog expired. |
| PROTOCOL_ERROR | On | A protocol-specific error has occurred. |

**LED Run (green)**

| Status | Flash Sequence | Description |
|---|---|---|
| BEFORE_INIT | Off | Stack not initialized |
| INIT | Flashing 1×, then 1 s off | Stack being initialized |
| ONLINE | Blinking | Stack is online (device can be accessed via the network interface) |
| CONNECTED | On | Stack is online (device can be accessed via the network interface) |

**LED Aux1 (yellow)**

| Status | Flash Sequence | Description |
|---|---|---|
| NO_PAR | Off | Parameter channel (PZD8) not configured or configured but not used yet. |
| PAR_ACCESS | Blinking | Parameter channel (PZD8) active, communication takes place |
| PAR_USED | On | Parameter channel (PZD8) active, however no communication at the moment. |

**LED Aux2 (yellow)**

LED Aux2 is reserved for the flash function and therefore only active after a corresponding function triggering by the Profinet configuration tool.

For detailed information on option F9 Profinet interface, see Operating Instructions 6770.237.

## 4.9 Output Encoder Signals (X10/ZG1, optional)

9-pin D sub male connector X10/ZG1 at the top side of the device:

| Pin | Assignment |
|---|---|
| 1 | – |
| 2 | 0 V reference voltage for encoder signals and power supply pin 6 |
| 3 | Ua1+ (channel A +) |
| 4 | Ua2+ (channel B +) |
| 5 | Ua0+ (index pulse +) |
| 6 | +5 V input power supply for output encoder signals |
| 7 | Ua1– (channel A –) |
| 8 | Ua2– (channel B –) |
| 9 | Ua0– (index pulse –) |
| Housg. | Connect cable shield via the D sub housing |

Output X10/ZG1 is equipped with an internal RS-422 compatible line driver for 5 V push-pull signals. With it, the servo drive can output encoder signals.

Output encoder signals is isolated galvanically from the servo drive. Therefore, it must be supplied with 5 V by the receiver side. The current consumption is approx. 50 mA.

For connecting the encoder signals see section Connection Encoder Input or Output [79].

(?) The output data of the encoder signals (number of pulses per revolution, index pulse function) depend on the motor position sensor used, see section Output Encoder Signals (Option ZG1) [31] .

## 4.10   Input Encoder Signals (X10/ZL1, optional)

9-pin D sub male connector X10/ZL1 at the top side of the device:

| Pin | Assignment |
|---|---|
| 1 | – |
| 2 | 0 V reference voltage for encoder signals and power supply for external position sensor |
| 3 | Ua1+ (channel A +) |
| 4 | Ua2+ (channel B +) |
| 5 | Ua0+ (index pulse +) |
| 6 | +5 V  output power supply for external position sensor |
| 7 | Ua1– (channel A –) |
| 8 | Ua2– (channel B –) |
| 9 | Ua0– (index pulse –) |
| Housg. | Connect cable shield via the D sub housing |

Input X10/ZL1 is equipped with an internal RS-422 compatible line receiver for 5 V push-pull signals. With it, the servo drive can process encoder signals.

Input encoder signals is not opto-isolated.

An incremental encoder can be supplied with current via pin 6 and 2. The maximally permissible current consumption is 200 mA. Attention: This 5 V output is not short-circuit proof.

For connecting the encoder signals, see section Connection Encoder Input or Output [79]. Details for the encoder signals input can be found in section Input Encoder Signals (Option ZL1) [32] .

## 4.11 Additional Interface for External Absolute Encoder (X10/ZL4, optional)

15-pin D sub female connector X10/ZL4 (high-density) at the top side of the device:

| Pin | Assignment EnDat or BiSS |
|---|---|
| 1 | – |
| 2 | – |
| 3 | CLOCK– / CLK– / MA– / C–    digital serial cycle |
| 4 | CLOCK+ / CLK+ / MA+ / C+ |
| 5 | – |
| 6 | – |
| 7 | – |
| 8 | DATA+ / DAT+ / SL+ / D+    digital serial data |
| 9 | DATA– / DAT– / SL– / D– |
| 10 | +5 V / V+                        +5 V supply voltage |
| 11 | – |
| 12 | – |
| 13 | – |
| 14 | – |
| 15 | 0 V / V–                          0 V supply voltage |
| Housg. | Connect cable shield via the D sub housing |

To this interface, an absolute encoder (EnDat or BiSS; Hiperface DSL 4-wire in preparation) may only be connected as additional external position sensor, in addition to the motor position sensor installed in the motor and connected to connector X6.1 or X6.2. Please, make sure that you do not mistake the connector of the external absolute encoder for the connector of the motor position sensor!

Only the digital signals of the absolute encoder are evaluated via this interface.

For connecting the external absolute encoder, see section Connection External Absolute Encoder [79].

## 4.12   Additional CAN Interface (X10/ZF2, optional)

9-pin D sub connector X10/ZF2 at the top side of the device:

| Pin | Signal | Assignment |
|-----|--------|------------|
| 1 | – | reserved |
| 2 | CAN_L | bus line (dominant low) |
| 3 | CAN_GND | ground / 0 V |
| 4 | – | reserved |
| 5 | – | not assigned |
| 6 | CAN_GND | ground / 0 V (optional) |
| 7 | CAN_H | bus line (dominant high) |
| 8 | – | not assigned |
| 9 | – | not assigned |
| Housg. | shield | connect cable shield via the D sub housing |

The D sub connector is assigned according to CiA CANopen® Cabling and Connector Pin Assignment DR 303-1. The signals correspond to standard ISO 11898.

Bus connector and drive are isolated galvanically.

## 4.13   Additional Serial Interface for Modbus (X10/ZF8, optional)

9-pin D sub female connector X10/ZF8 at the top side of the device:

| Pin | Assignment RS232 | Assignment RS 485 | Assignment RS 422 |
|-----|------------------|-------------------|-------------------|
| 1 | (do not use) | RS 485+ | RS 422 TX+ |
| 2 | RS 232 TxD | (do not use) | (do not use) |
| 3 | RS 232 RxD | (do not use) | (do not use) |
| 4 | (do not use) | (do not use) | RS 422 RX+ |
| 5 | GND | GND | GND |
| 6 | (do not use) | RS 485– | RS 422 TX– |
| 7 | (do not use) | jumper 7-8 | (do not use) |
| 8 | (do not use) | | (do not use) |
| 9 | (do not use) | (do not use) | RS 422 RX– |
| Housg. | Connect cable shield via the D sub housing | | |

⚠ Connect the pins of the used interface standards (RS 232, RS 485, or RS 422), only! Otherwise, the interface in the servo drive and/or the connected device can be damaged or destroyed!

⚠ Do not use standard lines for connecting RS 232, as well, in order to ensure that only the pins of the used protocol are connected! For the Servo Drives New Generation especially do not use serial connection cables as used for the serial interface of previous ESR digital servo drives!

The serial interface is galvanically connected with the drive.

For connecting the serial cable, see section <u>Connecting Other Peripheral Devices</u> [82].

## 4.14    Digital Inputs and Outputs (X7)

15-pin Combicon connector X7 (RM 3.81):

| Pin | Signal | Assignment [1] |
|-----|--------|----------------|
| 1 | +24 V | +24 V DC input supply digital inputs/outputs |
| 2 | 0 V | 0 V supply digital inputs/outputs |
| 3 | Ena. | digital input "Enable" (I 3.0) [2] |
| 4 | I 1.0 | digital input I 1.0 |
| 5 | I 1.1 | digital input I 1.1 |
| 6 | I 1.2 | digital input I 1.2 |
| 7 | I 1.3 | digital input I 1.3 |
| 8 | I 1.4 | digital input I 1.4 |
| 9 | I 1.5 | digital input I 1.5 |
| 10 | I 1.6 | digital input I 1.6 |
| 11 | I 1.7 | digital input I 1.7 |
| 12 | O 1.0 | digital output O 1.0 |
| 13 | O 1.1 | digital output O 1.1 |
| 14 | O 1.2 | digital output O 1.2 |
| 15 | O 1.3 | digital output O 1.3 |

[1]  Drive-specific functions and signals can be assigned to the individual inputs and outputs by means of machine data "Digital inputs signal" and "Digital outputs signal". Alternatively, inputs as well as outputs can be used freely.

[2]  If input "Enable" does not act on a drive-specific function, it can be used freely as I 3.0.

Via digital inputs and outputs, the servo drive communicates with

• sensors in the machine (e. g. switches),

• actuators in the machine (e. g. relays),

• other controllers.

The digital inputs and outputs of connector X7

• are opto-isolated and

• switch towards positive (PLC-compatible).

    Plus is the externally supplied voltage "+24 V I/O" at X7, see section <u>24 V Supply of Digital Inputs and Outputs</u> [58].

The logic levels are listed in the table in section <u>Digital and Analog Inputs and Outputs, Interfaces</u> [23].

The outputs are short-circuit proof.

If an output operates a miniature relay, the relay has to be shunted by a diode.

The following figure shows the internal circuitry of connector X7 together with an example of a connection.

Section Digital and Analog Inputs and Outputs, Interfaces [23] provides general information on the technical specifications of inputs and outputs.
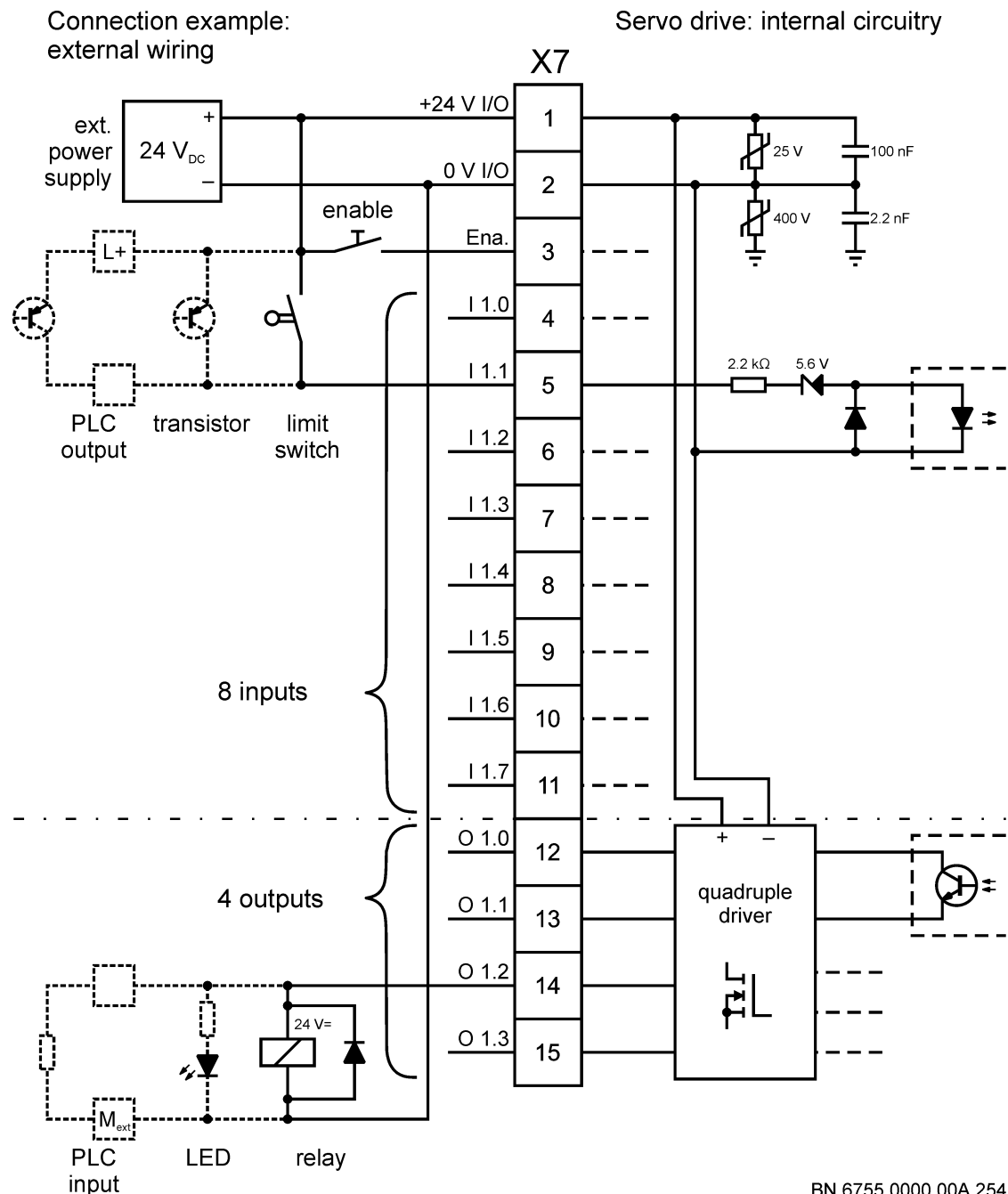


Figure 5: X7, Connection Example and Internal Circuitry

BN 6755.0000.00A.254

### 4.14.1   24 V Supply of Digital Inputs and Outputs

Through pins "+24 V I/O" and "0 V I/O", the supply voltage (+18 V to +32 V DC PELV, preferably +24 V) for the digital inputs and outputs and the connected consumers is applied from outside. This power supply may be

• an independent power supply unit or

• the power supply for the control supply voltage at X2.

When dimensioning the corresponding power supply units, take into account the current consumption of the consumers connected to the digital inputs and outputs.

### 4.14.2   Digital Input "Ena." (Enable)

At digital input "Ena.", the logic level for

• "1" leads to: "enabled"

• "0" leads to: "disabled"

The meaning of "enabled" (e. g. ready to accept a setpoint or start part program) and "disabled" can be set via the machine data ("Action enable inactive/ active").

Disabling via digital input "Ena." (Enable) does not meet the safety requirements of the machinery directive. Safety inputs SI1 and SI2 are provided for that (see section Safety System) [39]. If an emergency stop or safety shutdown is required, the safety requirements of the machinery directive must be observed under all circumstances.

If input "Ena." is set to "no action/no action" via parameter "Action enable inactive / active", this input can be used freely as I 3.0.

### 4.14.3   Digital Inputs I 1.0 to I 1.7

These inputs can be used freely. They can be queried by the part program or a higher-level controller via the communication interfaces.

Via the machine data, the inputs can be configured individually in a way that a drive-specific assignment is activated (e. g. "Limit switch +"). They then have a drive-specific function and cannot be used freely any longer.

The use of digital inputs for stopping the drive (e. g. as "limit switch") does not meet the safety requirements of the machinery directive. If an emergency stop or safety shutdown is required, the safety requirements of the machinery directive must be observed under all circumstances.

If the number of digital inputs is not sufficient, I/O modules may be connected via the fieldbus. If required, please contact ESR.

### 4.14.4   Digital Outputs O 1.0 to O 1.3

These outputs can be used freely. They can be set or reset by the part program or a higher-level controller via the communication interfaces.

Via the machine data, the outputs can be configured individually in a way that a drive-specific assignment is activated (e. g. "Overload"). They then have a drive-specific function and cannot be used freely any longer.

**(?)** The digital outputs are no relay outputs. For switching a load current higher than the one stated in section Digital and Analog Inputs and Outputs, Interfaces [23], an external relay is required.

**TIP** If the number of digital outputs is not sufficient, I/O modules may be connected via the fieldbus. If required, please contact ESR.

# 4.15 Analog Inputs and Outputs (X8/A1)

With the analog inputs and outputs, setpoints can be defined and actual values can be output as analog voltages. The inputs and outputs can be configured via the machine data.

9-pin D sub female connector X8/A1:

| Pin | Assignment |
|-----|------------|
| 1 | 0 V for actual value 1, 2 and auxiliary voltages ±15 V |
| 2 | output auxiliary voltage + 15 V |
| 3 | output auxiliary voltage –15 V |
| 4 | analog input setpoint 1 – |
| 5 | analog input setpoint 1 + |
| 6 | analog input setpoint 2 – |
| 7 | analog input setpoint 2 + |
| 8 | analog output actual value 1 |
| 9 | analog output actual value 2 |
| Housg. | connect cable shield via the D sub housing |

The figure in the following section shows the internal circuitry of connector X8 together with an example of a connection.

Section Digital and Analog Inputs and Outputs, Interfaces [23] provides general information on the technical specifications of the inputs and outputs.

## 4.15.1 Auxiliary Voltage Outputs +15 V, -15V

The two auxiliary voltage outputs primarily serve for connecting an external setpoint potentiometer (10 kΩ). Please note that the setpoint input can handle only ±10 V. With an additional 10 kΩ resistor in the wiper circuit, the full potentiometer control range can be used.

For loading the auxiliary voltages, the voltage drop at the PTCs (125 Ω) has to be considered; for maximum loading (10 mA), the voltage drop is approximately 1.25 V.
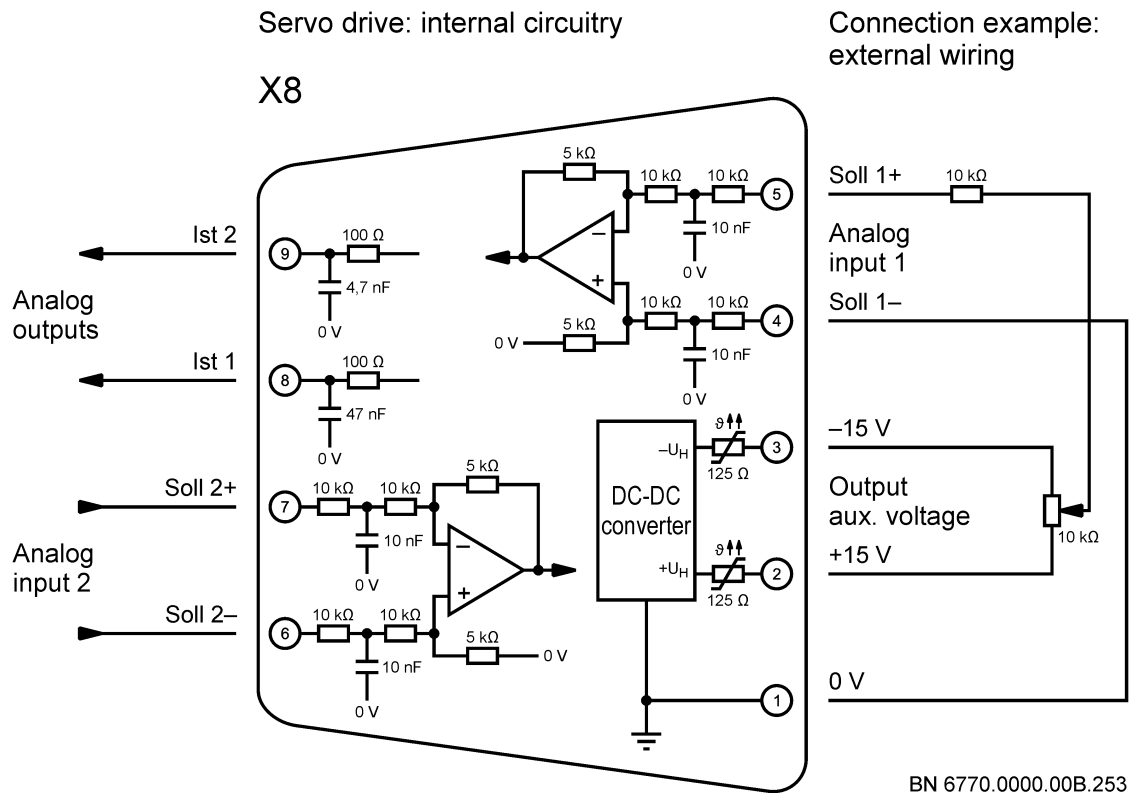
Figure 6: X8, Connection Example and Internal Circuitry

## 4.15.2  Analog Inputs Setpoint1, Setpoint2

The setpoint inputs with the connections Soll1+/Soll1– and Soll2+/Soll2– lead to differential amplifiers.

The input voltage range is ±10 V at 20 kΩ.

Machine data "Setpoint sources" can be used for selecting the function the setpoint input acts on:

• target velocity

• torque setpoint

• current limitation (max-current-amount)

Information on selecting the desired setpoint source can be found in Operating Instructions 6710.201 "Functions and Parameters", section "Machine Data Setpoint Sources". Options for scaling the values with a factor and for shifting zero with an offset are described there, as well.

## 4.15.3  Analog Outputs Actual1, Actual2

Actual values such as speed or current can be output as analog voltages via outputs Ist1 and Ist2. Which signal is given at which output can be set with the machine data; for further details see Operating Instructions 6710.201 "Functions and Parameters".

Connection "0 V" at D sub female connector X8 is the related zero point.

Technical specifications of the analog outputs:

| Analog Output | Ist1 | Ist2 |
|---|---|---|
| Signal and scaling (delivery state) | Actual speed 5 V = 16,384 r.p.m. | **Size 1**: actual current 1.0 V = max. cont. current of the drive<br><br>**Size 2 and 3**: actual current 1.5 V = max. cont. current of the drive |
| Output voltage range | ±5 V | |
| Resolution | 1,024 steps, corresponding to 8 mV per step | |
| Output resistance $R_A$ | 100 Ω | |
| Band width (–3dB) | 0.5 kHz | 1 kHz |
| Time constant | 2 ms | 1 ms |
| Voltage ripple | ±5 mV, 8 kHz | ±40 mV, 8 kHz |

# 5   Installation and Connection Instructions

This section deals with the installation of the servo drive in a control cabinet, the establishment of the electrical connections, and the commissioning. Information on the various connectors can be found in section Assignment of Connectors [34].

UL/CSA  For size 2, BN 6781 to BN 6783, please observe the UL requirements for increased clearance and creepage distances with a UL certification up to 600 V for connectors mains, motor, and DC-bus. Therefore, use only the corresponding connector set ST 6780.6430.0x by ESR.

⚠ The servo drive must not be installed in areas exposed to frequent impacts or excessive vibrations. Please, observe the specifications for the environmental conditions (section Environmental Conditions [22]). During installation, please make sure that conductive parts such as metal chips or wire scrap do not get into the device.

EMC  The values for the first and second environment according to EN 61800-3 regarding emission and immunity are kept within the EMC limits if the drive system package is connected according to the instructions given herein. Only in this case, the CE marking is valid.

If the connection instructions are not observed, the facility in which the drive is operated has to be checked for compliance with the EMC limits at the customer's own responsibility.

⚠ The connectors must not be plugged or unplugged while under voltage. The current rush might destroy the contacts of the connector or an electric arc endangering the commissioning personnel may occur when the connector is unplugged. The connectors are intended for fixed connection, only.

⚠ Electronical components in the servo drive may be damaged by electrostatic discharge (ESD). To avoid this, the following measures are required:

• Prior to and during installation: earth facility parts and use suitable ESD equipment.

• After installation: cover unused D Sub connectors with suitable protection caps (available in specialized shops).

TIP  Before carrying out an insulation measurement in compliance with the machinery directive in the facility, disconnect all connections at the servo drive as otherwise semiconductor components in the device may be destroyed. This is permitted as all servo drives undergo an insulation voltage test during final testing.

The following figures show the connection instructions for connectors X1, X2, X3/X3.1, X6, and X9 (if applicable).
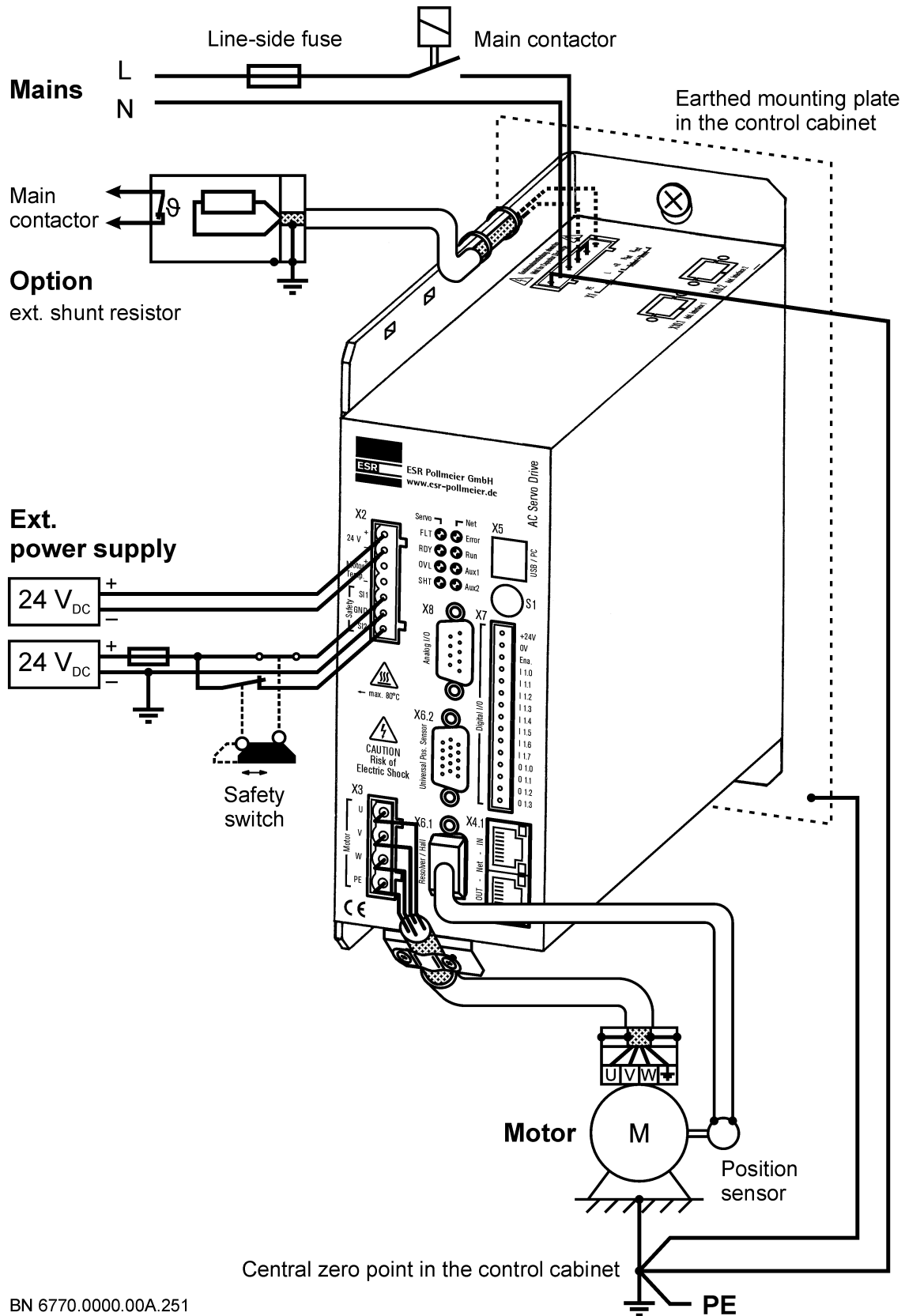
BN 6770.0000.00A.251

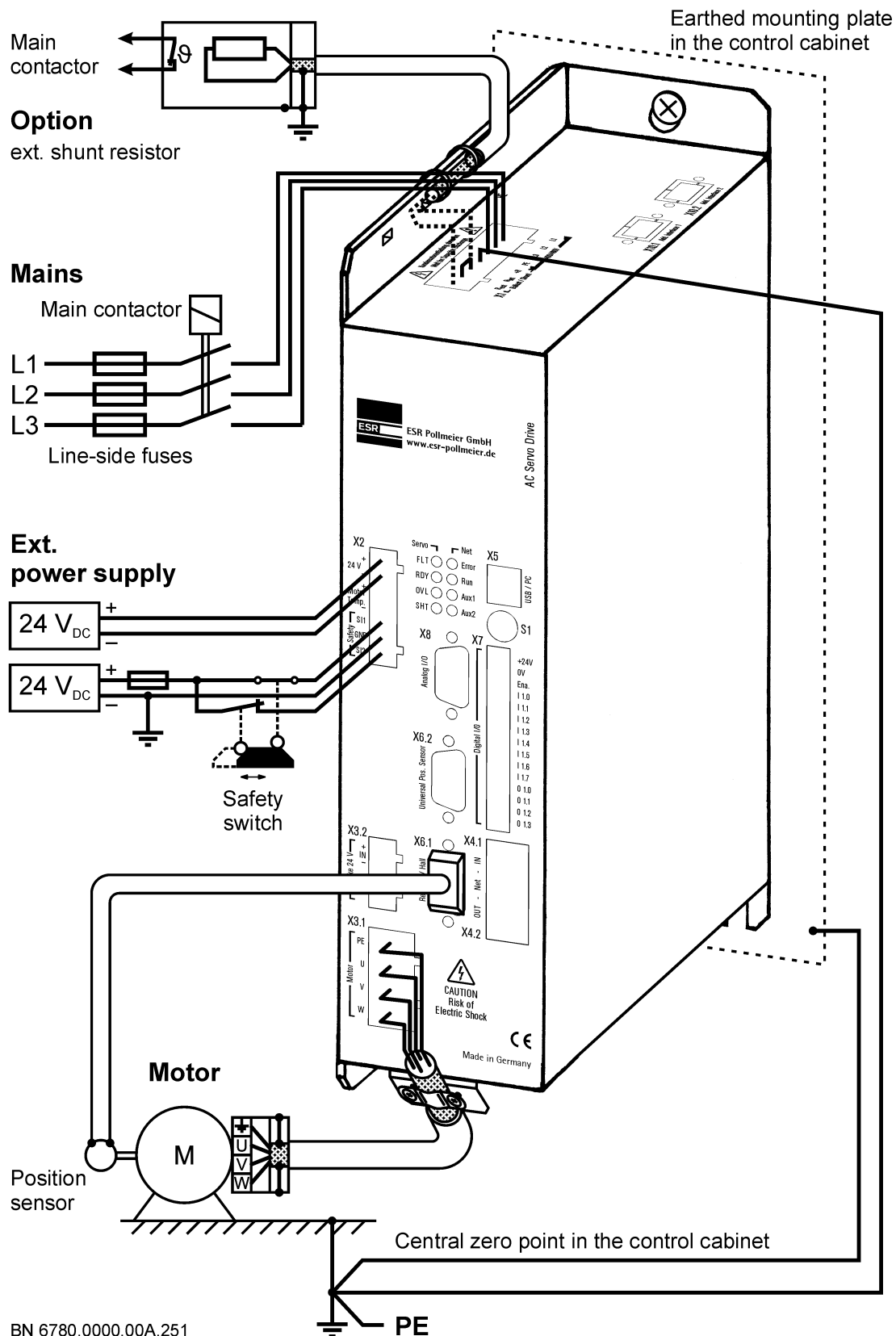Figure 7: Connection Instructions X1, X2, X3, and X6 for BN 6771 to BN 6774

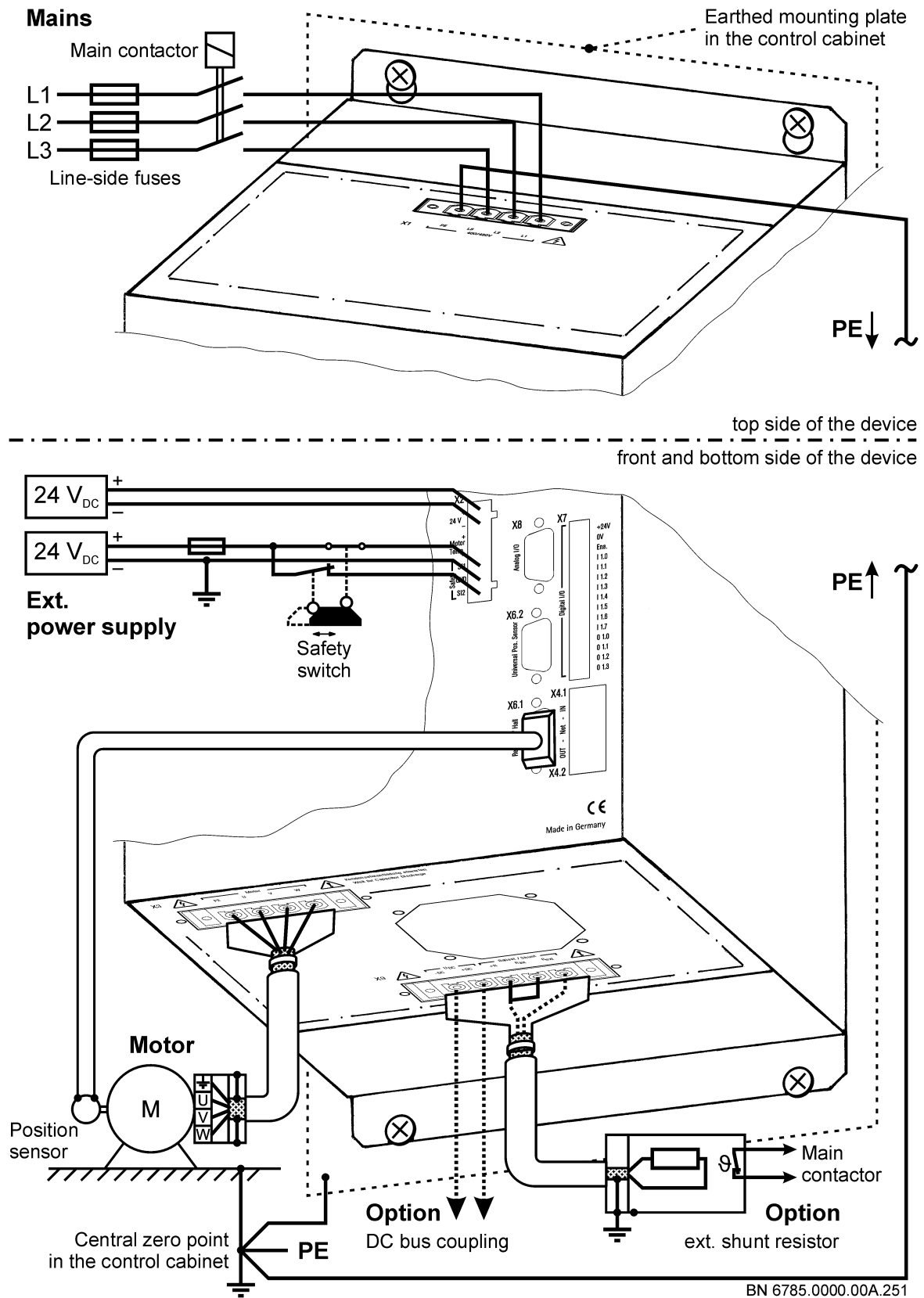Figure 8: Connection Instructions X1, X2, X3.1, and X6 for BN 6781 to BN 6783

Figure 9: Connection Instructions X1, X2, X3.1, X6, and X9 for BN 6785 and BN 6787

## 5.1     Preconditions

For commissioning, please proceed according to the steps described here in order to prevent damages to the devices or the driven machines.

First of all, check the equipment of the device you wish to put into operation on the basis of sections Type Code [14] and Modular Equipment [30] and gain an overview of the accessories to be used. Of these accessories, you require a PC with command and commissioning software  SPP Windows or SPP Windows light as commissioning aid.

Check the operating instructions for completeness under consideration of the included equipment and accessories on the basis of section About this Description [7].

Knowledge about mounting and connecting the device is assumed. For that, read at least the following sections of these Operating Instructions:

• Safety Instructions [9],

• Technical Specifications [15],

• Design [25], and

• Assignment of Connectors [34].

Additionally, knowledge about the basics of the functions of the device are required. For information on that see operating instructions 6710.201 "Functions and Parameters".

Please, note:

Connections may only be established or disconnected when the devices are switched off.

If this is the first time you use ESR servo drives and you would like to get acquainted to them step by step, the motor should not be mounted at the machine but fixed properly otherwise for the first commissioning.

It is essential to ensure that possible commissioning faults, such as uncontrolled running of the motor at maximum speed or excessive acceleration, cannot lead to an endangering of persons or damages to property.

## 5.2     Installation in the Control Cabinet

Mounting in the control cabinet:

• At the top of the rear side, there are one or two openings for hooking into M 5 bolts.

• At the bottom of the rear side, there are slots for additional fixing. For BN 6781 to BN 6783, the ones at the outer edge should be used preferably.

The Servo Drives New Generation size 2 und 3 (BN 6781 bis BN 6787) are equipped with fans for active cooling. Size 1 Servo Drives New Generation (BN 6771 to BN 6774) only have fans for active cooling when equipped with option S2. To ensure that the air can flow through housing and heat sink,

• leave a clearance of at least 80 mm above and below the devices.

Several of those devices can be mounted directly next to each other (without lateral gaps between the devices). However, some millimeters of space facilitate installation and subsequent disassembly and assembly of individual devices.

**(?)** If drive BN 6774 (6 A device) is operated with a loading of more than 70%, the convection cooling is insufficient. In this case, the device must be mounted directly above a control cabinet fan or equipped with option S2.

## 5.3    Installation on a Mounting Plate

**[EMC]** For installing the drive on a mounting plate, screw the drive

• with its bare metal housing

• onto a bare metal (e. g. zinc-plated) mounting plate.

For that, the mounting plate has to be

• earthed and therefore be

• connected to the central zero point of the control cabinet via the potential equalization cable.

The mounting plate also serves for heat dissipation. Therefore, it must

• have a sufficient size and

• be heat conductive in contact with the drive.

An adequate heat dissipation reduces the temperature of the devices thus increasing their service life and operational safety. In case of thermal problems, a mounting plate made of aluminum may be used, if required.

**(TIP)** If possible, an active ventilation should be installed near the drives.

## 5.4    Potential Equalization Cables

Potential equalization cables originate in the central zero point of the control cabinet. They

• connect different zero points with one another at low resistance and

• reduce equalizing currents on the cable shield.

Thus, they prevent electrical interferences.

The central zero point of the control cabinet is connected to the PE (protective earth) conductor. This connection avoids an endangering of operating and maintenance personnel in case of electrical faults.

Due to leakage currents of the built-in RFI filter, the potential equalization cable from drive to central zero point must (like the cable of the protective earth conductor) in accordance with EN 61800-5-1

• either have a cable cross-section of at least 10 mm$^2$ Cu (clamp at a free 5×10 mm hole in the cooling plate) or

- be routed double.

  The first connection is made to the PE terminal of mains connector X1 or X9. The second connection results from the electric connection of the servo drive mounted on the earthed mounting plate. Therefore, an additional cable is no longer required.

The other potential equalization cables must have a cross-section of at least 2.5 mm², or, if possible, 4 mm².

It is true: Drives can be run without potential equalization cables, without shielded cables, and without compliance with safety regulations. However, this

- is contradictory to elementary safety requirements,

- violates statutory regulations,

- endangers the safety of persons,

- endangers the operational safety of the system,

- may lead to disturbances in the devices caused by other parts of the system,

- may lead to disturbances in other parts of the system caused by the devices.

## 5.5    Mains Connection

The mains is connected directly at the servo drive via Power Combicon connector X1.

- With servo drives BN 6771 to BN 6774 (size 1, 230 V, 0.8 .. 6 A rated current), a 6-pin connector

- with servo drives BN 6781 to BN 6783 (size 2, 3×400/480 V, 2 .. 8 A rated current), a 7-pin connector, and

- with servo drives BN 6785 and BN 6787 (size 3, 3×400/480 V, 16 .. 32 A rated current), a 4-pin connector

must be used for connections at connector X1 in order to prevent contact with live parts.

The cable to the servo drive must have

- a sufficient cross-section and

- a fixed connection (also applies to transformers, if installed).

Shield is not required.

The recommended line-side fuse and cable cross-sections are listed in the table in section Line-Side Fuses, Cable Cross-Sections, and Lengths [17].

The mains connector must not be plugged or unplugged while under voltage. The current rush might destroy the contacts of the connector or an electric arc endangering the commissioning personnel may occur when the connector is unplugged. The connector is intended for fixed connection, only.

The EMC limits for the first and second environment according to EN 61800-3 regarding

• emission and

• immunity

are not exceeded with the filters installed in the servo drive if all connections are made in accordance with section Installation and Connection Instructions [62]. Please, note the remark regarding "limited availability" in section CE Marking [12].

## 5.6    DC-Bus Coupling (size 2 and 3, only)

Of the Servo Drives New Generation, several devices can be connected via DC-bus coupling. Please, observe the following:

• The servo drives must be equipped with a mains connection of their own.

• They must be connected to the same mains.

• For DC-bus coupling, use strands with the same line cross-section as the supply line.

• The strands must not be longer than 30 cm.

• Shield is not required.

• Connect connectors +DC with one another and connectors -DC with one another.

• With servo drives BN 6781 to BN 6783, a 2-pin connector and with servo drives BN 6785 and BN 6787, a 5-pin connector must be used for connections at connector X9 in order to prevent contact with live parts.

• For a DC-bus coupling of more than two devices, the connections of each device must be fused bipolar. In this case, please contact ESR.

• If required, connect a shunt resistor at one of the devices (for devices with different power, preferably at the device with the highest power) and parameterize the shunt circuit correspondingly.

• Deactivate the shunt resistor in all other devices.

The connector for DC-bus coupling must not be plugged or unplugged while under voltage. The current rush might destroy the contacts of the connector or an electric arc endangering the commissioning personnel may occur when the connector is unplugged. The connectors are intended for fixed connection, only.

## 5.7    Shunt Resistor

A shunt resistor is required for operating the servo drive. For that, either the internal shunt resistor of the device can be used or an external shunt resistor can be connected.

When using the internal shunt resistor make sure that

• with servo drives BN 6771 to BN 6774 (size 1, 230 V, 0.8 .. 6 A rated current) at Power Combicon connector X1,

- with servo drives BN 6781 to BN 6783 (size 2, 3×400/480 V, 2 .. 8 A rated current) at Power Combicon connector X1,

- with servo drives BN 6785 and BN 6787 (size 3, 3×400/480 V, 16 .. 32 A rated current) at Power Combicon connector X9

the connections $R_{int}$ and +R are connected by a jumper.

In case the braking power occurring in your application exceeds the values stated in the technical specifications of the respective servo drive, an external shunt resistor is required for operating the servo drive.

If you would like to connect an external shunt resistor to connector X1 or X9 instead of an internal one,

- remove the jumper between $R_{int}$ and +R,

- connect the external resistor to connections $R_{ext}$ and +R.

The external shunt resistor must be installed in an earthed metal housing

- to avoid emissions and as a protection against contact with live parts and the hot resistor.

The external shunt resistor becomes very hot during operation. Therefore, it should be mounted outside the control cabinet. Pay attention to the degree of protection of the resistor!

Recommended cross-sections for the shunt resistor lines are listed in the table of section Line-Side Fuses, Cable Cross-Sections, and Lengths [17].

On top of the device, servo drives BN 6771 to BN 6774 (size 1, 230 V, 0.8 .. 6 A rated current) and BN 6781 to BN 6783 (size 2, 3×400/480 V, 2 .. 8 A rated current) are equipped with a strap with several holes for the shielded cable. Uncover approx. 6 cm of the shield braiding and fix it using two cable ties or hose clamps.

A shrinkable tubing at the end of the shield braiding avoids untwisting.

With devices BN 6785 and BN 6787 (size 3, 3×400/480 V, 16 .. 32 A rated current) connect the shield near the servo drive with the mounting plate. To do so, uncover approx. 3 cm of the shield braiding and connect it with the mounting plate using a metal clamp. The line from this earthing point to connector X9 should be shielded and not exceed a length of 50 cm.

For temperature monitoring, the braking resistors supplied by ESR are equipped with a thermo switch opening the contactor in case of overtemperature (> 180 °C).

This contactor must be integrated in the coil circuit of the mains contactor or the safety system connection. It must not be integrated in the load circuit of the shunt resistor.

For a DC-bus coupling, the servo drive with the highest power should carry out the control of the shunt circuit. In this case, typically an external shunt resistor is required. Observe the following:

- In all servo drives without external shunt resistor, the jumper between: $R_{int}$ and +R must be installed.

- Parameterize the shunt circuit of the device that carries out the control of the shunt circuit according to the shunt resistor used.

- Deactivate the shunt circuit in all other devices.

For further information, see operating instructions 6710.201 "Functions and Parameters".

## 5.8    Motor Connection (Power)

The motor is connected at Power Combicon connector X3 or X3.1 by means of a 4-core shielded cable:

Proceed as follows:

- Connect the motor supply cable to the motor (shield, PE, motor phases U, V, W).

- Connect the machine earth to the central zero point of the control cabinet using a potential equalizer of 10 mm$^2$.

- Lay the motor supply cable separate from the encoder connection cable.

Connection to the drive:

- Connect the motor supply cable to Power Combicon connector X3 or 3.1 of the servo drive (PE, motor phases U, V, W). Pay attention to the correct assignment of the motor phases.

- Connect the shield as described in the following section.

- Use the motor supply cable by ESR. The cable cross-section must be in accordance with the mains connection cable, for that, please refer to the table in section Line-Side Fuses, Cable Cross-Sections, and Lengths [17].

The 3 motor phases must be connected with the correct assignments, otherwise

- the motor blocks,

- the motor runs unsmoothly,

- the motor runs with a lower torque, or

- the motor runs uncontrolled at full speed.

This does not damage motor or drive but may endanger machine and commissioning personnel.

The motor connector must not be plugged or unplugged while under voltage. The current rush might destroy the contacts of the connector or an electric arc endangering the commissioning personnel may occur when the connector is unplugged. The connector is intended for fixed connection, only.

The capacitive load caused by the motor supply cable is an additional load for the drive. Note the maximum cable lengths in section Line-Side Fuses, Cable Cross-Sections, and Lengths [17].

For a description of the connection cables with technical specifications, see data sheet 8817.201.

## 5.9    Shield Connection Motor Supply Cable

[EMC] For BN 6771 to BN 6774 (size 1, 230 V, 0.8 .. 6 A rated current) and BN 6781 to BN 6783 (size 2, 3×400/480 V, 2 .. 8 A rated current), a cable clamp is provided on the drive for the shielded motor supply cable. For BN 6785 and BN 6787 (size 3, 3×400/480 V, 16 .. 32 A rated current),  a Combicon connector with shield connection plate must be used (available as accessory).

- Use this to establish a large-area connection between the shield and the housing by folding back the strands of the shield over the cable insulation and securing the strands using the cable clamp or connecting it with the shield connection plate of the connector using metal hose clamps or plastics cable ties.

Alternatively, connect the shield with the upper and lower housing strap of BN 6771 to BN 6774 and BN 6781 to BN 6783. Several holes 10 × 5 mm are provided for that.

- Uncover approx. 6 cm of the shield braiding and fix it using two cable ties or hose clamps. A shrinkable tubing at the end of the shield braiding avoids untwisting.

Establish a large-area connection between shield and earth at the motor in a suitable manner.

- At all places, avoid earthing the shield using twirled strands (pigtails) of the shield braiding.

The shield of the motor supply cable must not be interrupted. If you have to install contactors, switches, or chokes in the motor supply cable,

- install these in metallic housings and

- establish a large-area connection between the shield and the housing using a cable clamp, as described above.

## 5.10    Connection of the Holding Brake

Devices BN 6771 to BN 6774 as well as BN 6785 and BN 6787 are not equipped with a special connector for the holding brake. In this case, it is operated via a digital output operating a contactor to be installed externally.

With devices BN 6781 to BN 6783, a holding brake can be connected directly to Power Combicon connector X3.2 via shielded cable. To do so, connect the 24 V DC supply for the holding brake as well as the brake line to Combicon connector X3.2 If required, the 24 V supply can be switched off externally in case of an emergency stop.

Pay attention to the correct polarity of supplied voltage and brake!

Fix the cable shield together with the shield of the motor supply cable under the shield connection clamp of the servo drive.

For information on the assignment of Combicon connector X3.2 and the connection of the holding brake, see section [Holding Brake (X3.2)](#) [41].

## 5.11 Connection of Control Supply Voltage +24 V and Safety System

Control supply voltage +24 V DC (PELV) and safety system are connected at Combicon connector X2.

⚠ The connector must not be plugged or unplugged while under voltage. The current rush may destroy the contacts of the connector or an electric arc endangering the commissioning personnel may occur when the connector is unplugged. The connector is intended for fixed connection, only.

Apply your safety signals to SI1 and SI2 of connector X2. Please observe the notes in sections [Control Supply Voltage, Motor Temperature Sensor, Safety System (X2)](#) [37], [Safety System](#) [39], and [Connection of Control Supply Voltage +24 V and Safety System](#) [73]. If a safety function is not required, connect +24 V directly to SI1 and SI2 as well as 0 V to GND.

⓪ For fault-free operation, the control supply voltage must meet the requirements specified in the "Technical Specifications" (see section [Technical Specifications](#) [15]). The control supply voltage should always be checked at maximum load. Please, remember that the load can change during operation, as well, e. g. when the integrated fans start working.

For the safety signals, ensure that earth faults or short circuits cannot occur by means of a suitable wiring.

- Earth the negative pole of the voltage source so that earth faults can be detected.

- As voltage source, use a power supply unit with integrated fuse or install an external fuse so that an earth fault is switched off safely.

The supply lines must be laid separately. According to DIN EN ISO 13849-1 (category 4), safety switches must not be cascaded. Please, note that the safety switch must be an opener-closer combination with a forced break contact in the opener circuit.

Information on the assignment of Combicon connector X2 and the control supply voltage can be found in sections [Control Supply Voltage, Motor Temperature Sensor, Safety System (X2)](#) [37] and [Connection of Control Supply Voltage +24 V and Safety System](#) [73]. For information on the safety system see [Safety System](#) [39].

## 5.12 Connection of a PC

A PC with command and commissioning software SPP Windows or SPP Windows light is required for commissioning the servo drives. For that, a USB inter-

face of the PC has to be connected to the USB interface (connector X5) of the servo drive.

For the connection between PC and servo drive, exclusively use shielded USB cables marked "USB certified" as otherwise the communication can be interrupted. In case of communication problems do not connect the USB cable to the USB interface at the front side of the PC but to one of the USB interfaces of the main board at the back side of the PC.

A suitable cable, 3 m long, for connecting the USB interface to a PC is included in the scope of delivery of the SPP Windows software (full version).

For details on the assignment of the USB interface, see section USB Interface [48]. The operation of SPP Windows is described in operating instructions 6710.207.

## 5.13  Parameterization of the Motor Position Sensor Interface

Before connecting the motor position sensor, make sure that the motor position sensor interface has been parameterized correctly. Proceed as follows:

- Switch on the 24 V supply voltage for the servo drive (X2). If possible, leave the power supply (X1 or X9) switched off.

- After an initialization period of a few seconds, check the state of the servo LEDs:
  - Fault LED "FLT" should be illuminated (no motor position sensor connected).
  - LED "RDY" should be flashing (power circuit not ready).
  - The other two LEDs "OVL" and "SHT" must be dark.

  The state of the bus LEDs ("Net") is not relevant at this point of time.

  For further information on the individual LEDs, see section LEDs [29].

- Establish a connection to the servo drive using the SPP Windows software, either automatically at program start or via menu item "Communication / Connect". Select option "Load all data from the device" or load the data from the servo drive via "Communication / Load from device / all data" after the connection has been established.

  A fault is displayed (e. g. 7303 "Encoder fault" or 4310 "Overtemperature motor") which is not relevant at this point of time, therefore, the fault window may be closed.

- In window "Parameterization", "Motor data / Motor position sensor" check whether or not the stated motor position sensor corresponds to the motor used. If not:
  - Select the correct motor position sensor for parameter *interface identification*. In case of a pure incremental encoder (sine/cosine 1 Vpp with or without commutation track or square-wave signals RS 422), enter its data under *sine periods per revolution* or *measuring steps per revolution*.
  - Transmit the new parameterization to the servo drive via "Communication / Send to device".

– Store the parameters in the servo drive using "Communication / Save in device".

– Wait for the message that the process has been terminated successfully.

• Switch the voltage supply for the servo drive off.

Now, you can proceed with the connection.

## 5.14   Connection of the Motor Temperature Sensor

The motor temperature sensor is usually routed via the motor supply cable (power) and connected via Combicon connector X2 to avoid a coupling of motor temperature line interferences to the sensitive encoder lines.

For resolvers or incremental encoders with square-wave signals, a connection via input X6.1 or X6.2 is possible without problems. A connection of the motor temperature sensor at X6.2 is also possible with absolute encoders and high-resolution incremental encoders, however, should be done only in special cases.

If the lead to the motor temperature sensor is routed within the motor supply cable, this lead must have a shield of its own. Connect the shield at the servo drive with the shield of the motor supply cable.

As temperature sensors can be used

• a thermo switch opening in the event of overheating,

• a PTC resistor increasing its value to more than 2.5 kΩ in the event of overheating, or

• type KTY-84-130 and KTY-83-110 sensors (others on request) which also permit a temperature measurement; the temperature to be monitored is set individually via the motor parameterization.

The insulation of the temperature sensor within the motor and the wiring towards the motor winding must be designed according to the regulations for protective separation.

If the motor does not have a temperature sensor, the pins have to be jumpered at one of the connectors. Otherwise, the servo drive would constantly signal a "motor overtemperature" fault.

When connecting a motor temperature sensor, make sure that it is not rendered ineffective by a jumper at the pins connected in parallel internally at the second connector.

Information on the assignment of Combicon connector X2 and the "motor temperature sensor" connection can be found in sections <u>Control Supply Voltage, Motor Temperature Sensor, Safety System (X2)</u> [37] and <u>Connection of the Motor Temperature Sensor</u> [75].

## 5.15   Shield Connection D Sub Connectors

**EMC**   These explanations for shield and shield connection apply to the following sections.

Use only shielded cables.

The housings of the D sub connectors are metallized. There, a low-resistance connection between shield and housing is made via the strain relief.

With that, you achieve the necessary large-area earth connection for the shield and avoid earthing the shield using twirled strands (pigtails) of the shield brading.

## 5.16 Connection of the Motor Position Sensor

Do not connect the motor position sensor until you have made sure that the motor position sensor interface has been parameterized correctly, see section Parameterization of the Motor Position Sensor Interface [74]! Otherwise, the motor position sensor can be damaged or destroyed!

The cable to the motor position sensor must be

• laid separately from the motor supply cable and

• connected exactly according to the instructions, otherwise
   – the motor blocks,
   – the motor runs unsmoothly,
   – the motor runs with a lower torque,
   – the motor runs uncontrolled at full speed, or
   – the servo drive reports a fault.

This does not damage motor or drive but may endanger machine and commissioning personnel.

When connecting the shield, please observe the following:

• Connect the shield at the drive side and the motor side.

• Connect the shield via the metallized housings of the connectors.

   Thus, you achieve the necessary large-area earth connection of the shield and avoid earthing the shield using twirled strands (pigtails) of the shield brading.

### 5.16.1 Connection of a Resolver

For connecting a resolver to the correspondingly parameterized connector X6.1 use a shielded cable with twisted-pair leads for sine, cosine, and excitation, e. g. encoder connection cable BN 8818.

### 5.16.2 Connection of an EnDat Absolute Encoder

For connecting an EnDat absolute encoder to the correspondingly parameterized connector X6.2 use a shielded cable with twisted-pair leads for the signals A+/A–, B+/B–, CLOCK+/CLOCK–, DATA+/DATA– , e. g. encoder connection cable BN 8829.

### 5.16.3   Connection of a Hiperface Absolute Encoder

For connecting a Hiperface absolute encoder to the correspondingly parameterized connector X6.2 use a shielded cable with twisted-pair leads for the signals SIN/REFSIN, COS/REFCOS and –485/+485, e. g. encoder connection cable BN 8821.

### 5.16.4   Connection of a BiSS Absolute Encoder

For connecting a BiSS absolute encoder to the correspondingly parameterized connector X6.2 use a shielded cable with twisted-pair leads for the signals MA +/MA– (C+/C–) and SL+/SL– (D+/D–) and, if available, A+/A– and B+/B–, e. g. encoder connection cable BN 8829.

### 5.16.5   Connection of a High-Resolution Incremental Encoder

For connecting a high-resolution incremental encoder to the correspondingly parameterized connector X6.2 use a shielded cable with twisted-pair leads for the signals A+/A– and B+/B–.

For the signals C+/C–, D+/D– and R+/R–, as well, twisted-pair leads should be used, e. g. encoder connection cable BN 8829.

### 5.16.6   Connection of an Incremental Encoder (Square-Wave Signals RS 422)

For connecting an incremental encoder with square-wave signals to the correspondingly parameterized connector X6.2 use a shielded cable with twisted-pair leads for the signals A+/A–D, B+/B–, Ua0+, Ua0–, e. g. encoder connection cable BN 8821.

### 5.16.7   Connection of a Hall Sensor

Description in preparation.

## 5.17   Connection to the Fieldbus

### 5.17.1   Connecting to the CANbus

Before connecting the servo drive to the CANbus, set node-ID and baud rate of the servo drive. To do so, use a PC with command and commissioning software SPP Windows, which is connected to the servo drive via the USB interface, see section . Proceed as follows:

- Switch the 24 V supply voltage for the servo drive (X2) on. If possible, leave the power supply (X1 or X9) switched off.

- After an initialization period of a few seconds, establish a connection to the servo drive using the SPP Windows software. Select option "Load all data from the device" or load the data from the servo drive via "Communication / Load from device / all data" after the connection has been established.

- In window "Parameterization" under "CANopen/EtherCAT" check whether or not node-ID and baud rate are set correctly. If not:

  – set the correct node-ID and baud rate,

  – transmit the new parameterization to the servo drive via "Communication / Send to device",

  – store the parameters in the servo drive using "Communication / Save in device",

  – wait for the message that the process has been terminated successfully.

• Switch the voltage supply for the servo drive off.

Now, you can proceed with the connection.

• Add cables and connectors to the CANbus line for additional bus users.

• Make sure each user's bus termination setting is correct (new devices and their neighbors).

• Connect the CANbus cable to the servo drive.

For further information on the CANbus interface, see operating instructions 6745.205 "CANopen® Interface".

### 5.17.2  Connecting to EtherCAT

Follow these steps to connect the servo drive to EtherCAT:

• Switch off the 24 V supply.

• Add cables and connectors to the EtherCAT line for additional bus users.

• Connect the EtherCAT cable to the servo drive.

For further information on the EtherCAT interface see Operating Instructions 6745.232 "EtherCAT Interface".

### 5.17.3  Connecting to Ethernet

Before connecting the servo drive to Ethernet, the IP configuration must be carried out. To do so, use a PC with command and commissioning software SPP Windows which is connected to the servo drive via the USB interface, see section Connection of a PC [73]. Proceed as follows:

• Switch the 24 V supply voltage for the servo drive (X2) on. If possible, leave the power supply (X1 or X9) switched off.

• After an initialization period of a few seconds, establish a connection to the servo drive using the SPP Windows software. Select option "Load all data from the device" or load the data from the servo drive via "Communication / Load from device / all data" after the connection has been established.

• In window "Parameterization" under "Ethernet" check whether or not the IP configuration is set correctly. If not:

  – set the correct IP configuration and assign an IP address which is unique within the Ethernet segment to the servo drive,

  – transmit the new parameterization to the servo drive via "Communication / Send to device",

      – store the parameters in the servo drive using "Communication / Save in device",

      – wait for the message that the process has been terminated successfully.

• Switch the voltage supply for the servo drive off.

Now, you can proceed with the connection.

• Add cables and connectors to the Ethernet line for additional bus users.

• Connect the Ethernet cable to the servo drive. Make sure that you use connector X4.1 Net-IN.

For further information on the Ethernet interface see Operating Instructions 6745.236 "Ethernet Interface".

### 5.17.4  Connecting to Profinet

Follow these steps to connect the servo drive to Profinet:

• Switch off the 24 V supply.

• Add cables and connectors to the Profinet line for additional bus users.

• Connect the Profinet cable to the servo drive.

For further information on the Profinet interface, see Operating Instructions 6770.237 "Profinet Interface".

## 5.18  Connection Encoder Input or Output

When connecting incremental encoder signals to connector X10, please observe:

• use twisted-pair leads for each channel

• use a shielded cable (e. g. encoder connection cable BN 8818).

• connect the shield at the drive to the earthed drive housing using the metallized D sub housing

• earth the shield additionally at the controller, follow the recommendations of the manufacturer of the controller regarding earthing and shield connection

For information on options ZG1 and ZL1 for the encoder signals see sections Input Encoder Signals [32] and Output Encoder Signals [31]. For details on the assignment of Combicon connector X10 see sections Input Encoder Signals [53] and Output Encoder Signals [52].

## 5.19  Connection External Absolute Encoder

For connecting the external absolute encoder to connector X10/ZL4, please follow the instructions for connecting the motor position sensor in section Connection of the Motor Position Sensor [76].

Please, make sure that you do not mistake the connector for the external absolute encoder for the connector of the motor position sensor!

Information on option ZL4 for the additional interface for external absolute en-coders can be found in section Additional Interface ZL4 for External Absolute Encoder [32]. For details on the assignment of connector X10/ZL4, see section Optional Interface X10/ZL4 for External Absolute Encoder [54].

## 5.20   First Tests

This section is intended for getting familiar with the drive system, e. g. when you are using ESR servo drive systems for the first time. In this case, the motor should not be installed in the machine yet in order to prevent damages due to drive motions. If you are already familiar with the drive system, you can skip this section.

Switch on the 24 V supply. If possible, keep the power supply (X1 or X9) swit-ched off.

Check the state of the servo LEDs after an initialization phase of some se-conds:

- LED "FLT" should go off.

- LED "RDY" must be flashing (power circuit not ready yet).

- The two other LEDs "OVL" and "SHT" must be dark.

- The status of the bus LEDs ("Net") is not relevant at this point of time.

For further information on the meaning of the individual LEDs, please refer to section LEDs [29].

Establish a connection to the servo drive using the SPP Windows software, eit-her automatically at program start or via menu item "Communication / Connect". In case of a correct wiring, LED "FLT" should not be lit and a fault should not be displayed in SPP Windows.

You can provoke a fault e. g. by disconnecting the motor position sensor. Due to that, LED "FLT" should be lit and a fault should be displayed in the device control window as well as in the fault window. The fault is described more pre-cisely in the fault window and the status line. As a motor position sensor has not been connected yet, it must either be an "encoder fault" or a "resolver fault". After having reconnected the motor position sensor, you can reset the fault manually in SPP Windows.

Turn the motor shaft by hand or move the linear motor back and forth. The cor-responding change should be observed in the device control window in the "Position".

For another test, switch off safety signal SI1 and SI2 and check the displays for SI1, SI2, and safety system in the device control window of SPP Windows.

- The displays for SI1, SI2, and safety system should change from green to red.

- Switch on the two signals, the displays for SI1 and SI2 change back to green. The red display for the safety system signals that the safety signals were switched off temporarily. (This message is reset automatically when the servo drive is released later on.)

Now, switch off SI1 only.

- The display for SI1 in the device control window changes from green to red. The SI2 display stays green, after 1 second error message "safety system input SI2 inactive" appears. This error message signals a fault in the safety wiring of SI2.

Switch on SI1.

- The SI1 display changes to green, the error message is still active.

- Acknowledge the fault by clicking on button "Reset fault".

Now, switch off SI2 only.

- The system reacts as described for SI1 except for the error message which says "safety system input SI1 inactive". Proceed as described for SI1.

As soon as the command and commissioning software SPP Windows is working together with the servo drive, you can continue parameterizing the drive system.

## 5.21  Setting the Machine Data

For setting the machine data, follow operating instructions 6710.201 "Functions and Parameters".

Please note that all transmitted data are lost when switching off the 24 V unless they have been stored in the servo drive via "Communication/Save in device...".

## 5.22  First Commissioning

This section is intended for getting familiar with the drive system, e. g. when you are using ESR servo drive systems for the first time. In this case, the motor should not be installed in the machine yet in order to prevent damages due to drive motions. If you are already familiar with the drive system, you can skip this section.

The following instructions apply to rotary drive systems. They also apply to linear drive systems, in this case, particular attention must be paid to travel distance, target velocity, and possibly limit switches.

After having selected a motor according to Operating Instructions 6710.201 "Functions and Parameters", section "Setting the machine data for the first commissioning", and transmitted the data to the servo drive, you can start the first commissioning of the motor.

- In the device control window, select axis operating mode velocity mode and device operating mode command mode.

- Switch on the mains voltage

- Open the status window, the DC-bus voltage shows approx. 320 V for size 1, or approx. 565 V for size 2 and 3.

- Operate button "Operation enabled" in the device control window.
  - Now, the servo drive is active and regulates the speed to zero.

- In the target velocity window enter 100 for the target velocity and click on the "set" button at the right.
  – The drive rotates at 100 r.p.m.
- Now, switch off safety inputs SI1 and SI2.
  – The drive stops and the SI1, SI2, and safety system displays in the device control window change from green to red.
- Switch on the two signals.
  – The SI1 and SI2 displays change to green but the drive does not start automatically. The red display for the safety system signals that the safety signals were switched off temporarily.
- Switch on the drive by confirming button "Operation enabled".
  – The drive is running again, the red display for the safety system changes to green.

Switch off the drive system, e. g. by operating button "Quick stop". If the first commissioning was successful, the drive will be working as desired and can be installed in the machine.

## 5.23  Connecting Other Peripheral Devices

After the drive system has been put into operation in accordance with the above sections, further peripheral devices can be connected to the servo drive.

When connecting further peripheral devices, ensure that the voltage supply of the control supply voltage is not overloaded and that 24 volts are still available for the basic device.

When connecting other peripheral devices, it is also important to make sure that the cables are shielded and that interferences at inputs and outputs are sufficiently suppressed so that interferences do not occur in the drive system.

## 5.24  Writing and Testing Part Programs

Part programs (option B2 or higher) should not be written and tested until all above-mentioned steps have been carried out. Part programs cannot run correctly unless the drive system is running in command mode and the machine data have been set correctly.

# 6   Appendix

## 6.1    Appendix A EC Declaration of Conformity

**EC Declaration of Conformity** $C\ E$

We hereby certify that the products described in these operating instructions comply with the following directives, standards and regulations. They are designed for installation in a machine. In accordance with the EC Machines Directive, commissioning is prohibited until it has been ascertained that the machine which this product is to be fitted into satisfies the provisions of the EC directive.

The requirements of the directives, standards and regulations are not satisfied until the installation and connection provisions in the operating instructions have been followed.

Applied directives:

- Low Voltage Directive
    - until 2016-04-19: 2006/95/EC,
    - from 2016-04-20 on: 2014/35/EC, published on 2014-03-29 in the Official Journal of the European Communities L96/357-374,
- EMC Directive
    - until 2016-04-19: 2004/108/EC,
    - from 2016-04-20 on: 2014/30/EC, published on 2014-03-29 in the Official Journal of the European Communities L96/79-106

Harmonized standards applied:

- EN 61800-5-1:2007 for the Low Voltage Directive
- EN 61800-3: 2004 + A1:2012 for the EMC Directive

ESR Pollmeier GmbH                                       Ernst E. Pollmeier
Ober-Ramstadt, 2016-03-15                          General Manager

## 6.2     Appendix B Manufacturer's Declaration

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# Manufacturer's Declaration

for variable speed drives (VSD) for securing protection against electric shock when using the products described in these operating instructions according to IEC/EN 61800-5-1.

Fault protection according to IEC/HD 60364-4-41 (DIN VDE 0100-410; VDE 0100-410) for output circuits of the products described in these operating instructions is secured under the following conditions:

- The products described in these operating instructions are installed according to the safety instructions of the manual.
- The installation meets the requirement of applicable standards of the IEC/HD 60364 (DIN VDE 0100; VDE 0100) series.
- The continuity of all associated PE and equipotential bonding conductors is secured including the bonding and connection points.

The products described in these operating instructions comply with the protection measure "automatic disconnection of the supply" according to IEC/HD 60364-4-41 (DIN VDE 0100-410; VDE 0100-410:2007-06), clause 411.3.2.5 if above-mentioned requirements are fulfilled.

This is based on following principle:

In case of a short circuit with negligible impedance to a PE conductor or against earth, the products described in these operating instructions will reduce the output voltage within a time which is required by table 41.1 of IEC/HD 60364-41 (DIN VDE 0100-410; VDE 0100-410):2007-06).

ESR Pollmeier GmbH                               Ernst E. Pollmeier
Ober-Ramstadt, 2016-03-22                        General Manager

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## 6.3     Appendix C UL/CSA Certification

In preparation.

## 6.4     Appendix D Terms of Warranty

ESR Pollmeier GmbH warrants that the device is free of material and production defects. In quality assurance, measured values are recorded in the final inspection and testing.

The warranty period begins with delivery. It lasts for 12 months.

Delivery is based on the "General Terms of Delivery for Products and Services of the Electrical Industry" (green terms of ZVEI, German electrical and electronic manufacturers' association). In case of a defect as to quality the device is to be returned. It is repaired in the works of the manufacturer free of charge, or replaced, at our discretion.

No other claims for damage which has not occurred in our device can be accepted. No claims for indirect damage resulting from a malfunction of or defect in our device may be put forward.

# 6.5    Appendix E Hardware Versions

This section summarizes notes on changes in the hardware with references to the corresponding sections in the text. The latest modifications are listed first.

The character group identifying the hardware version is stated on the nameplate behind the serial number (SN).

**Version AAA:**

• Series launch