# Siemens
# MOTION-CONNECT 300 Cables and Connectors Catalog



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# Siemens MOTION-CONNECT 300 Cables and Connectors

## 1. Overview

### 1.1 Overview of Cables

| MOTION-CONNECT 300 cables | | | | | Connectors (6FX2003-) | |
|---|---|---|---|---|---|---|
| **Type** | **Article No. 6FX3002-[1)]** | **Illustration (left: drive side; right: motor side)** | **Used for (SIMOTICS S-1FL6)** | **Cross-section of cores ($mm^2$)** | **Drive side** | **Motor side** |
| Power cable | 5CK01-.... |  | Low inertia:<br>  <br>0.05 kW to 1 kW | 4 × 0.75 | - | 0LL12 |
| Brake cable | 5BK02-.... |  | | 2 × 0.75 | - | 0LL52 |
| Incremental encoder cable | 2CT20-.... |  | | 3 × 2 × 0.20 + 2 × 2 × 0.25 | 0SB14 | 0SL12 |
| Absolute encoder cable | 2DB20-.... |  | | 3 × 2 × 0.20 + 2 × 2 × 0.25 | | 0DB12 |
| Power cable | 5CL01-.... | For high inertia motors of 0.4 kW to 1 kW:<br>  | High inertia (with straight connectors):<br>  <br>0.4 kW to 7 kW | 4 × 1.5 | - | 0LL11 |
| | 5CL11-.... | For high inertia motors of 1.5 kW to 7 kW:<br>  | | 4 × 2.5 | | 0LL11 |
| Brake cable | 5BL02-.... |  | | 2 x 0.75 | - | 0LL51 |
| Incremental encoder cable | 2CT10-.... |  | | 3 x 2 x 0.22 + 2 x 2 x 0.25 | 0SB14 | 0SL11 |
| Absolute encoder cable | 2DB10-.... |  | | 3 x 2 x 0.22 + 2 x 2 x 0.25 | | 0DB11 |


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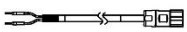
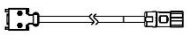
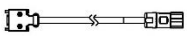
| MOTION-CONNECT 300 cables | | | | | Connectors (6FX2003-) | |
|---|---|---|---|---|---|---|
| **Type** | **Article No. 6FX3002-[1)]** | **Illustration (left: drive side; right: motor side)** | **Used for (SIMOTICS S-1FL6)** | **Cross-section of cores ($mm^2$)** | **Drive side** | **Motor side** |
| Power cable | 5CK32-.... | For low inertia motors of 1.5 kW to 2 kW:  | Low inertia (with angular connectors):  1.5 kW to 2 kW | 4 × 2.5 | - | 0LL13 |
| | 5CL02-.... | For high inertia motors of 0.4 kW to 1 kW:  | High inertia (with angular connectors): | 4 × 1.5 | | |
| | 5CL12-.... | For high inertia motors of 1.5 kW to 7 kW:  |  0.4 kW to 7 kW | 4 × 2.5 | | |
| Brake cable | 5BL03-.... |  | | 2 × 0.75 | - | 0LL53 |
| Incremental encoder cable | 2CT12-.... |  | | 3 × 2 × 0.22 + 2 × 2 × 0.25 | 0SB14 | 0SL13 |
| Absolute encoder cable | 2DB12-.... | For low inertia motors of 1.5 kW to 2 kW  | | 3 × 2 × 0.22 + 2 × 2 × 0.25 | | 0DB13 |
| | 2DB10-.... | For high inertia motors of 0.4 kW to 7 kW  | | 3 × 2 × 0.22 + 2 × 2 × 0.25 | | 0DB11 |

[1)] The "..." in the article number indicates the code for cable length, in which 1AD0 = 3 m, 1AF0 = 5 m, 1AH0 = 7 m, 1BA0 = 10 m, 1BF0 = 15 m, 1CA0 = 20 m.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## 1.2 Overview of Connectors

| Cable connectors (motor side) | | | | |
|---|---|---|---|---|
| **Article No. (6FX2003-)** | **0LL11** | **0LL51** | **0SL11** | **0DB11** [2] |
| Pin type[1] | Soldering | Soldering | Soldering | Soldering |
| Qty. per package | 30 | 30 | 30 | 30 |
| Illustration |  |  |  |  |
| **Article No. (6FX2003-)** | **0LL12** | **0LL52** | **0SL12** | **0DB12** |
| Pin type | Soldering | Soldering | Soldering | Soldering |
| Qty. per package | 5 | 5 | 5 | 5 |
| Illustration |  |  |  |  |
| **Article No. (6FX2003-)** | **0LL13** | **0LL53** | **0SL13** | **0DB13** |
| Pin type | Crimping | Crimping | Crimping | Crimping |
| Qty. per package | 5 | 5 | 5 | 5 |
| Illustration |  |  |  |  |
| **Cable connectors (drive side)** | | | | |
| **Article No. (6FX2003-)** | **0SB14** | | | |
| Pin type | Soldering | | | |
| Qty. per package | 30 | | | |
| Illustration |  | | | |

[1] Mind the pin type when assembling the cable connectors. Do not solder on the crimping type connectors or crimp the soldering type connectors.


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# 2. Technical data

## 2.1 Technical data - cables

| Parameter | MOTION-CONNECT 300 Power Cable | MOTION-CONNECT 300 Encoder Cable | MOTION-CONNECT 300 Brake Cable |
|---|---|---|---|
| **General technical data** | | | |
| Jacket material | PVC | PVC | PVC |
| Number of cores | 4 | 10 | 2 |
| Operation temperature (°C) | -25 to 80 | | |
| Shielding | Yes<br>• Coverage ≥ 60%:<br>For 200 V variant servo drives + low inertia motors of 0.05 kW to 1 kW<br>• Coverage ≥ 85%:<br>For 200 V variant servo drives + low inertia motors of 1.5 kW to 2 kW, and for 400 V variant servo drives + high inertia motors of 0.4 kW to 7 kW | | |
| Minimum bending radius, static (mm) | 5 x outer diameter | | |
| Minimum bending radius, dynamic (mm) | 155 | | |
| Oil resistance | EN60811-2-1 fulfilled | | |
| Flame-retardant | EN60332-1-1 to 1-3 fulfilled | | |
| Certification | RoHS, CE | RoHS | RoHS |
| **Specific technical data** | | | |
| Cable used for 200 V variant servo drive + low inertia motor of 0.05 kW to 1 kW | | | |
| Rated voltage (V) | 220 | 24 | 24 |
| Cross-section of cores ($mm^2$) | 4 x 0.75 | 3 x 2 x 0.20 + 2 x 2 x 0.25 | 2 x 0.75 |
| Outer diameter (mm) | ø (6.7±0.4) | ø (7.2±0.3) | ø (6.1±0.3) |


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| Parameter | MOTION-CONNECT 300 Power Cable | MOTION-CONNECT 300 Encoder Cable | MOTION-CONNECT 300 Brake Cable |
|---|---|---|---|
| Degree of protection (motor-side only) | IP20 | | |
| Bending cycles | 100000:<br>Maximum acceleration 3 m/s², maximum speed 40 m/min | | |
| Cable used for 200 V variant servo drives + low inertia motors of 1.5 kW to 2 kW, and for 400 V variant servo drives + high inertia motors of 0.4 kW to 7 kW | | | |
| Cross-section of cores (mm²) | • 4 x 1.5:<br>For high inertia motors of 0.4 kW to 1 kW<br>• 4 x 2.5:<br>For low inertia motors of 1.5 kW to 2 kW and high inertia motors of 1.5 kW to 7 kW | 3 x 2 x 0.22 + 2 x 2 x 0.25 | 2 x 0.75 |
| Rated voltage (V) | 380 | 24 | 24 |
| Outer diameter (mm) | • ø (7.8±0.3):<br>For high inertia motors of 0.4 kW to 1 kW<br>• ø (9.0±0.4):<br>For low inertia motors of 1.5 kW to 2 kW and high inertia motors of 1.5 kW to 7 kW | ø (6.9±0.3) | ø (6.0±0.3) |
| Degree of protection (motor-side only) | IP65 | | |
| Bending cycles | 1000000:<br>Maximum acceleration 3 m/s², maximum speed 40 m/min | | |


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# 3. System connection

## 3.1 Safety instructions

**⚠WARNING**

**Personal injury and damage to property from improper connections**

Improper connections have high risks of electrical shock and short circuit, which will jeopardize personal safety and equipment.

- The drive must be directly connected with the motor. It is not permissible to connect a capacitor, inductor or filter between them.
- The line supply voltage must be within the allowable range (refer to the drive rating plate). Never connect the line supply cable to the motor terminals U, V, W or connect the motor power cable to the line input terminals L1, L2, L3.
- Never wire up the U, V, W terminals in an interchanged phase sequence.
- If the CE marking for cables is mandatory in some cases, the motor power cable, the line supply cable from the line filter to the drive, and the brake cable used must be shielded cables.
- For terminal connection, make sure that the clearances in air between non-insulated live parts are at least 5.5 mm.
- Cables connected may not come into contact with rotating mechanical parts.

**⚠WARNING**

**Death or severe personal injury from electrical shock**

The earth leakage current for the drive can be greater than 3.5 mA AC, which may cause death or severe personal injury due to electrical shock.

- A fixed earth connection is required to eliminate the dangerous leakage current. In addition, the minimum size of the protective earth conductor shall comply with the local safety regulations for high leakage current equipment.

**⚠WARNING**

**Danger to life when PE terminals are touched**

When the equipment is working, hazardous touch current can be present at the PE terminal; if touched, this can result in death or severe personal injury.

- Do not touch the PE terminal during operation or within a certain period since power disconnection.

**⚠WARNING**

**Personal injury and damage to property from inadequate protection**

Inadequate protection may cause personal injury or damage to property.

- Route a second PE conductor with the cross section of the supply system lead in parallel to the protective earth via separate terminals or use a copper protective earth conductor with a cross section of 10 $mm^2$.
- Terminals for equipotential bondings that exist in addition to terminals for PE conductors must not be used for looping-through the PE conductors.

**NOTICE**

**Drive damage caused by short-circuiting between the shielding wire and the unused pin on the PROFINET I/O connector**

The shielding wire may inadvertently be short-circuited to the unused pin on the to-be-assembled PROFINET I/O connector. This can cause damage to the drive.

- Exercise caution when connecting the shielding cable to the PROFINET I/O connector.
- You can see the assembly method of the connector in Section "Assembly of cable terminals/connectors on the drive side (Page 343)".

**Note**

**Interruptions of the internal protective bonding of the equipment caused by cable movement**

The interruptions of the internal protective bonding of the equipment may be caused by cable movement such as dragging cables.

- Do not drag cables when in operation.
- Make sure that you have performed appropriate protective measures for the protective bonding when moving cables.

**Note**

**Low Voltage Directive complied**

Our products comply with EN61800-5-1: 2007 standards and Low Voltage Directive (Low Voltage Directive 2006/95/EC).

**Note**

For low inertia motors of shaft heights 20 mm, 30 mm and 40 mm, the encoder cable connectors may only be accessible to electrically skilled personnel.

**Note**

The mini-USB interface of the SINAMICS V90 PN is used for fast commissioning and diagnostics with SINAMICS V-ASSISTANT installed in the PC. Do not use it for long-term monitoring.

# 3.2 Using several single-phase drives in machines and plants

### 3.2.1 Overview

Evaluate the input currents ofsingle-phase drives in your machine or plant in terms of harmonics and unbalance.

### 3.2.2 Description

In unfavorable cases, the harmonic currents of several drives in the neutral conductor (N) add up to a value greater than the currents of the line conductors (L1, L2, L3). The current carrying capacity of the neutral conductor must be sufficient for this. IEC 60364-5-52:2019, section 524, makes recommendations for sizing the neutral conductor. If no more precise information is available, the standard recommends dimensioning the neutral conductor for 1.45 times the current carrying capacity of the line conductors.

**⚠ CAUTION**

**Fire caused by neutral conductor (N) overload**

The neutral conductor can heat up due to the load from harmonic currents and cause a fire.

- Consider the harmonic currents when dimensioning the neutral conductor.

**⚠ WARNING**

**Electric shock caused by PEN conductor overload**

In TN-C supply networks, the protective function of the PEN conductor can be adversely affected by exposure to harmonic currents.

- Consider the harmonic currents when dimensioning the PEN conductor.

### 3.2.3 EMC Instruction

Reliable and disturbance-free operation is only guaranteed for EMC-compliant installation. When connecting the drive system, you need to observe the following EMC-compliant instructions:

- To comply with the EMC standards, the following cables must be shielded cables: the line supply cable from the line filter to the SINAMICS V90 drive, the power cable, the encoder cable, and the brake cable. Siemens recommends that you use shielded cables to connect the line supply with the line filter.
- Route signal cables and power cables separately in different cable conduits. The signal cables shall be at least 10 cm away from the power cables.
- The SINAMICS V90 drives are designed for operation in the second environment (industrial area) and may not be used in the first environment (residential area) unless the appropriate noise suppression measures have been adopted.
- The SINAMICS V90 drives have been tested in accordance with the emission requirements of the category of C2 (domestic) environment. The conductive emissions and radiated emissions are in compliance with the standard of EN 55011 and reached Class A.

  – For a radiated emission test, an external AC filter (between the mains supply and the drive) need to be used to meet the EMC requirement and the drive need to be installed inside the shielded metallic chamber, other parts of the motion control system (including the PLC, DC power supply, spindle drive, motor) need to be put outside the shielded chamber.

  – For a conductive emission test, an external AC filter (between the mains supply and the drive) need to be used to meet the EMC requirement.

  – For the radiated emission and conductive emission test, the length of the line supply cable between the line filter and the drive must be shorter than 1 m.
- The harmonic current value of SINAMICS V90 exceed the class A limit of IEC 61000-3-2, but the SINAMICS V90 system installed within the Category C2 First Environment require supply authority acceptance for connection to the public low-voltage power supply network. Please contact your local supply network provider.


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## 3.3 EMC Instruction

Reliable and disturbance-free operation is only guaranteed for EMC-compliant installation. When connecting the drive system, you need to observe the following EMC-compliant instructions:

- To comply with the EMC standards, the following cables must be shielded cables: the line supply cable from the line filter to the SINAMICS V90 drive, the power cable, the encoder cable, and the brake cable. Siemens recommends that you use shielded cables to connect the line supply with the line filter.
- Route signal cables and power cables separately in different cable conduits. The signal cables shall be at least 10 cm away from the power cables.
- The SINAMICS V90 drives are designed for operation in the second environment (industrial area) and may not be used in the first environment (residential area) unless the appropriate noise suppression measures have been adopted.
- The SINAMICS V90 drives have been tested in accordance with the emission requirements of the category of C2 (domestic) environment. The conductive emissions and radiated emissions are in compliance with the standard of EN 55011 and reached Class A.

  – For a radiated emission test, an external AC filter (between the mains supply and the drive) need to be used to meet the EMC requirement and the drive need to be installed inside the shielded metallic chamber, other parts of the motion control system (including the PLC, DC power supply, spindle drive, motor) need to be put outside the shielded chamber.

  – For a conductive emission test, an external AC filter (between the mains supply and the drive) need to be used to meet the EMC requirement.

  – For the radiated emission and conductive emission test, the length of the line supply cable between the line filter and the drive must be shorter than 1 m.
- The harmonic current value of SINAMICS V90 exceed the class A limit of IEC 61000-3-2, but the SINAMICS V90 system installed within the Category C2 First Environment require supply authority acceptance for connection to the public low-voltage power supply network. Please contact your local supply network provider.

### Note

**Failure to meet the EMC requirements resulting from failure to observe the wiring instruction**

Failure to meet the EMC requirements because you do not observe the wiring instructions.

- To meet EMC requirements, the following cables must be shielded cables: the line supply cable from the line filter to the drive, the power cable, the encoder cable, and the brake cable. Siemens recommends that you use a shielded cable to connect the line supply with the line filter.
- Make sure that you connect the cable shields of shielded twisted-pair cables to the shielding plate or the hose clamp of the servo drive.


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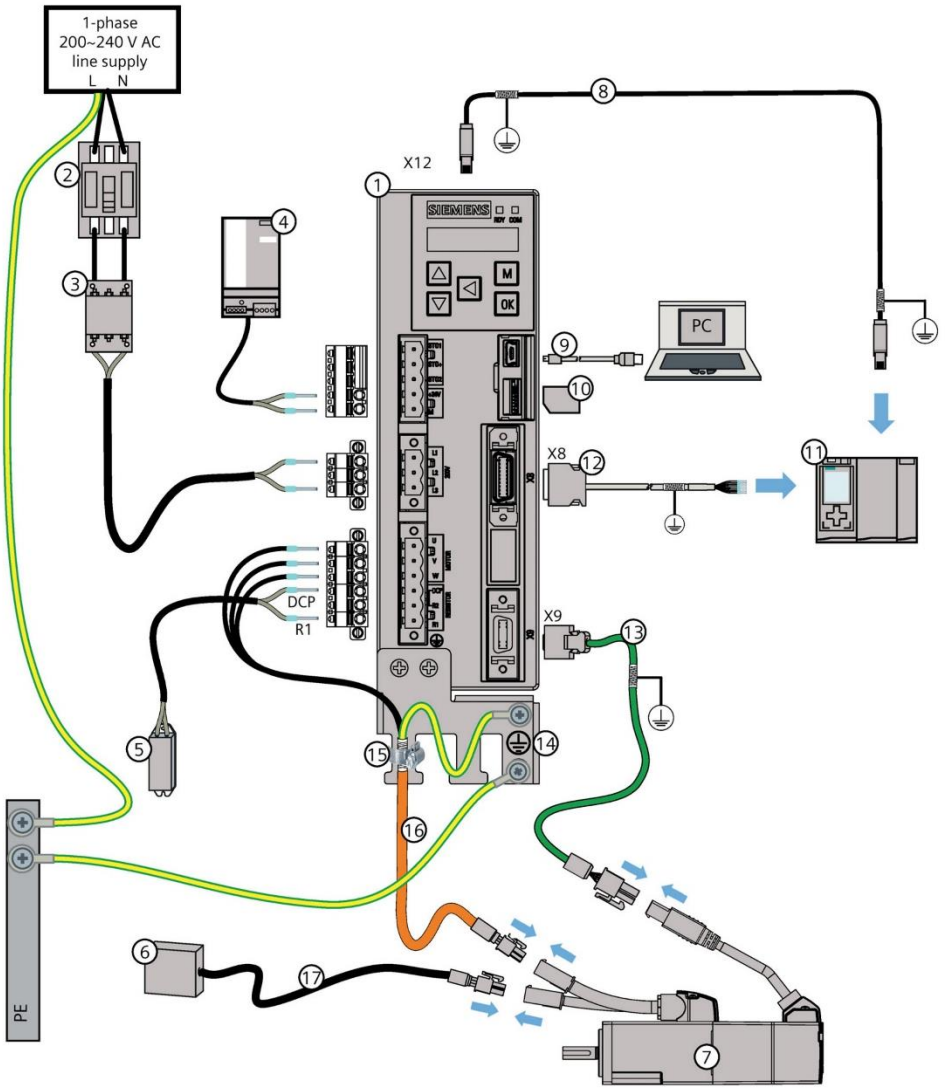
# 3.4 System connection diagrams

## 3.4.1 SINAMICS V90 PN 200 V variant

FSB on the single phase power network




① SINAMICS V90 PN servo drive
② Fuse/Type-E combination motor controller (option)
③ Line filter (option)
④ 24 V DC power supply (option)
⑤ External braking resistor (option, see "Braking resistor (Page 49)" for selection)
⑥ External relay (third-party device)
⑦ SIMOTICS S-1FL6 servo motor
⑧ PROFINET cable
⑨ USB cable
⑩ Micro SD card
⑪ Host controller
⑫ PROFINET I/O cable (20 pins)
⑬ Encoder cable
⑭ Shielding plate (in V90 package)
⑮ Hose clamp (attached on Siemens power cable)
⑯ Power cable
⑰ Brake cable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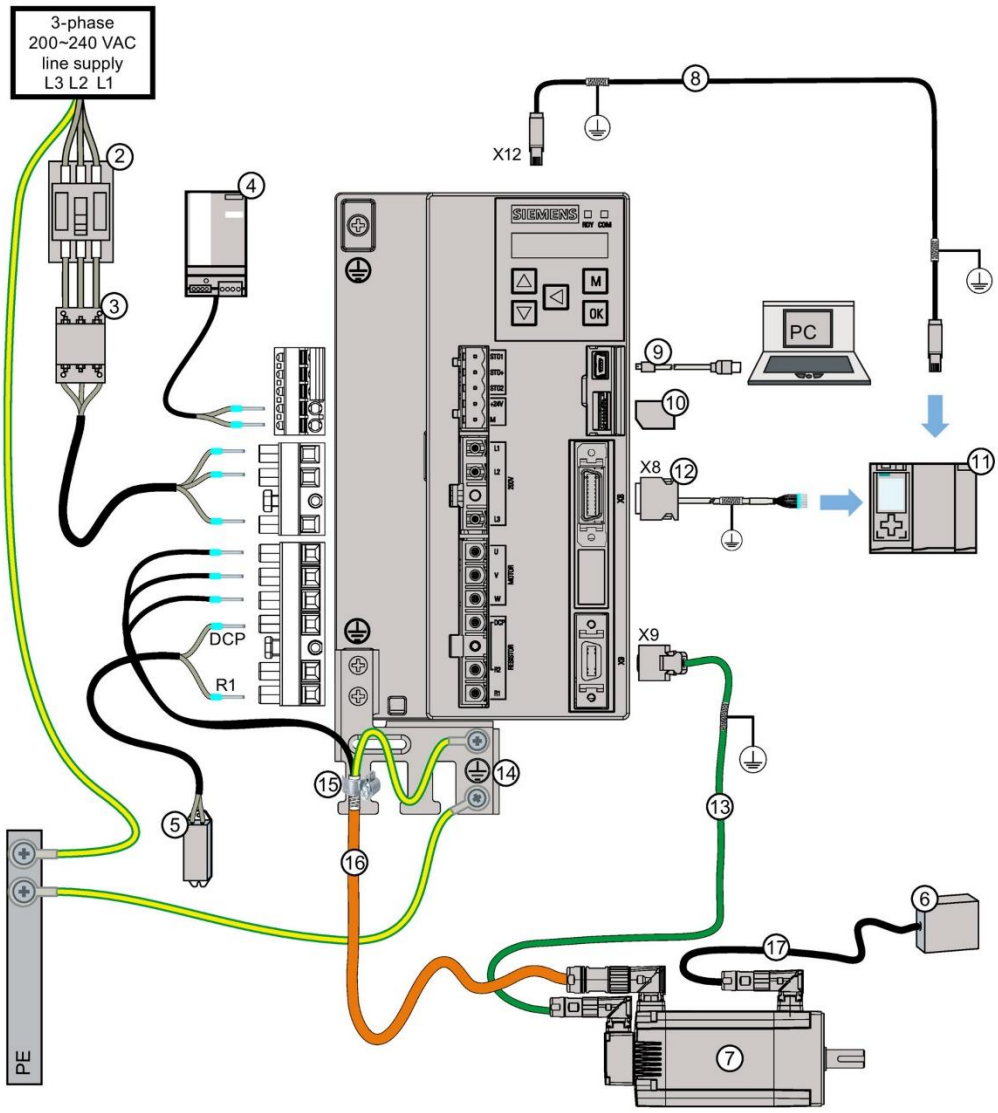
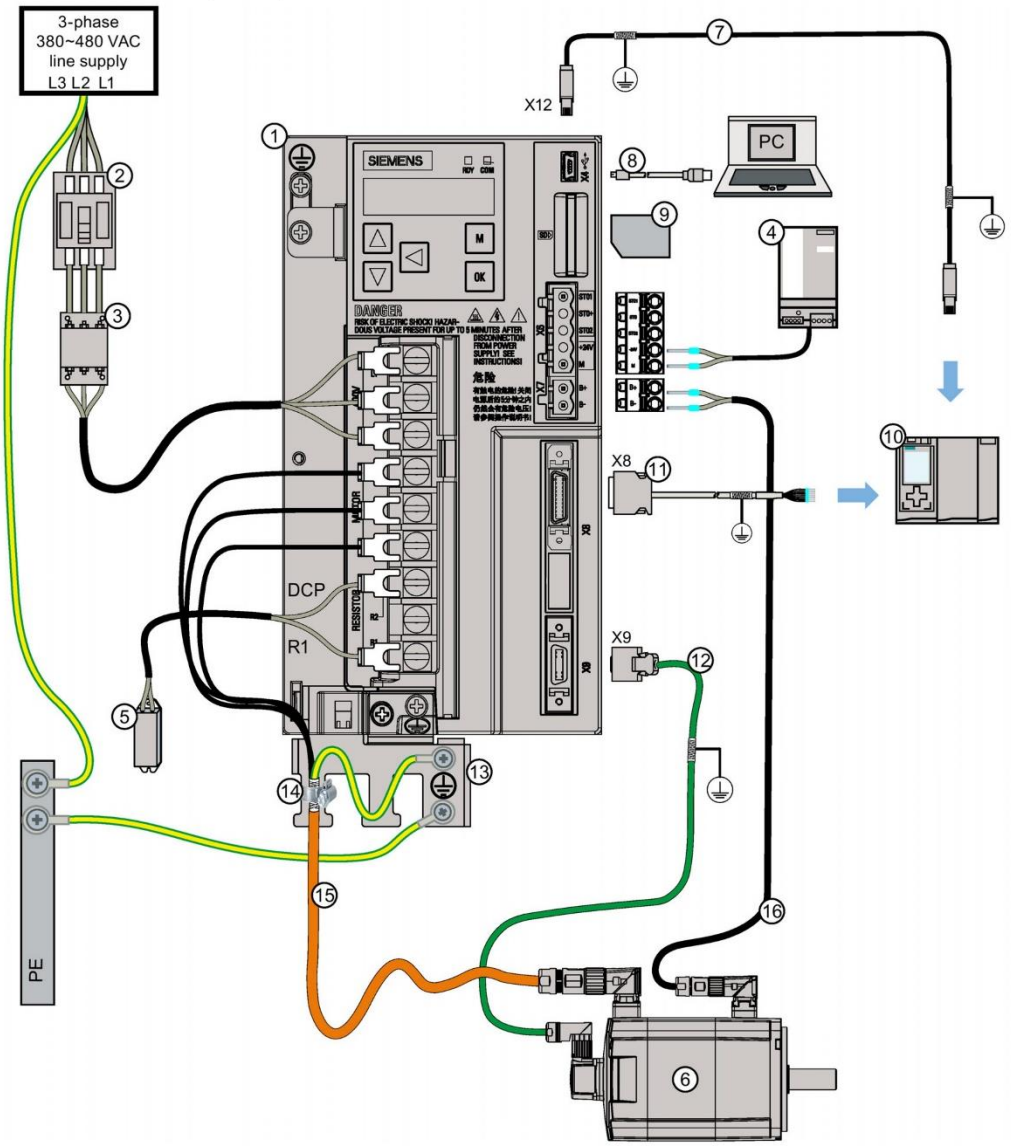
**FSD on the three phase power network**




① SINAMICS V90 PN servo drive
② Fuse/Type-E combination motor controller (option)
③ Line filter (option)
④ 24 V DC power supply (option)
⑤ External braking resistor (option, see "Braking resistor (Page 49)" for selection)
⑥ External relay (third-party device)
⑦ SIMOTICS S-1FL6 servo motor
⑧ PROFINET cable
⑨ USB cable
⑩ Micro SD card
⑪ Host controller
⑫ PROFINET I/O cable (20 pins)
⑬ Encoder cable
⑭ Shielding plate (in V90 package)
⑮ Hose clamp (attached on Siemens power cable)
⑯ Power cable
⑰ Brake cable

### 3.4.2 SINAMICS V90 PN 400 V variant

FSB on the three phase power network




① SINAMICS V90 PN servo drive
② Fuse/Type-E combination motor controller (option)
③ Line filter (option)
④ 24 V DC power supply (option)
⑤ External braking resistor (option, see "Braking resistor (Page 49)" for selection)
⑥ SIMOTICS S-1FL6 servo motor
⑦ PROFINET cable
⑧ USB cable
⑨ SD card
⑩ Host controller
⑪ PROFINET I/O cable (20 pins)
⑫ Encoder cable
⑬ Shielding plate (in V90 package)
⑭ Hose clamp (attached on Siemens power cable)
⑮ Power cable
⑯ Brake cable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# 3.5 Cable connection

## 3.5.1 Connecting the cable shields

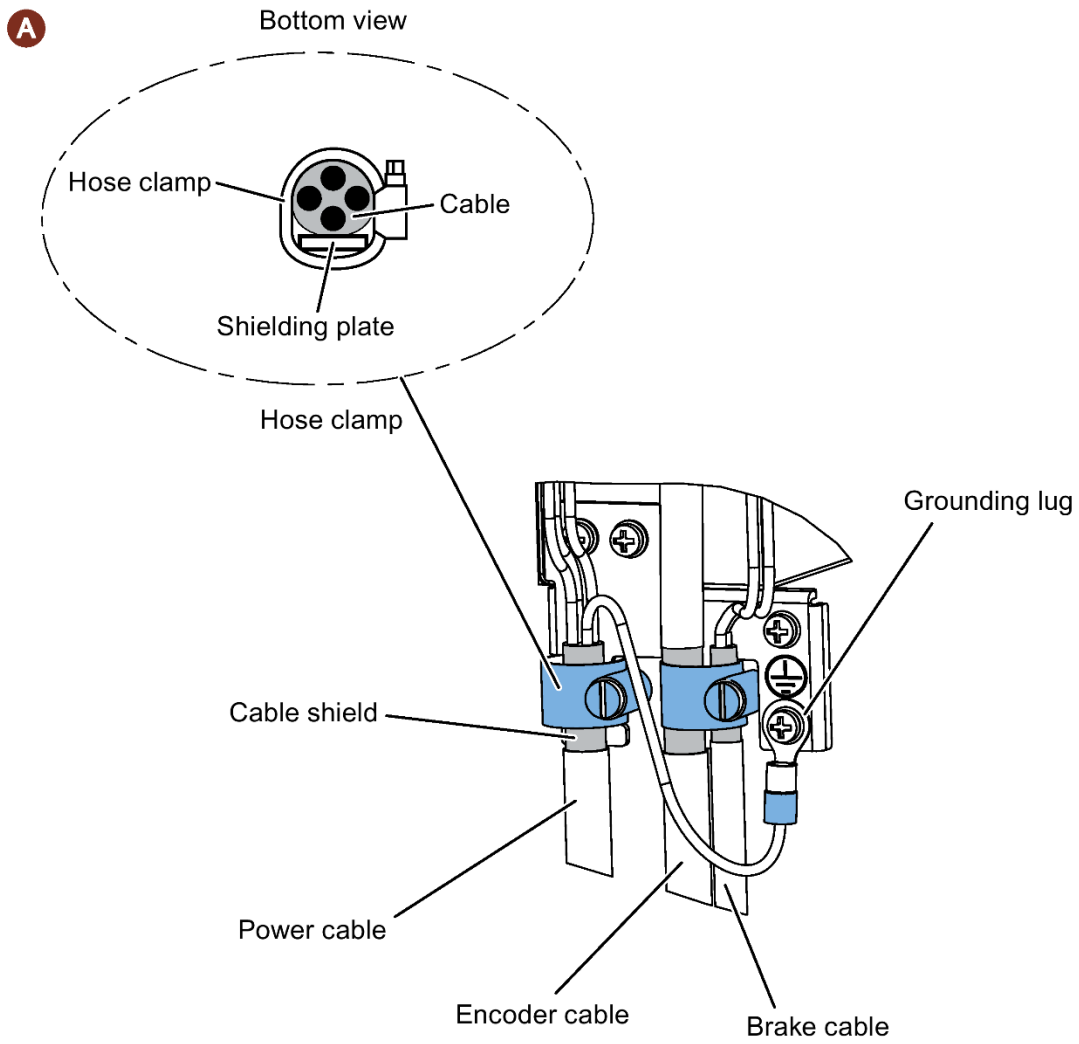
To achieve EMC-compliant installation of the drive, connect the shields of the power cable to the shielding plate via the hose clamps. The shielding plate is shipped with the drive. See figure A for steps to connect cable shields with the shielding plate.

To ensure better EMC effects, you are recommended to strip the brake cable and the encoder cable and connect the cable shields to earth, as shown in the figure A and figure B. Make sure that the shielding plate, the drive and the motor are properly grounded.

**Connecting the cable shields for power cable and brake cable**

1. Connect the power cable, and brake cable, and strip the cables where necessary.

2. Slip the hose clamps over the cable shields and the shielding plate; tighten the screws to press the cable shields onto the shielding plate as well as to fix the grounding lugs.





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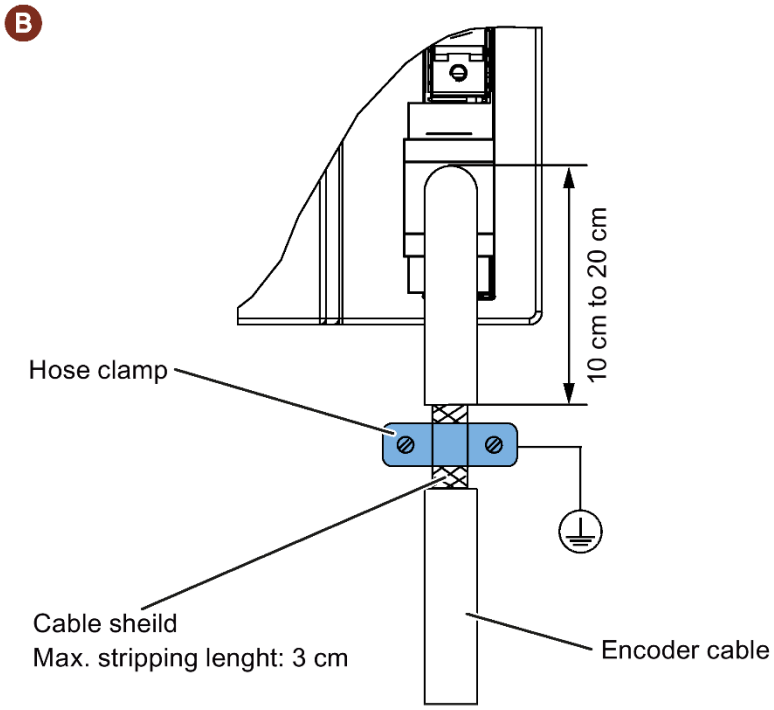
### Connecting the cable shields for the encoder cable

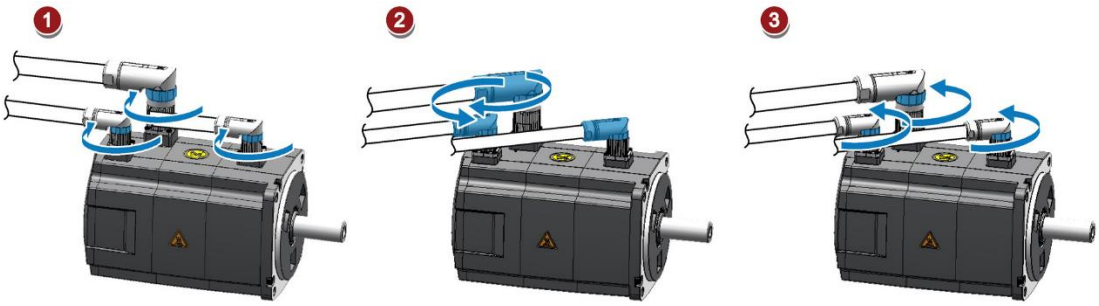



## 3.5.2 Adjusting cable directions from the motor side

For some low inertia motors and all high inertia motors, you can adjust the direction of the power cable, encoder cable, or brake cable from the motor side to facilitate cable connection.

The following illustrations take high inertia motors with the incremental encoder for example to show how to adjust the cable directions.

**High inertia motors with straight connectors**

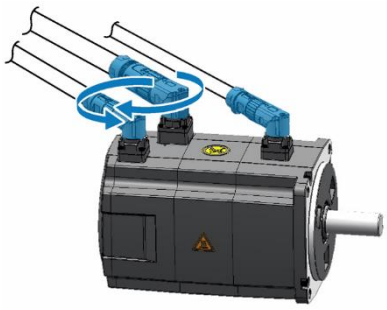



### Note

**Rotating the connectors**

After connecting the cable to the motor, you can rotate the incremental encoder connector within 270° and rotate the absolute encoder connector within 180°. For other connectors, you can rotate them within 360°.

**Low inertia motors with a shaft height of 50 mm and high inertia motors with angular connectors**



Rotate the connectors to adjust the cable directions.

**Note**

**Rotating the connectors**

For motors with angular connectors, you can rotate all the connectors within 310° except for the absolute encoder connector which can be rotated only within 180°.

**Note**

For an absolute encoder cable on a high inertia motor with angular connectors, adjust its direction just the same as you adjust the cable directions on a high inertia motor with straight connectors mentioned above.

## 3.5.3 Clamping cables on the motor side

When clamping cables on the motor side, observe the following requirements:

- The way of clamping the cable must be fully examined so that bending stress and cable's own weight stress are not applied to the cable connection.
- For use in any application where the servo motor moves, fix the cables (power cable, encoder cable, and brake cable) supplied with the servo motor, and flex the cables. Use the cables within the bending cycle of the cables.
- Avoid any probability that the cable sheath might be cut by sharp chips, rubbed by a machine corner or stamped by workers or vehicles.
- For installation on a machine where the servo motor will move, the bending radius should be made as large as possible. Refer to Section "Technical data - cables (Page 74)" for details.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# 4. Main Circuit Wiring

## 4.1 Line supply - L1, L2, L3

| Signal | Description |
|---|---|
| **200 V variant** | |
| L1 | Line phase L1 |
| L2 | Line phase L2 |
| L3 | Line phase L3 |
| Recommended minimum cable cross-section:<br>When used on the single phase power network:<br>FSA: 0.75 $mm^2$<br>FSB: 0.52 $mm^2$<br>FSC: 1.31 $mm^2$<br>When used on the three phase power network:<br>FSA: 0.75 $mm^2$<br>FSB: 0.33 $mm^2$<br>FSC: 0.52 $mm^2$<br>FSD (1 kW): 0.82 $mm^2$<br>FSD (1.5 kW to 2 kW): 2.08 $mm^2$ | |
| **400 V variant** | |
| L1 | Line phase L1 |
| L2 | Line phase L2 |
| L3 | Line phase L3 |
| Recommended minimum cable cross-section:<br>FSAA and FSA: 1.5 $mm^2$<br>FSB and FSC: 2.5 $mm^2$ | |

**Note**

For 200 V variant servo drive, when using the FSA, FSB and FSC on the single phase power network, you can connect the power supply to any two connectors of L1, L2, and L3.

### Assembling the line supply cable terminals

The procedure of assembling a line supply cable terminal is the same as that for a power cable terminal on the drive side.


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## Attaching the line supply cable

**CAUTION**

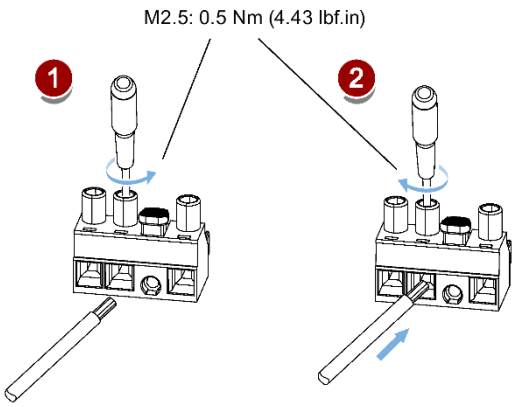
**Risk of injury due to improper cable connection**

When attaching the line supply cable to a line supply connector that has not been fixed on the drive, you can injure your fingers.

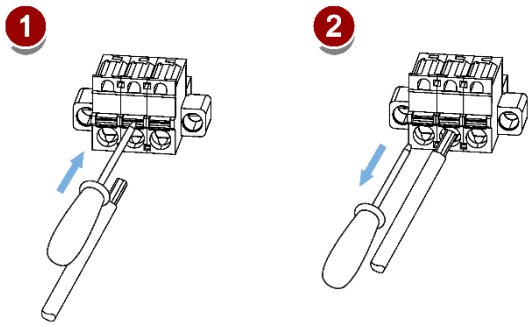
- Make sure you first assemble the line supply connector to the drive and tighten the fixing screws on the connector, and then attach the cable to the connector.

### 200 V variant

- For FSA and FSB




- For FSC and FSD




### 400 V variant

- For FSAA and FSA

  You can attach the line supply cable with the same method for 200 V variant drives of frame sizes FSC and FSD.

- For FSB and FSC

  The FSB and FSC servo drives are equipped with barrier-style terminal strips for line supply connection. You can fix the line supply cable on the servo drives by using the M4 screws with a tightening torque of 2.25 Nm (19.91 lbf.in).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## 4.2 Motor power - U, V, W

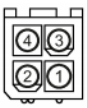
### 4.2.1 Motor output - drive side

| Signal | Description |
|---|---|
| **200 V variant** | |
| U | Motor phase U |
| V | Motor phase V |
| W | Motor phase W |
| Recommended minimum cable cross-section:<br>FSA and FSB: 0.75 mm²<br>FSC and FSD (1 kW): 0.75 mm²<br>FSD (1.5 kW to 2 kW): 2.5 mm² | |
| **400 V variant** | |
| U | Motor phase U |
| V | Motor phase V |
| W | Motor phase W |
| Recommended minimum cable cross-section:<br>FSAA and FSA: 1.5 mm²<br>FSB and FSC: 2.5 mm² | |

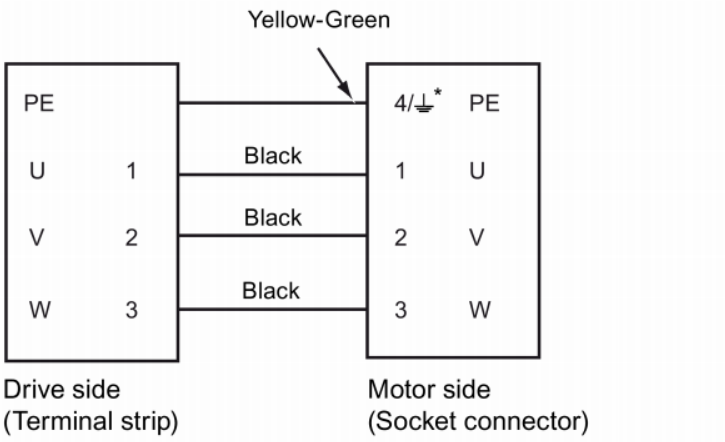
The drive provides short-circuit protection at the motor output terminals.

The manufacturer's declaration describes the conditions regarding protection against electric shock in the event of an insulation failure in the motor circuit.

### 4.2.2 Power connector - motor side

| Illustration | Pin No. | Signal | Color | Description |
|---|---|---|---|---|
| **Low inertia motor, shaft height: 20 mm, 30 mm, and 40 mm** | | | | |
|  | 1 | U | Black | Phase U |
| | 2 | V | Black | Phase V |
| | 3 | W | Black | Phase W |
| | 4 | PE | Yellow-green | Protective earthing |
| **Low inertia motor, shaft height: 50 mm**<br>**High inertia motor, shaft height: 45 mm, 60 mm, and 90 mm** | | | | |
| Straight connectors:<br>  <br>Angular connectors:<br>  | 1 | U | Black | Phase U |
| | 2 | V | Black | Phase V |
| | 3 | W | Black | Phase W |
| | 4/⏚ | PE | Yellow-green | Protective earthing |

### 4.2.3 Wiring




* 4: high inertia motors with straight connectors and low inertia motors SH20, SH30, and SH40
⏚: high inertia motors with angular connectors and low inertia motors SH50

### 4.2.4 Attaching the motor power cable

**⚠CAUTION**

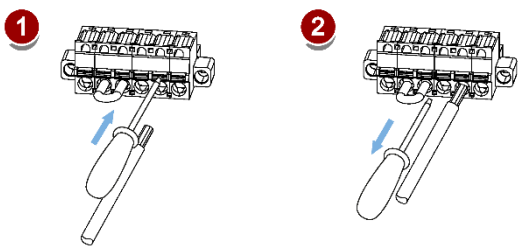
**Risk of injury due to improper cable connection**

When attaching the motor power cable to a motor power connector that has not been fixed on the drive, you can injure your fingers.

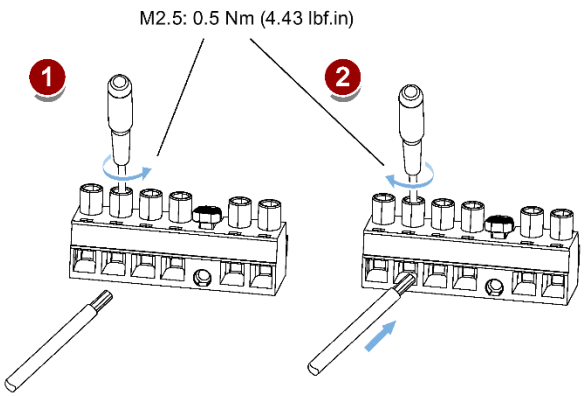
- Make sure you first assemble the motor power connector to the drive and tighten the fixing screw on the connector, and then attach the cable to the connector.

**200 V variant**

- For FSA and FSB




- For FSC and FSD



### 400 V variant

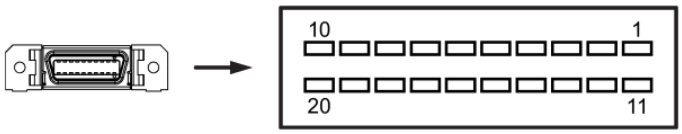
- For FSAA and FSA

  You can attach the motor power cable with the same method for 200 V variant drives of frame sizes FSC and FSD.

- For FSB and FSC

  The FSB and FSC servo drives are equipped with barrier-style terminal strips for motor power connection. You can fix the motor power cable on the servo drives by using the M4 screws with a tightening torque of 2.25 Nm (19.91 lbf.in).

# 5. Control/status interface - X8

| Pin | Signal | Wire color on the PROFINET I/O cable exposed side | Description |
|---|---|---|---|
|  Type: 20-pin MDR socket | | | |
| **Digital inputs/outputs** | | | |
| 1 | DI1 | Green | Digital input 1 |
| 2 | DI2 | Yellow | Digital input 2 |
| 3 | DI3 | White | Digital input 3 |
| 4 | DI4 | Brown | Digital input 4 |
| 6 | DI_COM | Red | Common terminal for digital inputs |
| 7 | DI_COM | Blue | Common terminal for digital inputs |
| 11 | DO1+ | Gray-Pink | Digital output 1, positive |
| 12 | DO1- | Red-Blue | Digital output 1, negative |
| 13 | DO2+ | Gray | Digital output 2, positive |
| 14 | DO2- | Pink | Digital output 2, negative |
| 17 * | BK+ | Black | Motor holding brake control signal, positive |
| 18 * | BK- | Violet | Motor holding brake control signal, negative |

| Pin | Signal | Wire color on the PROFINET I/O cable exposed side | Description |
|---|---|---|---|
| **None** | | | |
| 5 | - | - | Reserved |
| 8 | - | - | Reserved |
| 9 | - | - | Reserved |
| 10 | - | - | Reserved |
| 15 | - | - | Reserved |
| 16 | - | - | Reserved |
| 19 | - | - | Reserved |
| 20 | - | - | Reserved |

* The pins are used to connect the brake control signals for 200 V variant drive only.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# 5.1 Digital inputs/outputs (DIs/Dos)

SINAMICS V90 PN supports free assignment of signals to the following digital input and output terminals depending on the control mode selected:

DI1 to DI4 -- Assignable with parameters p29301 to p29304

DO1 to DO2 -- Assignable with parameters p29330 to p29331

For detailed information about default DI/DO signal assignments, see the table below:

| Pin | Digital inputs/outputs | Parameters | Default values/signals |
|---|---|---|---|
| 1 | DI1 | p29301 | 2 (RESET) |
| 2 | DI2 | p29302 | 11 (TLIM) |
| 3 | DI3 | p29303 | 0 |
| 4 | DI4 | p29304 | 0 |
| 11 | DO1 | p29330 | 2 (FAULT) |
| 13 | DO2 | p29331 | 9 (OLL) |

**Note**

The selected DI signal will respond with a delay time of 8 to 16 ms.

**Note**

**DO signal inverse**

The logics of digital output signals DO1 and DO2 can be inversed. You can inverse the logics of DO1 and DO2 by setting the bit 0 and bit 1 of parameter p0748.


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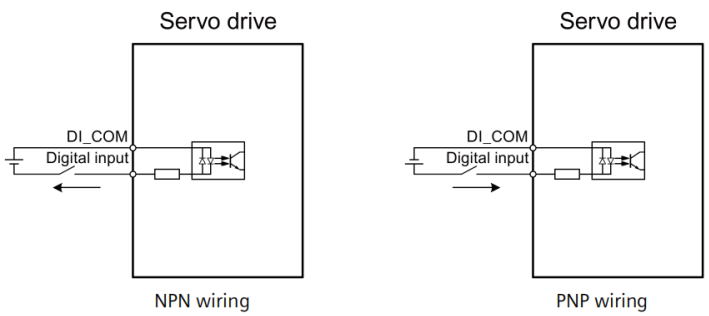
### 5.1.1 DIs

You can assign a maximum of seven internal digital input signals to the SINAMICS V90 PN servo drive. For detailed information about these signals, see the table below:

| Name | Type | Description |
|---|---|---|
| RESET | Edge<br>0→1 | Reset alarms<br>• 0→1: reset alarms |
| TLIM | Level | Torque limit selection<br>You can select two internal torque limit sources with the digital input signal TLIM.<br>• 0: internal torque limit 1<br>• 1: internal torque limit 2 |
| SLIM | Level | Speed limit selection<br>You can select two internal speed limit sources with the digital input signal SLIM.<br>• 0: internal speed limit 1<br>• 1: internal speed limit 2 |
| EMGS | Level | Quick stop<br>• 0: quick stop<br>• 1: servo drive is ready to run |
| REF | Edge<br>0→1 | Setting the reference point with a digital input or reference cam input for reference approaching mode<br>• 0→1: reference input |
| CWL | Edge<br>1→0 | Clockwise over-travel limit (positive limit)<br>• 1: condition for operation<br>• 1→0: quick stop (OFF3) |
| CCWL | Edge<br>1→0 | Counter-clockwise over-travel limit (negative limit)<br>• 1: condition for operation<br>• 1→0: quick stop (OFF3) |

### Wiring

The digital inputs support both PNP and NPN types of wirings. You can find detailed information from the following diagrams:



### 5.1.2 DOs

You can assign a maximum of 10 internal digital output signals to the SINAMICS V90 PN servo drive. For detailed information about these signals, see the table below:

| Name | Descriptions |
|---|---|
| RDY | Servo ready<br>• 1: the drive is ready.<br>• 0: the drive is not ready (a fault occurs or the enable signal is missing). |
| FAULT | Fault<br>• 1: in the fault state.<br>• 0: no fault. |
| ZSP | Zero speed detection<br>• 1: motor speed ≤ zero speed (can be set with parameter p2161).<br>• 0: motor speed > zero speed + hysteresis (10 rpm). |
| TLR | Torque limit reached<br>• 1: the generated torque has nearly (internal hysteresis) reached the value of the positive torque limit or negative torque limit.<br>• 0: the generated torque has not reached any torque limit. |
| MBR | Motor holding brake<br>• 1: the motor holding brake is engaged.<br>• 0: the motor holding brake is released.<br>**Note**: MBR is only a status signal because the control and the power supply of the motor holding brake are realized with separate terminals. |
| OLL | Overload level reached<br>• 1: the motor has reached the parameterizable output overload level (p29080 in % of the rated torque; default: 100%; max: 300%).<br>• 0: the motor has not reached the overload level. |
| RDY_ON | Ready for servo on<br>• 1: the drive is ready for servo on.<br>• 0: the drive is not ready for servo on (a fault occurs, the main power supply is missing, or STW1.1 and STW1.2 are not set to 1).<br>**Note:** after the drive is in "servo on" state, the signal remains at high level (1) unless the above abnormal cases happen. |
| INP | In-position signal<br>• 1: the number of droop pulses is in the preset in-position range (parameter p2544).<br>• 0: the number of droop pulses is beyond the preset in-position range. |
| REFOK | Referenced<br>• 1: referenced.<br>• 0: not referenced. |
| STO_EP | STO active<br>• 1: the enable signal is missing, indicating that STO is active.<br>• 0: the enable signal is available, indicating that STO is inactive.<br>**Note:** STO_EP is only a status signal for STO input terminals but not a safe DO for the Safety Integrated function. |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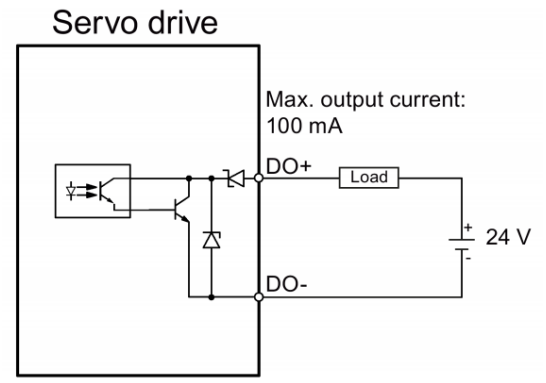
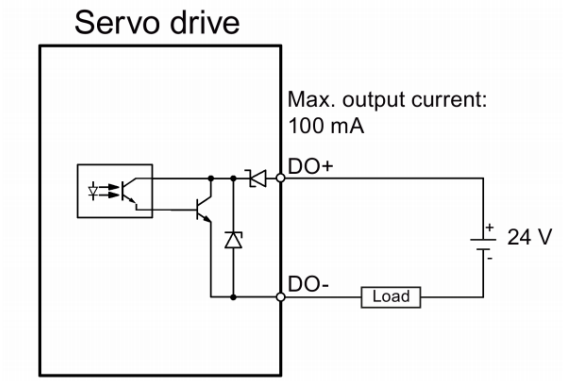
## Wiring

The digital outputs support both PNP and NPN types of wirings. You can find detailed information from the following diagrams:




NPN wiring




PNP wiring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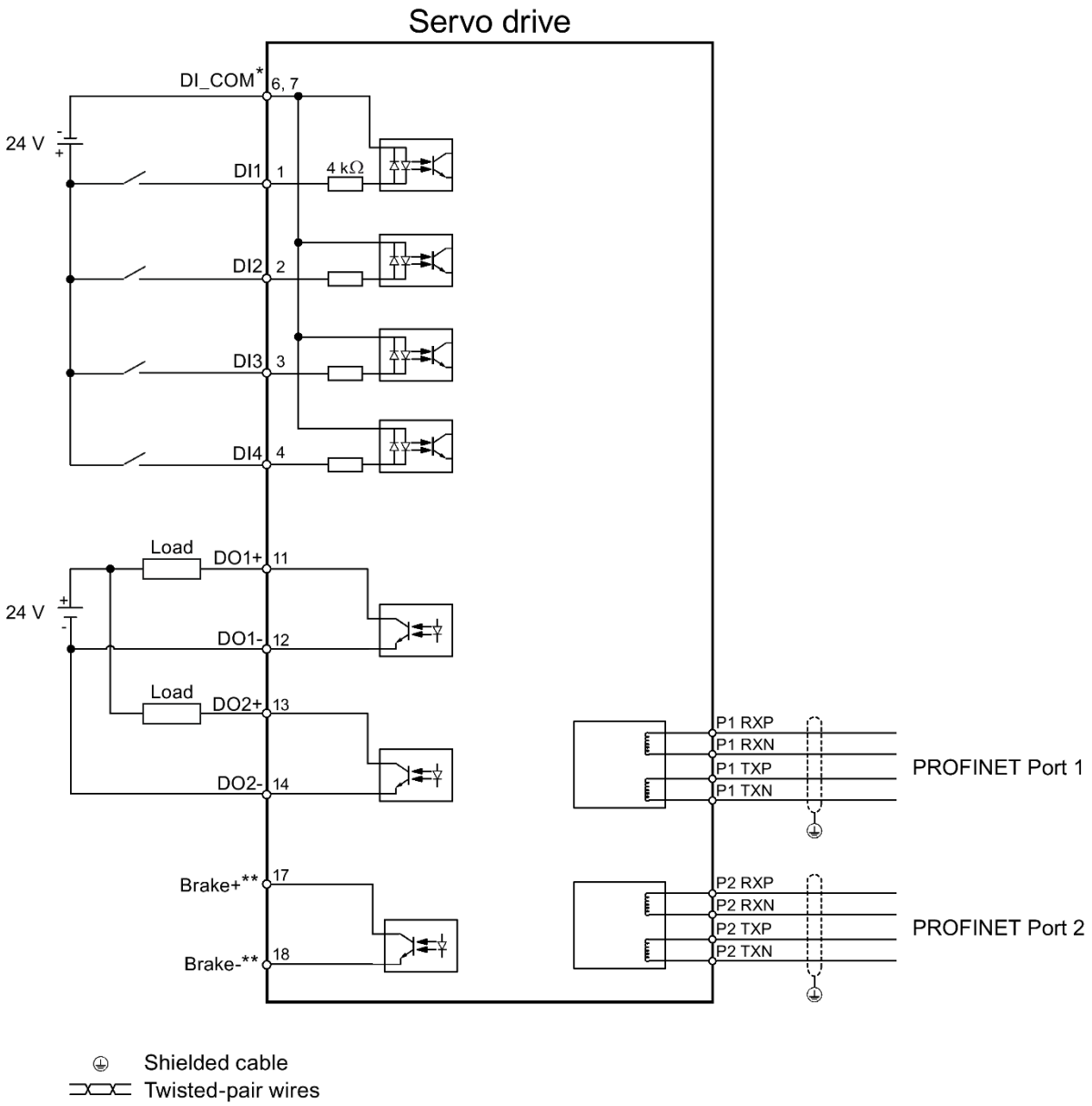
## 5.2 Standard application wiring based on factory settings

### Example 1





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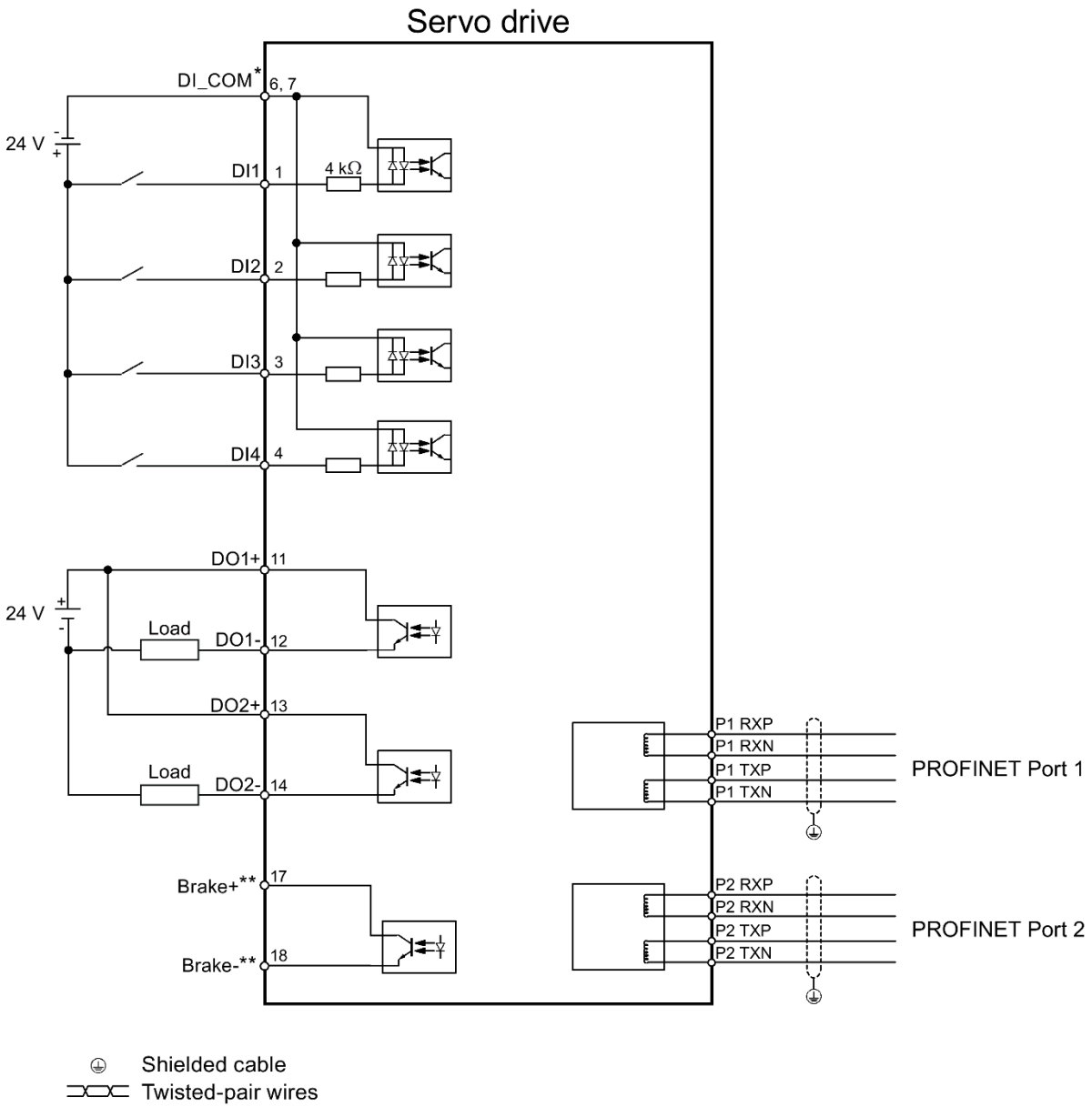
## Example 2

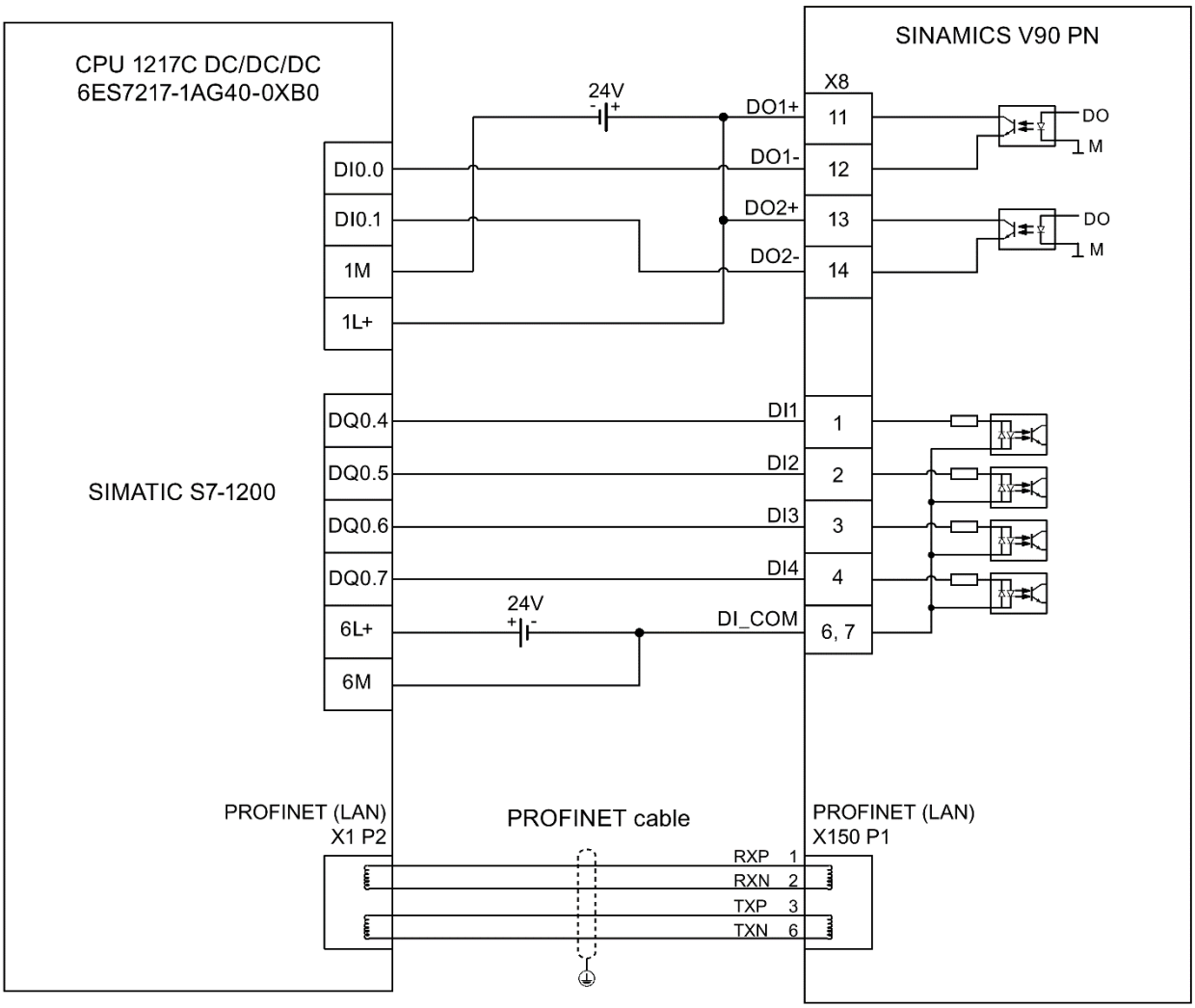



* Digital inputs, supporting both PNP and NPN types.

** The pins are used to connect the brake control signals for 200 V variant drive only. Refer to section "Motor holding brake (Page 131)" for the detailed connections.

## 5.3 Connection example with PLCs

### 5.3.1 SIMATICS S7-1200




⏚ Shielded cable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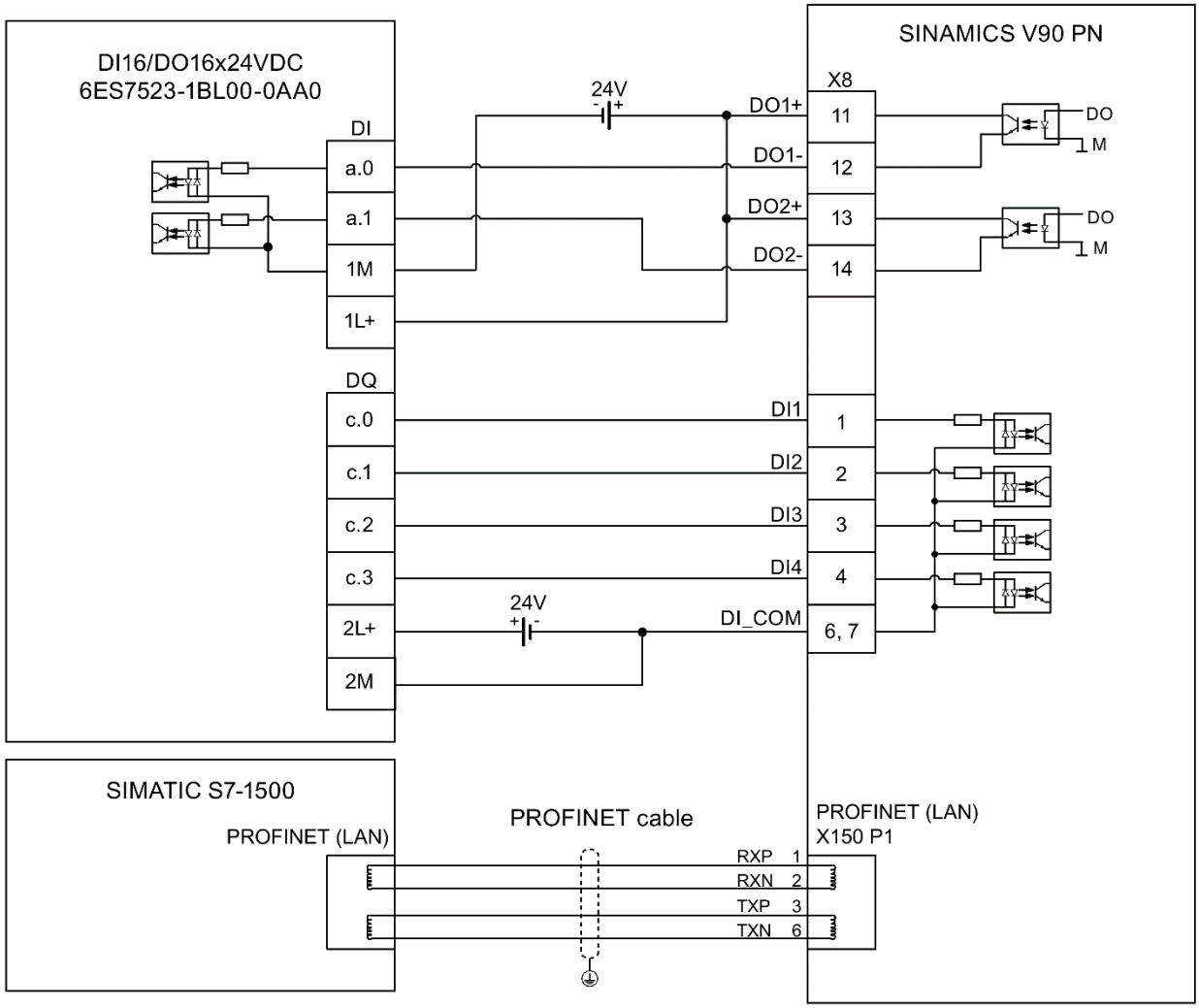
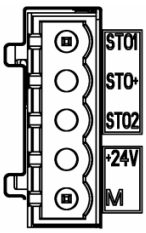
### 5.3.2 SIMATICS S7-1500




⏚ Shielded cable

# 6. 24 V power supply/STO

## Pin assignment

| Interface | Signal name | Description | Remarks |
|---|---|---|---|
|  | STO 1 | Safe torque off channel 1 | - |
| | STO + | Power supply for safe torque off | - |
| | STO 2 | Safe torque off channel 2 | - |
| | +24 V | Power supply, 24 V DC | Voltage tolerance:<br>• Without brake: -15% to +20%<br>• With brake: -10% to +10%<br>Maximum current consumption:<br>• Without brake: 1.5 A<br>• With brake: 1.5 A + motor holding brake rated current (See Section "Technical data - servo motors (Page 62)") |
| | M | Power supply, 0 V DC | |
| | Maximum conductor cross-section: 1.5 mm² | | |

## Wiring

**WARNING**

**Material damages and personal injuries by the drop of a hanging axis**

Unexpected drop of the hanging axis can cause material damages and personal injuries.

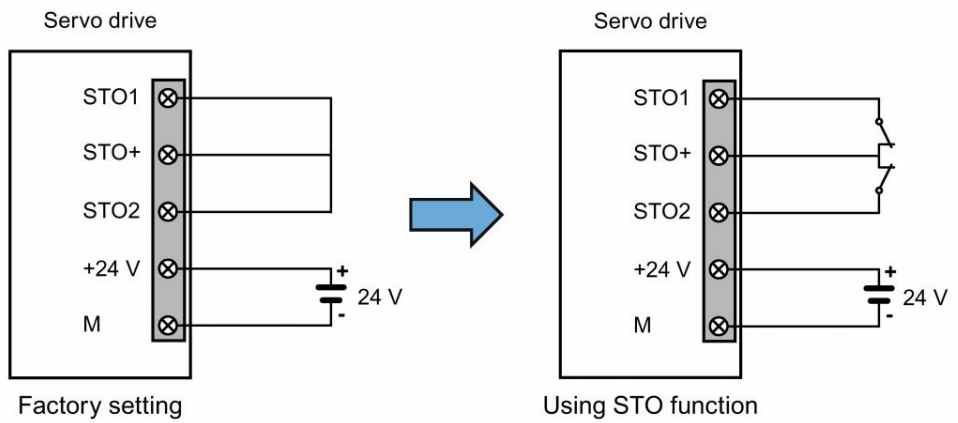
- It is not allowed to use the STO with a hanging axis because the axis may drop.

### Note

**Using the STO function**

The STO1, STO+ and STO2 are short connected at the factory setting.

When the STO function is to be used, you must remove the jumper before connecting the STO interfaces. The safety function of the servo drive is SIL 2 (EN61800-5-2). If you do not need to use it any more, you must reinsert the jumper; otherwise, the motor will not run.





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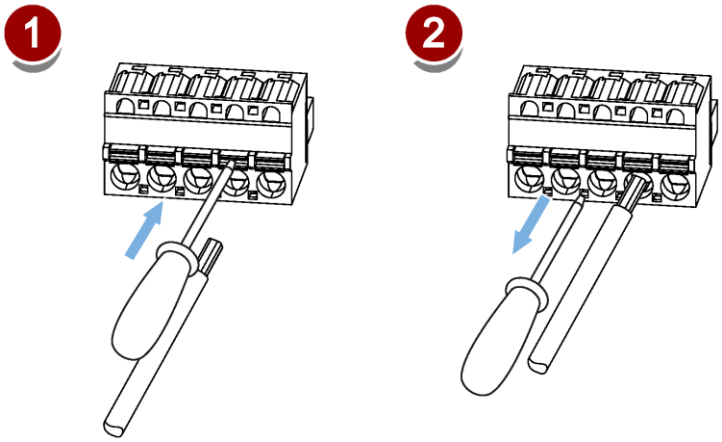
## Assembling the 24 V power supply and STO cable terminals

The procedure of assembling a 24 V power cable terminal or an STO cable terminal is the same as that for a power cable terminal on the drive side of the V90 PN 200 V servo drives.

## Plugging the 24 V power supply and STO cables



# 7. Encoder interface - X9

The SINAMICS V90 200 V variant servo drive supports three kinds of encoders:

- Incremental encoder TTL 2500 ppr
- Absolute encoder single-turn 21-bit
- Absolute encoder 20-bit + 12-bit multi-turn

The SINAMICS V90 400 V variant servo drive supports two kinds of encoders:

- Incremental encoder TTL 2500 ppr
- Absolute encoder 20-bit + 12-bit multi-turn

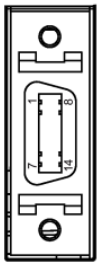
**Note**

**Failure to meet the EMC requirements because the cable is not shielded**

If a cable is not shielded, it cannot meet the EMC requirements.

- The encoder cable must be shielded to meet the EMC requirements.

## 7.1 Encoder interface - drive side

| Illustration | Pin No. | Signal name | Description |
|---|---|---|---|
|  | 1 | Biss_DataP | Absolute encoder data signal, positive |
| | 2 | Biss_DataN | Absolute encoder data signal, negative |
| | 3 | Biss_ClockN | Absolute encoder clock signal, negative |
| | 4 | Biss_ClockP | Absolute encoder clock signal, positive |
| | 5 | P5V | Encoder power supply, 5 V |
| | 6 | P5V | Encoder power supply, 5 V |
| | 7 | M | Encoder power supply, grounding |
| | 8 | M | Encoder power supply, grounding |
| | 9 | Rp | Encoder R phase positive signal |
| | 10 | Rn | Encoder R phase negative signal |
| | 11 | Bn | Encoder B phase negative signal |
| | 12 | Bp | Encoder B phase positive signal |
| | 13 | An | Encoder A phase negative signal |
| | 14 | Ap | Encoder A phase positive signal |
| | Screw type: UNC 4-40 (plug-in terminal block)<br>Tightening torque: 0.4 Nm | | |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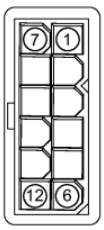
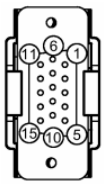
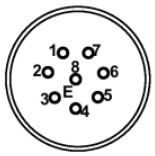
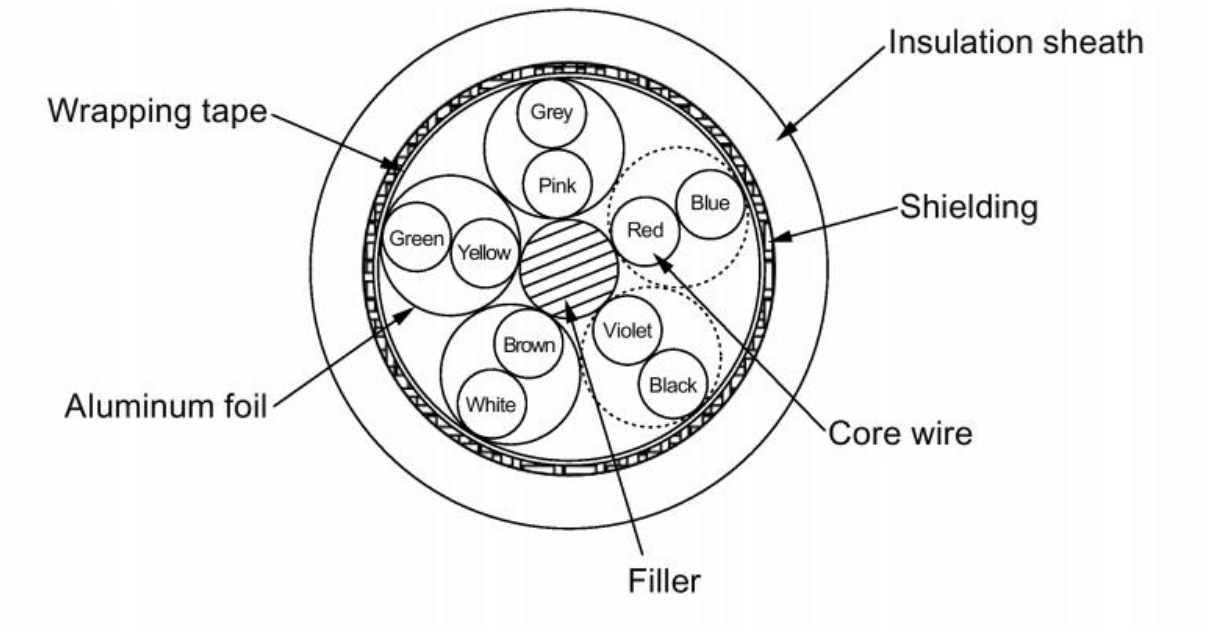
## 7.2 Encoder connector - motor side

| Illustration | Pin No. | Incremental encoder TTL 2500 ppr | | Illustration | Absolute encoder single-turn 21-bit<br>Absolute encoder 20-bit + 12-bit multi-turn | |
|---|---|---|---|---|---|---|
| | | Signal | Description | | Signal | Description |
| **Low inertia motor, shaft-height: 20 mm, 30 mm and 40 mm** | | | | | | |
|  | 1 | P_Supply | Power supply 5 V |  | P_Supply | Power supply 5 V |
| | 2 | M | Power supply 0 V | | M | Power supply 0 V |
| | 3 | A+ | Phase A+ | | Clock_P | Clock |
| | 4 | B+ | Phase B+ | | Data_P | Data |
| | 5 | R+ | Phase R+ | | n. c. | Not connected |
| | 6 | n. c. | Not connected | | P_Supply | Power supply 5 V |
| | 7 | P_Supply | Power supply 5 V | | M | Power supply 0 V |
| | 8 | M | Power supply 0 V | | Clock_N | Inverted clock |
| | 9 | A- | Phase A- | | Data_N | Inverted data |
| | 10 | B- | Phase B- | | Shielding | Grounding |
| | 11 | R- | Phase R- | | **Note**<br>The pin11 to pin15 of the absolute encoder connector are not connected. | |
| | 12 | Shielding | Grounding | | | |

| Illustration | Pin No. | Incremental encoder TTL 2500 ppr | | Absolute encoder single-turn 21-bit<br>Absolute encoder 20-bit + 12-bit multi-turn | |
|---|---|---|---|---|---|
| | | Signal | Description | Signal | Description |
| **Low inertia motor, shaft-height: 50 mm**<br>**High inertia motor, shaft-height: 45 mm, 65 mm, and 90 mm** | | | | | |
| Straight connectors:<br>  | 1 | P_Supply | Power supply 5 V | P_Supply | Power supply 5 V |
| | 2 | M | Power supply 0 V | M | Power supply 0 V |
| | 3 | A+ | Phase A+ | n. c. | Not connected |
| | 4 | A- | Phase A- | Clock_N | Inverted clock |
| | 5 | B+ | Phase B+ | Data_P | Data |
| | 6 | B- | Phase B- | Clock_P | Clock |
| Angular connectors:<br>  | 7 | R+ | Phase R+ | n. c. | Not connected |
| | 8 | R- | Phase R- | Data_N | Inverted data |

## 7.3 Internal Structure of Encoder Cable

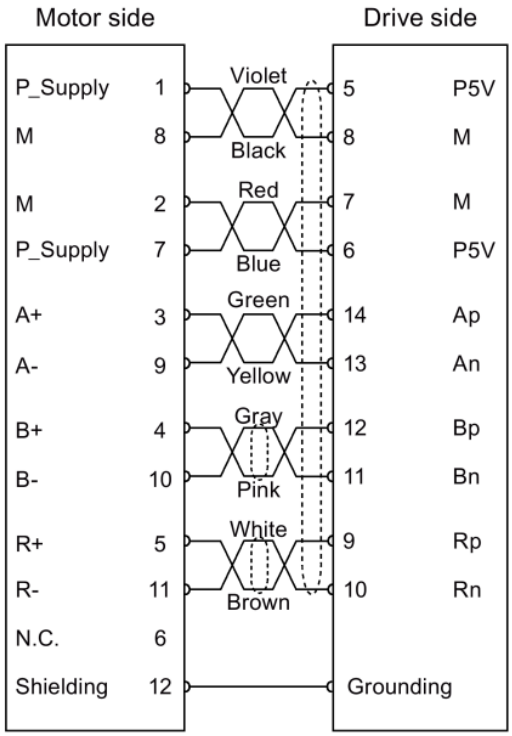
6FX3002-2CT..../6FX3002-2DB....



## 7.4 Wiring of encoder cable

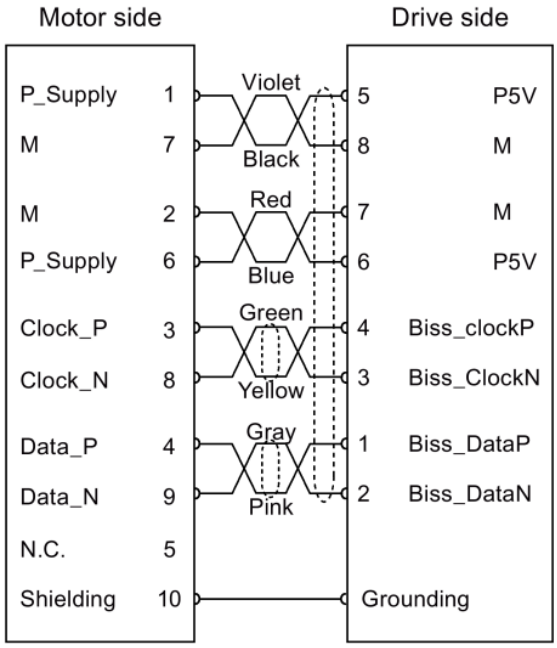
### Low inertia motor, shaft-height: 20 mm, 30 mm and 40 mm

6FX3002-2CT20-....




Incremental encoder TTL 2500 ppr

6FX3002-2DB20-....



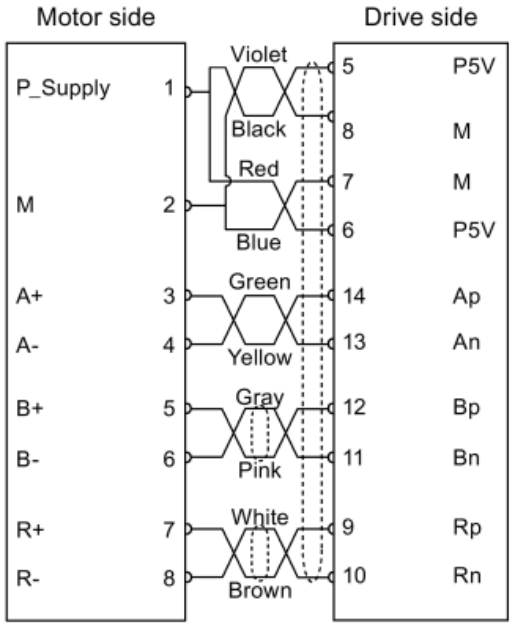

Absolute encoder single-turn 21-bit
Absolute encoder 20 bit + 12 bit multi-turn

Twisted-pair wires

Shielding

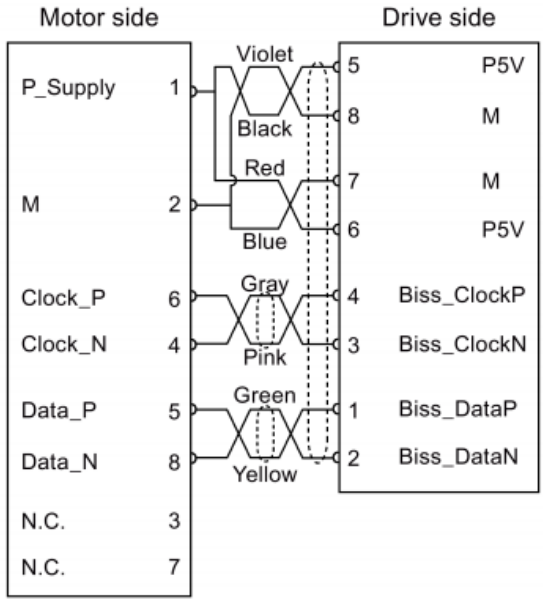
## Low inertia motor, shaft-height: 50 mm
## High inertia motor, shaft-height: 45 mm, 65 mm, and 90 mm

6FX3002-2CT10-..../6FX3002-2CT12-....




Incremental encoder TTL 2500 ppr

6FX3002-2DB10-..../6FX3002-2DB12-....




Absolute encoder single-turn 21-bit
Absolute encoder 20-bit + 12-bit multi-turn

Twisted-pair wires

Shielding

# 8. External braking resistor - DCP, R1

The SINAMICS V90 PN has been designed with an internal braking resistor to absorb regenerative energy from the motor. When the internal braking resistor cannot meet the braking requirements (e.g. the alarm A52901 is generated), you can connect an external braking resistor.

**Note**

The 200 V variant servo drive with rated power of 0.1 kW does not have a built-in resistor.

## Connecting an external braking resistor

**Notice:**

**Damage to the drive due to failure to remove the jumper between terminals DCP and R2**

The drive will be damaged if you do not remove the jumper between terminals DCP and R2 when using an external resistor.

• Before connecting an external resistor to DCP and R1, remove the connection between terminals DCP and R2.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# 9. Motor holding brake

The motor holding brake is used to prevent the moving load from unwanted motions (for example, falling under the influence of gravity) when the servo system is deactivated (for example, the servo power is shut off). The servo motor can move because of its own weight or an external force even the motor power has been cut off.

The holding brake is built in the servo motors with brakes.

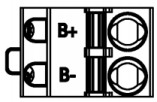
For 400 V variant servo drive, a motor holding brake interface (X7) is integrated in the front panel. You can connect it to a servo motor with brake to use the function of motor holding brake directly.

For 200 V variant servo drive, no specific interface is integrated. To use the function, you need to connect the drive to a third-party device via the control/status interface (X8).

**Note**

- Use this brake for the "hold" purpose only, that is, to hold the stalling state only. Never use this for the "brake" purpose to stop the load in motion. Use the holding brake only to hold a stopped motor.
- The holding brake is activated at the same time when the motor power is cut off.

## Motor holding brake interface - drive side (for the 400 V variant servo drive only)

| Illustration | Signal | Description |
|---|---|---|
|  | B+ | 24 V, motor brake voltage positive |
| | B- | 0 V, motor brake voltage negative |
| Maximum conductor cross-section: 1.5 $mm^2$<br>Output voltage tolerance: 24 V ± 10% | | |

## Brake connector - motor side

| Illustration | Pin No. | Signal | Description |
|---|---|---|---|
| **Low inertia motor, shaft height: 20 mm, 30 mm and 40 mm** | | | |
|  | 1 | Brake+ | Phase Brake+ |
| | 2 | Brake- | Phase Brake- |
| **Low inertia motor, shaft height: 50 mm**<br>**High inertia motor, shaft height: 45 mm, 65 mm, and 90 mm** | | | |
| Straight connectors:<br>  <br>Angular connectors:<br>  | 1 | Brake+ | Phase Brake+ |
| | 2 | Brake- | Phase Brake- |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## Single status

The following table describes the states of various interfaces and components when the brake works.

- 200 V variant

| Status | MBR (DO) | Brake control (Brake) | Relay | Motor brake function | Motor shaft |
|---|---|---|---|---|---|
| Brake engagement | High level (1) | Off | Without current | Activated | Cannot rotate |
| Brake release | Low level (0) | On | With current | Deactivated | Can rotate |

- 400 V variant

| Status | MBR (DO) | Brake control (B+, B-) | Motor brake function | Motor shaft |
|---|---|---|---|---|
| Brake engagement | High level (1) | 0 V | Activated | Cannot rotate |
| Brake release | Low level (0) | 24 V | Deactivated | Can rotate |

## DO signal

| Signal type | Signal name | Setting | Description |
|---|---|---|---|
| DO | MBR | ON = high level (1) | Motor holding brake is engaged. |
| | | OFF = low level (0) | Motor holding brake is released. |

You can also change the assignment of the digital output signal MBR and assign it to any DO pin with one of the following parameters:

| Parameter | Range | Factory setting | Unit | Description |
|---|---|---|---|---|
| p29330 | 1 to 14 | 2 (FAULT) | - | Assignment of digital output 1 |
| p29331 | 1 to 14 | 9 (OLL) | - | Assignment of digital output 2 |

## Wiring for the 200 V variant servo drive

The following diagrams show the examples when the brake is controlled through the motor holding brake signal (Brake) of the 200 V variant servo drive.


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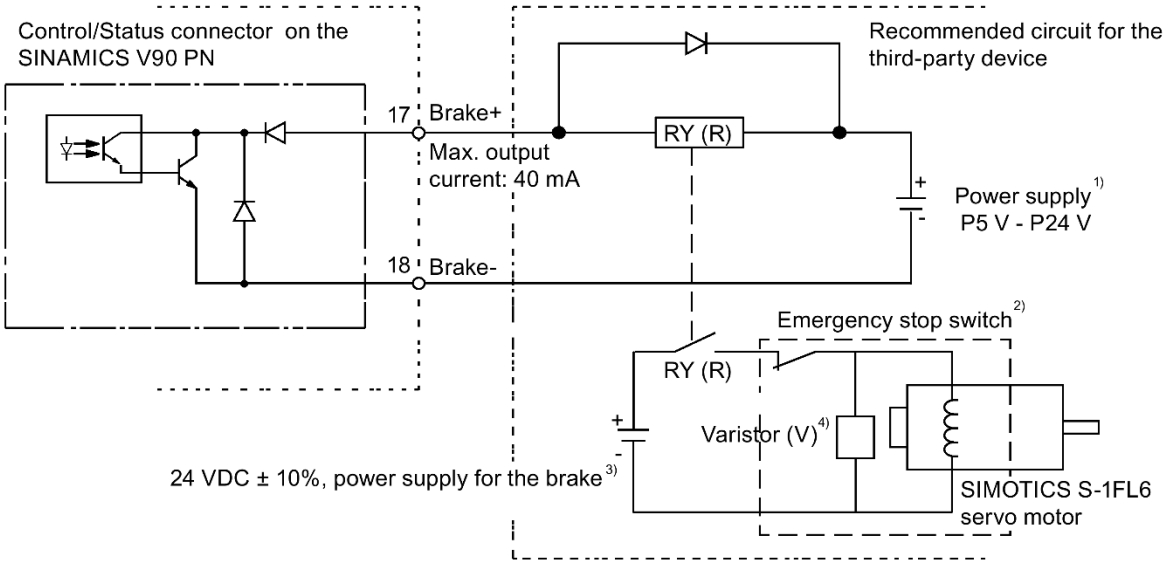
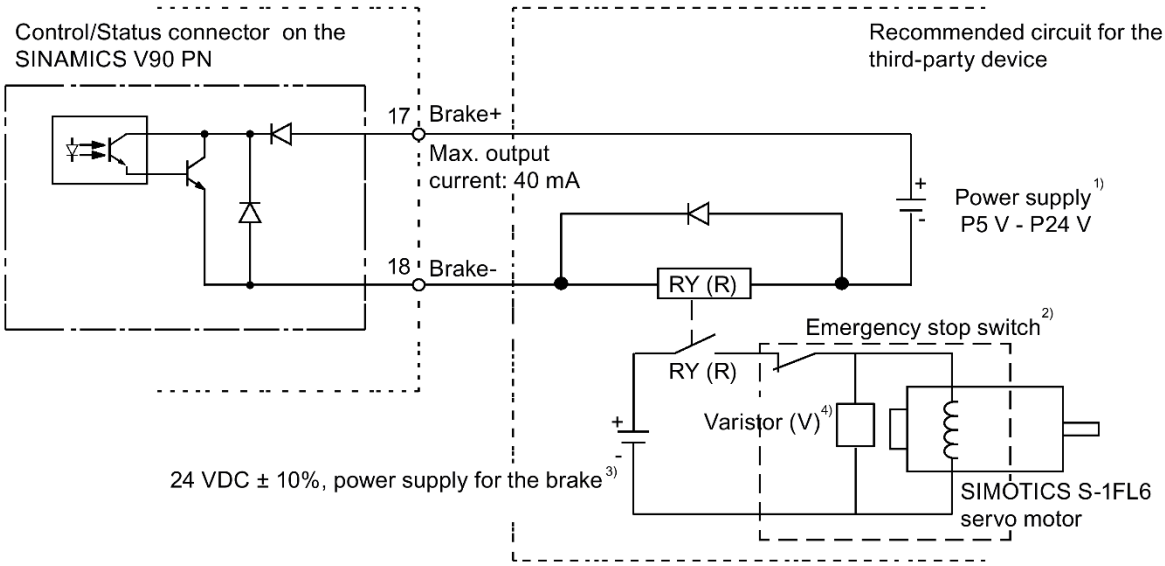
## Example 1:




## Example 2:




**Note**

1) It is the isolated digital output power supply. Select a proper power supply based on the relay type (see below for the recommended relay). When you use the 24 V DC power supply, it can also be the controller power supply.

2) The motor brake can be controlled not only by the brake control signal from the SINAMICS V90 PN servo drive but also by external emergency stop.

3) Make sure that you use different power supplies for the brake (24 V DC) and for the brake control signal (P24 V) separately to avoid electro-magnetic interference to electronic components.

4) Install a varistor as shown above to suppress the surge voltage or surge current generated by an ON/OFF action of the relay (RY).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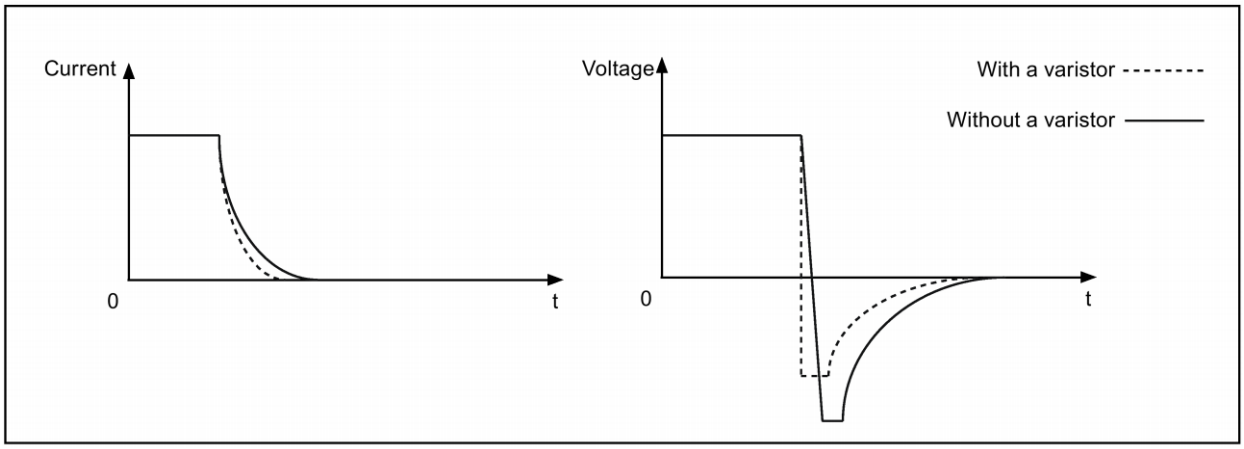
## Varistor (V) used for the power supply of the brake

**Note**

All the following data on a varistor is provided based on the low inertia motors with a rated power of 2 kW; however, the data is also applicable to the low inertia motors of other power ranges.

Consider the following current-time and voltage-time characteristics when using a varistor to suppress the surge voltage or surge current:




You may select an appropriate varistor with reference to the table below:

| Power supply voltage of the brake | | 24 V DC |
|---|---|---|
| Order information | Manufacturer | EPCOS |
| | Model | S20K20 |
| Specification require-ments | Operating temperature | -20 °C to 60 °C |
| | Delay switching frequency | < 10 times/min |
| | Maximum operating DC voltage | 26 V |
| | Average power dissipation | 0.2 W |
| | Voltage at 1 mA | 33 V ± 10% |
| | Clamping voltage at 20 A (8/20 μs) | 65 V |
| | Energy absorption (2 ms) at a time | 18 J |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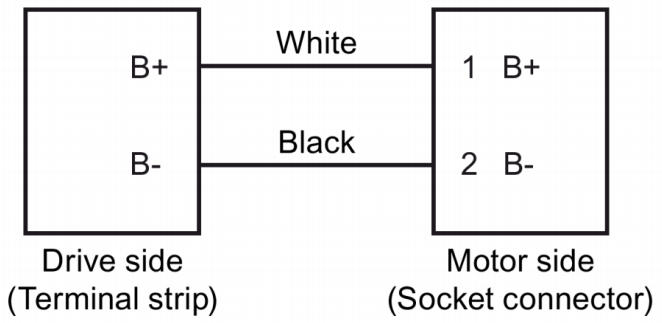
## Wiring for the 400 V variant servo drive




## Relevant parameters

| Parameter | Range | Default | Unit | Description |
|---|---|---|---|---|
| p1215 | 0 to 2 | 0 | - | Configuration of the holding brake.<br>• 0: No holding brake available<br>• 1: Motor holding brake according to sequence control<br>• 2: Motor holding brake always open |
| p1216 | 0 to 10000 | Motor dependent | ms | Motor holding brake opening time. |
| p1217 | 0 to 10000 | Motor dependent | ms | Motor holding brake closing time. |

You can configure the holding brake with the parameter p1215 according to the actual application. When you set p1215 = 1, the motor holding brake is open once the control word STW1.0 has a rising edge and becomes closed once the motor is in "servo off" state.

If the servo motor is used to control a vertical axis, the machine movable part can have a slight shift when the holding brake becomes open or closed. To eliminate such slight shift, you can configure a delay time for the close or open time of the motor holding brake by setting the parameters p1216 and p1217.

**Note**

The default values of p1216 and p1217 depend on the rated power of the motor which connects to the servo drive.

**Note**

For 200 V variant servo drives, the actual motor holding brake time consists of the time delay of the motor brake and the time delay of the current amplifying component (a relay in the example above); therefore, you can set the values of p1216 and p1217 as follows:

p1216 = motor brake opening time + relay opening time

p1217 = motor brake closing time + relay closing time

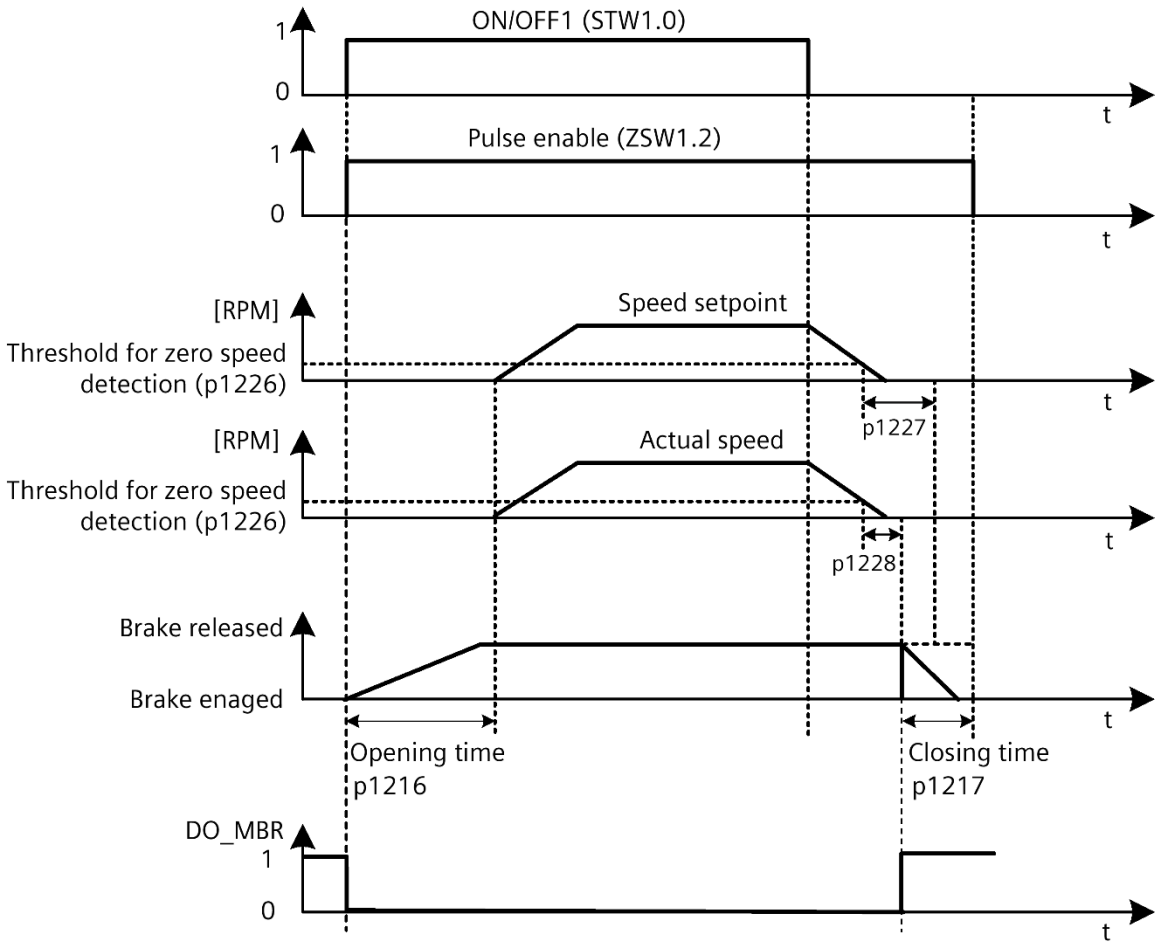
**Notice: Motor brake service life shortened due to the improper use**

The motor brake is used for holding purpose only. Frequent emergency stops with the motor brake will shorten its service life.

• Unless absolutely necessary, do not apply the motor brake as an emergency stop or deceleration mechanism.

## Braking sequence

The operating principle of the holding brake is configured during motor selection for motors with incremental encoders and configured automatically for motors with absolute encoders.




| Parameter | Range | Default | Unit | Description |
|---|---|---|---|---|
| p1226 | 0 to 210000 | 20 | rpm | Speed threshold for the standstill identification. |
| p1227 | 0 to 300 | 300 | s | Monitoring time for the standstill identification. |
| p1228 | 0 to 299 | 0 | s | Delay time for pulse suppression. |

The start of the closing time p1217 for the brake depends on the expiration of the shorter of p1227 (zero speed detection monitoring time) and p1228 (pulse suppression delay time).

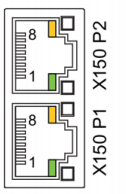
# 10. PROFINET interface - X150

## 10.1 PROFINET interface

PROFINET devices from the SINAMICS family have a PROFINET interface (Ethernet controller/interface) with two ports (physical connection possibilities).

Every PROFINET device on the network is uniquely identified via its PROFINET interface. For this purpose, each PROFINET interface has:

- A MAC address (factory default)
- An IP address
- A device name (name of the station)

| Illustration | Pin | PROFINET communication port 1 - P1 | | PROFINET communication port 2 - P2 | |
|---|---|---|---|---|---|
| | | Signal | Description | Signal | Description |
|   | 1 | P1RXP | Port 1 receive data + | P2RXP | Port 2 receive data + |
| | 2 | P1RXN | Port 1 receive data - | P2RXN | Port 2 receive data - |
| | 3 | P1TXP | Port 1 transmit data + | P2TXP | Port 2 transmit data + |
| | 4 | PE terminal | Protective earthing | PE terminal | Protective earthing |
| | 5 | PE terminal | Protective earthing | PE terminal | Protective earthing |
| | 6 | P1TXN | Port 1 transmit data - | P2TXN | Port 2 transmit data - |
| | 7 | PE terminal | Protective earthing | PE terminal | Protective earthing |
| | 8 | PE terminal | Protective earthing | PE terminal | Protective earthing |

## 10.2 LED displays

For diagnostic purposes, the RJ45 sockets are each equipped with a green and an orange LED.

This allows the following status information about the respective PROFINET port to be displayed:

| Name | Color | Status | Meaning |
|---|---|---|---|
| Link | Green | lit | Transfer rate 100 Mbit/s |
| | | off | No or faulty connection |
| Activity | Orange | lit | Data exchange |
| | | off | No data exchange |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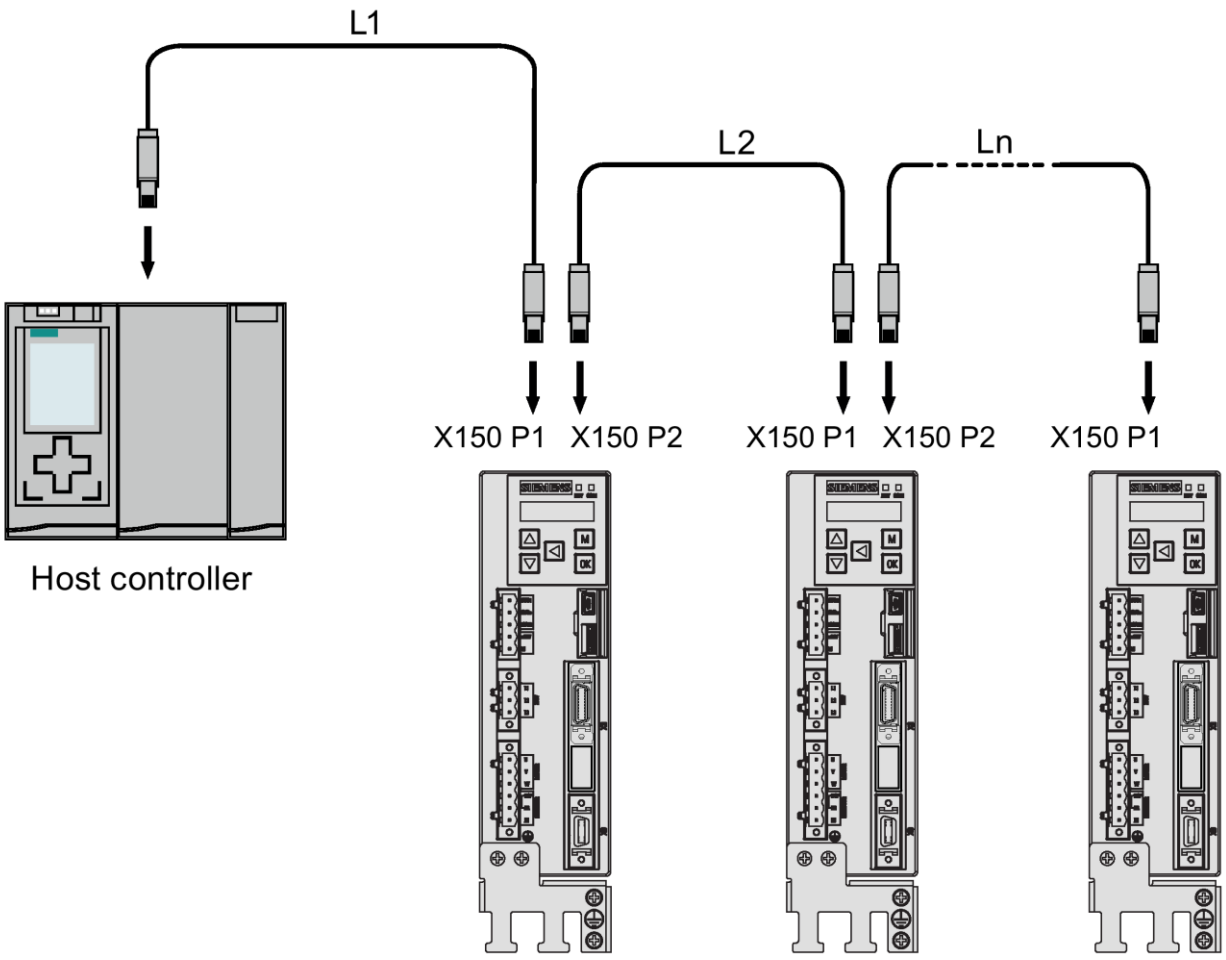
## 10.3 Wiring

The maximum length of cables between stations (L1 to Ln) is 100 m. For a long cable, you are recommended to fix the cable on the cabinet to prevent connector damage caused by dragging. If a cable with a length of more than 3 m is connected to the PROFINET port, electromagnetic interference may occur. Minimization of the interference emission is possible by the use of ferrite cores, cabinet feedthrough or fiber optic transceiver.




### Note

When connecting the ports P1 and P2, you need to make sure that the physical input and output connections are the same with the connections in the topology.

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