

# SIEMENS

## SINAMICS/SIMOTICS

### SINAMICS V90, SIMOTICS S-1FL6

#### Operating Instructions

#### Preface

---

#### Safety instructions

---

1

#### General information

---

2

#### Mounting

---

3

#### Connecting

---

4

#### Commissioning

---

5

#### Basic operator panel (BOP)

---

6

#### Control functions

---

7

#### Safety Integrated function

---

8

#### Tuning

---

9

#### Parameters

---

10

#### Diagnostics

---

11

#### Appendix

---

A

## Legal information

### Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

#### **DANGER**

indicates that death or severe personal injury **will** result if proper precautions are not taken.

#### **WARNING**

indicates that death or severe personal injury **may** result if proper precautions are not taken.

#### **CAUTION**

indicates that minor personal injury can result if proper precautions are not taken.

#### **NOTICE**

indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

### Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

### Proper use of Siemens products

Note the following:

#### **WARNING**

Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

### Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

### Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

# Preface

## Documentation components

Document	Content
Operating Instructions	(this manual)
Getting Started	Describes how to install, connect, operate, and perform basic commissioning of the SINAMICS V90 servo system.
SIMOTICS S-1FL6 Servo Motors Installation Guide	Describes how to install the SMOTICS S-1FL6 servo motor and relevant safety notices.

## Target group

This manual provides information about the SINAMICS V90 servo system for planners, operators, mechanical engineers, electrical engineers, commissioning engineers, and service engineers.

## Technical support

Country	Hotline
China	+86 400 810 4288
Germany	+49 911 895 7222
Italy	+39 (02) 24362000
India	+91 22 2760 0150
Turkey	+90 (216) 4440747
Further service contact information: Support contacts ( <a href="http://support.automation.siemens.com/WW/view/en/16604999">http://support.automation.siemens.com/WW/view/en/16604999</a> )	



# Table of contents

	<b>Preface .....</b>	<b>3</b>
<b>1</b>	<b>Safety instructions.....</b>	<b>11</b>
1.1	Fundamental safety instructions .....	11
1.1.1	General safety instructions .....	11
1.1.2	Handling electrostatic sensitive devices (ESD) .....	16
1.1.3	Industrial security .....	17
1.1.4	Residual risks of power drive systems.....	17
1.1.5	Residual risks during the operation of electric motors .....	19
1.2	Additional safety instructions .....	20
<b>2</b>	<b>General information .....</b>	<b>27</b>
2.1	Deliverables .....	27
2.1.1	Drive components .....	27
2.1.2	Motor components .....	30
2.2	Device combination.....	33
2.3	Product overview .....	35
2.4	System configuration .....	38
2.5	Accessories.....	42
2.6	Function list.....	52
2.7	Technical data.....	54
2.7.1	Technical data - servo drives.....	54
2.7.2	Technical data - servo motors .....	58
2.7.3	Technical data - cables .....	66
<b>3</b>	<b>Mounting.....</b>	<b>67</b>
3.1	Mounting the drive .....	67
3.1.1	Mounting orientation and clearance.....	67
3.1.2	Drill patterns and outline dimensions.....	68
3.1.3	Mounting the drive .....	72
3.2	Mounting the motor .....	72
3.2.1	Mounting orientation and dimensions.....	72
3.2.2	Mounting the motor .....	78
<b>4</b>	<b>Connecting .....</b>	<b>81</b>
4.1	System connection.....	81
4.2	Main circuit wirings.....	86
4.2.1	Line supply - L1, L2, L3.....	86
4.2.2	Motor power - U, V, W .....	87
4.3	Control/Status interface .....	90
4.3.1	Digital inputs/outputs (DIs/DOs) .....	91

4.3.1.1	DIs .....	92
4.3.1.2	DOs .....	97
4.3.2	Pulse train inputs/encoder outputs (PTIs/PTOs) .....	100
4.3.2.1	PTIs .....	100
4.3.2.2	PTOs .....	101
4.3.3	Analog inputs/outputs (AIs/AOs) .....	101
4.3.3.1	AIs .....	101
4.3.3.2	AOs .....	102
4.3.4	Standard application wirings (factory setting) .....	104
4.3.4.1	Pulse train input position control (PTI) .....	104
4.3.4.2	Internal position control (IPos) .....	106
4.3.4.3	Speed control (S) .....	108
4.3.4.4	Torque control (T) .....	110
4.3.5	Connection examples with PLCs .....	112
4.3.5.1	SIMATIC S7-200 SMART .....	112
4.3.5.2	SIMATIC S7-200 .....	116
4.3.5.3	SIMATIC S7-1200 .....	120
4.4	24V power supply/STO .....	124
4.5	Encoder interface .....	125
4.6	External braking resistor - DCP, R1 .....	129
4.7	Motor holding brake interface (400V variant only) .....	129
4.8	RS485 interface .....	130
<b>5</b>	<b>Commissioning .....</b>	<b>131</b>
5.1	General commissioning information .....	131
5.2	Initial commissioning in JOG mode .....	132
5.3	Commissioning in pulse train position control mode (PTI) .....	134
5.4	Commissioning in internal position control mode (IPos) .....	136
5.5	Commissioning in speed control mode (S) .....	138
5.6	Commissioning in torque control mode (T) .....	140
<b>6</b>	<b>Basic operator panel (BOP) .....</b>	<b>143</b>
6.1	BOP overview .....	143
6.1.1	BOP display .....	144
6.1.2	Control buttons .....	146
6.2	Parameter structure .....	147
6.3	Actual status display .....	148
6.4	Basic operations .....	149
6.4.1	Editing parameters .....	149
6.4.2	Viewing parameters .....	152
6.4.3	Searching parameters in "P ALL" menu .....	152
6.5	Auxiliary functions .....	153
6.5.1	Jog .....	154
6.5.2	Saving parameters (RAM to ROM) .....	155
6.5.3	Setting parameters to default .....	155

6.5.4	Transferring data (drive to SD) .....	156
6.5.5	Transferring data (SD to drive) .....	157
6.5.6	Updating firmware .....	157
6.5.7	Adjusting AI offsets .....	158
6.5.8	Adjusting an absolute encoder .....	160
<b>7</b>	<b>Control functions .....</b>	<b>161</b>
7.1	Compound controls .....	161
7.2	General functions .....	162
7.2.1	Servo ON .....	162
7.2.2	Direction of motor rotation .....	163
7.2.3	Over-travel .....	164
7.2.4	Motor holding brake .....	165
7.2.5	Stopping method at servo OFF .....	169
7.3	Pulse train input position control (PTI) .....	171
7.3.1	Sequence of SON .....	171
7.3.2	Selecting a setpoint pulse train input channel .....	171
7.3.3	Selecting a setpoint pulse train input form .....	172
7.3.4	In position (INP) .....	172
7.3.5	Smoothing function .....	173
7.3.6	Electronic gear ratio .....	173
7.3.7	Inhibiting pulse train input setpoint (P-TRG) .....	177
7.3.8	Speed limit .....	178
7.3.9	Torque limit .....	179
7.3.10	Clearing droop pulses (CLR) .....	182
7.3.11	Referencing (only for absolute encoder) .....	183
7.3.12	PTO function .....	183
7.4	Internal position control (IPos) .....	185
7.4.1	Setting mechanical system .....	185
7.4.2	Setting fixed position setpoint .....	186
7.4.3	Selecting a positioning mode - absolute/incremental .....	188
7.4.4	Configuring linear/modular axis .....	189
7.4.5	Backlash compensation .....	189
7.4.6	Referencing .....	190
7.4.7	Software position limit .....	198
7.4.8	Speed limit .....	199
7.4.9	Torque limit .....	199
7.4.10	Selecting a fixed position setpoint and starting positioning .....	199
7.5	Speed control (S) .....	201
7.5.1	Configuring speed setpoint .....	201
7.5.1.1	Speed control with external analog speed setpoint .....	202
7.5.1.2	Speed control with fixed speed setpoint .....	203
7.5.2	Direction and stop .....	204
7.5.3	Speed limit .....	204
7.5.4	Torque limit .....	204
7.5.5	Zero speed clamp .....	204
7.5.6	Ramp-function generator .....	205
7.6	Torque control (T) .....	207
7.6.1	300% overload capacity .....	207
7.6.2	Torque setpoint .....	208

7.6.2.1	Torque control with external analog torque setpoint.....	208
7.6.2.2	Torque control with fixed torque setpoint.....	209
7.6.3	Direction and stop .....	209
7.6.4	Speed limit .....	209
7.7	Communicating with the PLC.....	210
7.7.1	USS communication .....	210
7.7.2	Modbus communication .....	212
7.8	Absolute position system .....	224
7.8.1	Transmitting sequence for the absolute position data .....	225
<b>8</b>	<b>Safety Integrated function .....</b>	<b>227</b>
8.1	Standards and regulations .....	227
8.1.1	General information .....	227
8.1.1.1	Aims .....	227
8.1.1.2	Functional safety .....	228
8.1.2	Safety of machinery in Europe.....	228
8.1.2.1	Machinery Directive .....	228
8.1.2.2	Harmonized European Standards.....	229
8.1.2.3	Standards for implementing safety-related controllers .....	230
8.1.2.4	DIN EN ISO 13849-1 (replaces EN 954-1) .....	231
8.1.2.5	EN 62061 .....	232
8.1.2.6	Series of standards EN 61508 (VDE 0803) .....	234
8.1.2.7	Risk analysis/assessment.....	234
8.1.2.8	Risk reduction .....	236
8.1.2.9	Residual risk.....	236
8.1.3	Machine safety in the USA.....	236
8.1.3.1	Minimum requirements of the OSHA .....	236
8.1.3.2	NRTL listing.....	237
8.1.3.3	NFPA 79.....	237
8.1.3.4	ANSI B11 .....	238
8.1.4	Machine safety in Japan .....	239
8.1.5	Equipment regulations .....	239
8.2	General information about SINAMICS Safety Integrated .....	240
8.3	System features .....	240
8.3.1	STO functional safety data.....	240
8.3.2	Certification .....	240
8.3.3	Safety instructions.....	241
8.3.4	Probability of failure of the safety function .....	242
8.3.5	Response time .....	243
8.3.6	Residual risk.....	243
8.4	Safety Integrated basic functions.....	243
8.4.1	Safe Torque Off (STO).....	243
8.4.2	Forced dormant error detection .....	245
<b>9</b>	<b>Tuning .....</b>	<b>247</b>
9.1	Controller overview .....	247
9.2	Tuning mode .....	249
9.3	One-button auto tuning .....	250



9.4	Real-time auto tuning .....	255
9.5	Manual tuning .....	259
9.6	Resonance suppression .....	260
9.7	Low frequency vibration suppression .....	263
9.8	Gain switching.....	264
9.8.1	Gain switching using an external digital input signal (G-CHANGE) .....	265
9.8.2	Gain switching using position deviation .....	266
9.8.3	Gain switching using position setpoint frequency .....	267
9.8.4	Gain switching using actual speed .....	267
9.9	PI/P switching .....	268
9.9.1	PI/P switching using torque setpoint.....	270
9.9.2	PI/P switching using an external digital input signal (G-CHANGE) .....	270
9.9.3	PI/P switching using speed setpoint .....	271
9.9.4	PI/P switching using acceleration setpoint .....	272
9.9.5	PI/P switching using pulse deviation.....	273
<b>10</b>	<b>Parameters .....</b>	<b>275</b>
10.1	Overview .....	275
10.2	Parameter list.....	277
<b>11</b>	<b>Diagnostics .....</b>	<b>313</b>
11.1	Overview .....	313
11.2	List of faults and alarms .....	318
<b>A</b>	<b>Appendix.....</b>	<b>335</b>
A.1	Assembly of cable connectors on the motor side .....	335
A.2	Assembly of cable terminals on the drive side .....	337
A.3	Motor selection.....	340
A.3.1	Selection procedure .....	340
A.3.2	Parameter description.....	341
A.3.3	Selection examples .....	343
A.4	Replacing fans .....	344
	<b>Index.....</b>	<b>347</b>



# Safety instructions

## 1.1 Fundamental safety instructions

### 1.1.1 General safety instructions



#### **! DANGER**

##### **Danger to life due to live parts and other energy sources**

Death or serious injury can result when live parts are touched.

- Only work on electrical devices when you are qualified for this job.
- Always observe the country-specific safety rules.

Generally, six steps apply when establishing safety:

1. Prepare for shutdown and notify all those who will be affected by the procedure.
2. Disconnect the machine from the supply.
  - Switch off the machine.
  - Wait until the discharge time specified on the warning labels has elapsed.
  - Check that it really is in a no-voltage condition, from phase conductor to phase conductor and phase conductor to protective conductor.
  - Check whether the existing auxiliary supply circuits are de-energized.
  - Ensure that the motors cannot move.
3. Identify all other dangerous energy sources, e.g. compressed air, hydraulic systems, or water.
4. Isolate or neutralize all hazardous energy sources by closing switches, grounding or short-circuiting or closing valves, for example.
5. Secure the energy sources against switching on again.
6. Ensure that the correct machine is completely interlocked.

After you have completed the work, restore the operational readiness in the inverse sequence.




#### **! WARNING**


##### **Danger to life through a hazardous voltage when connecting an unsuitable power supply**

Touching live components can result in death or severe injury.


- Only use power supplies that provide SELV (Safety Extra Low Voltage) or PELV- (Protective Extra Low Voltage) output voltages for all connections and terminals of the electronics modules.

 <b>WARNING</b>
<b>Danger to life when live parts are touched on damaged motors/devices</b> Improper handling of motors/devices can damage them. For damaged motors/devices, hazardous voltages can be present at the enclosure or at exposed components. <ul style="list-style-type: none"><li>• Ensure compliance with the limit values specified in the technical data during transport, storage and operation.</li><li>• Do not use any damaged motors/devices.</li></ul>





 <b>WARNING</b>
<b>Danger to life through electric shock due to unconnected cable shields</b> Hazardous touch voltages can occur through capacitive cross-coupling due to unconnected cable shields. <ul style="list-style-type: none"><li>• As a minimum, connect cable shields and the cores of cables that are not used at one end at the grounded housing potential.</li></ul>



 <b>WARNING</b>
<b>Danger to life due to electric shock when not grounded</b> For missing or incorrectly implemented protective conductor connection for devices with protection class I, high voltages can be present at open, exposed parts, which when touched, can result in death or severe injury. <ul style="list-style-type: none"><li>• Ground the device in compliance with the applicable regulations.</li></ul>



 <b>WARNING</b>
<b>Danger to life due to electric shock when opening plug connections in operation</b> When opening plug connections in operation, arcs can result in severe injury or death. <ul style="list-style-type: none"><li>• Only open plug connections when the equipment is in a no-voltage state, unless it has been explicitly stated that they can be opened in operation.</li></ul>

 <b>WARNING</b>
<b>Danger to life due to fire spreading if housing is inadequate</b> Fire and smoke development can cause severe personal injury or material damage. <ul style="list-style-type: none"><li>• Install devices without a protective housing in a metal control cabinet (or protect the device by another equivalent measure) in such a way that contact with fire is prevented.</li><li>• Ensure that smoke can only escape via controlled and monitored paths.</li></ul>

 **WARNING****Danger to life through unexpected movement of machines when using mobile wireless devices or mobile phones**

Using mobile wireless devices or mobile phones with a transmit power > 1 W closer than approx. 2 m to the components may cause the devices to malfunction, influence the functional safety of machines therefore putting people at risk or causing material damage.

- Switch the wireless devices or mobile phones off in the immediate vicinity of the components.

 **WARNING****Danger to life due to the motor catching fire in the event of insulation overload**

There is higher stress on the motor insulation through a ground fault in an IT system. If the insulation fails, it is possible that death or severe injury can occur as a result of smoke and fire.

- Use a monitoring device that signals an insulation fault.
- Correct the fault as quickly as possible so the motor insulation is not overloaded.

 **WARNING****Danger to life due to fire if overheating occurs because of insufficient ventilation clearances**

Inadequate ventilation clearances can cause overheating of components with subsequent fire and smoke. This can cause severe injury or even death. This can also result in increased downtime and reduced service lives for devices/systems.

- Ensure compliance with the specified minimum clearance as ventilation clearance for the respective component.

 **WARNING****Danger of an accident occurring due to missing or illegible warning labels**

Missing or illegible warning labels can result in accidents involving death or serious injury.

- Check that the warning labels are complete based on the documentation.
- Attach any missing warning labels to the components, in the national language if necessary.
- Replace illegible warning labels.

**NOTICE**

**Device damage caused by incorrect voltage/insulation tests**

Incorrect voltage/insulation tests can damage the device.

- Before carrying out a voltage/insulation check of the system/machine, disconnect the devices as all converters and motors have been subject to a high voltage test by the manufacturer, and therefore it is not necessary to perform an additional test within the system/machine.



**WARNING**

**Danger to life when safety functions are inactive**

Safety functions that are inactive or that have not been adjusted accordingly can cause operational faults on machines that could lead to serious injury or death.

- Observe the information in the appropriate product documentation before commissioning.
- Carry out a safety inspection for functions relevant to safety on the entire system, including all safety-related components.
- Ensure that the safety functions used in your drives and automation tasks are adjusted and activated through appropriate parameterizing.
- Perform a function test.
- Only put your plant into live operation once you have guaranteed that the functions relevant to safety are running correctly.

**Note**

**Important safety notices for Safety Integrated functions**

If you want to use Safety Integrated functions, you must observe the safety notices in the Safety Integrated manuals.



**WARNING**

**Danger to life or malfunctions of the machine as a result of incorrect or changed parameterization**

As a result of incorrect or changed parameterization, machines can malfunction, which in turn can lead to injuries or death.

- Protect the parameterization (parameter assignments) against unauthorized access.
- Respond to possible malfunctions by applying suitable measures (e.g. EMERGENCY STOP or EMERGENCY OFF).

 **WARNING****Danger to life from permanent magnet fields**

Even when switched off, electric motors with permanent magnets represent a potential risk for persons with heart pacemakers or implants if they are close to converters/motors.

- If you are such a person (with heart pacemaker or implant) then keep a minimum distance of 2 m.
- When transporting or storing permanent magnet motors always use the original packing materials with the warning labels attached.
- Clearly mark the storage locations with the appropriate warning labels.
- IATA regulations must be observed when transported by air.

 **WARNING****Injury caused by moving parts or those that are flung out**

Touching moving motor parts or drive output elements and loose motor parts that are flung out (e.g. feather keys) in operation can result in severe injury or death.

- Remove any loose parts or secure them so that they cannot be flung out.
- Do not touch any moving parts.
- Safeguard all moving parts using the appropriate safety guards.

 **WARNING****Danger to life due to fire if overheating occurs because of insufficient cooling**

Inadequate cooling can cause overheating resulting in death or severe injury as a result of smoke and fire. This can also result in increased failures and reduced service lives of motors.

- Comply with the specified coolant requirements for the motor.

 **WARNING****Danger to life due to fire as a result of overheating caused by incorrect operation**

When incorrectly operated and in the case of a fault, the motor can overheat resulting in fire and smoke. This can result in severe injury or death. Further, excessively high temperatures destroy motor components and result in increased failures as well as shorter service lives of motors.

- Operate the motor according to the relevant specifications.
- Only operate the motors in conjunction with effective temperature monitoring.
- Immediately switch off the motor if excessively high temperatures occur.

 **CAUTION**

**Risk of injury due to touching hot surfaces**

In operation, the motor can reach high temperatures, which can cause burns if touched.

- Mount the motor so that it is not accessible in operation.

When maintenance is required

- allow the motor to cool down before starting any work.
- Use the appropriate personnel protection equipment, e.g. gloves.



 **WARNING**

**Danger to life from electromagnetic fields**

Electromagnetic fields (EMF) are generated by the operation of electrical power equipment such as transformers, converters or motors.

People with pacemakers or implants are at a special risk in the immediate vicinity of these devices/systems.

- Ensure that the persons involved are the necessary distance away (minimum 2 m).

### 1.1.2 Handling electrostatic sensitive devices (ESD)

Electrostatic sensitive devices (ESD) are individual components, integrated circuits, modules or devices that may be damaged by either electric fields or electrostatic discharge.



**NOTICE**

**Damage through electric fields or electrostatic discharge**

Electric fields or electrostatic discharge can cause malfunctions through damaged individual components, integrated circuits, modules or devices.

- Only pack, store, transport and send electronic components, modules or devices in their original packaging or in other suitable materials, e.g. conductive foam rubber or aluminum foil.
- Only touch components, modules and devices when you are grounded by one of the following methods:
  - Wearing an ESD wrist strap
  - Wearing ESD shoes or ESD grounding straps in ESD areas with conductive flooring
- Only place electronic components, modules or devices on conductive surfaces (table with ESD surface, conductive ESD foam, ESD packaging, ESD transport container).



### 1.1.3 Industrial security

---

**Note****Industrial security**

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens' products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. For more information about industrial security, visit this address (<http://www.siemens.com/industrialsecurity>).

To stay informed about product updates as they occur, sign up for a product-specific newsletter. For more information, visit this address (<http://support.automation.siemens.com>).

** WARNING****Danger as a result of unsafe operating states resulting from software manipulation**

Software manipulation (e.g. by viruses, Trojan horses, malware, worms) can cause unsafe operating states to develop in your installation which can result in death, severe injuries and/or material damage.

- Keep the software up to date.

You will find relevant information and newsletters at this address (<http://support.automation.siemens.com>).

- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.

You will find further information at this address (<http://www.siemens.com/industrialsecurity>).

- Make sure that you include all installed products into the holistic industrial security concept.

### 1.1.4 Residual risks of power drive systems

The control and drive components of a drive system are approved for industrial and commercial use in industrial line supplies. Their use in public line supplies requires a different configuration and/or additional measures.

These components may only be operated in closed housings or in higher-level control cabinets with protective covers that are closed, and when all of the protective devices are used.

1.1 Fundamental safety instructions

These components may only be handled by qualified and trained technical personnel who are knowledgeable and observe all of the safety instructions on the components and in the associated technical user documentation.

When assessing the machine's risk in accordance with the respective local regulations (e.g., EC Machinery Directive), the machine manufacturer must take into account the following residual risks emanating from the control and drive components of a drive system:

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example,
  - Hardware and/or software errors in the sensors, control system, actuators, and cables and connections
  - Response times of the control system and of the drive
  - Operation and/or environmental conditions outside the specification
  - Condensation/conductive contamination
  - Parameterization, programming, cabling, and installation errors
  - Use of wireless devices/mobile phones in the immediate vicinity of the control system
  - External influences/damage
2. In the event of a fault, exceptionally high temperatures, including an open fire, as well as emissions of light, noise, particles, gases, etc. can occur inside and outside the inverter, e.g.:
  - Component failure
  - Software errors
  - Operation and/or environmental conditions outside the specification
  - External influences/damage

Inverters of the Open Type/IP20 degree of protection must be installed in a metal control cabinet (or protected by another equivalent measure) such that contact with fire inside and outside the inverter is not possible.
3. Hazardous shock voltages caused by, for example,
  - Component failure
  - Influence during electrostatic charging
  - Induction of voltages in moving motors
  - Operation and/or environmental conditions outside the specification
  - Condensation/conductive contamination
  - External influences/damage
4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc., if they are too close
5. Release of environmental pollutants or emissions as a result of improper operation of the system and/or failure to dispose of components safely and correctly

**Note**

The components must be protected against conductive contamination (e.g. by installing them in a control cabinet with degree of protection IP54 according to IEC 60529 or NEMA 12).

Assuming that conductive contamination at the installation site can definitely be excluded, a lower degree of cabinet protection may be permitted.

---

For more information about residual risks of the components in a drive system, see the relevant sections in the technical user documentation.

### 1.1.5 Residual risks during the operation of electric motors

The motors may be operated only when all protective equipment is used.

Motors may be handled only by qualified and instructed qualified personnel that knows and observes all safety instructions for the motors that are explained in the associated technical user documentation.

When assessing the machine's risk in accordance with the respective local regulations (e.g., EC Machinery Directive), the machine manufacturer must take into account the following residual risks emanating from the control and drive components of a drive system:

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example,
  - Hardware and/or software errors in the sensors, control system, actuators, and cables and connections
  - Response times of the control system and of the drive
  - Operation and/or environmental conditions outside the specification
  - Condensation/conductive contamination
  - Errors during the assembly, installation, programming and parameterization
  - Use of wireless devices/mobile phones in the immediate vicinity of the control system
  - External influences/damage
2. In case of failure, unusually high temperatures inside and outside the motor, including open fire as well as the emission of light, noise, particles, gases, etc. can result, for example in
  - Component failure
  - Software errors in converter operation
  - Operation and/or environmental conditions outside the specification
  - External influences/damage

1.2 Additional safety instructions

- 3. Hazardous shock voltages caused by, for example,
  - Component failure
  - Influence during electrostatic charging
  - Induction of voltages in moving motors
  - Operation and/or environmental conditions outside the specification
  - Condensation/conductive contamination
  - External influences/damage
- 4. Electrical, magnetic and electromagnetic fields generated in operation that can pose a risk to people with a pacemaker, implants or metal replacement joints, etc., if they are too close
- 5. Release of noxious substances and emissions in the case of improper operation and/or improper disposal of components

## 1.2 Additional safety instructions

### Delivery check

---

**Note**

**Intact deliverables**

Deliverables received must be intact. It's not permissible to put a damaged unit into use.

---

### Transport and storage

<b>NOTICE</b>
<b>Property loss</b> Notify Siemens service personnel immediately of any damage discovered after delivery. If the equipment is put into storage, keep it in a dry, dust-free, and low-vibration environment. The storage temperature ranges from -40 °C to +70 °C. Otherwise you will suffer property loss.

## Mechanical installation

### WARNING

#### Death or severe personal injury from harsh installation environment

A harsh installation environment will jeopardize personal safety and equipment. Therefore,

- Do not install the drive and the motor in an area subject to inflammables or combustibles, water or corrosion hazards.
- Do not install the drive and the motor in an area where it is likely to be exposed to constant vibrations or physical shocks.
- Do not keep the drive exposed to strong electro-magnetic interference.
- Make sure that no foreign body (e.g., chips of wood or metal, dust, paper, etc.) can be seen inside the drive or on the heat sink of the drive.
- Make sure that the drive is installed in an electrical cabinet with an adequate degree of protection.

#### Note

##### Mounting clearance

To guarantee good heat dissipation and ease of cabling, keep sufficient clearance between drives, one drive and another device/inner wall of the cabinet.

#### Note

##### Screw tightening

Make sure you fix the screw to the terminal door of the drive after you have completed the installation work.

## Electrical installation



### DANGER

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

The earth leakage current for the drive can be greater than AC 3.5 mA, 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.



### DANGER

#### Danger to life when PE connectors are touched

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

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



**⚠ 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.
- Make sure that all connections are correct and reliable, the drive and the motor are well grounded.
- 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, line supply cable and brake cable used must all be shielded cables.
- For terminal box connection, make sure that the clearances in air between non-insulated live parts are at least 5.5 mm.
- 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.
- Cables connected may not come into contact with rotating mechanical parts.

**⚠ CAUTION**

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

Inadequate protection may cause minor personal injury or damage to property.

- The drive must have been disconnected from the power supply for at least five minutes before you perform any wiring to it.
- Check that the equipment is dead!
- Make sure that the drive and the motor are properly grounded.
- 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<sup>2</sup>.
- Terminals for equipotential bondings that exist in addition to terminals for PE conductors must not be used for looping-through the PE conductors.
- To ensure protective separation, an isolating transformer must be used for the 200 VAC/380 VAC line supply system.

**NOTICE**

**Damage to property from incorrect input voltage**

Incorrect input voltage will cause severe damage to the drive.

It is recommended that the actual input voltage should not be greater than 110% of the rated voltage or smaller than 75%.

**Note****STO wiring**

The safe torque off (STO) function can stop a motor using safety relays without involving any upper level control. It is disabled in the factory configuration by short-circuiting the STO terminals. The safety function of the servo drive is SIL 2 (EN61800-5-2). Connect the STO terminals as the actual requirements.

**Commissioning/Operation** **CAUTION****Burns from hot surface**

The operating temperature of drive base-plate and heat sink is higher than 65 °C, and the surface temperature of the motor may reach up to 80 °C. The hot surface may burn your hands.

Do not touch the motor or the heat sink of the drive during operation or within a certain period since power disconnection.

**NOTICE****Shortening the service life of motor brake**

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.

**NOTICE****Damage to the equipment from frequent power-on/off**

Frequent power-on/off will cause damage to the drive.

Do not switch on/off the power frequently.

**Note****Voltage requirement**

Before switching the power on, make sure that the drive system has been reliably installed and connected, and the line supply voltage is within the allowable range.

**Note****Drive functioning interfered by use of radio devices**

Some environmental factors may result in power derating, e.g. altitude and surrounding temperature. In this case, the drive cannot work normally.

Environmental factors must be taken into account during commissioning or operation.

## Troubleshooting



### **WARNING**

#### **Drive remaining charged**

The drive may remain charged in a short period after it is powered off.

Touching terminals or disassembling cables may cause minor injury due to electrical shock.

Do not touch terminals or disassemble cables until the drive system has been disconnected for at least five minutes.

### **WARNING**

#### **Personal injury due to unexpected restart**

The machine might unexpectedly restart after the power supply that was suddenly switched off is switched on again. Touching the machine at this time may cause personal injury.

Do not approach the machine after the power supply is switched on again.

## Disposal

### **Note**

#### **Equipment disposal**

Disposal of the equipment must be made in accordance with the regulations of the competent environmental protection administration on the disposal of electronic wastes.

## Certification

### **WARNING**

#### **Requirements for United States/Canadian installations (UL/cUL)**

Suitable for use on a circuit capable of delivering not more than 65000 rms Symmetrical Amperes, 480 VAC maximum for 400 V variants of drives or 240 VAC maximum for 200 V variant drives, when protected by UL/cUL listed (JDDZ) fuse or type E combination motor controller. For each frame size AA, A, B, C and D, use 75 °C copper wire only.

This equipment is capable of providing internal motor overload protection according to UL508C.

For Canadian (cUL) installations the drive mains supply must be fitted with any external recommended suppressor with the following features:

- Surge-protective devices; device shall be a Listed Surge-protective device (Category code VZCA and VZCA7)
- Rated nominal voltage 480/277 VAC, 50/60 Hz, 3-phase
- Clamping voltage VPR = 2000 V, IN = 3kA min, MCOV = 508 VAC, SCCR = 65 kA
- Suitable for Type 2 SPD application
- Clamping shall be provided between phases and also between phase and ground.



**⚠ WARNING****Harms to human health from electromagnetic radiation**

This product may cause high-frequency electromagnetic radiation, which will affect human health. Therefore, in a residential environment, make sure that necessary suppression measures are taken.

**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****EMC instructions**

- To comply with the EMC standards, all cables connected with the SINAMICS V90 system must be shielded cables, which include cables from the line supply to the line filter and from the line filter to the SINAMICS V90 drive.
- 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.
- In a residential environment, this product can cause high-frequency interferences that may necessitate suppression measures.
- For a radiated emission test, an external AC filter (between the mains supply and the drive) will be used to meet the EMC requirement and the drive will be installed inside the shielded metallic chamber, other parts of the motion control system (including the PLC, DC power supply, spindle drive, motor) will be put inside the shielded chamber.
- For a conductive emission test, an external AC filter (between the mains supply and the drive) will 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.

**Information regarding non-Siemens products**






**Note**

**Non-Siemens products**

This document contains recommendations relating to non-Siemens products. Non-Siemens products whose fundamental suitability is familiar to us. It goes without saying that equivalent products from other manufacturers may be used. Our recommendations are to be seen as helpful information, not as requirements or dictates. We cannot accept any liability for the quality and properties/features of non-Siemens products.

**Warning labels**

Warning labels attached to the motor or drive have the following meanings:

Symbol	Description
	<b>Risk of electric shock</b> Do not touch any terminals or disassemble cables until the drive has been disconnected from power for at least five minutes.
	<b>Caution</b> Pay attention to the information given on the rating plate and operating instructions. For more information, refer to this manual.
	<b>Hot surface</b> Do not touch the heatsink of the drive during operation or within a certain period since power disconnection because its surface temperature may reach up to 65 °C.
	<b>No knocking at the shaft</b> Do not exert any shock at the shaft end; otherwise, the encoder may be damaged.
	<b>Protective conductor terminal</b>

## General information

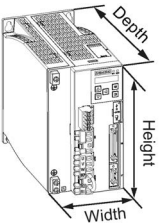
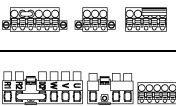
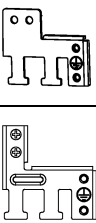
The SINAMICS V90 drives are available in two variants, 400 V variant and 200 V variant.

The V90 400 V variant has four frame sizes: FSAA, FSA, FSB, and FSC. They are used on three phase power network only. The V90 200 V variant has four frame sizes too. They are FSA, FSB, FSC, and FSD. The drives of frame sizes A, B, and C are used on the single phase or three phase power network while the drive of frame size D is used on the three phase power network only.

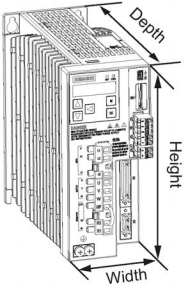




### 2.1 Deliverables

#### 2.1.1 Drive components

##### Components in SINAMICS V90 200 V variant drive package

Component	Illustration	Rated power (kW)	Outline dimension (Width x Height x Depth, mm)	Frame size	Order number
SINAMICS V90, single/three-phase, 200 V		0.1/0.2	45 x 170 x 170	FSA	6SL3210-5FB10-1UA0
					6SL3210-5FB10-2UA0
		0.4	55 x 170 x 170	FSB	6SL3210-5FB10-4UA1
		0.75	80 x 170 x 195	FSC	6SL3210-5FB10-8UA0
		1.0/1.5/2.0	95 x 170 x 195	FSD	6SL3210-5FB11-0UA1
					6SL3210-5FB11-5UA0
6SL3210-5FB12-0UA0					
Connectors		for FSA and FSB			
		for FSC and FSD			
Shielding plate		for FSA and FSB			
		for FSC and FSD			
User documentation	Getting Started	English-Chinese bilingual version			

Components in SINAMICS V90 400 V variant drive package

Component	Illustration	Rated power (kW)	Outline dimension (Width x Height x Depth, mm)	Frame size	Order number
SINAMICS V90, three phase, 400 V		0.4	60 x 180 x 200	FSAA	6SL3210-5FE10-4UA0
		0.75/1.0	80 x 180 x 200	FSA	6SL3210-5FE10-8UA0 6SL3210-5FE11-0UA0
		1.5/2.0	100 x 180 x 220	FSB	6SL3210-5FE11-5UA0 6SL3210-5FE12-0UA0
		3.5/5.0/7.0	140 x 260 x 240	FSC	6SL3210-5FE13-5UA0
					6SL3210-5FE15-0UA0
					6SL3210-5FE17-0UA0
Connectors		for FSAA and FSA			
		for FSB and FSC			
Shielding plate		for FSAA and FSA			
		for FSB and FSC			
User documentation	Getting Started	English-Chinese bilingual version			

Drive rating plate (example)

**SIEMENS**

① SINAMICS V90

② INPUT: 3AC 380-480V 1.5A 50/60Hz

③ OUTPUT: 3AC 0-input V 1.2A 0-330Hz

IND.CONT.EQ. 4TR2 LISTED

④ IP CLASS: IP20 MOTOR: 0.4kW FS: 02

⑤ 1P 6SL3210-5FE10-4UA0

⑥ S ZVXXXXXXXXXX

⑦ SNC-A5E03662016

CE Refer to user manual

EAC KCC-REM-S49-SINAMICS Made in China

Siemens Numerical Control Ltd.

No. 18 Siemens Rd, Jiangning Dev. Zone, Nanjing, 211100, P.R.C

**6SL3210-5FE10-4UA0**

Mains voltage  
 B: 1/3 phase 200~240 VAC  
 E: 3 phase 380~480 VAC

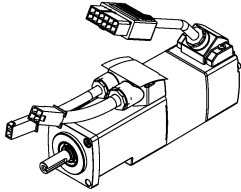
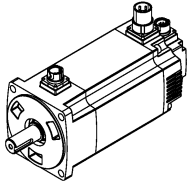
Supported motor power

200 V variant:	400 V variant:
10-1: 0.05/0.1 kW	10-4: 0.4 kW
10-2: 0.2 kW	10-8: 0.75 kW
10-4: 0.4 kW	11-0: 0.75/1.0 kW
10-8: 0.75 kW	11-5: 1.5/1.75 kW
11-0: 1.0 kW	12-0: 2.0/2.5 kW
11-5: 1.5 kW	13-5: 3.5 kW
12-0: 2.0 kW	15-0: 5.0 kW
	17-0: 7.0 kW

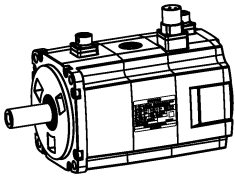
①	Drive name	⑤	Order number
②	Power input	⑥	Product serial number
③	Power output	⑦	Part number
④	Rated motor power		

## 2.1.2 Motor components

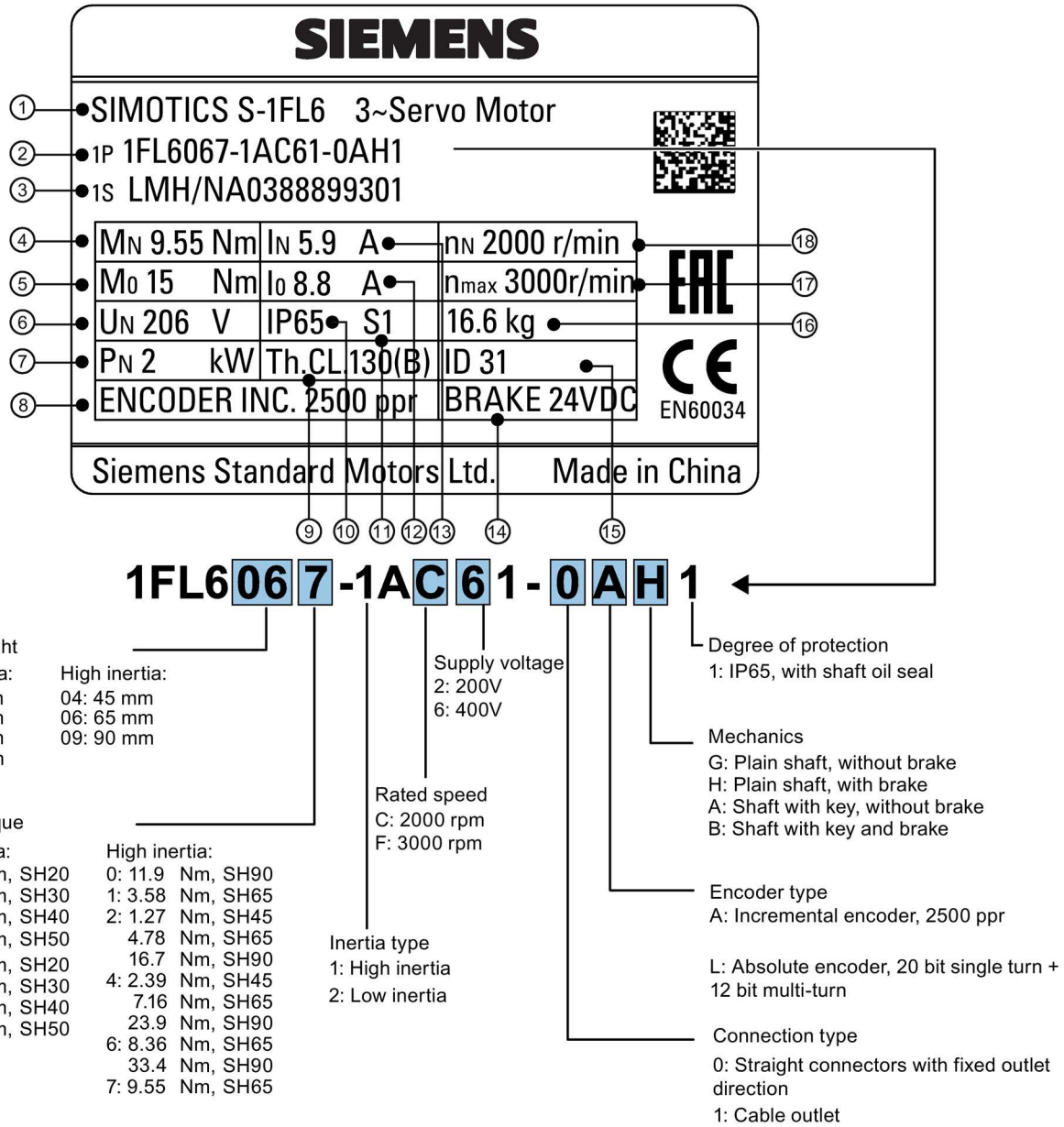
### Components in SIMOTICS S-1FL6 low inertia motor package

Component	Illustration	Rated torque (Nm)	Shaft height (mm)	Order number	
SIMOTICS S-1FL6, low inertia		<ul style="list-style-type: none"> <li>• 0.16</li> <li>• 0.32</li> </ul>	20	1FL6022-2AF21-1□□1	
				1FL6024-2AF21-1□□1	
		<ul style="list-style-type: none"> <li>• 0.64</li> <li>• 1.27</li> </ul>	30	1FL6032-2AF21-1□□1	
				1FL6034-2AF21-1□□1	
		<ul style="list-style-type: none"> <li>• 2.39</li> <li>• 3.18</li> </ul>	40	1FL6042-2AF21-1□□1	
				1FL6044-2AF21-1□□1	
		<ul style="list-style-type: none"> <li>• 4.78</li> <li>• 6.37</li> </ul>	50	1FL6052-2AF21-0□□1	
				1FL6054-2AF21-0□□1	
	User documentation	SIMOTICS S-1FL6 Servo Motors Installation Guide			

## Components in SIMOTICS S-1FL6 high inertia motor package

Component	Illustration	Rated torque (Nm)	Shaft height (mm)	Order number		
SIMOTICS S-1FL6, high inertia		<ul style="list-style-type: none"> <li>• 1.27</li> <li>• 2.39</li> </ul>	45	1FL6042-1AF61-0□□1		
				1FL6044-1AF61-0□□1		
		<ul style="list-style-type: none"> <li>• 3.58</li> <li>• 4.78</li> <li>• 7.16</li> <li>• 8.36</li> <li>• 9.55</li> </ul>	65	1FL6061-1AC61-0□□1		
				1FL6062-1AC61-0□□1		
				1FL6064-1AC61-0□□1		
				1FL6066-1AC61-0□□1		
				1FL6067-1AC61-0□□1		
		<ul style="list-style-type: none"> <li>• 11.90</li> <li>• 16.70</li> <li>• 23.90</li> <li>• 33.40</li> </ul>	90	1FL6090-1AC61-0□□1		
				1FL6092-1AC61-0□□1		
				1FL6094-1AC61-0□□1		
				1FL6096-1AC61-0□□1		
		User documentation	SIMOTICS S-1FL6 Servo Motors Installation Guide			

Motor rating plate (example)



①	Motor type	⑦	Rated power	⑬	Rated current
②	Order number	⑧	Encoder type and resolution	⑭	Holding brake
③	Serial number	⑨	Thermal class	⑮	Motor ID
④	Rated torque	⑩	Degree of protection	⑰	Weight
⑤	Stall torque	⑪	Motor operating mode	⑱	Maximum speed
⑥	Rated voltage	⑫	Stall current	⑱	Rated speed



## 2.2 Device combination

The tables below show the combination of SINAMICS V90 servo drives and SIMOTICS S-1FL6 servo motors.

### Combination between V90 200 V variant drives and low inertia motors

SIMOTICS S-1FL6 servo motor							SINAMICS V90 servo drive			
Type	Rated torque (Nm)	Rated power (kW)	Rated speed (rpm)	Shaft height (mm)	Motor ID		Order number <sup>1)</sup>	Order number	Frame size	Power supply
					Without brake	With brake				
Low inertia	0.16	0.05	3000	20	42 *	43	1FL6022-2AF21-1A□1	6SL3210-5FB10-1UA0	FSA	1/3-phase 200 VA C to 240 VA C
	0.32	0.1	3000	20	46	47	1FL6024-2AF21-1A□1			
	0.64	0.2	3000	30	50 *	51	1FL6032-2AF21-1A□1	6SL3210-5FB10-2UA0	FSB	
	1.27	0.4	3000	30	54 *	55	1FL6034-2AF21-1A□1	6SL3210-5FB10-4UA1		
	2.39	0.75	3000	40	58 *	59	1FL6042-2AF21-1A□1	6SL3210-5FB10-8UA0	FSC	
	3.18	1	3000	40	62 *	63	1FL6044-2AF21-1A□1	6SL3210-5FB11-0UA1	FSD	3-phase 200 VA C to 240 VA C
	4.78	1.5	3000	50	66 *	67	1FL6052-2AF21-0A□1	6SL3210-5FB11-5UA0		
	6.37	2	3000	50	70 *	71	1FL6054-2AF21-0A□1	6SL3210-5FB12-0UA0		

### Combination between V90 400 V variant drives and high inertia motors

SIMOTICS S-1FL6 servo motor							SINAMICS V90 servo drive			
Type	Rated torque (Nm)	Rated power (kW)	Rated speed (rpm)	Shaft height (mm)	Motor ID		Order number <sup>1)</sup>	Order number	Frame size	Power supply
					Without brake	With brake				
High inertia	1.27	0.4	3000	45	18 *	19	1FL6042-1AF61-0A□1	6SL3210-5FE10-4UA0	FSAA	3-phase 380 VA C to 480 VA C
					10009	10038	1FL6042-1AF61-0L□1			
	2.39	0.75	3000	45	20 *	21	1FL6044-1AF61-0A□1	6SL3210-5FE10-8UA0	FSA	
					10010	10039	1FL6044-1AF61-0L□1			
	3.58	0.75	2000	65	22	23	1FL6061-1AC61-0A□1	6SL3210-5FE11-0UA0	FSA	
					10011	10040	1FL6061-1AC61-0L□1			
	4.78	1.0	2000	65	24 *	25	1FL6062-1AC61-0A□1	6SL3210-5FE11-0UA0	FSA	
					10012	10041	1FL6062-1AC61-0L□1			

SIMOTICS S-1FL6 servo motor							SINAMICS V90 servo drive			
Type	Rated torque (Nm)	Rated power (kW)	Rated speed (rpm)	Shaft height (mm)	Motor ID		Order number <sup>1)</sup>	Order number	Frame size	Power supply
					Without brake	With brake				
7.16	1.5	2000	65	65	26 *	27	1FL6064-1AC61-0A□1	6SL3210-5FE11-5UA0	FSB	
					10013	10042	1FL6064-1AC61-0L□1			
8.36	1.75	2000	65	65	28	29	1FL6066-1AC61-0A□1			
					10014	10043	1FL6066-1AC61-0L□1			
9.55	2.0	2000	65	65	30 *	31	1FL6067-1AC61-0A□1	6SL3210-5FE12-0UA0		
					10015	10044	1FL6067-1AC61-0L□1			
11.9	2.5	2000	90	90	32	33	1FL6090-1AC61-0A□1			
					10016	10045	1FL6090-1AC61-0L□1			
16.7	3.5	2000	90	90	34 *	35	1FL6092-1AC61-0A□1	6SL3210-5FE13-5UA0	FSC	
					10017	10046	1FL6092-1AC61-0L□1			
23.9	5.0	2000	90	90	36 *	37	1FL6094-1AC61-0A□1	6SL3210-5FE15-0UA0		
					10018	10047	1FL6094-1AC61-0L□1			
33.4	7.0	2000	90	90	38 *	39	1FL6096-1AC61-0A□1	6SL3210-5FE17-0UA0		
					10019	10048	1FL6096-1AC61-0L□1			

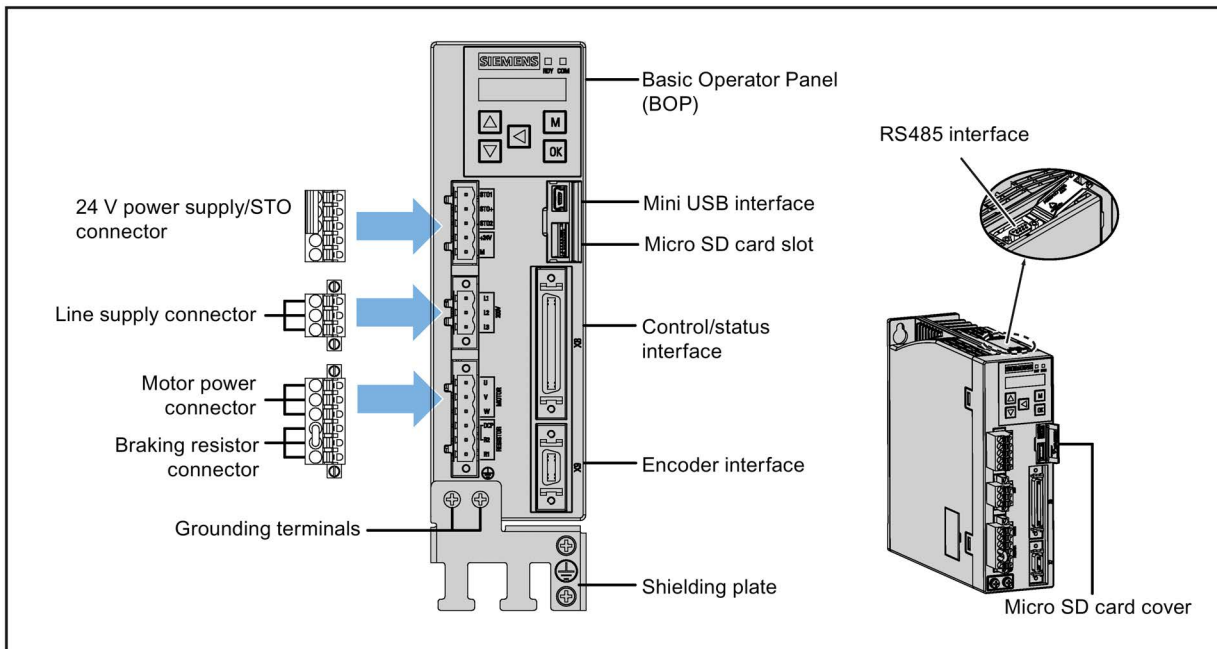
1) The symbol □ in the motor order numbers is for optional configurations (mechanics). Refer to the motor rating plate explanation in Motor components (Page 30) for detailed information.

2) The Motor ID values marked with an asterisk (\*) are the default incremental motor IDs for V90 drives. If you have connected a different motor to the drive, you need to configure the motor ID manually.

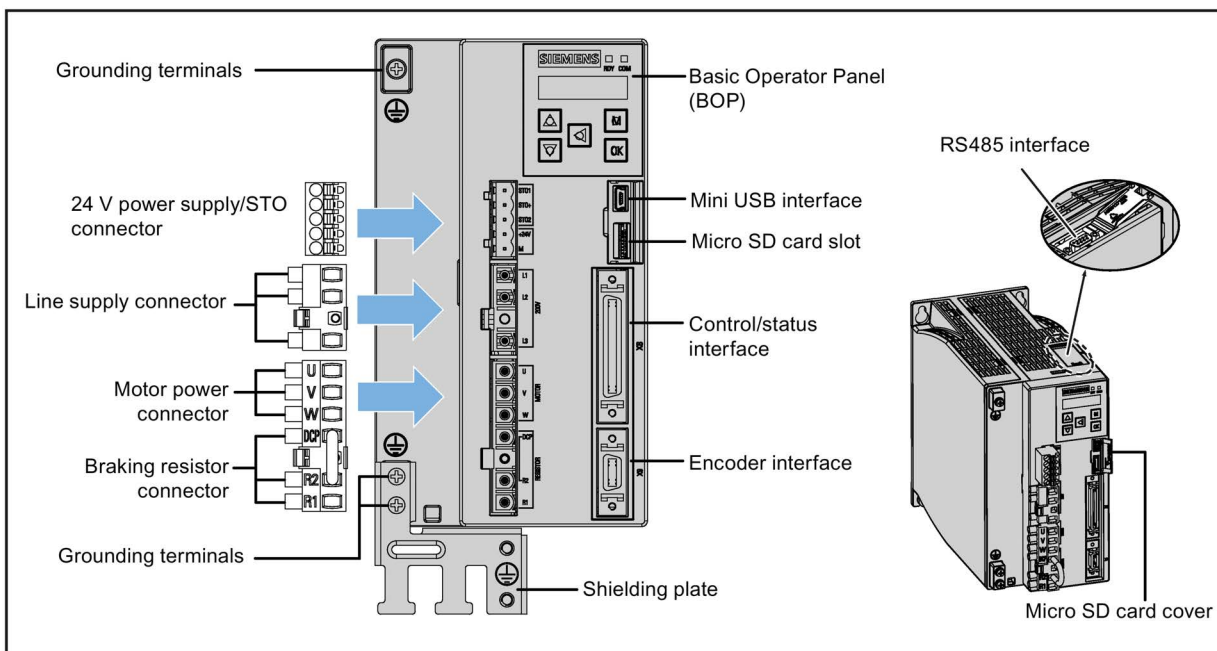
## 2.3 Product overview

### SINAMICS V90 servo drives

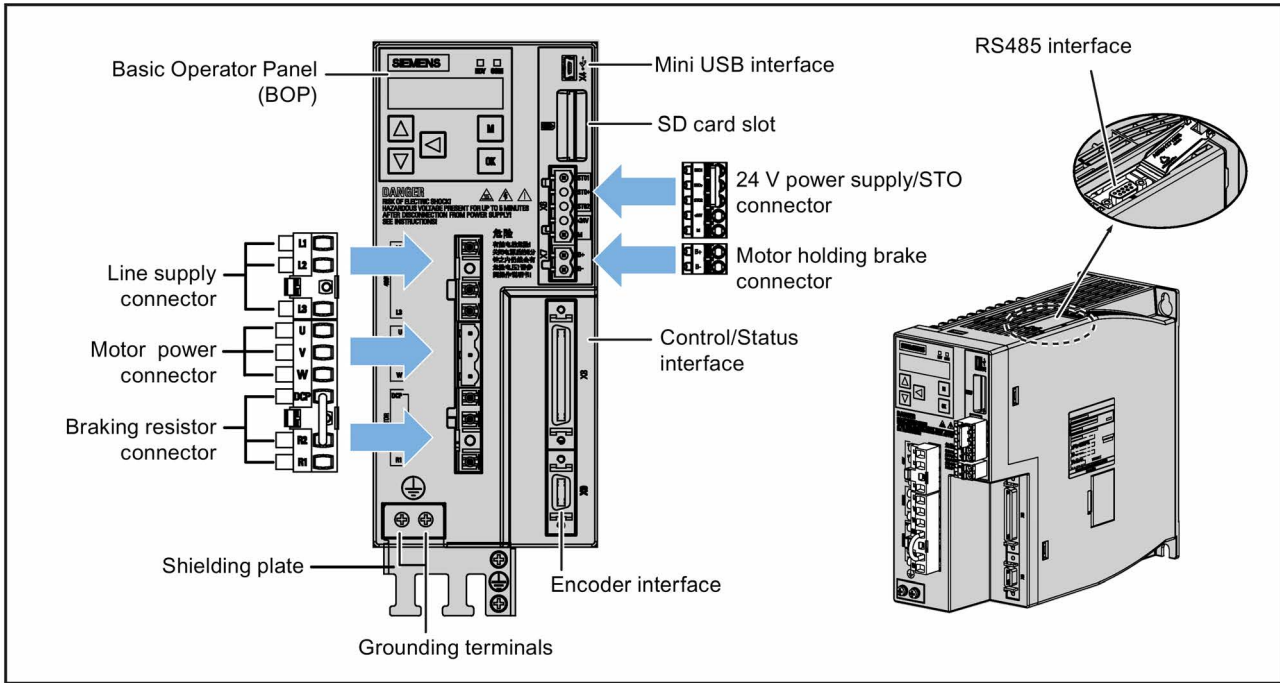
- SINAMICS V90 200 V variant  
FSA and FSB



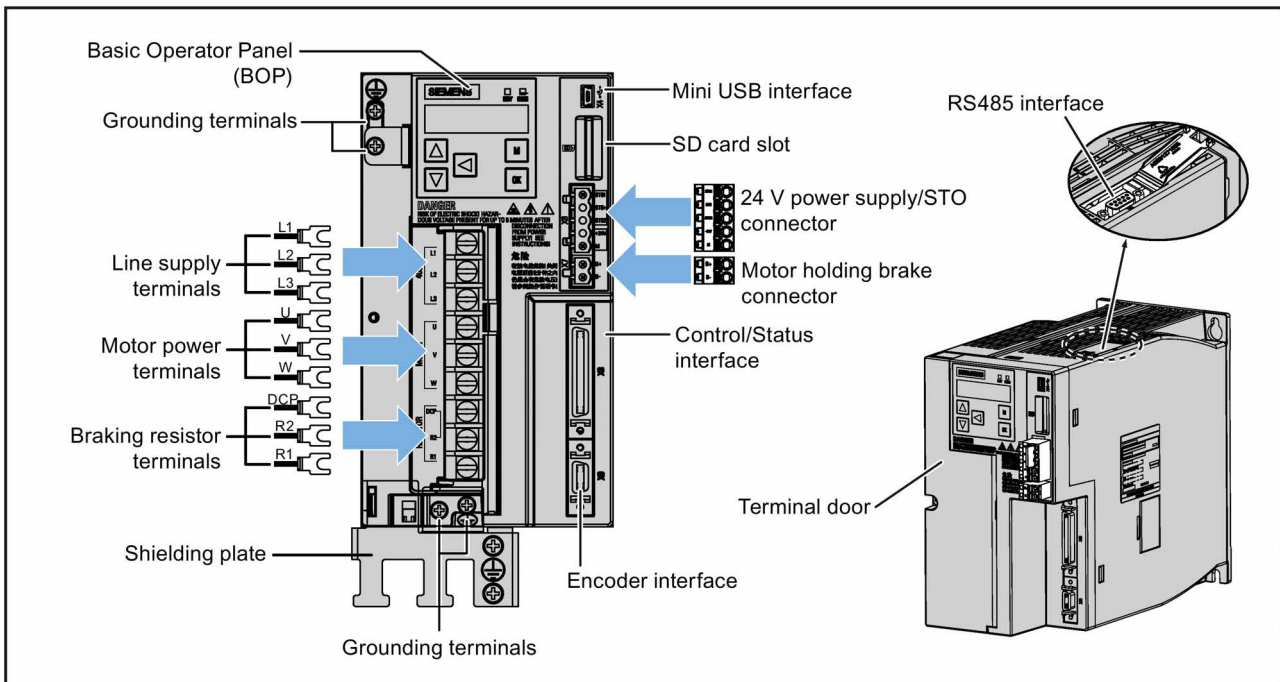
### FSC and FSD



- SINAMICS V90 400V variant  
FSA and FSA

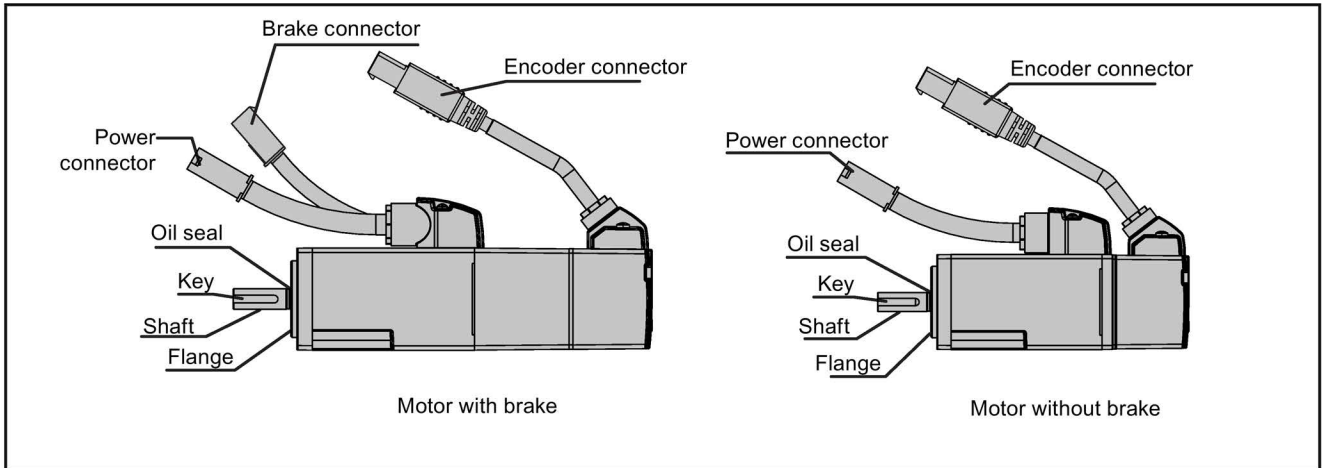


FSB and FSC

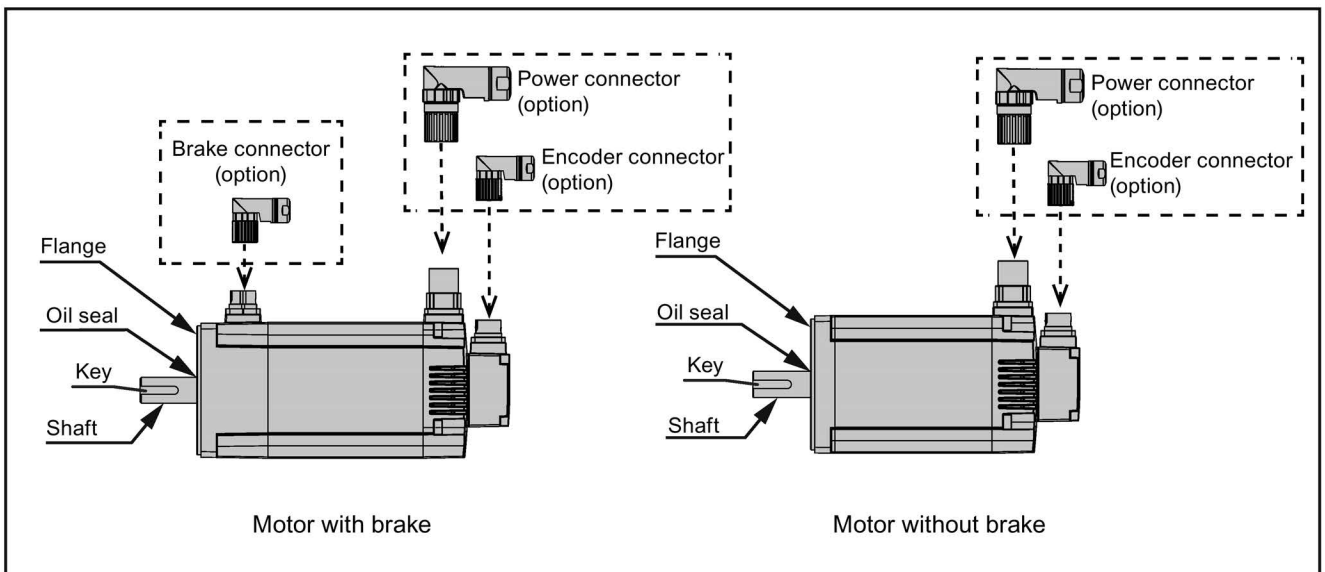


### SIMOTICS S-1FL6 servo motors

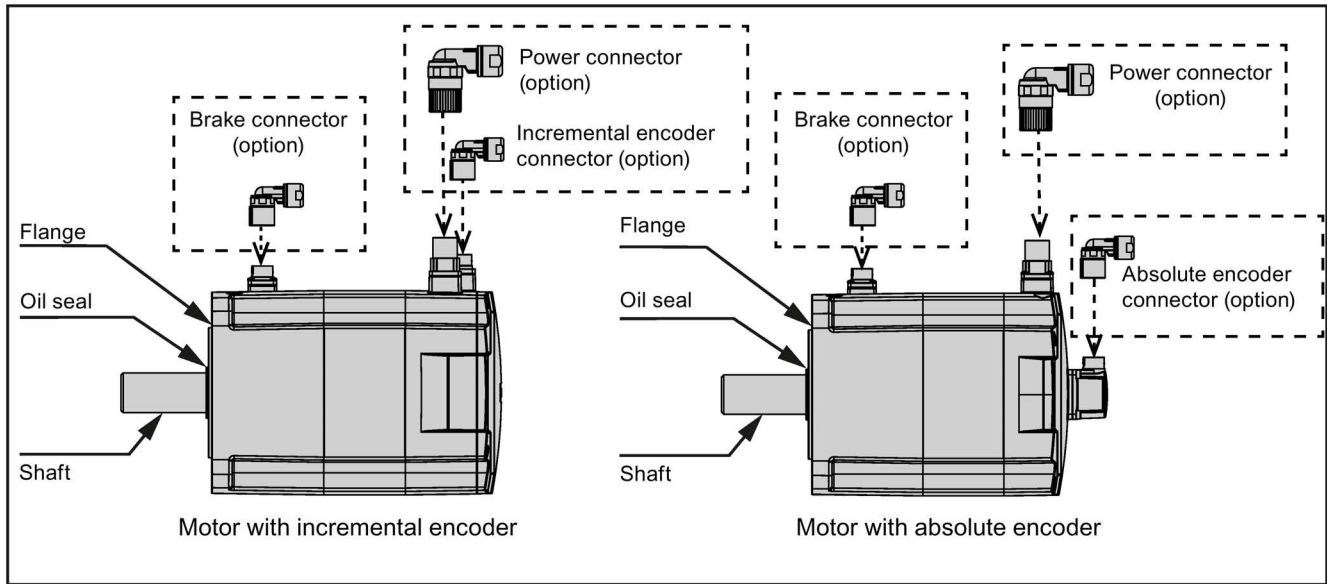
- Low inertia motors  
Shaft-height: 20 mm, 30 mm, and 40 mm



Shaft-height: 50 mm



- High inertia motors  
Shaft-height: 45 mm, 65 mm, and 90 mm



## 2.4 System configuration

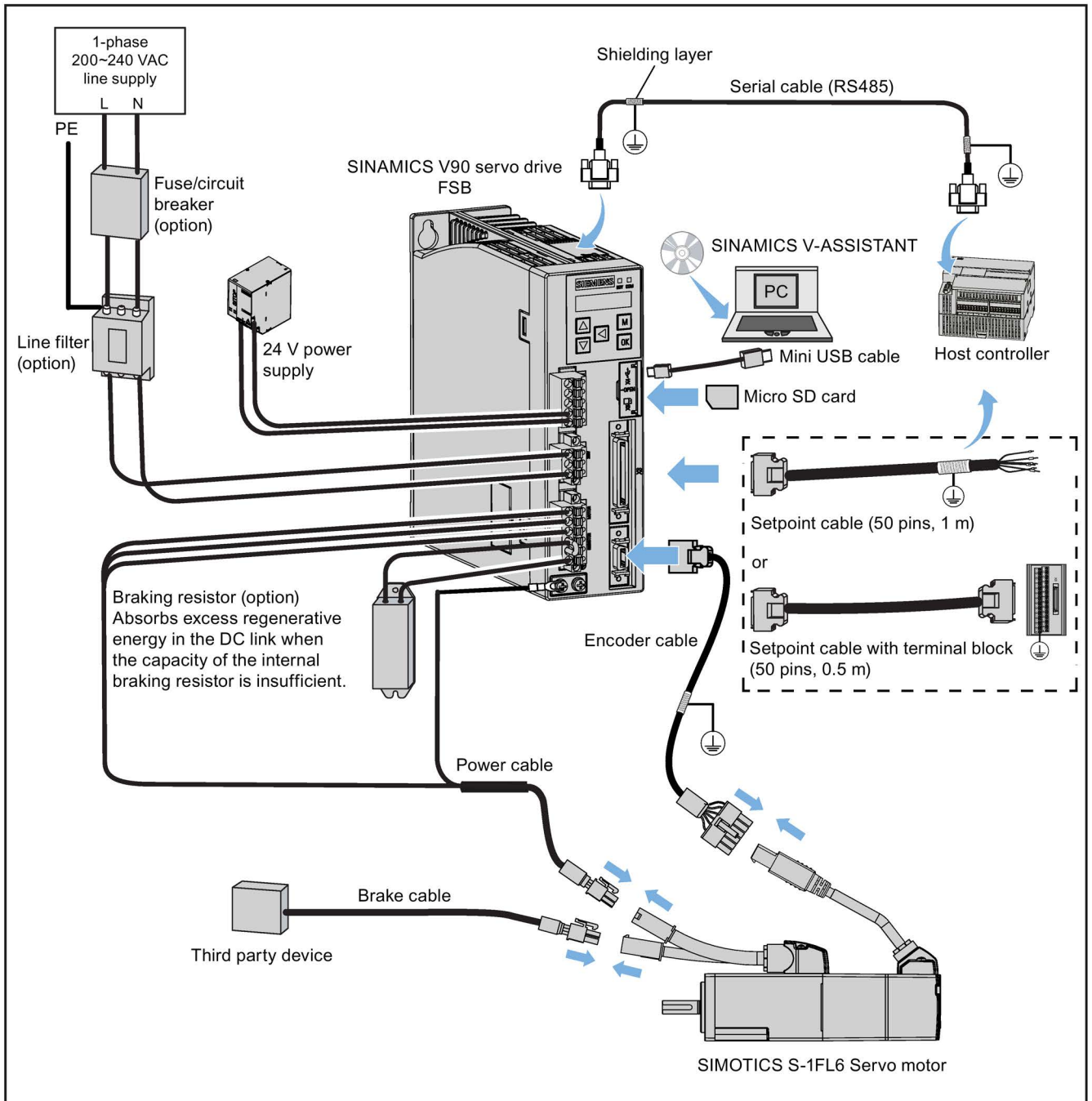
The SINAMICS V90 servo drive is integrated with digital input/output interface, pulse train interface and analog interface. It can be connected either to a Siemens controller like S7-200, S7-1200 or S7-200 SMART, or to a third-party controller. Absolute position information can be read from the servo drive by the PLC via RS485 port.

A configuration software tool, SINAMICS V-ASSISTANT, can be installed on a PC. The PC can communicate with SINAMICS V90 servo drive with a USB cable for performing parameter settings, trial run, status display monitoring, gain adjustments, and so on.

The following illustration shows an example of the SINAMICS V90 servo system configuration:

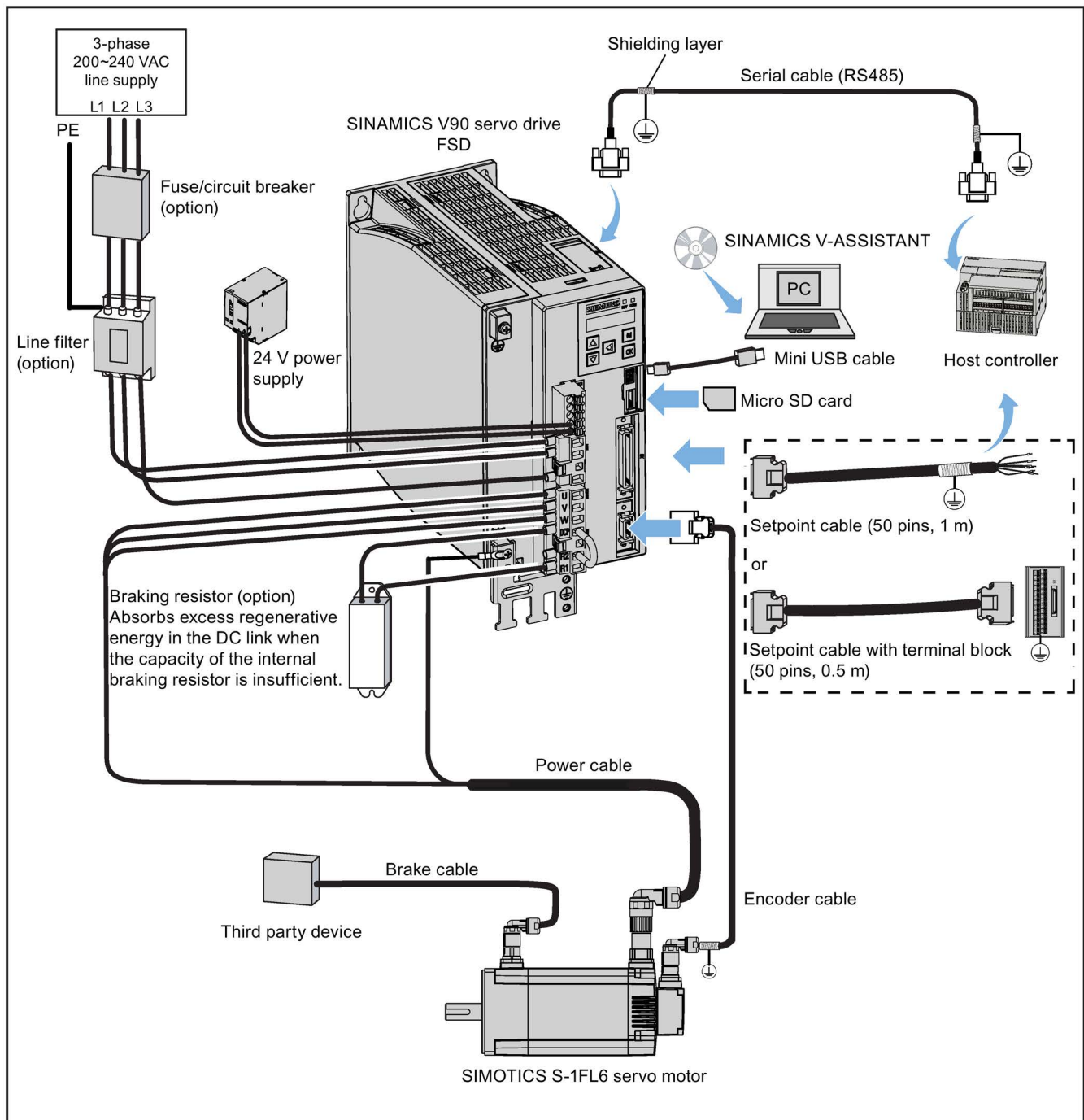
### SINAMICS V90 200 V variant

The configuration for FSB when used on the single phase power network:



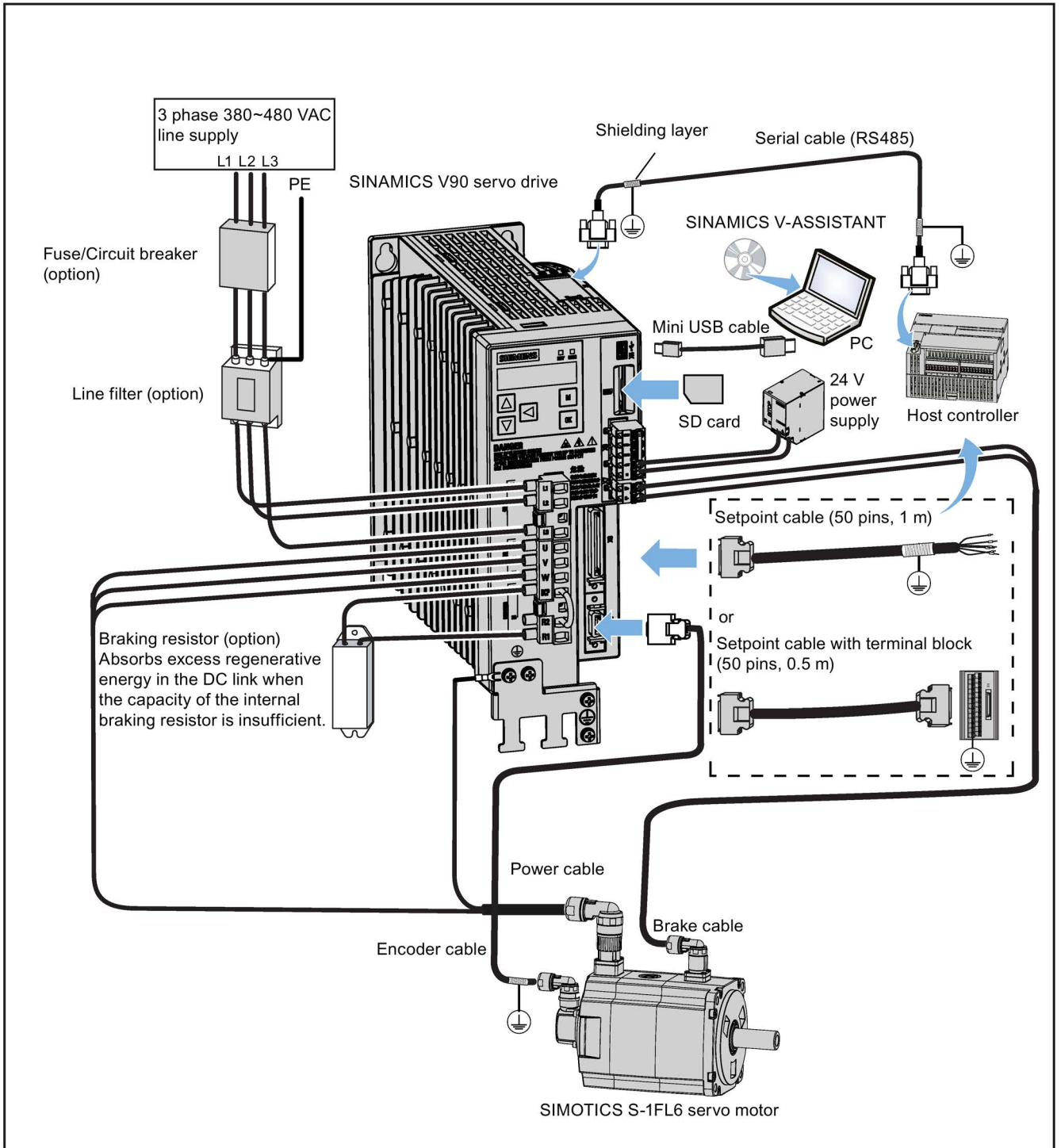
2.4 System configuration

The illustration below takes the connection between FSD and low inertia servo motor of 50 mm shaft-height when used on the three phase power network for an example.





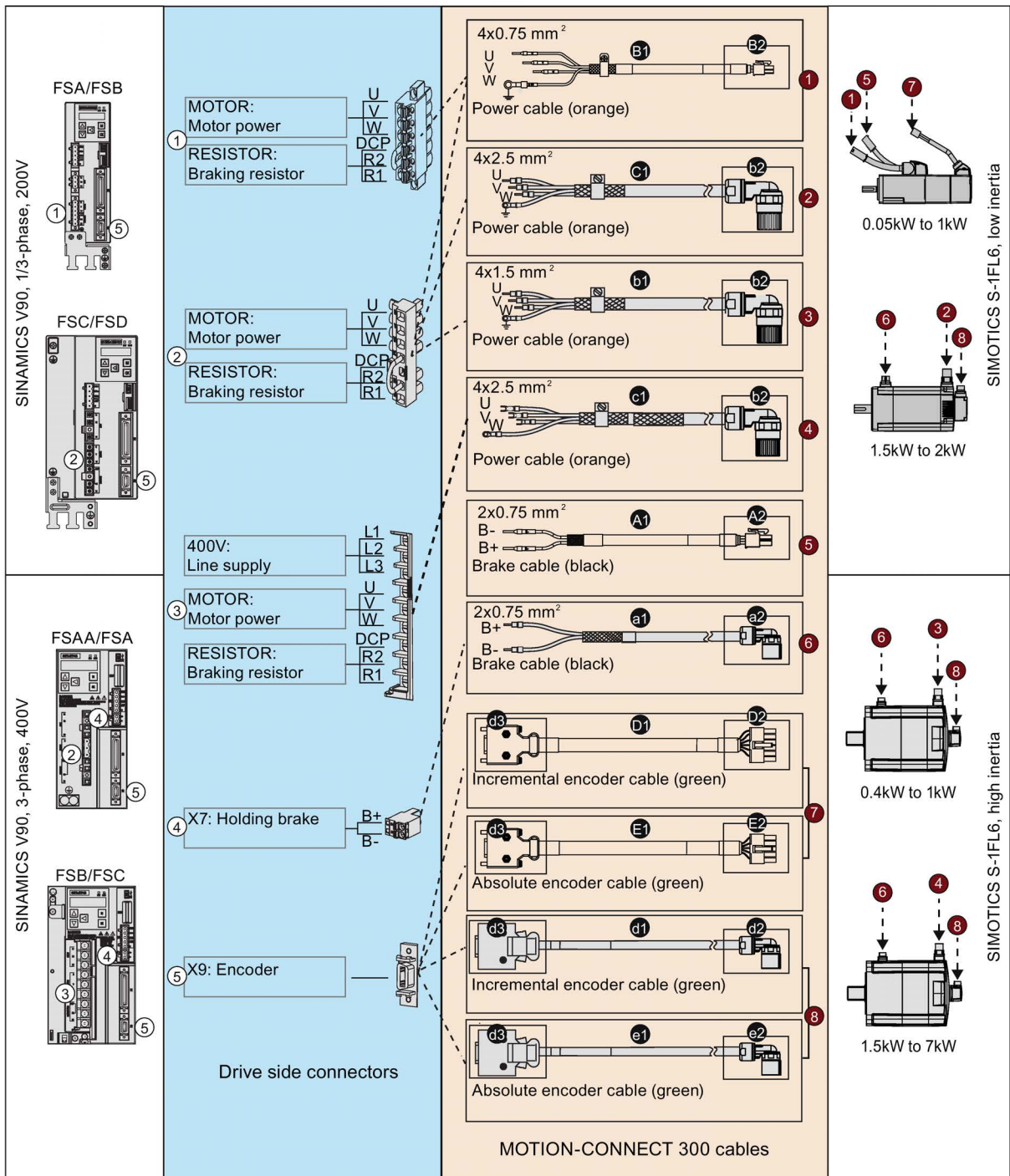
SINAMICS V90 400 V variant



## 2.5 Accessories

### Cables and connectors

The illustration below shows cables between the drive and the motor and configurable cable connectors:



You can select cables and connectors according to the table below:

MOTION-CONNECT 300 cable			Cable connector (motor side)		Cable connector (drive side)	
Type	Length	Order No. 6FX3002-...	Type	Order No. 6FX2003-...	Type	Order No. 6FX2003-...
Brake cable (A1)	3 m	5BK02-1AD0	Brake connector (A2)	0LL52	-	-
	5 m	5BK02-1AF0				
	10 m	5BK02-1BA0				
	20 m	5BK02-1CA0				
Brake cable (a1)	3 m	5BL02-1AD0	Brake connector (a2)	0LL51	-	-
	5 m	5BL02-1AF0				
	7 m *	5BL02-1AH0				
	10 m	5BL02-1BA0				
	15 m *	5BL02-1BF0				
	20 m	5BL02-1CA0				
Power cable (B1)	3 m	5CK01-1AD0	Power connector (B2)	0LL12	-	-
	5 m	5CK01-1AF0				
	10 m	5CK01-1BA0				
	20 m	5CK01-1CA0				
Power cable (b1)	3 m	5CL01-1AD0	Power connector (b2)	0LL11	-	-
	5 m	5CL01-1AF0				
	7 m *	5CL01-1AH0				
	10 m	5CL01-1BA0				
	15 m *	5CL01-1BF0				
	20 m	5CL01-1CA0				
Power cable (C1)	3 m	5CK31-1AD0				
	5 m	5CK31-1AF0				
	10 m	5CK31-1BA0				
	20 m	5CK31-1CA0				
Power cable (c1)	3 m	5CL11-1AD0				
	5 m	5CL11-1AF0				
	7 m	5CL11-1AH0				
	10 m	5CL11-1BA0				
	15 m	5CL11-1BF0				
	20 m	5CL11-1CA0				

MOTION-CONNECT 300 cable			Cable connector (motor side)		Cable connector (drive side)	
Type	Length	Order No. 6FX3002-...	Type	Order No. 6FX2003-...	Type	Order No. 6FX2003-...
Incremental encoder cable (D1)	3 m	2CT20-1AD0	Incremental encoder connector (D2)	0SL12	Encoder connector (d3)	0SB14
	5 m	2CT20-1AF0				
	10 m	2CT20-1BA0				
	20 m	2CT20-1CA0				
Incremental encoder cable (d1)	3 m	2CT10-1AD0	Incremental encoder connector (d2)	0SL11		
	5 m	2CT10-1AF0				
	7 m *	2CT10-1AH0				
	10 m	2CT10-1BA0				
	15 m *	2CT10-1BF0				
	20 m	2CT10-1CA0				
Absolute encoder cable (E1)	3 m	2DB20-1AD0	Absolute encoder connector (E2)	0DB12		
	5 m	2DB20-1AF0				
	10 m	2DB20-1BA0				
	20 m	2DB20-1CA0				
Absolute encoder cable (e1)	3 m	2DB10-1AD0	Absolute encoder connector (e2)	0DB11		
	5 m	2DB10-1AF0				
	7 m *	2DB10-1AH0				
	10 m	2DB10-1BA0				
	15 m *	2DB10-1BF0				
	20 m	2DB10-1CA0				

\* The cables with length of 7 m and 15 m are only supplied for high inertia motor.

**Cable and connector (between V90 drive and controller)**

Name	Order number	Length (m)
Option 1		
Setpoint connector (50 pins)	6SL3260-2NA00-0VA0	-
Setpoint cable (50 pins)	6SL3260-4NA00-1VB0	1
Option 2		
Setpoint cable with terminal block (50 pins)	6SL3260-4NA00-1VA5	0.5

## External 24 VDC power supply

A 24 VDC power supply is needed to supply the V90 servo drive. Refer to the table below to select the power supply:

Without a holding brake		With a holding brake	
Rated voltage (V)	Maximum current (A)	Rated voltage (V)	Maximum current (A)
24 (-15% to +20%)	1.6	24 (-10% to +10%) <sup>1)</sup>	3.6

<sup>1)</sup> The minimum voltage of 24 VDC -10% must be available at the connector on the motor side in order to guarantee that the brake reliably opens. If the maximum voltage of 24 VDC +10% is exceeded, then the brake could re-close. The voltage drop along the brake feeder cable must be taken into consideration. The voltage drop  $\Delta U$  for copper cables can be approximately calculated as follows:

$$\Delta U [V] = 0.042 \Omega \cdot \text{mm}^2/\text{m} \cdot (l/q) \cdot I_{\text{Brake}}$$

Where:  $l$  = Cable length [m],  $q$  = Brake cable cross section [ $\text{mm}^2$ ],  $I_{\text{Brake}}$  = DC current of brake [A]

## Fuse/circuit breaker

A fuse/circuit breaker can be used to protect the system. Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes. Refer to the table below for the selection of fuses and circuit breakers:

### SINAMICS V90 200 V variant

SINAMICS V90			Standard fuse		Type E combination motor controller			
Power supply	Frame size	Order number	Rated current	Class	Rated current	Rated current/voltage	Rated power (HP)	Order number
1-phase, 200 VAC to 240 VAC	FSA	6SL3210-5FB10-1UA0	6 A	J	2.8 A to 4 A	230 VAC/240 VAC	1/3	3RV 2011-1EA10
		6SL3210-5FB10-2UA0	6 A	J	2.8 A to 4 A	230 VAC/240 VAC	1/3	3RV 2011-1EA10
	FSB	6SL3210-5FB10-4UA1	10 A	J	5.5 A to 8 A	230 VAC/240 VAC	1	3RV 2011-1HA10
	FSC	6SL3210-5FB10-8UA0	20 A	J	9 A to 12.5 A	230 VAC/240 VAC	2	3RV 2011-1KA10
3-phase, 200 VAC to 240 VAC	FSA	6SL3210-5FB10-1UA0	6 A	J	2.8 A to 4 A	230 VAC/240 VAC	3/4	3RV 2011-1EA10
		6SL3210-5FB10-2UA0	6 A	J	2.8 A to 4 A	230 VAC/240 VAC	3/4	3RV 2011-1EA10
	FSB	6SL3210-5FB10-4UA1	10 A	J	2.8 A to 4 A	230 VAC/240 VAC	3/4	3RV 2011-1EA10
	FSC	6SL3210-5FB10-8UA0	20 A	J	5.5 A to 8 A	230 VAC/240 VAC	2	3RV 2011-1HA10
	FSD	6SL3210-5FB11-0UA1	20 A	J	7 A to 10 A	230 VAC/240 VAC	3	3RV 2011-1JA10
		6SL3210-5FB11-5UA0	25 A	J	10 A to 16 A	230 VAC/240 VAC	5	3RV 2011-4AA1
		6SL3210-5FB12-0UA0	25 A	J	10 A to 16 A	230 VAC/240 VAC	5	3RV 2011-4AA1

**SINAMICS V90 400 V variant**

SINAMICS V90			CE-compliant				UL-compliant			
Power supply	Frame size	Order number	Standard fuse		Circuit breaker		Standard fuse		Circuit breaker	
			Rated current	Order number	Rated current/voltage	Order number	Rated current/voltage	Class	Rated current/voltage	Order number
3-phase, 380 V AC to 480 V AC	FSA	6SL3210-5FE10-4UA0	6 A	3NA3 801-6	3.2 A, 690 VAC	3RV 1021-1DA10	10 A, 600 VAC	J	3.2 A, 690 VAC	3RV 1021-1DA10
	FSA	6SL3210-5FE10-8UA0	6 A	3NA3 801-6	4 A, 690 VAC	3RV 1021-1EA10	10 A, 600 VAC	J	4 A, 690 VAC	3RV 1021-1EA10
		6SL3210-5FE11-0UA0	10 A	3NA3 803-6	5 A, 690 VAC	3RV 1021-1FA10	10 A, 600 VAC	J	5 A, 690 VAC	3RV 1021-1FA10
	FSB	6SL3210-5FE11-5UA0	10 A	3NA3 803-6	10 A, 690 VAC	3RV 1021-1HA10	15 A, 600 VAC	J	10 A, 690 VAC	3RV 1021-1HA10
		6SL3210-5FE12-0UA0	16 A	3NA3 805-6	16 A, 690 VAC	3RV 1021-4AA10	15 A, 600 VAC	J	16 A, 690 VAC	3RV 1021-4AA10
	FSC	6SL3210-5FE13-5UA0	20 A	3NA3 807-6	20 A, 690 VAC	3RV 1021-4BA10	25 A, 600 VAC	J	20 A, 690 VAC	3RV 1021-4BA10
		6SL3210-5FE15-0UA0	20 A	3NA3 807-6	20 A, 690 VAC	3RV 1021-4BA10	25 A, 600 VAC	J	20 A, 690 VAC	3RV 1021-4BA10
		6SL3210-5FE17-0UA0	25 A	3NA3 810-6	25 A, 690 VAC	3RV 1021-4DA10	25 A, 600 VAC	J	25 A, 690 VAC	3RV 1021-4DA10

**Braking resistor**

The SINAMICS V90 has a built-in braking resistor, the table below shows the information of the built-in resistor:

SINAMICS V90		Resistance (Ω)	Max. power (kW)	Rated power (W)	Max. energy (kJ)
Power supply	Frame size				
1/3-phase, 200 VAC to 240 VAC	FSA	150	1.09	13.5	0.55
	FSB	100	1.64	20.5	0.82
	FSC	50	3.28	41	1.64
3-phase, 200 VAC to 240 VAC	FSD (1 kW)	50	3.28	41	1.64
	FSD (1.5 kW to 2 kW)	25	6.56	82	3.28

SINAMICS V90		Resistance ( $\Omega$ )	Max. power (kW)	Rated power (W)	Max. energy (kJ)
Power supply	Frame size				
3-phase, 380 VAC to 480 VAC	FSA	533	1.2	17	1.8
	FSA	160	4	57	6
	FSB	70	9.1	131	13.7
	FSC	27	23.7	339	35.6

When the motor works in a fast round-trip process, the voltage of the line supply increases. The braking resistor starts to work if the voltage reaches to the set threshold. The temperature of the heat sink increases ( $>100\text{ }^{\circ}\text{C}$ ) when the braking resistor is working. If alarm A52901 and A5000 appear at the same time, you need to switch the internal braking resistor to the external braking resistor. You can select a standard braking resistor according to the table below:

SINAMICS V90		Resistance ( $\Omega$ )	Max. power (kW)	Rated power (W)	Max. energy (kJ)
Power supply	Frame size				
1/3-phase, 200 VAC to 240 VAC	FSA	150	1.09	20	0.8
	FSB	100	1.64	21	1.23
	FSC	50	3.28	62	2.46
3-phase, 200VAC to 240 VAC	FSD (1 kW)	50	3.28	62	2.46
	FSD (1.5 kW to 2 kW)	25	6.56	123	4.92
3-phase, 380 VAC to 480 VAC	FSA	533	1.2	30	2.4
	FSA	160	4	100	8
	FSB	70	9.1	229	18.3
	FSC	27	23.7	1185	189.6

## Filter

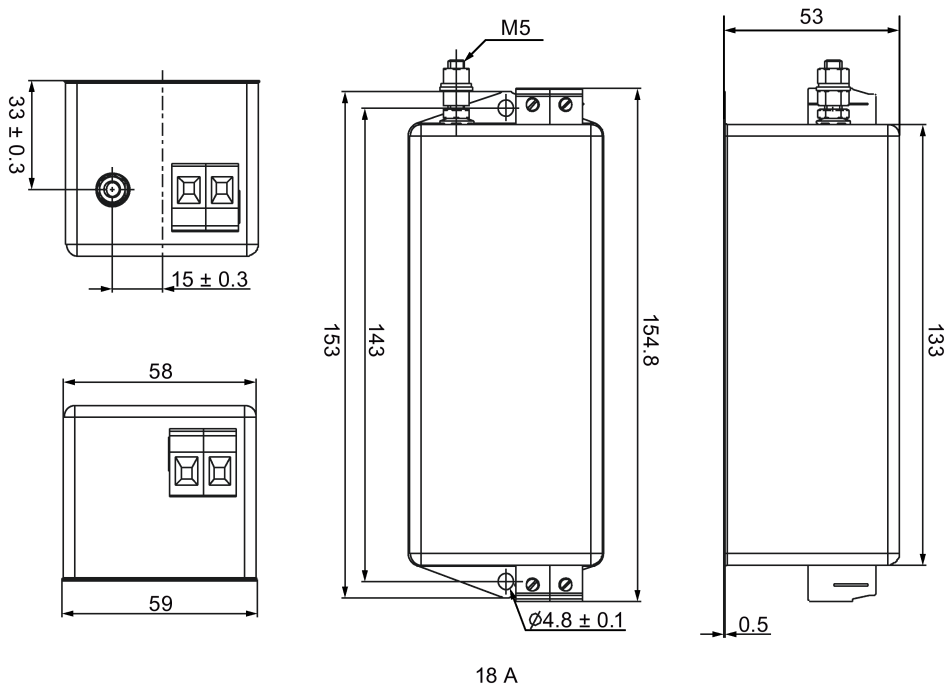
Siemens recommends you to use a line filter to protect the system from high frequency noise. The line filter restricts the conductive interference emitted from the SINAMICS V90 to the permissible values. The SINAMICS V90 drives with these external line filters have been tested in accordance with the emission requirements of the Category C2 environment. The conductive emissions and radiated emissions are in compliance with the Class A requirements of the EN 55011 standard.

The table below lists all filters recommended by Siemens:

SINAMICS V90		Rated current (A)	Degree of protection	Order number	
Power supply	Frame size				
1-phase, 200 VAC to 240 VAC	FSA	18	IP20	6SL3203-0BB21-8VA0	
	FSB				
	FSC				
3-phase, 200 VAC to 240 VAC	FSA	5		IP20	6SL3203-0BE15-0VA0
	FSB				
	FSC	12			6SL3203-0BE21-2VA0
	FSD				
3-phase, 380 VAC to 480 VAC	FSA	5		IP20	6SL3203-0BE15-0VA0
	FSA				
	FSB	12			6SL3203-0BE21-2VA0
	FSC				

Outline dimensions (mm)

Filter used on the single phase power network





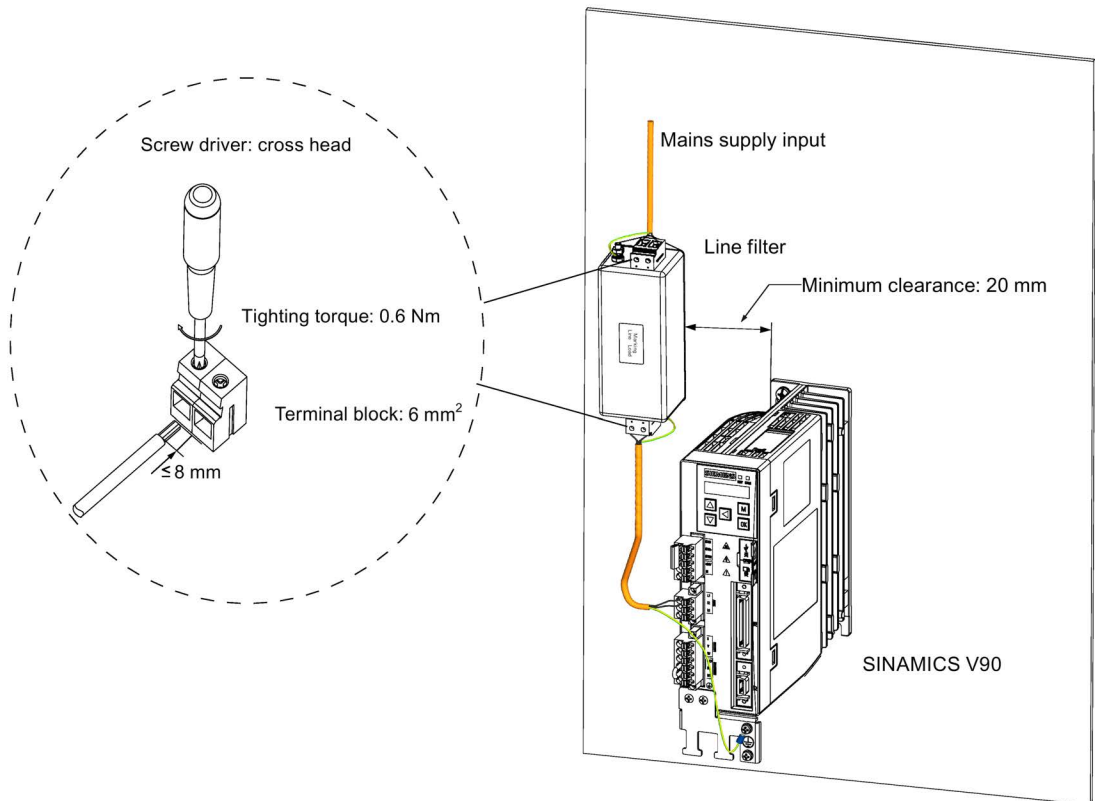


Parameter	Description					
<b>Rated current</b>	<b>12 A</b>					
Noise frequency (MHz)	0.15	0.5	1.0	5.0	10	30
CM (dB)	60	70	70	55	45	15
DM (dB)	60	65	60	50	45	30
<b>Rated current</b>	<b>18 A</b>					
Noise frequency (MHz)	0.15	0.5	1.0	5.0	10	30
CM (dB)	32	70	82	88	81	90
DM (dB)	40	67	68	72	69	59
<b>Rated current</b>	<b>20 A</b>					
Noise frequency (MHz)	0.15	0.5	1.0	5.0	10	30
CM (dB)	60	60	60	55	35	15
DM (dB)	40	55	55	50	45	30

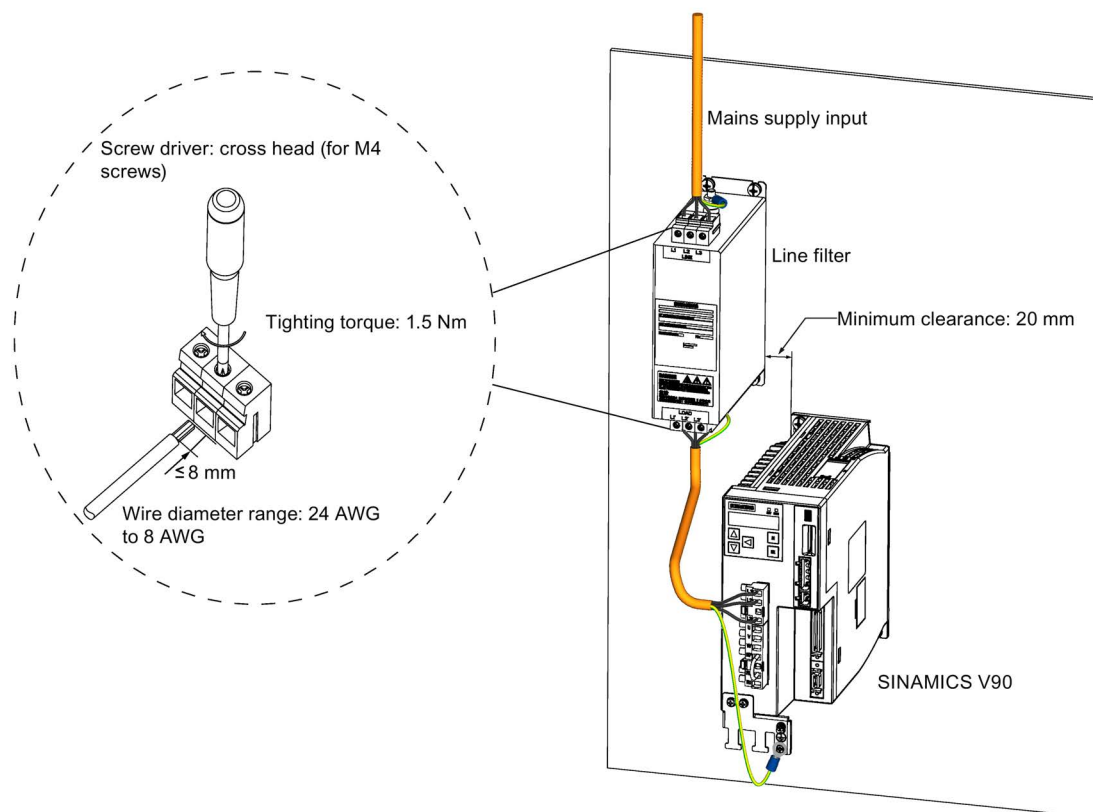
**Connecting (example)**

The figure below provides a connection example. It shows how to connect a line filter to a SINAMICS V90 drive.

**Filter used on the single phase power network**



### Filter used on the three phase power network



### Micro SD card/SD card

Optionally a micro SD card/SD card can be used to copy drive parameters or perform a firmware update. For the servo drives with firmware version 1.04 or higher, you can select high quality micro SD cards/SD cards with a maximum capacity of 32 GB from manufacturers such as Kingston or SanDisk. For the servo drives with earlier firmware version, you can select high quality micro SD cards/SD cards with a maximum capacity of 2 GB from manufacturers such as KINGMAX, Kingston or SanDisk.

### Replacement fans

For SINAMICS V90 400 V variant:

- Fan kits for frame size B: 6SL3200-0WF00-0AA0
- Fan kits for frame size C: 6SL3200-0WF01-0AA0

## 2.6 Function list

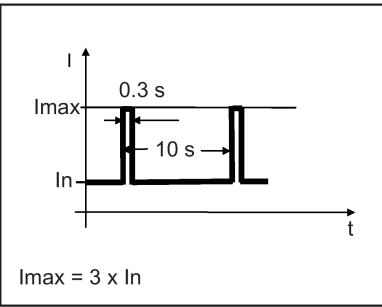
Function	Description	Control mode
Pulse train input position control (PTI) (Page 171)	Implements accurate positioning through two pulse train input channels: 5 V differential or 24 V single end signal. In addition, it supports S-curve position smoothing function	PTI
Internal position control (IPos) (Page 185)	Implements accurate positioning through internal position commands (up to eight groups) and allows to specify the acceleration/speed for positioning	IPos
Speed control (S) (Page 201)	Flexibly controls motor speed and direction through external analog speed commands (0 - ±10 VDC) or internal speed commands (up to seven groups)	S
Torque control (T) (Page 207)	Flexibly controls motor output torque through external analog torque commands (0 - ±10 VDC) or internal torque commands. In addition, it supports speed limit function to prevent overspeed when a motor has no loads	T
Compound controls (Page 161)	Supports flexible switches among position control mode, speed control mode, and torque control mode	PTI/S, IPos/S, PTI/T, IPos/T, S/T
Absolute position system (Page 224)	Allows to implement motion control tasks immediately after the servo system with an absolute encoder is powered on, needless of carrying out referencing or zero position operation beforehand	PTI
Gain switching (Page 264)	Switches between gains during motor rotation or stop with an external signal or internal parameters to reduce noise and positioning time, or improve the operation stability of a servo system	PTI, IPos, S
PI/P switching (Page 268)	Switches from PI control to P control with an external signal or internal parameters to suppress overshooting during acceleration or deceleration (for speed control mode) or to suppress undershooting during positioning and reduce the settling time (for position control mode)	PTI, IPos, S
Safe Torque Off (STO) (Page 243)	Safely disconnects torque-generating motor power supply to prevent an unintentional motor restart	PTI, IPos, S, T
Zero speed clamp (Page 204)	Stops motor and clamps the motor shaft when motor speed setpoint is below a parameterized threshold level	S
Modbus communication (Page 212)	Supports the communication between the SINAMICS V90 servo drive and PLC with the standard Modbus communication protocol	PTI, IPos, S, T
One-button auto tuning (Page 250)	Estimates the machine characteristic and sets the closed loop control parameters (position loop gain, speed loop gain, speed integral compensation, filter if necessary, etc.) without any user intervention	PTI, IPos, S, T
Real-time auto tuning (Page 255)	Estimates the machine characteristic and sets the closed loop control parameters (position loop gain, speed loop gain, speed integral compensation, filter if necessary, etc.) continuously in real time without any user intervention	PTI, IPos, S, T
Resonance suppression (Page 260)	Suppresses the mechanical resonance, such as workpiece vibration and base shake	PTI, IPos, S, T
Low frequency vibration suppression (Page 263)	Suppresses the low frequency vibration in the machine system	IPos

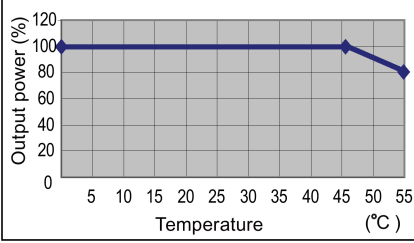
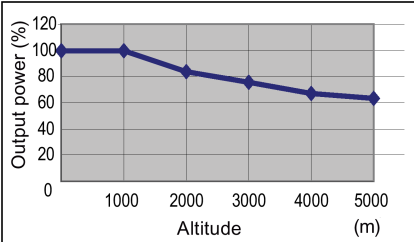

Function	Description	Control mode
Speed limit (Page 178)	Limits motor speed through external analog speed limit commands (0 - $\pm 10$ VDC) or internal speed limit commands (up to three groups)	PTI, IPos, S, T
Torque limit (Page 179)	Limits motor torque through external analog torque limit commands (0 - $\pm 10$ VDC) or internal torque limit commands (up to three groups)	PTI, IPos, S
Electronic gear ratio (Page 173)	Defines a multiplier factor for input pulses	PTI, IPos
Basic operator panel (BOP) (Page 143)	Displays servo status on a 6-digit 7-segment LED display	PTI, IPos, S, T
External braking resistor - DCP, R1 (Page 129)	An external braking resistor can be used when the internal braking resistor is insufficient for regenerative energy	PTI, IPos, S, T
Digital inputs/outputs (DIs/DOs) (Page 91)	Control signals and status signals can be assigned to eight programmable digital inputs and six digital outputs	PTI, IPos, S, T
Smoothing function (Page 173)	Transforms position characteristics from the pulse train input setpoint into an S-curve profile with a parameterized time constant	PTI
SINAMICS V-ASSISTANT	You can perform parameter settings, test operation, adjustment and other operations with a PC	PTI, IPos, S, T

## 2.7 Technical data

### 2.7.1 Technical data - servo drives

#### General technical data

Parameter		Description
24 VDC power supply	Voltage (V)	24 (-15% to +20%) <sup>1)</sup>
	Maximum current (A)	1.6 A (when using a motor without a brake) 3.6 A (when using a motor with a brake)
Overload capability		300% 
Control system		Servo control
Dynamic brake		Built-in
Protective functions		Earthing fault protection, output short-circuit protection <sup>2)</sup> , overvoltage/undervoltage protection, I <sup>2</sup> t inverter, I <sup>2</sup> t motor, IGBT overtemperature protection <sup>3)</sup>
Speed control mode	Speed control range	Analog speed command 1:2000, internal speed command 1:5000
	Analog speed command input	-10 VDC to +10 VDC/rated speed
	Torque limit	Set through a parameter or the analog input command (0 VDC to +10 VDC/max. torque)
Position control mode	Max. input pulse frequency	1 M (differential input), 200 kpps (open collector input)
	Command pulse multiplying factor	Electronic gear ratio (A/B) A: 1 - 10000, B: 1 - 10000 1/50 < A/B < 200
	In-position range setting	0 to ±10000 pulse (command pulse unit)
	Error excessive	±1/10 revolutions
	Torque limit	Set through a parameter or the analog input command (0 VDC to +10 VDC/max. torque)
Torque control mode	Analog torque command input	-10 VDC to +10VDC/max. torque (input impedance 10 kΩ to 12 kΩ)
	Speed limit	Set through a parameter or the analog input command (0 VDC to +10 VDC/max. rated speed)

Parameter		Description		
Environmental conditions	Surrounding air temperature	Operation	0 °C to 45 °C: without power derating 45 °C to 55 °C: with power derating	
				
	Storage	-40 °C to +70 °C		
	Ambient humidity	Operation	< 90% (non-condensing)	
		Storage	90% (non-condensing)	
	Operating environment	Indoors (without direct sunlight), free from corrosive gas, combustible gas, oil gas, or dust		
	Altitude	≤ 1000 m (without power derating)		
				
	Degree of protection	IP 20		
	Degree of pollution	Class 2		
Certifications				

- 1) When SINAMICS V90 works with a motor with a brake, the voltage tolerance of 24 VDC power supply must be -10% to +10% to meet the voltage requirement of the brake.
- 2) Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.
- 3) SINAMICS V90 does not support motor overtemperature protection. Motor overtemperature is calculated by  $I^2t$  and protected by the output current from the drive.

Specific technical data

SINAMICS V90 200 V variant

Order No.	6SL3210-5FB...		10-1UA0	10-2UA0	10-4UA1	10-8UA0	11-0UA1	11-5UA0	12-0UA0	
<b>Frame size</b>			<b>FSA</b>	<b>FSA</b>	<b>FSB</b>	<b>FSC</b>	<b>FSD</b>	<b>FSD</b>	<b>FSD</b>	
Rated output current (A)			1.2	1.4	2.6	4.7	6.3	10.6	11.6	
Max. output current (A)			3.6	4.2	7.8	14.1	18.9	31.8	34.8	
Max. supported motor power (kW)			0.1	0.2	0.4	0.75	1.0	1.5	2	
Output frequency (Hz)			0 to 330							
Power supply	Voltage/frequency		FSA, FSB and FSC: single phase/three phase 200 VAC to 240 VAC, 50/60 Hz FSD: three phase 200 VAC to 240 VAC, 50/60 Hz							
	Permissible voltage fluctuation		-15% to +10%							
	Permissible frequency fluctuation		-10% to +10%							
	Rated input current (A)	1-phase		2.5	3.0	5.0	10.4	-	-	-
		3-phase		1.5	1.8	3.0	5.0	7.0	11.0	12.0
	Power supply capacity (kVA)	1-phase		0.5	0.7	1.2	2.0	-	-	-
3-phase			0.5	0.7	1.1	1.9	2.7	4.2	4.6	
Inrush current (A)			8.0							
Cooling method			Self-cooled				Fan-cooled			
Vibration	Operation	Shock:	Operational area II Peak acceleration: 5 g, 30 ms and 15 g, 11 ms Quantity of shocks: 3 per direction × 6 direction Duration of shock: 1 s							
		Vibration:	Operational area II 10 Hz to 58 Hz: 0.075 mm deflection 58 Hz to 200 Hz: 1g vibration							
	Transport	Vibration:	2 Hz to 9 Hz: 7.5 mm deflection 9 Hz to 200 Hz: 2 g vibration Quantity of cycles: 10 per axis Sweep seed: 1 octave/min							
	Storage	Vibration:	2 Hz to 9 Hz: 3.5 mm deflection 9 Hz to 200 Hz: 1 g vibration Quantity of cycles: 10 per axis Sweep seed: 1 octave/min							
Mechanical design	Outline dimensions (W x H x D, mm)	45 x 170 x 170			55 x 170 x 170	80 x 170 x 195	95 x 170 x 195			
Weight (kg)			1.1	1.3	2.0	2.3	2.4			

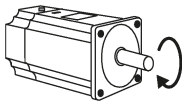



## SINAMICS V90 400 V variant

Order No.	6SL3210-5FE...		10-4UA0	10-8UA0	11-0UA0	11-5UA0	12-0UA0	13-5UA0	15-0UA0	17-0UA0
Frame size			FSAA	FSA	FSA	FSB	FSB	FSC	FSC	FSC
Rated output current (A)			1.2	2.1	3.0	5.3	7.8	11.0	12.6	13.2
Max. output current (A)			3.6	6.3	9.0	13.8	23.4	33.0	37.8	39.6
Max. supported motor power (kW)			0.4	0.75	1.0	1.75	2.5	3.5	5.0	7.0
Output frequency (Hz)			0 to 330							
Power supply	Voltage/frequency		3-phase 380 VAC to 480 VAC, 50/60 Hz							
	Permissible voltage fluctuation		-15% to +10%							
	Permissible frequency fluctuation		-10% to +10%							
	Rated input current (A)		1.5	2.6	3.8	5.8	9.8	13.8	15.8	16.5
	Power supply capacity (kVA)		1.7	3.0	4.3	6.6	11.1	15.7	18.0	18.9
	Inrush current (A)		8.0	8.0	8.0	4.0	4.0	2.5	2.5	2.5
Cooling method			Self-cooled			Fan-cooled				
Vibration	Operation	Shock:	Operational area II Peak acceleration: 5 g Duration of shock: 30 ms							
		Vibration:	Operational area II 10 Hz to 58 Hz: 0.075 mm deflection 58 Hz to 200 Hz: 1g vibration							
	Transport & storage	Vibration:	5 Hz to 9 Hz: 7.5 mm deflection 9 Hz to 200 Hz: 2 g vibration Vibration class: 2M3 transportation							
Mechanical design	Outline dimensions (W x H x D, mm)	60 x 180 x 200	80 x 180 x 200			100 x 180 x 220		140 x 260 x 240		
Weight (kg)			1.800	2.500	2.510	3.055	3.130	6.515	6.615	6.615

2.7.2 Technical data - servo motors

General technical data

Parameter	Description
Type of motor	Permanent-magnet synchronous motor
Cooling	Self-cooled
Relative humidity [RH]	90% (non-condensing at 30°C )
Installation altitude [m]	≤ 1000 (without power derating)
Thermal class	B
Vibration severity grade	A (according to IEC 60034-14)
Shock resistance [m/s <sup>2</sup> ]	25 (continuous in axial direction); 50 (continuous in radial direction); 250 (in a short time of 6 ms)
Bearing lifetime [h]	> 20000 <sup>1)</sup>
Paint finish	Black
Protection degree of shaft	IP 65, with shaft oil seal
Type of construction	IM B5, IM V1, and IM V3
Positive rotation	Clockwise (default setting in SINAMICS V90 servo drives) 
Certification	

<sup>1)</sup> This lifetime is only for reference. When a motor keeps running at rated speed under rated load, replace its bearing after 20,000 to 30,000 hours of service time. Even if the time is not reached, the bearing must be replaced when unusual noise, vibration, or faults are found.

Specific technical data

SIMOTICS S-1FL6, low inertia servo motor

Order No.	1FL60...	22	24	32	34	42	44	52	54
Rated power [kW]		0.05	0.1	0.2	0.4	0.75	1	1.5	2
Rated torque [Nm]		0.16	0.32	0.64	1.27	2.39	3.18	4.78	6.37
Maximum torque [Nm]		0.48	0.96	1.91	3.82	7.2	9.54	14.3	19.1
Rated speed [rpm]		3000							
Maximum speed [rpm]		5000							
Rated frequency [Hz]		200							
Rated current [A]		1.2	1.2	1.4	2.6	4.7	6.3	10.6	11.6
Maximum current [A]		3.6	3.6	4.2	7.8	14.2	18.9	31.8	34.8
Moment of inertia [10 <sup>-4</sup> kgm <sup>2</sup> ]		0.031	0.052	0.214	0.351	0.897	1.15	2.04	2.62

Order No.	1FL60...	22	24	32	34	42	44	52	54
Moment of inertia (with brake) [ $10^{-4}$ kgm <sup>2</sup> ]		0.038	0.059	0.245	0.381	1.06	1.31	2.24	2.82
Recommended load to motor inertia ratio		Max. 30x				Max. 20x		Max. 15x	
Operating temperature [°C]		1FL602□, 1FL603□ and 1FL604□: 0 to 40 (without power derating) 1FL605□: 0 to 30 (without power derating)							
Storage temperature [°C]		-20 to +65							
Maximum noise level [dB]		60							
Holding brake	Rated voltage (V)	24 ± 10%							
	Rated current (A)	0.25		0.3		0.35		0.57	
	Holding brake torque [Nm]	0.32		1.27		3.18		6.37	
	Maximum brake opening time [ms]	35		75		105		90	
	Maximum brake closing time [ms]	10		10		15		35	
	Maximum number of emergency stops	2000 <sup>1)</sup>							
Oil seal lifetime [h]		3000 to 5000							
Encoder lifetime [h]		> 20000 <sup>2)</sup>							
Protection degree of motor body		IP 65							
Protection degree of cable end connector		IP20						-	
Weight [kg]	With brake	0.70	0.86	1.48	1.92	3.68	4.20	6.76	8.00
	Without brake	0.47	0.63	1.02	1.46	2.80	3.39	5.35	6.56

1) Restricted emergency stop operation is permissible. Up to 2000 braking operations can be executed with 300% rotor moment of inertia as external moment of inertia from a speed of 3000 rpm without the brake being subject to an inadmissible amount of wear.

2) This lifetime is only for reference. When a motor keeps running at 80% rated value and the surrounding temperature is 30 °C, the encoder lifetime can be ensured.

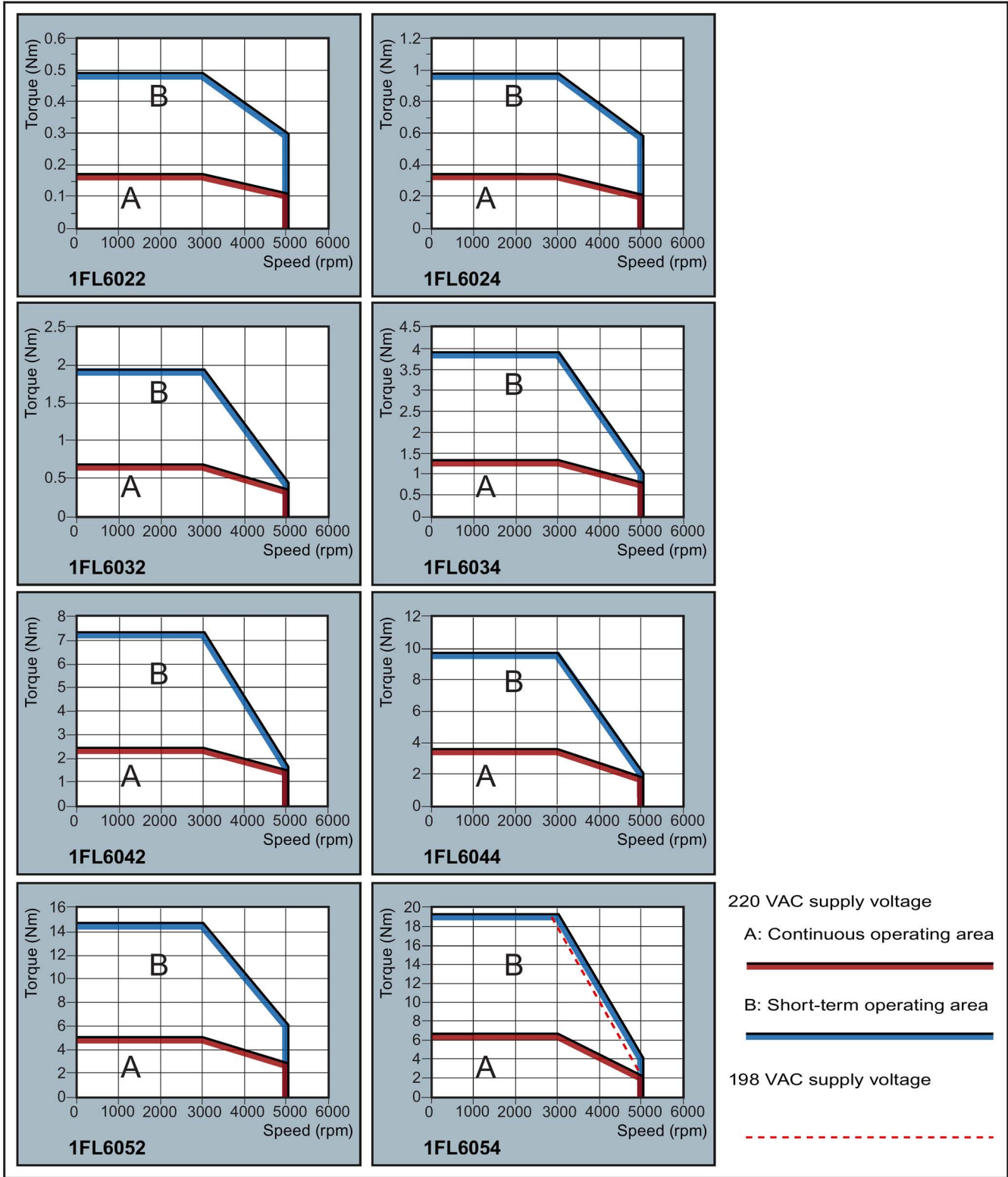
**Note:**

When the surrounding temperature is between 30 °C and 40 °C, the 1FL605 motor will have a power derating of 10%.

**Note**

The data of rated torque, rated power, maximum torque, and armature resistance in the above table allow a tolerance of 10%.

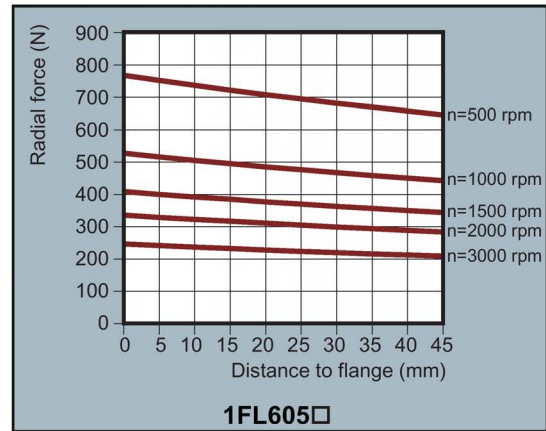
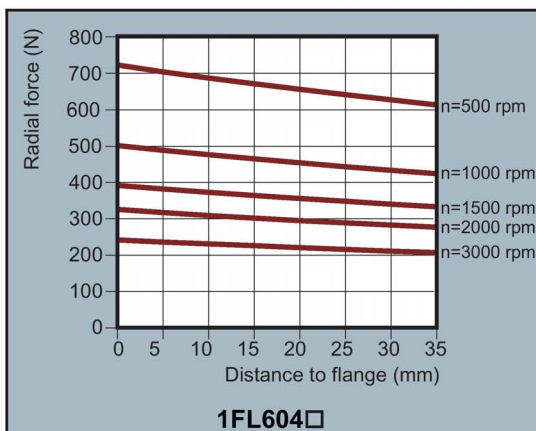
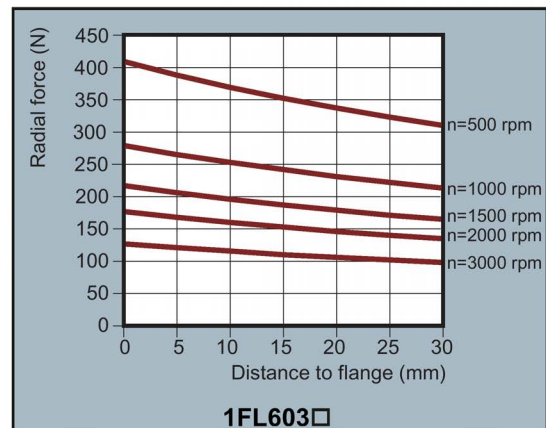
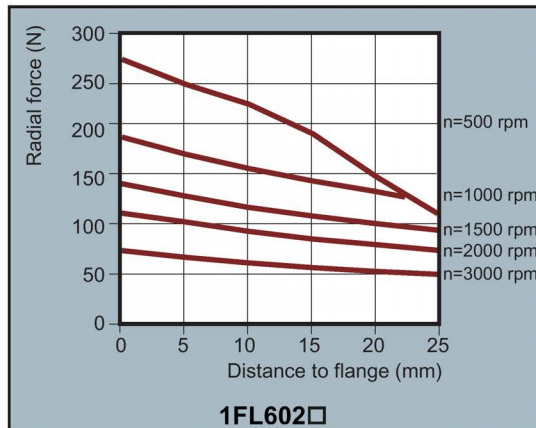
Torque-Speed characteristics



**Note**

- Continuous operating area is a series of states when a motor can operate continuously and safely. The effective torque must be located in this area.
- Short-term operating area is a series of states when a motor can operate for a short duration if its effective torque is larger than the rated torque.
- For the motors with different rated and maximum speeds, the output torque will decline at a faster rate after the speed exceeds the rated speed.
- The feature in short-term operating area varies with power supply voltages.
- The continuous operating area becomes smaller and the voltage consumptions on the cables grow larger when the cables in the major loop exceed 20 m.

**Permissible radial and axial forces**



**Axial force:**

When using, for example, helical toothed wheels as drive element, in addition to the radial force, there is also an axial force on the motor bearings. For axial forces, the spring-loading of the bearings can be overcome so that the rotor moves corresponding to the axial bearing present (up to 0.2 mm).

The permissible axial force can be approximately calculated using the following formula:

$$F_A = 0.35 \cdot F_r$$

Where  $F_A$  represents axial force and  $F_r$  radial force.

**SIMOTICS S-1FL6, high inertia servo motor**

Order No.	1FL60...	42	44	61	62	64	66	67	90	92	94	96
Rated power [kW]		0.40	0.75	0.75	1.00	1.50	1.75	2.00	2.5	3.5	5.0	7.0 <sup>1)</sup>
Rated torque [Nm]		1.27	2.39	3.58	4.78	7.16	8.36	9.55	11.9	16.7	23.9	33.4
Maximum torque [Nm]		3.8	7.2	10.7	14.3	21.5	25.1	28.7	35.7	50.0	70.0	90.0
Rated speed [rpm]		3000			2000				2000			
Maximum speed [rpm]		4000			3000				3000		2500	2000
Rated frequency [Hz]		200			133				133			
Rated current [A]		1.2	2.1	2.5	3.0	4.6	5.3	5.9	7.8	11.0	12.6	13.2
Maximum current [A]		3.6	6.3	7.5	9.0	13.8	15.9	17.7	23.4	33.0	36.9	35.6
Moment of inertia [10 <sup>-4</sup> kgm <sup>2</sup> ]		2.7	5.2	8.0	15.3	15.3	22.6	29.9	47.4	69.1	90.8	134.3
Moment of inertia (with brake) [10 <sup>-4</sup> kgm <sup>2</sup> ]		3.2	5.7	9.1	16.4	16.4	23.7	31.0	56.3	77.9	99.7	143.2
Recommended load to motor inertia ratio		Max. 10×		Max. 5×				Max. 5×				
Operating temperature [°C]		0 to 40 (without power derating)										
Storage temperature [°C]		-15 to +65										
Maximum noise level [dB]		65			70				70			
Holding brake	Rated voltage (V)	24 ± 10%										
	Rated current (A)	0.88			1.44				1.88			
	Holding brake torque [Nm]	3.5			12				30			
	Maximum brake opening time [ms]	60			180				220			
	Maximum brake closing time [ms]	45			60				115			
	Maximum number of emergency stops	2000 <sup>2)</sup>										
Oil seal lifetime [h]		5000										
Encoder lifetime [h]		20000 - 30000 <sup>3)</sup>										
Degree of protection		IP65, with shaft oil seal										

Order No.	1FL60...	42	44	61	62	64	66	67	90	92	94	96
Weight of incremental encoder motor [kg]	With brake	4.6	6.4	8.6	11.3	11.3	14.0	16.6	21.3	25.7	30.3	39.1
	Without brake	3.3	5.1	5.6	8.3	8.3	11.0	13.6	15.3	19.7	24.3	33.2
Weight of absolute encoder motor [kg]	With brake	4.4	6.2	8.3	11.0	11.0	13.6	16.3	20.9	25.3	29.9	38.7
	Without brake	3.1	4.9	5.3	8.0	8.0	10.7	13.3	14.8	19.3	23.9	32.7

- 1) When the surrounding temperature is higher than 30 °C, the 1FL6096 motors with brake will have a power derating of 10%.
- 2) Restricted emergency stop operation is permissible. Up to 2000 braking operations can be executed with 300% rotor moment of inertia as external moment of inertia from a speed of 3000 rpm without the brake being subject to an inadmissible amount of wear.
- 3) This lifetime is only for reference. When a motor keeps running at 80% rated value and the surrounding temperature is 30 °C, the encoder lifetime can be ensured.

---

### Note

The data of rated torque, rated power, and maximum torque in the above table allow a tolerance of 10%.

---

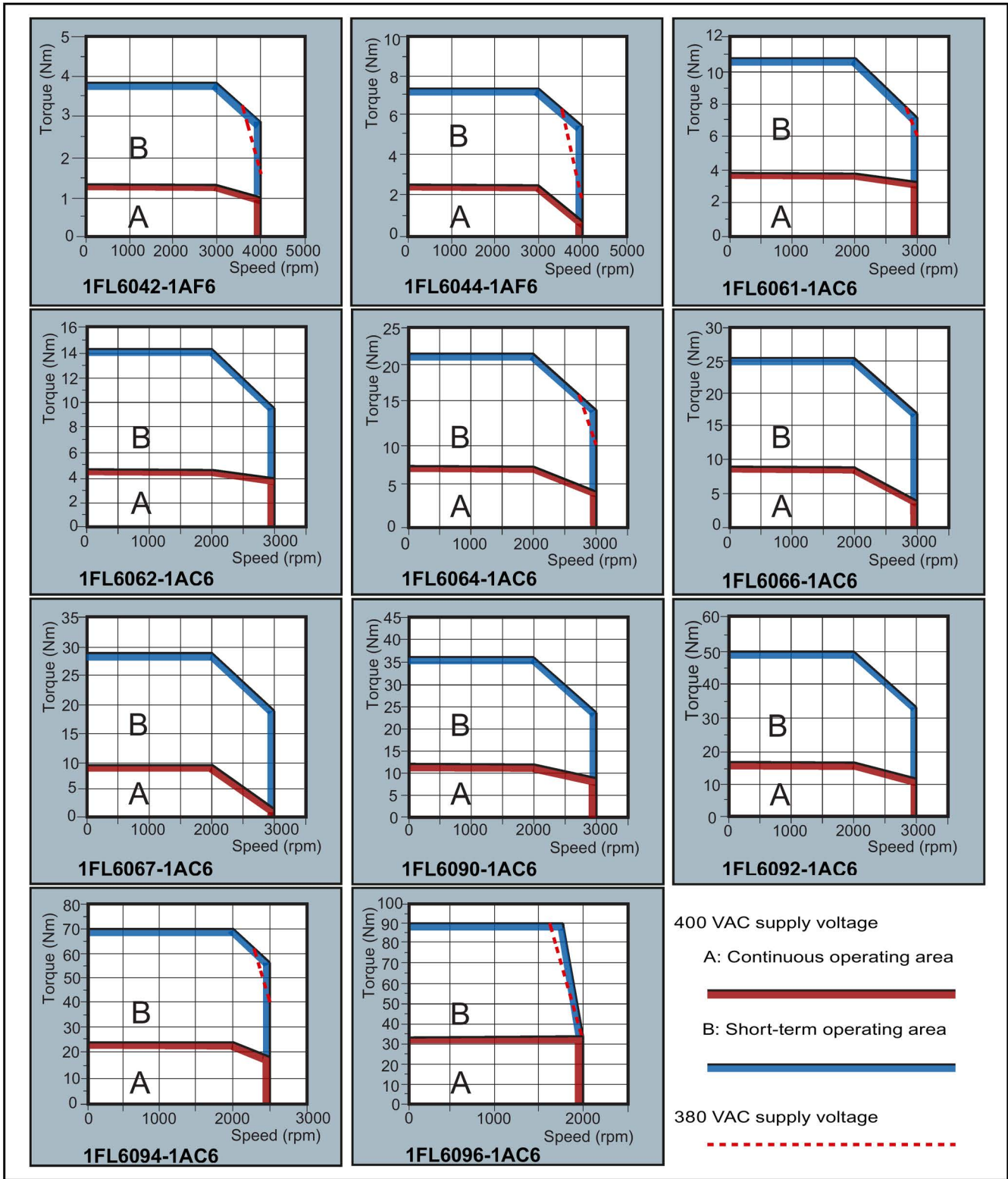
### Power derating

For deviating conditions (surrounding temperature > 40 °C or installation altitude > 1000 m above sea level) the permissible torque/power must be determined from the following table. Surrounding temperatures and installation altitudes are rounded off to 5 °C and 500 m respectively.

### Power derating as a function of the installation altitude and ambient temperature

Installation altitude above sea level (m)	Surrounding temperature in °C				
	< 30	30 to 40	45	50	55
1000	1.07	1.00	0.96	0.92	0.87
1500	1.04	0.97	0.93	0.89	0.84
2000	1.00	0.94	0.90	0.86	0.82
2500	0.96	0.90	0.86	0.83	0.78
3000	0.92	0.86	0.82	0.79	0.75
3500	0.88	0.82	0.79	0.75	0.71
4000	0.82	0.77	0.74	0.71	0.67

Torque-Speed characteristics

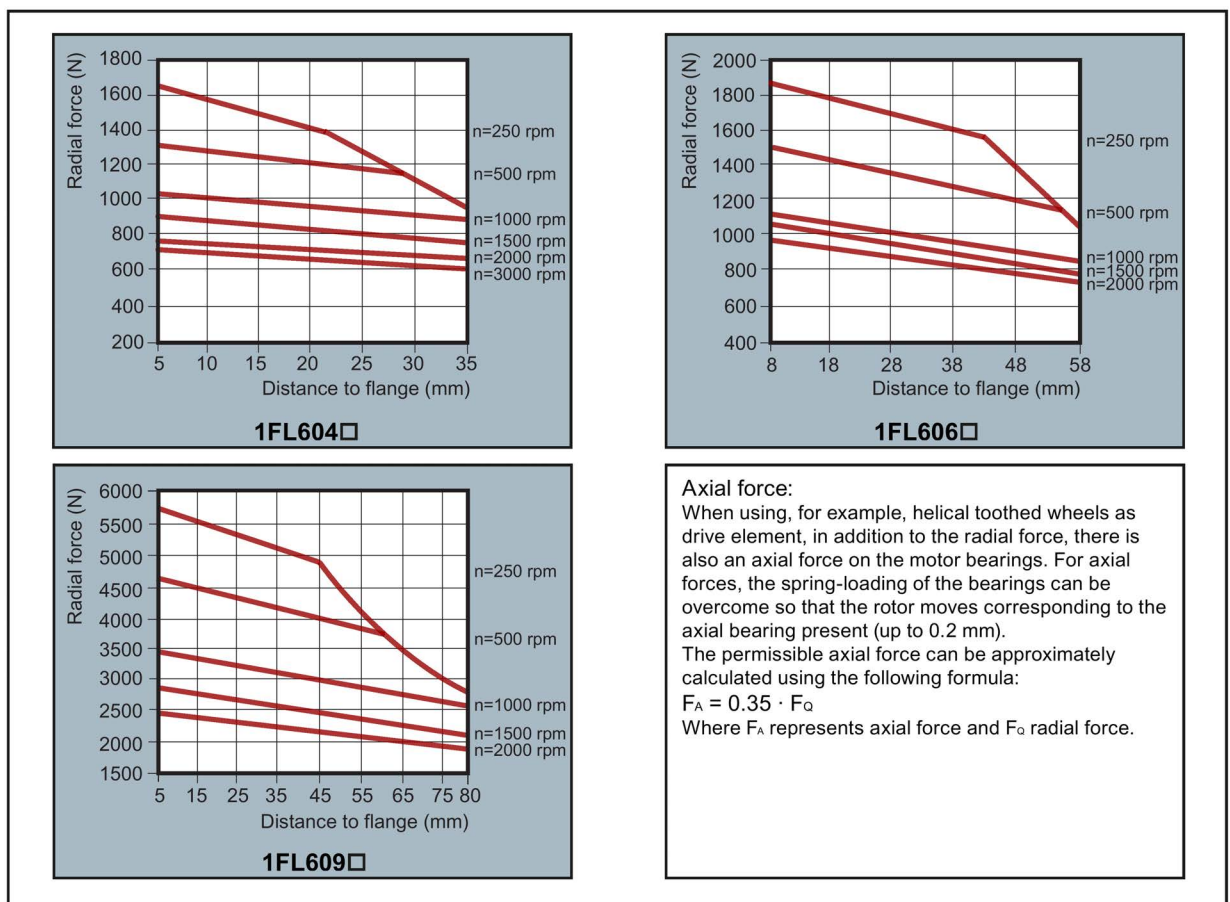




**Note**

- Continuous operating area is a series of states when a motor can operate continuously and safely. The effective torque must be located in this area.
- Short-term operating area is a series of states when a motor can operate for a short duration if its effective torque is larger than the rated torque.
- For the motors with different rated and maximum speeds, the output torque will decline at a faster rate after the speed exceeds the rated speed.
- The feature in short-term operating area varies with power supply voltages.
- The continuous operating area becomes smaller and the voltage consumptions grows larger when the cables in the major loop exceed 20 meters.
- For 1FL6096 motors, the maximum speed can be ensured when the line supply voltage is higher than 380V.

**Permissible radial and axial forces**



**Note**

1FL604 and 1FL609 have a 5 mm of shaft sheltered in sleeves, and 1FL606 has an 8 mm of shaft in sleeves. Therefore, the distances to flange in the above three figures begin respectively from 5 mm, 8mm, and 5 mm.

2.7.3 Technical data - cables

Cables used in V90 200 V variant servo system

Parameter	MOTION-CONNECT 300 Power Cable	MOTION-CONNECT 300 Encoder Cable	MOTION-CONNECT 300 Brake Cable
Jacket material	PVC	PVC	PVC
Number of cores	4	10	2
Cross-section of cores (mm <sup>2</sup> )	4 x 0.75 (for motors of 0.05 kW to 1 kW) 4 x 2.5 (for motors of 1.5 kW to 2 kW)	3 x 2 x 0.20 + 4 x 0.25	2 x 0.75
Rated voltage (V)	300/500	30	30
Degree of protection (motor-side only)	IP20 (for motors of 0.05 kW to 1 kW) IP65 (for motors of 1.5 kW to 2 kW)		
Operation temperature (°C)	-25 to 80		
Shielding	Yes		
Minimum bending radius, static (mm)	6 x outer diameter		
Minimum bending radius, dynamic (mm)	155		
Bending cycles	Maximum acceleration 3 m/s <sup>2</sup> , maximum speed 40 m/min: 100000 (for motors of 0.05 kW to 1 kW) 1000000 (for motors of 1.5 kW to 2 kW)		
Oil resistance	EN60811-2-1 fulfilled		
Flame-retardant	EN60332-1-1 to 1-3 fulfilled		
Certifications	RoHS, CE	RoHS	RoHS

Cables used in V90 400 V variant servo system

Parameter	MOTION-CONNECT 300 Power Cable	MOTION-CONNECT 300 Encoder Cable	MOTION-CONNECT 300 Brake Cable
Material	PVC	PVC	PVC
Degree of protection (motor-side only)	IP65	IP65	IP65
Number of cores	4	10	2
Cross-section of cores (mm <sup>2</sup> )	4 x 1.5 (for FSAA/FSA) 4 x 2.5 (for FSB/FSC)	6 x 0.22 + 4 x 0.25	2 x 0.75
Rated voltage (V)	600/1000	30	30
Operation temperature (°C)	-25 to 80		
Shielding	Yes		
Minimum bending radius, static (mm)	6 x outer diameter		
Bending cycles	1000000		
Oil resistance	EN60811-2-1 fulfilled		
Flame-retardant	EN60332-1-1to 1-3 fulfilled		
Certifications	RoHS, UL, CE		

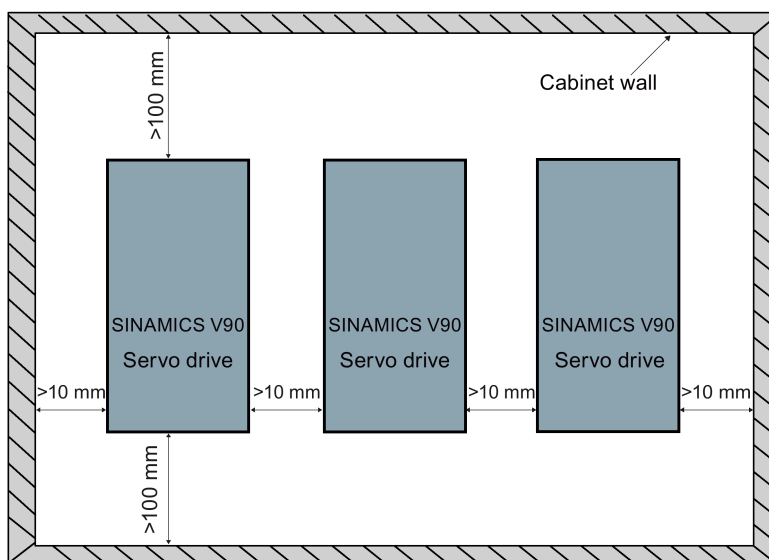
## Mounting

### 3.1 Mounting the drive

For mounting conditions, see Technical data - servo drives (Page 54).

#### 3.1.1 Mounting orientation and clearance

Mount the drive vertically in a shielded cabinet and observe the mounting clearances specified in the illustration below:



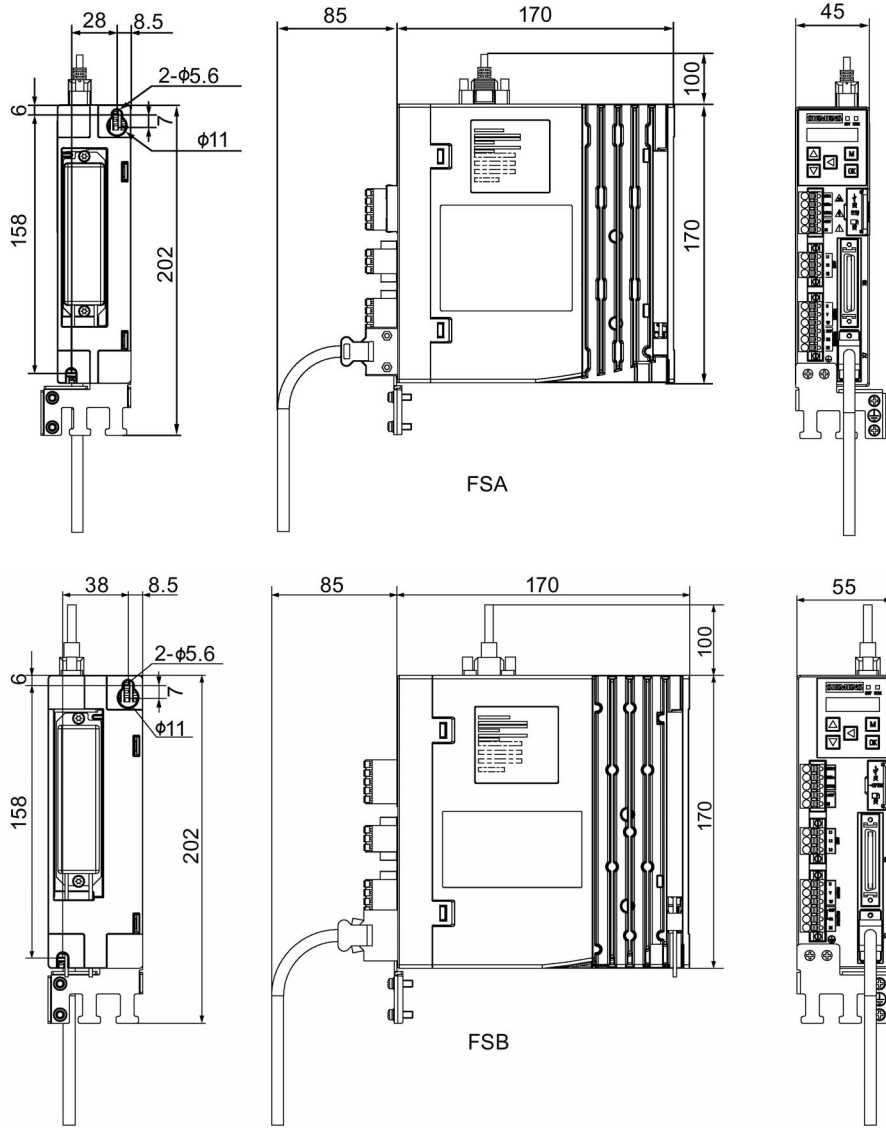
#### Note

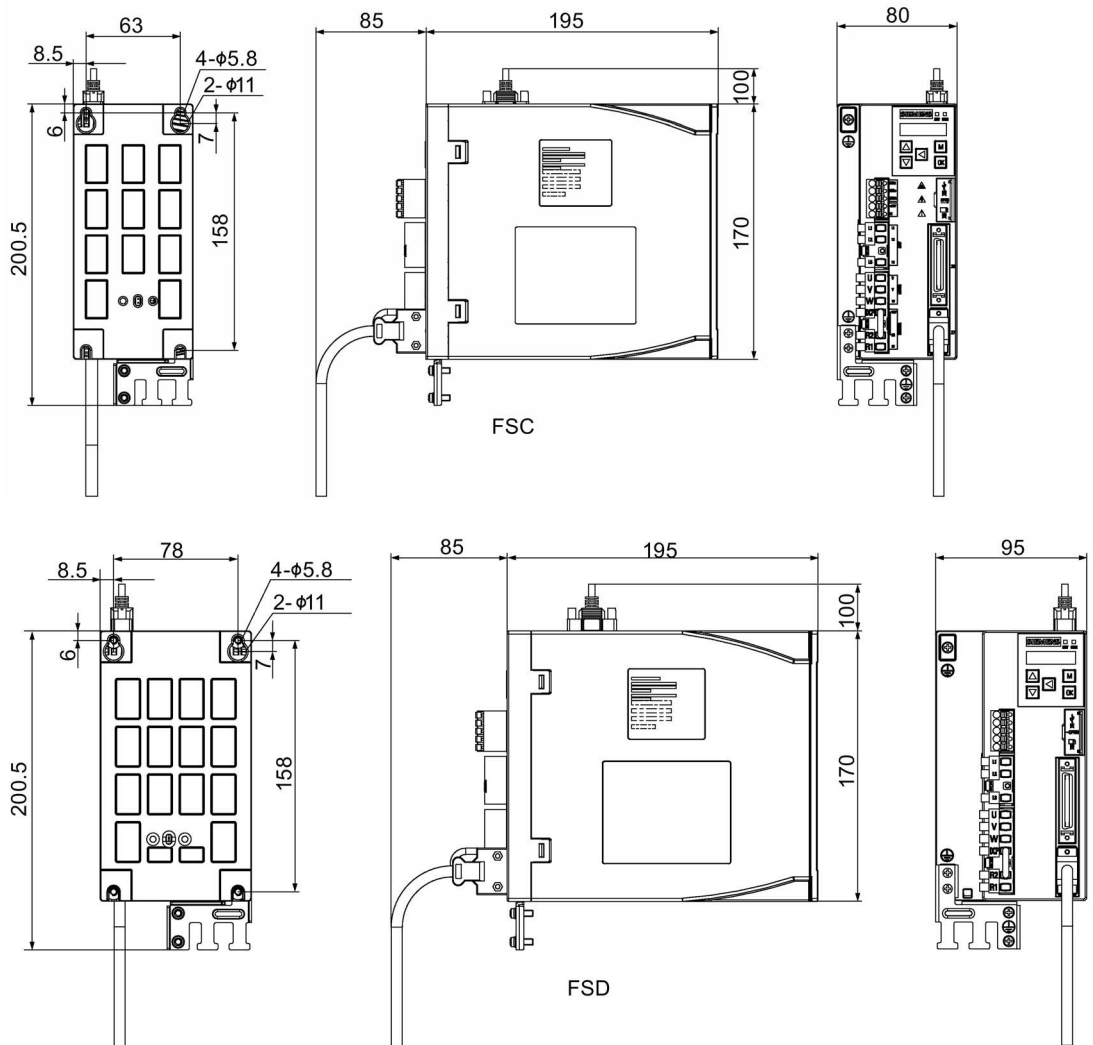
The drive must be derated to 80% when the following conditions are satisfied:

- The surrounding temperature is  $0\text{ °C}$  to  $45\text{ °C}$ , and the mounting clearance is less than  $10\text{ mm}$ . In this case, the minimum mounting clearance should not be less than  $5\text{ mm}$ .
- The surrounding temperature is  $45\text{ °C}$  to  $55\text{ °C}$ . In this case, the minimum mounting clearance should not be less than  $20\text{ mm}$ .

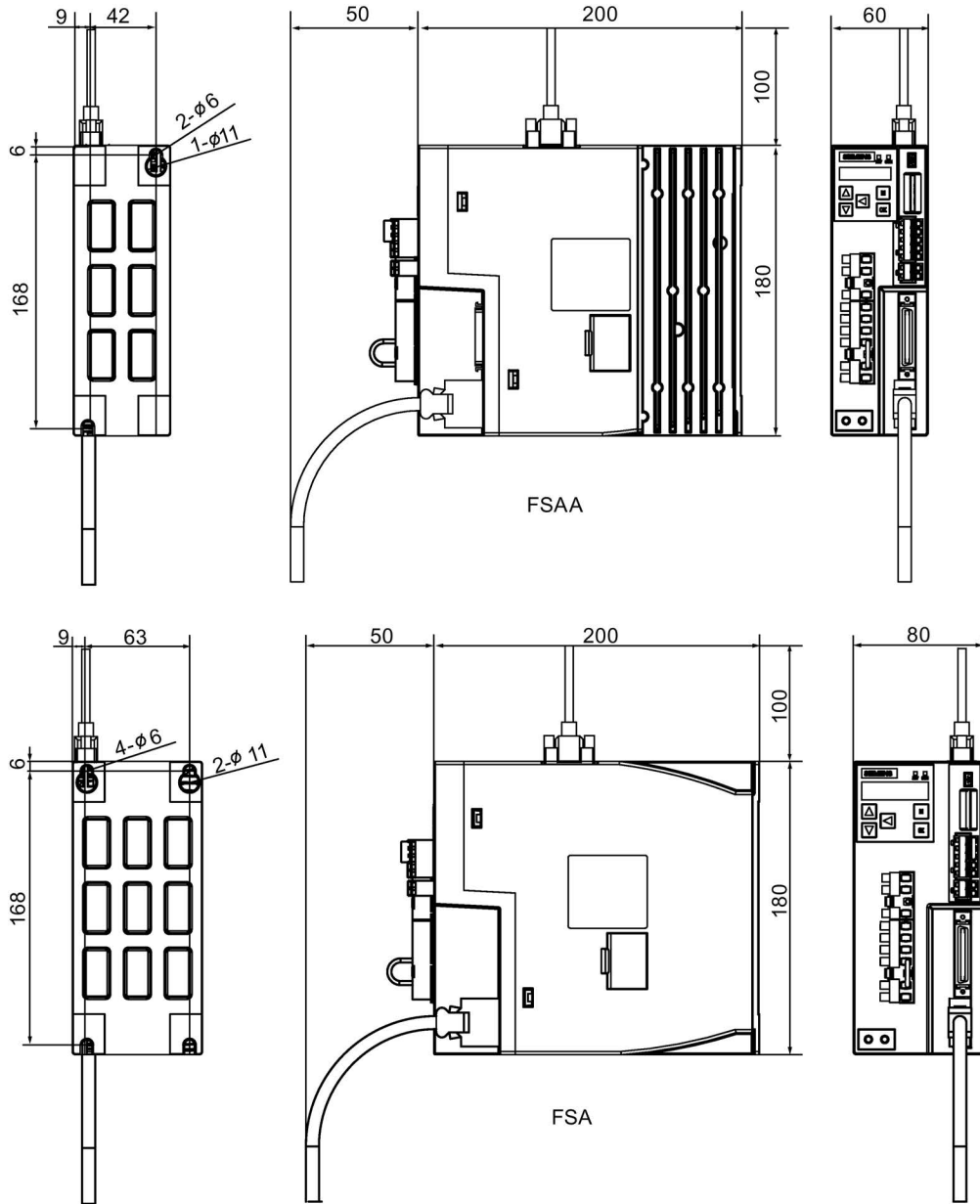
### 3.1.2 Drill patterns and outline dimensions

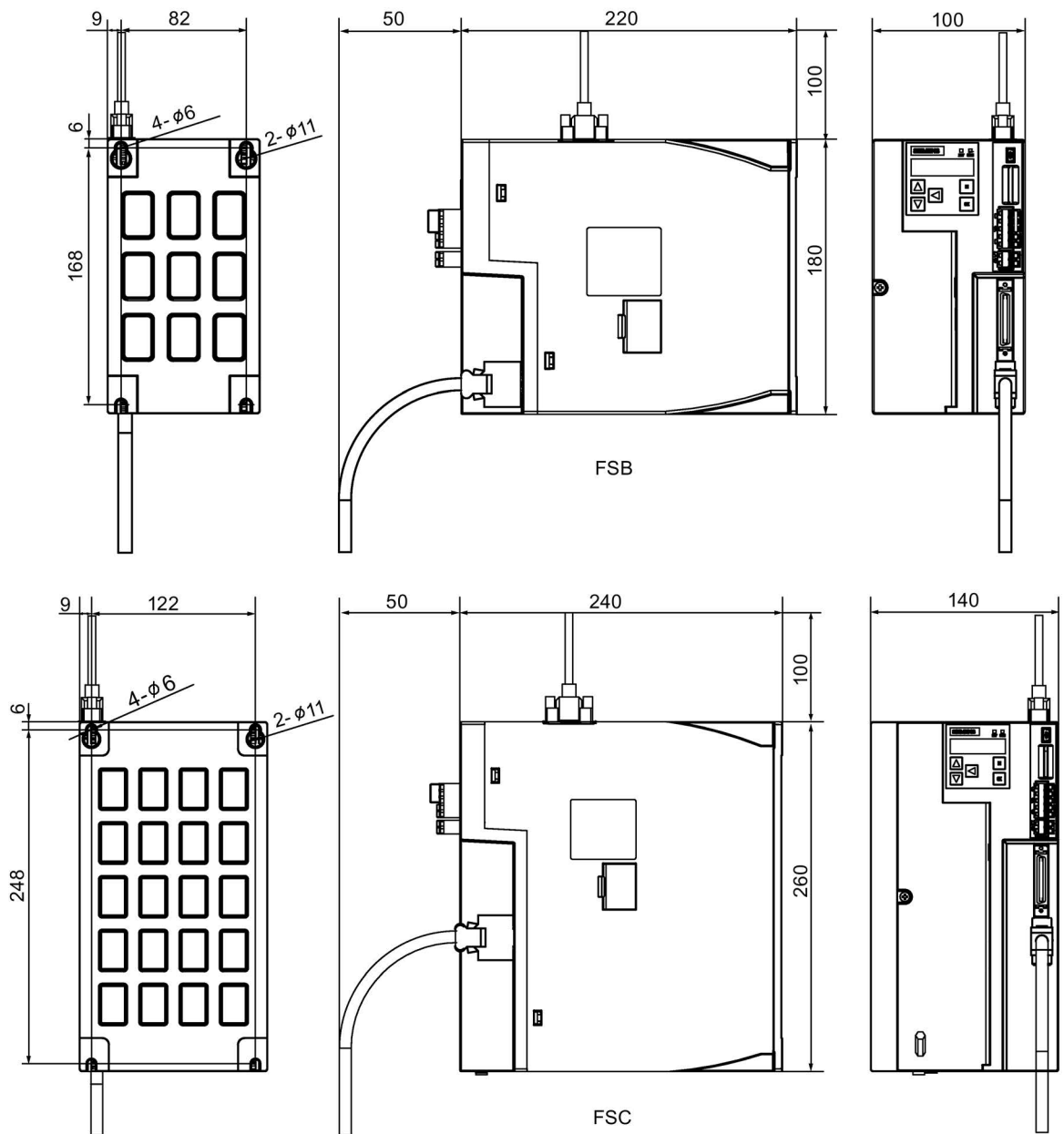
SINAMICS V90 200 V variant (unit: mm)



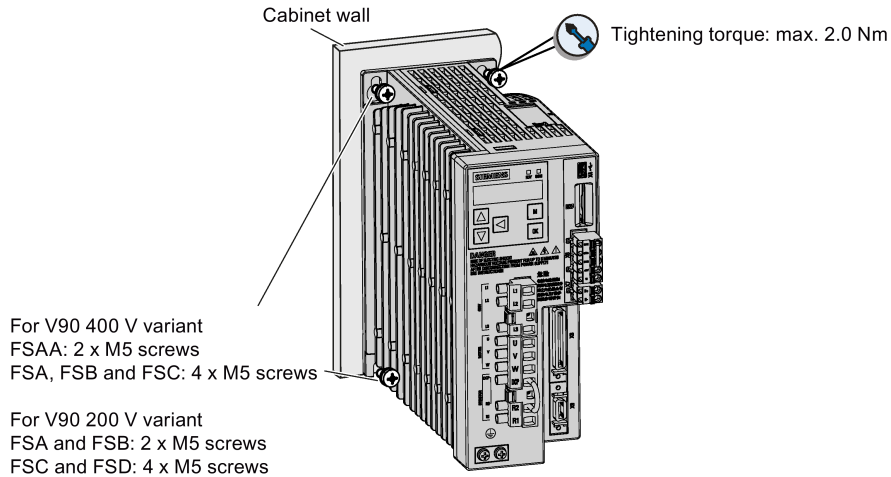


SINAMICS V90 400 V variant (unit: mm)





### 3.1.3 Mounting the drive



---

#### Note

Taking EMC factors into account, you are recommended to mount the drive in a shielded cabinet.

---

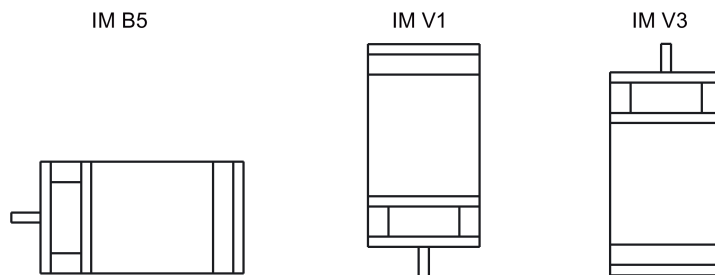
## 3.2 Mounting the motor

For mounting conditions, see Technical data - servo motors (Page 58).

### 3.2.1 Mounting orientation and dimensions

#### Mounting orientation

SIMOTICS S-1FL6 supports flange mounting only and three types of constructions, so it can be installed in three orientations as shown in the following figure.

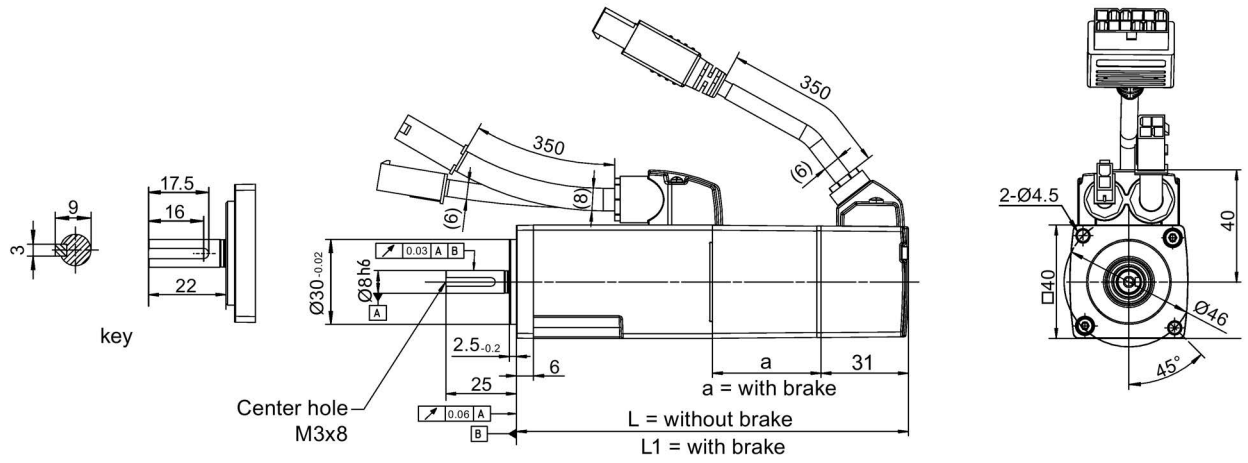




**Note**

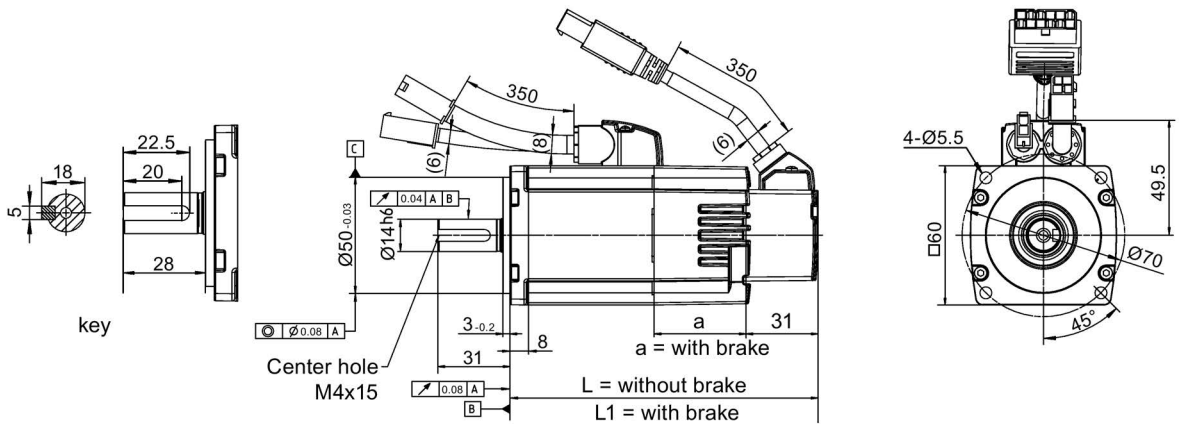
When configuring the IM V3 type of construction, pay particular attention to the permissible axial force (weight force of the drive elements) and the necessary degree of protection.

**SIMOTICS S-1FL6 Low inertia servo motors**  
Shaft-height 20 mm (unit: mm)



Rated power	Rated torque	a	L	L1
0.05 kW	0.16 Nm	38.5	86	119
0.1 kW	0.32 Nm	38.5	106	139

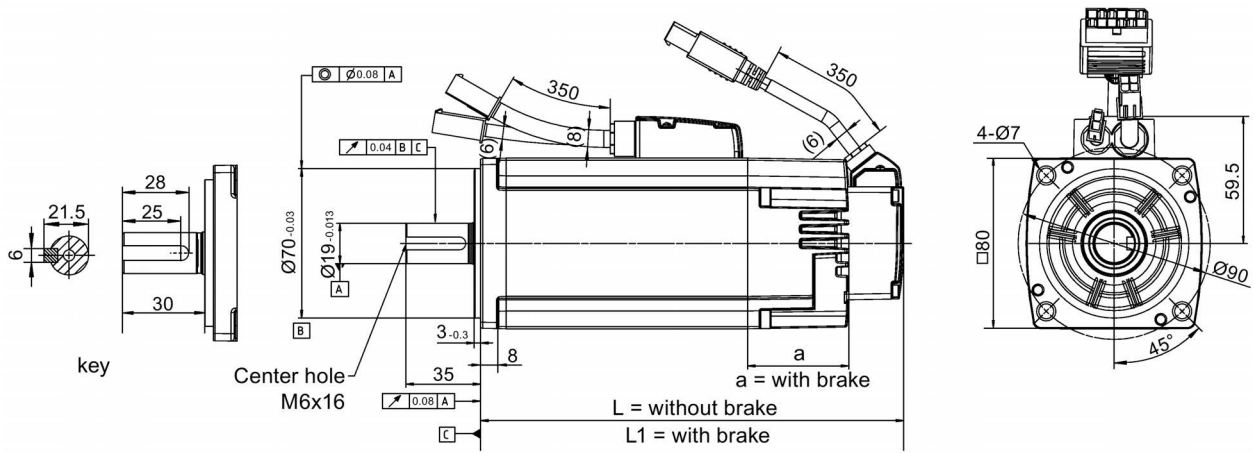
Shaft-height 30 mm (unit: mm)



Rated power	Rated torque	a	L	L1
0.2 kW	0.64 Nm	39.5	98	132.5
0.4 kW	1.27 Nm	39.5	123	157.5

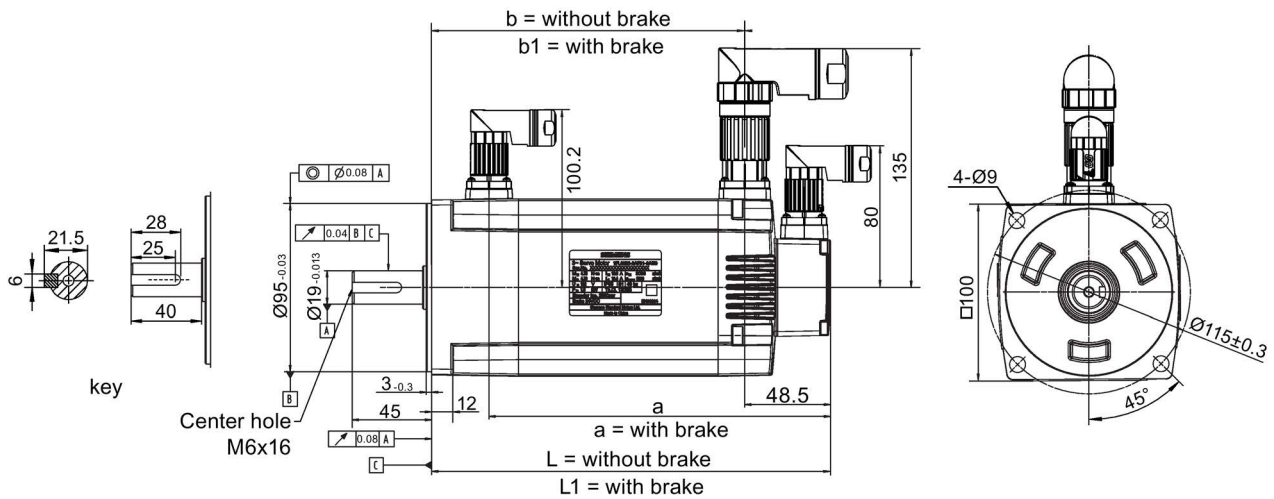
3.2 Mounting the motor

Shaft-height 40 mm (unit: mm)



Rated power	Rated torque	a	L	L1
0.75 kW	2.39 Nm	48	139	178.3
1.0 kW	3.18 Nm	48	158.8	198.1

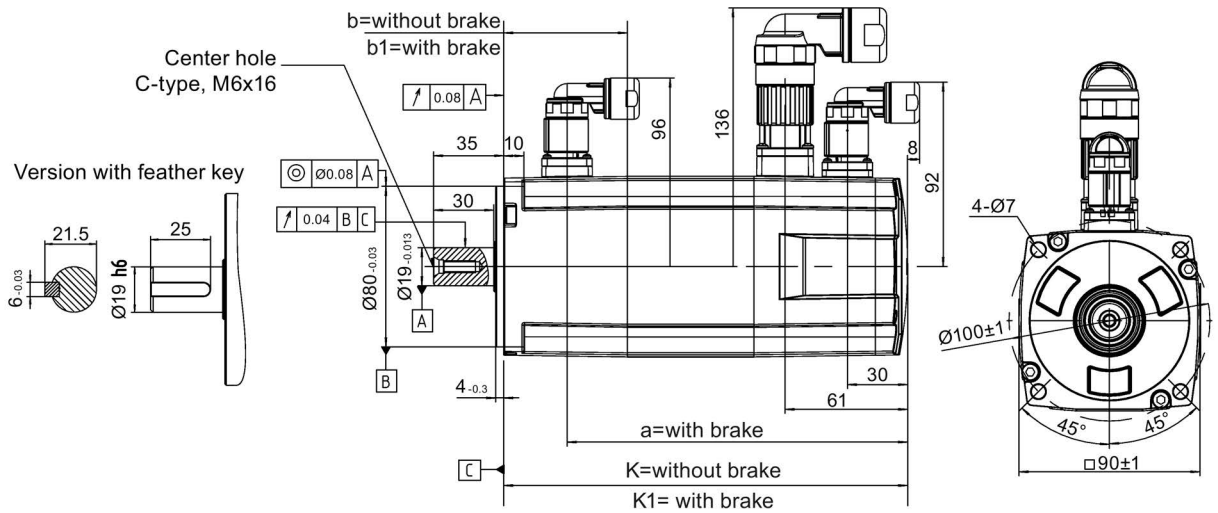
Shaft-height 50 mm (unit: mm)



Rated power	Rated torque	a	b	b1	L	L1
1.5 kW	4.78 Nm	195	143.5	177.5	192	226
2.0 kW	6.37 Nm	219	167.5	201.5	216	250

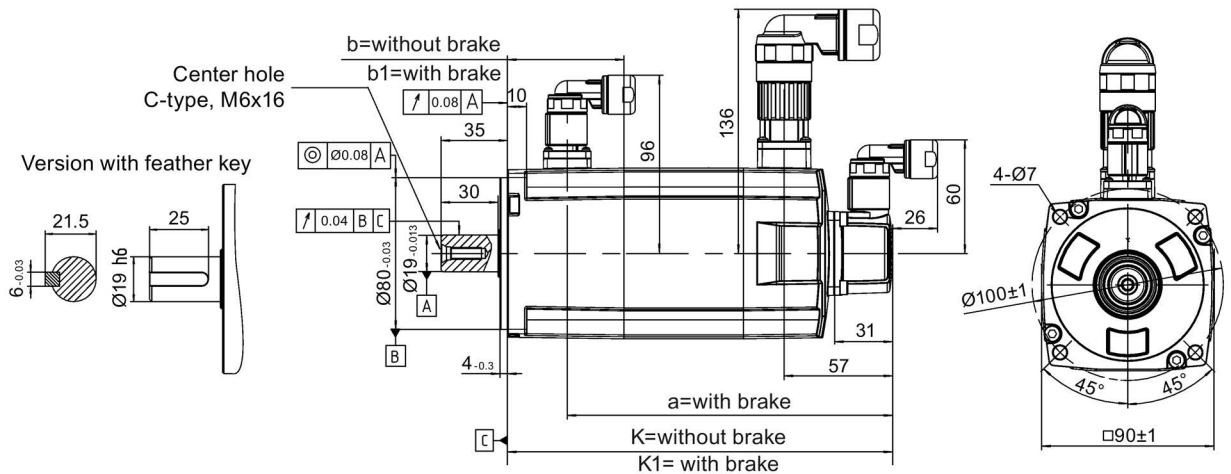
**SIMOTICS S-1FL6 high inertia servo motors**

**Shaft-height 45 mm, with incremental encoder (unit: mm)**



Rated power	Rated torque	k	k1	a	b	b1
0.4 kW	1.27 Nm	154.5	201	169.5	15	61.5
0.75 kW	2.39 Nm	201.5	248	216.5		

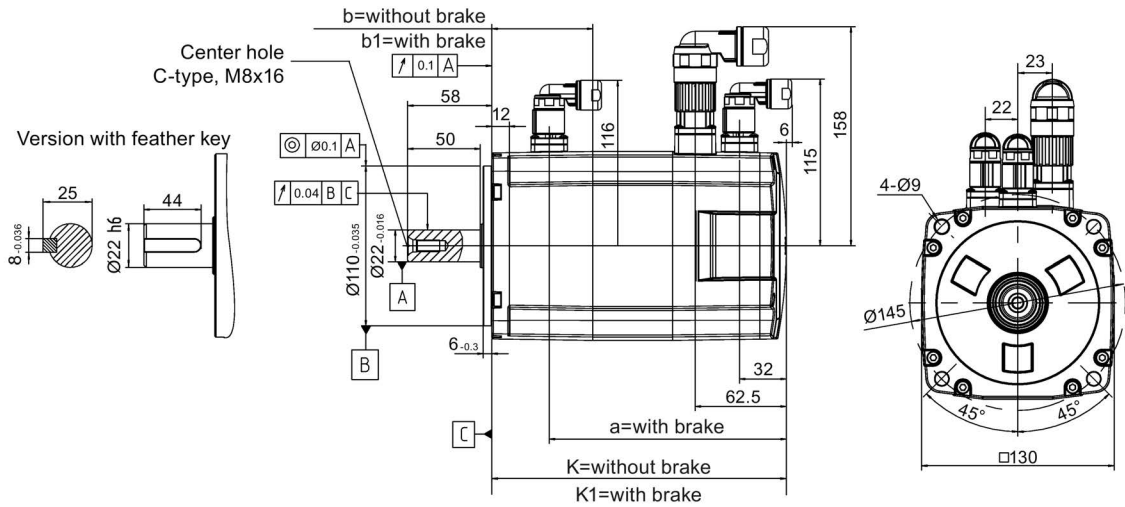
**Shaft-height 45 mm, with absolute encoder (unit: mm)**



Rated power	Rated torque	k	k1	a	b	b1
0.4 kW	1.27 Nm	157	203.5	172	15	61.5
0.75 kW	2.39 Nm	204	250.5	219		

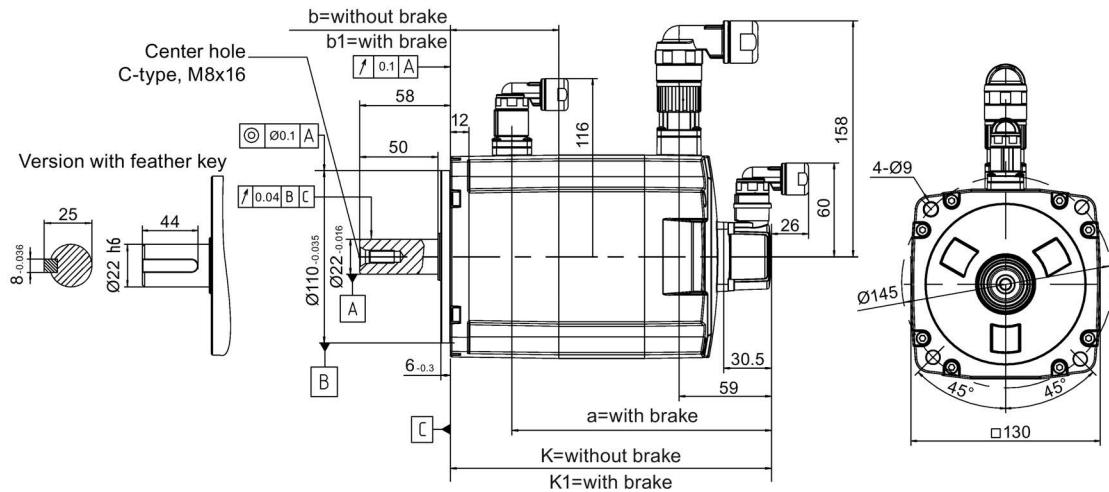
3.2 Mounting the motor

Shaft-height 65 mm, with incremental encoder (unit: mm)



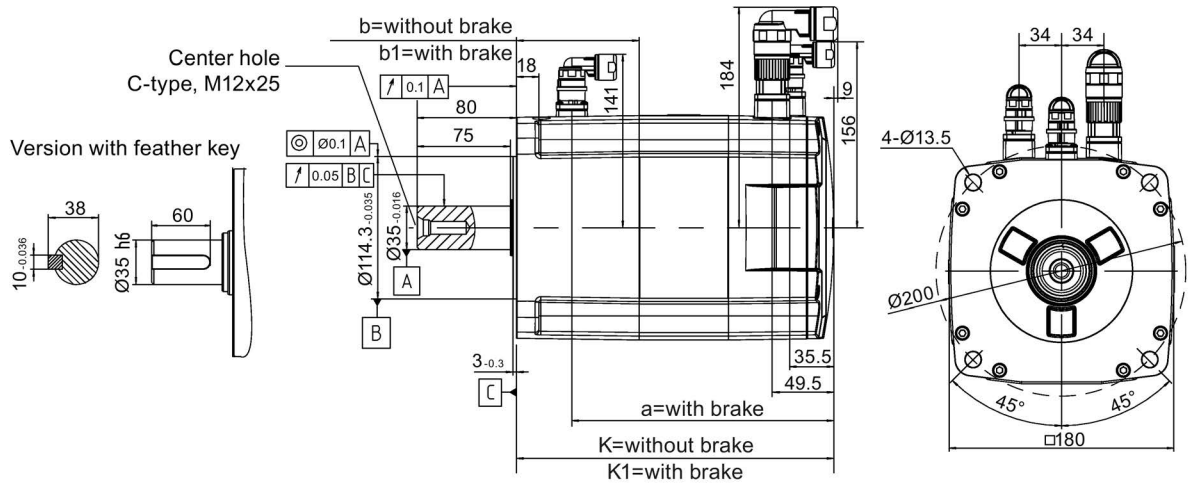
Rated power	Rated torque	k	k1	a	b	b1
0.75 kW	3.58 Nm	148	202.5	163	15	69.5
1.0 kW	4.78 Nm	181	235.5	196		
1.5 kW	7.16 Nm	181	235.5	196		
1.75 kW	8.36 Nm	214	268.5	229		
2.0 kW	9.55 Nm	247	301.5	262		

Shaft-height 65 mm, with absolute encoder (unit: mm)



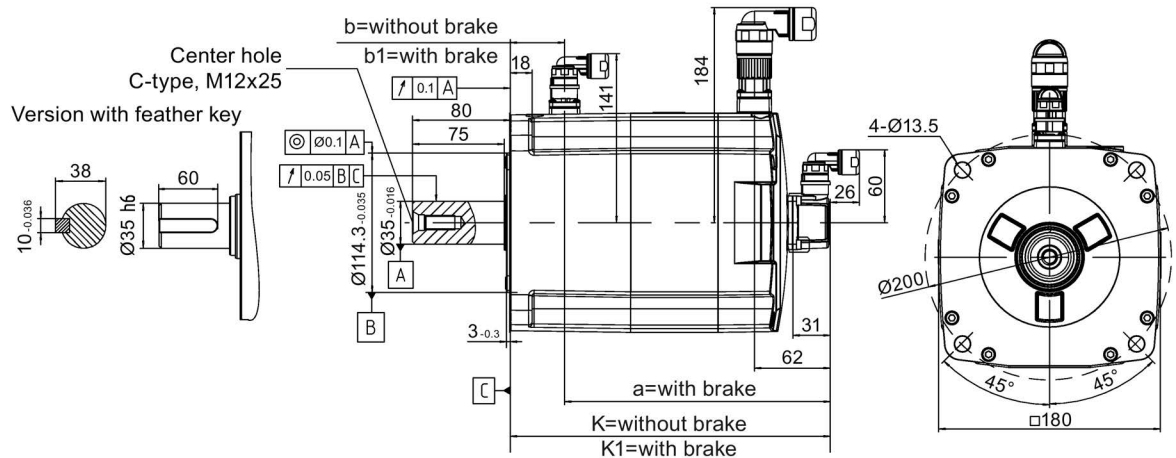
Rated power	Rated torque	k	k1	a	b	b1
0.75 kW	3.58 Nm	151	205.5	166	15	69.5
1.0 kW	4.78 Nm	184	238.5	199		
1.5 kW	7.16 Nm	184	238.5	199		
1.75 kW	8.36 Nm	217	271.5	232		
2.0 kW	9.55 Nm	250	304.5	265		

Shaft-height 90 mm, with incremental encoder (unit: mm)



Rated power	Rated torque	k	k1	a	b	b1
2.5 kW	11.9 Nm	189.5	255	210.5	33	98.5
3.5 kW	16.7 Nm	211.5	281	236.5		
5.0 kW	23.9 Nm	237.5	307	262.5		
7.0 kW	33.4 Nm	289.5	359	314.5		

Shaft-height 90 mm, with absolute encoder (unit: mm)



Rated power	Rated torque	k	k1	a	b	b1
2.5 kW	11.9 Nm	197	263	218	33	98.5
3.5 kW	16.7 Nm	223	289	244		
5.0 kW	23.9 Nm	249	315	270		
7.0 kW	33.4 Nm	301	367	322		

### 3.2.2 Mounting the motor

<b>⚠ WARNING</b>
<b>Personal injury and material damage</b>
Some motors, especially the 1FL609□ are heavy. The excessive weight of the motor should be considered and any necessary assistance required for mounting should be sought.
Otherwise, the motor can fall down during mounting. This can result in serious personal injury or material damage.

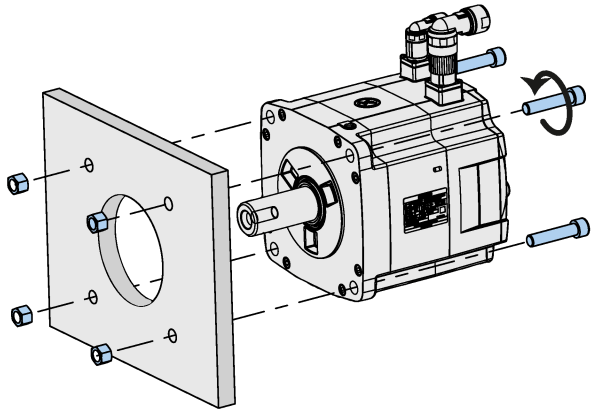
<b>NOTICE</b>
<b>Damage to the motor</b>
If the liquid enters the motor, the motor may be damaged
During motor installation or operation, make sure that no liquid (water, oil, etc.) can penetrate into the motor. Besides, when installing the motor horizontally, make sure that the cable outlet faces downward to protect the motor from ingress of oil or water.

**Note**  
**Using the eyebolts**

The 1FL609□ motor (90 mm shaft height) has two M8 screw holes for screwing in two eyebolts. Lift the 1FL609□ motor only at the eyebolts.

Eyebolts that have been screwed in must be either tightened or removed after mounting.

To ensure better heat dissipation, install a flange between the machine and the motor. You can install the motor onto the flange with four screws as shown in the following figure.



The information about the screws and the flange is as follows:

#### SIMOTICS S-1FL6 low inertia servo motors

Motor	Screw	Recommended flange size	Tightening torque	Flange material
1FL602□	2 x M4	120 x 100 x 40 (mm)	2.4 Nm	Aluminum alloy
1FL603□	4 x M5	120 x 100 x 40 (mm)	4.7 Nm	
1FL604□	4 x M6	120 x 100 x 40 (mm)	8 Nm	
1FL605□	4 x M8	120 x 100 x 40 (mm)	20 Nm	

#### SIMOTICS S-1FL6 high inertia servo motors

Motor	Screw	Recommended flange size	Tightening torque	Flange material
1FL604□	4 x M6	270 x 270 x 10 (mm)	8 Nm	Aluminum alloy
1FL606□	4 x M8	390 x 390 x 15 (mm)	20 Nm	
1FL609□	4 x M12	420 x 420 x 20 (mm)	85 Nm	





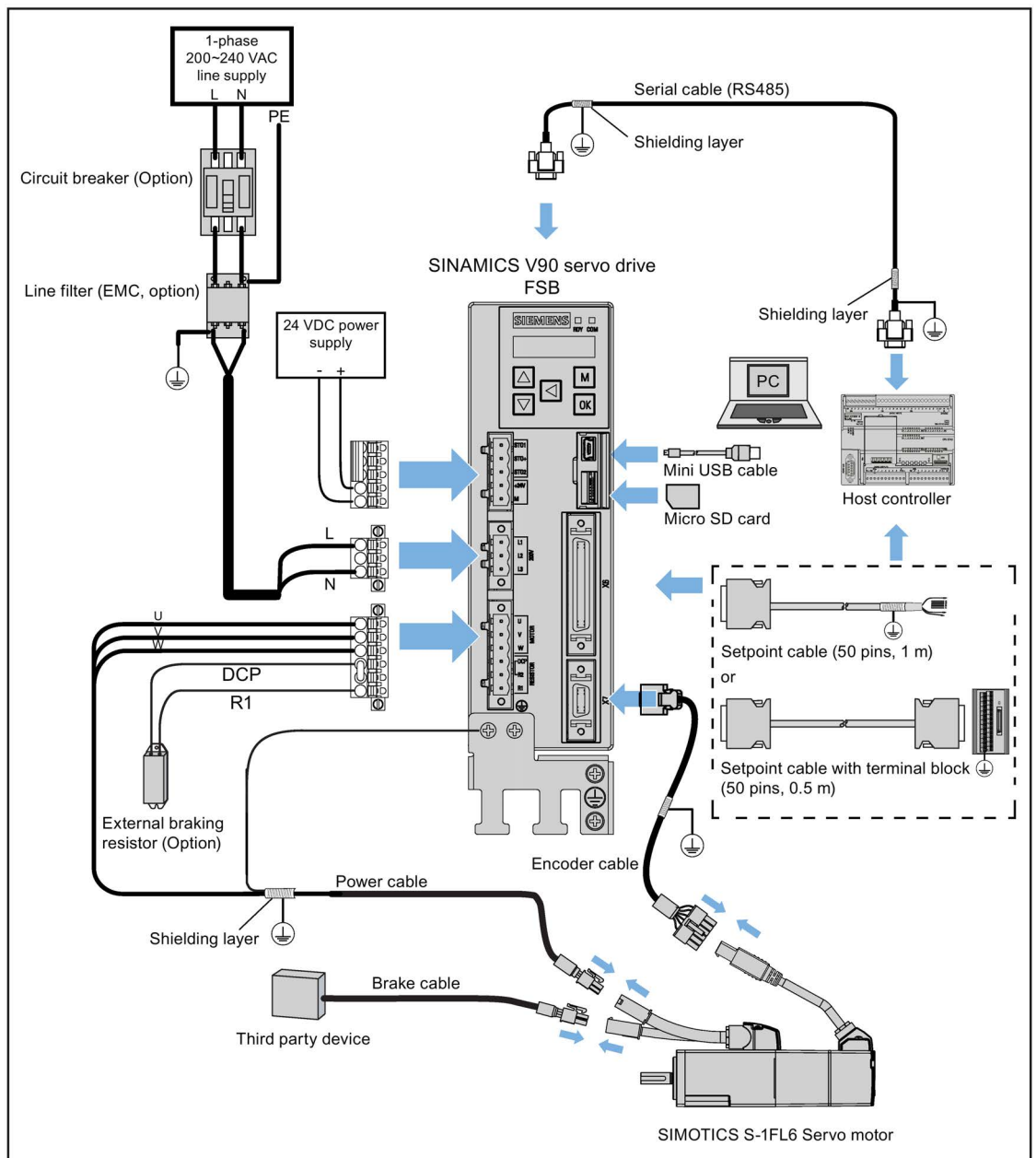
## Connecting

### 4.1 System connection

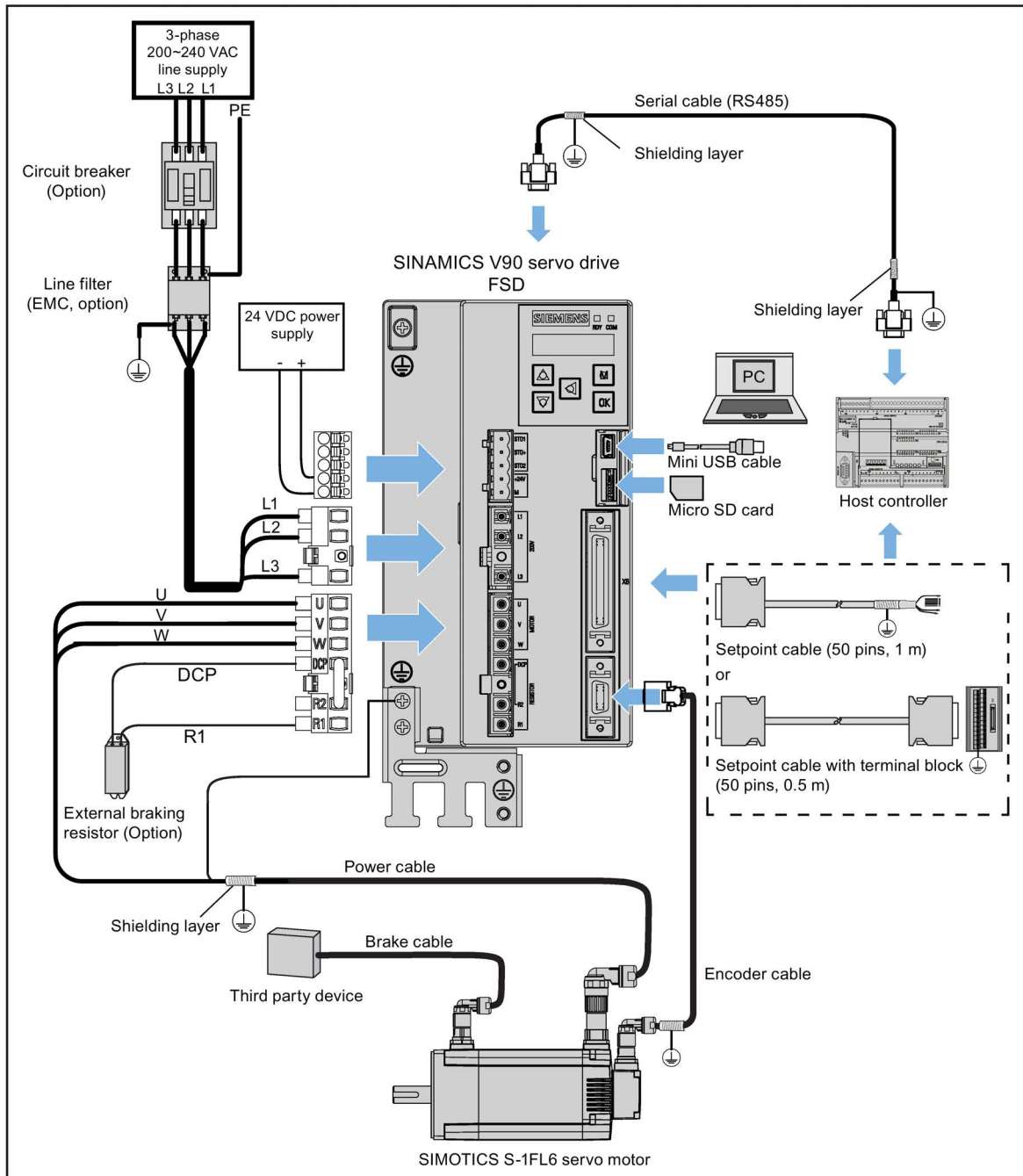
The SINAMICS V90 servo system is connected as follows:

#### SINAMICS V90 200 V variant

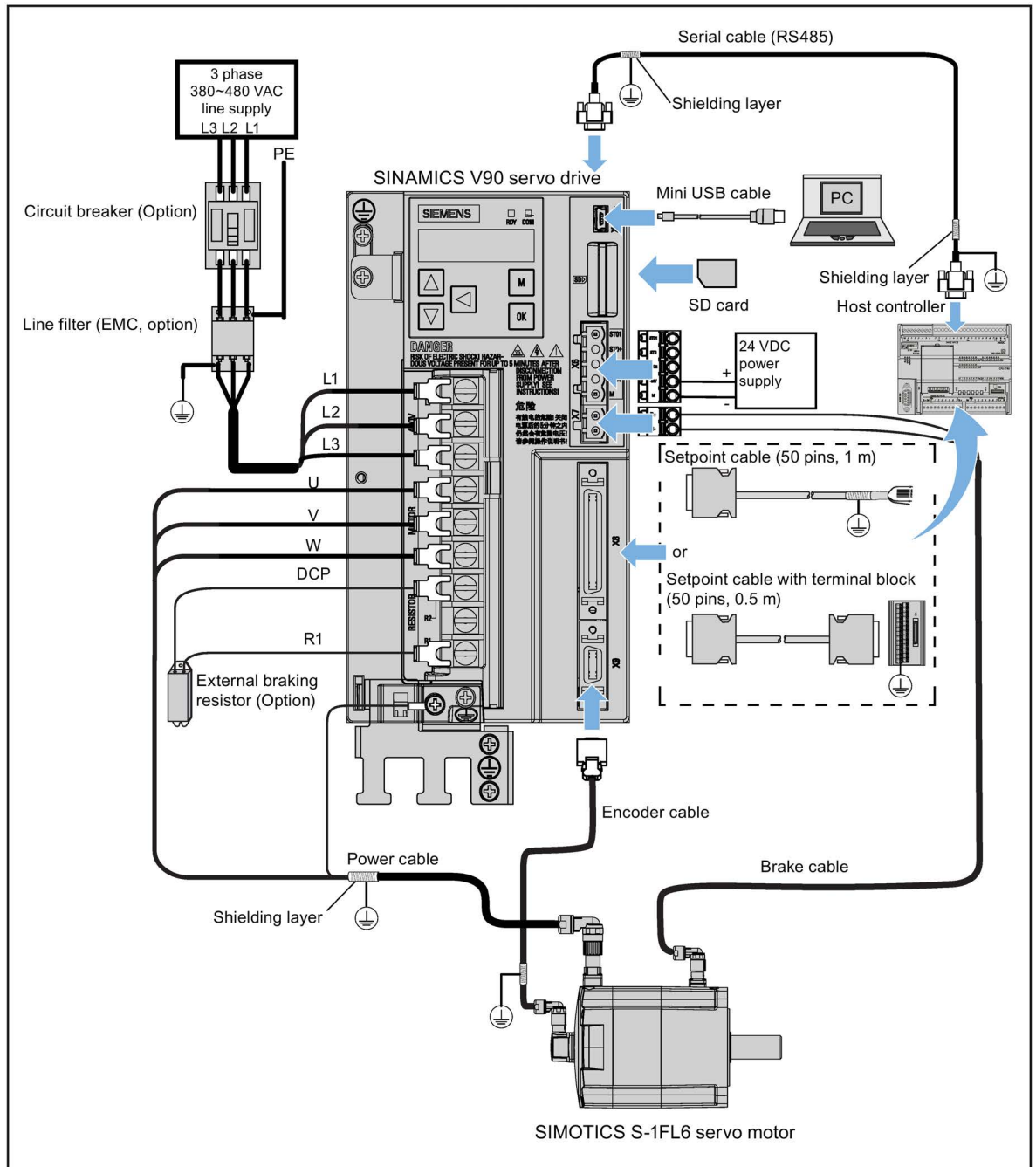
The connection for FSB when used on the single phase power network:



The connection for FSD when used on the three phase power network:



SINAMICS V90 400 V variant



**NOTICE**

**Important wiring information**

In order to meet **EMC** requirements, all cables must be shielded cables.

The cable shields of shielded twisted-pair cables should be connected to the shielding plate or the cable clamp of the servo drive.

**NOTICE**

**Drive damage caused by short-circuiting between the shielding wire and the unused pin on the setpoint connector**

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

Exercise caution when connecting the shielding cable to the setpoint connector.

You can see the assembly method of encoder connector in chapter "Assembly of cable terminals on the drive side (Page 337)" for reference.

---

**Note**

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

---

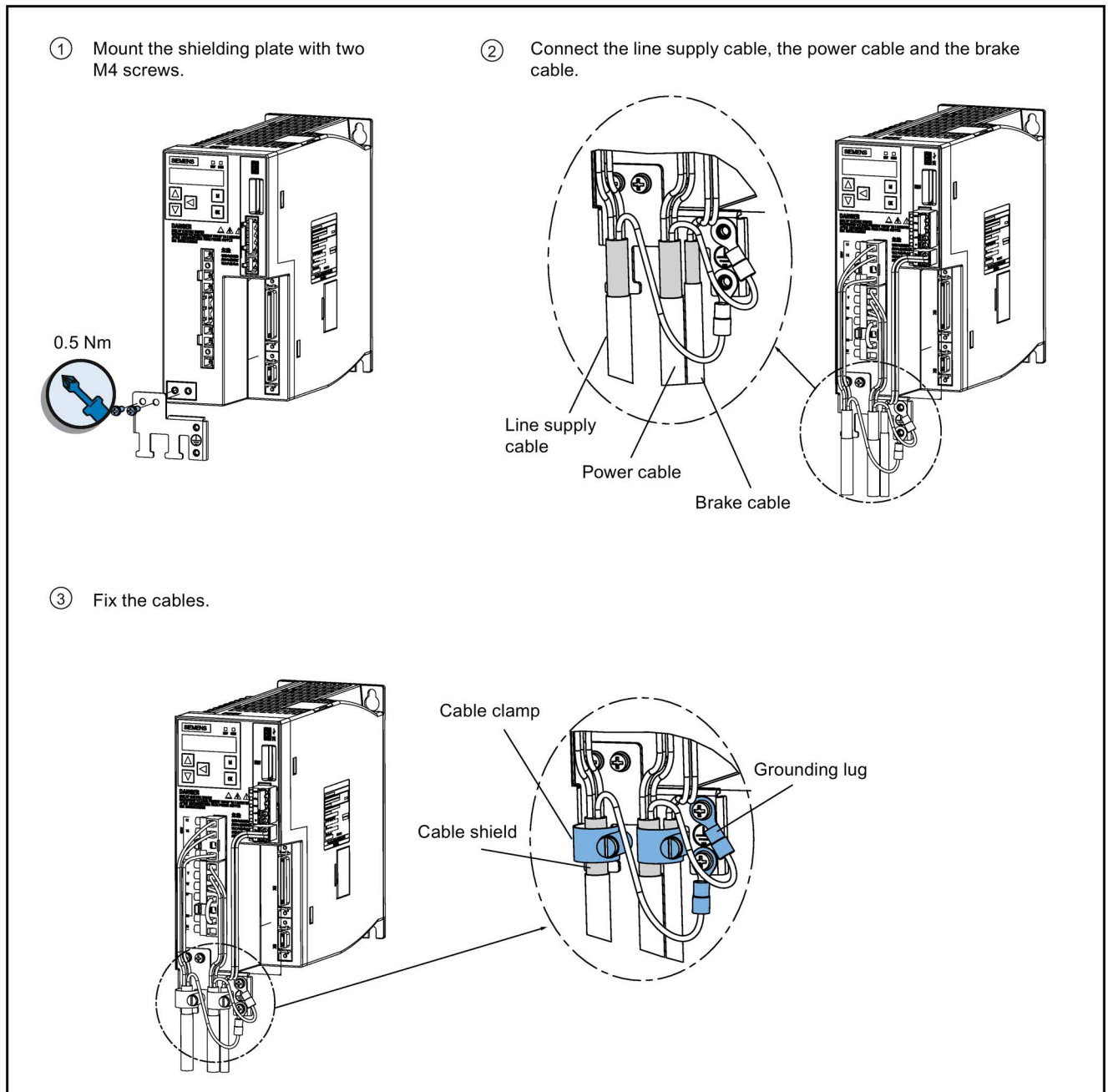
**Note**

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

---

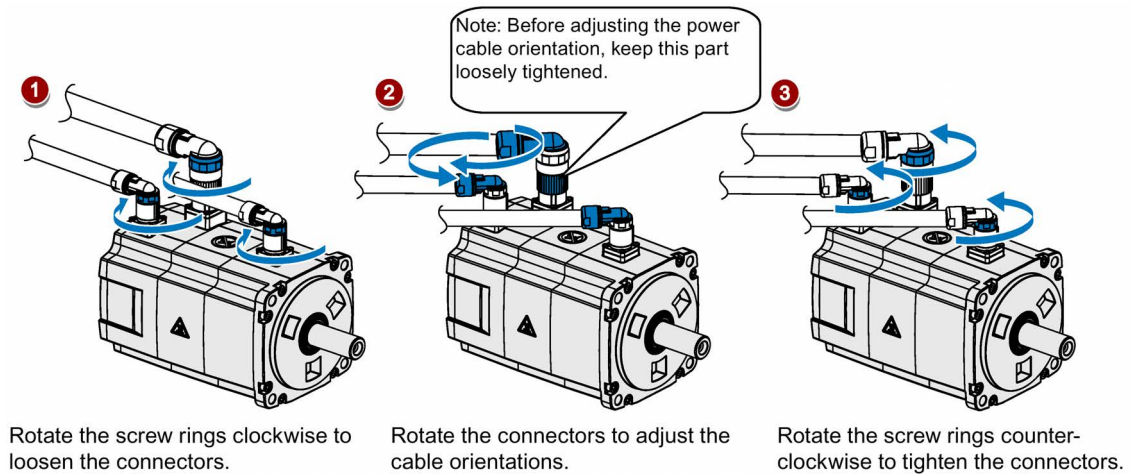
### Connecting the cable shields with the shielding plate

To achieve EMC-compliant installation of the drive, use the shielding plate that is shipped with the drive to connect the cable shields. See the following example for steps to connect cable shields with the shielding plate:



### Adjusting cable orientations from the motor side

For the low inertia motors with shaft-height of 50 mm and high inertia motors, you can adjust the orientation of the power cable, encoder cable, and brake cable from motor side to facilitate cable connection.



**Note**

**Rotating the connectors**

All the three motor-side connectors can be rotated only within 360°.

## 4.2 Main circuit wirings

### 4.2.1 Line supply - L1, L2, L3

Signal	Description
<b>SINAMICS V90 200 V variant</b>	
L1	Line phase L1
L2	Line phase L2
L3	Line phase L3
Required wire range and tightening torque: FSA and FSB: 26 AWG to 12 AWG FSC and FSD: 20 AWG to 12 AWG, 0.4 Nm to 0.5 Nm	

Signal	Description
<b>SINAMICS V90 400 V variant</b>	
L1	Line phase L1
L2	Line phase L2
L3	Line phase L3
Maximum conductor cross-section: FSA and FSA: 1.5 mm <sup>2</sup> (M2.5 screws, 4.43 lb.in/0.5 Nm) FSB and FSC: 2.5 mm <sup>2</sup> (M4 screws, 19.91 lb.in/2.25 Nm)	

**Note**

For 200 V variant, 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.


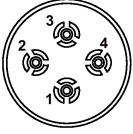
## 4.2.2 Motor power - U, V, W

### Motor output - drive side

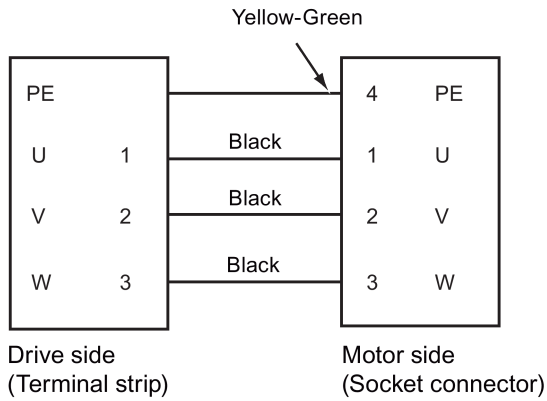
Signal	Description
<b>SINAMICS V90 200 V variant</b>	
U	Motor phase U
V	Motor phase V
W	Motor phase W
Required wire range and tightening torque: FSA and FSB: 26 AWG to 12 AWG FSC and FSD: 20 AWG to 12 AWG, 0.4 Nm to 0.5 Nm	

Signal	Description
<b>SINAMICS V90 400 V variant</b>	
U	Motor phase U
V	Motor phase V
W	Motor phase W
Maximum conductor cross-section: FSA and FSA: 1.5 mm <sup>2</sup> (M2.5 screws, 4.43 lb.in/0.5 Nm) FSB and FSC: 2.5 mm <sup>2</sup> (M4 screws, 19.91 lb.in/2.25 Nm)	

Power connector - motor side

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

Wiring

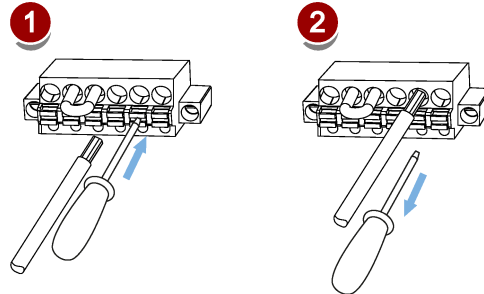




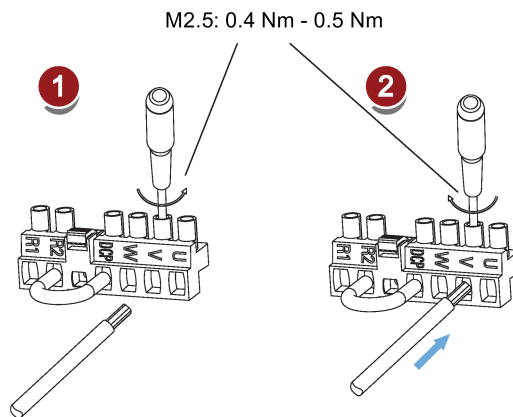
## Plugging the motor power cable

### SINAMICS V90 200 V variant

- For FSA and FSB



- For FSC and FSD



### SINAMICS V90 400 V variant

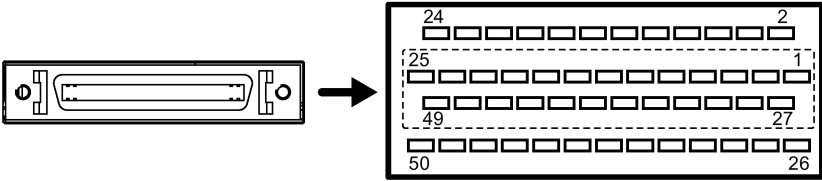
- For FSAA and FSA

You can plug the motor power cable with the same plugging method for V90 200 V variant drives of frame size FSA and FSB.

- For FSB and FSC

The FSB and FSC servo drives are equipped with barrier terminals for motor power connection. You can fix the motor power cable using the M4 screws with the tightening torque of 2.25 Nm on the servo drives.

### 4.3 Control/Status interface

Signal type	Pin No.	Signal	Description	Pin No.	Signal	Description
 <p>Type: 50-pin MDR socket</p>						
Pulse train inputs (PTI)/Pulse train encoder outputs (PTO)	1, 2, 26, 27		Position setpoint with pulse train input. High-speed 5 V differential pulse train input (RS485) Maximum frequency: 1MHz Signal transmission of this channel has better noise immunity.	36, 37, 38, 39		Position setpoint with pulse train input. 24 V single end pulse train input Maximum frequency: 200 kHz
	15, 16, 40, 41		Encoder emulation pulse output with high-speed 5 V differential signals (A+/A-, B+/B-)	42, 43		Encoder Zero phase pulse output with high-speed 5 V differential signals
	17		Encoder Zero phase pulse output with open collector			
	1	PTIA_D+	High-speed 5 V differential pulse train input A (+)	15	PTOA+	High-speed 5 V differential pulse train encoder output A (+)
	2	PTIA_D-	High-speed 5 V differential pulse train input A (-)	16	PTOA-	High-speed 5 V differential pulse train encoder output A (-)
	26	PTIB_D+	High-speed 5 V differential pulse train input B (+)	40	PTOB+	High-speed 5 V differential pulse train encoder output B (+)
	27	PTIB_D-	High-speed 5 V differential pulse train input B (-)	41	PTOB-	High-speed 5 V differential pulse train encoder output B (-)
	36	PTIA_24P	24 V pulse train input A, positive	42	PTOZ+	High-speed 5 V differential pulse train encoder output Z (+)
	37	PTIA_24M	24 V pulse train input A, ground	43	PTOZ-	High-speed 5 V differential pulse train encoder output Z (-)
	38	PTIB_24P	24 V pulse train input B, positive	17	PTOZ (OC)	Pulse train encoder output Z signal (open collector output)
39	PTIB_24M	24 V pulse train input B, ground				

Signal type	Pin No.	Signal	Description	Pin No.	Signal	Description
Digital in-puts/outputs	3	DI_COM	Common terminal for digital inputs	23	Brake	Motor holding brake control signal (for SINAMICS V90 200 V variant only)
	4	DI_COM	Common terminal for digital inputs	28	P24V_DO	External 24 V supply for digital outputs
	5	DI1	Digital input 1	29	P24V_DO	External 24 V supply for digital outputs
	6	DI2	Digital input 2	30	DO1	Digital output 1
	7	DI3	Digital input 3	31	DO2	Digital output 2
	8	DI4	Digital input 4	32	DO3	Digital output 3
	9	DI5	Digital input 5	33	DO4	Digital output 4
	10	DI6	Digital input 6	34	DO5	Digital output 5
	11	DI7	Digital input 7	35	DO6	Digital output 6
	12	DI8	Digital input 8	49	MEXT_DO	External 24 V ground for digital outputs
	13	DI9	Digital input 9	50	MEXT_DO	External 24 V ground for digital outputs
Analog in-puts/outputs	14	DI10	Digital input 10			
	18	P12AI	12 V power output for analog input	45	AO_M	Analog output ground
	19	AI1+	Analog input channel 1, positive	46	AO1	Analog output channel 1
	20	AI1-	Analog input channel 1, negative	47	AO_M	Analog output ground
	21	AI2+	Analog input channel 2, positive	48	AO2	Analog output channel 2
None	22	AI2-	Analog input channel 2, negative			
	24	-	Reserved	44	-	Reserved
	25	-	Reserved			

### 4.3.1 Digital inputs/outputs (DIs/DOs)

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

DI1 to DI8 -- Assignable with parameters p29301 to p29308

DO1 to DO6 -- Assignable with parameters p29330 to p29335

Exception: DI9 and DI10

DI9 is permanently assigned with the signal EMGS (emergency stop) and DI10 is permanently assigned with the signal C-MODE (change mode).

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

Pin No.	Digital in-puts/outputs	Parameters	Default signals/values			
			Index 0 (PTI)	Index 1 (IPos)	Index 2 (S)	Index 3 (T)
5	DI1	p29301	1 (SON)	1 (SON)	1 (SON)	1 (SON)
6	DI2	p29302	2 (RESET)	2 (RESET)	2 (RESET)	2 (RESET)
7	DI3	p29303	3 (CWL)	3 (CWL)	3 (CWL)	3 (CWL)
8	DI4	p29304	4 (CCWL)	4 (CCWL)	4 (CCWL)	4 (CCWL)
9	DI5	p29305	5 (G-CHANGE)	5 (G-CHANGE)	12 (CWE)	12 (CWE)
10	DI6	p29306	6 (P-TRG)	6 (P-TRG)	13 (CCWE)	13 (CCWE)
11	DI7	p29307	7 (CLR)	21 (POS1)	15 (SPD1)	18 (TSET)
12	DI8	p29308	10 (TLIM1)	22 (POS2)	16 (SPD2)	19 (SLIM1)
30	DO1	p29330	1 (RDY)			
31	DO2	p29331	2 (FAULT)			
32	DO3	p29332	3 (INP)			
33	DO4	p29333	5 (SPDR)			
34	DO5	p29334	6 (TLR)			
35	DO6	p29335	8 (MBR)			

**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 to DO6 can be inverted. You can invert the logics of DO1 to DO6 by setting the bit 0 to bit 5 of parameter p0748.

**4.3.1.1 DIs**

You can assign a maximum of 28 internal digital input signals to the SINAMICS V90 servo drive. For detailed information about these signals, see the table below:

No.	Name	Type	Description	Control mode			
				PTI	IPos	S	T
1	SON	Edge 0→1 1→0	Servo-on <ul style="list-style-type: none"> <li>0→1: powers on power circuit and makes servo drive ready to operate.</li> <li>1→0: motor ramps down (OFF1) in PTI, IPos, and S modes; motor coasts down (OFF2) in T mode.</li> </ul>	✓	✓	✓	✓
2	RESET	Edge 0→1	Reset alarms <ul style="list-style-type: none"> <li>0→1: Reset alarms</li> </ul>	✓	✓	✓	✓

No.	Name	Type	Description	Control mode			
				PTI	IPos	S	T
3	CWL	Edge 1→0	Clockwise over-travel limit (positive limit) <ul style="list-style-type: none"> <li>1 = condition for operation</li> <li>1→0: emergency stop (OFF3)</li> </ul>	✓	✓	✓	✓
4	CCWL	Edge 1→0	Counter-clockwise over-travel limit (negative limit) <ul style="list-style-type: none"> <li>1 = condition for operation</li> <li>1→0: emergency stop (OFF3)</li> </ul>	✓	✓	✓	✓
5	G- CHANGE	Level	Gain change between the first and the second gain parameter set. <ul style="list-style-type: none"> <li>0: the first gain parameter set</li> <li>1: the second gain parameter set</li> </ul>	✓	✓	✓	X
6	P-TRG (P_TRG in PTI mode is reserved for future use)	Level Edge 0→1	In PTI mode: pulse allowable/inhibit. <ul style="list-style-type: none"> <li>0: operation with pulse train setpoint is possible</li> <li>1: inhibit the pulse train setpoint</li> </ul> In IPos mode: position trigger <ul style="list-style-type: none"> <li>0→1: starts positioning of selected fixed position setpoint</li> </ul>	✓	✓	X	X
7	CLR	Level	Clear position control droop pulses. <ul style="list-style-type: none"> <li>0: not clear</li> <li>1: clear the droop pulses based on the selected clear mode by p29242</li> </ul>	✓	X	X	X
8	EGEAR1	Level	Electronic gear.	✓	X	X	X
9	EGEAR2	Level	A combination of the signals EGEAR1 and EGEAR2 can select four electronic gear ratios. EGEAR2 : EGEAR1 <ul style="list-style-type: none"> <li>0 : 0: electronic gear ratios 1</li> <li>0 : 1: electronic gear ratios 2</li> <li>1 : 0: electronic gear ratios 3</li> <li>1 : 1: electronic gear ratios 4</li> </ul>	✓	X	X	X
10	TLIM1	Level	Torque limit selection.	✓	✓	✓	X
11	TLIM2	Level	A combination of TLIM1 and TLIM2 can select four torque limit sources (one external torque limit, three internal torque limits). TLIM2 : TLIM1 <ul style="list-style-type: none"> <li>0 : 0: internal torque limit 1</li> <li>0 : 1: external torque limit (analog input 2)</li> <li>1 : 0: internal torque limit 2</li> <li>1 : 1: internal torque limit 3</li> </ul>	✓	✓	✓	X
12	CWE	Level	Enable clockwise rotations. <ul style="list-style-type: none"> <li>1: Enable clockwise rotation, ramp up</li> <li>0: Disable clockwise rotation, ramp down</li> </ul>	X	X	✓	✓

4.3 Control/Status interface

No.	Name	Type	Description	Control mode			
				PTI	IPos	S	T
13	CCWE	Level	Enable counter-clockwise rotations. <ul style="list-style-type: none"> <li>1: Enable counter-clockwise rotation, ramp down</li> <li>0: Disable counter-clockwise rotation, ramp up</li> </ul>	X	X	✓	✓
14	ZSCLAMP	Level	Zero speed clamps. <ul style="list-style-type: none"> <li>1 = when the motor speed setpoint is an analog signal and lower than the threshold level (p29075), the motor is clamped.</li> <li>0 = no action</li> </ul>	X	X	✓	X
15	SPD1	Level	Select speed mode: fixed speed setpoint.	X	X	✓	X
16	SPD2	Level	A combination of the signals SPD1, SPD2 and SPD3 can select eight speed setpoint sources (one external speed setpoint, seven fixed speed setpoints). SPD3 : SPD2 : SPD1 <ul style="list-style-type: none"> <li>0 : 0 : 0: external analog speed setpoint</li> <li>0 : 0 : 1: fixed speed setpoint 1</li> <li>0 : 1 : 0: fixed speed setpoint 2</li> <li>0 : 1 : 1: fixed speed setpoint 3</li> <li>1 : 0 : 0: fixed speed setpoint 4</li> <li>1 : 0 : 1: fixed speed setpoint 5</li> <li>1 : 1 : 0: fixed speed setpoint 6</li> <li>1 : 1 : 1: fixed speed setpoint 7</li> </ul>				
17	SPD3	Level					
18	TSET	Level	Torque setpoint selection. This signal can select two torque setpoint sources (one external torque setpoint, one fixed torque setpoint). <ul style="list-style-type: none"> <li>0: external torque setpoint (analog input 2)</li> <li>1: fixed torque setpoint</li> </ul>	X	X	X	✓
19	SLIM1	Level	Speed limit selection.	✓	✓	✓	✓
20	SLIM2	Level	A combination of SLIM1 to SLIM2 can select four speed limit sources (one external speed limit, three internal speed limits). SLIM2 : SLIM1 <ul style="list-style-type: none"> <li>0 : 0: internal speed limit 1</li> <li>0 : 1: external speed limit (analog input 1)</li> <li>1 : 0: internal speed limit 2</li> <li>1 : 1: internal speed limit 2</li> </ul>				

No.	Name	Type	Description	Control mode			
				PTI	IPos	S	T
21	POS1	Level	Select position setpoint.	X	✓	X	X
22	POS2	Level	A combination of the signals POS1 to POS3 can select eight fixed position setpoint sources. POS3 : POS2 : POS1 <ul style="list-style-type: none"> <li>• 0 : 0 : 0: fixed position setpoint 1</li> <li>• 0 : 0 : 1: fixed position setpoint 2</li> <li>• 0 : 1 : 0: fixed position setpoint 3</li> <li>• 0 : 1 : 1: fixed position setpoint 4</li> <li>• 1 : 0 : 0: fixed position setpoint 5</li> <li>• 1 : 0 : 1: fixed position setpoint 6</li> <li>• 1 : 1 : 0: fixed position setpoint 7</li> <li>• 1 : 1 : 1: fixed position setpoint 8</li> </ul>	X	✓	X	X
23	POS3	Level					
24	REF	Edge 0→1	Set reference point with digital input or reference cam input for reference approaching mode. <ul style="list-style-type: none"> <li>• 0→1: reference input</li> </ul>	X	✓	X	X
25	SREF	Edge 0→1	The reference approach will be started with the signal SREF. <ul style="list-style-type: none"> <li>• 0→1 start reference approach</li> </ul>	X	✓	X	X
26	STEPF	Edge 0→1	Step forward to the next fixed position setpoint. <ul style="list-style-type: none"> <li>• 0→1 start step action</li> </ul>	X	✓	X	X
27	STEPB	Edge 0→1	Step backward to the previous fixed position setpoint. <ul style="list-style-type: none"> <li>• 0→1 start step action</li> </ul>	X	✓	X	X
28	STEPH	Edge 0→1	Step to the fixed position setpoint 1. <ul style="list-style-type: none"> <li>• 0→1 start step action</li> </ul>	X	✓	X	X

**Note**

When working in the torque control mode, the torque setpoint equals to 0 if CWE and CCWE are at the same status. For more information, please refer to section Direction and stop (Page 209).

**Note****Invalid circumstances for DI signals**

- When SINAMICS V-ASSISTANT is communicating with the drive or you are operating the drive on SINAMICS V-ASSISTANT, some DI signals are invalid:
  - When referencing by SINAMICS V-ASSISTANT, the DI signal SREF is invalid.
  - During trial run test, the DI signal SON is invalid; meanwhile, DI7 and DI8 are occupied by SINAMICS V-ASSISTANT.

**Direct signal map**

Force the following six signals to logical "1" with parameter p29300 (P\_DI\_Mat):

- SON
- CWL
- CCWL
- TLIM1
- SPD1
- TSET
- EMGS

The definition for p29300 is as follows:

Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
EMGS	TSET	SPD1	TLIM1	CCWL	CWL	SON

For example, if you set p29300 = 1 to force the signal SON to a logical high signal, DI1 can then be assigned to other desired signals.

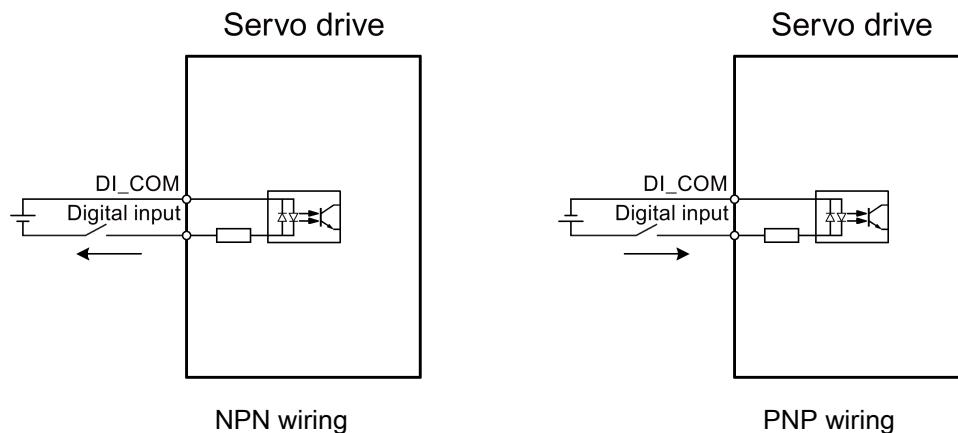
**Note**

The parameter p29300 has higher priority than the DIs.

The bit 6 of p29300 is used for emergency stop. You are not allowed to modify it when the drive is in the servo on state.

**Wiring**

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





## 4.3.1.2 DOs

You can assign a maximum of 14 internal digital output signals to the SINAMICS V90 servo drive. For detailed information about these signals, see the table below:

No.	Name	Descriptions	Control mode			
			PTI	IPos	S	T
1	RDY	Servo ready <ul style="list-style-type: none"> <li>1: ready to operate</li> <li>0: drive not ready (alarm occurs or enable signal is missing)</li> </ul>	✓	✓	✓	✓
2	FAULT	Fault <ul style="list-style-type: none"> <li>1: in fault status</li> <li>0: no fault</li> </ul>	✓	✓	✓	✓
3	INP	In-position signal <ul style="list-style-type: none"> <li>1: number of droop pulses is in the preset in-position range (parameter p2544)</li> <li>0: droop pulses are beyond the in-position range</li> </ul>	✓	✓	X	X
4	ZSP	Zero speed detection <ul style="list-style-type: none"> <li>1: motor speed is equal with or lower than the zero speed (can be set with parameter p2161).</li> <li>0: motor speed is higher than zero speed + hysteresis (10 rpm).</li> </ul>	✓	✓	✓	✓
5	SPDR	Speed reached <ul style="list-style-type: none"> <li>1: motor actual speed has nearly (internal hysteresis 10 rpm) reached the speed of the internal speed command or analog speed command. The speed approaching range can be set via parameter (p29078)</li> <li>0: speed difference between speed setpoint and actual is larger than internal hysteresis.</li> </ul>	X	X	✓	X
6	TLR	Torque limit reached <ul style="list-style-type: none"> <li>1: the generated torque has nearly (internal hysteresis) reached the value of the positive torque limit, negative torque limit or analog torque limit</li> <li>0: the generated torque has not reached the limit</li> </ul>	✓	✓	✓	X
7	SPLR	Speed limit reached <ul style="list-style-type: none"> <li>1: the speed has nearly (internal hysteresis, 10 rpm) reached the speed limit.</li> <li>0: the speed has not reached the speed limit.</li> </ul>	✓	✓	✓	X
8	MBR	Motor holding brake <ul style="list-style-type: none"> <li>1: motor holding brake is closed</li> <li>0: motor holding brake is released</li> </ul> <b>Note:</b> MBR is only status signal because the control and the power supply of the motor holding brake is realized with separate terminals.	✓	✓	✓	✓

No.	Name	Descriptions	Control mode			
			PTI	IPos	S	T
9	OLL	Overload level reached <ul style="list-style-type: none"> <li>1: motor has reached the parameterizable output overload level (p29080 in % of rated torque, default: 100%, max: 300%)</li> <li>0: motor has not reached the overload level</li> </ul>	✓	✓	✓	✓
10	WARNING1	Warning 1 condition reached <ul style="list-style-type: none"> <li>1: parameterizable warning 1 condition has been reached.</li> <li>0: warning 1 condition has not been reached.</li> </ul> See note below.	✓	✓	✓	✓
11	WARNING2	Warning 2 condition reached <ul style="list-style-type: none"> <li>1: parameterizable warning 2 condition has been reached</li> <li>0: warning 2 condition has not been reached.</li> </ul> See note below	✓	✓	✓	✓
12	REFOK	Referenced <ul style="list-style-type: none"> <li>1 = Referenced</li> <li>0 = Not referenced</li> </ul>	X	✓	X	X
13	CM_STA	Current control mode <ul style="list-style-type: none"> <li>1 = The second mode in five compound control modes (PTI/S, IPos/S, PTI/T, IPos/T, S/T)</li> <li>0 = The first mode in five compound control modes or four basic modes (PTI, IPos, S, T)</li> </ul>	✓	✓	✓	✓
14	RDY_ON	Ready for servo on <ul style="list-style-type: none"> <li>1: ready to servo on</li> <li>0: drive is not ready for servo on (fault occurs or main power supply is missing)</li> </ul> <b>Note:</b> After the drive is servo on, the signal remains in 1 status unless the above abnormal cases happen.	✓	✓	✓	✓

### Assigning warning signals to digital outputs

You can assign two groups of warning signals to digital outputs with parameters p29340 (first group of warning signals active) and p29341 (second group of warning signals active).

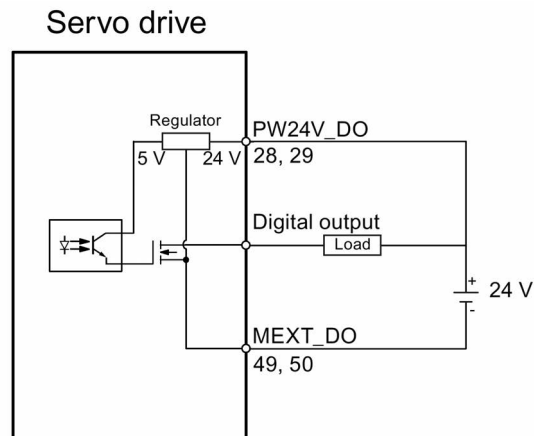
Setting (p29340/p29341)	Warning conditions
1	Overload protection: load factor is 85% of or above the motor utilization.
2	Braking resistor: capacity of the braking resistor is 85% of or above the resistor power rating.
3	Fan alarm: fan has stopped for 1 second or longer.
4	Encoder alarm
5	Motor overheat: motor has reached 85% of the maximum allowed motor temperature.
6	Lifetime detection: the life expectancy of the capacity or the fan is shorter than the specified time.

If warning condition assigned to p29340 occurs, WARNING1 becomes ON.

If warning condition assigned to p29341 occurs, WARNING2 becomes ON.

### Wiring

The digital outputs only support NPN type of wiring as illustrated below:



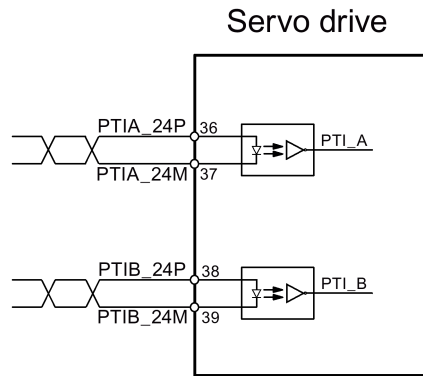
### 4.3.2 Pulse train inputs/encoder outputs (PTIs/PTOs)

#### 4.3.2.1 PTIs

Two channels of pulse train input are available for the SINAMICS V90 servo drive:

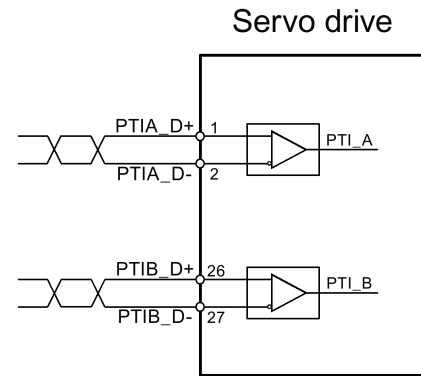
- 24 V single end pulse train input
- High-speed 5 V differential pulse train input (RS485)

When using the 24 V single end PTI:



 Twisted-pair wires

When using the 5 V differential PTI:



 Twisted-pair wires

#### Note

Only one channel can be used. The 24 V single end PTI is the factory setting of the SINAMICS V90 servo drives.

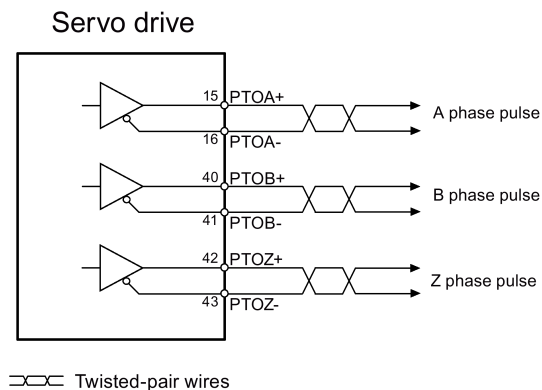
When you choose to use the high-speed 5 V differential PTI (RS485), you must change the value of parameter p29014 from 1 to 0. Refer to "Selecting a setpoint pulse train input channel (Page 171)".

### 4.3.2.2 PTOs

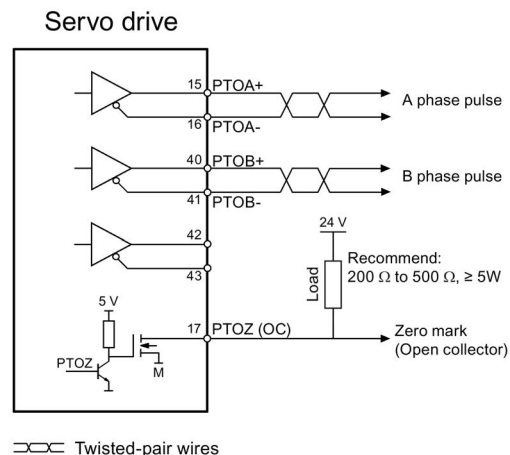
High-speed 5 V differential signals (A+/A-, B+/B-, Z+/Z-) and open collector (zero pulse) are supported.

#### Wirings

When not using the open collector:



When using the open collector:



### 4.3.3 Analog inputs/outputs (AIs/AOs)

#### 4.3.3.1 AIs

SINAMICS V90 has two analog input terminals. The input voltage at each analog input varies with control modes.

Pin No.	Analog input	Input voltage	Control mode	Function
19, 20	Analog input 1	0 V to 10 V	PTI	Not used
		0 V to 10 V	IPos	Not used
		-10 V to +10 V	S	Speed setpoint (reference p29060) *
		0 V to 10 V	T	Speed limit (reference p29060) *
21, 22	Analog input 2	0 V to 10 V	PTI	Torque limit (reference r0333)
		0 V to 10 V	IPos	Torque limit (reference r0333)
		0 V to 10 V	S	Torque limit (reference r0333)
		-10 V to +10 V	T	Torque setpoint (reference r0333)

\* If the AI input voltage is higher than 10 V, the speed is not limited to the value at 10 V (p29060), but scaled according to p29060. For example, if p29060 = 3000 rpm, the speed is 3300 rpm at 11 V and 3600 rpm at 12 V.

**Command voltage**

The command voltage of the analog inputs always follows the formula below:

$$V_{input} = (AI+) - (AI-)$$

**4.3.3.2 AOs**

The SINAMICS V90 has two analog outputs. You can find detailed information about these two analog outputs from the table below:

Pin No.	Analog output	Output voltage	Function
46	Analog output 1	-10 V to +10 V	Analog output 1 for monitoring
48	Analog output 2	-10 V to +10 V	Analog output 2 for monitoring

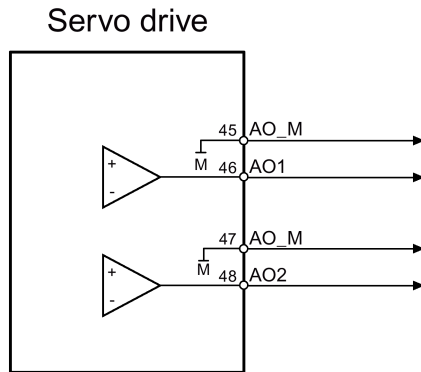
**Parameterization**

Two parameters, p29350 (selects signal sources for AO1) and p29351 (selects signal sources for AO2), are used to select the source of analog output:

Parameter	Value	Source	Value	Source
p29350	0 (default)	Actual speed (reference p29060)	7	Pulse input frequency (reference 100 k)
	1	Actual torque (reference 3 × r0333)	8	Pulse input frequency (reference 1000 k)
	2	Speed setpoint (reference p29060)	9	Remaining number of pulses (reference 1 k)
	3	Torque setpoint (reference 3 × r0333)	10	Remaining number of pulses (reference 10 k)
	4	DC bus voltage (reference 1000 V)	11	Remaining number of pulses (reference 100 k)
	5	Pulse input frequency (reference 1 k)	12	Remaining number of pulses (reference 1000 k)
	6	Pulse input frequency (reference 10 k)		
p29351	0	Actual speed (reference p29060)	7	Pulse input frequency (reference 100 k)
	1 (default)	Actual torque (reference 3 × r0333)	8	Pulse input frequency (reference 1000 k)
	2	Speed setpoint (reference p29060)	9	Remaining number of pulses (reference 1 k)
	3	Torque setpoint (reference 3 × r0333)	10	Remaining number of pulses (reference 10 k)
	4	DC bus voltage (reference 1000 V)	11	Remaining number of pulses (reference 100 k)
	5	Pulse input frequency (reference 1 k)	12	Remaining number of pulses (reference 1000 k)
	6	Pulse input frequency (reference 10 k)		

## Wiring

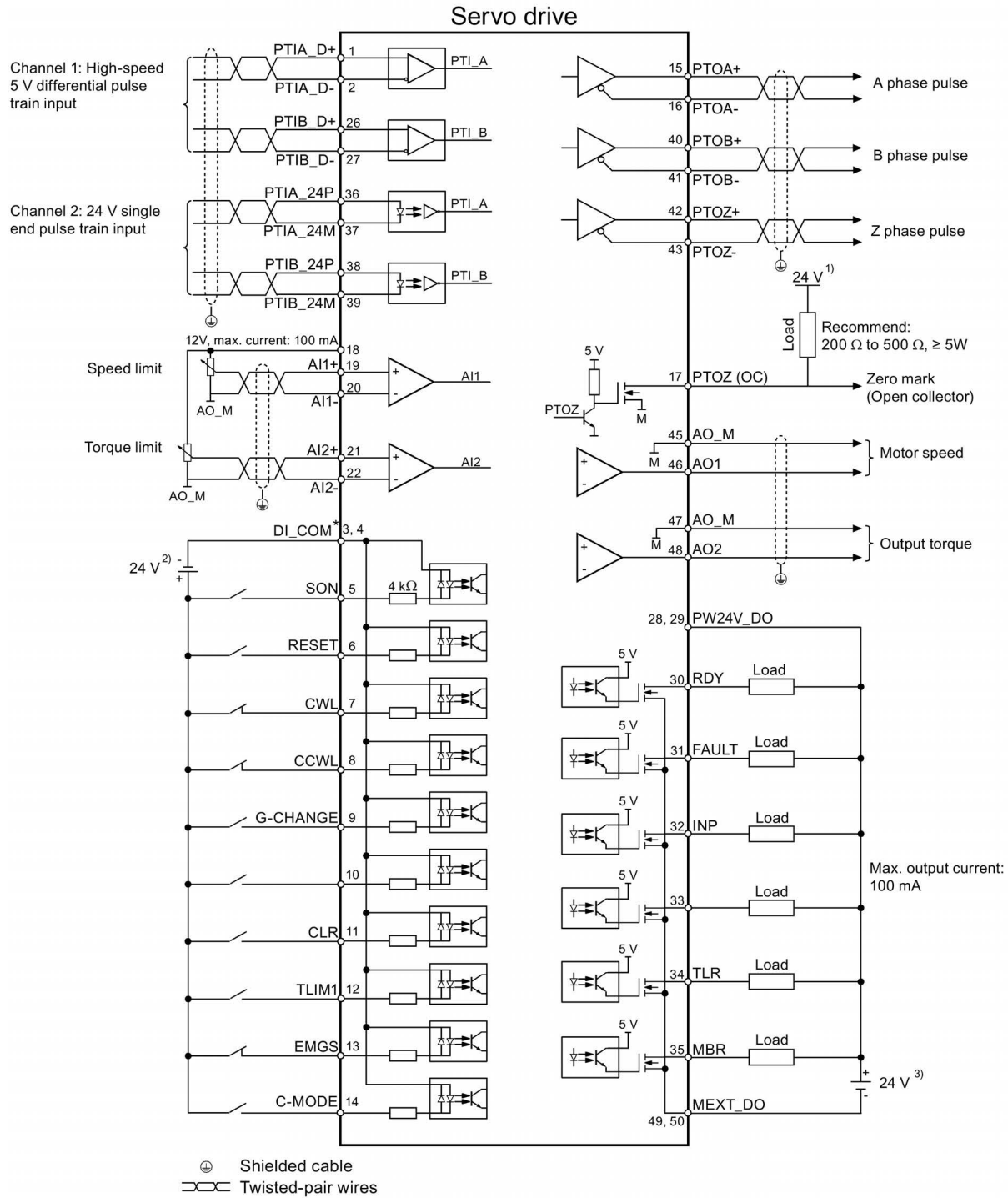
Do wiring of analog outputs as follows:



### 4.3.4 Standard application wirings (factory setting)

#### 4.3.4.1 Pulse train input position control (PTI)

Standard wiring for pulse train input position control mode:





\* Digital inputs, supporting both PNP and NPN types.

The 24 V power supplies in the connection diagram are as follows:

- 1) 24 V power supply for SINAMICS V90. All the PTO signals must be connected to the controller with the same 24 V power supply as SINAMICS V90.
- 2) Isolated digital input power supply. It can be the controller power supply.
- 3) Isolated digital output power supply. It can be the controller power supply.

---

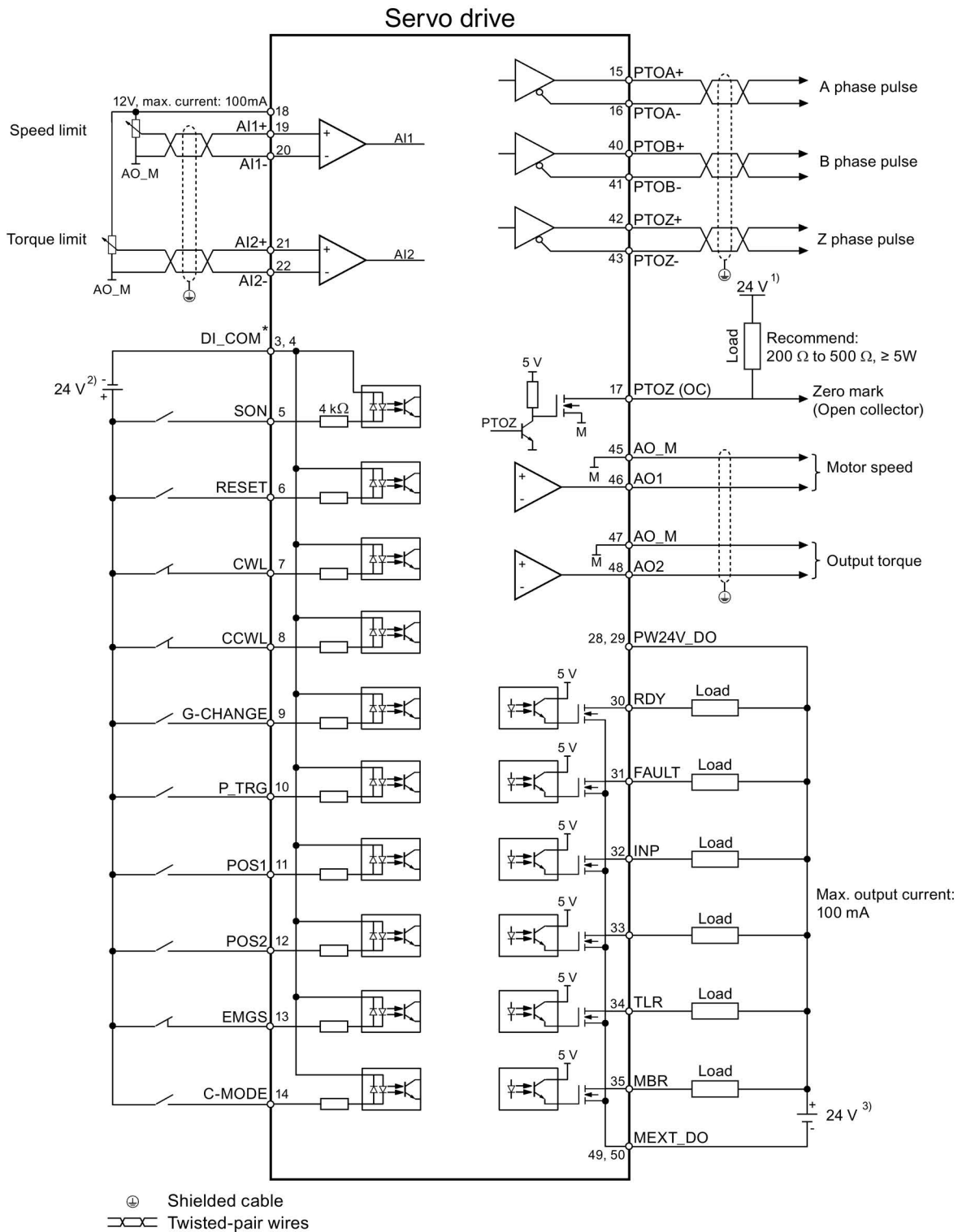
**Note**

Only one of the pulse train input channels can be used.

---

### 4.3.4.2 Internal position control (IPos)

Standard wiring for internal position control mode:



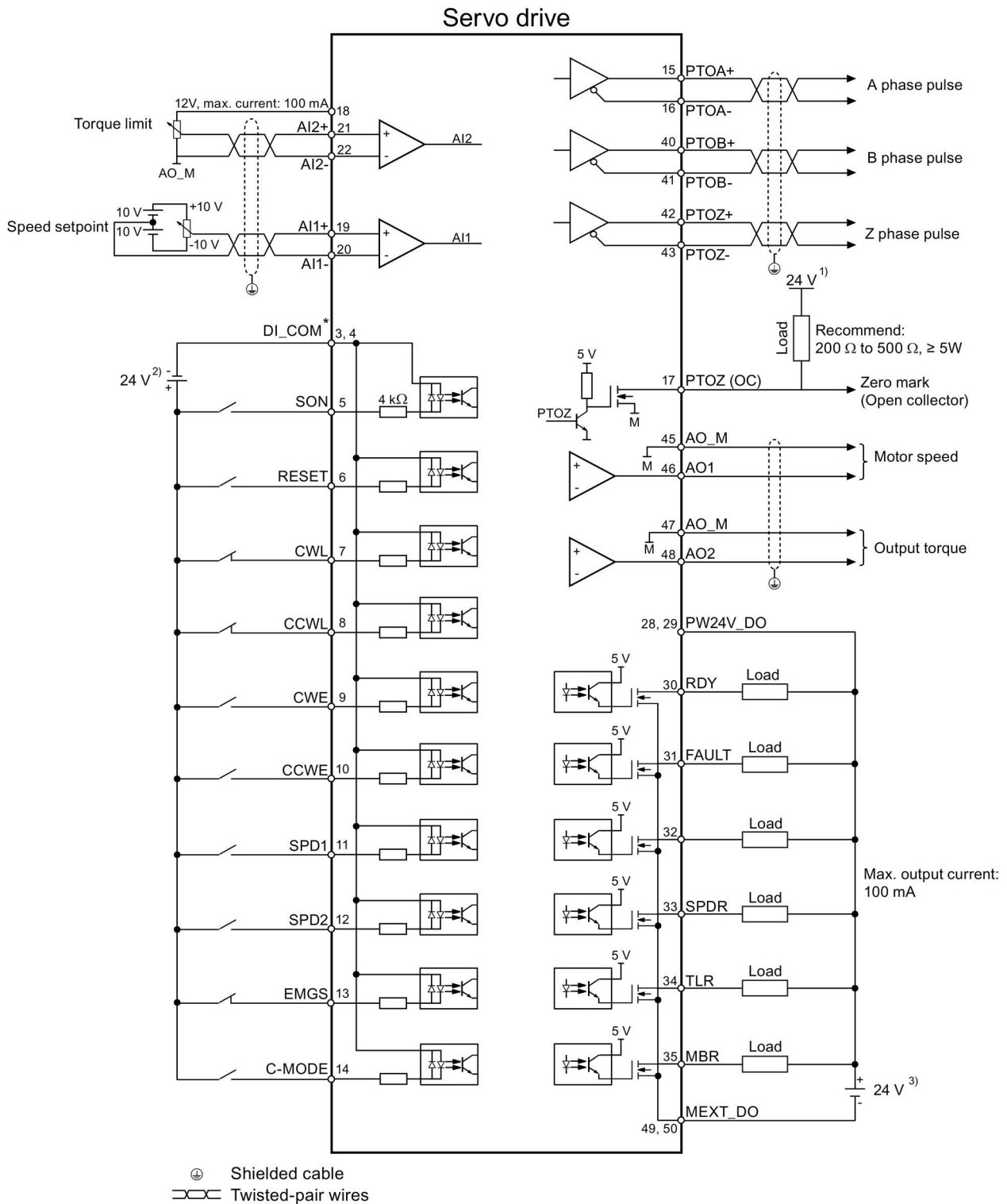
\* Digital inputs, supporting both PNP and NPN types.

The 24 V power supplies in the connection diagram are as follows:

- 1) 24 V power supply for SINAMICS V90. All the PTO signals must be connected to the controller with the same 24 V power supply as SINAMICS V90.
- 2) Isolated digital input power supply. It can be the controller power supply.
- 3) Isolated digital output power supply. It can be the controller power supply.

### 4.3.4.3 Speed control (S)

Standard wiring for speed control mode:



\* Digital inputs, supporting both PNP and NPN types.

The 24 V power supplies in the connection diagram are as follows:

- 1) 24 V power supply for SINAMICS V90. All the PTO signals must be connected to the controller with the same 24 V power supply as SINAMICS V90.
- 2) Isolated digital input power supply. It can be the controller power supply.
- 3) Isolated digital output power supply. It can be the controller power supply.

---

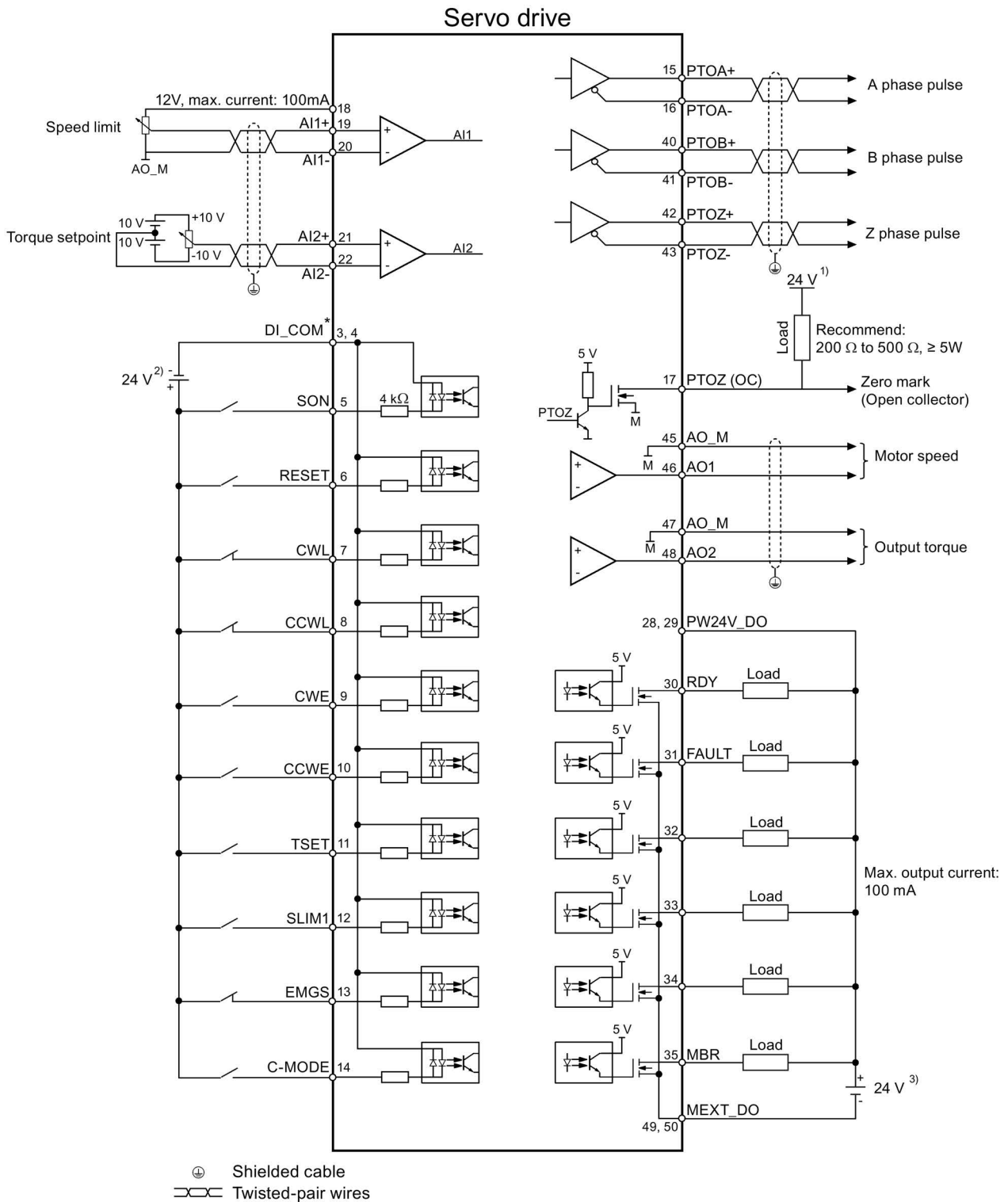
**Note**

The analog outputs to analog inputs on the servo unit and the 24V input for the servo unit **must** use a common ground (M).

---

### 4.3.4.4 Torque control (T)

Standard wiring for torque control mode:



\* Digital inputs, supporting both PNP and NPN types.

The 24 V power supplies in the connection diagram are as follows:

- 1) 24 V power supply for SINAMICS V90. All the PTO signals must be connected to the controller with the same 24 V power supply as SINAMICS V90.
- 2) Isolated digital input power supply. It can be the controller power supply.
- 3) Isolated digital output power supply. It can be the controller power supply.

---

**Note**

The analog outputs to analog inputs on the servo unit and the 24V input for the servo unit **must** use a common ground (M).

---

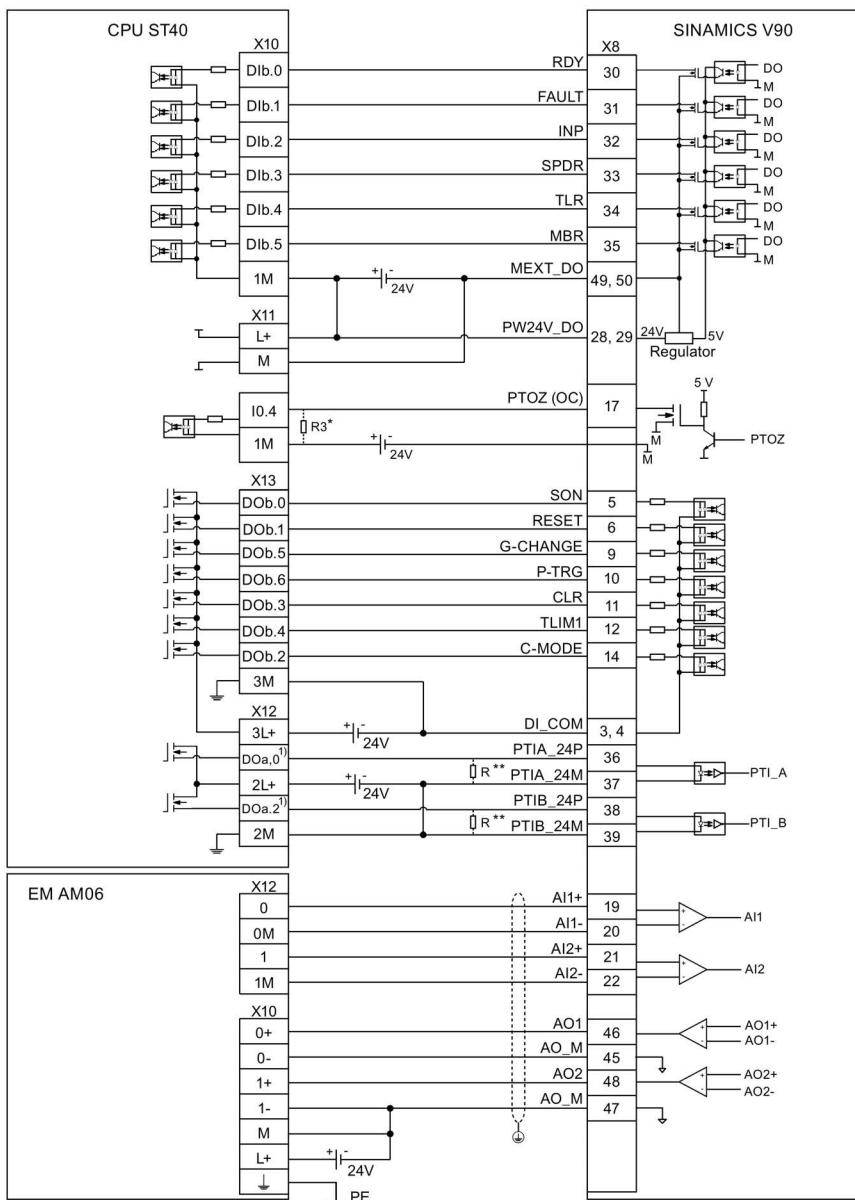
### 4.3.5 Connection examples with PLCs

This section gives examples of connections between the drive and the PLC. All of the connection examples shown in this section are made based on factory default settings for digital inputs/outputs. You can assign different digital inputs/outputs based on your actual requirement.

#### 4.3.5.1 SIMATIC S7-200 SMART

##### Pulse train input position control (PTI)

When connect to different axes, the outputs are different. The diagram below take the connection with axis 0 as example.

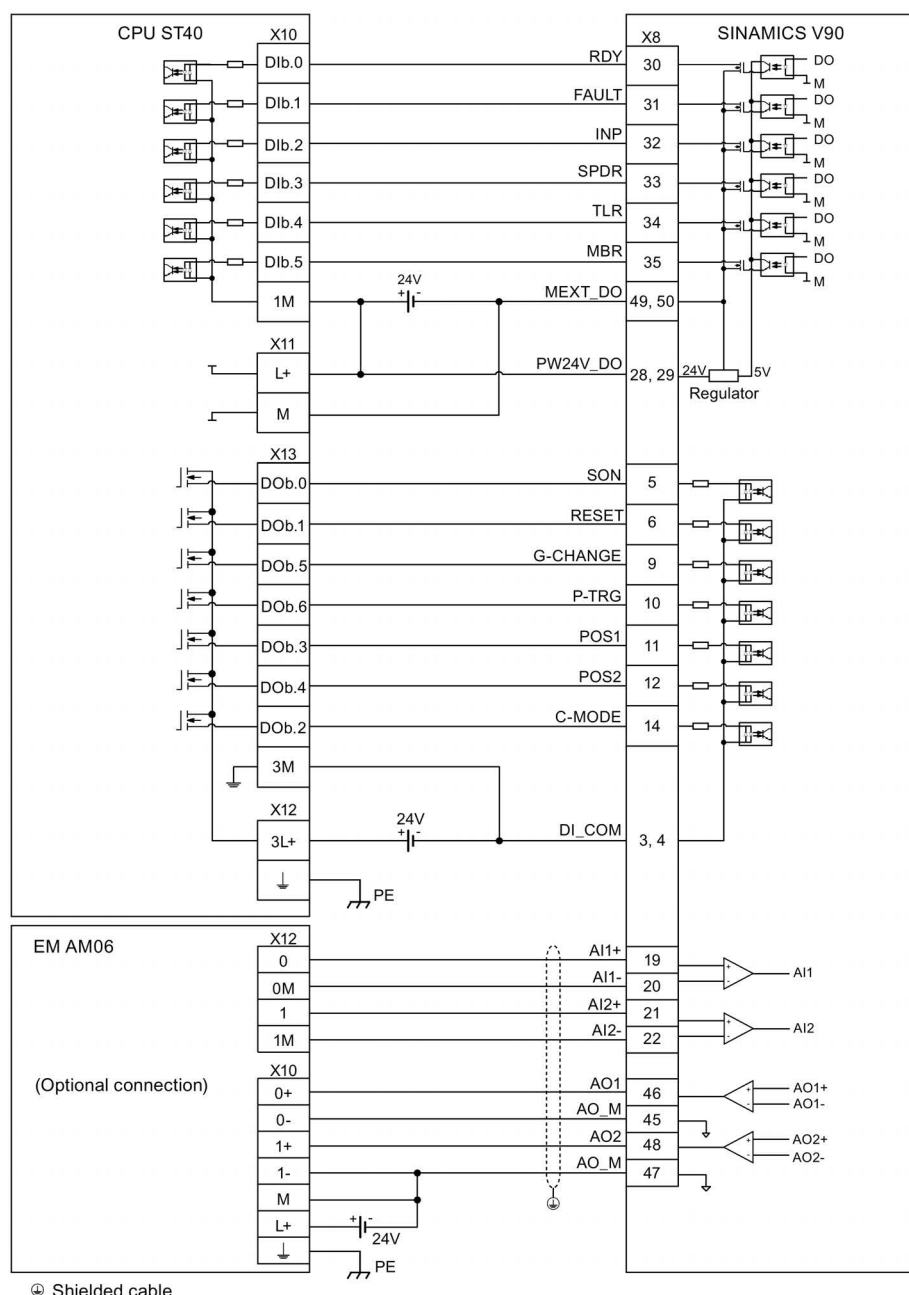


© Shielded cable

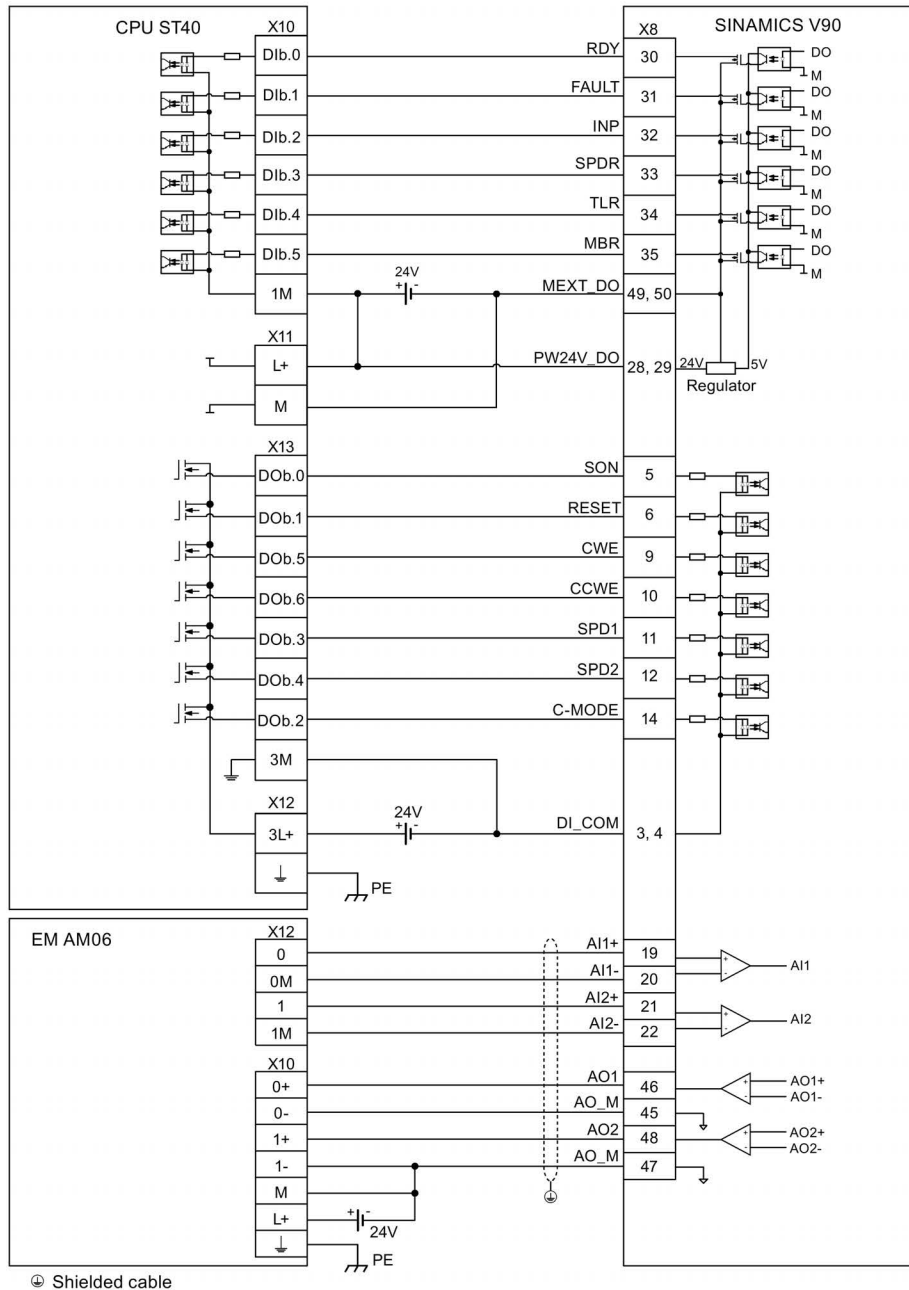


- 1) When connect to axis 1, the outputs are DO a.1 and DO a.7;  
When connect to axis 2, the outputs are DO a.3 and DO b.0.
- \* The resistor R3 (200 Ohm to 500 Ohm) is required only if the speed for searching the zero position exceeds 300 rpm.
- \*\* The resistor R (200 Ohm to 500 Ohm, recommended power  $\geq 5 W$ ) is required only if the PTI input frequency exceeds 100 KHz.

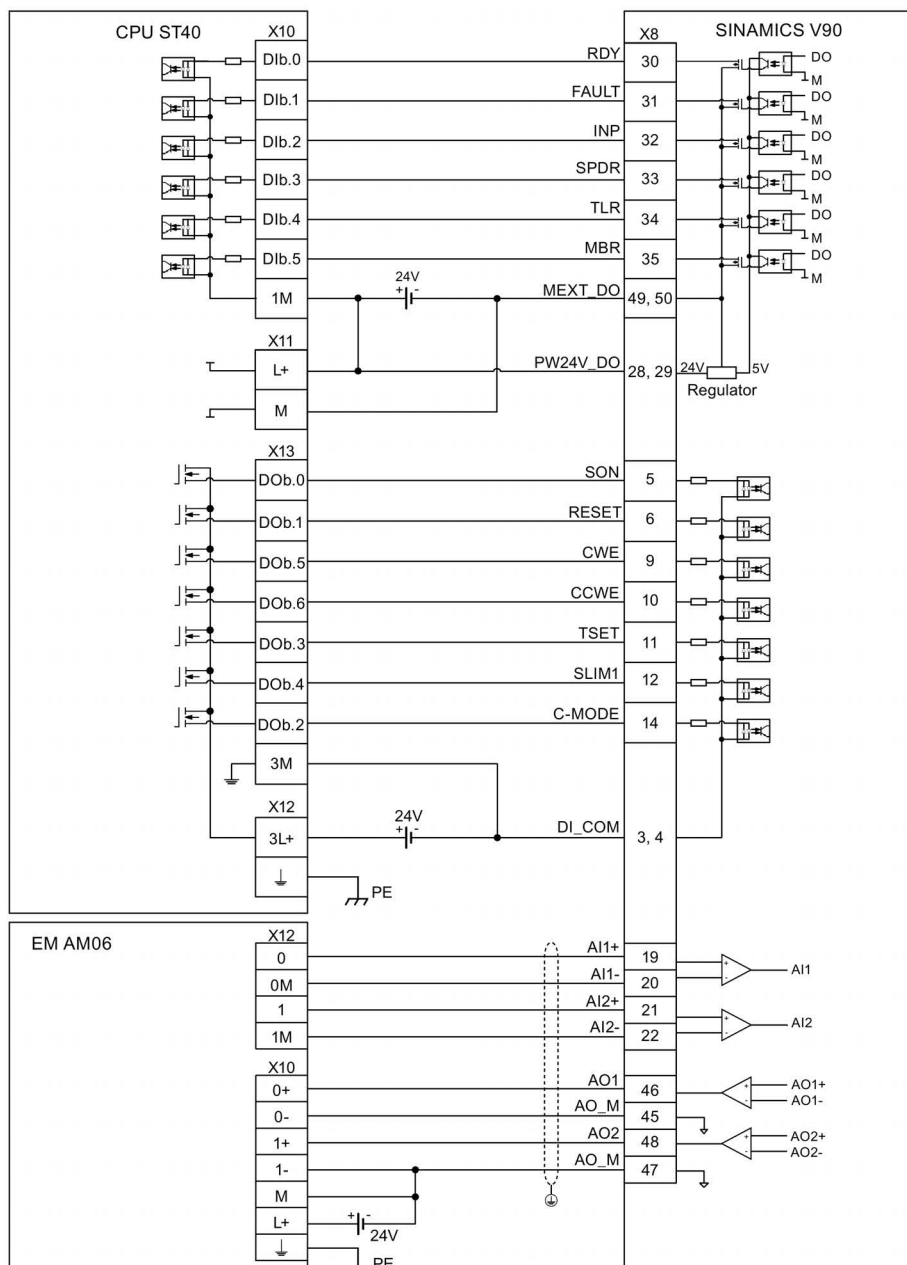
**Internal position control (IPos)**



Speed control (S)



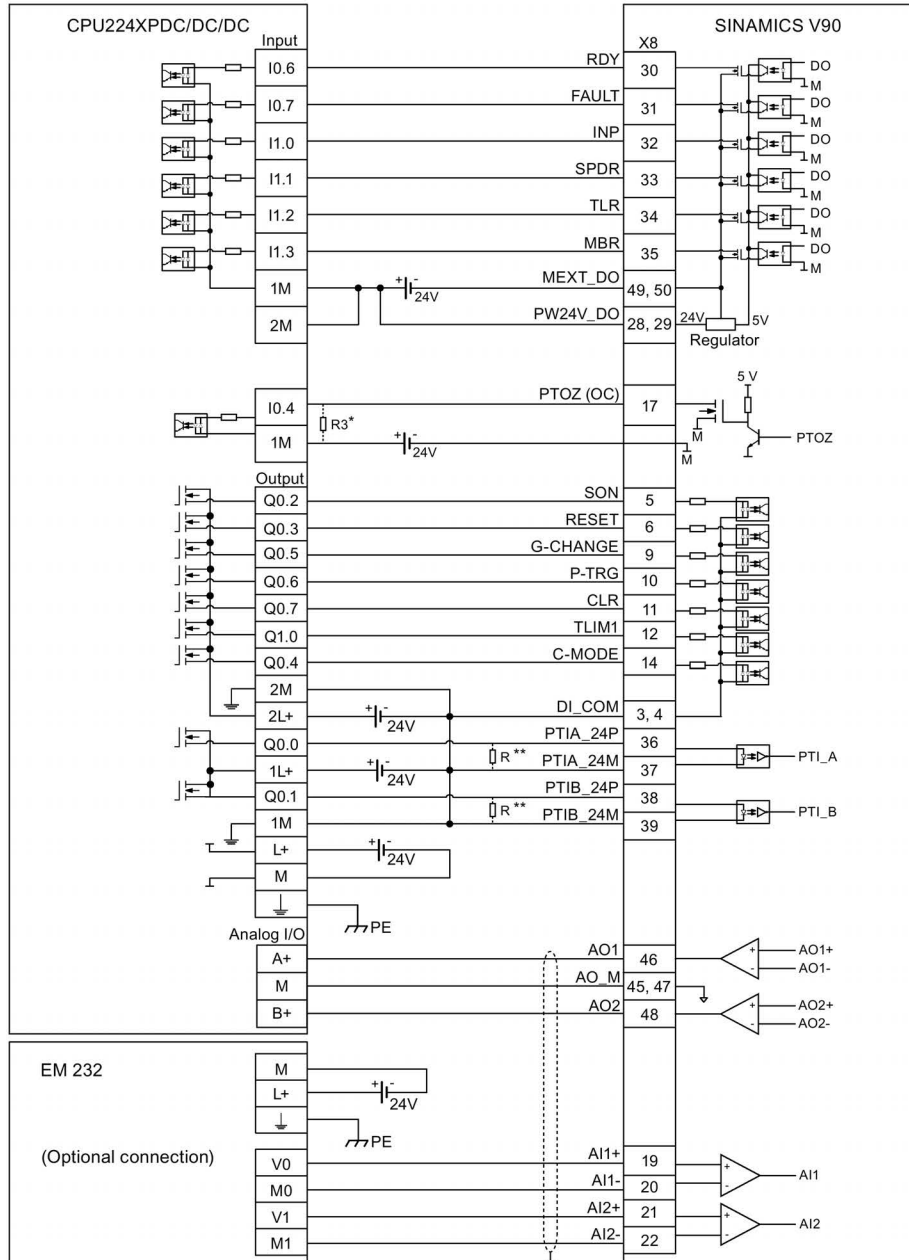
Torque control (T)



Ⓢ Shielded cable

4.3.5.2 SIMATIC S7-200

Pulse train input position control (PTI)

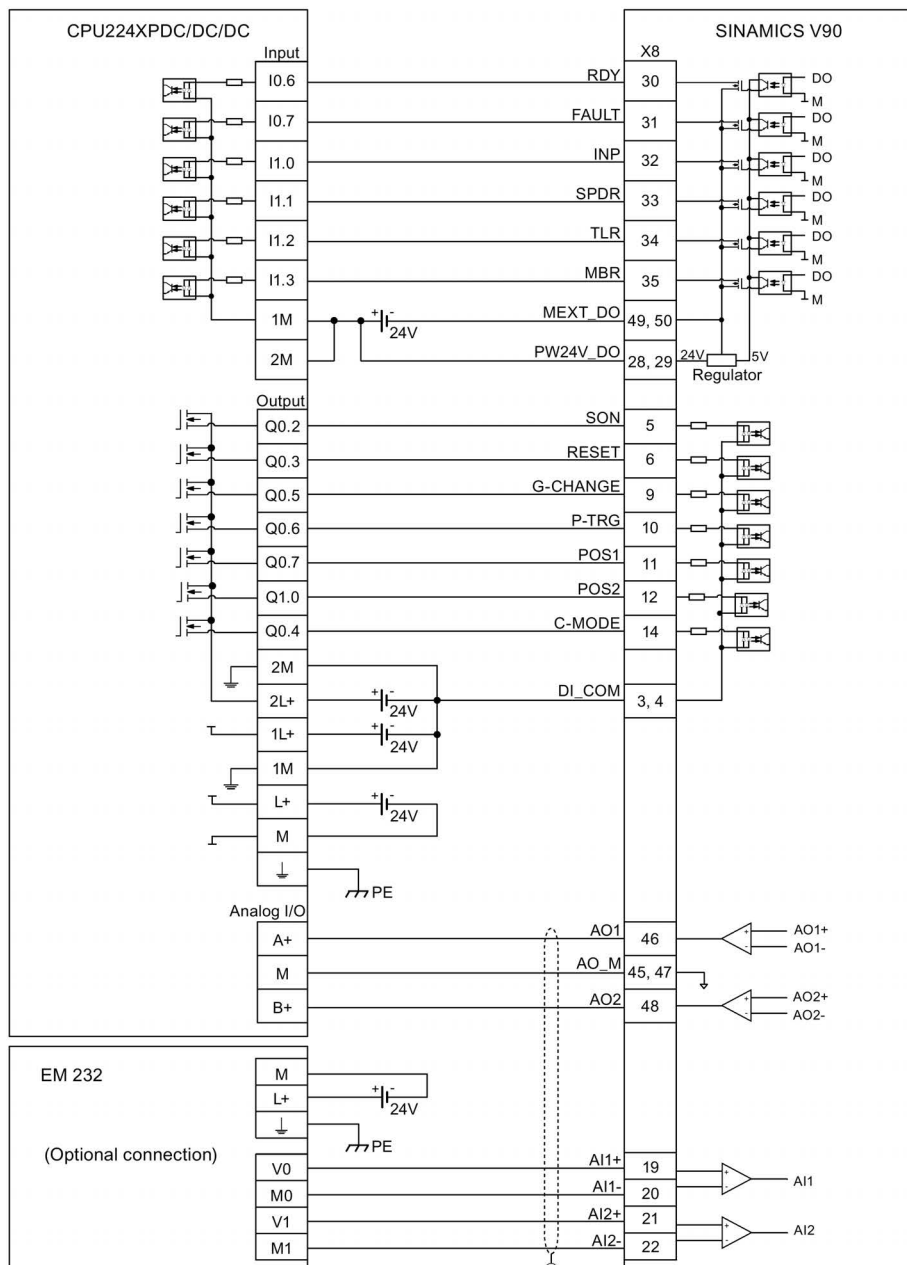


⊕ Shielded cable

\* The resistor R3 (200 Ohm to 500 Ohm) is required only if the speed for searching the zero position exceeds 300 rpm.

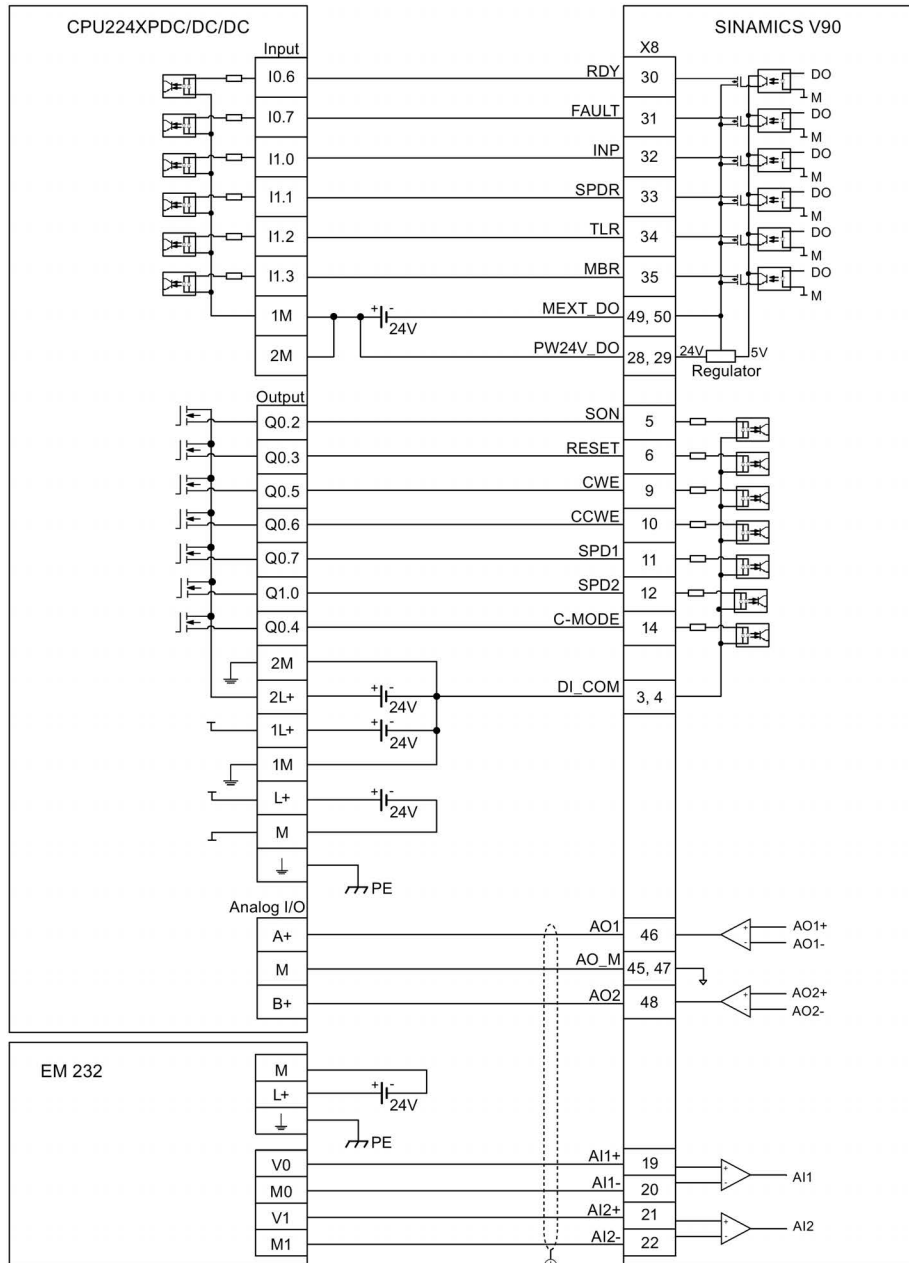
\*\* The resistor R (200 Ohm to 500 Ohm, recommended power  $\geq 5 W$  ) is required only if the PTI input frequency exceeds 100 KHz.

Internal position control (IPos)



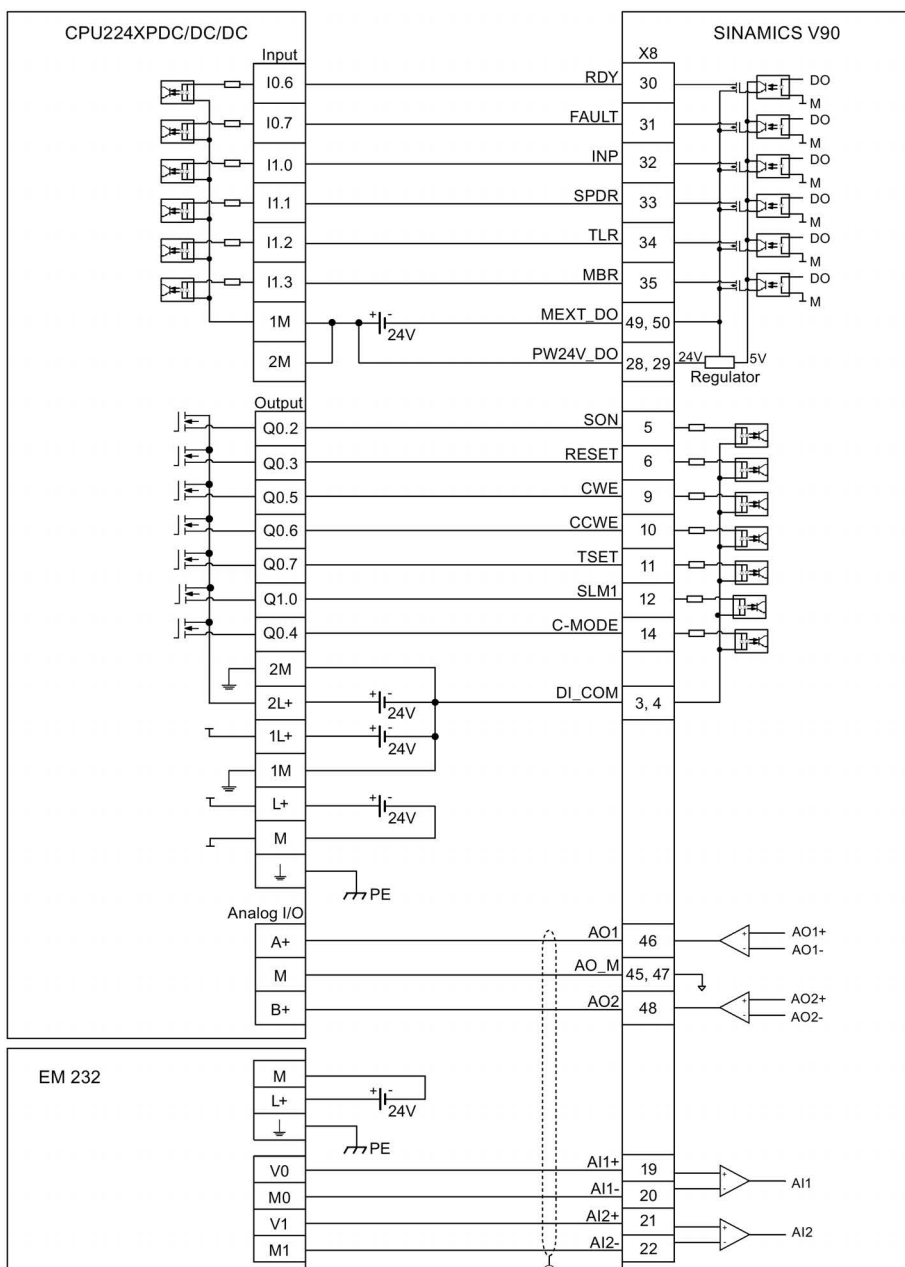
Ⓢ Shielded cable

Speed control (S)



⊕ Shielded cable

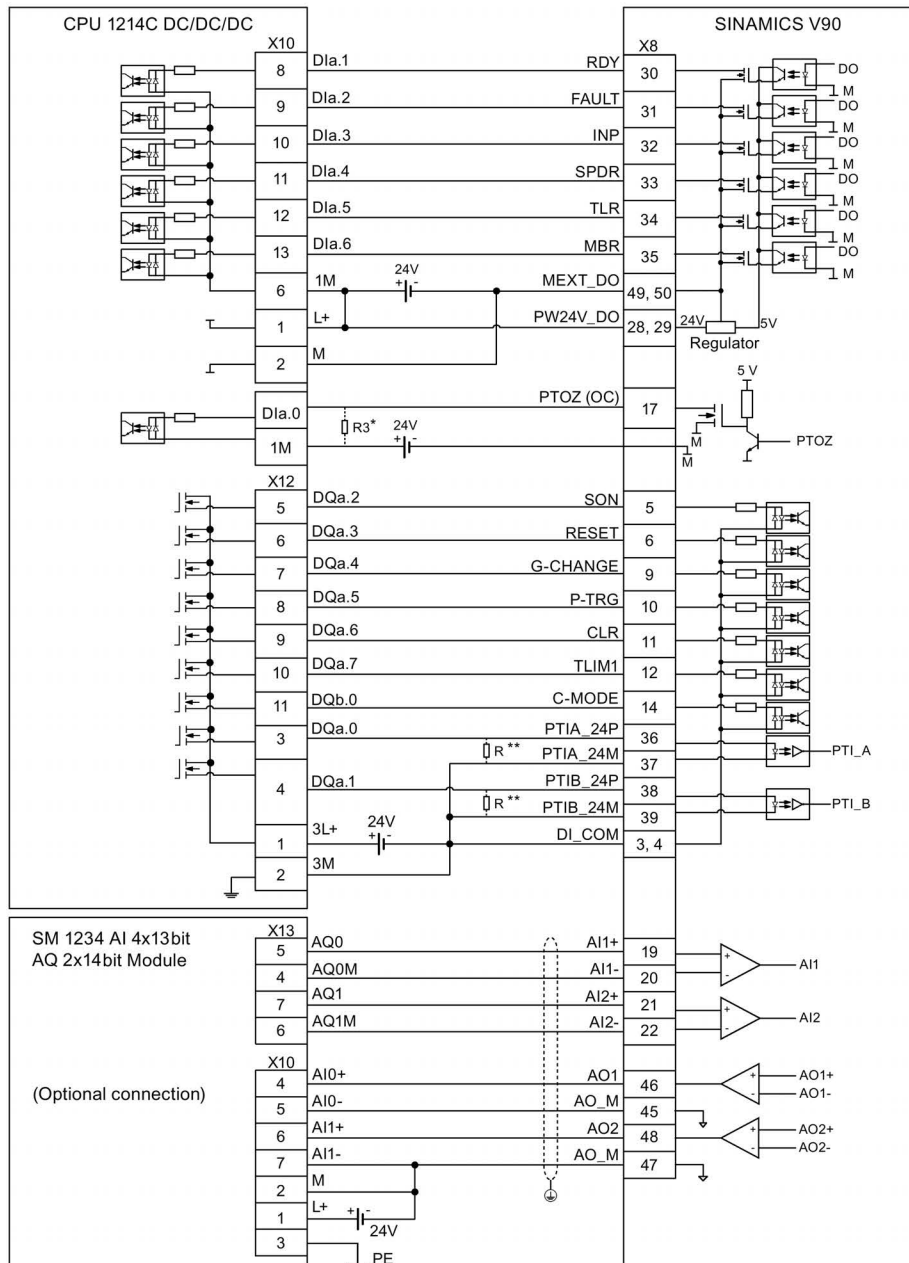
Torque control (T)



Ⓢ Shielded cable

4.3.5.3 SIMATIC S7-1200

Pulse train input position control (PTI)



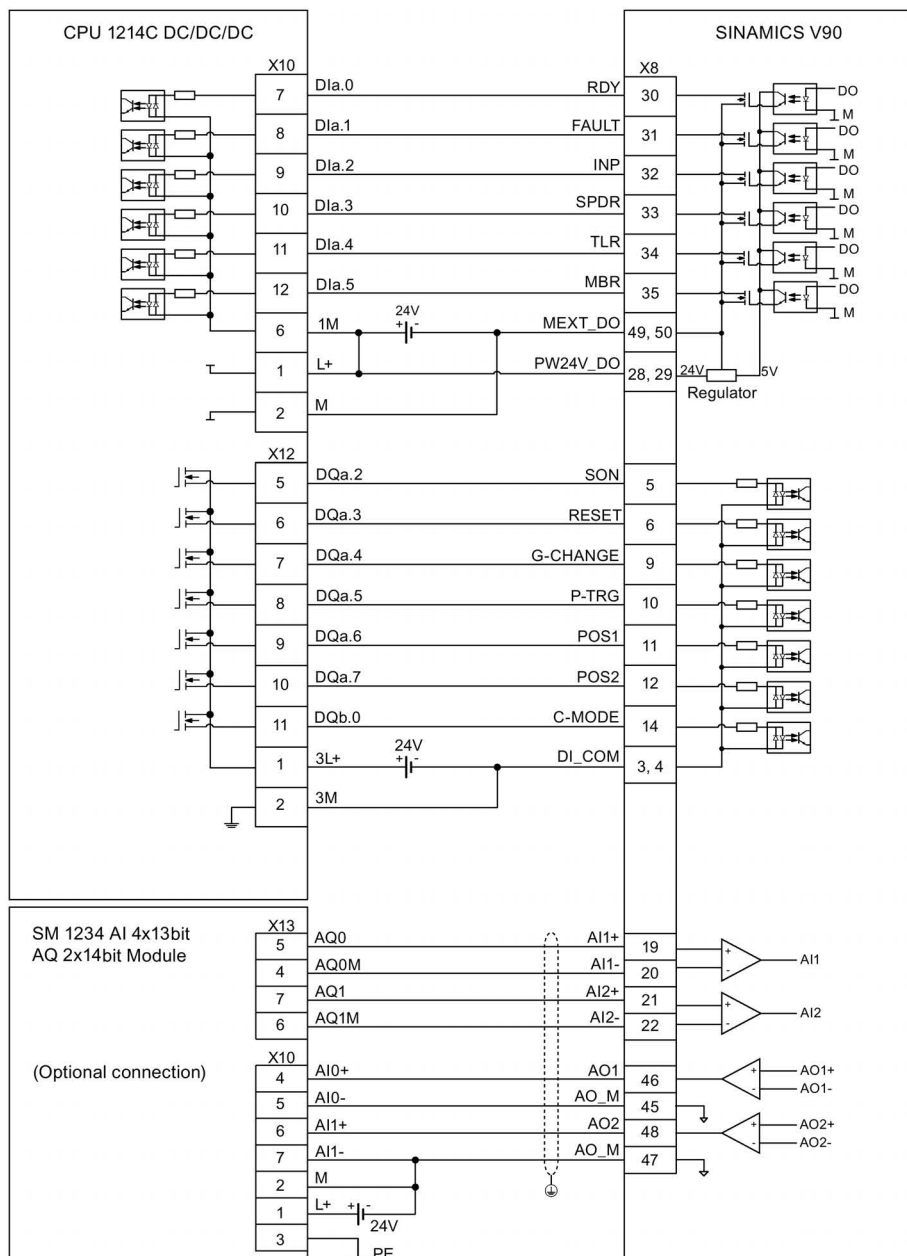
⊕ Shielded cable

\* The resistor R3 (200 Ohm to 500 Ohm) is required only if the speed for searching the zero position exceeds 300 rpm.

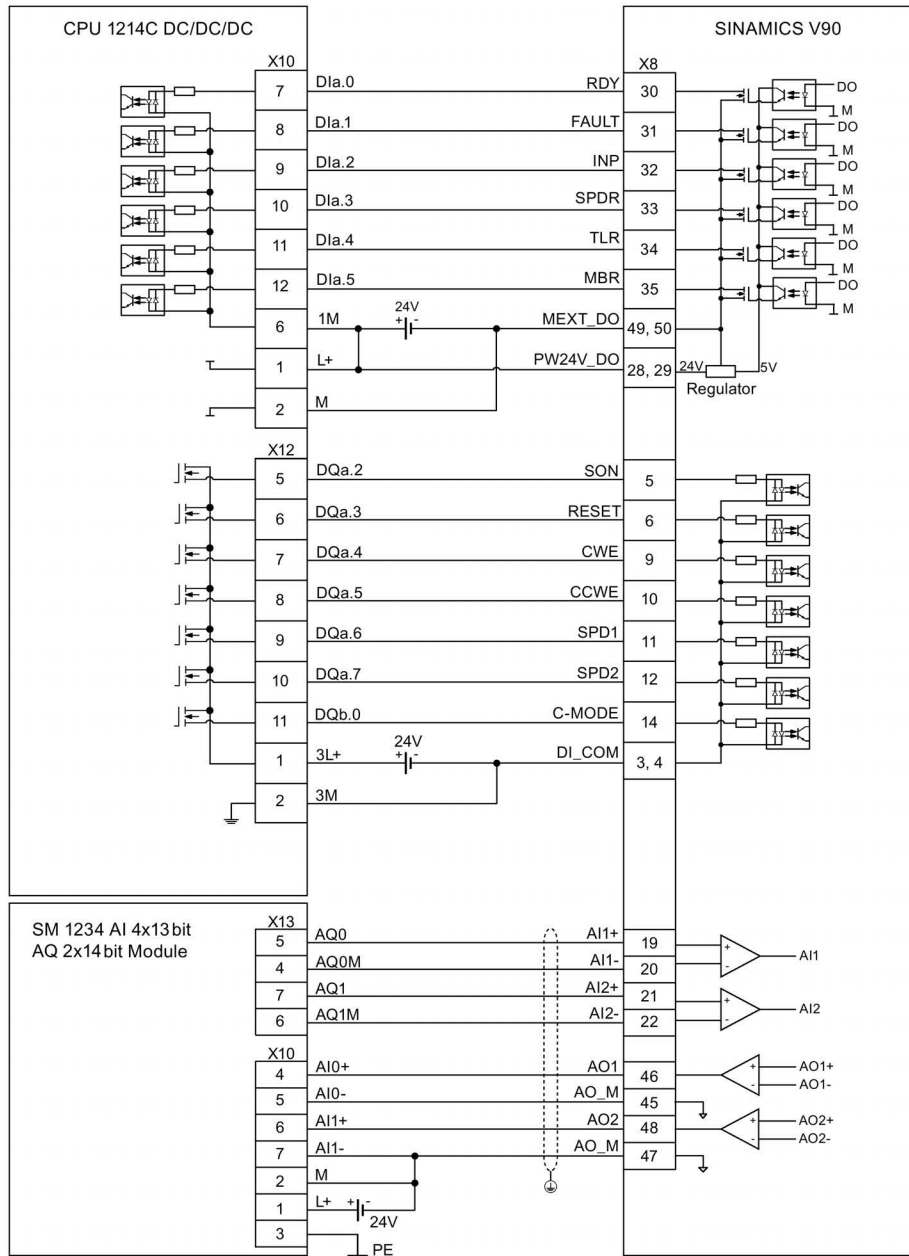
\*\* The resistor R (200 Ohm to 500 Ohm, recommended power  $\geq 5 W$ ) is required only if the PTI input frequency exceeds 100 KHz.



Internal position control (IPos)

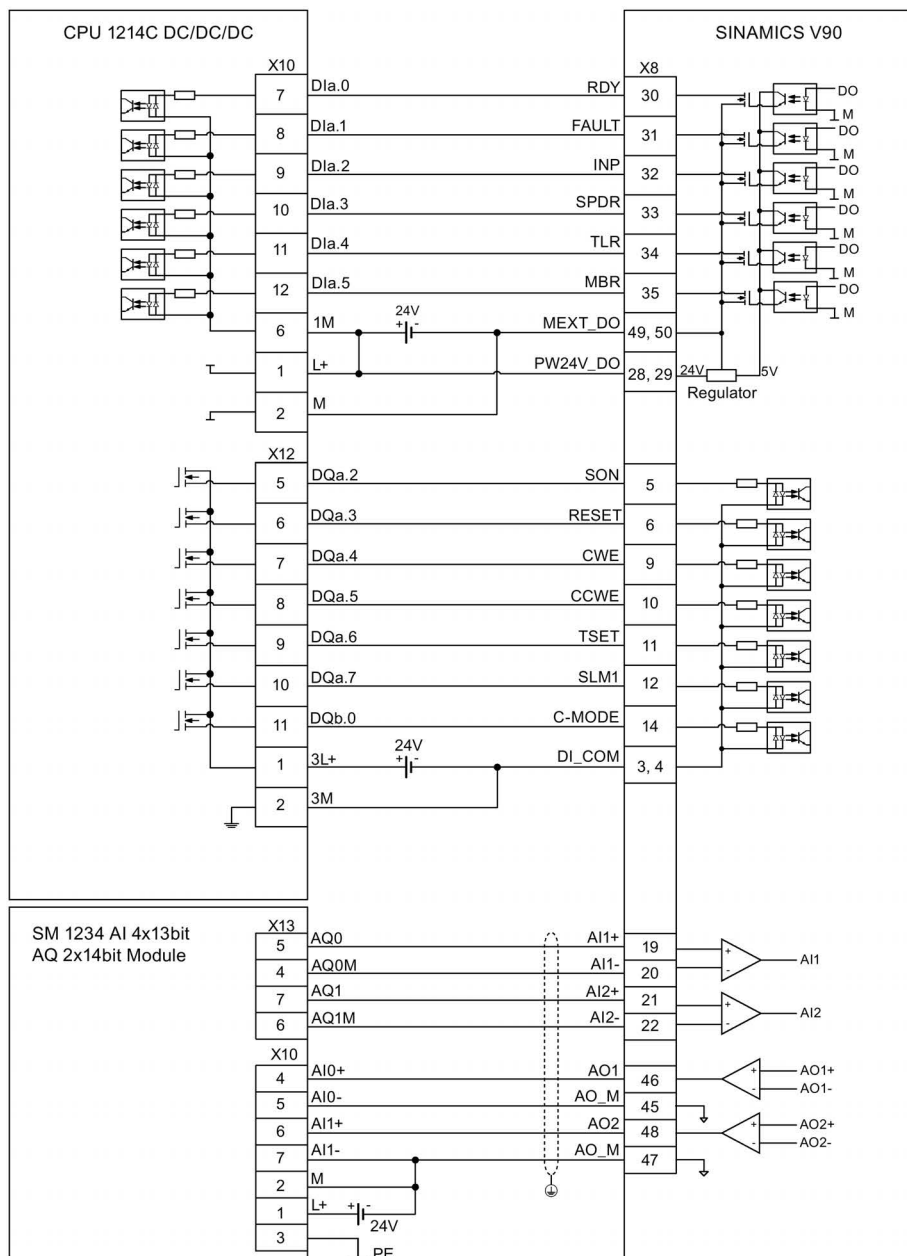


Speed control (S)



⊕ Shielded cable

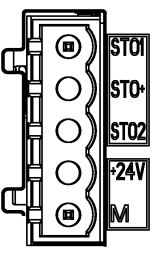
Torque control (T)



⊕ Shielded cable

## 4.4 24V 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 VDC	Voltage tolerance: <ul style="list-style-type: none"> <li>• Without brake: -15% to +20%</li> <li>• With brake: -10% to +10%</li> </ul> Maximum current consumption: <ul style="list-style-type: none"> <li>• 1.6 A without brake power supply</li> <li>• 3.6 A with brake power supply</li> </ul>
	M	Power supply, 0 VDC	
	Maximum conductor cross-section: 1.5 mm <sup>2</sup>		

### Wiring

**⚠ WARNING**

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

When the servo system is used as a hanging axis, the axis will drop if the positive and negative poles of the 24 V power supply are connected inversely. Unexpected drop of the hanging axis may cause material damages and personal injuries.

Make sure that the 24 V power supply is correctly connected.

**⚠ WARNING**

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

It is not allowed to use the STO with a hanging axis because the axis may drop. Unexpected drop of the hanging axis may cause material damages and personal injuries.

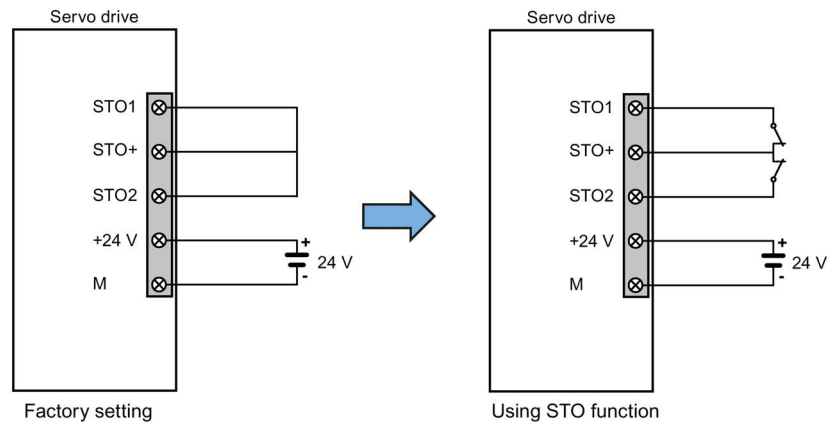
#### Note

##### Using the STO function

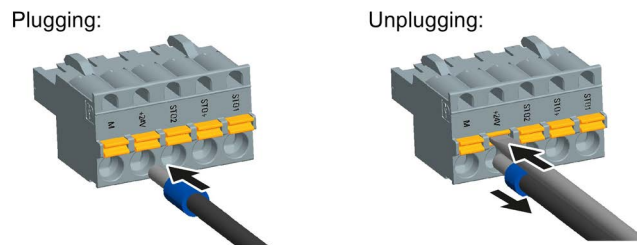
The STO1, STO+ and STO2 are short connected at the factory setting.

When the STO function is to be used, you must remove the short-circuit stick before connecting the STO interfaces. If you do not need to use it any more, you must reinsert the short-circuit stick; otherwise, the motor will not run.

For detailed information about the STO function, refer to "Safety Integrated basic functions (Page 243)".



### Plugging the 24 V power supply and STO cables



## 4.5 Encoder interface

The SINAMICS V90 200 V variant servo drive supports incremental encoder only, while the SINAMICS V90 400 V variant servo drive supports incremental encoder and absolute encoder.

### NOTICE

#### Cable shielding

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

### NOTICE

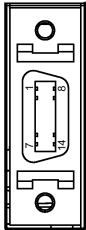
#### Drive damage caused by short-circuiting between the shielding wire and the unused pin on the encoder connector

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

Exercise caution when connecting the shielding cable to the encoder connector.

For more information, see section "Assembly of cable terminals on the drive side (Page 337)".

Encoder interface - drive side

Illustration	Pin	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, +5V
	6	P5V	Encoder power supply, +5V
	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) Tightening torque: 0.5 - 0.6 Nm			

Encoder connector - motor side

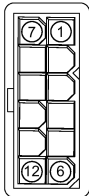
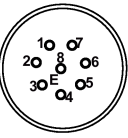
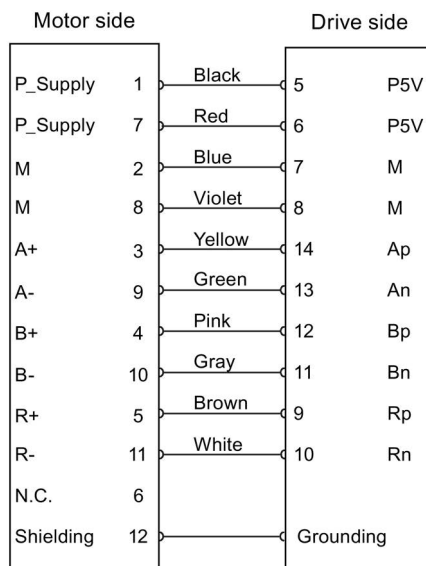
Illustration	Pin No.	Incremental encoder	
		Signal	Description
<b>Low inertia motor, shaft-height: 20 mm, 30 mm and 40 mm</b>			
	1	P_Supply	Power supply 5 V
	2	M	Power supply 0 V
	3	A+	Phase A+
	4	B+	Phase B+
	5	R+	Phase R+
	6	n. c.	Not connected
	7	P_Supply	Power supply 5 V
	8	M	Power supply 0 V
	9	A-	Phase A-
	10	B-	Phase B-
	11	R-	Phase R-
	12	Shielding	Grounding

Illustration	Pin No.	Incremental encoder		Absolute encoder (for high inertia motor only)	
		Signal	Description	Signal	Description
Low inertia motor, shaft-height: 50 mm High inertia motor, shaft-height: 45 mm, 65 mm, and 90 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+	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
	7	R+	Phase R+	n. c.	Not connected
	8	R-	Phase R-	Data_N	Inverted data

## Wiring

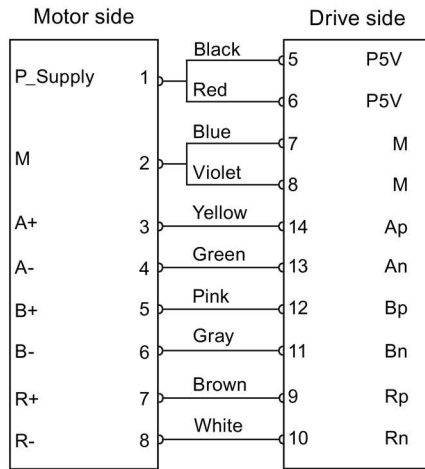
### Low inertia motor, shaft-height: 20 mm, 30 mm and 40 mm



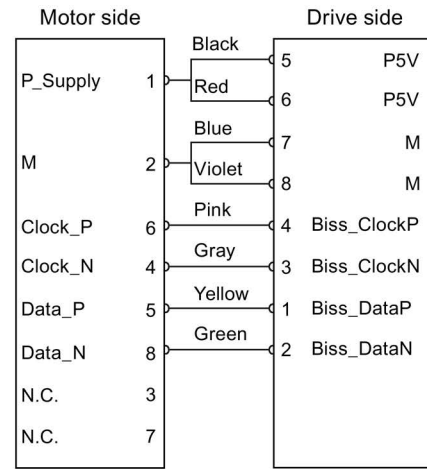
Incremental encoder

Low inertia motor, shaft-height: 50 mm

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



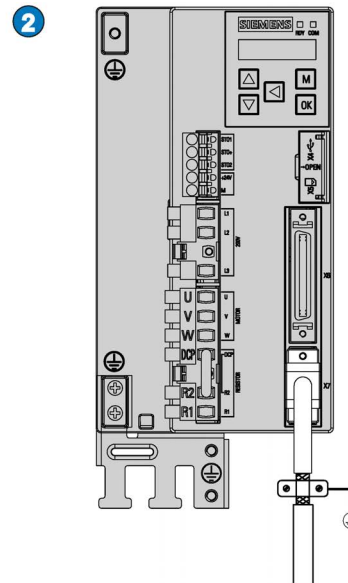
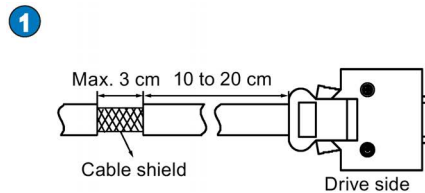
Incremental encoder



Absolute encoder  
(for high inertia motor only)

### Grounding

To ensure better EMC effects, you are recommended to strip the encoder cable and connect the cable shield to earth, as shown in the following figure:






## 4.6 External braking resistor - DCP, R1

The SINAMICS V90 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. For the selection of braking resistors, refer to Accessories (Page 42).

### Connecting an external braking resistor

 <b>WARNING</b>
<b>Damage to the drive</b>
Before connecting an external resistor to DCP and R1, remove the short-circuit stick on the connectors. Otherwise, the drive may be damaged.

For the connection of the external braking resistor, refer to System connection (Page 81).

## 4.7 Motor holding brake interface (400V variant only)

You can connect the SINAMICS V90 servo drive to a servo motor with brake to use the function of motor holding brake.

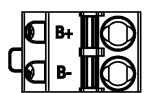
The relevant information about the interface and wiring is described as follows.

### Note

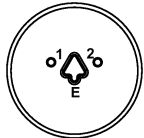
#### Motor holding brake

For detailed information about the function of motor holding brake, refer to the section "Motor holding brake (Page 165)".

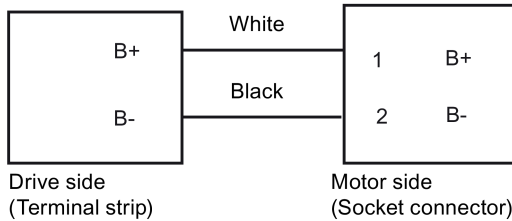
### Motor holding brake - drive side

Illustration	Signal	Description
	B+	+ 24 V, motor brake voltage positive
	B-	0 V, motor brake voltage negative
Maximum conductor cross-section: 1.5 mm <sup>2</sup> Input voltage tolerance: 24 V ± 10%		

**Motor holding brake - motor side**

Illustration	Pin No.	Signal	Description
	1	Brake+	Phase Brake+
	2	Brake-	Phase Brake-

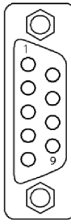
**Wiring**



**4.8 RS485 interface**

The SINAMICS V90 servo drives support communication with the PLCs through the RS485 interface over the USS or Modbus protocol.

**Pin assignment**

Illustration	Pin	Signal name	Description
	1	Reserved	Do not use
	2	Reserved	Do not use
	3	RS485+	RS485 differential signal
	4	Reserved	Do not use
	5	M	Ground to internal 3.3 V
	6	3.3 V	3.3 V power supply for internal signal
	7	Reserved	Do not use
	8	RS485-	RS485 differential signal
	9	Reserved	Do not use

Type: 9-pin, Sub-D, female

# Commissioning

## 5.1 General commissioning information

Prior to commissioning, read "Basic operator panel (BOP) (Page 143)" for more information about the BOP operations. In case of any faults or alarms during commissioning, refer to Chapter "Diagnostics (Page 313)" for detailed description.

### CAUTION

#### **Carefully read the safety instructions**

Before your commissioning or operation, read the safety instructions in Section "Safety instructions (Page 11)" carefully. Failure to observe the instructions may cause serious effects.

### WARNING

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

When the servo system is used as a hanging axis, the axis will drop if the positive and negative poles of the 24 V power supply are connected inversely. Unexpected drop of the hanging axis may cause material damages and personal injuries.

Before commissioning, a crosstie must be used to hold the hanging axis in prevention of an unexpected drop. In addition, make sure that the 24 V power supply is correctly connected.

### NOTICE

#### **Plugging or unplugging the micro SD card/SD card will cause startup failure.**

Do not plug or unplug the micro SD card/SD card during startup; otherwise, the drive will fail to start up.

### NOTICE

#### **Firmware damage due to drive power-off during data transfer**

Switching off the 24 VDC power supply for the drive during data transfer from the micro SD card/SD card to the drive can cause damage to the drive firmware.

- Do not switch off the drive power supply when the data transfer from the micro SD card/SD card to the drive is in process.

**NOTICE**

**Existing setting data may be overwritten by the setting data on the micro SD card/SD card during startup.**

- When a drive is switched on with a micro SD card/SD card containing user setting data, the existing setting data on the drive will be overwritten.
- When a drive is switched on with a micro SD card/SD card containing no user setting data, the drive will automatically save the existing user setting data onto the micro SD card/SD card.

Before starting up the drive with a micro SD card/SD card, check whether the micro SD card/SD card contains user setting data. Otherwise, the existing data on the drive may be overwritten.

**Note**

In S control mode, if the motor shaft is blocked, the blocked torque is the current effective torque. Long time shaft blocking can cause damage to the motor.

**Engineering tool - SINAMICS V-ASSISTANT**

You can use the engineering tool SINAMICS V-ASSISTANT to perform the trial operation.

SINAMICS V-ASSISTANT is a software tool that can be installed on a PC and runs on the Windows operating system. It communicates with the SINAMICS V90 servo drive with a USB cable. With SINAMICS V-ASSISTANT, you can change drive parameters and monitor drive working states in online mode.

For more information, refer to SINAMICS V-ASSISTANT Online Help. You can search and download SINAMICS V-ASSISTANT from Technical support website.

**5.2 Initial commissioning in JOG mode**

**Commissioning purpose**

When the servo drive is powered on for the first time, you can perform a test run with the BOP or the engineering tool SINAMICS V-ASSISTANT to check:

- Whether the line supply has been connected correctly
- Whether the 24 VDC power supply has been connected correctly
- Whether the cables (power cable, encoder cable, and brake cable) between the servo drive and the servo motor have been connected correctly
- Whether the motor speed and direction of rotation are correct.

## Prerequisites

- The servo drive is connected to the servo motor without load.
- No PLC is connected to the drive system.

## Operating sequence

### Note

The digital signal EMGS **must** be kept at high level (1) to ensure normal operation.

Step	Description	Remarks
1	Connect necessary units and check wiring.	<p>It is necessary to connect the following cables:</p> <ul style="list-style-type: none"> <li>• Power cable</li> <li>• Encoder cable</li> <li>• Brake cable</li> <li>• Line supply cable</li> <li>• 24 VDC cable</li> </ul> <p>Check:</p> <ul style="list-style-type: none"> <li>• Is the device or cable damaged?</li> <li>• Do the connected cables have excessive pressure, load or tension?</li> <li>• Are the connected cables put on sharp edges?</li> <li>• Is the line supply within the permissible range?</li> <li>• Are all the terminals firmly and correctly connected?</li> <li>• Are all the connected system components well grounded?</li> </ul> <p>Refer to "Connecting (Page 81)".</p>
2	Switch on the 24 VDC power supply.	
3	<p>Check the servo motor type.</p> <ul style="list-style-type: none"> <li>• If the servo motor has an incremental encoder, input motor ID (p29000).</li> <li>• If the servo motor has an absolute encoder, the servo drive can identify the servo motor automatically.</li> </ul>	<p>Fault <b>F52984</b> occurs when the servo motor is not identified.</p> <p>You can find the motor ID from the motor rating plate. Go to "Motor components (Page 30)" for detailed descriptions about motor rating plate.</p> <p>Refer to "Basic operations (Page 149)" for information about how to change a parameter with the BOP.</p>
4	<p>Check the direction of motor rotation.</p> <p>The default direction of rotation is CW (clockwise). You can change it by setting the parameter p29001 if necessary.</p>	<p>p29001=0: CW</p> <p>p29001=1: CCW</p>
5	<p>Check the Jog speed.</p> <p>The default Jog speed is 100 rpm. You can change it by setting the parameter p1058.</p>	

5.3 Commissioning in pulse train position control mode (PTI)

Step	Description	Remarks
6	Save parameters with the BOP.	For detailed information about the parameter setting / saving with the BOP, refer to the sections "Basic operations (Page 149)" or "Saving parameters (RAM to ROM) (Page 155)".
7	Switch on the line supply.	
8	Clear faults and alarms.	Refer to "Diagnostics (Page 313)".
9	For the BOP, enter the <b>Jog</b> menu function and press the <b>UP</b> or <b>DOWN</b> button to run the servo motor. For the engineering tool, use the Jog function to run the servo motor.	For more information about Jog with the BOP, see Section "Jog (Page 154)". For more information about Jog with SINAMICS V-ASSISTANT, see SINAMICS V-ASSISTANT Online Help.

**Note**

When you run the servo motor with an incremental encoder in JOG mode, the servo motor makes a short buzzing sound indicating that it is identifying the magnetic pole position of the rotor.

**5.3 Commissioning in pulse train position control mode (PTI)**

Step	Description	Comment
1	Switch off the line supply.	
2	Power off the servo drive and connect it to the controller (for example, SIMATIC S7-200 SMART) with the signal cable.	The digital signals CWL, CCWL and EMGS <b>must</b> be kept at high level (1) to ensure normal operation. Refer to "Standard application wirings (factory setting) (Page 104)" and "Connection examples with PLCs (Page 112)".
3	Switch on the 24 VDC power supply.	
4	Check the servo motor type. <ul style="list-style-type: none"> <li>If the servo motor has an incremental encoder, input motor ID (p29000).</li> <li>If the servo motor has an absolute encoder, the servo drive can identify the servo motor automatically.</li> </ul>	Fault <b>F52984</b> occurs when the servo motor is not identified. You can find the motor ID from the motor rating plate. Go to "Motor components (Page 30)" for detailed descriptions about motor rating plate. Refer to "Basic operations (Page 149)" for information about how to change a parameter with the BOP.
5	Check current control mode by viewing value of the parameter p29003. Pulse train input position control mode (p29003=0) is the factory setting of SINAMICS V90 servo drives.	Refer to "Compound controls (Page 161)".
6	Save the parameter and restart the servo drive to apply the setting of the pulse train input position control mode.	

Step	Description	Comment
7	Select a setpoint pulse train input form by setting parameter p29010.	<ul style="list-style-type: none"> <li>• p29010=0: pulse + direction, positive logic</li> <li>• p29010=1: AB track, positive logic</li> <li>• p29010=2: pulse + direction, negative logic</li> <li>• p29010=3: AB track, negative logic</li> </ul> <p>The factory setting is p29010=0 (pulse + direction, positive logic).</p> <p>Refer to "Selecting a setpoint pulse train input form (Page 172)".</p>
8	Select a pulse input channel by setting parameter p29014.	<ul style="list-style-type: none"> <li>• p29014=0: high-speed 5 V differential pulse train input (RS485)</li> <li>• p29014=1: 24 V single end pulse train input</li> </ul> <p>24 V single end pulse train input is the factory setting.</p> <p>Refer to "Selecting a setpoint pulse train input channel (Page 171)".</p>
9	Set the electronic gear ratio.	<p>You can use one of the following three methods to set the electronic gear ratio:</p> <ul style="list-style-type: none"> <li>• Set the electronic gear ratio with parameters p29012 and p29013. <ul style="list-style-type: none"> <li>– p29012: numerator of the electronic gear. Four numerators in total (p29012[0] to p29012[3]) are available.</li> <li>– p29013: denominator of the electronic gear.</li> </ul> </li> <li>• Set the setpoint pluses per revolution. <ul style="list-style-type: none"> <li>– p29011: number of setpoint pulses per revolution.</li> </ul> </li> <li>• Calculate the electronic gear ratio by selecting mechanical structure. <ul style="list-style-type: none"> <li>– For more information, see SINAMICS V90 V-ASSISTANT Online Help.</li> </ul> </li> </ul> <p>Refer to "Electronic gear ratio (Page 173)".</p>
10	Set the torque limitation and speed limitation.	Refer to "Torque control (T) (Page 207)" and "Speed control (S) (Page 201)".
11	Configure necessary digital input signals by setting the following parameters: <ul style="list-style-type: none"> <li>• p29301[0]: DI1</li> <li>• p29302[0]: DI2</li> <li>• p29303[0]: DI3</li> <li>• p29304[0]: DI4</li> <li>• p29305[0]: DI5</li> <li>• p29306[0]: DI6</li> <li>• p29307[0]: DI7</li> <li>• p29308[0]: DI8</li> </ul>	<p>The factory settings are:</p> <ul style="list-style-type: none"> <li>• p29301[0]: 1 (SON)</li> <li>• p29302[0]: 2 (RESET)</li> <li>• p29303[0]: 3 (CWL)</li> <li>• p29304[0]: 4 (CCWL)</li> <li>• p29305[0]: 5 (G-CHANGE)</li> <li>• p29306[0]: 6 (P-TRG)</li> <li>• p29307[0]: 7 (CLR)</li> <li>• p99308[0]: 10 (TLIM1)</li> </ul> <p>Refer to "Digital inputs/outputs (DIs/DOs) (Page 91)".</p>
12	Check the encoder type. If it is an absolute encoder, adjust the absolute encoder with the BOP menu function "ABS".	Refer to "Adjusting an absolute encoder (Page 160)".

5.4 Commissioning in internal position control mode (IPos)

Step	Description	Comment
13	Set the pulse train encoder output.	Refer to "PTO function (Page 183)".
14	Save parameters with the BOP.	
15	Switch on the line supply.	
16	Clear faults and alarms.	Refer to "Diagnostics (Page 313)".
17	Trigger SON to the high level, input the setpoint pulse train from the command device, and then the servo motor starts running.	Use a low pulse frequency at first to check the direction and speed of rotation.
18	The system commissioning in pulse train input position control mode ends.	You can check the system performance. If it is not satisfied, you can adjust it. Refer to "Tuning (Page 247)".

## 5.4 Commissioning in internal position control mode (IPos)

Step	Description	Remarks
1	Switch off the line supply.	
2	Power off the servo drive and connect it to the controller (for example, SIMATIC S7-200 SMART) with the signal cable.	The digital signals CWL, CCWL and EMGS <b>must</b> be kept at high level (1) to ensure normal operation. Refer to "Standard application wirings (factory setting) (Page 104)" and "Connection examples with PLCs (Page 112)".
3	Switch on the 24 VDC power supply.	
4	Check the servo motor type. <ul style="list-style-type: none"> <li>If the servo motor has an incremental encoder, input motor ID (p29000).</li> <li>If the servo motor has an absolute encoder, the servo drive can identify the servo motor automatically.</li> </ul>	Fault <b>F52984</b> occurs when the servo motor is not identified. You can find the motor ID from the motor rating plate. Go to "Motor components (Page 30)" for detailed descriptions about motor rating plate. Refer to "Basic operations (Page 149)" for information about how to change a parameter with the BOP.
5	Switch to the internal position control mode by setting parameter p29003=1.	Refer to "Compound controls (Page 161)".
6	Save the parameter and restart the servo drive to apply the setting of the internal position control mode.	
7	Set the mechanical gear ratio with parameters p29247, p29248 and p29249.	<ul style="list-style-type: none"> <li>p29247: LU per load revolution</li> <li>p29248: load revolutions</li> <li>p29249: motor revolutions</li> </ul> Refer to "Setting mechanical system (Page 185)".
8	Select the axis type by setting parameter p29245. If you use the modular axis, you need to define the modular range by setting parameter p29246.	<ul style="list-style-type: none"> <li>p29245 = 0: linear axis</li> <li>p29245 = 1: modular axis</li> </ul> Refer to "Configuring linear/modular axis (Page 189)".



Step	Description	Remarks
9	Check and select a positioning mode by setting parameter p29241.	For linear axis, there are two positioning modes: <ul style="list-style-type: none"> <li>• p29241=0: incremental</li> <li>• p29241=1: absolute</li> </ul> For modular axis, there are four positioning modes: <ul style="list-style-type: none"> <li>• p29241=0: incremental</li> <li>• p29241=1: absolute</li> <li>• p29241=2: absolute, positive (only for a rotary axis with modulo correction)</li> <li>• p29241=3: absolute, negative (only for a rotary axis with modulo correction)</li> </ul> Refer to "Selecting a positioning mode - absolute/incremental (Page 188)".
10	Configure the fixed position setpoint (p2617[0] to p2617[7] and p2618[0] to p2618[7]) according to mechanism.	Refer to "Setting fixed position setpoint (Page 186)".
11	Set the torque limitation and speed limitation.	Refer to "Torque limit (Page 199)" and "Speed limit (Page 199)".
12	Configure necessary digital input signals by setting the following parameters: <ul style="list-style-type: none"> <li>• p29301[1]: DI1</li> <li>• p29302[1]: DI2</li> <li>• p29303[1]: DI3</li> <li>• p29304[1]: DI4</li> <li>• p29305[1]: DI5</li> <li>• p29306[1]: DI6</li> <li>• p29307[1]: DI7</li> <li>• p29308[1]: DI8</li> </ul>	The factory settings are: <ul style="list-style-type: none"> <li>• p29301[1]: 1 (SON)</li> <li>• p29302[1]: 2 (RESET)</li> <li>• p29303[1]: 3 (CWL)</li> <li>• p29304[1]: 4 (CCWL)</li> <li>• p29305[1]: 5 (G-CHANGE)</li> <li>• p29306[1]: 6 (P-TRG)</li> <li>• p29307[1]: 21 (POS1)</li> <li>• p29308[1]: 22 (POS2)</li> </ul> Refer to "Digital inputs/outputs (DIs/DOs) (Page 91)".  <b>NOTE:</b> You must configure the digital input signal REF or SREF according to your selection of referencing mode. Refer to "Referencing (Page 190)".
13	Check the encoder type and perform referencing: <ul style="list-style-type: none"> <li>• For an incremental encoder, choose a referencing mode by setting parameter p29240 and perform referencing.</li> <li>• For an absolute encoder, choose a referencing mode and adjust the encoder with the BOP menu function "ABS". Refer to "Adjusting an absolute encoder (Page 160)".</li> </ul>	Five referencing modes are available: <ul style="list-style-type: none"> <li>• p29240=0: with digital input signal REF</li> <li>• p29240=1 (default): external referencing cam (REF) and encoder zero mark</li> <li>• p29240=2: only encoder zero mark</li> <li>• p29240=3: external referencing cam (CCWL) and encoder zero mark</li> <li>• p29240=4: external referencing cam (CWL) and encoder zero mark.</li> </ul> Refer to "Referencing (Page 190)".
14	Set the pulse train encoder output.	Refer to "PTO function (Page 183)".
15	Save parameters with the BOP.	
16	Switch on the line supply.	

5.5 Commissioning in speed control mode (S)

Step	Description	Remarks
17	Clear faults and alarms.	Refer to "Diagnostics (Page 313)".
18	Trigger the digital signal SON to be high level.	
19	Select a fixed position setpoint by configuring the digital inputs POS1, POS2 and POS3, then start positioning with the triggering signal P-TRG.	POS3 : POS2 : POS1 0 : 0 : 0: fixed position setpoint 1 (p2617[0]) 0 : 0 : 1: fixed position setpoint 2 (p2617[1]) 0 : 1 : 0: fixed position setpoint 3 (p2617[2]) 0 : 1 : 1: fixed position setpoint 4 (p2617[3]) 1 : 0 : 0: fixed position setpoint 5 (p2617[4]) 1 : 0 : 1: fixed position setpoint 6 (p2617[5]) 1 : 1 : 0: fixed position setpoint 7 (p2617[6]) 1 : 1 : 1: fixed position setpoint 8 (p2617[7]) Refer to "Selecting a fixed position setpoint and starting positioning (Page 199)".
20	The system commissioning in internal position control mode ends.	You can check the system performance. If it is not satisfied, you can adjust it. Refer to "Tuning (Page 247)".

## 5.5 Commissioning in speed control mode (S)

Step	Description	Remarks
1	Switch off the line supply.	
2	Power off the servo drive and connect it to the controller (for example, SIMATIC S7-200 SMART) with the signal cable.	The digital signals CWL, CCWL and EMGS <b>must</b> be kept at high level (1) to ensure normal operation. Refer to "Standard application wirings (factory setting) (Page 104)" and "Connection examples with PLCs (Page 112)".
3	Switch on the 24 VDC power supply.	
4	Check the servo motor type. <ul style="list-style-type: none"> <li>• If the servo motor has an incremental encoder, input motor ID (p29000).</li> <li>• If the servo motor has an absolute encoder, the servo drive can identify the servo motor automatically.</li> </ul>	Fault <b>F52984</b> occurs when the servo motor is not identified. You can find the motor ID from the motor rating plate. Go to "Motor components (Page 30)" for detailed descriptions about motor rating plate. Refer to "Basic operations (Page 149)" for information about how to change a parameter with the BOP.
5	Switch to the speed control mode by setting p29003=2.	Refer to "Compound controls (Page 161)".
6	Save the parameter and restart the servo drive to apply the setting of the speed control mode.	

Step	Description	Remarks
7	Configure speed setpoint.	You can select the external analog speed setpoint or one of seven fixed speed setpoints by configuring the digital signals SPD3, SPD2 and SPD1. SPD3 : SPD2 : SPD1 0 : 0 : 0: external analog speed setpoint (analog input 1) 0 : 0 : 1: fixed speed setpoint 1 (p1001) 0 : 1 : 0: fixed speed setpoint 2 (p1002) 0 : 1 : 1: fixed speed setpoint 3 (p1003) 1 : 0 : 0: fixed speed setpoint 4 (p1004) 1 : 0 : 1: fixed speed setpoint 5 (p1005) 1 : 1 : 0: fixed speed setpoint 6 (p1006) 1 : 1 : 1: fixed speed setpoint 7 (p1007) Refer to "Configuring speed setpoint (Page 201)".
8	If the external analog speed setpoint is used, configure the maximum analog speed setpoint corresponding to 10 V by setting parameter p29060.	
9	Set the torque limitation and speed limitation.	Refer to "Torque limit (Page 204)" and "Speed limit (Page 204)".
10	Configure necessary digital input signals by setting the following parameters: <ul style="list-style-type: none"> <li>p29301[2]: DI1</li> <li>p29302[2]: DI2</li> <li>p29303[2]: DI3</li> <li>p29304[2]: DI4</li> <li>p29305[2]: DI5</li> <li>p29306[2]: DI6</li> <li>p29307[2]: DI7</li> <li>p29308[2]: DI8</li> </ul>	The factory settings are: <ul style="list-style-type: none"> <li>p29301[2]: 1 (SON)</li> <li>p29302[2]: 2 (RESET)</li> <li>p29303[2]: 3 (CWL)</li> <li>p29304[2]: 4 (CCWL)</li> <li>p29305[2]: 12 (CWE)</li> <li>p29306[2]: 13 (CCWE)</li> <li>p29307[2]: 15 (SPD1)</li> <li>p29308[2]: 16 (SPD2)</li> </ul> Refer to "Digital inputs/outputs (DIs/DOs) (Page 91)".
11	Save parameters with the BOP.	
12	Switch on the line supply.	
13	Clear faults and alarms.	Refer to "Diagnostics (Page 313)".
14	Enable the CWE or CCWE and change SON status to be high level (1) then the servo motor starts running according to configured speed setpoint.	The actual speed of the servo motor can be viewed from the BOP operating display. The default display is the actual speed. Refer to "Actual status display (Page 148)".
15	The system commissioning in speed control mode ends.	You can check the system performance. If it is not satisfied, you can adjust it. Refer to "Tuning (Page 247)".

## 5.6 Commissioning in torque control mode (T)

Step	Description	Remarks
1	Switch off the line supply.	
2	Power off the servo drive and connect it to the controller (for example, SIMATIC S7-200 SMART) with the signal cable.	The digital signals CWL, CCWL and EMGS <b>must</b> be kept at high level (1) to ensure normal operation. Refer to "Standard application wirings (factory setting) (Page 104)" and "Connection examples with PLCs (Page 112)".
3	Switch on the 24 VDC power supply.	
4	Check the servo motor type. <ul style="list-style-type: none"> <li>If the servo motor has an incremental encoder, input motor ID (p29000).</li> <li>If the servo motor has an absolute encoder, the servo drive can identify the servo motor automatically.</li> </ul>	Fault <b>F52984</b> occurs when the servo motor is not identified. You can find the motor ID from the motor rating plate. Go to "Motor components (Page 30)" for detailed descriptions about motor rating plate. Refer to "Basic operations (Page 149)" for information about how to change a parameter with the BOP.
5	Switch to the torque control mode by setting p29003=3.	Refer to "Compound controls (Page 161)".
6	Save the parameter and restart the servo drive to apply the setting of the torque control mode.	
7	Select torque setpoint by configuring the digital input signal TSET.	<ul style="list-style-type: none"> <li>TSET = low level (0): external analog torque setpoint (analog input 2)</li> <li>TSET = high level (1): fixed torque setpoint</li> </ul>
8	If the fixed torque setpoint is used, input your desired torque setpoint value and offset value into parameter p29043 and p29042.	Refer to "Torque control with fixed torque setpoint (Page 209)".
9	If the external analog torque setpoint is used, configure the scaling (percentage of the rated torque) for analog torque setpoint corresponding to 10 V by setting parameter p29041[0].	Refer to "Torque control with external analog torque setpoint (Page 208)".
10	Set the speed limitation.	Refer to "Speed limit (Page 209)".
11	Configure necessary digital input signals by setting the following parameters: <ul style="list-style-type: none"> <li>p29301[3]: DI1</li> <li>p29302[3]: DI2</li> <li>p29303[3]: DI3</li> <li>p29304[3]: DI4</li> <li>p29305[3]: DI5</li> <li>p29306[3]: DI6</li> <li>p29307[3]: DI7</li> <li>p29308[3]: DI8</li> </ul>	The factory settings are: <ul style="list-style-type: none"> <li>p29301[3]: 1 (SON)</li> <li>p29302[3]: 2 (RESET)</li> <li>p29303[3]: 3 (CWL)</li> <li>p29304[3]: 4 (CCWL)</li> <li>p29305[3]: 12 (CWE)</li> <li>p29306[3]: 13 (CCWE)</li> <li>p29307[3]: 18 (TSET)</li> <li>p29308[3]: 19 (SLIM1)</li> </ul> Refer to "Digital inputs/outputs (DIs/DOs) (Page 91)".
12	Save parameters with the BOP.	
13	Switch on the line supply.	
14	Clear faults and alarms.	Refer to "Diagnostics (Page 313)".

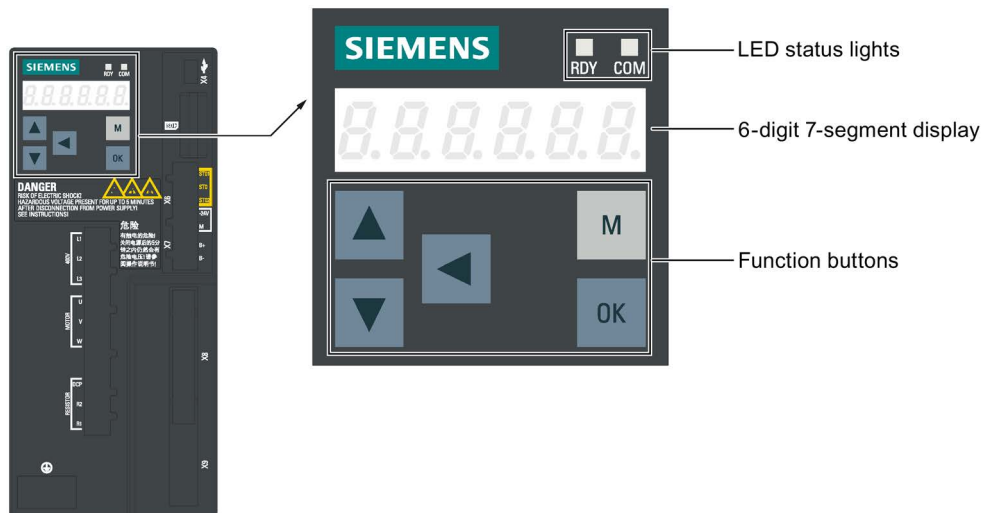
Step	Description	Remarks
15	Enable the CWE or CCWE and Change SON status to be high level (1) then the servo motor starts running according to configured torque setpoint.	The actual torque of the servo motor can be viewed from the BOP operating display. The default display is actual speed. You can change it by setting p29002=2. Refer to "Actual status display (Page 148)".
16	The system commissioning in torque control mode ends.	You can check the system performance. If it is not satisfied, you can adjust it. Refer to "Tuning (Page 247)".



## Basic operator panel (BOP)

### 6.1 BOP overview




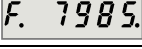
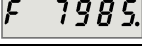
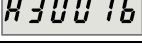


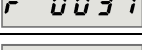



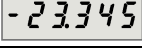

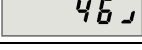
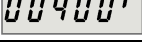
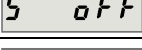
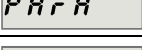

The SINAMICS V90 servo drive is designed with a Basic Operator Panel (BOP) on the front panel of the servo drive:



You can use the BOP for the following operations:

- Standalone commissioning
- Diagnosis
- Parameter access
- Parameter settings
- Micro SD card/SD card operations
- Drive restart












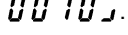
6.1.1 BOP display

Display	Example	Description	Remarks
8.8.8.8.8.8.		Drive is in startup state	
-----		Drive is busy	
Fxxxxx		Fault code	In the case of a single fault
F.xxxxx.		Fault code of the first fault	In the case of multiple faults
Fxxxxx.		Fault code	In the case of multiple faults
Axxxxx		Alarm code	In the case of a single alarm
A.xxxxx.		Alarm code of the first alarm	In the case of multiple alarms
Axxxxx.		Alarm code	In the case of multiple alarms
Rxxxxx		Parameter number	Read-only parameter
Pxxxxx		Parameter number	Editable parameter
P.xxxxx		Parameter number	Editable parameter; the dot means that at least one parameter has been changed
In xx		Indexed parameter	Figure after "In" indicates the number of indices. For example, "In 01" means that this indexed parameter is 1.
xxx.xxx		Negative parameter value	
xxx.xx<>		Current display can be moved to left or right	
xxxx.xx>		Current display can be moved to right	
xxxx.xx<		Current display can be moved to left	
S Off		Operating display: servo off	
Para		Editable parameter group	Refer to the section "Change a parameter value (Page 149)".
P 0x		Parameter group	Six groups are available: 1. <b>P0A</b> : basic 2. <b>P0B</b> : gain adjustment 3. <b>P0C</b> : speed control 4. <b>P0D</b> : torque control 5. <b>P0E</b> : position control 6. <b>P0F</b> : IO



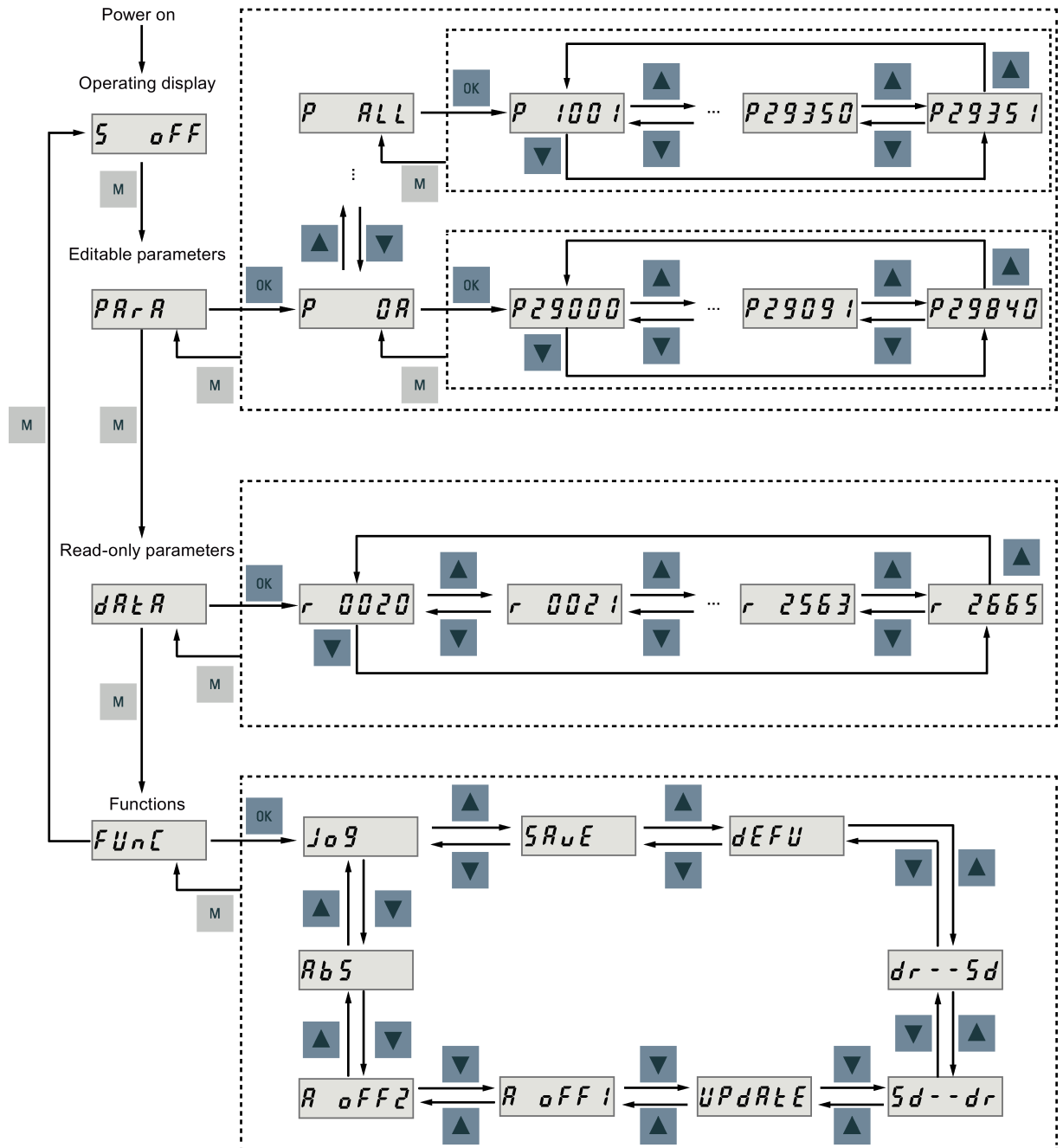
Display	Example	Description	Remarks
Data		Read-only parameter group	Refer to "Read a parameter value (Page 152)".
Func		Function group	Refer to "Function overview (Page 153)".
Jog		Jog function	Refer to "Jog (Page 154)".
Save		Save data in drive	Refer to "Save parameters in the servo drive (Page 155)".
defu		Restore drive to default settings	Refer to "Reset parameters to default values (Page 155)".
dr--sd		Save data from drive to micro SD card/SD card	Refer to "Copy parameters from the servo drive to a micro SD card/SD card (Page 156)".
sd--dr		Upload data from micro SD card/SD card to drive	Refer to "Copy parameters from a micro SD card/SD card to the servo drive (Page 157)".
Update		Update firmware	Refer to "Update firmware (Page 157)".
A OFF1		Adjust AI1 offset	Refer to "Adjust AI offset (Page 158)".
A OFF2		Adjust AI2 offset	Refer to "Adjust AI offset (Page 158)".
ABS		The zero position has not been set	Refer to "Set zero position (Page 160)".
A.B.S.		The zero position has been set	Refer to "Set zero position (Page 160)".
r xxx		Actual speed (positive direction)	
r -xxx		Actual speed (negative direction)	
T x.x		Actual torque (positive direction)	
T -x.x		Actual torque (negative direction)	
DCxxx.x		Actual DC link voltage	
Exxxx		Position following error	
Con		The communication between the SINAMICS V-ASSISTANT and the servo drive is established. In this case, the BOP is protected from any operations except clearing alarms and acknowledging faults.	

### 6.1.2 Control buttons

Button	Description	Functions
	M button	<ul style="list-style-type: none"> <li>Exits from the current menu</li> <li>Switches between operating modes in the top level menu</li> </ul>
	OK button	<p>Short-pressing:</p> <ul style="list-style-type: none"> <li>Confirms selection or input</li> <li>Enters sub menu</li> <li>Acknowledges faults</li> </ul> <p>Long-pressing:</p> <p>Activates auxiliary functions</p> <ul style="list-style-type: none"> <li>Sets Drive Bus address</li> <li>Jog</li> <li>Saves parameter set in drive (RAM to ROM)</li> <li>Sets parameter set to default</li> <li>Transfers data (drive to micro SD card/SD card)</li> <li>Transfers data (micro SD card/SD card to drive)</li> <li>Updates firmware</li> </ul>
	UP button	<ul style="list-style-type: none"> <li>Navigates to the next item</li> <li>Increases a value</li> <li>JOG in CW (clockwise)</li> </ul>
	DOWN button	<ul style="list-style-type: none"> <li>Navigates to the previous item</li> <li>Decreases a value</li> <li>JOG in CCW (counter-clockwise)</li> </ul>
	SHIFT button	<p>Moves the cursor from digit to digit for single digit editing, including the digit of positive/negative sign</p> <p><b>Note:</b> When the sign is edited, "_" indicates positive and "-" indicates negative.</p>
	Press the key combination for four seconds to restart the drive	
	Moves current display to the left page when  is displayed at the upper right corner, for example  .	
	Moves current display to the right page when  is displayed at the lower right corner, for example  .	

## 6.2 Parameter structure

The overall parameter structure of SINAMICS V90 BOP is designed as follows:



### Note

There is no ABS menu function for a servo motor with an incremental encoder.

The ABS menu function is **only** available for a servo motor with an absolute encoder

## 6.3 Actual status display

The following drive states can be monitored using the operating panel after power-on:

- Servo off
- Actual speed
- Actual torque
- DC voltage
- Actual position
- Position following error

If servo enable signal is available, actual drive speed is displayed by default; otherwise, "S OFF" (servo off) is displayed.

With p29002, you define which of the following drive operating status data is to be displayed on the BOP.:

Parameter	Value	Meaning
p29002	0 (default)	Actual speed
	1	DC voltage
	2	Actual torque
	3	Actual position
	4	Position following error

---

### Note

Make sure you save p29002 after modification.

---

## 6.4 Basic operations

### Overview

- Editable parameters: all **P** parameters under the "**Para**" menu are settable parameters. Seven groups in total are available:
  - **P0A**: basic
  - **P0B**: gain adjustment
  - **P0C**: speed control
  - **P0D**: torque control
  - **P0E**: position control
  - **P0F**: IO
  - **P All**: all parameters
- Read-only parameters: All **r** parameters under the "**Data**" menu are read-only parameters. You can only read values of these parameters.

### Parameters with index

Some parameters have several indices. Each index has its own meaning and corresponding value.

### Parameters without index

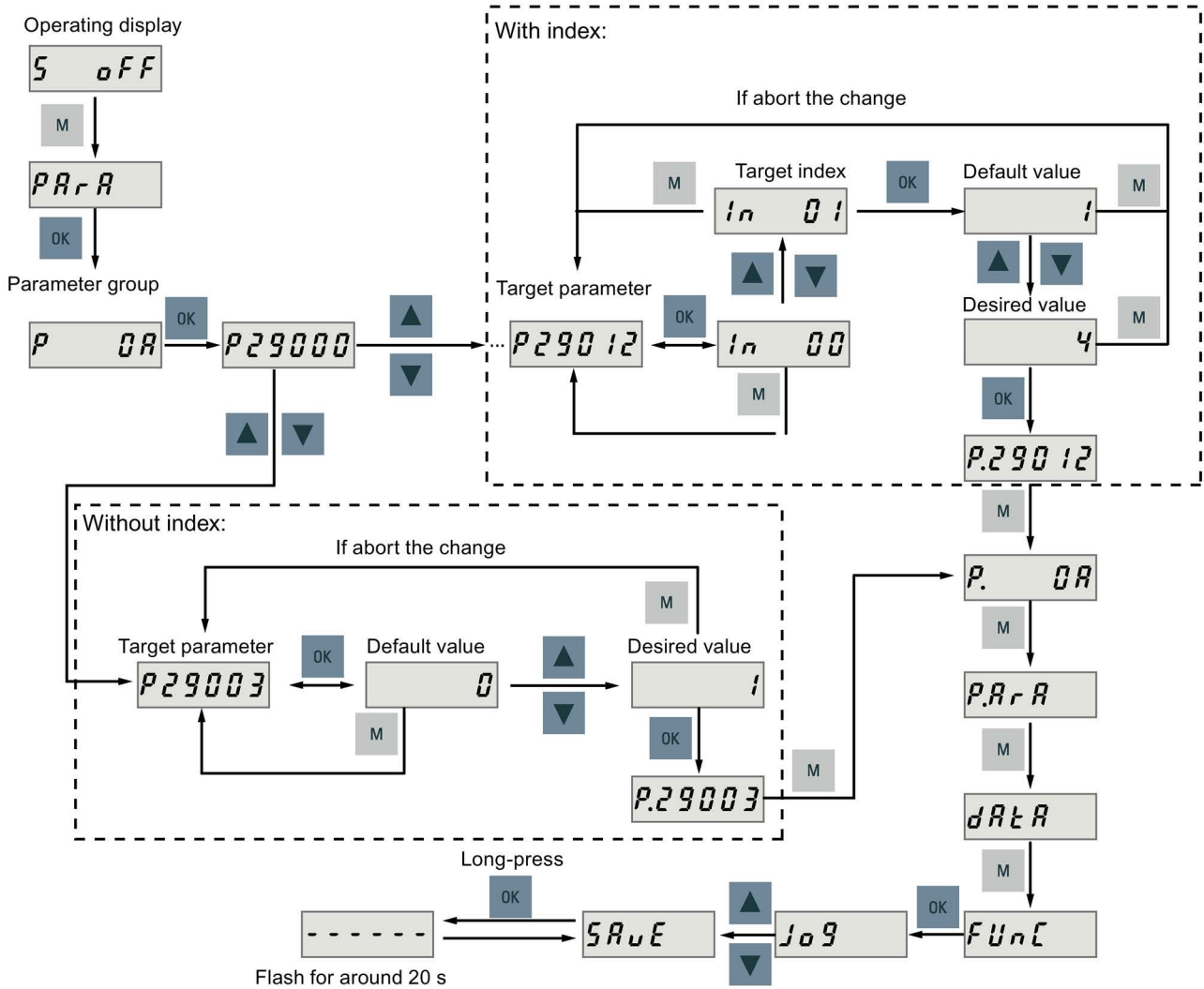
All parameters that do not have indices are parameters without index.

#### 6.4.1 Editing parameters

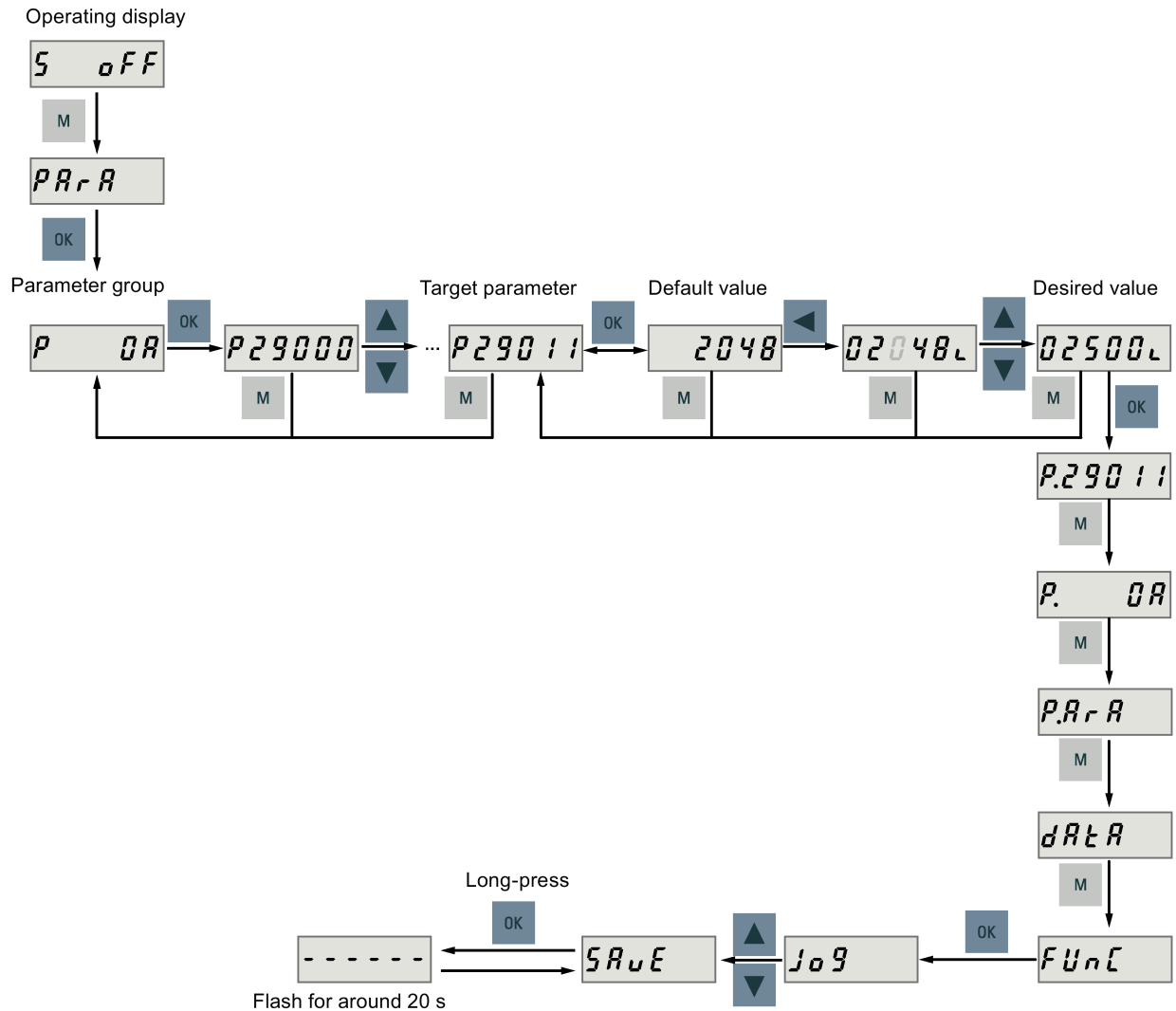
You can edit a parameter value in two methods:

- Method 1: change the value directly with the **UP** or **DOWN** button
- Method 2: move the cursor to a digit with the **SHIFT** button, then change the digit value with the **UP** or **DOWN** button

If you edit a parameter value with Method 1, proceed as follows:



To edit a parameter value with Method 2, proceed as follows:



#### NOTICE

It is forbidden to use this function when the servo is ON.

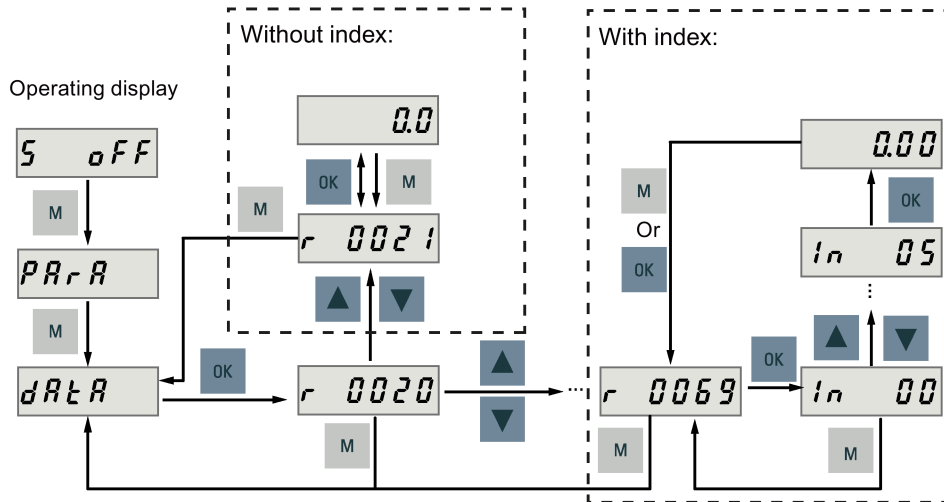
Use this function when the servo is OFF.

#### Note

The parameters p1414 and p1656 cannot be changed using the **SHIFT** button.

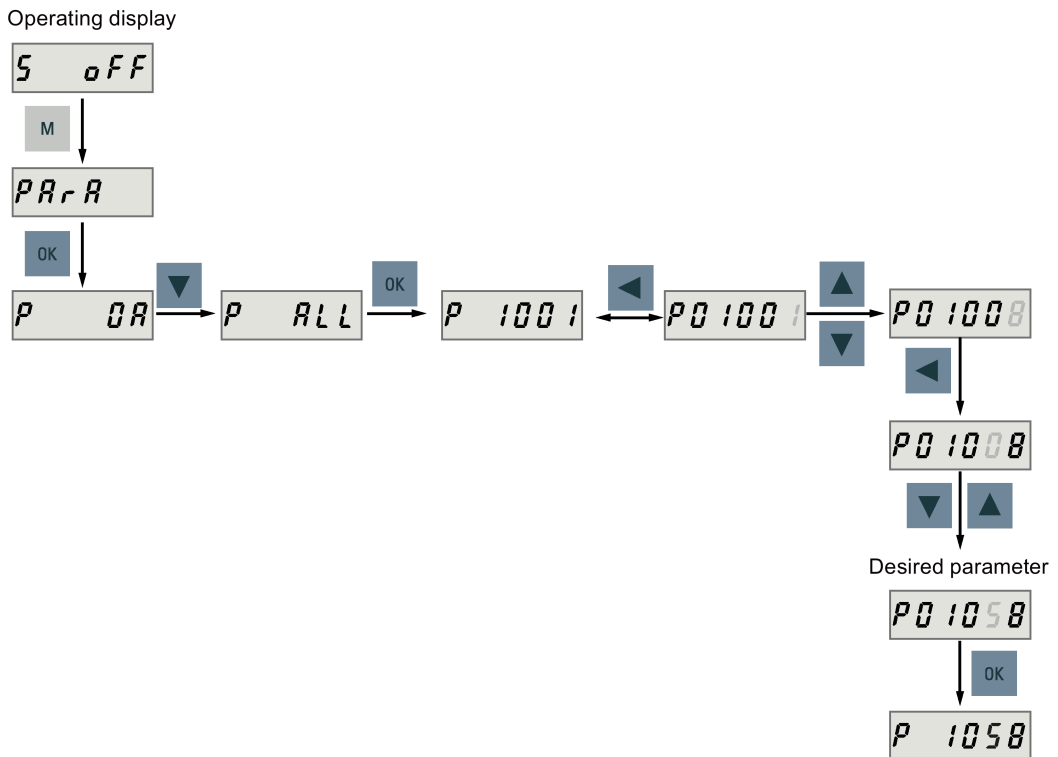
### 6.4.2 Viewing parameters

To view a parameter, proceed as follows:



### 6.4.3 Searching parameters in "P ALL" menu

If you do not know which group that a parameter belongs to, you can find it in the "P ALL" menu.



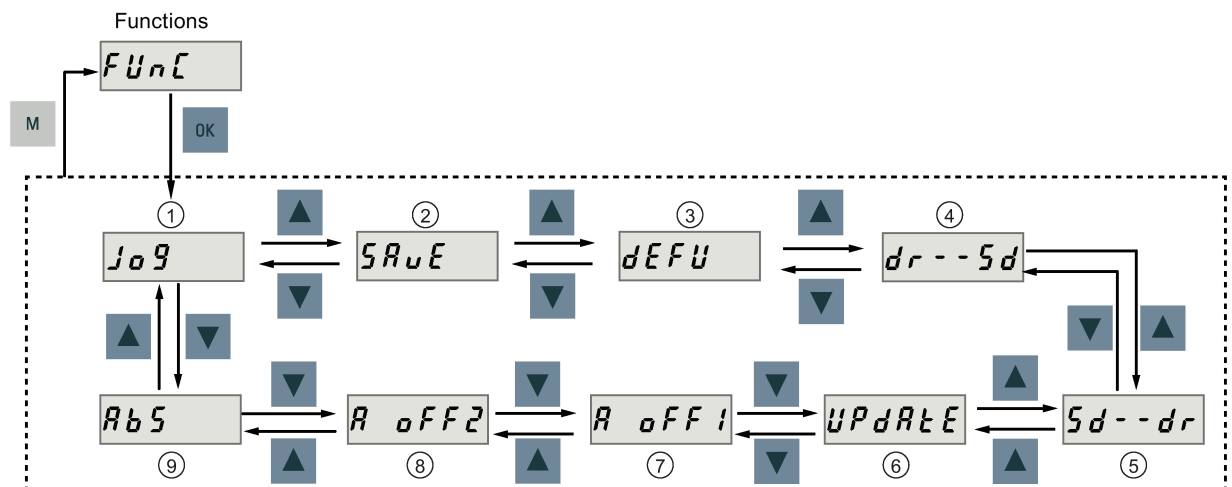


**Note****Invalid parameter number**

If the input parameter number is unavailable, the nearest parameter number to the input value is displayed.

## 6.5 Auxiliary functions

In total, there are 9 BOP functions available:



- |  |                           |
|--|---------------------------|
| ① Jog  | ⑥ Update firmware         |
| ② Save parameter set in drive                              | ⑦ Adjust AI1 offset       |
| ③ Restore parameter values to default                      | ⑧ Adjust AI2 offset       |
| ④ Copy parameter set from drive to a micro SD card/SD card | ⑨ Adjust absolute encoder |
| ⑤ Copy parameter set from a micro SD card/SD card to drive |                           |

**NOTE:**

This function is available only when the servo motor with an absolute encoder is connected.

### 6.5.1 Jog

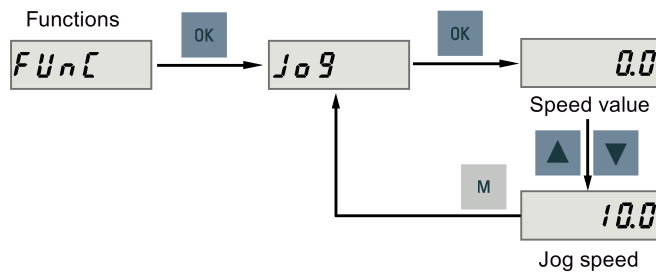
#### Note

The digital signal EMGS **must** be kept at high level (1) to ensure normal operation.

With the Jog function, you can run the connected motor and view Jog speed or Jog torque.

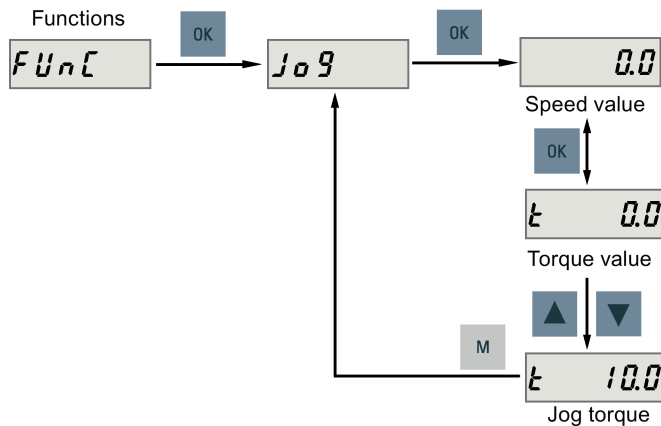
To run the connected motor with the Jog function and view the Jog speed, proceed as follows:

#### Jog in speed (example)



To run the connected motor with the Jog function and view the Jog torque, proceed as follows:

#### Jog in torque (example)



#### NOTICE

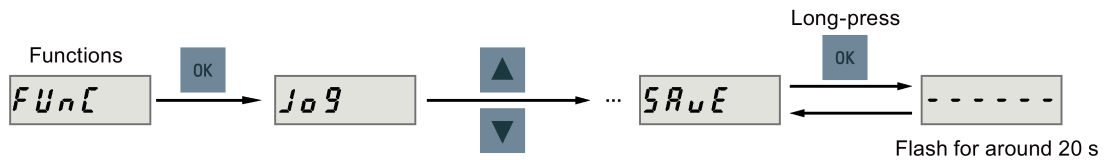
**Exit the Jog mode after completing Jog run.**

The servo motor cannot run if the servo drive is in the Jog mode.

## 6.5.2 Saving parameters (RAM to ROM)

This function is used for saving a parameter set from the drive RAM to drive ROM.

To use this function, proceed as follows:



### NOTICE

**Plugging or unplugging the micro SD card/SD card will cause saving failure.**

Do not plug or unplug the micro SD card/SD card during saving; otherwise, the saving operation will fail.

### Note

- If a micro SD card/SD card has been inserted, the parameter set will be saved onto the micro SD card/SD card simultaneously.
- All signal functions become inactive during the saving process. Use the signal functions afterwards.

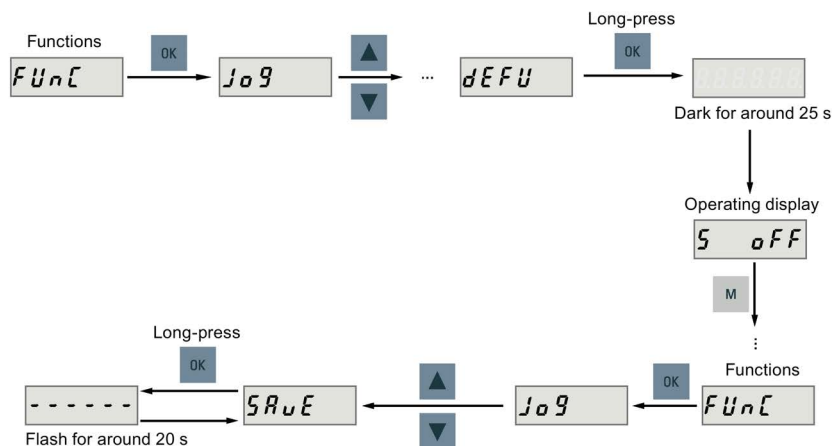
## Reference

Editing parameters (Page 149)

## 6.5.3 Setting parameters to default

This function is used to reset all parameters to their default values.

To reset the parameters to their default values, proceed as follows:



**Note**

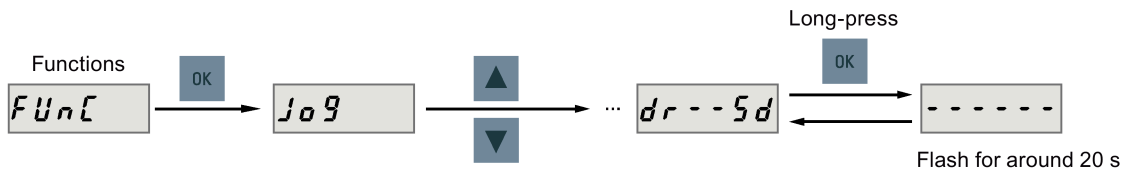
You **must** save the parameter set after setting the parameter set to the default values; otherwise, the default values will not be activated.

**Reference**

Saving parameters (RAM to ROM) (Page 155)

**6.5.4 Transferring data (drive to SD)**

You can save the parameter set from the drive ROM to a micro SD card/SD card with the BOP. To do this, proceed as follows:



**NOTICE**  
It is forbidden to use this function when the servo is ON.  
Use this function when the servo is OFF.

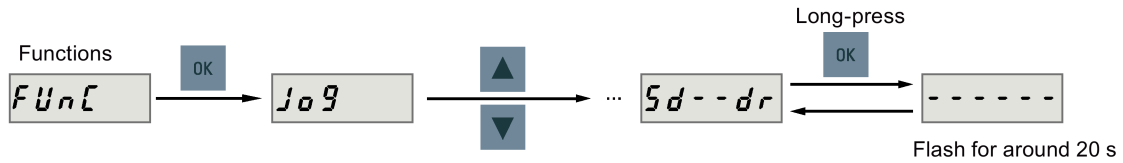
**NOTICE**  
Plugging or unplugging the micro SD card/SD card will cause copying failure.  
Do not plug or unplug the micro SD card/SD card during copying; otherwise, the copying operation will fail.

**Note**

Write protection function is not supported by SINAMICS V90. Data in the micro SD card/SD card will be overwritten even if the write protection function of the micro SD card/SD card is enabled.

### 6.5.5 Transferring data (SD to drive)

You can also upload the parameters from a micro SD card/SD card to the drive ROM. To do this, proceed as follows:



#### NOTICE

It is forbidden to use this function when the servo is ON.

Use this function when the servo is OFF.

#### NOTICE

Plugging or unplugging the micro SD card/SD card will cause copying failure.

Do not plug or unplug the micro SD card/SD card during copying; otherwise, the copying operation will fail.

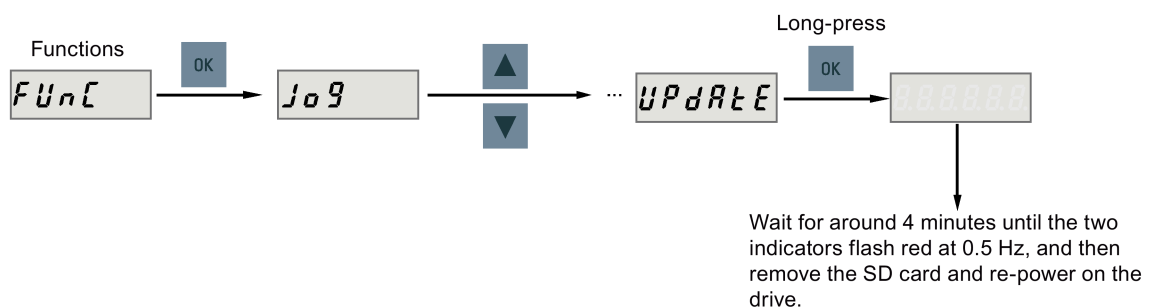
#### Note

##### Parameter inconsistency

If the parameters on the micro SD card/SD card are inconsistent with existing parameters in the drive memory, you **must** restart the servo drive to apply the changes.

### 6.5.6 Updating firmware

With the firmware update function of the BOP, you can update the drive firmware. To do this, you have to store proper firmware files on a micro SD card/SD card and insert it into the micro SD card/SD card slot. After that, proceed as follows:



After you have updated the firmware, you need to set parameters to their default values. Refer to "Setting parameters to default (Page 155)" about the default process.

**Note**

Before you update the firmware, you can back up the drive data on a micro SD card/SD card. If you want to use them after the update, you can copy the data from the micro SD card/SD card to the drive (Page 157).

 **CAUTION**

**Improper firmware files will cause update failure.**

When the update fails, the RDY indicator flashes red at 2 Hz and the COM indicator becomes red on. An update failure is probably caused by improper firmware files or files missing.

- If the firmware files on the micro SD card/SD card are corrupt, the servo drive **cannot** start up after power-on.
- If the firmware on the micro SD card/SD card is the same with the current firmware of the servo drive, **only** a restart is performed.

When a failure occurs, try to update the firmware again using proper firmware files. If the failure persists, contact your local distributor.

**Note**

**Update the firmware by restarting the drive.**

After inserting the micro SD card/SD card with proper firmware files, you can also update the firmware by restarting the drive.

### 6.5.7 Adjusting AI offsets

**NOTICE**

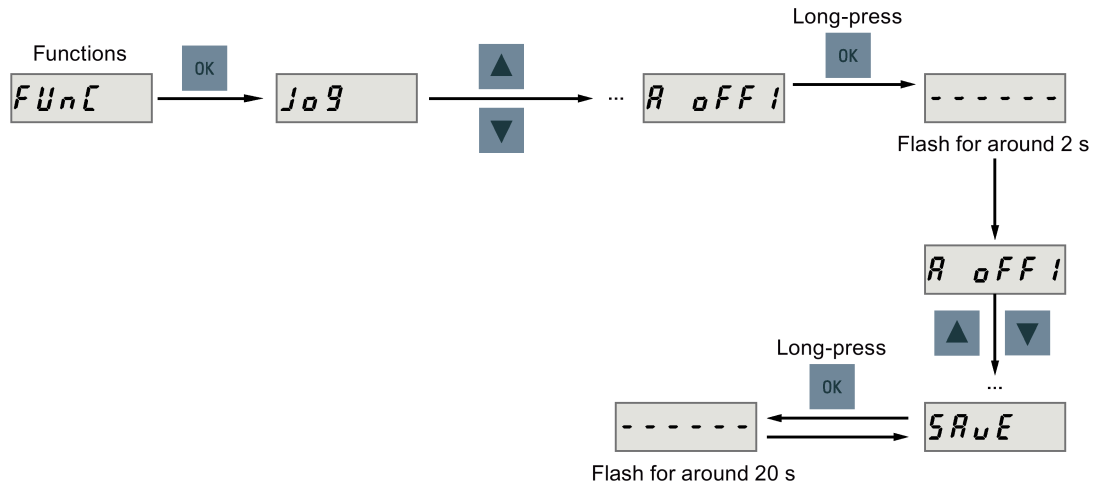
**Connect to ground**

You must firstly connect the AI1 or AI2 to ground and then adjust AI offset.

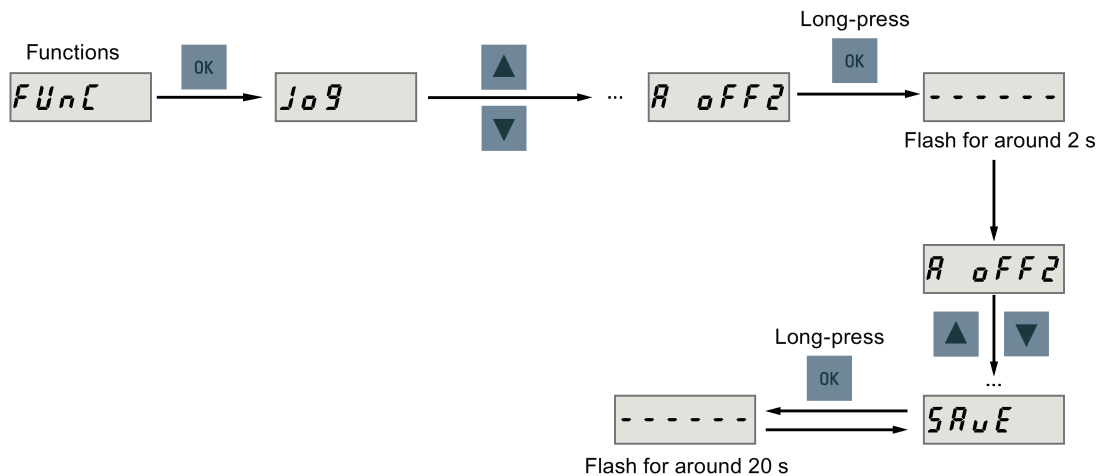
Refer to section "Analog inputs (Page 101)".

With the BOP function menu "A OFF1" or "A OFF2", AI offset can be adjusted automatically. Proceed as follows to adjust AI offset:

- Adjust AI1 offset



- Adjust AI2 offset



### Note

#### Save parameter

Offset value is set into parameter p29042 (for AI1) or parameter p29061 (for AI2). You **must** perform parameter saving after the automatic adjustment of AI offset.

#### Parameter range

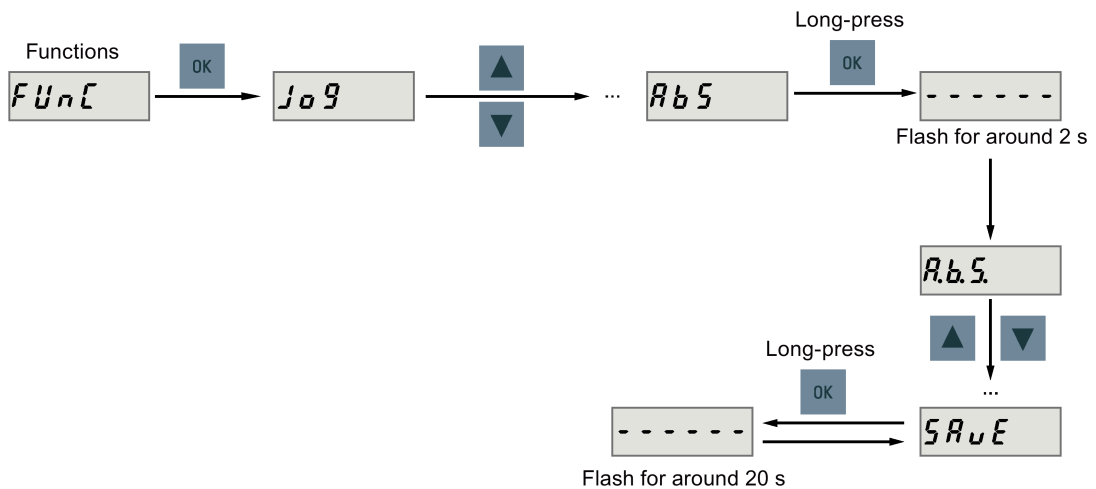
p29042 or p29061 ranges from -0.5 V to + 0.5 V. A value that is out of this range causes an alarm.

Refer to chapter "Parameter list (Page 275)".

### 6.5.8 Adjusting an absolute encoder

<b>NOTICE</b>
<b>Motor type</b> This function is <b>only</b> available when you are using a servo motor with the absolute encoder.
<b>Stop servo motor</b> You must stop servo motor before adjusting absolute encoder.

With the BOP function menu "**ABS**", you can set current position of absolute encoder to be zero position. To do this, proceed as follows:



**Note**

**Save parameter**

The position value is set in parameter p2525. You **must** save the parameters after setting the zero position.



# Control functions

## 7.1 Compound controls

### Control modes

Nine control modes are available for the SINAMICS V90 servo drive:

Control modes		Abbreviation
Basic control modes	Pulse train input position control mode (PTI) <sup>1)</sup>	PTI
	Internal position control mode (IPos)	IPos
	Speed control mode (S)	S
	Torque control mode (T)	T
Compound control modes	Control change mode: PTI/S	PTI/S
	Control change mode: IPos/S	IPos/S
	Control change mode: PTI/T	PTI/T
	Control change mode: IPos/T	IPos/T
	Control change mode: S/T	S/T

<sup>1)</sup> Default control mode

### Selecting a basic control mode

You can select a basic control mode by directly setting parameter p29003:

Parameter	Setting value	Description
p29003	0 (default)	Pulse train input position control mode
	1	Internal position control mode
	2	Speed control mode
	3	Torque control mode

### Control mode change for a compound control mode

For a compound control mode, you can change between two basic control modes by setting the parameter p29003 and configuring the level sensitive signal C-MODE on DI10:

p29003	C-MODE	
	0 (the first control mode)	1 (the second control mode)
4	PTI	S
5	IPos	S
6	PTI	T

p29003	C-MODE	
	0 (the first control mode)	1 (the second control mode)
7	IPos	T
8	S	T

Refer to Section "DIs (Page 92)" for detailed information about DIs.

**Note**

Note that if p29003 = 5 and the motor has been working in speed control mode for a certain period of time; or p29003 = 7 and the motor has been working in torque control mode for a certain period of time, the fault code F7493 might appear on the drive BOP. This, however, will not cause the motor to stop. The motor remains operative under this circumstance and you can clear the fault code manually.

**Note**

Fault F52904 occurs when the control mode is changed via p29003. You must save the parameter and then re-power on the servo drive to apply relevant configurations. For more information about the remedy and acknowledgement of this fault, refer to Section "List of faults and alarms (Page 318)".

**Note**

**Switching conditions**

For the switching from PTI or IPos to S or T, you are recommended to perform control mode switching after the INP (in position) signal is at high level.

For the switching from S or T to PTI or IPos, you can perform control mode switching only after the motor speed is lower than 30 rpm.

## 7.2 General functions

### 7.2.1 Servo ON

**Servo ON signal (SON)**

Signal type	Signal name	Setting	Description
DI	SON	ON = rising edge	Servo motor circuit is connected (servo is ON). Servo motor is ready to run.
		OFF = falling edge	Servo motor circuit is shut off (servo is OFF). Servo motor is not ready to run.

## Relevant parameter settings

Parameter	Value setting	Description
p29301	1	Signal <b>SON</b> (signal number: 1) is assigned to digital input 1 (DI1).
p29300	bit 0 = 1	Set <b>SON</b> at high level or rising edge forcedly.


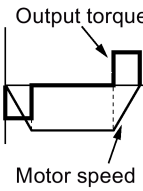
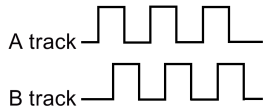
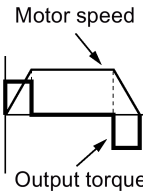
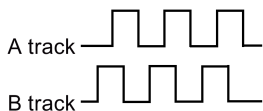

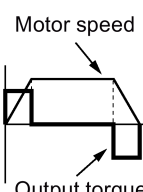
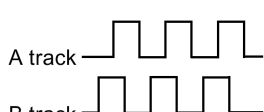
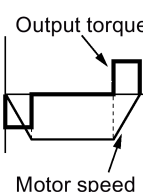
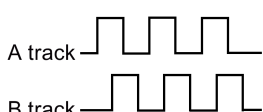
### Note

Refer to Section "Digital inputs/outputs (DIs/DOs) (Page 91)" for detailed information about DI parameterization.

Refer to Chapter "Parameters (Page 275)" for detailed information about parameters.

## 7.2.2 Direction of motor rotation

With parameter p29001, you can reverse the direction of rotation of the motor without changing the polarity of pulse train input setpoint and analog input setpoint. The polarity of output signals like pulse train encoder output (PTO) and analog monitoring remains unchanged at a reversal of direction.

Parameter	Value	Description	Setpoint	
			Positive	Negative
p29001	0	CW is forward direction (factory setting) 	<ul style="list-style-type: none"> <li>Analog monitoring:   </li> <li>PTO:   </li> </ul>	<ul style="list-style-type: none"> <li>Analog monitoring:   </li> <li>PTO:   </li> </ul>
	1	CCW is forward direction 	<ul style="list-style-type: none"> <li>Analog monitoring:   </li> <li>PTO:   </li> </ul>	<ul style="list-style-type: none"> <li>Analog monitoring:   </li> <li>PTO:   </li> </ul>

---

**Note**

After modifying parameter p29001, you must save the parameter and then restart the drive to ensure normal operation. In this case, you must perform referencing again because the reference point will be lost after p29001 changes.

---

### 7.2.3 Over-travel

When the servo motor travels over distance limit, limit switch is turned on and servo motor then has an emergency stop.

#### Travel limit signals (CWL/CCWL)

**NOTICE**

**Some important information about the travel limit signals (CWL/CCWL)**

- Both of the signals **must** be at the high level when the servo drive is powered on.
- When the drive is under the S or T control mode, operation is possible after you acknowledge the fault; while when the drive is under the PTI or IPos control mode, operation is possible **only** when both **CWL** and **CCWL** are at the high level (logic 1) after you acknowledge the fault.
- In all the modes, signal **CWL/CCWL** can be responded, which means when F7492 or F7491 happens, the motor can run over the travel limit if the fault is acknowledged.
  - For a positive traversing direction, if the STOP cam plus is reached, F7492 will happen. To clear the fault, acknowledge it with RESET, and then leave away from the STOP cam plus in the negative traversing direction to return the axis to the valid traversing range.
  - For a negative traversing direction, if the STOP cam minus is reached, F7491 will happen. To clear the fault, acknowledge it with RESET, and then leave away from the STOP cam minus in the positive traversing direction to return the axis to the valid traversing range.

Signal **CWL** functions as the clockwise travel limit while signal **CCWL** functions as the counter-clockwise travel limit. Both of them are level and edge sensitive signals.

Signal type	Signal name	Setting	Description
DI	CWL	Falling edge (1→0)	Servo motor has traveled to clockwise travel limit. Servo motor has an emergency stop after that.
DI	CCWL	Falling edge (1→0)	Servo motor has traveled to counter-clockwise travel limit. Servo motor has an emergency stop after that.

### Relevant parameter settings

Parameter	Value setting	Description
p29303	3	Signal <b>CWL</b> (signal number: 3) is assigned to digital input 3 (DI3).
p29304	4	Signal <b>CCWL</b> (signal number: 4) is assigned to digital input 4 (DI4).
p29300	bit 1 = 1	Set <b>CWL</b> at high level or rising edge forcibly.
	bit 2 = 1	Set <b>CCWL</b> at high level or rising edge forcibly.

#### Note

##### DI parameterization

Refer to Section "Digital inputs/outputs (DIs/DOs) (Page 91)" for detailed information about DI parameterization.

Refer to Chapter "Parameters (Page 275)" for detailed information about parameters.

## 7.2.4 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.

#### 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.
- Refer to Section "System connection (Page 81)" for the standard wiring of the holding brake.

## Signal status

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

- SINAMICS V90 200 V variant

Status	MBR (DO)	Brake control (Brake)	Relay	Motor brake function	Motor shaft
Brake engagement	High level (1)	Brake off	Without current	Opened	Cannot run
Brake release	Low level (0)	Brake on	With current	Closed	Can run

- SINAMICS V90 400 V variant

Status	MBR (DO)	Brake control (B+, B-)	Motor brake function	Motor shaft
Brake engagement	High level (1)	0 V	Opened	Cannot run
Brake release	Low level (0)	24 V	Closed	Can run

### DO signal

Signal type	Signal name	Setting	Description
DO	MBR	ON = high level (1)	Motor holding brake is closed.
		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	1 (RDY)	-	Assignment of digital output 1
p29331	1 to 14	2 (FAULT)	-	Assignment of digital output 2
p29332	1 to 14	3 (INP)	-	Assignment of digital output 3

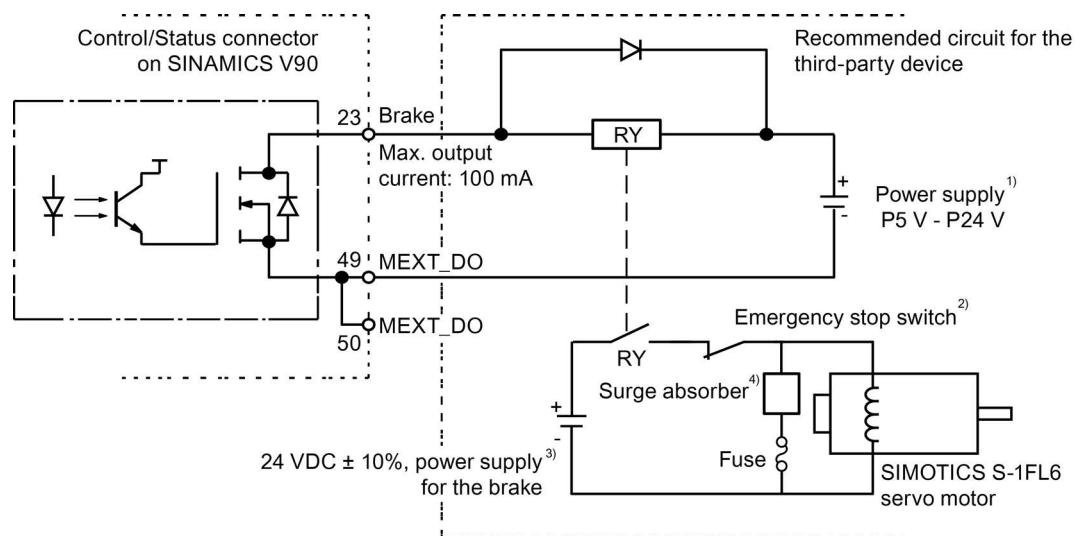
Parameter	Range	Factory setting	Unit	Description
p29333	1 to 14	5 (SPDR)	-	Assignment of digital output 4
p29334	1 to 14	6 (TLR)	-	Assignment of digital output 5
p29335	1 to 14	8 (MBR)	-	Assignment of digital output 6

### Note

Refer to Section "Digital inputs/outputs (DIs/DOs) (Page 91)" for detailed information about the digital outputs.

### Connection example (for V90 200 V variant only)

The following shows the example when the brake is controlled through the motor holding brake signal (Brake) of the SINAMICS V90 200 V variant servo drive.



### Note

- 1) It is the Isolated digital output power supply. When you use the 24 VDC power supply, it can be also the controller power supply.
- 2) The motor brake can be controlled not only by the brake control signal from the SINAMICS V90 servo drive but also by external emergency stop.
- 3) Never use the same power supply for the brake (24 VDC) and for the brake control signal (P24 V).
- 4) Install a surge absorber as the above figure shows to suppress surge voltage generated by ON/OFF action of the relay (RY). When you use a diode, the time from the brake release to brake engagement is slower than the case when you use a surge absorber.

## Relevant parameters

No.	Unit	Range	Default	Description
p1215	-	0 to 3	0	Configuration of the holding brake. <ul style="list-style-type: none"> <li>• 0: No holding brake available</li> <li>• 1: Motor holding brake according to sequence control (SON)</li> <li>• 2: Motor holding brake always open</li> <li>• 3: SIEMENS internal use</li> </ul>
p1216	ms	0 to 10000	Motor dependent	Motor holding brake opening time.
p1217	ms	0 to 10000	Motor dependent	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 digital input signal SON has a rising edge and becomes closed once a falling edge comes to SON.

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 simultaneously with the action of SON. 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 SINAMICS V90 servo drive.

**Note**

For SINAMICS V90 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:

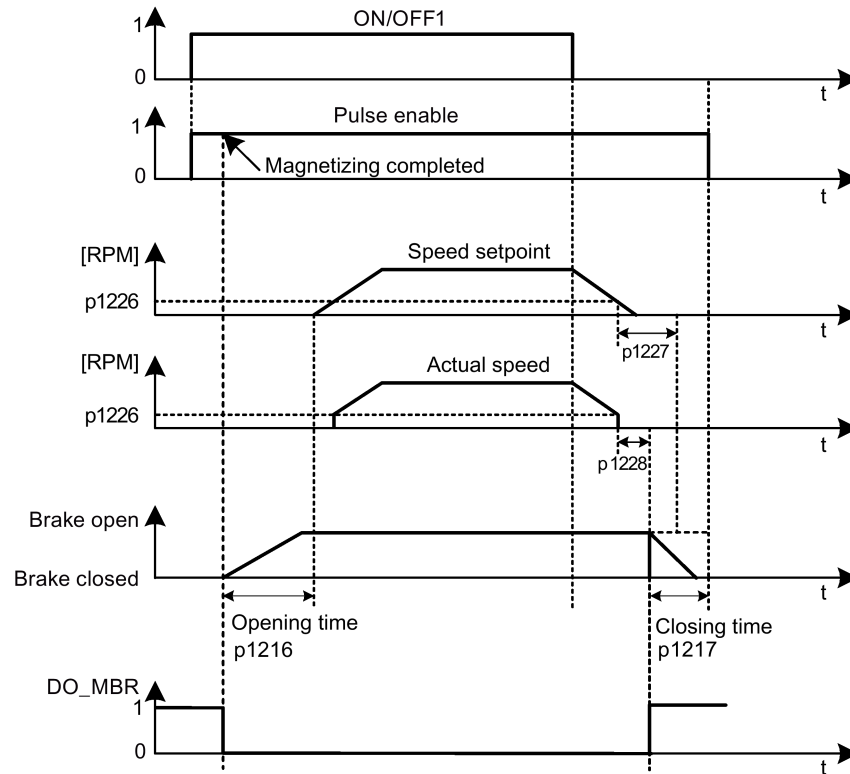
p1216 = motor brake opening time + relay opening time

p1217 = motor brake closing time + relay closing time



## 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.



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

### 7.2.5 Stopping method at servo OFF

You can select a stopping method when the servo is OFF. The following stopping methods are available:

- Ramp-down (OFF1)
- Coast-down (OFF2)
- Emergency stop (OFF3)

**Ramp-down (OFF1) and coast-down (OFF2)**

The ramp-down and coast-down can be configured with the digital input signal SON:

**SON in PTI, IPos or S mode**

Signal type	Signal name	Setting	Description
DI	SON	Rising edge (0→1)	Power circuit is powered on and the servo drive is ready to run.
		Falling edge (1→0)	Motor ramps down.

**SON in T mode**

Signal type	Signal name	Setting	Description
DI	SON	Rising edge (0→1)	Power circuit is powered on and the servo drive is ready to run.
		Falling edge (1→0)	Motor coasts down.

**Emergency stop (OFF3)**

The emergency stop can be configured with the digital input signal EMGS.

Signal type	Signal name	Setting	Description
DI	EMGS	1	Servo drive is ready to run.
		0	Emergency stop.

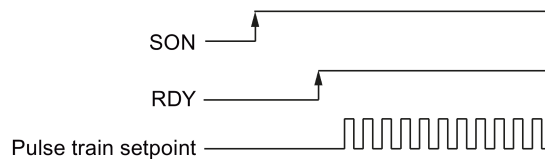
For detailed information about the digital input signals SON and EMGS, refer to Section "Digital inputs/outputs (DIs/DOs) (Page 91)".

## 7.3 Pulse train input position control (PTI)

### 7.3.1 Sequence of SON

When the SINAMICS V90 servo drive operates in pulse train input position control mode (PTI), the pulse train setpoint must be send out after the RDY signal is ok.

#### Timing diagram



### 7.3.2 Selecting a setpoint pulse train input channel

As mentioned before, the SINAMICS V90 servo drive supports two channels for the setpoint pulse train input:

- 24 V single end pulse train input
- High-speed 5 V differential pulse train input (RS485)

You can select one of these two channels by setting the parameter p29014:

Parameter	Value	Setpoint pulse train input channel	Default
p29014	0	High-speed 5 V differential pulse train input (RS485)	
	1	24 V single end pulse train input	✓

The position pulse train inputs come from either of the following two terminal groups:

- PTIA\_D+, PTIA\_D-, PTIB\_D+, PTIB\_D-
- PTIA\_24P, PTIA\_24M, PTIB\_24P, PTIB\_24M

For more information about wiring, refer to Section "Control/Status interface (Page 90)" and "PTIs (Page 100)".

### 7.3.3 Selecting a setpoint pulse train input form

The SINAMICS V90 servo drive supports two kinds of setpoint pulse train input forms:

- AB track pulse
- Pulse + Direction

For both forms, positive logic and negative logic are supported:

Pulse train input form	Positive logic = 0		Negative logic = 1	
	Forward (CW)	Reverse (CCW)	Forward (CW)	Reverse (CCW)
AB track pulse				
Pulse + Direction				

You can select one of the setpoint pulse train input forms by setting the parameter p29010:

Parameter	Value	Setpoint pulse train input form	Default
p29010	0	Pulse + Direction, positive logic	✓
	1	AB track, positive logic	
	2	Pulse + Direction, negative logic	
	3	AB track, negative logic	

**Note**

After modifying parameter p29010, you must save the parameter and then restart the drive to ensure normal operation. In this case, you must perform referencing again because the reference point will be lost after p29010 changes.

### 7.3.4 In position (INP)

When the deviation between the position setpoint and the actual position is within the preset in-position range specified in p2544, the signal INP (in position) is output.

#### Parameter settings

Parameter	Value range	Setting value	Unit	Description
p2544	0 to 2147483647	40 (default)	LU	Position window (in-position range)
p29332	1 to 13	3	-	Digital output 3 assignment

## DO configuration

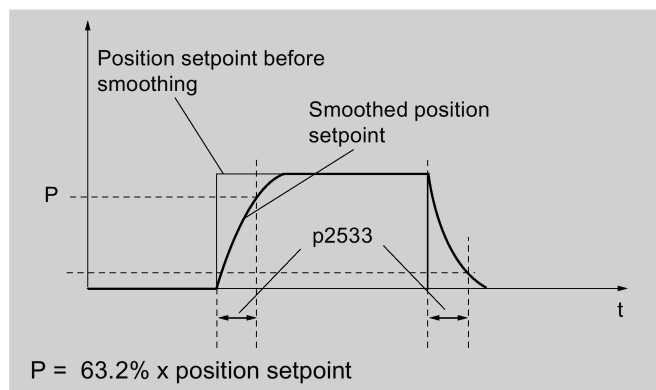
Signal type	Signal name	Setting	Description
DO	INP	1	Number of droop pulses is in the preset in-position range (parameter p2544)
		0	Droop pulses are beyond the in-position range

## 7.3.5 Smoothing function

With the smoothing function, the position characteristics curve from the pulse train input setpoint can be transformed into an S-curve profile with a time constant specified in p2533.

## Parameter setting

Parameter	Range	Factory setting	Unit	Description
p2533	0 to 1000	0	ms	Smooths the parameter in response to a sudden position setpoint



## 7.3.6 Electronic gear ratio

## Encoder specifications

The encoder specifications are shown as follows:

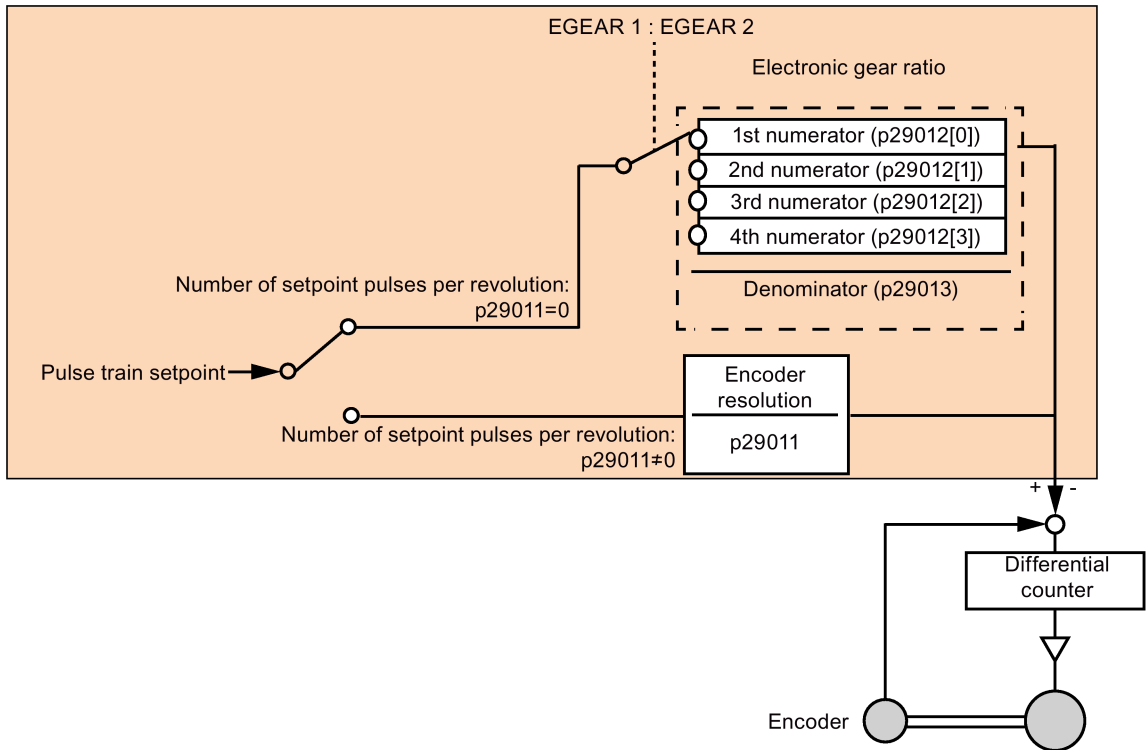
1FL6    -1A  61-0   1

↓

	Type	Resolution
A	Incremental encoder	2500 ppr
L	Absolute encoder	20 bit single turn + 12 bit multi-turn

**Electronic gear**

With the function of electronic gear, you can define the motor revolutions according to the number of setpoint pulses, and sequentially define the distance of mechanical movement. The minimum travelling distance of load shaft according to one setpoint pulse is called a length unit (LU); for example, one pulse results in 1 µm movement.



**Benefits of electronic gear (example):**

Move the workpiece for 10 mm:

LU: 1 µm

Encoder resolution: 2500 ppr

Pitch of ball screw: 6 mm

Workpiece

Without electronic gear	With electronic gear
Required number of setpoint pulses: 2500 ppr × 4 × (10 mm/6 mm) = 16666	Required number of setpoint pulses: (10 mm × 1000) / 1 LU = 10000

The electronic gear ratio is a multiplier factor to pulse train setpoint. It is realized with a numerator and a denominator. Four numerators (p29012[0], p29012[1], p29012[2], p29012[3]) and one denominator (p29013) are used for the four electronic gear ratios:

Parameter	Range	Factory setting	Unit	Description
p29012[0]	1 to 10000	1	-	The first numerator of electronic gear
p29012[1]	1 to 10000	1	-	The second numerator of electronic gear

Parameter	Range	Factory setting	Unit	Description
p29012[2]	1 to 10000	1	-	The third numerator of electronic gear
p29012[3]	1 to 10000	1	-	The forth numerator of electronic gear
p29013	1 to 10000	1	-	The denominator of electronic gear

These four electronic gear ratios can be selected with the combination of the digital input signals EGEAR1 and EGEAR2 (refer to Section "DIs (Page 92)"):

EGEAR2 : EGEAR1	Electronic gear ratio	Ratio value
0 : 0	Electronic gear ratio 1	p29012[0] : p29013
0 : 1	Electronic gear ratio 2	p29012[1] : p29013
1 : 0	Electronic gear ratio 3	p29012[2] : p29013
1 : 1	Electronic gear ratio 4	p29012[3] : p29013

---

#### Note

After a gear ratio is switched to another one via digital inputs, you need to wait five seconds and then perform **SERVO ON**.

---

#### Note

The range of electronic gear ratio is from 0.02 to 200.

The electronic gear ratio can be set at **SERVO OFF** state only. After the setting, you need to reference the drive again.

---

Calculation formula for electronic gear ratio

The electronic gear ratio can be calculated from the formula below:

$$\frac{a}{b} = \frac{p29012}{p29013} : \text{electronic gear ratio}$$

c: pitch of ball screw

$$\frac{n}{m} : \text{deduction gear ratio}$$

$$\frac{c}{LU} \times \frac{a}{b} = r \times \frac{n}{m}$$

$$\frac{a}{b} = \frac{rLU}{c} \times \frac{n}{m}$$

Examples for calculating the electronic gear ratio

Step	Description	Mechanism	
		Ball screw	Disc table
		LU: 1 μm Encoder resolution: 2500 ppr Pitch of ball screw: 6 mm	LU: 0.01° Encoder resolution: 2500 ppr
1	Identify mechanism	<ul style="list-style-type: none"> <li>Pitch of ball screw: 6 mm</li> <li>Deduction gear ratio: 1:1</li> </ul>	<ul style="list-style-type: none"> <li>Rotary angle: 360°</li> <li>Deduction gear ratio: 3:1</li> </ul>
2	Identify encoder resolution	10000	10000
3	Define LU	1 LU=1 μm	1 LU=0.01°
4	Calculate the travel distance per load shaft revolution	6/0.001=6000 LU	360°/0.01°=36000 LU
5	Calculate electronic gear ratio	$(1/6000) \times (1/1) \times 10000 = 10000/6000$	$(1/36000) \times (3/1) \times 10000 = 10000/12000$
6	Set parameters	p29012/p29013 $= 10000/6000 = 5/3$	$= 10000/12000 = 5/6$



### 7.3.7 Inhibiting pulse train input setpoint (P-TRG)

#### Note

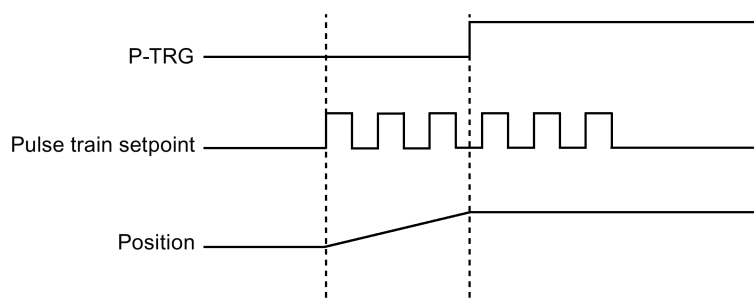
##### P-TRG in PTI mode

Note that the function "inhibiting pulse train by P-TRG in PTI mode" as described in this section and the rest of the manual is reserved for future use.

The digital input signal P-TRG is the default connection of DI6 in the position control mode. In the pulse train input position control mode, P-TRG is level sensitive and can be used to allow or inhibit positioning operation according to pulse train input setpoint:

- 0: positioning according to pulse train input setpoint
- 1: inhibit pulse train input setpoint

#### Timing diagram



#### DI configuration

The signal P-TRG is the factory setting of DI6:

Signal type	Signal name	Setting	Description
DI	P-TRG	High level (1)	Inhibit pulse train input setpoint
		Low level (0)	Positioning according to pulse train input setpoint

#### Note

Refer to Section "Digital inputs/outputs (DIs/DOs) (Page 91)" for detailed information about DI parameterization.

- The signal P-TRG is active only when the digital input signal SON is in OFF state.
- When the signal P-TRG is active in the PTI mode or a compound mode with PTI, the alarm A7585 occurs.

### 7.3.8 Speed limit

Four sources in total are available for the speed limit. You can select one of them via a combination of digital input signals SLIM1 and SLIM2:

Digital signal		Speed limit
SLIM2	SLIM1	
0	0	Internal speed limit 1
0	1	External speed limit (analog input 1)
1	0	Internal speed limit 2
1	1	Internal speed limit 3

**Note**

**Control mode**

The above four sources are valid in all control modes. You can switch among them when the servo drive is running.

**Note**

Fault F7901 occurs when the actual speed exceeds the positive speed limit + hysteresis speed (p2162) or the negative speed limit - hysteresis speed (p2162). Go to "List of faults and alarms (Page 318)" for information about the acknowledgment of this fault.

**Note**

If the drive is working with external speed limit, the system continues to work automatically after you repower on the 24 VDC power supply which is shut off unexpectedly for the drive. In this case, do not touch the equipment.

Refer to "DIs (Page 92)" for more information about the digital input signals SLIM1 and SLIM2.

### Overall speed limit

Besides the above four channels, an overall speed limit is also available for all control modes.

The overall speed limit can be configured by setting the following parameters:

Parameter	Value range	Default	Unit	Description
p1083	0 to 210000	210000	rpm	Overall speed limit (positive)
p1086	-210000 to 0	-210000	rpm	Overall speed limit (negative)

## Internal speed limit

Select an internal speed limit by setting the following parameters:

Parameter	Value range	Default	Unit	Description	Digital input	
					SLIM2	SLIM1
p29070[0]	0 to 210000	210000	rpm	Internal speed limit 1 (positive)	0	0
p29070[1]	0 to 210000	210000	rpm	Internal speed limit 2 (positive)	1	0
p29070[2]	0 to 210000	210000	rpm	Internal speed limit 3 (positive)	1	1
p29071[0]	-210000 to 0	-210000	rpm	Internal speed limit 1 (negative)	0	0
p29071[1]	-210000 to 0	-210000	rpm	Internal speed limit 2 (negative)	1	0
p29071[2]	-210000 to 0	-210000	rpm	Internal speed limit 3 (negative)	1	1

### Note

After the motor is commissioned, p1082, p1083, p1086, p29070 and p29071 set to the maximum speed of the motor automatically.

## External speed limit

Select an external speed limit by setting the following parameters:

Parameter	Value range	Default	Unit	Description
p29060	6 to 210000	3000	rpm	Scaling for analog speed setpoint (maximum speed setpoint corresponding to 10 V)
p29061	-0.50 to 0.50	0	V	Offset adjustment for analog input 1 (speed setpoint)

### 7.3.9 Torque limit

Four sources in total are available for the torque limit. You can select one of them via a combination of digital input signals TLIM1 and TLIM2:

Digital signal		Torque limit
TLIM2	TLIM1	
0	0	Internal torque limit 1
0	1	External torque limit (analog input 2)
1	0	Internal torque limit 2
1	1	Internal torque limit 3

7.3 Pulse train input position control (PTI)

When the torque setpoint reaches torque limit, the torque is limited to the value selected by TLIM1/TLIM2.

**Note**

**Control mode**

The above four sources are valid in the PTI mode, the IPos mode and the S mode. You can switch among them when the servo drive is running.

**Note**

When the motor torque exceeds the torque limit, fault F52911/F52912 appears. The fault indicates the motor torque exceeds the torque limitation of the selected group which is determined by TLM1 and TLM2.

Refer to "DIs (Page 92)" for more information about the digital input signals TLIM1 and TLIM2.

**Overall torque limit**

Besides the above four sources, an overall torque limit is also available for **all** control modes. The overall torque limit takes effect when an emergency stop (OFF3) happens. In this case, the servo drive brakes with a maximum torque.

Parameter settings:

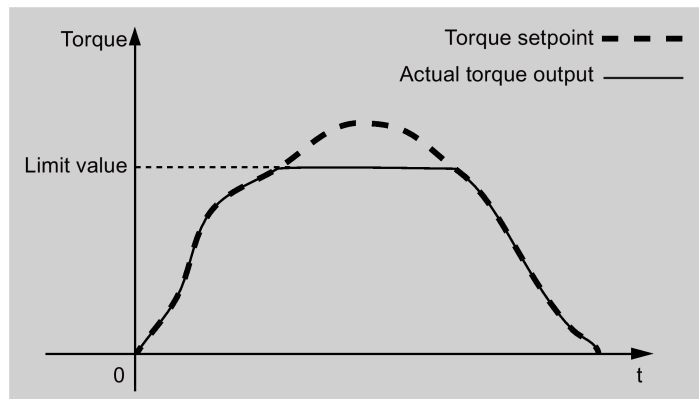
Parameter	Value range	Default	Unit	Description
p1520	-1000000.00 to 20000000.00	0	Nm	Overall torque limit (positive)
p1521	-20000000.00 to 1000000.00	0	Nm	Overall torque limit (negative)

**Internal torque limit**

Select an internal torque limit by setting the following parameters:

Parameter	Value range	Default	Unit	Description	Digital input	
					TLIM1	TLIM2
p29043	-100 to 100	0	%	Fixed torque setpoint	-	-
p29050[0]	-150 to 300	300	%	Internal torque limit 1 (positive)	0	0
p29050[1]	-150 to 300	300	%	Internal torque limit 2 (positive)	1	0
p29050[2]	-150 to 300	300	%	Internal torque limit 3 (positive)	1	1
p29051[0]	-300 to 150	-300	%	Internal torque limit 1 (negative)	0	0
p29051[1]	-300 to 150	-300	%	Internal torque limit 2 (negative)	1	0
p29051[2]	-300 to 150	-300	%	Internal torque limit 3 (negative)	1	1

The following diagram shows how the internal torque limit functions:



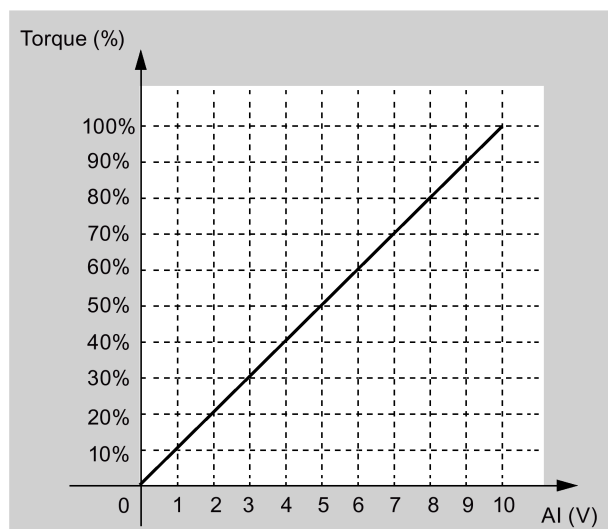
### External torque limit

Parameter settings:

Parameter	Value range	Default	Unit	Description	Digital input	
					TLIM1	TLIM2
p29041[1]	0 to 300	300	%	Analog torque limit scaling (value corresponding to 10V)	0	1

p29041[1] is the scaling of analog input 2.

For example, if p29041[1] is 100%, the relationship between torque limit value and analog input is shown as follows:



In this case, analog input of 5 V corresponds to 50% of rated torque and 10 V corresponds to 100% of rated torque.

**Torque limit reached (TLR)**

When the generated torque has nearly (internal hysteresis) reached the value of the positive torque limit, negative torque limit or analog torque limit, the signal TLR is output.

**7.3.10 Clearing droop pulses (CLR)**

The droop pulses can be cleared with the parameter p29242 and the digital input signal CLR.

**Selecting a clear mode by setting p29242**

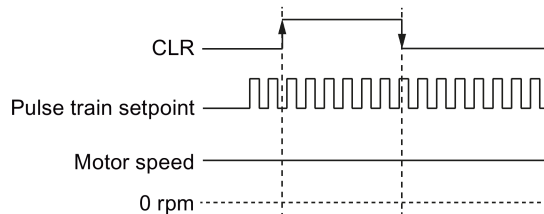
You can select a clear mode by setting the parameter p29242:

Parameter	Range	Factory setting	Unit	Description
p29242	0 to 2	0	-	<ul style="list-style-type: none"> <li>0: do not clear droop pulses</li> <li>1: clear droop pulses with the high level</li> <li>2: clear droop pulses with the rising edge</li> </ul>

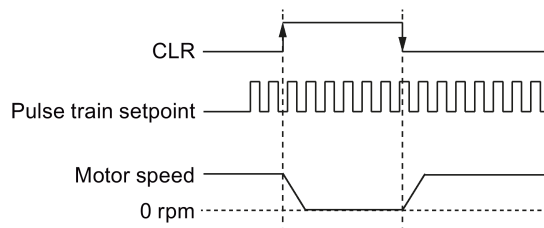
**Clearing droop pulses with DI signal CLR**

You can clear the droop pulses with the DI signal CLR after p29242 is set. The signal CLR is the factory setting of pin 11 (DI7) on the control/status interface.

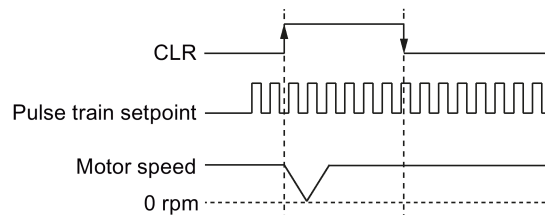
**p29242 = 0**



**p29242 = 1**



p29242 = 2



### Note

When you use the CLR high level to clear the pulses (p29242 = 1), the high level need to be kept for more than 8 ms.

When the signal CLR is active in the PTI mode or a compound mode with PTI, the alarm A7585 occurs.

If there are overshoot when you use the CLR function, you need to increase the integral time (p29121).

### 7.3.11 Referencing (only for absolute encoder)

If an absolute encoder is used, you must adjust the absolute encoder with the BOP menu function "ABS". For detailed information about "ABS" menu function, refer to "Adjusting an absolute encoder (Page 160)".

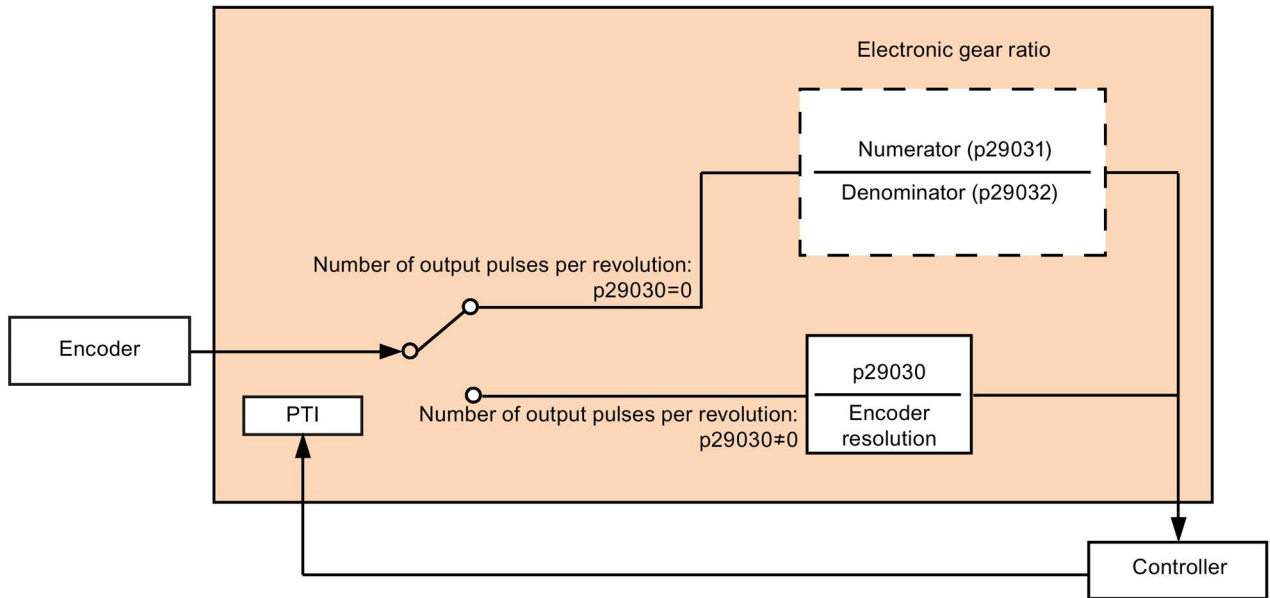
### 7.3.12 PTO function

#### Function

A pulse train encoder output (PTO) which provides pulse signals can transmit the signals to the controller to realize a closed-loop control system inside the controller, or transmit them to another drive as pulse train setpoint for a synchronous axis.

**Electronic gear**

The electronic gear ratio is a multiplier factor to the PTO to a controller. It is realized with a numerator and a denominator. One numerator (p29031) and one denominator (p29032) are used for the PTO electronic gear ratio:



Parameter	Range	Factory setting	Unit	Description
p29031	1 to 2147000000	1	-	Numerator of output pulse
p29032	1 to 2147000000	1	-	Denominator of output pulse

**Note**

When you use the PTO electronic gear function, for the absolute encoder, the electronic gear is based on the resolution of 8192 ppr.

The range of electronic gear ratio is from 0.02 to 200.

The electronic gear ratio can be set at **SERVO OFF** state only.

**Note**

**PTO direction**

For an application of fully closed-loop position control using PTI and PTO, you can set the PTO direction with parameter p29033.



---

**Note**

When using the PTO function, the drive will output some pulses before the motor servo on if you executing the following operations.

- Default the drive with the BOP instruction.
- Configure the motor ID on the drive.

---

**Note**

When you use the PTO electronic gear ratio function, zero mark will not be generated.

---

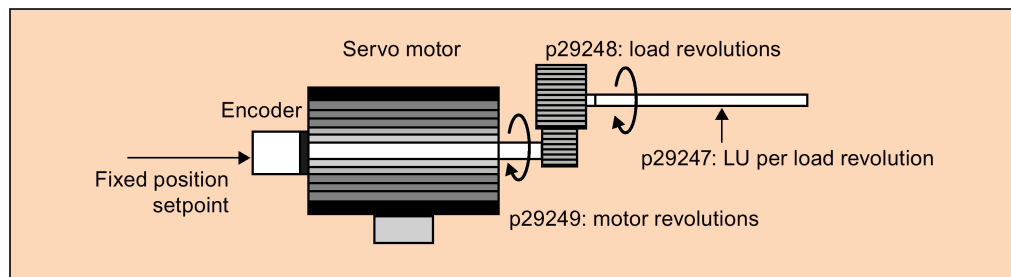
### PTO zero mark

Make the servo motor rotate for more than one revolution before using PTO's zero mark for referencing.

## 7.4 Internal position control (IPos)

### 7.4.1 Setting mechanical system

By parameterizing the mechanical system, the link between the physical moving part and the length unit (LU) is established.



The unit of the fixed position setpoint is the Length Unit (LU). All subsequent position setpoint, related speed value, and acceleration value will maintain the LU as the unit in internal position control mode.

Taking a ball screw system for example, if the system has a pitch of 10 mm/revolution (10000  $\mu\text{m}$ /revolution) and the resolution of the length unit is 1  $\mu\text{m}$  (1 LU = 1  $\mu\text{m}$ ), one load revolution corresponds to 10000 LU (p29247 = 10000).

---

**Note**

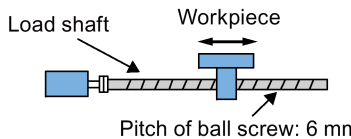
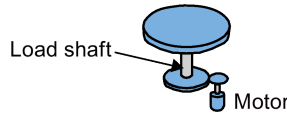
If the value of p29247 increases by N times, the values of p2542, p2544 and p2546 should increase by N times accordingly. Otherwise, the fault F7450 or F7452 occur.

---

Relevant parameters

Parameter	Range	Factory setting	Unit	Description
p29247	1 to 2147483647	10000	-	LU per load revolution
p29248	1 to 1048576	1	-	Load revolutions
p29249	1 to 1048576	1	-	Motor revolutions

Examples for configuring mechanical system

Step	Description	Mechanical system		
		Ball screw	Disc table	
		 <p>Pitch of ball screw: 6 mm</p>		
1	Identify the mechanical system	<ul style="list-style-type: none"> <li>Pitch of ball screw: 6 mm</li> <li>Reduction gear ratio: 1:1</li> </ul>	<ul style="list-style-type: none"> <li>Rotary angle: 360°</li> <li>Reduction gear ratio: 3:1</li> </ul>	
2	Define LU	1 LU = 1 µm	1 LU = 0.01°	
3	Calculate the LU per load shaft revolution	6/0.001 = 6000 LU	360/0.01 = 36000 LU	
4	Set parameters	p29247	6000	36000
		p29248	1	1
		p29249	1	3

7.4.2 Setting fixed position setpoint

Eight position setpoints in total are available. Each position setpoint comes from one group of position data:

Fixed position setpoint	Corresponding parameters	
	Parameter	Description
Fixed position setpoint 1	p2617[0]	Fixed position setpoint 1 (P_pos1)
	p2618[0]	Speed of fixed position setpoint 1 (P_pos_spd1)
	p2572	IPos maximum acceleration
	p2573	IPos maximum deceleration
Fixed position setpoint 2	p2617[1]	Fixed position setpoint 2 (P_pos2)
	p2618[1]	Speed of fixed position setpoint 2 (P_pos_spd2)
	p2572	IPos maximum acceleration
	p2573	IPos maximum deceleration

Fixed position setpoint	Corresponding parameters	
	Parameter	Description
Fixed position setpoint 3	p2617[2]	Fixed position setpoint 3 (P_pos3)
	p2618[2]	Speed of fixed position setpoint 3 (P_pos_spd3)
	p2572	IPos maximum acceleration
	p2573	IPos maximum deceleration
Fixed position setpoint 4	p2617[3]	Fixed position setpoint 4 (P_pos4)
	p2618[3]	Speed of fixed position setpoint 4 (P_pos_spd4)
	p2572	IPos maximum acceleration
	p2573	IPos maximum deceleration
Fixed position setpoint 5	p2617[4]	Fixed position setpoint 5 (P_pos5)
	p2618[4]	Speed of fixed position setpoint 5 (P_pos_spd5)
	p2572	IPos maximum acceleration
	p2573	IPos maximum deceleration
Fixed position setpoint 6	p2617[5]	Fixed position setpoint 6 (P_pos6)
	p2618[5]	Speed of fixed position setpoint 6 (P_pos_spd6)
	p2572	IPos maximum acceleration
	p2573	IPos maximum deceleration
Fixed position setpoint 7	p2617[6]	Fixed position setpoint 7 (P_pos7)
	p2618[6]	Speed of fixed position setpoint 7 (P_pos_spd7)
	p2572	IPos maximum acceleration
	p2573	IPos maximum deceleration
Fixed position setpoint 8	p2617[7]	Fixed position setpoint 8 (P_pos8)
	p2618[7]	Speed of fixed position setpoint 8 (P_pos_spd8)
	p2572	IPos maximum acceleration
	p2573	IPos maximum deceleration

## Parameter settings

Parameter	Range	Factory setting	Unit	Description
p2617[0]...[7]	-2147482648 to 2147482647	0	LU	Fixed position setpoint 1 to 8
p2618[0]...[7]	1 to 40000000	600	1000 LU/min	Speed of fixed position setpoint 1 to 8
p2572	1 to 2000000	Motor dependent	1000 LU/s <sup>2</sup>	IPos maximum acceleration
p2573	1 to 2000000	Motor dependent	1000 LU/s <sup>2</sup>	IPos maximum deceleration

### Note

When the motor is working in the IPos control mode, you need to check that whether the values of the parameters p2542, p2544, p2546, p2547 and p2573 are your desired values. The values are set automatically by the drive based on the encoder resolution.

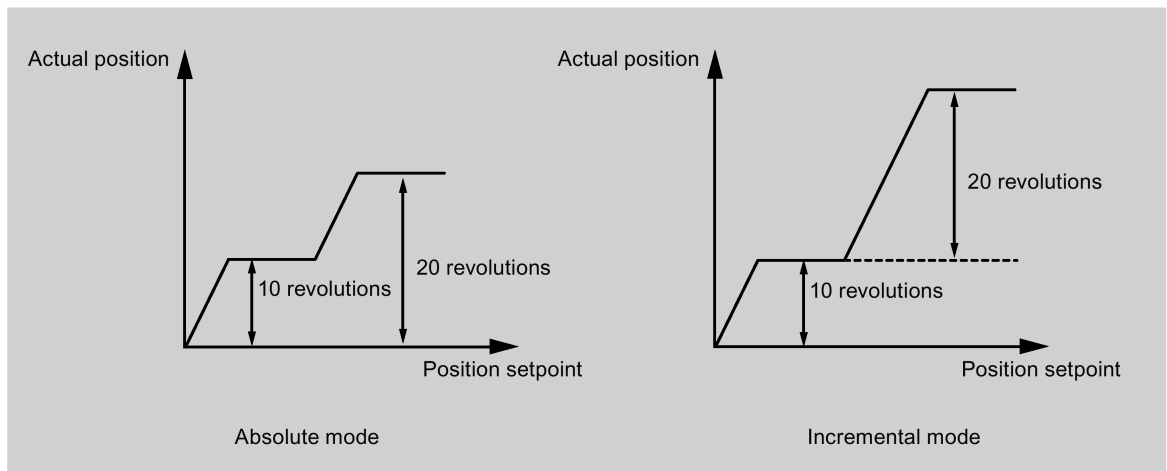
### 7.4.3 Selecting a positioning mode - absolute/incremental

In the internal position control mode, you can select between absolute positioning mode and incremental positioning mode with the parameter p29241:

Parameter	Range	Factory setting	Unit	Description
p29241	0 to 3	0	-	Absolute or incremental positioning mode: <ul style="list-style-type: none"> <li>• 0: incremental</li> <li>• 1: absolute</li> <li>• 2: absolute, positive (only for a rotary axis with modulo correction)</li> <li>• 3: absolute, negative (only for a rotary axis with modulo correction)</li> </ul>

<b>NOTICE</b>
<p><b>Pre-conditions for using the absolute mode</b></p> <p>The absolute mode can be used only after:</p> <ul style="list-style-type: none"> <li>• the axis has been referenced for incremental measuring system. Refer to Section "Referencing (Page 190)" for detailed information about referencing.</li> <li>• the axis has been adjusted for absolute measuring system. Refer to Section "Adjusting an absolute encoder (Page 160)" for reference.</li> </ul>

#### Example



### 7.4.4 Configuring linear/modular axis

Linear axis or modular axis can be used depending on your actual application. The linear axis has a restricted traversing range and it is the factory setting of the SINAMICS V90 servo drive.

The modular axis has an unrestricted traversing range. The value range of the position repeats itself after a value specified in p29245. You can use the modular axis by setting the following parameters additionally:

Parameter	Range	Unit	Default	Description
p29245	0 to 1	-	0	<ul style="list-style-type: none"> <li>• 0: linear axis</li> <li>• 1: modular axis</li> </ul>
p29246	1 to 2147482647	LU	360000	Modular range

---

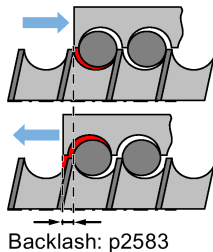
#### Note

After modifying parameter p29245, you must perform the referencing again.

---

### 7.4.5 Backlash compensation

Generally, backlash occurs when the mechanical force is transferred between a machine part and its drive:



If the mechanical system was to be adjusted/designed so that there was absolutely no backlash, this would result in high wear. Thus, backlash can occur between the machine component and the encoder. For axes with indirect position sensing, mechanical backlash results in a false traversing distance because the axis, at direction reversal, travels either too far or not far enough corresponding to the absolute value of the backlash.

---

#### Note

##### Pre-conditions for backlash compensation

The backlash compensation is active after

- the axis has been referenced for incremental measuring system. Refer to Section "Referencing (Page 190)" for detailed information about referencing.
  - the axis has been adjusted for absolute measuring system. Refer to Section "Adjusting an absolute encoder (Page 160)" for reference.
-

7.4 Internal position control (IPos)

In order to compensate the backlash, the determined backlash must be specified in p2583 with correct polarity. At each direction of rotation reversal, the axis actual value is corrected dependent on the actual traversing direction.

If the axis has been referenced or adjusted, then the setting of parameter p2604 (reference point approach, starting direction) is used to activate the compensation value:

p2604	Traversing direction	Activate compensation value
0	Negative	Immediately
1	Positive	Immediately

Parameter settings

Parameter	Range	Unit	Default	Description
p2583	-200000 to 200000	LU	0	Backlash compensation
p2604	0 to 1	-	0	Set signal source for start direction of searching cam: <ul style="list-style-type: none"> <li>0: start in positive direction</li> <li>1: start in negative direction</li> </ul>

7.4.6 Referencing

Referencing modes

If the servo motor has an incremental encoder, five referencing modes in total are available:

- Setting reference point with the digital input signal REF
- External reference cam (signal REF) and encoder zero mark
- Encoder zero mark only
- External reference cam (signal CWL) and encoder zero mark
- External reference cam (signal CCWL) and encoder zero mark

If the servo motor has an absolute encoder, the five referencing modes are available. You can also adjust the absolute encoder (by setting current position as the zero position) with the BOP function "ABS". Refer to Section "Adjusting an absolute encoder (Page 160)" for details.

You can select one of these referencing modes by setting the parameter p29240:

Parameter	Value	Description
p29240	0	Setting reference point with the digital input signal REF
	1 (default)	External reference cam (signal REF) and encoder zero mark
	2	Encoder zero mark only
	3	External reference cam (signal CCWL) and encoder zero mark
	4	External reference cam (signal CWL) and encoder zero mark

---

**Note**

**Referencing mode for absolute encoder**

If an absolute encoder is connected, the five referencing modes are available. You can select the different referencing modes with parameter p29240. When p29240 = 1 to 4, the referencing process can only be implemented before you use the "ABS" function. Once the "ABS" function is implemented, the four referencing modes are not available any more.

---

**Note**

p29240 can be modified only when the drive is in IPos mode.

---

**Setting reference point with the digital input signal REF (p29240=0)**

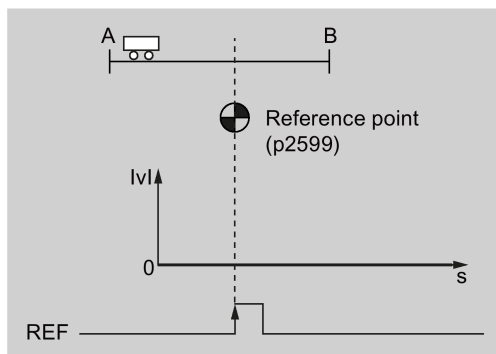
---


**Note**

**Preconditions for this referencing mode**

- The servo motor must be in servo on state and keep standstill.
  - The signal REF must be OFF under the following conditions:
    - before power-on
    - when switching from another referencing mode to this referencing mode
    - when switching from another control mode to internal position control mode
- 

The current position is set to zero at a rising edge of the signal REF and the servo drive is referenced:

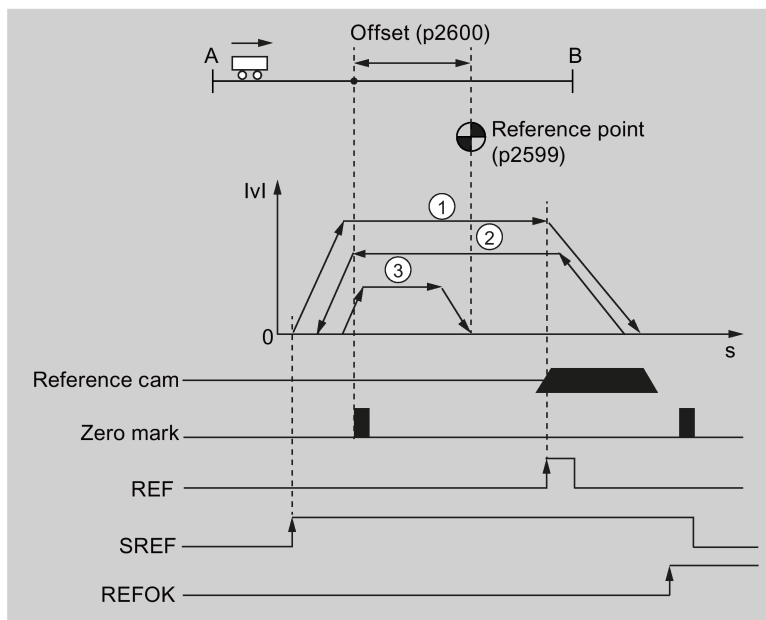


 <b>CAUTION</b>
<b>The referencing point may not be fixed during referencing.</b>
The servo motor must be in servo on state so that the referencing point is fixed during referencing.

**External reference cam (signal REF) and encoder zero mark (p29240=1)**

The referencing is triggered by signal SREF. After that, the servo motor accelerates to the speed specified in p2605 to find the reference cam. The direction (CW or CCW) for searching the reference cam is defined by p2604. When the reference cam is reached (signal REF: 0→1), the servo motor decelerates to standstill. After that, the servo motor accelerates again to the speed specified in p2608 and the running direction is opposite to the direction defined by p2604. Then the signal REF should be switched off (1→0). When the servo motor reaches the first zero mark, it starts to travel towards the reference point defined in p2600 with the speed specified in p2611. When the servo motor reaches the reference point (p2599), the signal REFOK is output. Switch off the signal SREF (1→0) and the referencing finishes successfully.

The whole process is shown in the diagram below:



- ① Speed for searching the cam (p2605)
- ↓
- ② Speed for searching zero mark (p2608)
- ↓
- ③ Speed for searching reference point (p2611)



Follow the steps below to perform referencing with this mode:

1. Set relevant parameters:

Parameter	Range	Factory setting	Unit	Description
p2599	-2147482648 to 2147482647	0	LU	Sets the position value for the reference point coordinate.
p2600	-2147482648 to 2147482647	0	LU	Reference point offset
p2604	0 to 1	0	-	Sets signal source for start direction of searching cam: <ul style="list-style-type: none"> <li>• 0: start in positive direction</li> <li>• 1: start in negative direction</li> </ul>
p2605	1 to 40000000	5000	1000 LU/min	Speed for searching the cam
p2606	0 to 2147482647	2147482647	LU	Maximum distance for searching the cam
p2608	1 to 40000000	300	1000 LU/min	Speed for searching zero mark
p2609	0 to 2147482647	20000	LU	Maximum distance for searching the zero mark
p2611	1 to 40000000	300	1000 LU/min	Speed for searching reference point

2. Configure signals SREF and REF.

Refer to Chapter "Digital inputs/outputs (DIs/DOs) (Page 91)" for reference.

3. Trigger SREF to a rising edge to start referencing.

---

**Note**

During the referencing, if SREF is OFF, the referencing stops.

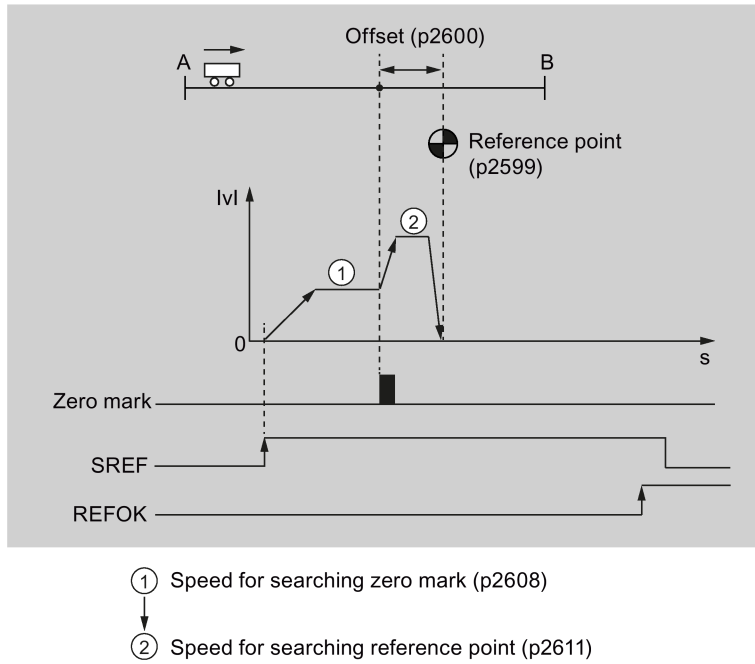
---

4. If the servo motor reaches the reference point, the signal REFOK (if configured) is output.
5. Switch off the signal SREF, and the referencing finishes successfully.

### Encoder zero mark only (p29240=2)

In this mode, there is no cam available. The referencing is triggered by signal SREF. After that, the servo motor accelerates to the speed specified in p2608 and the direction (CW or CCW) is defined by p2604. When the servo motor reaches the first zero mark, it starts to travel towards the reference point defined in p2600 with the speed specified by p2611. When the servo motor reaches the reference point (p2599), the signal REFOK is output. Switch off the signal SREF (1→0) and the referencing finishes successfully.

The whole process is shown in the diagram below:



Follow the steps below to perform referencing with this mode:

1. Set relevant parameters:

Parameter	Range	Factory setting	Unit	Description
p2599	-2147482648 to 2147482647	0	LU	Sets the position value for the reference point coordinate.
p2600	-2147482648 to 2147482647	0	LU	Reference point offset
p2604	0 to 1	0	-	Sets signal source for start direction of searching cam: • 0: start in positive direction • 1: start in negative direction
p2608	1 to 40000000	300	1000 LU/min	Speed for searching zero mark
p2609	0 to 2147482647	20000	LU	Maximum distance for searching the zero mark
p2611	1 to 40000000	300	1000 LU/min	Speed for searching reference point

2. Configure the signal SREF.

3. Trigger SREF to a rising edge to start referencing.

**Note**

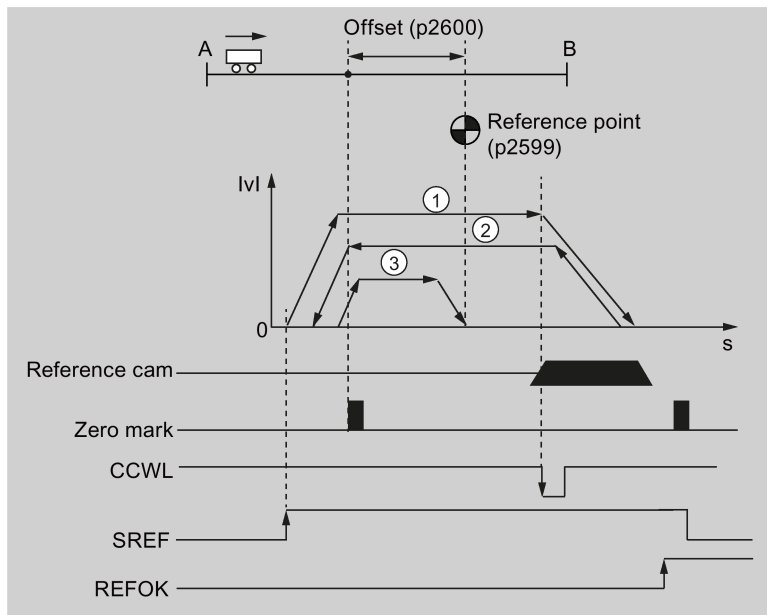
During the referencing, if SREF is OFF, the referencing stops.

4. If the servo motor reaches the reference point, the signal REFOK (if configured) is output.
5. Switch off the signal SREF, and the referencing finishes successfully.

**External reference cam (signal CCWL) and encoder zero mark (p29240=3)**

The referencing is triggered by signal SREF. After that, the servo motor accelerates to the speed specified in p2605 to find the reference cam. The direction (CCW) for searching the reference cam is defined by p2604. When the signal CCWL is detected (1→0), the servo motor decelerates to standstill with maximum deceleration. After that, the servo motor accelerates again to the speed specified in p2608 and the running direction (CW) is opposite to the direction defined by p2604. The signal CCWL switches to high level (0→1). When the servo motor finds the first zero mark, it starts to travel towards the reference point defined in p2600 with the speed specified in p2611. When the servo motor reaches the reference point (p2599), the signal REFOK is output. Switch off the signal SREF (1→0) and the referencing finishes successfully.

The whole process is shown in the diagram below:



- ① Speed for searching the cam (p2605)
- ↓
- ② Speed for searching zero mark (p2608)
- ↓
- ③ Speed for searching reference point (p2611)

**Note**

- During the referencing process, the signals CWL and CCWL are unavaible. Once the process is complete, the signals will act as limits signal again.
- For the safety purpose, the maximum distance for searching the cam (p2606) and the maximum distance for searching the zero mark (p2609) **must** be set.

Follow the steps below to perform referencing with this mode:

1. Set relevant parameters:

Parameter	Range	Factory setting	Unit	Description
p2599	-2147482648 to 2147482647	0	LU	Sets the position value for the reference point coordinate.
p2600	-2147482648 to 2147482647	0	LU	Reference point offset
p2604 <sup>1)</sup>	0 to 1	0	-	Sets signal source for start direction of searching cam: <ul style="list-style-type: none"> <li>• 0: start in positive direction (CW)</li> <li>• 1: start in negative direction (CCW)</li> </ul>
p2605	1 to 40000000	5000	1000 LU/min	Speed for searching the cam
p2606	0 to 2147482647	2147482647	LU	Maximum distance for searching the cam
p2608	1 to 40000000	300	1000 LU/min	Speed for searching zero mark
p2609	0 to 2147482647	20000	LU	Maximum distance for searching the zero mark
p2611	1 to 40000000	300	1000 LU/min	Speed for searching reference point

<sup>1)</sup> When p29240= 3, the direction for searching the reference cam must be CCW, that is p2604=1.

2. Configure the signal SREF and CCWL.
3. Trigger SREF to a rising edge to start referencing.

**Note**

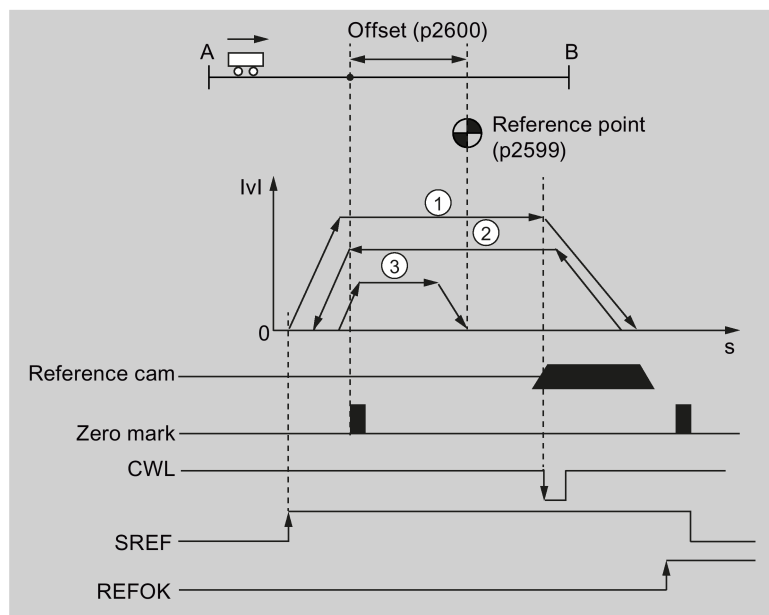
During the referencing, if SREF is OFF, the referencing stops.

4. If the servo motor reaches the reference point, the signal REFOK (if configured) is output.
5. Switch off the signal SREF, and the referencing finishes successfully.

### External reference cam (signal CWL) and encoder zero mark (p29240=4)

The referencing is triggered by signal SREF. After that, the servo motor accelerates to the speed specified in p2605 to find the reference cam. The direction (CW) for searching the reference cam is defined by p2604. When the signal CWL is detected (1→0), the servo motor decelerates to standstill with maximum deceleration. After that, the servo motor accelerates again to the speed specified in p2608 and the running direction (CCW) is opposite to the direction defined by p2604. The signal CWL switches to high level (0→1). When the servo motor finds the first zero mark, it starts to travel towards the reference point defined in p2600 with the speed specified in p2611. When the servo motor reaches the reference point (p2599), the signal REFOK is output. Switch off the signal SREF (1→0) and the referencing finishes successfully.

The whole process is shown in the diagram below:



- ① Speed for searching the cam (p2605)
- ↓
- ② Speed for searching zero mark (p2608)
- ↓
- ③ Speed for searching reference point (p2611)

#### Note

- During the referencing process, the signals CWL and CCWL are unavailable. Once the process is complete, the signals will act as limits signal again.
- For the safety purpose, the maximum distance for searching the cam (p2606) and the maximum distance for searching the zero mark (p2609) **must** be set.

Follow the steps below to perform referencing with this mode:

1. Set relevant parameters:

Parameter	Range	Factory setting	Unit	Description
p2599	-2147482648 to 2147482647	0	LU	Sets the position value for the reference point coordinate.
p2600	-2147482648 to 2147482647	0	LU	Reference point offset
p2604 <sup>1)</sup>	0 to 1	0	-	Sets signal source for start direction of searching cam: <ul style="list-style-type: none"> <li>• 0: start in positive direction</li> <li>• 1: start in negative direction</li> </ul>
p2605	1 to 40000000	5000	1000 LU/min	Speed for searching the cam
p2606	0 to 2147482647	2147482647	LU	Maximum distance for searching the cam
p2608	1 to 40000000	300	1000 LU/min	Speed for searching zero mark
p2609	0 to 2147482647	20000	LU	Maximum distance for searching the zero mark
p2611	1 to 40000000	300	1000 LU/min	Speed for searching reference point

<sup>1)</sup> When p29240= 4, the direction for searching the reference cam must be CW, that is p2604=0.

2. Configure the signal SREF and CWL.
3. Trigger SREF to a rising edge to start referencing.

---

#### Note

During the referencing, if SREF is OFF, the referencing stops.

---

4. If the servo motor reaches the reference point, the signal REFOK (if configured) is output.
5. Switch off the signal SREF, and the referencing finishes successfully.

### 7.4.7 Software position limit

The following two software position limits are available in the internal position control mode:

- positive position limit
- negative position limit

The function of software position limit only becomes active after going to reference. When the actual position reaches one of the above-mentioned software position limits, motor speed decelerates to 0.

## Parameter settings

Parameter	Range	Factory setting	Unit	Description
p2580	-2147482648 to 2147482647	-2147482648	LU	Negative software position limit switch
p2581	-2147482648 to 2147482647	2147482648	LU	Positive software position limit switch
p2582	0 to 1	0	-	Activation of software limit switch: <ul style="list-style-type: none"> <li>• 0: deactivate</li> <li>• 1: activate</li> </ul>

### 7.4.8 Speed limit

Refer to "Speed limit (Page 178)" for details.

### 7.4.9 Torque limit

Refer to "Torque limit (Page 179)" for details.

### 7.4.10 Selecting a fixed position setpoint and starting positioning

In the IPos mode, two methods are available to select a fixed position setpoint and then start motor running according to selected fixed position setpoint:

- select a fixed position setpoint with the co-settings of signals POS1, POS2 and POS3 and then use the trigger signal P-TRG to start positioning
- use the rising edge of the signal STEPF, STEPB or STEPH

Refer to Chapter "Digital inputs/outputs (DIs/DOs) (Page 91)" for detailed information about the signals POS1, POS2, POS3, P-TRG, STEPF, STEPB, STEPH.

#### Selecting the target position with the signals POS1, POS2 and POS3, and starting the positioning with the trigger signal P-TRG

Select one of the eight fixed position setpoints with the co-settings of signals POS1, POS2 and POS3:

Fixed position setpoint	Signal		
	POS3	POS2	POS1
Fixed position setpoint 1	0	0	0
Fixed position setpoint 2	0	0	1
Fixed position setpoint 3	0	1	0
Fixed position setpoint 4	0	1	1
Fixed position setpoint 5	1	0	0

Fixed position setpoint	Signal		
	POS3	POS2	POS1
Fixed position setpoint 6	1	0	1
Fixed position setpoint 7	1	1	0
Fixed position setpoint 8	1	1	1

In the fixed position control mode, the signals POS1 and POS2 are default assignments of DI7 and DI8 while the signal POS3 is not assigned:

Signal type	Signal name	Description
DI	POS1	Select a fixed position setpoint.
DI	POS2	
DI	POS3	

**Note**

**Configuration of POS3**

If the POS3 is not assigned to any DI, its status is assumed to be 0, which means only the following fixed position setpoints can be used:

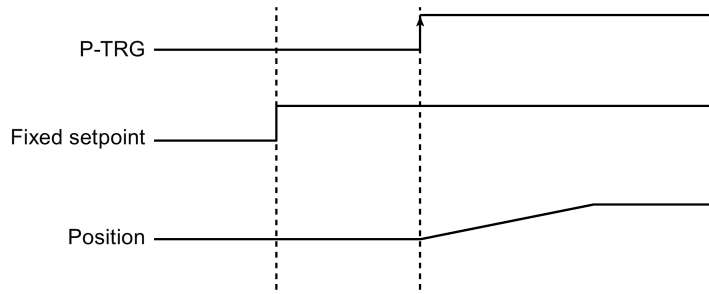
- Fixed position setpoint 1
- Fixed position setpoint 2
- Fixed position setpoint 3
- Fixed position setpoint 4

After selecting a fixed position setpoint, the servo motor can start positioning at a rising edge of the signal P-TRG.

The digital input signal P-TRG is the default assignment of DI6 in the internal position control mode:

Signal type	Signal name	Setting	Description
DI	P-TRG	0→1	Starts positioning according to selected fixed position setpoint

The timing diagram for starting positioning with the trigger signal P-TRG is shown as follows:





## Selecting the target position and starting the positioning with the rising edge of the signal STEP F, STEP B or STEP H

If the signal STEP F is enabled, the servo motor, at a rising edge of STEP F, traverses to next fixed position setpoint. For example, if the servo motor currently locates at the fixed position setpoint 3, the servo motor traverses to the fixed position setpoint 4 at a rising edge of STEP F.

If the signal STEP B is enabled, the servo motor, at a rising edge of STEP B, traverses to previous fixed position setpoint.

If the signal STEP H is enabled, the servo motor, at a rising edge of STEP H, traverses to the fixed position setpoint 1.

---

### Note

The servo drive can respond to the rising edge of the signal STEP F, STEP B or STEP H **only** when the servo motor is at a standstill.

If the servo motor is at fixed position 8, a rising edge of STEP F is not responded.

If motor is at fixed position 1, a rising edge of STEP H is responded, but a rising edge of STEP B is not responded.

During positioning, if the motor stops unexpectedly, the drive assumes that the target position has been reached; for example, if the motor stops between POS2 and POS3 because of a fault after the signal STEP B (traversing to POS2) is given, the drive assumes that POS2 has been reached.

---

## 7.5 Speed control (S)

### 7.5.1 Configuring speed setpoint

Eight sources in total are available for speed setpoint. You can select one of them with the combination of digital input signals SPD1, SPD2 and SPD3:

Digital signal			Torque limit
SPD3	SPD2	SPD1	
0	0	0	External analog speed setpoint (analog input 1)
0	0	1	Fixed speed setpoint 1 (p1001)
0	1	0	Fixed speed setpoint 2 (p1002)
0	1	1	Fixed speed setpoint 3 (p1003)
1	0	0	Fixed speed setpoint 4 (p1004)
1	0	1	Fixed speed setpoint 5 (p1005)
1	1	0	Fixed speed setpoint 6 (p1006)
1	1	1	Fixed speed setpoint 7 (p1007)

Refer to "DIs (Page 92)" for more information about the digital signals SPD1, SPD2 and SPD3.

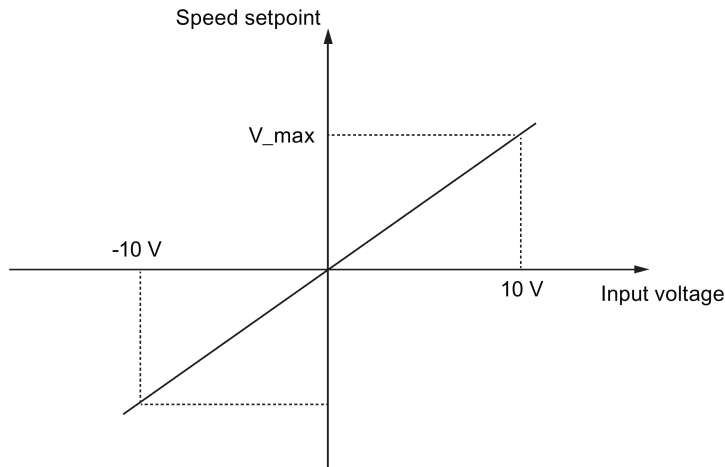
### 7.5.1.1 Speed control with external analog speed setpoint

In the S mode, when the digital input signals SPD1, SPD2 and SPD3 are all at low level (0), analog voltage from the analog input 1 is used as the speed setpoint.

The analog voltage from the analog input 1 corresponds to a parameterized speed value. Default speed value is rated motor speed. The analog voltage of 10 V corresponds to the maximum speed setpoint ( $V_{max}$ ) and this maximum speed setpoint can be specified by parameter p29060.

Parameter	Range	Factory setting	Unit	Description
p29060	6 to 210000	3000	rpm	Maximum analog speed setpoint corresponding to 10 V

The relationship between the analog voltage and the speed setpoint is shown as follows:



#### Note

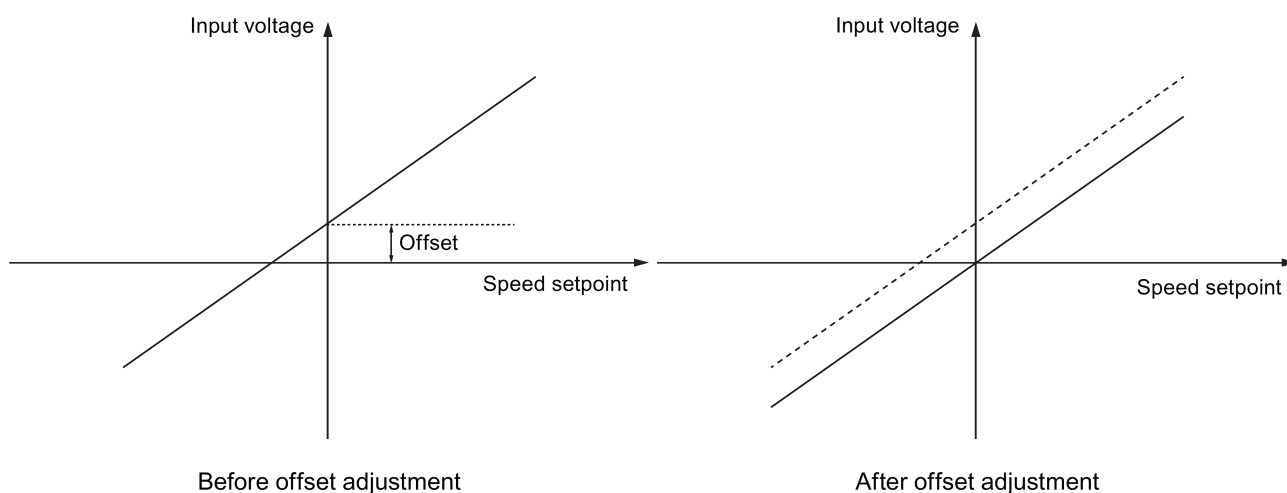
If the drive is working with external analog speed setpoint, the system continues to work automatically after you repower on the 24 VDC power supply which is shut off unexpectedly for the drive. In this case, do not touch the equipment.

### Offset adjustment for analog input 1

Offset exists for the input voltage from the analog input 1. You have two methods to adjust such offset:

- Automatic adjustment with BOP function: refer to "Adjusting AI offsets (Page 158)" for details.
- Manual input of an offset value (p29061)

Parameter	Range	Factory setting	Unit	Description
p29061	-0.50 to 0.50	0	V	Offset adjustment for analog input 1 (speed setpoint)



#### 7.5.1.2 Speed control with fixed speed setpoint

##### Parameter settings

In the S mode, when at least one of the three digital input signals SPD1, SPD2 and SPD3 is at high level, one of the following parameter values is used as speed setpoint:

Parameter	Value range	Default	Unit	Description	Digital input		
					SPD3	SPD2	SPD2
p1001	-210000 to 210000	0	rpm	Fixed speed setpoint 1	0	0	1
p1002	-210000 to 210000	0	rpm	Fixed speed setpoint 2	0	1	0
p1003	-210000 to 210000	0	rpm	Fixed speed setpoint 3	0	1	1
p1004	-210000 to 210000	0	rpm	Fixed speed setpoint 4	1	0	0
p1005	-210000 to 210000	0	rpm	Fixed speed setpoint 5	1	0	1

7.5 Speed control (S)

Parameter	Value range	Default	Unit	Description	Digital input		
					SPD3	SPD2	SPD2
p1006	-210000 to 210000	0	rpm	Fixed speed setpoint 6	1	1	0
p1007	-210000 to 210000	0	rpm	Fixed speed setpoint 7	1	1	1

7.5.2 Direction and stop

Two digital input signals are used to control motor direction and run/stop.

- CWE: clockwise enable
- CCWE: counter-clockwise enable

The following table shows you in details:

Signal		Fixed torque setpoint	Analog torque setpoint		
CCWE	CWE		+ polarity	- polarity	0 V
0	0	0	0	0	0
0	1	CW	CW	CCW	0
1	0	CCW	CCW	CW	0
1	1	0	0	0	0

**Note**

In S mode or T mode, when the servo motor is ready to run, signal CWE or CCWE is a must to start running the motor.

For more information about signals CWE and CCWE, refer to "DIs (Page 92)".

7.5.3 Speed limit

Refer to "Speed limit (Page 178)" for details.

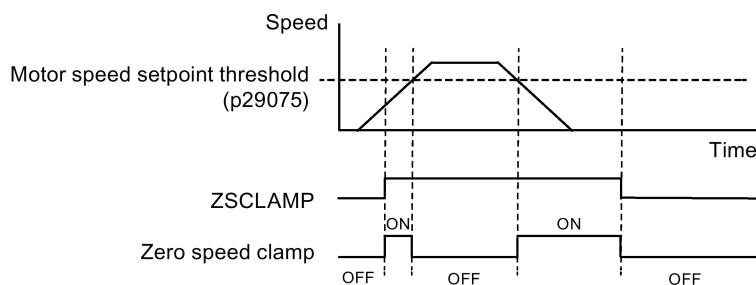
7.5.4 Torque limit

Refer to "Torque limit (Page 179)" for details.

7.5.5 Zero speed clamp

The function of zero speed clamp is used to stop motor and lock motor axis when motor speed setpoint is below a parameterized threshold level (p29075).

This function is available only when the analog input 1 is used as the source of speed setpoint. The digital input signal ZSCLAMP is used to activate this function. When both motor speed setpoint and motor actual speed are below the parameterized threshold level and signal ZSCLAMP is logic "1", the motor is locked. Drive exits from clamping state either when the motor speed setpoint is above the threshold level or when the signal ZSCLAMP is logic "0".



## Parameter settings

Parameter	Value range	Default	Unit	Description
p29075	0 to 200	200	rpm	Zero speed clamp threshold
p29060	6 to 210000	3000	%	Maximum analog speed setpoint corresponding to 10 V

## DI configuration

Signal type	Signal name	Pin assignment	Setting	Description
DI	ZSCLAMP	To be assigned	1	When the motor speed setpoint is below zero speed clamp threshold, the motor is locked.
			0	No action

### Note

When p29003=4 and CMODE is "1", the drive is working in speed control mode. In this case if ZSCLAMP is activated, the drive will switch to PTI control mode and PTI pulse input will lead motor running under PTI control mode.

### Note

For more information about the signal ZSCLAMP, refer to "DIs (Page 92)".

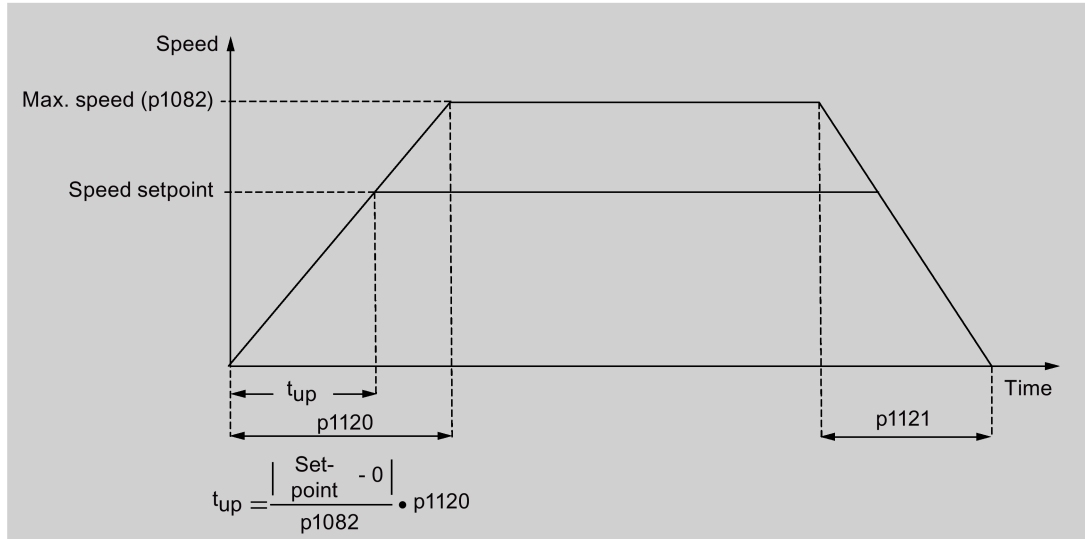
## 7.5.6 Ramp-function generator

The ramp-function generator is used to limit acceleration in the event of abrupt setpoint changes and thus helps prevent load surges during drive operation.

The ramp-up time p1120 and ramp-down time p1121 can be used to set acceleration and deceleration ramps separately. This allows a smoothed transition in the event of setpoint changes.

The maximum speed p1082 is used as the reference value for calculating the ramp-up and ramp-down times.

You can see the properties of the ramp-function generator from the diagram below:

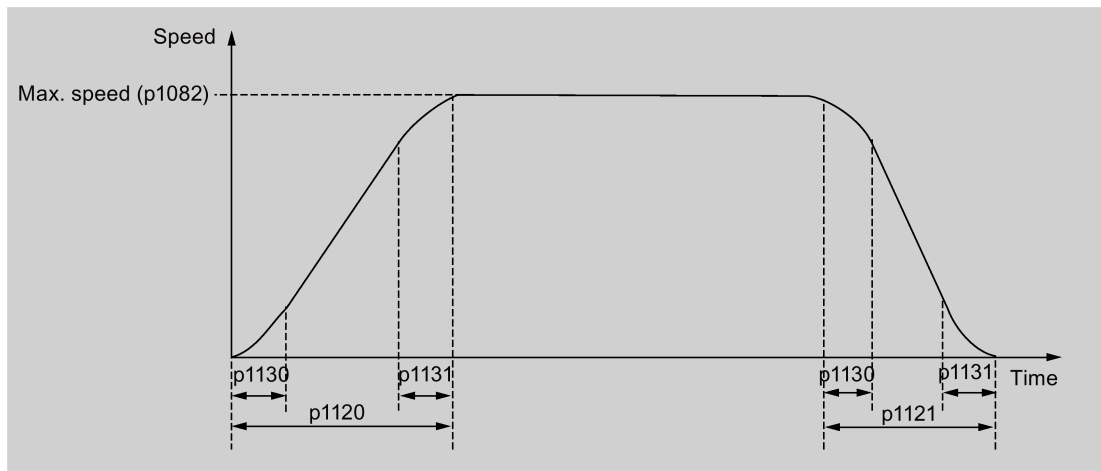


### S-curve ramp-function generator

You can also use the S-curve ramp-function generator by setting p1115 to 1. The S-curve ramp-function generator is realized with:

- the acceleration (p1120) and deceleration (p1121) ramps
- the initial (p1130) and final (p1131) rounding-off times

You can see the properties of the S-curve ramp-function generator from the diagram below:



## Parameter settings

Parameter	Value range	Default	Unit	Description
p1082	0 to 210000	1500	rpm	Maximum motor speed
p1115	0 to 1	0	-	Ramp-function generator selection
p1120	0 to 999999	1	s	Ramp-function generator ramp-up time
p1121	0 to 999999	1	s	Ramp-function generator ramp-down time
p1130	0 to 30	0	s	Ramp-function generator initial rounding-off time
p1131	0 to 30	0	s	Ramp-function generator final rounding-off time

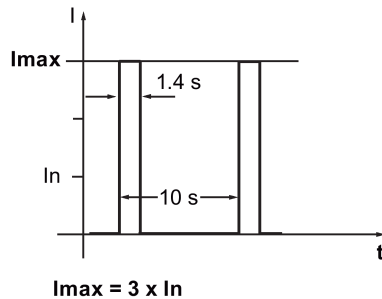
## 7.6 Torque control (T)

### 7.6.1 300% overload capacity

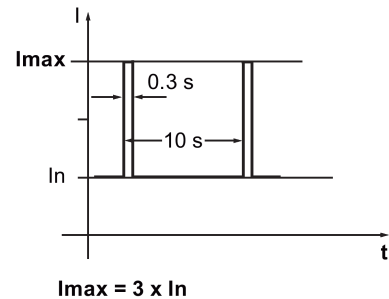
SINAMICS V90 servo drives can work with 300% overload capacity for a specific time period. The following diagrams show in details:

#### SINAMICS V90 200 V servo drive

Without load

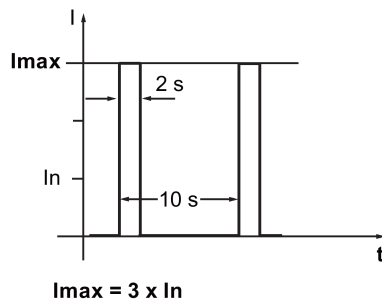


With load

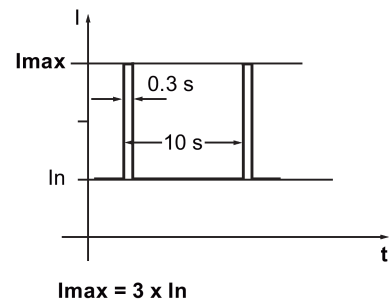


#### SINAMICS V90 400 V servo drive

Without load



With load



### 7.6.2 Torque setpoint

Two sources are available for torque setpoint:

- External setpoint: analog input 2
- Fixed setpoint: p29043

These two resources can be selected with the digital input signal TSET:

Signal	Level	Source of torque setpoint
TSET	0 (default)	Analog torque setpoint (analog input 2)
	1	Fixed torque setpoint (p29043)

Refer to "DIs (Page 92)" for detailed information about the signal TSET.

#### 7.6.2.1 Torque control with external analog torque setpoint

In the T mode, when the digital input signal TSET is at low level, analog voltage from the analog input 2 is used as the torque setpoint.

The analog voltage from the analog input 2 corresponds to a parameterized torque value scaling (p29041[0]). If p29041[0] = 100%, analog input voltage of 10 V corresponds to rated torque; if p29041[0] = 50%, the analog input value of 10 V corresponds to 50% of the rated torque.

Parameter	Range	Factory setting	Unit	Description
p29041[0]	0 to 100	100	%	Scaling for analog torque setpoint (corresponding to 10 V)

**Note**

The value of analog input 2 can be monitored through parameter p29351.

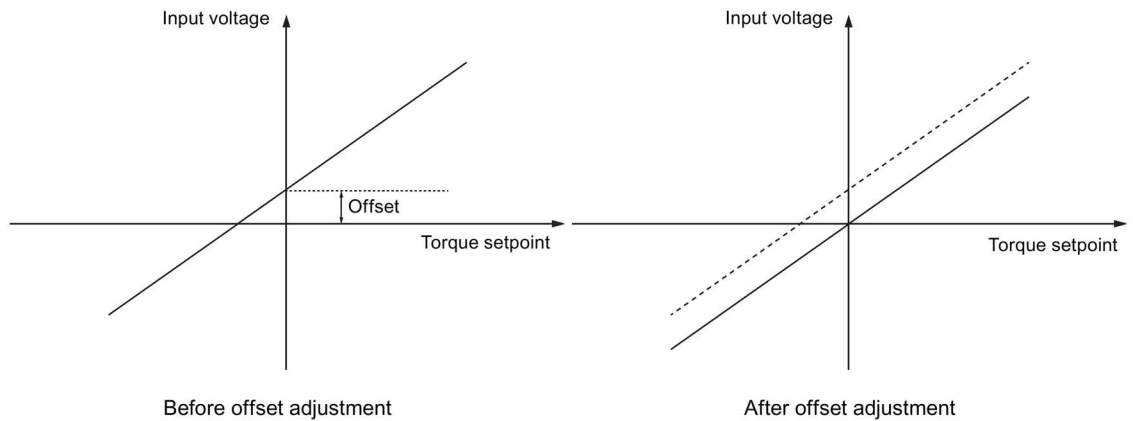
#### Offset adjustment for analog input 2

Offset exists for the input voltage from the analog input 2. The motor can run at a very low speed even the current input voltage is 0 V. You have 2 methods to adjust such offset:

- Automatic adjustment with BOP function: refer to "Adjusting AI offsets (Page 158)" for details.
- Manual input of an offset value (p29042)

Parameter	Range	Factory setting	Unit	Description
p29042	-0.50 to 0.50	0	V	Offset adjustment for analog input 2 (torque setpoint)





### 7.6.2.2 Torque control with fixed torque setpoint

#### Parameter settings

Parameter	Range	Factory setting	Unit	Description
p29043	-100 to 100	0	%	Fixed torque setpoint

### 7.6.3 Direction and stop

Two digital input signals are used to control motor direction and run/stop:

- CWE: clockwise enable
- CCWE: counter-clockwise enable

The following table shows you in details:

Signal		Fixed torque setpoint	Analog torque setpoint		
CCWE	CWE		+ polarity	- polarity	0 V
0	0	0	0	0	0
0	1	CW	CW	CCW	0
1	0	CCW	CCW	CW	0
1	1	0	0	0	0

#### Note

In S mode or T mode, when the servo motor is ready to run, signal CWE or CCWE is a must to start running the motor.

For more information about the signals CWE and CCWE, refer to "DIs (Page 92)".

### 7.6.4 Speed limit

Refer to "Speed limit (Page 178)" for details.

## 7.7 Communicating with the PLC

The SINAMICS V90 supports communication with the PLC on RS485 interface. You can parameterize whether the RS485 interface shall apply USS or Modbus RTU protocol. USS is the default bus setting. A shielded twisted pair cable is recommended for the RS485 communication.

### 7.7.1 USS communication

The SINAMICS V90 can communicate with the PLC through an RS485 cable with the standard USS communication protocol. After the communication is established, you can change the position setpoint and speed setpoint through the USS communication protocol. The servo drive can also transmit the actual speed, torque, and alarm to the PLC through the USS communication protocol.

#### Telegram format

The telegram format is shown as follows:

STX	LGE	ADR	PKE	IND	PWE	PWE	BCC
-----	-----	-----	-----	-----	-----	-----	-----

**STX:** start of text

**LGE:** length

**ADR:** slave address

**PKE:** parameter ID

**IND:** sub-index

**PWE:** parameter value

**BCC:** block check character

#### Relevant parameters

You can access the following parameters by USS.

Parameter	Description	Parameter	Description
p1001	Fixed speed setpoint 1	r0020	Speed setpoint smoothed
p1002	Fixed speed setpoint 2	r0021	Actual speed smoothed
p1003	Fixed speed setpoint 3	r0026	DC link voltage smoothed
p1004	Fixed speed setpoint 4	r0027	Absolute actual current smoothed
p1005	Fixed speed setpoint 5	r0031	Actual torque smoothed
p1006	Fixed speed setpoint 6	r0032	Active power actual value smoothed
p1007	Fixed speed setpoint 7	r0034	Motor utilization thermal
p2617[0...7]	Fixed position setpoint	r0807	Master control active
p2618[0...7]	Speed of fixed position setpoint	r2521	LR position actual value
p2572	IPos maximum acceleration	r2556	LR position setpoint after setpoint smoothing
p2573	IPos maximum deceleration		

**Note**

There is no priority when BOP, V-ASSISTANT, and USS access the same parameter at the same time, the value of the parameter depends on the last access operation.

**Operating steps**

Main step	Sub step/comment
① Configure the setup and program the PLC.	
② Configure the RS485 bus address by parameter p29004.	The RS485 bus is used to transfer current absolute position of the servo drive to the upper controller/PLC. You can configure the slaver address from 1 to 31.
③ Select the USS communication protocol by parameter p29007.	<ul style="list-style-type: none"> <li>• p29007 = 0: no protocol</li> <li>• p29007 = 1: USS protocol</li> <li>• p29007 = 2: Modbus protocol</li> </ul>
④ Set the transmission baud rate by parameter p29009.	<ul style="list-style-type: none"> <li>• 5: 4800 baud</li> <li>• 6: 9600 baud</li> <li>• 7: 19200 baud</li> <li>• 8: 38400 baud</li> <li>• 9: 57600 baud</li> <li>• 10: 76800 baud</li> <li>• 11: 93750 baud</li> <li>• 12: 115200 baud</li> <li>• 13: 187500 baud</li> </ul>
⑤ Set control mode for the drive.	
⑥ Save the parameters and restart the drive.	
⑦ Access the parameters via USS.	<p>For IPos control mode, you can change the following parameters via USS:</p> <ul style="list-style-type: none"> <li>• p2617[0...7], p2618[0...7], p2572, p2573</li> </ul> <p>For S control mode, you can change the following parameter via USS:</p> <ul style="list-style-type: none"> <li>• p1001 to p1007</li> </ul> <p>Ten monitor parameters can be read by USS:</p> <ul style="list-style-type: none"> <li>• r0020, r0021, r0026, r0027, r0031, r0032, r0034, r0807, r2556, and r2521</li> </ul>

**Note**

The USS protocol communication libraries of S7-200, S7-200 SMART V1.0, and S7-1200 do not support the communication with the SINAMICS V90 servo drive.

**7.7.2 Modbus communication**

The SINAMICS V90 servo drive can communicate with the PLC through an RS485 cable with the standard Modbus communication protocol. For Modbus data format, V90 supports Modbus RTU while Modbus ASCII is not supported. Registers of the servo drive can be read by Modbus function code FC3 and written via function code FC6 (single register) or FC16 (multiple registers).

**Supported function codes**

The SINAMICS V90 supports only three function codes. If a request with an unknown function code is received, an error message will be returned.

**FC3 - Read holding registers**

When a message with FC = 0x03 is received, then four bytes of data are expected, that is, FC3 has four bytes of data:

- Two bytes for the starting address
- Two bytes for the number of registers

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Address	FC (0x03)	Start address (most significant byte)	Start address (least significant byte)	Number of registers (most significant byte)	Number of registers (least significant byte)	CRC	CRC

**FC6 - Write single register**

When a message with FC = 0x06 is received, then four bytes of data are expected, that is, FC6 has four bytes of data:

- Two bytes for the register address
- Two bytes for the register value

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Address	FC (0x06)	Start address (most significant byte)	Start address (least significant byte)	New register value (most significant byte)	New register value (least significant byte)	CRC	CRC

### FC16 - Write multiple registers

When a message with FC = 0x10 is received, then 5 + N bytes of data are expected, that is, FC16 has 5 + N bytes of data:

- Two bytes for the starting address
- Two bytes for the number of registers
- One byte for the byte count
- N bytes for the register values

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 7 + n	Byte 8 + n	Byte 9 + n	Byte 10 + n
Address	FC (0x10)	Start address (most significant byte)	Start address (least significant byte)	Number of registers (most significant byte)	Number of registers (least significant byte)	Number of bytes	nth value (most significant byte)	nth value (least significant byte)	CRC	CRC

### Operating steps

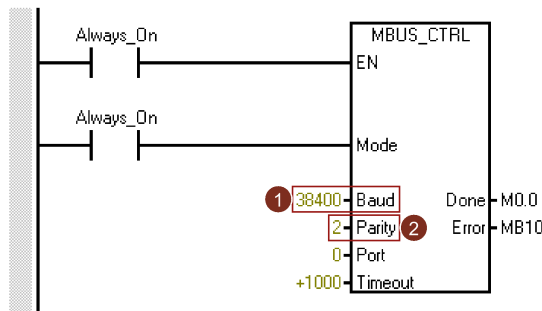
Description		Comment
①	Configure the RS485 bus address by parameter p29004.	You can configure the slaver address from 1 to 31.
②	Select the communication protocol by parameter p29007.	<ul style="list-style-type: none"> <li>• p29007 = 0: No protocol</li> <li>• p29007 = 1: USS protocol</li> <li>• p29007 = 2: Modbus protocol</li> </ul>
③	Select the command and setpoint source by parameter p29008.	<ul style="list-style-type: none"> <li>• p29008 = 1: Setpoint and control word from Modbus PZD</li> <li>• p29008 = 2: No control word.</li> </ul>
④	Set the transmission baud rate by parameter p29009.	<ul style="list-style-type: none"> <li>• 5: 4800 baud</li> <li>• 6: 9600 baud</li> <li>• 7: 19200 baud</li> <li>• 8: 38400 baud</li> <li>• 9: 57600 baud</li> <li>• 10: 76800 baud</li> <li>• 11: 93750 baud</li> <li>• 12: 115200 baud</li> <li>• 13: 187500 baud</li> </ul>
⑤	Set control mode for the drive by p29003.	
⑥	Save the parameters and restart the drive.	
⑦	Configure the PLC parameters.	<p><b>Note:</b></p> <p>Keep the PLC baud rate the same as the drive setting. Set even parity check for the PLC.</p>

	Description	Comment
⑧	Write the control word via PLC.	<b>Note:</b> Bit 10 of the register 40100 must be set to 1 to allow the PLC to control the drive.  You need to trigger a rise edge for OFF1 to enable SON status for the motor, and OFF2 and OFF3 must be set to 1. The step must be executed when you enable SON for the first time.
⑨	Write the setpoint and read the status word via PLC.	

**Example 1**

This example shows the operating procedures when we use setpoint and control word from Modbus as the Modbus control source in S control mode.

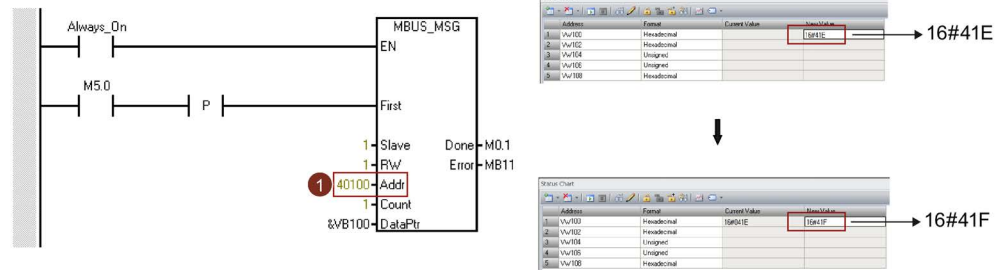
1. Set RS485 bus address for the drive.
  - p29004 = 1
2. Select the Modbus protocol by p29007.
  - p29007 = 2
3. Select Modbus control source by p29008.
  - p29008 = 1
4. Set the transmission baud rate by p29009.
  - p29009 = 8 (38400 baud)
5. Save the parameters and restart the drive.
6. Set the drive work mode to S control mode.
7. Configure the PLC parameters.



**Note:**

Keep the PLC baud rate the same as the drive setting.  
 Set even parity check for the PLC (parity = 2).

8. Write the control word you desired via the register 40100.

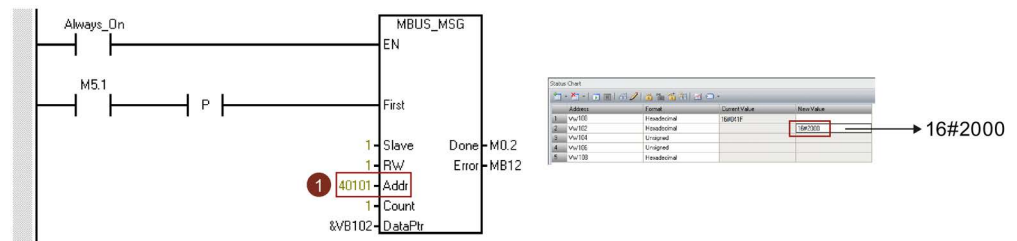


**Note:**

Bit 10 of the register 40100 must be set to 1 to allow the PLC to control the drive. You need to trigger a rise edge for OFF1 to enable SON status for the motor, and OFF2 and OFF3 must be set to 1. The step must be executed when you enable SON for the first time.

For example, we write 0x41E to the register 40100 firstly and then write 0x41F to the register. The motor now is in SON status. You can check the control word definition table below to see the meaning of "0x41E" and "0x41F".

9. Write the speed setpoint via the register 40101.



**Note:**

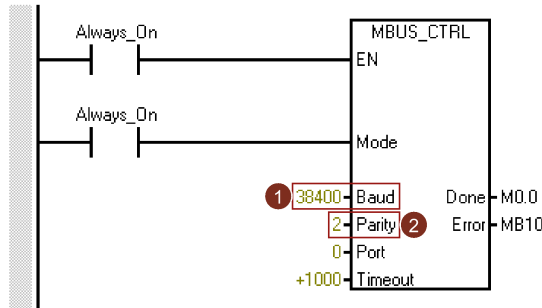
You can calculate the actual speed value with the scale factor. Value 0x4000 represents the value of 100% × motor rated speed. Therefore, 0x2000 represents half of the motor rated speed.

**Example 2**

This example shows the operating procedures when we use the setpoint and control word from Modbus as the Modbus control source in IPos control mode.

1. Set RS485 bus address for the drive.
  - p29004 = 1
2. Select the Modbus protocol by p29007.
  - p29007 = 2
3. Select Modbus control source by p29008.
  - p29008 = 1
4. Set the transmission baud rate by p29009.
  - p29009 = 8 (38400 baud)
5. Save the parameters and restart the drive.

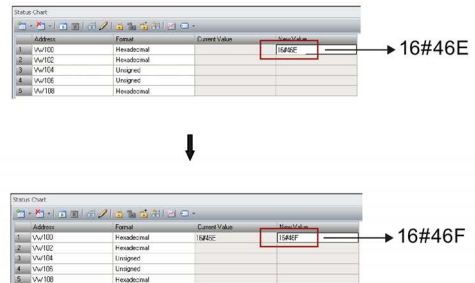
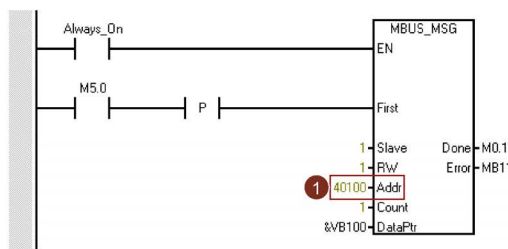
6. Set the drive work mode to IPos control mode.
7. Configure the PLC parameters.



**Note:**

Keep the PLC baud rate the same as the drive setting.  
Set even parity check for the PLC (parity = 2).

8. Write the control word you desired via the register 40100.

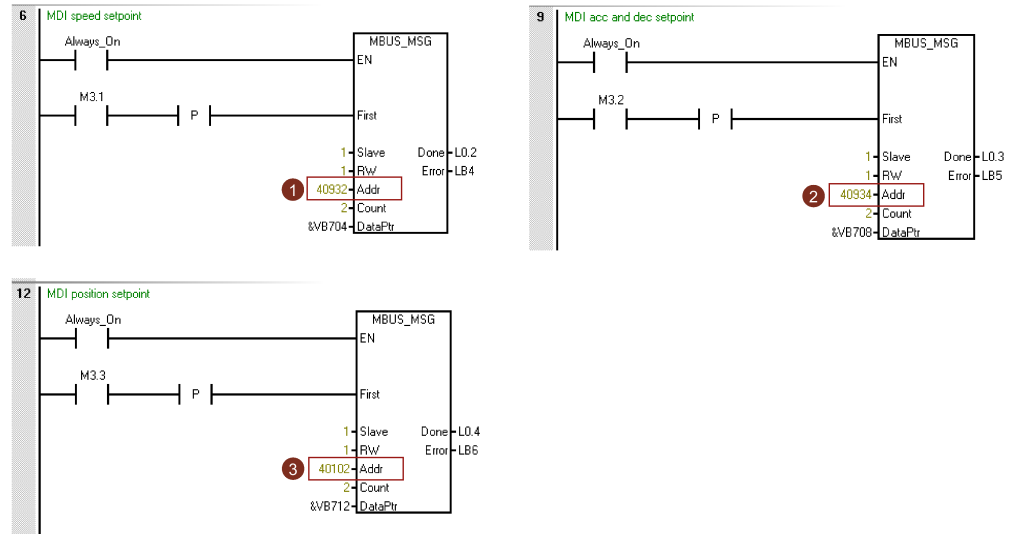


**Note:**

Bit 10 of the register 40100 must be set to 1 to allow the PLC to control the drive.  
You need to trigger a rise edge for OFF1 to enable SON (0→1) status for the motor, and OFF2 and OFF3 must be set to 1. The step must be executed when you enable SON for the first time.  
For example, we write 0x46E to the register 40100 firstly and then write 0x46F to the register. The motor now is in SON status. You can check the control word definition table below to see the meaning of "0x46E" and "0x46F".



9. Implement referencing for the drive.  
Keep the drive in SON status and implement referencing by writing the control word 40100.
10. Write the position setpoint and speed setpoint via the registers 40932, 40933, 40934, 40935, 40102 and 40103.



### Mapping table

The SINAMICS V90 servo drive supports the following registers. "R", "W", "R/W" in the column access stand for read, write, read/write.

Modbus register number	Description	Modbus access	Unit	Scaling factor	Range or On/Off text	Data/parameter
40100	Control word (PTI, IPos, S, T)	R/W	-	1	-	Process data 1, receive word, PZD1
40101	Speed setpoint (S)	R/W	-	0x4000 hex = 100% × motor rated speed	-	Process data 2, receive word, PZD2
40102	Position setpoint high-word (IPos)	R/W	LU	1	-2147482648 to 2147482647	Process data 3, receive word, PZD3
40103	Position setpoint low-word (IPos)	R/W	LU	1		Process data 4, receive word, PZD4
40110	Status word (PTI, IPos, S, T)	R	-	1	-	Process data 1, send word, PZD1
40111	Actual speed (PTI, IPos, S, T)	R	-	0x4000 hex = 100% × motor rated speed	-	Process data 2, send word, PZD2
40112	Actual position high-word (PTI, IPos)	R	LU	1	-2147482648 to 2147482647	Process data 3, send word, PZD3
40113	Actual position low-word (PTI, IPos)	R	LU	1		Process data 4, send word, PZD4

Modbus register number	Description	Modbus access	Unit	Scaling factor	Range or On/Off text	Data/parameter
40200	DO 1	R/W	-	1	HIGH/LOW	r0747.0
40201	DO 2	R/W	-	1	HIGH/LOW	r0747.1
40202	DO 3	R/W	-	1	HIGH/LOW	r0747.2
40203	DO 4	R/W	-	1	HIGH/LOW	r0747.3
40204	DO 5	R/W	-	1	HIGH/LOW	r0747.4
40205	DO 6	R/W	-	1	HIGH/LOW	r0747.5
40220	AO 1	R	%	100	-100.0 to 100.0	-
40221	AO 2	R	%	100	-100.0 to 100.0	-
40240	DI 1	R	-	1	HIGH/LOW	r0722.0
40241	DI 2	R	-	1	HIGH/LOW	r0722.1
40242	DI 3	R	-	1	HIGH/LOW	r0722.2
40243	DI 4	R	-	1	HIGH/LOW	r0722.3
40244	DI 5	R	-	1	HIGH/LOW	r0722.4
40245	DI 6	R	-	1	HIGH/LOW	r0722.5
40246	DI 7	R	-	1	HIGH/LOW	r0722.6
40247	DI 8	R	-	1	HIGH/LOW	r0722.7
40248	DI 9	R	-	1	HIGH/LOW	r0722.8
40249	DI 10	R	-	1	HIGH/LOW	r0722.9
40260	AI 1	R	%	100	-300.0 to 300.0	-
40261	AI 2	R	%	100	-300.0 to 300.0	-
40280	Enable DI simulation (high part)	R/W	-	1	HIGH/LOW	-
40281	Enable DI simulation (low part)	R/W	-	1	HIGH/LOW	-
40282	Setpoint DI simulation (high part)	R/W	-	1	HIGH/LOW	-
40283	Setpoint DI simulation (low part)	R/W	-	1	HIGH/LOW	-
40300	Power stack code number	R	-	1	0 to 32767	-
40301	V90 OA version	R	-	1	e.g. 104xx for V01.04.xx	p29018[0]/10000
40320	Rated power of the power unit	R	kW	100	0.00 to 327.67	-
40321	Current limit	R/W	%	10	10.0 to 400.0	-
40322	Ramp-up time	R/W	s	100	0.0 to 650.0	p1120
40323	Ramp-down time	R/W	s	100	0.0 to 650.0	p1121
40324	Reference speed	R	rpm	1	6 to 32767	Motor rated speed
40325	Control mode	R/W	-	1	0 to 8	p29003
40340	Speed setpoint	R	rpm	1	-16250 to 16250	r0020
40341	Actual speed value	R	rpm	1	-16250 to 16250	r0021

Modbus register number	Description	Modbus access	Unit	Scaling factor	Range or On/Off text	Data/parameter
40344	DC-link voltage	R	V	1	0 to 32767	r0026
40345	Actual current value	R	A	100	0 to 163.83	r0027
40346	Actual torque value	R	Nm	100	-325.00 to 325.00	r0031
40347	Actual active power	R	kW	100	0 to 327.67	r0032
40348	Energy consumption	R	kWh	1	0 to 32767	-
40349	Control priority	R	-	1	Manual/Auto	r0807
40350/40351	Position setpoint	R	LU	1	-2147482648 to 2147482647	r2556
40352/40353	Actual position value	R	LU	1	-2147482648 to 2147482647	r2521[0]
40354	Motor utilization	R	%	100	-320.00 to 320.00	r0034
40400	Failure number, index 0	R	-	1	0 to 32767	-
40401	Failure number, index 1	R	-	1	0 to 32767	-
40402	Failure number, index 2	R	-	1	0 to 32767	-
40403	Failure number, index 3	R	-	1	0 to 32767	-
40404	Failure number, index 4	R	-	1	0 to 32767	-
40405	Failure number, index 5	R	-	1	0 to 32767	-
40406	Failure number, index 6	R	-	1	0 to 32767	-
40407	Failure number, index 7	R	-	1	0 to 32767	-
40408	Alarm number	R	-	1	0 to 32767	-
40800/40801	Fixed position setpoint 1	R/W	LU	1	-2147482648 to 2147482647	p2617[0]
40802/40803	Fixed position setpoint 2	R/W	LU	1	-2147482648 to 2147482647	p2617[1]
40804/40805	Fixed position setpoint 3	R/W	LU	1	-2147482648 to 2147482647	p2617[2]
40806/40807	Fixed position setpoint 4	R/W	LU	1	-2147482648 to 2147482647	p2617[3]
40808/40809	Fixed position setpoint 5	R/W	LU	1	-2147482648 to 2147482647	p2617[4]
40810/40811	Fixed position setpoint 6	R/W	LU	1	-2147482648 to 2147482647	p2617[5]
40812/40813	Fixed position setpoint 7	R/W	LU	1	-2147482648 to 2147482647	p2617[6]

Modbus register number	Description	Modbus access	Unit	Scaling factor	Range or On/Off text	Data/parameter
40814/40815	Fixed position setpoint 8	R/W	LU	1	-2147482648 to 2147482647	p2617[7]
40840/40841	Speed of the fixed position 1	R/W	1000 LU/min	1	1 to 40000000	p2618[0]
40842/40843	Speed of the fixed position 2	R/W	1000 LU/min	1	1 to 40000000	p2618[1]
40844/40845	Speed of the fixed position 3	R/W	1000 LU/min	1	1 to 40000000	p2618[2]
40846/40847	Speed of the fixed position 4	R/W	1000 LU/min	1	1 to 40000000	p2618[3]
40848/40849	Speed of the fixed position 5	R/W	1000 LU/min	1	1 to 40000000	p2618[4]
40850/40851	Speed of the fixed position 6	R/W	1000 LU/min	1	1 to 40000000	p2618[5]
40852/40853	Speed of the fixed position 7	R/W	1000 LU/min	1	1 to 40000000	p2618[6]
40854/40855	Speed of the fixed position 8	R/W	1000 LU/min	1	1 to 40000000	p2618[7]
40880/40881	IPos maximum acceleration	R/W	1000 LU/s <sup>2</sup>	1	1 to 2000000	p2572
40882/40883	IPos maximum deceleration	R/W	1000 LU/s <sup>2</sup>	1	1 to 2000000	p2573
40884/40885	IPos jerk limiting	R/W	1000 LU/s <sup>3</sup>	1	1 to 100000000	p2574
40900	Fixed speed setpoint 1	R/W	-	0x4000 hex = 100% × motor rated speed	-210000.000 to 210000.00	p1001
40901	Fixed speed setpoint 2	R/W	-	0x4000 hex = 100% × motor rated speed	-210000.000 to 210000.00	p1002
40902	Fixed speed setpoint 3	R/W	-	0x4000 hex = 100% × motor rated speed	-210000.000 to 210000.00	p1003
40903	Fixed speed setpoint 4	R/W	-	0x4000 hex = 100% × motor rated speed	-210000.000 to 210000.00	p1004
40904	Fixed speed setpoint 5	R/W	-	0x4000 hex = 100% × motor rated speed	-210000.000 to 210000.00	p1005

Modbus register number	Description	Modbus access	Unit	Scaling factor	Range or On/Off text	Data/parameter
40905	Fixed speed setpoint 6	R/W	-	0x4000 hex = 100% × motor rated speed	-210000.000 to 210000.00	p1006
40906	Fixed speed setpoint 7	R/W	-	0x4000 hex = 100% × motor rated speed	-210000.000 to 210000.00	p1007
40932/40933	MDI speed of position setpoint	R/W	1000 LU/min	1	1 to 2147482647	p2691
40934	MDI acceleration override	R/W	%	100	0.1 to 100	p2692
40935	MDI deceleration override	R/W	%	100	0.1 to 100	p2693
40950	Fixed torque setpoint	R/W	%	100	-100 to 100	p29043

### Process data overview

Control mode		PTI	IPos	S	T
Control data	40100	PTI mode control word	IPos mode control word	S mode control word	T mode control word
	40101	-	-	Speed setpoint	-
	40102	-	Position setpoint high word	-	-
	40103	-	Position setpoint low word	-	-
Status data	40110	Status word	Status word	Status word	Status word
	40111	Actual speed	Actual speed	Actual speed	Actual speed
	40112	Actual position high word	Actual position high word	-	-
	40113	Actual position low word	Actual position low word	-	-

### Definition of the register 40100

Bit	PTI control mode		IPos control mode	
	Signals	Description	Signals	Description
0	SON_OFF1	Rising edge to enable SON (pulses can be enabled). 0: OFF1 (braking with ramp-function generator, then pulse cancellation, ready to power up)	SON_OFF1	Rising edge to enable SON (pulses can be enabled). 0: OFF1 (braking with ramp-function generator, then pulse cancellation, ready to power up)
1	OFF2	1: No OFF2 (enable is possible) 0: OFF2 (immediate pulse cancellation and power on inhibit)	OFF2	1: No OFF2 (enable is possible) 0: OFF2 (immediate pulse cancellation and power on inhibit)

Bit	PTI control mode		IPos control mode	
	Signals	Description	Signals	Description
2	OFF3	1: No OFF3 (enable is possible) 0: OFF3 (fast braking then pulse cancellation and power on inhibit)	OFF3	1: No OFF3 (enable is possible) 0: OFF3 (fast braking then pulse cancellation and power on inhibit)
3	OPER	1: Enable operation (pulses can be enabled) 0: Inhibit operation (cancel pulses)	OPER	1: Enable operation (pulses can be enabled) 0: Inhibit operation (cancel pulses)
4	Reserved	-	SETP_ACC	Rising edge to accept MDI setpoint
5	Reserved	-	TRANS_TY PE SE	1: Accept new setpoint immediately 0: Accept on rising edge of SETP_ACC
6	Reserved	-	POS_TYP	1: Absolute positioning 0: Relative positioning
7	RESET	Reset faults	RESET	Reset faults
8	Reserved	-	Reserved	-
9	Reserved	-	Reserved	-
10	PLC	Enable master control from the PLC	PLC	Enable master control from the PLC
11	Reserved	-	Reserved	-
12	Reserved	-	Reserved	-
13	Reserved	-	SREF	Start referencing (act as REF for reference mode 0)
14	Reserved	-	Reserved	-
15	Reserved	-	Reserved	-

Bit	S control mode		T control mode	
	Signals	Description	Signals	Description
0	SON_OFF1	Rising edge to enable SON (pulses can be enabled). 0: OFF1 (braking with ramp-function generator, then pulse cancellation, ready to power up)	SON_OFF1	Rising edge to enable SON (pulses can be enabled).
1	OFF2	1: No OFF2 (enable is possible) 0: OFF2 (immediate pulse cancellation and power on inhibit)	OFF2	1: No OFF2 (enable is possible) 0: OFF2 (immediate pulse cancellation and power on inhibit)
2	OFF3	1: no OFF3 (enable is possible) 0: OFF3 (fast braking then pulse cancellation and power on inhibit)	OFF3	1: no OFF3 (enable is possible) 0: OFF3 (fast braking then pulse cancellation and power on inhibit)
3	OPER	1: Enable operation (pulses can be enabled) 0: Inhibit operation (cancel pulses)	OPER	1: Enable operation (pulses can be enabled) 0: Inhibit operation (cancel pulses)
4	EN_PAMP	1: Operating condition (the ramp function generator can be enabled) 0: Inhibit ramp function generator (set the ramp function generator output to zero)	Reserved	-
5	Reserved	-	Reserved	-

Bit	S control mode		T control mode	
	Signals	Description	Signals	Description
6	Reserved	-	Reserved	-
7	RESET	Reset faults	RESET	Reset faults
8	Reserved	-	Reserved	-
9	Reserved	-	Reserved	-
10	PLC	Enable master control from the PLC	PLC	Enable master control from the PLC
11	Rev	Direction of rotation reversal	Reserved	-
12	Reserved	-	Reserved	-
13	Reserved	-	Reserved	-
14	Reserved	-	Reserved	-
15	Reserved	-	Reserved	-

---

**Note**

The following signals are occupied by Modbus control word when you use the setpoint and control word from Modbus as the Modbus control source (p29008 = 1). They can only be enabled by Modbus control word while cannot be enabled by external DI terminals.

- PTI control mode: SON
- IPos control mode: SON, SREF (REF for reference mode 0)
- S control mode: SON, CWE/CCWE
- T control mode: SON

---

**Note**

In IPos control mode, when the relative positioning mode is selected, the method for accepting MDI setpoint must be a rising edge (bit 5 = 0); otherwise, fault F7488 occurs.

---

**Note**

In IPos control mode, when you implement the absolute positioning for the modular axis with Modbus, you can select the MDI direction with parameter p29230.

---

**Note**

All the reserved bits in register 40100 must be set to 0.

---

**Definition of register 40110**

Bit	PTI, IPos, S and T control modes	
	Signals	Description
0	RDY	Servo ready
1	FAULT	Fault status
2	INP	In-position signal

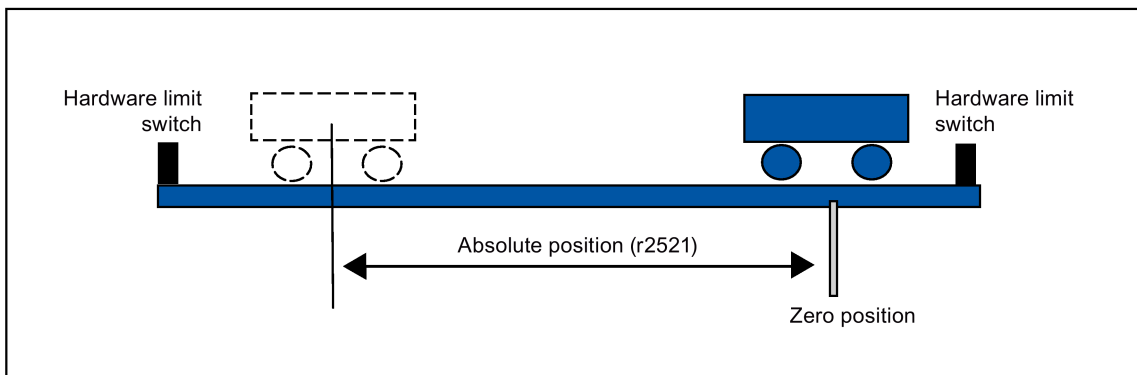
Bit	PTI, IPos, S and T control modes	
	Signals	Description
3	ZSP	Zero speed detection
4	SPDR	Speed reached
5	TLR	Torque limit reached
6	SPLR	Speed limit reached
7	MBR	Motor holding brake
8	OLL	Overload level reached
9	WARNING 1	Warning 1 condition reached
10	WARNING 2	Warning 2 condition reached
11	REFOK	Referenced
12	MODE 2	In the second control mode
13	Reserved	-
14	Reserved	-
15	Reserved	-

**Parameter scaling**

Due to the limits of the integer data in the Modbus protocol, it is necessary to convert the drive parameters before transmitting them. This is done by scaling, so that a parameter, which has a position after decimal point, is multiplied by a factor, to get rid of the fractional part. The scaling factor is as defined in the above table.

**7.8 Absolute position system**

When the SINAMICS V90 servo drive uses a servo motor with an absolute encoder. the current absolute position can be detected and transmitted to the controller. With this function of absolute position system, you can perform motion control task immediately after the servo system is powered on, which means you do not have to carry out referencing or zero position operation beforehand.





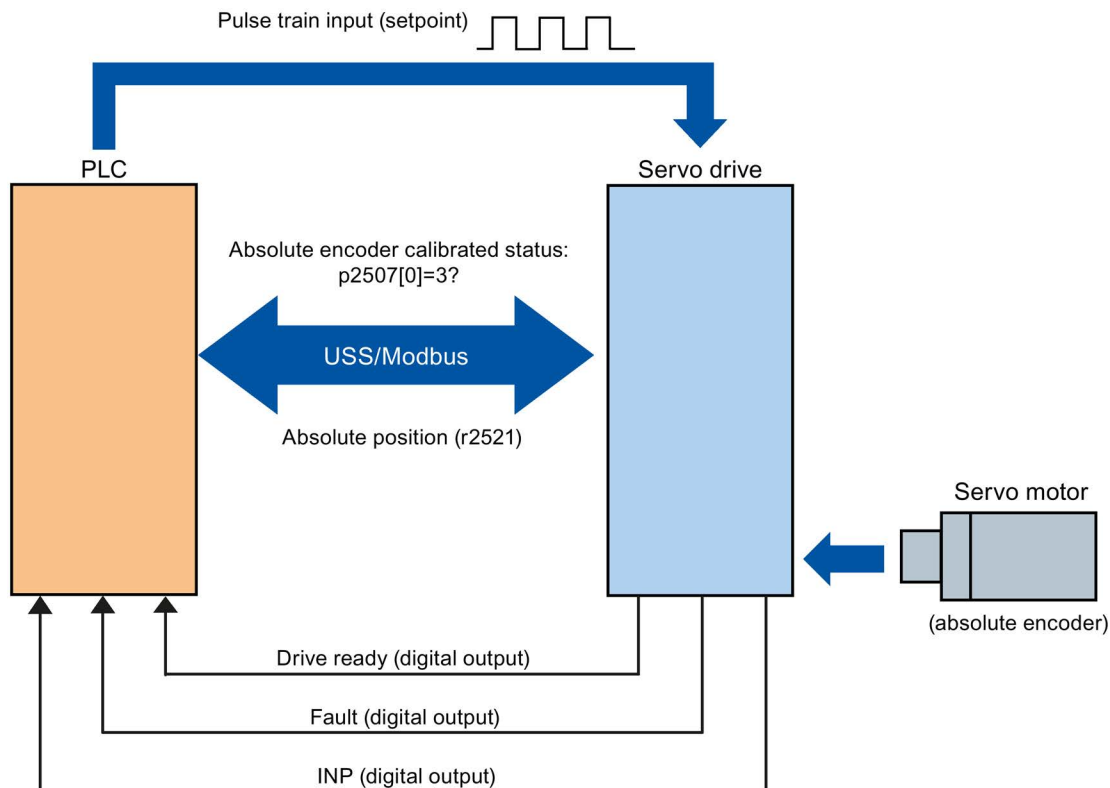
## Restrictions

The absolute position system **cannot** be configured under the following conditions:

- Internal position control (IPos)
- Speed control (S)
- Torque control (T)
- Control change mode
- Strokeless coordinate system, for example, rotary shaft, infinitely long positioning operation
- Change of electronic gear after referencing
- Use of alarm code output

### 7.8.1 Transmitting sequence for the absolute position data

The following table shows you the transmitting sequence for the absolute position data:



	Main step	Sub step/comment
①	Set PTI control mode.	Set p29003 = 0.
②	Enable absolute position mode.	Set p29250 = 1.

Main step	Sub step/comment
③ Configure relative parameters.	<ol style="list-style-type: none"> <li>1. Set PTI input parameters (p29010 to p29014).</li> <li>2. Set position control parameters (p29247 to p29249).</li> <li>3. Set electrical gear p29012 and p29013.</li> </ol>
④ Referencing with the BOP or SINAMICS V-ASSISTANT. <b>NOTE:</b> You must perform the referencing operation under the following conditions: <ul style="list-style-type: none"> <li>• System setup is performed.</li> <li>• The servo drive has been changed.</li> <li>• The servo motor has been changed.</li> <li>• An alarm occurs.</li> </ul>	<ol style="list-style-type: none"> <li>1. Run the servo motor for a proper distance.</li> <li>2. Adjust the absolute encoder with the BOP menu function "ABS" or SINAMICS V-ASSISTANT.</li> </ol>
⑤ Select a communication protocol with p29007.	Set value for p29007. <ul style="list-style-type: none"> <li>• 0: no protocol</li> <li>• 1: USS protocol</li> <li>• 2: Modbus protocol</li> </ul>
⑥ Configure the parameters for selected communication protocol.	<ol style="list-style-type: none"> <li>1. Set RS485 address (p29004).</li> <li>2. Set baud rate (p29009).</li> <li>3. Set the command and setpoint source if you use Modbus protocol (p29008).</li> </ol>
⑦ Save the parameters and restart the drive.	
⑧ Start transmitting.	
⑨ Transmit the calibration status of the absolute encoder to the PLC.	<ol style="list-style-type: none"> <li>1. Turn on the servo-on enable signal (SON).</li> <li>2. The PLC checks the standstill status and alarm status through the digital output of the servo drive.</li> <li>3. If there is no alarm and the motor is in standstill status, the PLC sends a data request to the servo drive through the RS485 cable.</li> <li>4. In response to the data request from PLC, the servo drive transmits calibration status (p2507[0]=3) of encoder to the PLC.</li> </ol>
⑩ Transmit the absolute position data to the PLC.	<ol style="list-style-type: none"> <li>1. If the absolute encoder is calibrated, and meanwhile, the servo drive is ready (the digital output RDY is logic 1) and in standstill status (the digital output signal INP is logic 1), the PLC sends a data request to drive through the RS485 cable.</li> <li>2. In response to the data request from the PLC, the servo drive transmits the absolute position data (r2521) to the PLC.</li> </ol>

# Safety Integrated function

## 8.1 Standards and regulations

### 8.1.1 General information

#### 8.1.1.1 Aims

Manufacturers and operating companies of equipment, machines, and products are responsible for ensuring the required level of safety. This means that plants, machines, and other equipment must be designed to be as safe as possible in accordance with the current state of the art. To ensure this, companies describe in the various standards the current state of the art covering all aspects relevant to safety. When the relevant Standards are observed, this ensures that state-of-the-art technology has been utilized and, in turn, the erector/builder of a plant or a manufacturer of a machine or a piece of equipment has fulfilled his appropriate responsibility.

Safety systems are designed to minimize potential hazards for both people and the environment by means of suitable technical equipment, without restricting industrial production and the use of machines more than is necessary. The protection of man and environment must be assigned equal importance in all countries, which is it is important that rules and regulations that have been internationally harmonized are applied. This is also designed to avoid distortions in the competition due to different safety requirements in different countries.

There are different concepts and requirements in the various regions and countries of the world when it comes to ensuring the appropriate degree of safety. The legislation and the requirements of how and when proof is to be given and whether there is an adequate level of safety are just as different as the assignment of responsibilities.

The most important thing for manufacturers of machines and companies that set up plants and systems is that the legislation and regulations in the country where the machine or plant is being operated apply. For example, the control system for a machine that is to be used in the US must fulfill local US requirements even if the machine manufacturer (OEM) is based in the European Economic Area (EEA).

### 8.1.1.2 Functional safety

Safety, from the perspective of the object to be protected, cannot be split-up. The causes of hazards and, in turn, the technical measures to avoid them can vary significantly. This is why a differentiation is made between different types of safety (e.g. by specifying the cause of possible hazards). "Functional safety" is involved if safety depends on the correct function. To ensure the functional safety of a machine or plant, the safety-related parts of the protection and control devices must function correctly. In addition, the systems must behave in such a way that either the plant remains in a safe state or it is brought into a safe state if a fault occurs. In this case, it is necessary to use specially qualified technology that fulfills the requirements described in the associated Standards. The requirements to achieve functional safety are based on the following basic goals:

- Avoiding systematic faults
- Controlling systematic faults
- Controlling random faults or failures

Benchmarks for establishing whether or not a sufficient level of functional safety has been achieved include the probability of hazardous failures, the fault tolerance, and the quality that is to be ensured by minimizing systematic faults. This is expressed in the Standards using different terms. In IEC/EN 61508, IEC/EN 62061 "Safety Integrity Level" (SIL) and EN ISO 13849-1 "Categories" and "Performance Level" (PL).

## 8.1.2 Safety of machinery in Europe

The EU Directives that apply to the implementation of products are based on Article 95 of the EU contract, which regulates the free exchange of goods. These are based on a new global concept ("new approach", "global approach"):

- EU Directives only specify general safety goals and define basic safety requirements.
- Technical details can be defined by means of standards by Standards Associations that have the appropriate mandate from the commission of the European Parliament and Council (CEN, CENELEC). These standards are harmonized in line with a specific directive and listed in the official journal of the commission of the European Parliament and Council. Legislation does not specify that certain standards have to be observed. When the harmonized Standards are observed, it can be assumed that the safety requirements and specifications of the Directives involved have been fulfilled.
- EU Directives specify that the Member States must mutually recognize domestic regulations.

The EU Directives are equal. This means that if several Directives apply for a specific piece of equipment or device, the requirements of all of the relevant Directives apply (e.g. for a machine with electrical equipment, the Machinery Directive and the Low-Voltage Directive apply).

### 8.1.2.1 Machinery Directive

The basic safety and health requirements specified in Annex I of the Directive must be fulfilled for the safety of machines.

The protective goals must be implemented responsibly to ensure compliance with the Directive.

Manufacturers of a machine must verify that their machine complies with the basic requirements. This verification is facilitated by means of harmonized standards.

### **8.1.2.2 Harmonized European Standards**

The two Standards Organizations CEN (Comité Européen de Normalisation) and CENELEC (Comité Européen de Normalisation Électrotechnique), mandated by the EU Commission, drew-up harmonized European standards in order to precisely specify the requirements of the EC directives for a specific product. These standards (EN standards) are published in the official journal of the commission of the European Parliament and Council and must be included without revision in domestic standards. They are designed to fulfill basic health and safety requirements as well as the protective goals specified in Annex I of the Machinery Directive.

When the harmonized standards are observed, it is "automatically assumed" that the Directive is fulfilled. As such, manufacturers can assume that they have observed the safety aspects of the Directive under the assumption that these are also covered in this standard. However, not every European Standard is harmonized in this sense. Key here is the listing in the official journal of the commission of the European Parliament and Council.

The European Safety of Machines standard is hierarchically structured. It is divided into:

- A standards (basic standards)
- B standards (group standards)
- C standards (product standards)

#### **Type A standards/basic standards**

A standards include basic terminology and definitions relating to all types of machine. This includes EN ISO 12100-1 (previously EN 292-1) "Safety of Machines, Basic Terminology, General Design Principles".

A standards are aimed primarily at the bodies responsible for setting the B and C standards. The measures specified here for minimizing risk, however, may also be useful for manufacturers if no applicable C standards have been defined.

#### **Type B standards/group standards**

B standards cover all safety-related standards for various different machine types. B standards are aimed primarily at the bodies responsible for setting C standards. They can also be useful for manufacturers during the machine design and construction phases, however, if no applicable C standards have been defined.

A further sub-division has been made for B standards:

- Type B1 standards for higher-level safety aspects (e.g. ergonomic principles, safety clearances from sources of danger, minimum clearances to prevent parts of the body from being crushed).
- Type B2 standards for protective safety devices are defined for different machine types (e.g. EMERGENCY STOP devices, two-hand operating circuits, interlocking elements, contactless protective devices, safety-related parts of controls).

**Type C standards/product standards**

C standards are product-specific standards (e.g. for machine tools, woodworking machines, elevators, packaging machines, printing machines etc.). Product standards cover machine-specific requirements. The requirements can, under certain circumstances, deviate from the basic and group standards. Type C/product standards have the highest priority for machine manufacturers who can assume that it fulfills the basic requirements of Annex I of the Machinery Directive (automatic presumption of compliance). If no product standard has been defined for a particular machine, type B standards can be applied when the machine is constructed.

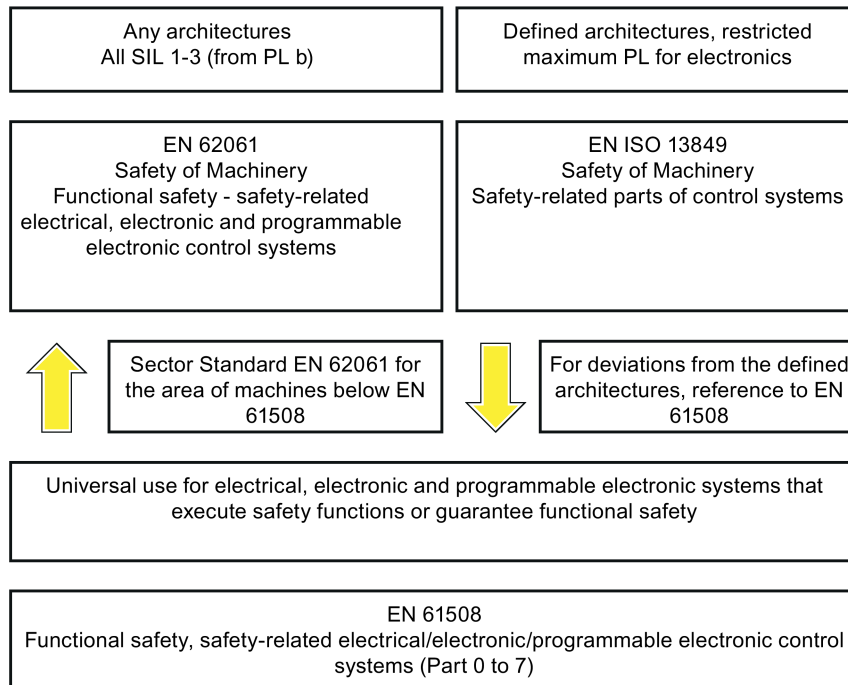
A complete list of the standards specified and the mandated draft standards are available on the Internet at the following address:

<http://www.newapproach.org/>

Recommendation: Due to the rapid pace of technical development and the associated changes in machine concepts, the standards (and C standards in particular) should be checked to ensure that they are up to date. Please note that the application of a particular standard may not be mandatory provided that all the safety requirements of the applicable EU directives are fulfilled.

**8.1.2.3 Standards for implementing safety-related controllers**

If the functional safety of a machine depends on various control functions, the controller must be implemented in such a way that the probability of the safety functions failing is sufficiently minimized. EN ISO 13849-1 (formerly EN 954-1) and EN IEC61508 define principles for implementing safety-related machine controllers which, when properly applied, ensure that all the safety requirements of the EC Machinery Directive are fulfilled. These standards ensure that the relevant safety requirements of the Machinery Directive are fulfilled.



The application areas of EN ISO 13849-1, EN 62061, and EN 61508 are very similar. To help users make an appropriate decision, the IEC and ISO associations have specified the application areas of both standards in a joint table in the introduction to the standards. EN ISO 13849-1 or EN 62061 should be applied depending on the technology (mechanics, hydraulics, pneumatics, electrics, electronics and programmable electronics), risk classification and architecture.

Type	Systems for executing safety-related control functions	EN ISO 13849-1	EN 62061
A	Non-electrical (e.g. hydraulic, pneumatic)	X	Not covered
B	Electromechanical (e.g. relay and/or basic electronics)	Restricted to the designated architectures (see comment 1) and max. up to PL = e	All architectures and max. up to SIL 3
C	Complex electronics (e.g. programmable electronics)	Restricted to the designated architectures (see comment 1) and max. up to PL = d	All architectures and max. up to SIL 3
D	A standards combined with B standards	Restricted to the designated architectures (see comment 1) and max. up to PL = e	X See comment 3
E	C standards combined with B standards	Restricted to the designated architectures (see comment 1) and max. up to PL = d	All architectures and max. up to SIL 3
F	C standards combined with A standards or C standards combined with A standards and B standards	X See comment 2	X See comment 3
<p>"X" indicates that the point is covered by this standard.</p> <p>Comment 1: Designated architectures are described in Annex B of EN ISO 13849-1 and provide a simplified basis for the quantification.</p> <p>Comment 2: For complex electronics: Using designated architectures in compliance with EN ISO 13849-1 up to PL = d or every architecture in compliance with EN 62061.</p> <p>Comment 3: For non-electrical systems: Use components that comply with EN ISO 13849-1 as sub-systems.</p>			

#### 8.1.2.4 DIN EN ISO 13849-1 (replaces EN 954-1)

A qualitative analysis according to DIN EN 13849-1 is not sufficient for modern control systems due to their technology. Among other things, DIN EN ISO 13849-1 does not take into account time behavior (e.g. test interval and/or cyclic test, lifetime). This results in the probabilistic approach in DIN EN ISO 13849-1 (probability of failure per unit time). DIN EN ISO 13849-1 is based on the known categories of EN 954-1. It now also takes into account complete safety functions and all the devices required to execute these. With DIN EN ISO 13849-1, safety functions are investigated from a quantitative perspective going beyond the qualitative basis of EN 954-1. Performance levels (PL), which are based on the categories, are used. The following safety-related characteristic quantities are required for devices/equipment:

- Category (structural requirement)
- PL: Performance level

- $MTTF_d$ : Mean time to dangerous failure
- DC: Diagnostic coverage
- CCF: Common cause failure

The standard describes how the performance level (PL) is calculated for safety-related components of the controller on the basis of designated architectures. In the event of any deviations from this, EN ISO 13849-1 refers to EN 61508.

When combining several safety-related parts to form a complete system, the standard explains how to determine the resulting PL.

---

**Note**

**DIN EN ISO 13849-1 and machinery directive**

Since May 2007, DIN EN ISO 13849-1 has been harmonized as part of the Machinery Directive.

---

### 8.1.2.5 EN 62061

EN 62061 (identical to IEC 62061) is a sector-specific standard subordinate to IEC/EN 61508. It describes the implementation of safety-related electrical machine control systems and looks at the complete life cycle, from the conceptual phase to decommissioning. The standard is based on the quantitative and qualitative analyses of safety functions, whereby it systematically applies a top-down approach to implementing complex control systems (known as "functional decomposition"). The safety functions derived from the risk analysis are sub-divided into sub-safety functions, which are then assigned to real devices, sub-systems, and sub-system elements. Both the hardware and software are covered. EN 62061 also describes the requirements placed on implementing application programs.

A safety-related control system comprises different sub-systems. From a safety perspective, the sub-systems are described in terms of the SIL claim limit and PFHD characteristic quantities.

Programmable electronic devices (e.g. PLCs or variable-speed drives) must fulfill EN 61508. They can then be integrated in the controller as sub-systems. The following safety-related characteristic quantities must be specified by the manufacturers of these devices.

Safety-related characteristic quantities for subsystems:

- SIL CL: SIL claim limit
- PFHD: Probability of dangerous failures per hour
- T1: Lifetime

Simple sub-systems (e.g. sensors and actuators) in electromechanical components can, in turn, comprise sub-system elements (devices) interconnected in different ways with the characteristic quantities required for determining the relevant PFHD value of the sub-system.

Safety-related characteristic quantities for subsystem elements (devices):

- $\lambda$ : Failure rate
- B10 value: For elements that are subject to wear
- T1: Lifetime



For electromechanical devices, a manufacturer specifies a failure rate  $\lambda$  with reference to the number of operating cycles. The failure rate per unit time and the lifetime must be determined using the switching frequency for the particular application.

Parameters for the sub-system, which comprises sub-system elements, that must be defined during the design phase:

- T2: Diagnostic test interval
- $\beta$ : Susceptibility to common cause failure
- DC: Diagnostic coverage

The PFHD value of the safety-related controller is determined by adding the individual PFHD values for subsystems.

The user has the following options when setting up a safety-related controller:

- Use devices and sub-systems that already comply with EN ISO 13849-1, IEC/EN 61508, or IEC/EN 62061. The standard provides information specifying how qualified devices can be integrated when safety functions are implemented.
- Develop own subsystems:
  - Programmable, electronic systems and complex systems: Application of EN 61508 or EN 61800-5-2.
  - Simple devices and subsystems: Application of EN 62061.

EN 62061 does not include information about non-electric systems. The standard provides detailed information on implementing safety-related electrical, electronic, and programmable electronic control systems. EN ISO 13849-1 must be applied for non-electric systems.

---

**Note**

**Function examples**

Details of simple sub-systems that have been implemented and integrated are now available as "functional examples".

---

**Note**

**EN 62061 and machinery directive**

IEC 62061 has been ratified as EN 62061 in Europe and harmonized as part of the Machinery Directive.

---

### 8.1.2.6 Series of standards EN 61508 (VDE 0803)

This series of standards describes the current state of the art.

EN 61508 is not harmonized in line with any EU directives, which means that an automatic presumption of conformity for fulfilling the protective requirements of a directive is not implied. The manufacturer of a safety-related product, however, can also use EN 61508 to fulfill basic requirements of European directives in accordance with the latest conceptual design, for example, in the following cases:

- If no harmonized standard exists for the application in question. In this case, the manufacturer can use EN 61508, although no presumption of conformity exists here.
- A harmonized European standard (e.g. EN 62061, EN ISO 13849, EN 60204-1) references EN 61508. This ensures that the appropriate requirements of the directives are fulfilled ("standard that is also applicable"). When manufacturers apply EN 61508 properly and responsibly in accordance with this reference, they can use the presumption of conformity of the referencing standard.

EN 61508 covers all the aspects that must be taken into account when E/E/PES systems (electrical, electronic, and programmable electronic System) are used in order to execute safety functions and/or to ensure the appropriate level of functional safety. Other hazards (e.g. electric shock) are, as in EN ISO 13849, not part of the standard.

EN 61508 has recently been declared the "International Basic Safety Publication", which makes it a framework for other, sector-specific standards (e.g. EN 62061). As a result, this standard is now accepted worldwide, particularly in North America and in the automotive industry. Today, many regulatory bodies already stipulate it (e.g. as a basis for NRTL listing).

Another recent development with respect to EN 61508 is its system approach, which extends the technical requirements to include the entire safety installation from the sensor to the actuator, the quantification of the probability of hazardous failure due to random hardware failures, and the creation of documentation covering all phases of the safety-related lifecycle of the E/E/PES.

### 8.1.2.7 Risk analysis/assessment

Risks are intrinsic in machines due to their design and functionality. For this reason, the Machinery Directive requires that a risk assessment be performed for each machine and, if necessary, the level of risk reduced until the residual risk is less than the tolerable risk. To assess these risks, the following standards must be applied:

EN ISO 12100-1 "Safety of Machinery - basic terminology, general principles for design"

EN ISO 13849-1 (successor to EN 954-1) "Safety-related parts of control systems"

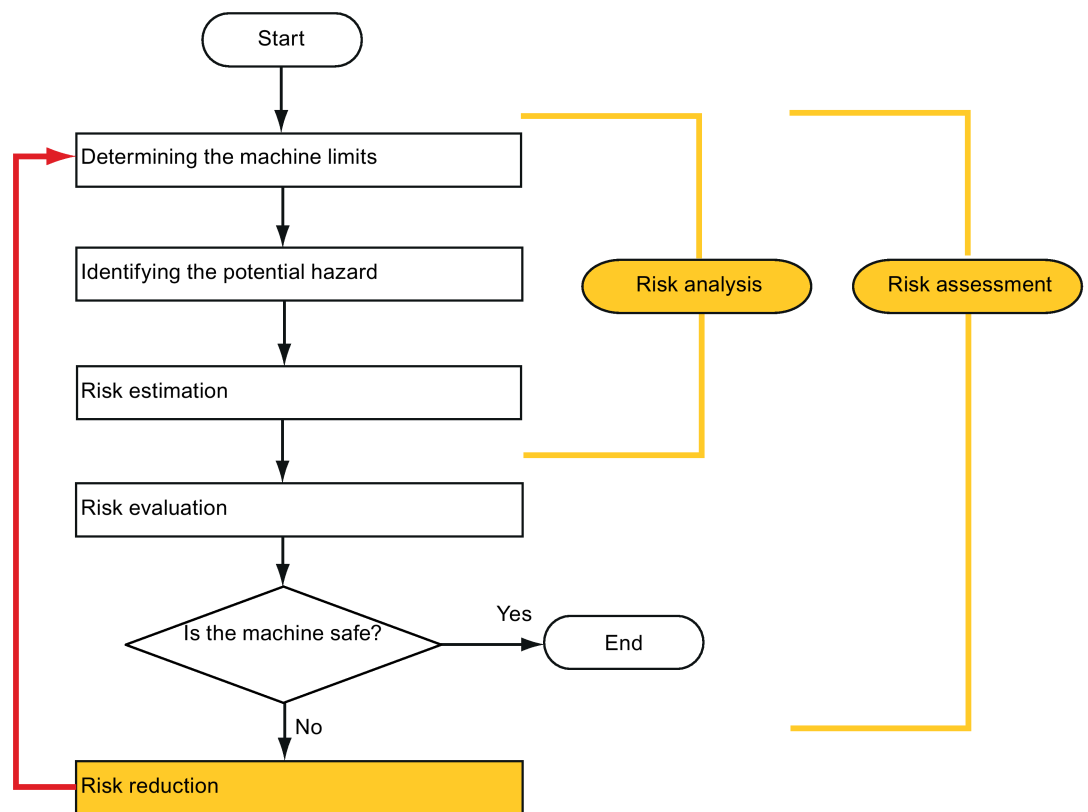
EN ISO 12100-1 focuses on the risks to be analyzed and the design principles for minimizing risk.

The risk assessment is a procedure that allows hazards resulting from machines to be systematically investigated. Where necessary, the risk assessment is followed by a risk reduction procedure. When the procedure is repeated, this is known as an iterative process. This can help eliminate hazards (as far as this is possible) and can act as a basis for implementing suitable protective measures.

The risk assessment involves the following:

- Risk analysis
  - Determines the limits of the machine (EN ISO 12100-1)
  - Identification of the hazards (EN ISO 12100-114)
  - Estimating the level of risk (EN 1050 Paragraph 7)
- Risk evaluation

As part of the iterative process to achieve the required level of safety, a risk assessment is carried out after the risk estimation. A decision must be made here as to whether the residual risk needs to be reduced. If the risk is to be further reduced, suitable protective measures must be selected and applied. The risk assessment must then be repeated.



— Minimizing risks and selecting suitable protective measures are not part of the risk assessment

Risks must be reduced by designing and implementing the machine accordingly (e.g. by means of controllers or protective measures suitable for the safety-related functions).

If the protective measures involve the use of interlocking or control functions, these must be designed according to EN ISO 13849-1. For electrical and electronic controllers, EN 62061 can be used as an alternative to EN ISO 13849-1. Electronic controllers and bus systems must also comply with IEC/EN 61508.

### 8.1.2.8 Risk reduction

Risk reduction measures for a machine can be implemented by means of safety-related control functions in addition to structural measures. To implement these control functions, special requirements must be taken into account, graded according to the magnitude of the risk. These are described in EN ISO 13849-1 or, in the case of electrical controllers (particularly programmable electronics), in EN 61508 or EN 62061. The requirements regarding safety-related controller components are graded according to the magnitude of the risk and the level to which the risk needs to be reduced.

**EN ISO 13849-1** defines a risk flow chart that instead of categories results in hierarchically graduated Performance Levels (PL).

**IEC/EN 62061** uses "Safety Integrity Level" (SIL) for classification purposes. This is a quantified measure of the safety-related performance of a controller. The required SIL is also determined in accordance with the risk assessment principle according to ISO 12100 (EN 1050). Annex A of the standard describes a method for determining the required Safety Integrity Level (SIL).

Regardless of which standard is applied, steps must be taken to ensure that all the machine controller components required for executing the safety-related functions fulfill these requirements.

### 8.1.2.9 Residual risk

In today's technologically advanced world, the concept of safety is relative. The ability to ensure safety to the extent that risk is ruled out in all circumstances – "zero-risk guarantee" – is practically impossible. The residual risk is the risk that remains once all the relevant protective measures have been implemented in accordance with the latest state of the art.

Residual risks must be clearly referred to in the machine/plant documentation (user information according to EN ISO 12100-2).

## 8.1.3 Machine safety in the USA

A key difference between the USA and Europe in the legal requirements regarding safety at work is that, in the USA, no legislation exists regarding machinery safety that is applicable in all of the states and that defines the responsibility of the manufacturer/supplier. A general requirement exists stating that employers must ensure a safe workplace.

### 8.1.3.1 Minimum requirements of the OSHA

The Occupational Safety and Health Act (OSHA) from 1970 regulates the requirement that employers must offer a safe place of work. The core requirements of OSHA are specified in Section 5 "Duties".

The requirements of the OSH Act are managed by the "Occupational Safety and Health Administration" (also known as OSHA). OSHA employs regional inspectors who check whether or not workplaces comply with the applicable regulations.

The OSHA regulations are described in OSHA 29 CFR 1910.xxx ("OSHA Regulations (29 CFR) PART 1910 Occupational Safety and Health"). (CFR: Code of Federal Regulations.)

<http://www.osha.gov>

The application of standards is regulated in 29 CFR 1910.5 "Applicability of standards". The concept is similar to that used in Europe. Product-specific standards have priority over general standards insofar as they cover the relevant aspects. Once the standards are fulfilled, employers can assume that they have fulfilled the core requirements of the OSH Act with respect to the aspects covered by the standards.

In conjunction with certain applications, OSHA requires that all electrical equipment and devices that are used to protect workers be authorized by an OSHA-certified, "Nationally Recognized Testing Laboratory" (NRTL) for the specific application.

In addition to the OSHA regulations, the current standards defined by organizations such as NFPA and ANSI must be carefully observed and the extensive product liability legislation that exists in the US taken into account. Due to the product liability legislation, it is in the interests of manufacturing and operating companies that they carefully maintain the applicable regulations and are "forced" to fulfill the requirement to use state-of-the-art technology.

Third-party insurance companies generally demand that their customers fulfill the applicable standards of the standards organizations. Self-insured companies are not initially subject to this requirement but, in the event of an accident, they must provide verification that they have applied generally-recognized safety principles.

### **8.1.3.2 NRTL listing**

To protect employees, all electrical equipment used in the USA must be certified for the planned application by a "Nationally Recognized Testing Laboratory" (NRTL) certified by the OSHA. NRTLs are authorized to certify equipment and material by means of listing, labeling, or similar. Domestic standards (e.g. NFPA 79) and international standards (e.g. IEC/EN 61508 for E/E/PES systems) are the basis for testing.

### **8.1.3.3 NFPA 79**

Standard NFPA 79 (Electrical Standard for Industrial Machinery) applies to electrical equipment on industrial machines with rated voltages of less than 600 V. A group of machines that operate together in a coordinated fashion is also considered to be one machine.

For programmable electronics and communication buses, NFPA 79 states as a basic requirement that these must be listed if they are to be used to implement and execute safety-related functions. If this requirement is fulfilled, then electronic controls and communication buses can also be used for Emergency Stop functions, Stop Categories 0 and 1 (refer to NFPA 79 9.2.5.4.1.4). Like EN 60204-1, NFPA 79 no longer specifies that the electrical energy must be disconnected by electromechanical means for emergency stop functions.

The core requirements regarding programmable electronics and communication buses are: system requirements (see NFPA 79 9.4.3)

1. Control systems that contain software-based controllers must:
  - In the event of a single fault
    - cause the system to switch to a safe shutdown mode
    - prevent the system from restarting until the fault has been rectified
    - prevent an unexpected restart
  - Offer the same level of protection as hard-wired controllers
  - Be implemented in accordance with a recognized standard that defines the requirements for such systems.
2. IEC 61508, IEC 62061, ISO 13849-1, ISO 13849 2 and IEC 61800-5-2 are specified as suitable standards in a note.

**Underwriter Laboratories Inc. (UL)** has defined a special category for "Programmable Safety Controllers" for implementing this requirement (code NRGF). This category covers control devices that contain software and are designed for use in safety-related functions.

A precise description of the category and a list of devices that fulfill this requirement can be found on the Internet at the following address:

<http://www.ul.com> → certifications directory → UL Category code/ Guide information → search for category "NRGF"

**TUV Rheinland of North America, Inc.** is also an NRTL for these applications.

### 8.1.3.4 ANSI B11

ANSI B11 standards are joint standards developed by associations such as the Association for Manufacturing Technology (AMT) and the Robotic Industries Association (RIA).

The hazards of a machine are evaluated by means of a risk analysis/assessment. The risk analysis is an important requirement in accordance with NFPA 79, ANSI/RIA 15.06, ANSI B11.TR-3 and SEMI S10 (semiconductors). The documented findings of a risk analysis can be used to select a suitable safety system based on the safety class of the application in question.

The situation in Japan is different from that in Europe and the US. Legislation such as that prescribed in Europe does not exist. Similarly, product liability does not play such an important role as it does in the US.

Instead of legal requirements to apply standards have been defined, an administrative recommendation to apply JIS (Japanese Industrial Standard) is in place: Japan bases its approach on the European concept and uses basic standards as national standards (see table).

#### Japanese standards

ISO/IEC number	JIS number	Comment
ISO12100-1	JIS B 9700-1	Earlier designation TR B 0008
ISO12100-2	JIS B 9700-2	Earlier designation TR B 0009
ISO14121- 1 / EN1050	JIS B 9702	
ISO13849- 1	JIS B 9705-1	

ISO/IEC number	JIS number	Comment
ISO13849- 2	JIS B 9705-1	
IEC 60204-1	JIS B 9960-1	Without annex F or route map of the European foreword
IEC 61508-0 to -7	JIS C 0508	
IEC 62061		JIS number not yet assigned

In addition to the requirements of the guidelines and standards, company-specific requirements must be taken into account. Large corporations in particular (e.g. automobile manufacturers) make stringent demands regarding automation components, which are often listed in their own equipment specifications.

Safety-related issues (e.g. operating modes, operator actions with access to hazardous areas, EMERGENCY STOP concepts, etc.) should be clarified with customers early on so that they can be integrated in the risk assessment/risk reduction process.

### 8.1.4 Machine safety in Japan

The situation in Japan is different from that in Europe and the US. Legislation such as that prescribed in Europe does not exist. Similarly, product liability does not play such an important role as it does in the US.

Instead of legal requirements to apply standards have been defined, an administrative recommendation to apply JIS (Japanese Industrial Standard) is in place: Japan bases its approach on the European concept and uses basic standards as national standards (see table).

#### Japanese standards

ISO/IEC number	JIS number	Comment
ISO12100-1	JIS B 9700-1	Earlier designation TR B 0008
ISO12100-2	JIS B 9700-2	Earlier designation TR B 0009
ISO14121- 1 / EN1050	JIS B 9702	
ISO13849-1	JIS B 9705-1	
ISO13849-2	JIS B 9705-1	
IEC 60204-1	JIS B 9960-1	Without annex F or route map of the European foreword
IEC 61508-0 to -7	JIS C 0508	
IEC 62061		JIS number not yet assigned

### 8.1.5 Equipment regulations

In addition to the requirements of the guidelines and standards, company-specific requirements must be taken into account. Large corporations in particular (e.g. automobile manufacturers) make stringent demands regarding automation components, which are often listed in their own equipment specifications.

Safety-related issues (e.g. operating modes, operator actions with access to hazardous areas, EMERGENCY STOP concepts, etc.) should be clarified with customers early on so that they can be integrated in the risk assessment/risk reduction process.

## 8.2 General information about SINAMICS Safety Integrated

### Safety Integrated function - STO

The Safe Torque Off (STO) is a safety function that prevents the drive from restarting unexpectedly, in accordance with EN 60204-1:2006 Section 5.4.

The STO function is in conformance with the IEC 61508, SIL2 standard, in the operating mode with a high demand, Category 3 and Performance Level d (PL d) acc. to ISO 13849-1:2006, as well as IEC 61800-5-2.

### Controlling the STO Function

The STO function can be controlled via terminals. For the details about STO wiring, refer to the chapter "24V power supply/STO (Page 124)".

## 8.3 System features

### 8.3.1 STO functional safety data

The STO functional safety data of SINAMICS V90 is as follows:

Applied standards	IEC 61508, IEC 62061, ISO 13849-1
Type	A
Safety Integrity Level (SIL)	2
Hardware Fault Tolerance (HFT)	1
Probability of Failure per Hour (PFH)	$5 \times 10^{-8}$ per hour

### 8.3.2 Certification

The safety function of the SINAMICS V90 drive system meets the following requirements:

- Category 3 according to ISO 13849-1:2006
- Performance Level (PL) d to ISO 13849-1:2006
- Safety integrity level 2 (SIL 2) to IEC 61508



In addition, the safety function of SINAMICS V90 has been certified by independent institutes. An up-to-date list of certified components is available on request from your local Siemens office.

### 8.3.3 Safety instructions

---

#### Note

Additional safety information and residual risks not specified in this section are included in the chapter "Safety instructions (Page 11)".

---

#### DANGER

Safety Integrated can be used to minimize the level of risk associated with machines and plants.

Machines and plants can only be operated safely in conjunction with Safety Integrated, however, when the machine manufacturer is familiar with and observes every aspect of this technical user documentation, including the documented general conditions, safety information, and residual risks.

Precisely knows and observes this technical user documentation - including the documented limitations, safety information and residual risks;

Carefully constructs and configures the machine/plant. A careful and thorough acceptance test must then be performed by qualified personnel and the results documented.

Implements and validates all the measures required in accordance with the machine/plant risk analysis by means of the programmed and configured Safety Integrated functions or by other means.

The use of Safety Integrated does not replace the machine/plant risk assessment carried out by the machine manufacturer as required by the EC machinery directive.


In addition to using Safety Integrated functions, further risk reduction measures must be implemented.


#### WARNING

The Safety Integrated functions cannot be activated until the system has been completely powered up. System startup is a critical operating state with increased risk. No personnel may be present in the immediate danger zone in this phase.

The drives of vertical axes must be in torque state.

A complete forced dormant error detection cycle is required after power on.

 <b>WARNING</b>
EN 60204-1:2006
Emergency Stop function must bring the machine to a standstill in accordance with STO.
The machine must not restart automatically after EMERGENCY STOP.
When the safety function is deactivated, an automatic restart is permitted under certain circumstances depending on the risk analysis (except when Emergency Stop is reset). An automatic start is permitted when a protective door is closed, for example.

 <b>WARNING</b>
After hardware and/or software components have been modified or replaced, all protective equipment must be closed prior to system startup and drive activation. Personnel shall not be present within the danger zone.
Before allowing anybody to re-enter the danger zone, you should test steady control response by briefly moving the drives in forward and reverse direction (+/-).
<b>To observe during power on:</b>
The Safety Integrated functions are only available and can only be selected after the system has completely powered up.

### 8.3.4 Probability of failure of the safety function

#### Probability of failure per hour (PFH)

The probability of the failure of safety functions must be specified in the form of a PFH value in accordance with IEC 61508, IEC 62061, and ISO 13849-1:2006. The PFH value of a safety function depends on the safety concept of the drive unit and its hardware configuration, as well as on the PFH values of other components used for this safety function.

Corresponding PFH values are provided for the SINAMICS V90 drive system, depending on the hardware configuration (number of drives, control type, number of encoders used). The various integrated safety functions are not differentiated.

The PHF value of SINAMICS V90 drive system is  $5 \times 10^{-8}$  per hour.

#### Hardware fault tolerance (HFT)


The HFT value of SINAMICS V90 drive system is one. It means that the system can handle one fault without brake down. SINAMICS V90 STO function is a subsystem from type A, and only the discrete components are involved in the STO function.


### 8.3.5 Response time

Response time means the time from the control via terminals until the response actually occurs. The worst response time for the STO function is 5 ms. The response time of fault reaction functions is 2 s.

### 8.3.6 Residual risk

The fault analysis enables the machine manufacturer to determine the residual risk at this machine with regard to the drive unit. The following residual risks are known:

 <b>WARNING</b>
Due to the intrinsic potential of hardware faults, electrical systems are subject to additional residual risk, which can be expressed by means of the PFH value.

 <b>WARNING</b>
Simultaneous failure of two power transistors (one in the upper and the other offset in the lower inverter bridge) in the inverter may cause brief movement of the drive, depending on the number of poles of the motor.
Maximum value of this movement:
Synchronous rotary motors: Max. movement = $180^\circ / \text{no. of pole pairs}$

## 8.4 Safety Integrated basic functions

### 8.4.1 Safe Torque Off (STO)

In conjunction with a machine function or in the event of a fault, the "Safe Torque Off" (STO) function is used to safely disconnect and de-energize the torque-generating energy feed to the motor.

When the function is selected, the drive unit is in a "safe status". The switching on inhibited function prevents the drive unit from being restarted.

The two-channel pulse suppression function integrated in the Motor Modules/Power Modules is a basis for this function.

#### Functional features of "Safe Torque Off"

- This function is integrated in the drive; this means that a higher-level controller is not required.
- The function is drive-specific, i.e. it is available for each drive and must be individually commissioned.

- When the "Safe Torque Off" function is selected, the following applies:
  - The motor cannot be started accidentally.
  - The pulse suppression safely disconnects the torque-generating energy feed to the motor.
  - The power unit and motor are not electrically isolated.
- By selecting/deselecting STO, in addition to the fault messages, the safety messages are also automatically withdrawn.

The STO function can be used wherever the drive naturally reaches a standstill due to load torque or friction in a sufficiently short time or when "coasting down" of the drive will not have any relevance for safety.

<b>WARNING</b>
Appropriate measures must be taken to ensure that the motor does not undesirably move once the energy feed has been disconnected, e.g. against coasting down.

<b>CAUTION</b>
If two power transistors simultaneously fail in the power unit (one in the upper and one in the lower bridge), then this can cause brief momentary movement.  The maximum movement can be:  Synchronous rotary motors: Max. movement = $180^\circ / \text{No. of pole pairs}$ Synchronous linear motors: Max. movement = pole width

**Note**

**Closing delay of the holding brake**

The closing signal (low level) of the holding brake is output 30 ms after the STO is triggered.

**Preconditions for using the STO function**

When use the STO function, the following preconditions should be fulfilled:

- Each monitoring channel (STO1 and STO2) triggers safe pulse suppression with its switch off signal path.
- If a motor holding brake is connected and configured, the connected brake is not safe because there is no safety function for brake, such as safe brake.

**Behaviors of the STO function**

Terminal		State	Action
STO1	STO2		
High level	High level	Safe	The servo motor can normally run when you power on the servo drive.
Low level	Low level	Safe	The servo drive starts up normally but the servo motor cannot run.

Terminal		State	Action
STO1	STO2		
High level	Low level	Unsafe	Fault F1611 occurs and servo motor coasts down (OFF2).
Low level	High level	Unsafe	Fault F1611 occurs and servo motor coasts down (OFF2).

### Selecting/deselecting "Safe Torque Off"

The following is executed when "Safe Torque Off" is selected:

- Each monitoring channel triggers safe pulse suppression via its switch-off signal path.
- A motor holding brake is closed (if connected and configured).

---

#### Note

If "Safe Torque Off" is selected and de-selected through one channel within 2 seconds, the pulses are suppressed without a message being output.

---

### Restart after the "Safe Torque Off" function has been selected

1. Deselect the function in each monitoring channel via the input terminals.
2. Issue drive enable signals.
3. Switch the drive back on.
  - 1/0 edge at input signal "ON/OFF1"
  - 0/1 edge at input signal "ON/OFF1" (switch on drive)
4. Operate the drives again.

### Response time for the "Safe Torque Off" function

The worst response time for the STO function is 5 ms.

## 8.4.2 Forced dormant error detection

### Forced dormant error detection or test of the switch-off signal paths for Safety Integrated Basic Functions

The forced dormant error detection function at the switch-off signal paths is used to detect software/hardware faults at both monitoring channels in time and is automated by means of activation/deactivation of the "Safe Torque Off" function.

To fulfill the requirements of ISO 13849-1:2006 regarding timely error detection, the two switch-off signal paths must be tested at least once within a defined time to ensure that they are functioning properly. This functionality must be implemented by means of forced dormant error detection function, triggered either in manual mode or by the automated process.

A timer ensures that forced dormant error detection is carried out as quickly as possible.

8760 hours for the forced dormant error detection.

Once this time has elapsed, an alarm is output and remains present until forced dormant error detection is carried out.

The timer returns to the set value each time the STO function is deactivated.

When the appropriate safety devices are implemented (e.g. protective doors), it can be assumed that running machinery will not pose any risk to personnel. For this reason, only an alarm is output to inform the user that a forced dormant error detection run is due and to request that this be carried out at the next available opportunity. This alarm does not affect machine operation.

Examples of when to carry out forced dormant error detection:

- When the drives are at a standstill after the system has been switched on (POWER ON).
- When the protective door is opened.
- At defined intervals.
- In automatic mode (time and event dependent)

---

**Note**

The timer will be reset if the associated forced dormant error detection is executed. The corresponding alarm is not triggered.

The forced dormant error detection procedure of Safety Function (STO) always has to be executed through the terminals.

The mission time of the devices is 40000 hours.

---

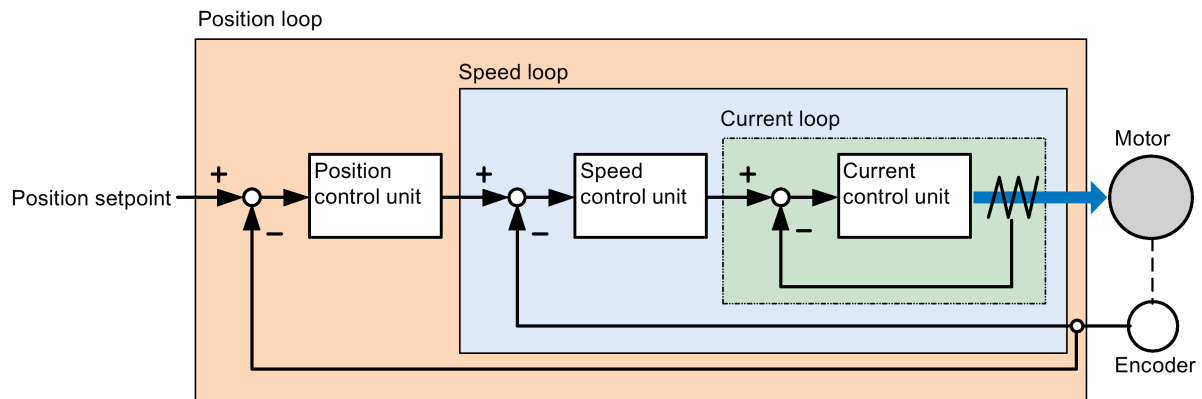
# Tuning

## 9.1 Controller overview

The SINAMICS V90 servo drive consists of three control loops:

- Current control
- Speed control
- Position control

The following block diagram shows the relationship between these three control loops:



In theory, frequency width of the inside control loop **must** be wider than that of the outer control loop; otherwise, the whole control system can vibrate or have a low response level. The relationship between the frequency widths of these three control loops is as follows:

**Current loop > speed loop > position loop**

Since the current loop of SINAMICS V90 servo drive already has a perfect frequency width, it is only necessary for you to adjust the speed loop gain and the position loop gain.

## Servo gains

- Position loop gain

Position loop gain directly influences the response level of the position loop. If the mechanical system does not vibrate or produce noises, you can increase the value of position loop gain so that the response level can be increased and positioning time can be shortened.

Parameter	Value range	Default value	Unit	Description
p29110[0]	0.00 to 300.00	Motor dependent	1000/min	Position loop gain 1
p29110[1]	0.00 to 300.00	1.00	1000/min	Position loop gain 2

- Speed loop gain

Speed loop gain directly influences the response level of the speed loop. If the mechanical system does not vibrate or produce noises, you can increase the value of speed loop gain so that the response level can be increased.

Parameter	Value range	Default value	Unit	Description
p29120[0]	0 to 999999	Motor dependent	Nms/rad	Speed loop gain 1
p29120[1]	0 to 999999	0.3	Nms/rad	Speed loop gain 2

- Speed loop integral gain

With adding integral component into speed loop, the servo drive can efficiently eliminate the steady-state error of speed and give response to a small change to speed.

Generally speaking, if the mechanical system does not vibrate or produce noises, you can decrease speed loop integral gain so that the system rigidity can be increased.

If the load inertia ratio is very high or the mechanical system has a resonance factor, it must be guaranteed that the speed loop integral time constant is big enough; otherwise, the mechanical system may have a resonance.

Parameter	Value range	Default value	Unit	Description
p29121[0]	0 to 100000	15	ms	Speed loop integral time 1
p29121[1]	0 to 100000	20	ms	Speed loop integral time 2
p29022	1 to 10000	1	-	Load moment of inertia ratio

- Position loop feed forward gain

With position loop feed forward gain, the responsiveness level can be increased. If the position loop feed forward gain is too big, motor speed can have overshoots and the digital output signal INP can have a repeated on/off. You, therefore, must monitor the changes to speed waveform and the action of the digital output signal INP during adjustment. You can slowly adjust the position loop feed forward gain. The effect of feed forward function is not obvious if the position loop gain is too big.

Parameter	Value range	Default value	Unit	Description
p29111	0.00 to 200.00	0	%	Position loop feed forward gain



## 9.2 Tuning mode

Responsivity of a machine can be optimized by tuning. The responsivity is reflected by dynamic factor and determined by the servo gains that is set in the servo drive.

The servo gains are set by using a combination of parameters. These parameters influence each other so you must consider the balance between set values when setting these values.

Generally, the responsivity of a machine with high rigidity can be improved by increasing the servo gains; however, if the servo gains of a machine with low rigidity are increased, the machine can vibrate and the responsivity cannot be improved.

<b>NOTICE</b>
<b>Effectiveness of servo gains</b>
The tuning function <b>only</b> uses the first group of servo gains (position loop gain 1, speed loop gain 1 and speed loop integral time 1).

The following tuning functions are available for the SINAMICS V90 servo drive.

Select a tuning mode by setting the parameter p29021:

Parameter	Setting value	Description
p29021	0 (default)	Auto tuning is disabled (manual tuning) without changing servo gains relevant parameters.
	1	One-button auto tuning Identify the ratio of load moment of inertia and automatically adjust servo gains accordingly.
	3	Real-time auto tuning Identify the ratio of load moment of inertia and automatically adjust servo gains in real time.
	5	Auto tuning is disabled (manual tuning). All servo gains relevant parameters are set to tuning default values.

### Auto-tuning modes

The SINAMICS V90 supplies two auto-tuning modes: one-button auto tuning and real-time auto tuning. The auto tuning function can optimize control parameters with ratio of machine load moment of inertia (p29022) and set suitable current filter parameters to suppress the machine resonance automatically. You can change the dynamic performance of the system by setting different dynamic factors.

- One-button auto tuning
  - One-button auto tuning estimates the machine load moment of inertia and mechanical characteristics with internal motion commands. To achieve the desired performance, you can execute the process many times before you control the drive with the host controller. The maximum speed is limited by the rated speed.
- Real-time auto tuning
  - Real-time auto tuning estimates the machine load moment of inertia automatically while the drive is running with the host controller command. After enabling the servo

on (SON), the real-time auto tuning function stays effective for the servo drive. If you do not need to estimate the load moment of inertia continuously, you can disable the function when the system performance is acceptable.

For IPos control mode, if you have obtained the machine load inertia (p29022) and desired dynamic performance with tuned dynamic factor, you can set the drive to the servo off state and set p29025.5 = 1 to make sure that there is no position overshoot on the axis.

You are recommended to save the tuned parameters when the tuning is completed and the drive performance is acceptable.

## Tuning with SINAMICS V-ASSISTANT

You are recommended to perform tuning with the engineering tool SINAMICS V-ASSISTANT. For more information, refer to SINAMICS V-ASSISTANT Online Help.

## 9.3 One-button auto tuning

---

### Note

The function is valid for firmware version V1.04.00 and higher.

---

### Note

Before using the one-button auto tuning, move the servo motor to the middle of mechanical position to avoid approaching the actual machine position limit.

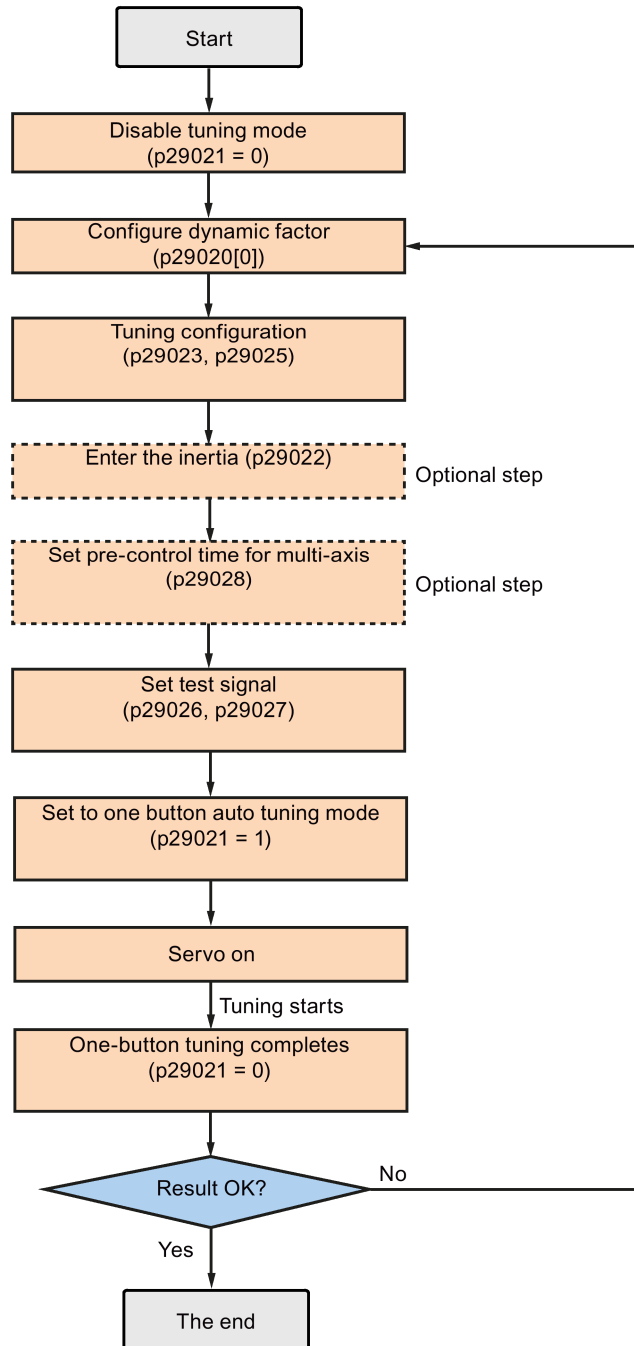
---

### Pre-conditions for one-button auto tuning

- The ratio of machine load moment of inertia is unknown and needs to be estimated.
- The motor is allowed to rotate clockwise and counter clockwise.
- The motor rotation position (p29027 defines that one revolution equals to 360 degree) is allowed by the machine.
  - For the motor with an absolute encoder: position limitation is defined by p29027
  - For the motor with an incremental encoder: the motor must be allowed to rotate freely about two rounds when tuning starts

**One-button auto tuning procedure**

Proceed as follows to perform one-button auto tuning for the SINAMICS V90 servo drive.



### Parameter settings

You can set the ratio of machine load moment of inertia (p29022) with the following methods:

- Enter it manually if you have known the ratio of machine load moment of inertia.
- Estimate the ratio of machine load moment of inertia with one-button auto tuning (p29023.2 = 1). When you have executed the one-button tuning many times and obtained a stable value of p29022, you can stop estimating it by setting p29023.2 = 0.

Parameter	Value range	Default value	Unit	Description
p29020[0...1]	1 to 35	18	-	The dynamic factor of auto tuning <ul style="list-style-type: none"> <li>• [0]: dynamic factor for one-button auto tuning</li> <li>• [1]: dynamic factor for real-time auto tuning</li> </ul>
p29021	0 to 5	0	-	Selection of a tuning mode <ul style="list-style-type: none"> <li>• 0: disabled</li> <li>• 1: one-button auto tuning</li> <li>• 3: real-time auto tuning</li> <li>• 5: disabled with default control parameters</li> </ul>
p29022	1 to 10000	1	-	Ratio of load moment of inertia
p29023	0 to 0xffff	0x0007	-	One-button auto tuning configuration
p29025	0 to 0x003f	0x0004	-	Overall tuning configuration
p29026	0 to 5000	2000 (default)	ms	Test signal duration
p29027	0 to 3000	0 (default)	°	Limit rotation position of the motor
p29028	0.0 to 60.0	7.5	ms	Pre-control time constant

Parameter p29028 is available when the multi-axis interpolation function is activated (p29023.7 = 1). If the axes are used as the interpolation axes, you need to set the same pre-control time constants (p29028) for them. After tuning is completed, you need to manually set the same position loop gains (p29110 [0]) for them if the tuning results are different.

You can configure the dynamic factor of the servo system with the parameter p29020. Higher dynamic factor means higher tracking ability and shorter settling time but also higher possibility of resonance. You should find a desired dynamic factor within a resonance-free range.

35 dynamic factors are available for the SINAMICS V90 servo drive:

Dynamic factor (p29020)	Machine rigidity
1	Low
2	↑
...	
17	
18	Middle

Dynamic factor (p29020)	Machine rigidity
19	
...	↓
35	High

If the dynamic factor setting cannot be increased up to the desired level because of machine resonance beyond 250 Hz, the function of resonance suppression can be used to suppress machine resonance and thus increase dynamic factor. Refer to Section "Resonance suppression (Page 260)" for detailed information about the function of resonance suppression.

---

#### Note

The tuning configuration parameters must be set carefully when the auto tuning function is disabled (p29021=0).

After servo on, the motor will run with the test signal.

When the one-button auto tuning process completes successfully, the parameter p29021 will be set to 0 automatically. You can also set the parameter p29021 to 0 before servo on to interrupt the one-button tuning process. Before you save the parameters on the drive, make sure that p29021 has changed to 0.

---

#### Note

Do not use the JOG function when you use the one-button tuning function.

---

#### Note

After the one-button tuning is activated, no operation will be allowed except the servo off and emergency stop.

With one-button auto tuning, the servo drive can automatically estimate the ratio of load moment of inertia and set the following relevant parameters accordingly.

Parameter	Value range	Default value	Unit	Description
p1414	0 to 3	0	-	Speed setpoint filter activation
p1415	0 to 2	0	-	Speed setpoint filter 1 type
p1417	0.5 to 16000	1999	Hz	Speed setpoint filter 1 denominator natural frequency
p1418	0.001 to 10	0.7	-	Speed setpoint filter 1 denominator damping
p1419	0.5 to 16000	1999	Hz	Speed setpoint filter 1 numerator natural frequency
p1420	0.001 to 10	0.7	-	Speed setpoint filter 1 numerator damping
p1441	0 to 50	0	ms	Actual speed smoothing time
p1656	0 to 15	1	-	Activates current setpoint filter
p1658	0.5 to 16000	1999	Hz	Current setpoint filter 1 denominator natural frequency
p1659	0.001 to 10	0.7	-	Current setpoint filter 1 denominator damping
p2533	0 to 1000	0	ms	LR position setpoint filter time constant

Parameter	Value range	Default value	Unit	Description
p2572	1 to 2000000	Motor dependent	1000 LU/s <sup>2</sup>	IPos maximum acceleration
p2573	1 to 2000000	Motor dependent	1000 LU/s <sup>2</sup>	IPos maximum deceleration
p29022	1 to 10000	1	-	Ratio of load moment of inertia
p29110[0]	0.00 to 300.00	Motor dependent	1000/min	Position loop gain 1
p29120[0]	0 to 999999	Motor dependent	Nms/rad	Speed loop gain 1
p29121[0]	0 to 100000	15	ms	Speed loop integral time 1
p29111	0.00 to 200.00	0.00	%	Position loop feed forward gain

After one-button tuning, four current setpoint filters can be activated at most. The following parameters related to the filters may be tuned accordingly.

Parameter	Value range	Default value	Unit	Description
p1663	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 2 denominator.
p1664	0.001 to 10	0.3	-	Damp of current notch filter 2 denominator.
p1665	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 2 numerator.
p1666	0.0 to 10	0.01	-	Damp of current notch filter 2 numerator.
p1668	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 3 denominator.
p1669	0.001 to 10	0.3	-	Damp of current notch filter 3 denominator.
p1670	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 3 numerator.
p1671	0.0 to 10	0.01	-	Damp of current notch filter 3 numerator.
p1673	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 4 denominator.
p1674	0.001 to 10	0.3	-	Damp of current notch filter 4 denominator.
p1675	0.5 to 16000	1000	Hz-	Natural frequency of current notch filter 4 numerator.
p1676	0.0 to 10	0.01	-	Damp of current notch filter 4 numerator.

#### Note

After one-button auto tuning is activated, do not change other auto tuning related control/filter parameters since these parameters can be set automatically and your changes will not be accepted.

#### Note

One-button auto tuning may cause some changes of the control parameters. When the system rigidity is low, this may lead to a situation that when you set EMGS = 0, the motor needs take long time to emergency stop.

## 9.4 Real-time auto tuning

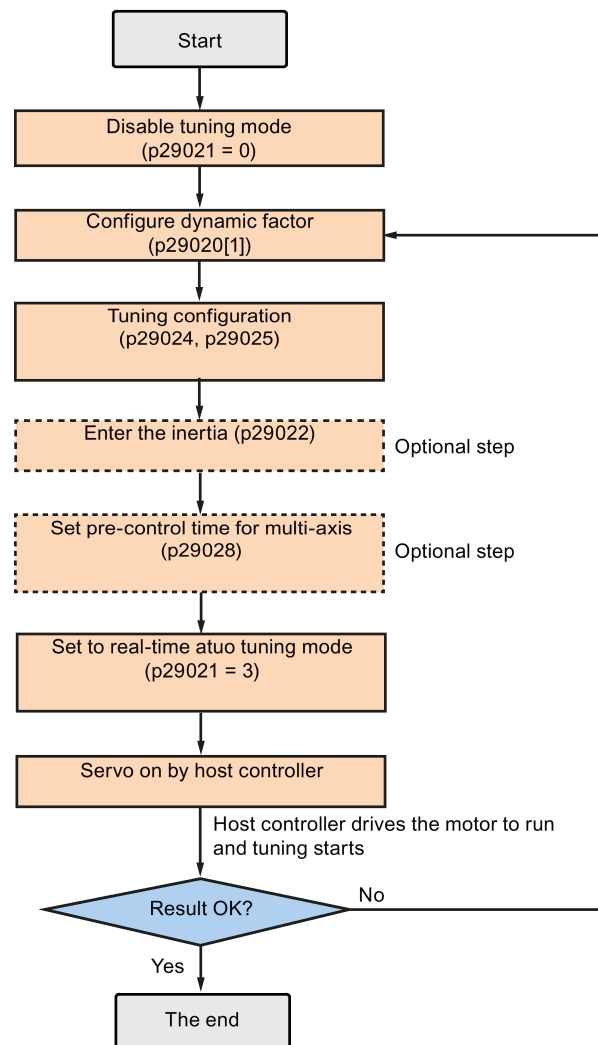
With real-time auto tuning, the servo drive can automatically estimate the ratio of load moment of inertia and set the optimum control parameters.

### Pre-conditions for the real-time auto tuning

- The drive must be controlled by the host controller.
- The machine actual load moment of inertia is different when the machine moves to the different positions.
- Make sure that the motor has multiple accelerations and decelerations. Step command is recommended.
- Machine resonance frequency changes when the machine is running.

### Real-time auto tuning procedure

Proceed as follows to perform real-time auto tuning for the SINAMICS V90 servo drive.



**Parameter settings**

You can set the ratio of machine load moment of inertia (p29022) with the following methods:

- Enter it manually if you have known the ratio of machine load moment of inertia
- Use the ratio of machine load moment of inertia estimated by the one-button auto tuning function directly
- Estimate the ratio of machine load moment of inertia with real-time auto tuning (p29024.2 = 1). When you have obtained a stable value of p29022, you can stop estimating it by setting p29024.2 = 0.

Parameter	Value range	Default value	Unit	Description
p29020[0...1]	1 to 35	18	-	The dynamic factor of auto tuning. <ul style="list-style-type: none"> <li>• [0]: dynamic factor for one-button auto tuning</li> <li>• [1]: dynamic factor for real-time auto tuning</li> </ul>
p29021	0 to 5	0	-	Selection of a tuning mode. <ul style="list-style-type: none"> <li>• 0: disabled</li> <li>• 1: one-button auto tuning</li> <li>• 3: real-time auto tuning</li> <li>• 5: disable with default controller parameters</li> </ul>
p29022	1 to 10000	1	-	Ratio of load moment of inertia
p29024	0 to 0xffff	0x004c	-	Real-time auto tuning configuration
p29025	0 to 0x003f	0x0004	-	Overall tuning configuration
p29028	0.0 to 60.0	7.5	ms	Pre-control time constant

Parameter p29028 is available when the multi-axis interpolation function is activated (p29024.7 = 1). If the axes are used as the interpolation axes, you need to set the same pre-control time constants (p29028) for them. After tuning is completed, you need to manually set the same position loop gains (p29110 [0]) for them if the tuning results are different.

You can configure the dynamic factor of the servo system with the parameter p29020. Higher dynamic factor means higher tracking ability and shorter settling time but also higher possibility of resonance. You should find a desired dynamic factor within a resonance-free range.

35 dynamic factors are available for the SINAMICS V90 servo drive:

Dynamic factor (p29020)	Machine rigidity
1	Low
2	↑
...	
17	
18	Middle
19	↓
...	
35	
	High



If the dynamic factor setting cannot be increased up to the desired level because of machine resonance beyond 250 Hz, the function of resonance suppression can be used to suppress machine resonance and thus increase dynamic factor. Refer to Section "Resonance suppression (Page 260)" for detailed information about the function of resonance suppression.

---

#### Note

The tuning configuration parameters must be set carefully when the auto tuning function is disabled (p29021=0).

During tuning, you can modify the dynamic factor with p29020[1] to obtain the different dynamic performance after p29022 has been tuned and accepted by the drive.

After servo on, the real-time auto tuning function will always effective for the servo drive. If you want to end or interrupt the real-time auto tuning process, set the drive to the servo off state then set p29021 to 0.

---

The following relevant parameters can be continuous set in real time when you are using the real-time auto tuning:

Parameter	Value range	Default value	Unit	Description
p1417	0.5 to 16000	1999	Hz	Speed setpoint filter 1 denominator natural frequency
p1419	0.5 to 16000	1999	Hz	Speed setpoint filter 1 numerator natural frequency
p29022	1 to 10000	1	-	Ratio of load moment of inertia
p29110[0]	0.00 to 300.00	Motor dependent	1000/min	Position loop gain 1
p29120[0]	0 to 999999	Motor dependent	Nms/rad	Speed loop gain 1
p29121[0]	0 to 100000	15	ms	Speed loop integral time 1
p29111	0.00 to 200.00	0.00	%	Position loop feed forward gain

---

#### Note

When using the real-time auto tuning function, if the default values are inappropriate, the host controller cannot run the motor. To run the motor with the host controller, you need to let the drive tune the parameters automatically through trial run with the real-time auto tuning function. After the tuning is completed, the host controller can run the motor.

---

#### Note

After the real-time auto tuning is activated, do not change other auto tuning related control/filter parameters since these parameters can be set automatically and your changes will not be accepted.

---

---

**Note**

The real-time auto tuning may not be performed properly if the following conditions are not satisfied:

- Accelerate the motor for 100 ms or more with the acceleration torque.
- The acceleration/deceleration torque is 15% or more of the rated torque.

Under operating conditions that impose sudden disturbance torque during acceleration/deceleration or on a machine that its rigidity is poor, auto tuning may not function properly, either. In such cases, use the one-button auto tuning or manual tuning to optimize the drive.

---

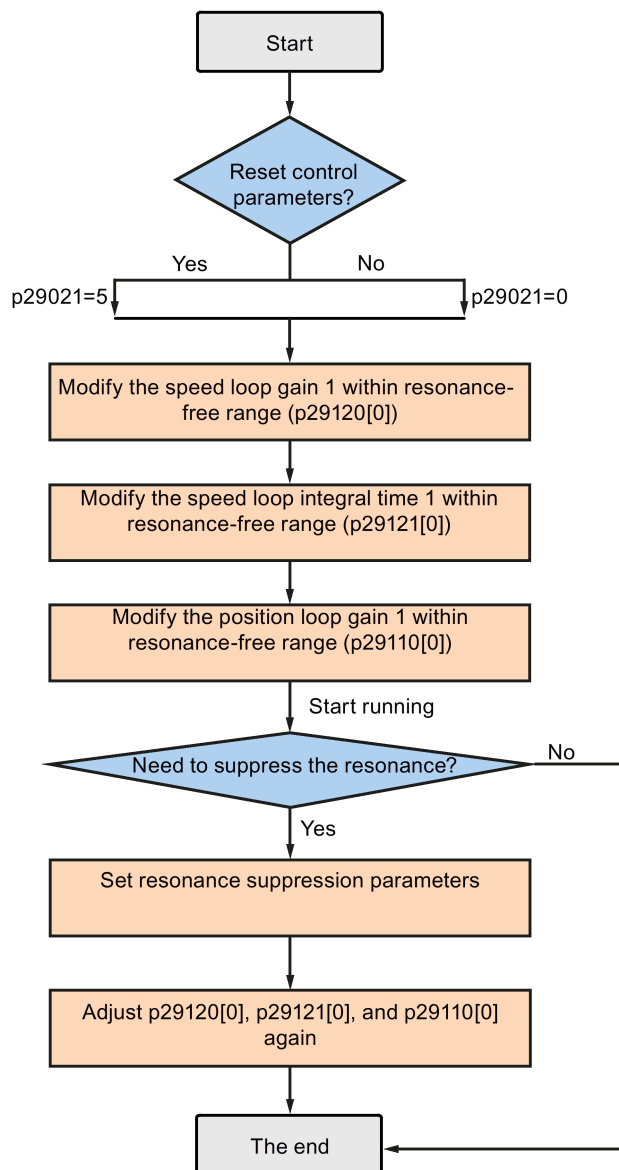
## 9.5 Manual tuning

When the auto tuning cannot reach expected tuning results, you can disable the auto tuning function by setting the parameter p29021 and manually perform tuning:

- p29021=5: auto tuning function is disabled and all control parameters are reset to tuning default values.
- p29021=0: auto tuning function is disabled without changing control parameters.

### Procedure for manual tuning

Follow the procedure below to perform manual tuning:



**Note****Resonance suppression**

For detailed information about the resonance suppression, refer to Section "Resonance suppression (Page 260)".

**Parameter settings**

You need to set the following servo gains related parameters manually when using the manual tuning function:

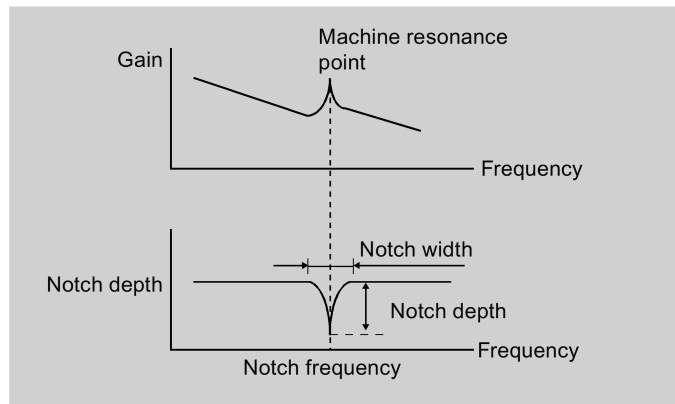
Parameter	Value range	Default value	Unit	Description
p2533	0 to 1000	0	ms	LR position setpoint filter time constant
p2572	1 to 2000000	Motor dependent	1000 LU/s <sup>2</sup>	IPos maximum acceleration
p2573	1 to 2000000	Motor dependent	1000 LU/s <sup>2</sup>	IPos maximum deceleration
p29110[0]	0.00 to 300.00	Motor dependent	1000 /min	Position loop gain 1
p29120[0]	0 to 999999	Motor dependent	Nms /rad	Speed loop gain 1
p29121[0]	0 to 100000	15	ms	Speed loop integral time 1
p29111	0.00 to 200.00	0.00	%	Position loop feed forward gain

**9.6 Resonance suppression**

The resonance suppression function is filter (notch filter) function. It detects mechanical resonance at a frequency between 250 Hz and 1500 Hz, and decreases the gain of specific frequency (by automatically setting notch filter) to suppress the mechanical resonance.

Now four current setpoint filters are available for the V90 servo drive. Filter 1 is lowpass filter. Filter 2, filter 3 and filter 4 are band damp filters.

The gain decreasing frequency, width as well as depth can be set by setting the notch filter:



## Using the resonance suppression function

### Note

The resonance suppression function is used together with the auto tuning function. In real-time auto tuning and one-button auto tuning mode, the function is activated by default.

When you use real-time auto tuning function, you are recommended to disable the resonance suppression function to get a high dynamic performance if there is no resonance in the machine.

The function can be activated/deactivated with the following parameters:

- For one-button auto tuning: bit 1 of p29023
- For real-time auto tuning: bit 6 of p29024

## Resonance suppression with one-button auto tuning (p29021=1, p29023.1=1)

Before you use the resonance suppression function with one-button auto tuning, make sure the load is mounted as required and the servo motor can rotate freely. When the one-button auto tuning process completes successfully, the servo drive automatically sets the following notch filter relevant parameters with real machine characteristic. Four current setpoint filters can be activated at most.

Parameter	Value range	Default value	Unit	Description
p1663	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 2 denominator.
p1664	0.001 to 10	0.3	-	Damp of current notch filter 2 denominator.
p1665	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 2 numerator.
p1666	0.0 to 10	0.01	-	Damp of current notch filter 2 numerator.
p1668	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 3 denominator.
p1669	0.001 to 10	0.3	-	Damp of current notch filter 3 denominator.
p1670	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 3 numerator.

Parameter	Value range	Default value	Unit	Description
p1671	0.0 to 10	0.01	-	Damp of current notch filter 3 numerator.
p1673	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 4 denominator.
p1674	0.001 to 10	0.3	-	Damp of current notch filter 4 denominator.
p1675	0.5 to 16000	1000	Hz-	Natural frequency of current notch filter 4 numerator.
p1676	0.0 to 10	0.01	-	Damp of current notch filter 4 numerator.

**Note**

**Notch filter remains active when the resonance suppression function is activated automatically.**

After one-button tuning is completed, four filters can be activated at most. You can deactivate the notch filters by setting the parameter p1656.

**Resonance suppression with real-time auto tuning (p29021=3, p29024.6=1)**

When you choose to use the resonance suppression function with real-time auto tuning, the servo drive performs real-time detection of the resonance frequency and configures the following notch filter relevant parameters accordingly:

Parameter	Value range	Default value	Unit	Description
p1663	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 2 denominator.
p1664	0.001 to 10	0.3	-	Damp of current notch filter 2 denominator.
p1665	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 2 numerator.
p1666	0.0 to 10	0.01	-	Damp of current notch filter 2 numerator.

**Resonance suppression with manual tuning (p29021=0)**

When both the resonance suppression with real-time auto tuning and one-button tuning mode cannot reach the suppression effect, you can do the resonance suppression by manually setting the following parameters:

Parameter	Value range	Default value	Unit	Description
p1663	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 2 denominator.
p1664	0.001 to 10	0.3	-	Damp of current notch filter 2 denominator.
p1665	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 2 numerator.
p1666	0.0 to 10	0.01	-	Damp of current notch filter 2 numerator.
p1668	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 3 denominator.
p1669	0.001 to 10	0.3	-	Damp of current notch filter 3 denominator.
p1670	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 3 numerator.
p1671	0.0 to 10	0.01	-	Damp of current notch filter 3 numerator.

Parameter	Value range	Default value	Unit	Description
p1673	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 4 denominator.
p1674	0.001 to 10	0.3	-	Damp of current notch filter 4 denominator.
p1675	0.5 to 16000	1000	Hz	Natural frequency of current notch filter 4 numerator.
p1676	0.0 to 10	0.01	-	Damp of current notch filter 4 numerator.

Assume the notch frequency is  $f_{sp}$ , notch width is  $f_{BB}$ , and notch depth is  $K$ , then the filter parameters can be calculated as follows:

$$p1663=p1665=f_{sp}$$

$$p1664=f_{BB} / (2 \times f_{sp})$$

$$p1666=(f_{BB} \times 10^{(K/20)}) / (2 \times f_{sp})$$

## 9.7 Low frequency vibration suppression

Low frequency vibration suppression function is position setpoint filter function. It can suppress the vibration between 0.5 Hz to 62.5 Hz. The function is available in IPos control mode.

### Related parameters

When you use the vibration suppression function, you need to configure the following parameters accordingly:

Parameter	Value range	Default value	Unit	Description
p29035	0 to 1	0	-	Vibration suppression activation. <ul style="list-style-type: none"> <li>0: disable</li> <li>1: enable</li> </ul>
p31581	0 to 1	0	-	Vibration suppression filter type. <ul style="list-style-type: none"> <li>0: filter type rugged</li> <li>1: filter type sensitive</li> </ul>
p31585	0.5 to 62.5	1	Hz	Vibration suppression filter frequency.
p31586	0 to 0.99	0.03	-	Vibration suppression filter damp.

### Operating steps

Step	Description	Comment
①	Set the drive to servo off status.	
②	Select the filter type by p31581.	Vibration suppression filter type. <ul style="list-style-type: none"> <li>0: filter type rugged</li> <li>1: filter type sensitive</li> </ul>

Step	Description	Comment
③	Set the suppression frequency by p31585.	You can set the suppression frequency from 0.5 Hz to 62.5 Hz.
④	Set damp of the filter by p31586.	You can set the damp from 0 to 0.99.
⑤	Set control mode for the drive by p29003.	
⑥	Enable the vibration suppression function by p29035.	Set p29035 = 1 to activate the function.
⑦	Set the drive to servo on status.	

## 9.8 Gain switching

### Note

The Gain Switching function is **not** available in **T** mode (torque control mode).

The function of auto-tuning must be disabled so that the function of gain switching can be available.

With this function, you can:

- increase the gains during servo lock and decrease gains to reduce noise during rotation.
- increase the gains during settling to shorten the stop settling time.
- switch between two groups of gains using an external signal (G-CHANGE) to ensure stability of the servo system because the load inertia moment ratio varies greatly during a stop (for example, a large load is mounted on a carrier).

### Selection of a gain switching mode

Five gain switching modes in total are available:

- Gain switching disabled
- Gain switching using digital input signal (G-CHANGE)
- Gain switching using position deviation
- Gain switching using position setpoint frequency
- Gain switching using actual speed



You can select one of the five modes by setting parameter p29130:

Parameter	Value	Description
p29130	0 (default)	The function of gain switching is disabled. Only the first group of gains is valid and the function of PI to P switching of speed controller is enabled.
	1	Gain switching using digital input signal (G-CHANGE). When G-CHANGE is 0, the first group of gains is selected; when G-CHANGE is 1, the second one is selected.
	2	Gain switching using position deviation. In the position control mode, gain switching can be decided by position deviation. If the position deviation is less than preset value, the first group of gains is selected; otherwise, the second one is selected.
	3	Gain switching using position setpoint frequency. In the position control mode, gain switching can also be decided by position setpoint frequency. If the position setpoint frequency is less than preset value, the first group of gain is selected; otherwise, the second one is selected.
	4	In the speed control mode, gain switching can be decided by actual speed. If the actual speed is below preset value; otherwise, the second one is selected.

### 9.8.1 Gain switching using an external digital input signal (G-CHANGE)

#### DI settings

- Position control mode

Signal	Setting	Description
G-CHANGE	0	The first group of gains is selected.
	1	The second group of gains is selected.

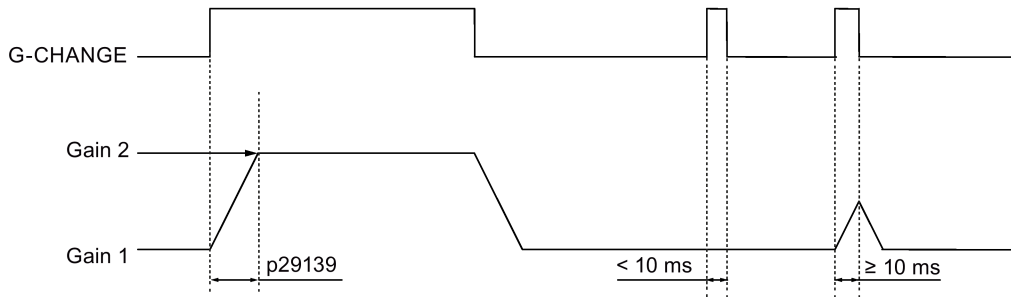
- Speed control mode

Signal	Setting	Description
G-CHANGE	0	The first group of gains is selected.
	1	The second group of gains is selected.

#### Parameter settings (p29130 = 1)

Parameter	Value range	Default value	Unit	Description
p29110[0]	0.00 to 300.00	Motor dependent	1000/min	Position loop gain 1
p29110[1]	0.00 to 300.00	1.00	1000/min	Position loop gain 2
p29120[0]	0 to 999999	Motor dependent	Nms/rad	Speed loop gain 1
p29120[1]	0 to 999999	0.3	Nms/rad	Speed loop gain 2
p29121[0]	0 to 100000	15	ms	Speed loop integral time 1
p29121[1]	0 to 100000	20	ms	Speed loop integral time 2
p29139	8 to 1000	20	ms	Time constant to smooth the switching between gain sets

Timing diagram



**Note**

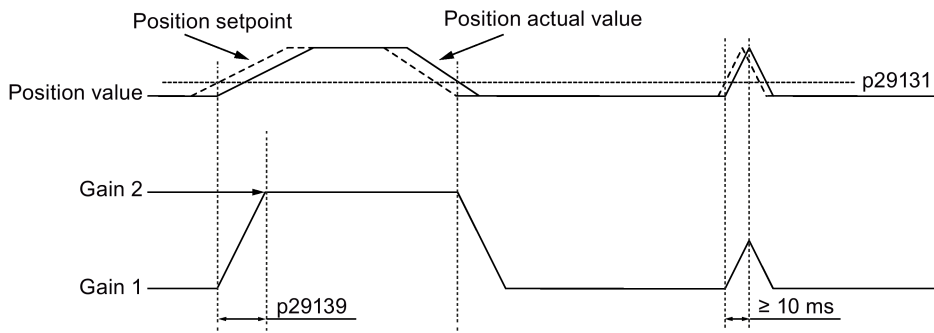
If the pulse duration is shorter than 10 ms, there is no reaction.

9.8.2 Gain switching using position deviation

Parameter settings (p29130 = 2)

Parameter	Value range	Default value	Unit	Description
p29110[0]	0.00 to 300.00	Motor dependent	1000/min	Position loop gain 1
p29110[1]	0.00 to 300.00	1.00	1000/min	Position loop gain 2
p29120[0]	0 to 999999	Motor dependent	Nms/rad	Speed loop gain 1
p29120[1]	0 to 999999	0.3	Nms/rad	Speed loop gain 2
p29121[0]	0 to 100000	15	ms	Speed loop integral time 1
p29121[1]	0 to 100000	20	ms	Speed loop integral time 2
p29131	0 to 2147483647	100	LU	Position deviation threshold for automatically triggering gain switching
p29139	8 to 1000	20	ms	Time constant to smooth the switching between gain sets

Timing diagram

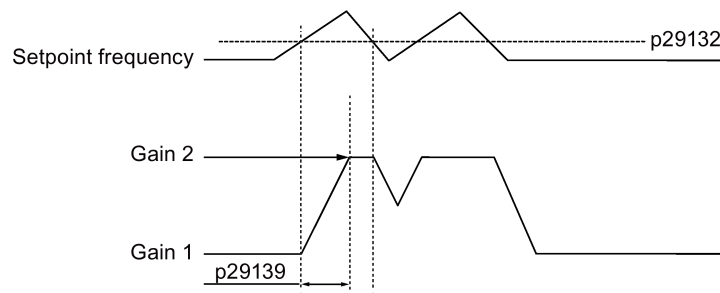


### 9.8.3 Gain switching using position setpoint frequency

#### Parameter settings (p29130 = 3)

Parameter	Value range	Setting value	Unit	Description
p29110[0]	0.00 to 300.00	Motor dependent	1000/min	Position loop gain 1
p29110[1]	0.00 to 300.00	1.00	1000/min	Position loop gain 2
p29120[0]	0 to 999999	Motor dependent	Nms/rad	Speed loop gain 1
p29120[1]	0 to 999999	0.3	Nms/rad	Speed loop gain 2
p29121[0]	0 to 100000	15	ms	Speed loop integral time 1
p29121[1]	0 to 100000	20	ms	Speed loop integral time 2
p29132	0 to 2147000064	100	1000 LU/min	Position setpoint frequency threshold for automatically triggering gain switching
p29139	8 to 1000	20	ms	Time constant to smooth the switching between gain sets

#### Timing diagram

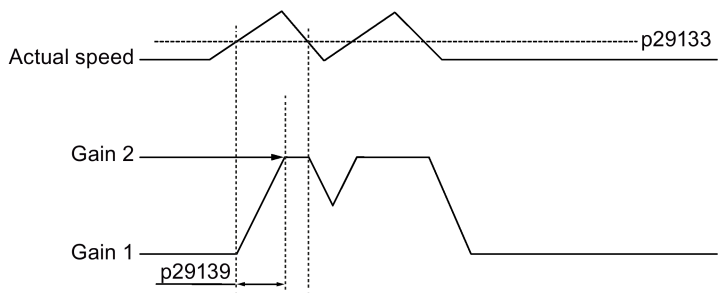


### 9.8.4 Gain switching using actual speed

#### Parameter settings (p29130 = 4)

Parameter	Value range	Setting value	Unit	Description
p29110[0]	0.00 to 300.00	Motor dependent	1000/min	Position loop gain 1
p29110[1]	0.00 to 300.00	1.00	1000/min	Position loop gain 2
p29120[0]	0 to 999999	Motor dependent	Nms/rad	Speed loop gain 1
p29120[1]	0 to 999999	0.3	Nms/rad	Speed loop gain 2
p29121[0]	0 to 100000	15	ms	Speed loop integral time 1
p29121[1]	0 to 100000	20	ms	Speed loop integral time 2
p29133	0 to 2147000064	100	rpm	Speed threshold for automatically triggering gain switching
p29139	8 to 1000	20	ms	Time constant to smooth the switching between gain sets

Timing diagram



## 9.9 PI/P switching

**Note**

**PI/P switching**

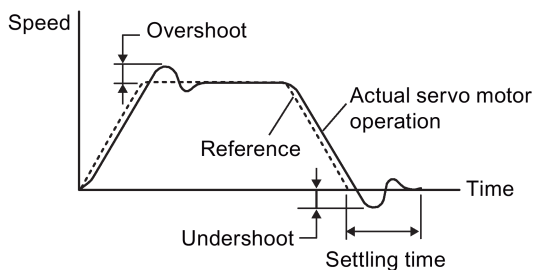
Function of PI/P switching is **not** available for the **T** mode (torque control mode).

The functions of auto-tuning and gain switching must be disabled so that the function of PI/P switching can be available.

The PI/P switching will respond with a delay time of several milliseconds.

The function of PI/P switching is used to switch from **PI** (Proportional/Integral) control of speed controller to **P** (Proportional) control. With this function, you can:

- shorten the position setting time (for the position control mode).
- avoid overshooting of actual speed value during acceleration or deceleration (for the speed control mode).
- avoid unnecessary torque when the target position is at a mechanical limitation (for the position control mode).



### Selection of a switching mode for PI/P switching

Five switching modes in total are available for PI/P switching:

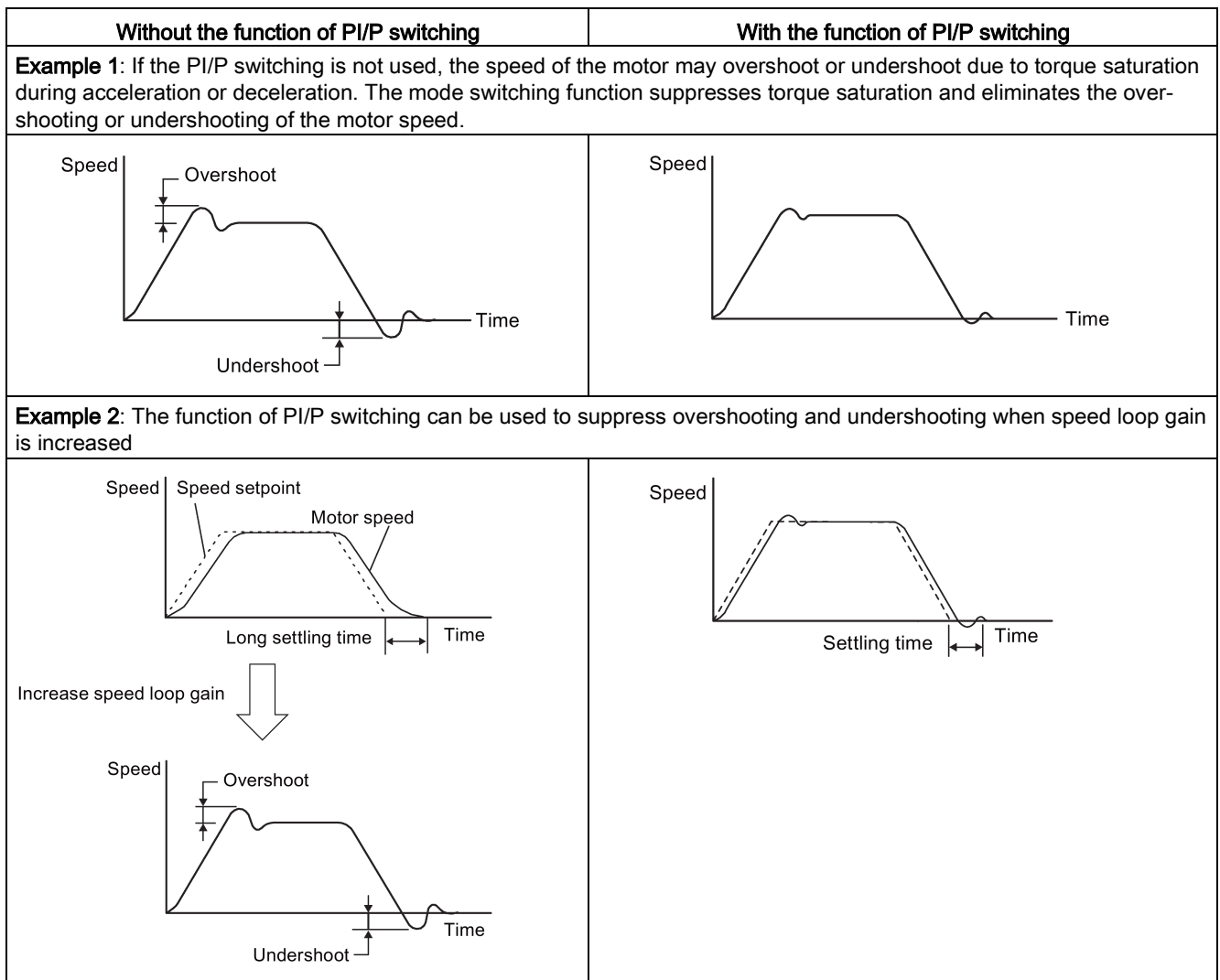
- using torque setpoint
- using an external digital input signal (G-CHANGE)

- using speed setpoint
- using acceleration setpoint
- using pulse deviation

You can select one of the switching modes by setting parameter p29140:

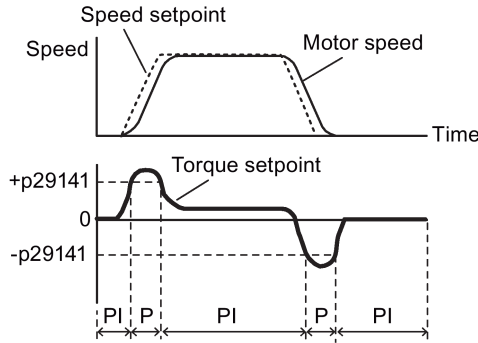
Parameter	Value	Description
p29140	0 (default)	Disabled.
	1	Torque is higher than a parameterizable setting value.
	2	Using the digital input signal (G-CHANGE)
	3	Speed is higher than a parameterizable setting value.
	4	Acceleration is higher than a parameterizable setting value.
	5	Pulse deviation is higher than a parameterizable setting value.

### Example



### 9.9.1 PI/P switching using torque setpoint

When torque setpoint exceeds preset torque value (p29141), the speed loop is switched from PI control to P control.



#### Parameter settings

Parameter	Value range	Setting value	Unit	Description
p29140	0 to 5	1	-	Switches PI control to P control using torque setpoint
p29141	0 to 300	200 (default)	%	Torque threshold for automatically triggering PI to P switch
p29120[0]	0 to 999999	0.3 (default)	Nms/rad	Speed loop gain 1
p29121[0]	0 to 100000	15 (default)	ms	Speed loop integral time 1

#### Note

##### Speed setpoint

For detailed information about speed setpoint, refer to "Configuring speed setpoint (Page 201)".

##### Torque setpoint

For detailed information about torque setpoint, refer to "Torque setpoint (Page 208)".

### 9.9.2 PI/P switching using an external digital input signal (G-CHANGE)

#### DI settings

- Position control mode

Signal	Setting	Description
G-CHANGE	0	The first group of gains is selected.
	1	The second group of gains is selected.

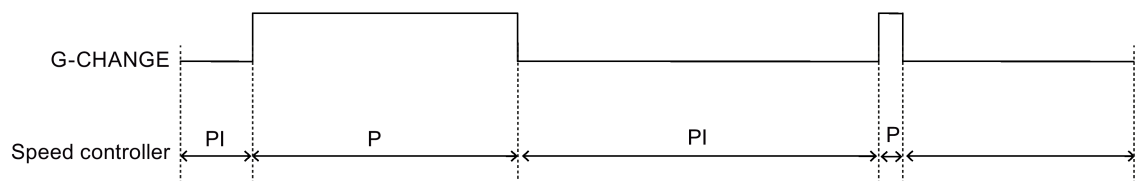
- Speed control mode

Signal	Setting	Description
G-CHANGE	0	The first group of gains is selected.
	1	The second group of gains is selected.

### Parameter settings

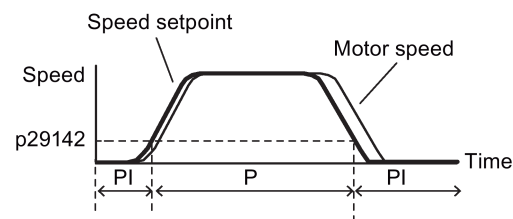
Parameter	Value range	Setting value	Unit	Description
p29140	0 to 5	2	-	Switches PI control to P control using an external digital input signal (G-CHANGE)
p29120[0]	0 to 999999	0.3 (default)	Nms/rad	Speed loop gain 1
p29121[0]	0 to 100000	15 (default)	ms	Speed loop integral time 1

### Timing diagram



### 9.9.3 PI/P switching using speed setpoint

When the speed setpoint exceeds the preset speed value (p29142), the speed loop is switched from PI control to P control.



### Parameter settings

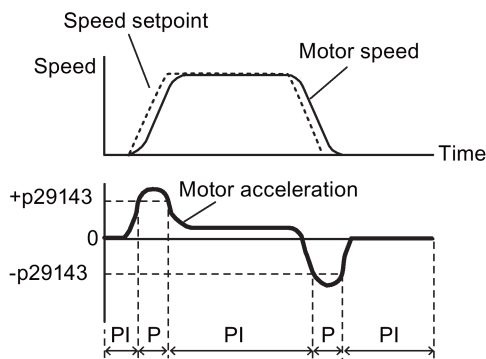
Parameter	Value range	Setting value	Unit	Description
p29140	0 to 5	3	-	Switches PI control to P control using speed setpoint.
p29142	0 to 210000	2000 (default)	rpm	Speed threshold for automatically triggering PI to P switch.
p29120[0]	0 to 999999	0.3 (default)	Nms/rad	Speed loop gain 1
p29121[0]	0 to 100000	15 (default)	ms	Speed loop integral time 1

**Note**

For detailed information about speed setpoint, refer to "Configuring speed setpoint (Page 201)".

**9.9.4 PI/P switching using acceleration setpoint**

When the motor acceleration exceeds the preset acceleration rate (p29143), the speed loop is switched from PI control to P control.



**Parameter settings**

Parameter	Value range	Setting value	Unit	Description
p29140	0 to 5	4	-	Switches PI control to P control using acceleration setpoint.
p29143	0 to 30000	20 (default)	rev/s <sup>2</sup>	Acceleration threshold for automatically triggering PI to P switch.
p29120[0]	0 to 999999	0.3 (default)	Nms/rad	Speed loop gain 1
p29121[0]	0 to 100000	15 (default)	ms	Speed loop integral time 1

**Note**

**Speed setpoint**

For detailed information about speed setpoint, refer to "Configuring speed setpoint (Page 201)".

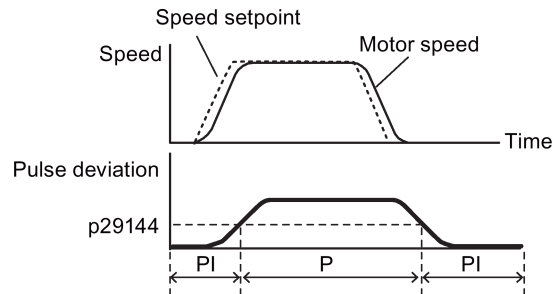
**Acceleration**

For detailed information about acceleration, refer to "Setting fixed position setpoint (Page 186)" of the internal position control mode.



### 9.9.5 PI/P switching using pulse deviation

The speed loop is switched from PI control to P control when the pulse deviation exceeds the preset value (p29144).



#### Parameter settings

Parameter	Value range	Setting value	Unit	Description
p29140	0 to 5	5	-	Switches PI control to P control using pulse deviation
p29144	0 to 2147483647	30000 (default)	-	Pulse deviation threshold for automatically triggering PI to P switching
p29120[0]	0 to 999999	0.3 (default)	Nms/rad	Speed loop gain 1
p29121[0]	0 to 100000	15 (default)	ms	Speed loop integral time 1

#### Note

##### Speed setpoint

For detailed information about speed setpoint, refer to "Configuring speed setpoint (Page 201)".



# Parameters

## 10.1 Overview

### Parameter number

Numbers prefixed with an "r" indicate that parameter is a read-only parameter.

Numbers prefixed with a "P" indicate that the parameter is an editable parameter.

### Effective

Indicates the conditions for making parameterization effective. Two conditions are possible:

- IM (**I**mmediately): Parameter value becomes effective immediately after changing.
- RE (**R**eset): Parameter value becomes effective after repower-on.

### Can be changed

This indicates when the parameter can be changed. Two states are possible:

- U (Run): Can be changed in the "**R**unning" state when the drive is in the servo on state. The "RDY" LED lights up green.
- T (Ready to run): Can be changed in the "**R**eady" state when the drive is in the servo off state. The "RDY" LED lights up red.

---

### Note

When judging the state of the drive according to the "RDY" LED, ensure that no faults or alarms exist.

---

### Data type

Type	Description
I16	16-bit integer
I32	32-bit integer
U16	16 bits without sign
U32	32 bits without sign
Uint16	16-bit unsigned integer
Uint32	32-bit unsigned integer
Float	32-bit floating point number

## Parameter groups

The SINAMICS V90 parameters are divided into the following groups:

Parameter group	Available parameters	Parameter group display on the BOP
Basic parameters	p290xx	P 0A
Gain adjustment parameters	p291xx	P 0b
Speed control parameters	p10xx to p14xx, p21xx	P 0c
Torque control parameters	p15xx to p16xx	P 0d
Position control parameters	p25xx to p26xx, p292xx	P 0E
I/O parameters	p293xx	P 0F
Status monitoring parameters	All read-only parameters	dAŁA

## 10.2 Parameter list

### Editable parameters

The values of the parameters marked with an asterisk (\*) may be changed after commissioning. Make sure you back up the parameters first as required if you desire to replace the motor. The default values of the parameters marked with two asterisks (\*\*) are motor dependent. They may have different default values when different motor connected.

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p0748	CU invert digital outputs	0	63	0	-	U32	IM	T, U
	Description: Inverts the signals at the digital outputs. <ul style="list-style-type: none"> <li>• Bit 0: inverts signal DO1.               <ul style="list-style-type: none"> <li>– Bit 0 = 0: not inverted</li> <li>– Bit 0 = 1: inverted</li> </ul> </li> <li>• Bit 1: inverts signal DO2.               <ul style="list-style-type: none"> <li>– Bit 1 = 0: not inverted</li> <li>– Bit 1 = 1: inverted</li> </ul> </li> <li>• Bit 2: inverts signal DO3.               <ul style="list-style-type: none"> <li>– Bit 2 = 0: not inverted</li> <li>– Bit 2 = 1: inverted</li> </ul> </li> <li>• Bit 3: inverts signal DO4.               <ul style="list-style-type: none"> <li>– Bit 3 = 0: not inverted</li> <li>– Bit 3 = 1: inverted</li> </ul> </li> <li>• Bit 4: inverts signal DO5.               <ul style="list-style-type: none"> <li>– Bit 4 = 0: not inverted</li> <li>– Bit 4 = 1: inverted</li> </ul> </li> <li>• Bit 5: inverts signal DO6.               <ul style="list-style-type: none"> <li>– Bit 5 = 0: not inverted</li> <li>– Bit 5 = 1: inverted</li> </ul> </li> </ul>							
p1001	Fixed speed setpoint 1	-210000.000	210000.000	0.000	rpm	Float	IM	T, U
	<b>Description:</b> Sets a value for the fixed speed / velocity setpoint 1.							
p1002	Fixed speed setpoint 2	-210000.000	210000.000	0.000	rpm	Float	IM	T, U
	<b>Description:</b> Sets a value for the fixed speed / velocity setpoint 2.							
p1003	Fixed speed setpoint 3	-210000.000	210000.000	00.000	rpm	Float	IM	T, U
	<b>Description:</b> Sets a value for the fixed speed / velocity setpoint 3.							
p1004	Fixed speed setpoint 4	-210000.000	210000.000	0.000	rpm	Float	IM	T, U
	<b>Description:</b> Sets a value for the fixed speed / velocity setpoint 4.							
p1005	Fixed speed setpoint 5	-210000.000	210000.000	0.000	rpm	Float	IM	T, U
	<b>Description:</b> Sets a value for the fixed speed / velocity setpoint 5.							
p1006	Fixed speed setpoint 6	-210000.000	210000.000	0.000	rpm	Float	IM	T, U
	<b>Description:</b> Sets a value for the fixed speed / velocity setpoint 6.							

## 10.2 Parameter list

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p1007	Fixed speed setpoint 7	-210000.000	210000.000	0.000	rpm	Float	IM	T, U
<b>Description:</b> Sets a value for the fixed speed / velocity setpoint 7.								
p1058	Jog 1 speed setpoint	0.00	210000.000	100.00	rpm	Float	IM	T
<b>Description:</b> Sets the speed/velocity for jog 1. Jogging is level-triggered and allows the motor to be incrementally moved.								
<b>Note:</b> The parameter values displayed on the BOP are integers.								
p1082 *	Maximum speed	0.000	210000.000	1500.00 0	rpm	Float	IM	T
<b>Description:</b> Sets the highest possible speed.								
<b>Notice:</b> After the value has been modified, no further parameter modifications can be made.								
<b>Note:</b> The parameter values displayed on the BOP are integers. The parameter applies for both motor directions. The parameter has a limiting effect and is the reference quantity for all ramp-up and ramp-down times (e.g. down ramps, ramp-function generator and motor potentiometer). The range of the parameter is different when connect with different motors.								
p1083 *	Speed limit in positive direction of rotation	0.000	210000.000	210000. 000	rpm	Float	IM	T, U
<b>Description:</b> Sets the maximum speed for the positive direction.								
<b>Note:</b> The parameter values displayed on the BOP are integers.								
p1086 *	Speed limit in negative direction of rotation	-210000.000	0.000	- 210000. 000	rpm	Float	IM	T, U
<b>Description:</b> Sets the speed limit for the negative direction.								
<b>Note:</b> The parameter values displayed on the BOP are integers.								
p1115	Ramp-function generator selection	0	1	0	-	I16	IM	T
<b>Description:</b> Sets the ramp-function generator type.								
<b>Note:</b> Another ramp-function generator type can only be selected when the motor is at a standstill.								
p1120	Ramp-function generator ramp-up time	0.000	999999.000	1	s	Float	IM	T, U
<b>Description:</b> The ramp-function generator ramps-up the speed setpoint from standstill (setpoint = 0) up to the maximum speed (p1082) in this time.								
<b>Dependency:</b> Refer to p1082								
p1121	Ramp-function generator ramp-down time	0.000	999999.000	1	s	Float	IM	T, U
<b>Description:</b> Sets the ramp-down time for the ramp-function generator. The ramp-function generator ramps-down the speed setpoint from the maximum speed (p1082) down to standstill (setpoint = 0) in this time. Further, the ramp-down time is always effective for OFF1.								
<b>Dependency:</b> Refer to p1082								
p1130	Ramp-function generator initial rounding-off time	0.000	30.000	0.000	s	Float	IM	T, U
<b>Description:</b> Sets the initial rounding-off time for the extended ramp generator. The value applies to ramp-up and ramp-down.								
<b>Note:</b> Rounding-off times avoid an abrupt response and prevent damage to the mechanical system.								

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p1131	Ramp-function generator final rounding-off time	0.000	30.000	0.000	s	Float	IM	T, U
	<b>Description:</b> Sets the final rounding-off time for the extended ramp generator. The value applies to ramp-up and ramp-down.							
	<b>Note:</b> Rounding-off times avoid an abrupt response and prevent damage to the mechanical system.							
p1215 *	Motor holding brake configuration	0	3	0	-	l16	IM	T
	<b>Description:</b> Sets the holding brake configuration.							
	<b>Dependency:</b> Refer to p1216, p1217, p1226, p1227, p1228							
	<b>Caution:</b> For the setting p1215 = 0, if a brake is used, it remains closed. If the motor moves, this will destroy the brake.							
	<b>Notice:</b> If p1215 was set to 1 or if p1215 was set to 3, then when the pulses are suppressed, the brake is closed even if the motor is still rotating.							
	<b>Note:</b> If a holding brake integrated in the motor is used, then it is not permissible that p1215 is set to 3. The parameter can only be set to zero when the pulses are inhibited.							
p1216 *	Motor holding brake opening time	0	10000	100	ms	Float	IM	T, U
	<b>Description:</b> Sets the time to open the motor holding brake. After controlling the holding brake (opens), the speed/velocity setpoint remains at zero for this time. After this, the speed/velocity setpoint is enabled.							
	<b>Dependency:</b> Refer to p1215, p1217							
	<b>Note:</b> For a motor with integrated brake, this time is pre-assigned the value saved in the motor. For p1216 = 0 ms, the monitoring and the message A7931 "Brake does not open" are deactivated.							
p1217 *	Motor holding brake closing time	0	10000	100	ms	Float	IM	T, U
	<b>Description:</b> Sets the time to apply the motor holding brake. After OFF1 or OFF3 and the holding brake is controlled (the brake closes), then the drive remains closed-loop controlled for this time stationary with a speed setpoint/velocity setpoint of zero. The pulses are suppressed when the time expires.							
	<b>Dependency:</b> Refer to p1215, p1216							
	<b>Note:</b> For a motor with integrated brake, this time is pre-assigned the value saved in the motor. For p1217 = 0 ms, the monitoring and the message A07932 "Brake does not close" are deactivated.							
p1226	Threshold for zero speed detection	0.00	210000.00	20.00	rpm	Float	IM	T, U
	<b>Description:</b> Sets the speed threshold for the standstill identification. Acts on the actual value and setpoint monitoring. When braking with OFF1 or OFF3, when the threshold is undershot, standstill is identified. The following applies when the brake control is activated: When the threshold is undershot, the brake control is started and the system waits for the brake closing time in p1217. The pulses are then suppressed. If the brake control is not activated, the following applies: When the threshold is undershot, the pulses are suppressed and the drive coasts down.							
	<b>Dependency:</b> Refer to p1215, p1216, p1217, p1227							
	<b>Notice:</b> For reasons relating to the compatibility to earlier firmware versions, a parameter value of zero in indices 1 to 31 is overwritten with the parameter value in index 0 when the drive boots.							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
	<p><b>Note:</b> Standstill is identified in the following cases:</p> <ul style="list-style-type: none"> <li>- The speed actual value falls below the speed threshold in p1226 and the time started after this in p1228 has expired.</li> <li>- The speed setpoint falls below the speed threshold in p1226 and the time started after this in p1227 has expired.</li> </ul> <p>The actual value sensing is subject to measuring noise. For this reason, standstill cannot be detected if the speed threshold is too low.</p>							
p1227	Zero speed detection monitoring time	0.000	300.000	300.000	s	Float	IM	T, U
	<p><b>Description:</b> Sets the monitoring time for the standstill identification.</p> <p>When braking with OFF1 or OFF3, standstill is identified after this time has expired, after the setpoint speed has fallen below p1226.</p> <p>After this, the brake control is started, the system waits for the closing time in p1217 and then the pulses are suppressed.</p>							
	<p><b>Dependency:</b> Refer to p1215, p1216, p1217, p1226</p>							
	<p><b>Notice:</b> The setpoint is not equal to zero dependent on the selected value. This can therefore cause the monitoring time in p1227 to be exceeded. In this case, for a driven motor, the pulses are not suppressed..</p>							
	<p><b>Note:</b> Standstill is identified in the following cases:</p> <ul style="list-style-type: none"> <li>- The speed actual value falls below the speed threshold in p1226 and the time started after this in p1228 has expired.</li> <li>- The speed setpoint falls below the speed threshold in p1226 and the time started after this in p1227 has expired.</li> </ul> <p>For p1227 = 300.000 s, the following applies: Monitoring is de-activated.</p> <p>For p1227 = 0.000 s, the following applies: With OFF1 or OFF3 and a ramp-down time = 0, the pulses are immediately suppressed and the motor "coasts" down.</p>							
p1228	Pulse suppression delay time	0.000	299.000	0.000	s	Float	IM	T, U
	<p><b>Description:</b> Sets the delay time for pulse suppression. After OFF1 or OFF3, the pulses are canceled, if at least one of the following conditions is fulfilled:</p> <ul style="list-style-type: none"> <li>- The speed actual value falls below the threshold in p1226 and the time started after this in p1228 has expired.</li> <li>- The speed setpoint falls below the threshold in p1226 and the time started after this in p1227 has expired.</li> </ul>							
	<p><b>Dependency:</b> Refer to p1226, p1227</p>							
	<p><b>Notice:</b> When the motor holding brake is activated, pulse cancellation is additionally delayed by the brake closing time (p1217).</p>							
p1414	Speed setpoint filter activation	0000 bin	0011 bin	0000 bin	-	U16	IM	T, U
	<p><b>Description:</b> Setting for activating/de-activating the speed setpoint filter.</p>							
	<p><b>Dependency:</b> The individual speed setpoint filters are parameterized as of p1415.</p>							
	<p><b>Note:</b> The drive unit displays the value in hex format. To know the logic (high/low) assignment to each bit, you must convert the hex number to the binary number, for example, FF (hex) = 11111111 (bin).</p>							



Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p1415	Speed setpoint filter 1 type	0	2	0	-	I16	IM	T, U
	<b>Description:</b> Sets the type for speed setpoint filter 1.							
	<b>Dependency:</b> PT1 low pass: p1416 PT2 low pass: p1417, p1418 General filter: p1417 ... p1420							
p1416	Speed setpoint filter 1 time constant	0.00	5000.00	0.00	ms	Float	IM	T, U
	<b>Description:</b> Sets the time constant for the speed setpoint filter 1 (PT1).							
	<b>Dependency:</b> Refer to p1414, p1415 <b>Note:</b> This parameter is only effective if the filter is set as a PT1 low pass.							
p1417	Speed setpoint filter 1 denominator natural frequency	0.5	16000.0	1999.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the denominator natural frequency for speed setpoint filter 1 (PT2, general filter).							
	<b>Dependency:</b> Refer to p1414, p1415 <b>Note:</b> This parameter is only effective if the speed filter is parameterized as a PT2 low pass or as general filter. The filter is only effective if the natural frequency is less than half of the sampling frequency.							
p1418	Speed setpoint filter 1 denominator damping	0.001	10.000	0.700	-	Float	IM	T, U
	<b>Description:</b> Sets the denominator damping for speed setpoint filter 1 (PT2, general filter).							
	<b>Dependency:</b> Refer to p1414, p1415 <b>Note:</b> This parameter is only effective if the speed filter is parameterized as a PT2 low pass or as general filter.							
p1419	Speed setpoint filter 1 numerator natural frequency	0.5	16000.0	1999.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the numerator natural frequency for speed setpoint filter 1 (general filter).							
	<b>Dependency:</b> Refer to p1414, p1415 <b>Note:</b> This parameter is only effective if the speed filter is set as a general filter. The filter is only effective if the natural frequency is less than half of the sampling frequency.							
p1420	Speed setpoint filter 1 numerator damping	0.001	10.000	0.700	-	Float	IM	T, U
	<b>Description:</b> Sets the numerator damping for speed setpoint filter 1 (general filter).							
	<b>Dependency:</b> Refer to p1414, p1415 <b>Note:</b> This parameter is only effective if the speed filter is set as a general filter.							
p1421	Speed setpoint filter 2 type	0	2	0	-	I16	IM	T, U
	<b>Description:</b> Sets the type for speed setpoint filter 2.							
	<b>Dependency:</b> PT1 low pass: p1422 PT2 low pass: p1423, p1424 General filter: p1423 ... p1426							

## 10.2 Parameter list

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p1422	Speed setpoint filter 2 time constant	0.00	5000.00	0.00	ms	Float	IM	T, U
	<b>Description:</b> Sets the time constant for the speed setpoint filter 2 (PT1).							
	<b>Dependency:</b> Refer to p1414, p1421							
	<b>Note:</b> This parameter is only effective if the speed filter is set as a PT1 low pass.							
p1423	Speed setpoint filter 2 denominator natural frequency	0.5	16000.0	1999.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the denominator natural frequency for speed setpoint filter 2 (PT2, general filter).							
	<b>Dependency:</b> Refer to p1414, p1421							
	<b>Note:</b> This parameter is only effective if the speed filter is parameterized as a PT2 low pass or as general filter. The filter is only effective if the natural frequency is less than half of the sampling frequency.							
p1424	Speed setpoint filter 2 denominator damping	0.001	10.000	0.700	-	Float	IM	T, U
	<b>Description:</b> Sets the denominator damping for speed setpoint filter 2 (PT2, general filter).							
	<b>Dependency:</b> Refer to p1414, p1421							
	<b>Note:</b> This parameter is only effective if the speed filter is parameterized as a PT2 low pass or as general filter.							
p1425	Speed setpoint filter 2 numerator natural frequency	0.5	16000.0	1999.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the numerator natural frequency for speed setpoint filter 2 (general filter).							
	<b>Dependency:</b> Refer to p1414, p1421							
	<b>Note:</b> This parameter is only effective if the speed filter is set as a general filter. The filter is only effective if the natural frequency is less than half of the sampling frequency.							
p1426	Speed setpoint filter 2 numerator damping	0.000	10.000	0.700	-	Float	IM	T, U
	<b>Description:</b> Sets the numerator damping for speed setpoint filter 2 (general filter).							
	<b>Dependency:</b> Refer to p1414, p1421							
	<b>Note:</b> This parameter is only effective if the speed filter is set as a general filter.							
p1441	Actual speed smoothing time	0.00	50.00	0.00	ms	Float	IM	T, U
	<b>Description:</b> Sets the smoothing time constant (PT1) for the speed actual value.							
	<b>Note:</b> The speed actual value should be smoothed for increment encoders with a low pulse number. After this parameter has been changed, we recommend that the speed controller is adapted and/or the speed controller settings checked Kp (p29120) and Tn (p29121).							
p1520 *	Torque limit upper	-1000000.00	20000000.00	0.00	Nm	Float	IM	T, U
	<b>Description:</b> Sets the fixed upper torque limit.							
	<b>Danger:</b> Negative values when setting the upper torque limit (p1520 < 0) can result in the motor accelerating in an uncontrollable fashion.							
	<b>Notice:</b> The maximum value depends on the maximum torque of the connected motor.							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p1521 *	Torque limit lower	-20000000.00	1000000.00	0.00	Nm	Float	IM	T, U
	<b>Description:</b> Sets the fixed lower torque limit.							
	<b>Danger:</b> Positive values when setting the lower torque limit (p1521 > 0) can result in the motor accelerating in an uncontrollable fashion.							
	<b>Notice:</b> The maximum value depends on the maximum torque of the connected motor.							
p1656 *	Activates current setpoint filter	0000 bin	1111 bin	0001 bin	-	U16	IM	T, U
	<b>Description:</b> Setting for activating/de-activating the current setpoint filter.							
	<b>Dependency:</b> The individual current setpoint filters are parameterized as of p1658.							
	<b>Note:</b> If not all of the filters are required, then the filters should be used consecutively starting from filter 1. The drive unit displays the value in hex format. To know the logic (high/low) assignment to each bit, you must convert the hex number to the binary number, for example, FF (hex) = 11111111 (bin).							
p1658 *	Current setpoint filter 1 denominator natural frequency	0.5	16000.0	1999.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the denominator natural frequency for current setpoint filter 1 (PT2, general filter).							
	<b>Dependency:</b> The current setpoint filter 1 is activated via p1656.0 and parameterized via p1658 ... p1659.							
p1659 *	Current setpoint filter 1 denominator damping	0.001	10.000	0.700	-	Float	IM	T, U
	<b>Description:</b> Sets the denominator damping for current setpoint filter 1.							
	<b>Dependency:</b> The current setpoint filter 1 is activated via p1656.0 and parameterized via p1658 ... p1659.							
p1663	Current setpoint filter 2 denominator natural frequency	0.5	16000.0	1000.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the denominator natural frequency for current setpoint filter 2 (PT2, general filter).							
	<b>Dependency:</b> Current setpoint filter 2 is activated via p1656.1 and parameterized via p1663 ... p1666.							
p1664	Current setpoint filter 2 denominator damping	0.001	10.000	0.300	-	Float	IM	T, U
	<b>Description:</b> Sets the denominator damping for current setpoint filter 2.							
	<b>Dependency:</b> Current setpoint filter 2 is activated via p1656.1 and parameterized via p1663 ... p1666.							
p1665	Current setpoint filter 2 numerator natural frequency	0.5	16000.0	1000.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the numerator natural frequency for current setpoint filter 2 (general filter).							
	<b>Dependency:</b> Current setpoint filter 2 is activated via p1656.1 and parameterized via p1662 ... p1666.							
p1666	Current setpoint filter 2 numerator damping	0.000	10.000	0.010	-	Float	IM	T, U
	<b>Description:</b> Sets the numerator damping for current setpoint filter 2.							
	<b>Dependency:</b> Current setpoint filter 2 is activated via p1656.1 and parameterized via p1663 ... p1666.							
p1668	Current setpoint filter 3 denominator natural frequency	0.5	16000.0	1000.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the denominator natural frequency for current setpoint filter 3 (PT2, general filter).							
	<b>Dependency:</b> Current setpoint filter 3 is activated via p1656.2 and parameterized via p1668 ... p1671.							

## 10.2 Parameter list

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p1669	Current setpoint filter 3 denominator damping	0.001	10.000	0.300	-	Float	IM	T, U
	<b>Description:</b> Sets the denominator damping for current setpoint filter 3.							
	<b>Dependency:</b> Current setpoint filter 3 is activated via p1656.2 and parameterized via p1668 ... p1671.							
p1670	Current setpoint filter 3 numerator natural frequency	0.5	16000.0	1000.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the numerator natural frequency for current setpoint filter 3 (general filter).							
	<b>Dependency:</b> Current setpoint filter 3 is activated via p1656.2 and parameterized via p1668 ... p1671.							
p1671	Current setpoint filter 3 numerator damping	0.000	10.000	0.010	-	Float	IM	T, U
	<b>Description:</b> Sets the numerator damping for current setpoint filter 3.							
	<b>Dependency:</b> Current setpoint filter 3 is activated via p1656.2 and parameterized via p1668 ... p1671.							
p1673	Current setpoint filter 4 denominator natural frequency	0.5	16000.0	1000.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the denominator natural frequency for current setpoint filter 4 (PT2, general filter).							
	<b>Dependency:</b> Current setpoint filter 4 is activated via p1656.3 and parameterized via p1673 ... p1675.							
p1674	Current setpoint filter 4 denominator damping	0.001	10.000	0.300	-	Float	IM	T, U
	<b>Description:</b> Sets the denominator damping for current setpoint filter 4.							
	<b>Dependency:</b> Current setpoint filter 4 is activated via p1656.3 and parameterized via p1673 ... p1675.							
p1675	Current setpoint filter 4 numerator natural frequency	0.5	16000.0	1000.0	Hz	Float	IM	T, U
	<b>Description:</b> Sets the numerator natural frequency for current setpoint filter 4 (general filter).							
	<b>Dependency:</b> Current setpoint filter 4 is activated via p1656.3 and parameterized via p1673 ... p1675.							
p1676	Current setpoint filter 4 numerator damping	0.000	10.000	0.010	-	Float	IM	T, U
	<b>Description:</b> Sets the numerator damping for current setpoint filter 4.							
	<b>Dependency:</b> Current setpoint filter 4 is activated via p1656.3 and parameterized via p1673 ... p1675.							
p2153	Speed actual value filter time constant	0	1000000	0	ms	Float	IM	T, U
	<b>Description:</b> Sets the time constant of the PT1 element to smooth the speed / velocity actual value. The smoothed actual speed/velocity is compared with the threshold values and is only used for messages and signals.							
p2161 *	Speed threshold 3	0.00	210000.00	10.00	rpm	Float	IM	T, U
	<b>Description:</b> Sets the speed threshold value for the signal that indicates the axis is stationary.							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p2162 *	Hysteresis speed $n_{act} > n_{max}$	0.00	60000.00	0.00	rpm	Float	IM	T, U
	<b>Description:</b> Sets the hysteresis speed (bandwidth) for the signal " $n_{act} > n_{max}$ ".							
	<b>Note:</b> For a negative speed limit, the hysteresis is effective below the limit value and for a positive speed limit above the limit value. If significant overshoot occurs in the maximum speed range (for example, due to load shedding), you are advised to increase the dynamic response of the speed controller (if possible). If this is insufficient, the hysteresis p2162 can only be increased by more than 10% of the rated speed when the maximum speed of the motor is sufficiently greater than the speed limit p1082. The range of the parameter is different when connect with different motors.							
p2525	LR encoder adjustment offset	0	4294967295	0	LU	U32	IM	T
	<b>Description:</b> For the absolute encoder adjustment, a drive determines the position offset.							
	<b>Note:</b> The position offset is only relevant for absolute encoders. The drive determines it when making the adjustment and the user should not change it.							
p2533	LR position setpoint filter time constant	0.00	1000.00	0.00	ms	Float	IM	T, U
	<b>Description:</b> Sets the time constant for the position setpoint filter (PT1).							
	<b>Note:</b> The effective Kv factor (position loop gain) is reduced with the filter. This allows a softer control behavior with improved tolerance with respect to noise/disturbances. Applications: - Reduces the pre-control dynamic response. - Jerk limiting.							
p2542 *	LR standstill window	0	2147483647	1000	LU	U32	IM	T, U
	<b>Description:</b> Sets the standstill window for the standstill monitoring function. After the standstill monitoring time expires, it is cyclically checked whether the difference between the setpoint and actual position is located within the standstill window and, if required, an appropriate fault is output. Value = 0: The standstill monitoring is deactivated.							
	<b>Dependency:</b> Refer to: p2543, p2544, and F07450							
	<b>Note:</b> The following applies for the setting of the standstill and positioning window: Standstill window (p2542) $\geq$ positioning window (p2544)							
p2543 *	LR standstill monitoring time	0.00	100000.00	200.00	ms	Float	IM	T, U
	<b>Description:</b> Sets the standstill monitoring time for the standstill monitoring function. After the standstill monitoring time expires, it is cyclically checked whether the difference between the setpoint and actual position is located within the standstill window and, if required, an appropriate fault is output.							
	<b>Dependency:</b> Refer to: p2542, p2545, and F07450							
	<b>Note:</b> The following applies for the setting of the standstill and positioning monitoring time: Standstill monitoring time (p2543) $\leq$ positioning monitoring time (p2545)							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p2544 *	LR positioning window	0	2147483647	40	LU	U32	IM	T, U
	<p><b>Description:</b> Sets the positioning window for the positioning monitoring function. After the positioning monitoring time expires, it is checked once as to whether the difference between the setpoint and actual position lies within the positioning window and if required an appropriate fault is output. Value = 0 --&gt; The positioning monitoring function is de-activated.</p>							
	<p><b>Dependency:</b> Refer to F07451.</p>							
	<p><b>Note:</b> The following applies for the setting of the standstill and positioning window: Standstill window (p2542) ≥ positioning window (p2544)</p>							
p2545 *	LR positioning monitoring time	0.00	100000.00	1000.00	ms	Float	IM	T, U
	<p><b>Description:</b> Sets the positioning monitoring time for the positioning monitoring. After the positioning monitoring time expires, it is checked once as to whether the difference between the setpoint and actual position lies within the positioning window and if required an appropriate fault is output.</p>							
	<p><b>Dependency:</b> The range of p2545 depends on p2543. Refer to: p2543, p2544, F07451</p>							
	<p><b>Note:</b> The tolerance bandwidth is intended to prevent the dynamic following error monitoring incorrectly responding due to operational control sequences (for example, during load surges).</p>							
p2546 *	LR dynamic following error monitoring tolerance	0	2147483647	1000	LU	U32	IM	T, U
	<p><b>Description:</b> Sets the tolerance for the dynamic following error monitoring. If the dynamic following error (r2563) exceeds the selected tolerance, then an appropriate fault is output. Value = 0 --&gt; The dynamic following error monitoring is de-activated.</p>							
	<p><b>Dependency:</b> Refer to r2563, F07452</p>							
	<p><b>Note:</b> The tolerance bandwidth is intended to prevent the dynamic following error monitoring incorrectly responding due to operational control sequences (e.g. during load surges).</p>							
p2571	IPos maximum velocity	1	40000000	30000	1000 LU/min	U32	IM	T, U
	<p><b>Description:</b> Sets the maximum velocity for the "basic positioner" function (IPos).</p>							
	<p><b>Note:</b> The maximum velocity is active in all of the operating modes of the basic positioner. The maximum velocity for the basic positioner should be aligned with the maximum speed/velocity of the speed/velocity controller.</p>							
p2572 **	IPos maximum acceleration	1	2000000	Motor dependent	1000 LU/s <sup>2</sup>	U32	IM	T
	<p><b>Description:</b> Sets the maximum acceleration for the "basic positioner" function (IPos).</p>							
	<p><b>Note:</b> The maximum acceleration appears to exhibit jumps (without jerk). "Traversing blocks" operating mode: The programmed acceleration override acts on the maximum acceleration. "Direct setpoint input/MDI" mode: The acceleration override is effective. "Jog" and "search for reference" modes: No acceleration override is active. The axis starts with the maximum acceleration.</p>							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p2573 **	IPos maximum deceleration	1	2000000	Motor dependent	100 0 LU/s <sup>2</sup>	U32	IM	T
<p><b>Description:</b> Sets the maximum deceleration for the "basic positioner" function (IPos).</p> <p><b>Note:</b> The maximum deceleration appears to exhibit jumps (without jerk).  "Traversing blocks" operating mode:  The programmed deceleration override acts on the maximum deceleration.  "Direct setpoint input/MDI" mode:  The deceleration override is effective.  "Jog" and "search for reference" modes:  No deceleration override is effective. The axis brakes with the maximum deceleration.</p>								
p2574	IPOS jerk limiting	1	100000000	10000	100 0 LU/s <sup>3</sup>	U32	IM	T, U
<p><b>Description:</b> Sets the jerk limiting.</p> <p><b>Dependency:</b> Refer to p2572, p2573, p2575</p> <p><b>Note:</b> The jerk limiting is internally converted into a jerk time as follows:  <math>Jerk\ time\ Tr = \max(p2572, p2573) / p2574</math></p>								
p2580	EPOS software limit switch minus	-2147482648	2147482647	- 214748 2648	LU	I32	IM	T, U
<p><b>Description:</b> Sets the software limit switch in the negative direction of travel.</p> <p><b>Dependency:</b> Refer to p2581, p2582</p>								
p2581	EPOS software limit switch plus	-2147482648	2147482647	214748 2647	LU	I32	IM	T, U
<p><b>Description:</b> Sets the software limit switch in the positive direction of travel.</p> <p><b>Dependency:</b> Refer to p2580, p2582</p>								
p2582	EPOS software limit switch activation	-	-	0	-	U32/Binary	IM	T
<p><b>Description:</b> Sets the signal source to activate the "software limit switch".</p> <p><b>Dependency:</b> Refer to p2580, p2581</p> <p><b>Caution:</b> Software limit switch effective:  - Axis is referenced.  Software limit switch ineffective:  - Modulo correction active.  - Search for reference is executed.</p> <p><b>Notice:</b> Target position for relative positioning outside software limit switch:  The traversing block is started and the axis comes to a standstill at the software limit switch. An appropriate alarm is output and the traversing block is interrupted. Traversing blocks with valid position can be activated.  Target position for absolute positioning outside software limit switch:  In the "traversing blocks" mode, the traversing block is not started and an appropriate fault is output.  Axis outside the valid traversing range:  If the axis is already outside the valid traversing range, then an appropriate fault is output. The fault can be acknowledged at standstill. Traversing blocks with valid position can be activated.</p> <p><b>Note:</b> The traversing range can also be limited using STOP cams.</p>								

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p2583	EPOS backlash compensation	-200000	200000	0	LU	I32	IM	T, U
<p><b>Description:</b> Sets the amount of play (backlash) for positive or negative play.</p> <ul style="list-style-type: none"> <li>• = 0: The backlash compensation is de-activated.</li> <li>• &gt; 0: Positive backlash (normal case) When the direction is reversed, the encoder actual value leads the actual value.</li> <li>• &lt; 0: Negative backlash When the direction is reversed, the actual value leads the encoder actual value.</li> </ul> <p><b>Dependency:</b> If a stationary axis is referenced by setting the reference point, or an adjusted with absolute encoder is powered up, then the setting of p2604 is relevant for entering the compensation value.</p> <p>p2604 = 1: Traveling in the positive direction -&gt; A compensation value is immediately entered. Traveling in the negative direction -&gt; A compensation value is not entered</p> <p>p2604 = 0: Traveling in the positive direction -&gt; A compensation value is not entered Traveling in the negative direction -&gt; A compensation value is immediately entered.</p> <p>When again setting the reference point (a referenced axis) or for "flying referencing", p2604 is not relevant but instead the history of the axis. Refer to p2604</p>								
p2599	EPOS reference point coordinate value	-2147482648	2147482647	0	LU	I32	IM	T, U
<p><b>Description:</b> Sets the position value for the reference point coordinate. This value is set as the actual axis position after referencing or adjustment.</p> <p><b>Dependency:</b> Refer to p2525</p>								
p2600	EPOS search for reference point offset	-2147482648	2147482647	0	LU	I32	IM	T, U
<p><b>Description:</b> Sets the reference point offset for search for reference.</p>								
p2604	EPOS search for reference start direction	-	-	0	-	U32/Binary	IM	T
<p><b>Description:</b> Sets the signal sources for the start direction of the search for reference.</p> <ul style="list-style-type: none"> <li>• 1 signal: Start in the negative direction.</li> <li>• 0 signal: Start in the positive direction.</li> </ul> <p><b>Dependency:</b> Refer to p2583</p>								
p2605	EPOS search for reference approach velocity reference cam	1	40000000	5000	1000 LU/min	U32	IM	T, U
<p><b>Description:</b> Sets the approach velocity to the reference cam for the search for reference.</p> <p><b>Dependency:</b> The search for reference only starts with the approach velocity to the reference cam when there is a reference cam. Refer to p2604, p2606</p> <p><b>Note:</b> When traversing to the reference cam, the velocity override is effective. If, at the start of the search for reference, the axis is already at the reference cam, then the axis immediately starts to traverse to the zero mark.</p>								



Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p2606	EPOS search for reference reference cam maximum distance	0	2147482647	2147482647	LU	U32	IM	T, U
	<b>Description:</b> Sets the maximum distance after the start of the search for reference when traversing to the reference cam.							
	<b>Dependency:</b> Refer to p2604, p2605, F07458							
	<b>Note:</b> When using a reversing cam, the maximum distance must be set appropriately long.							
p2608	EPOS search for reference approach velocity zero mark	1	40000000	300	100 0 LU/ min	U32	IM	T, U
	<b>Description:</b> Sets the approach velocity after detecting the reference cam to search for the zero mark for the search for reference.							
	<b>Dependency:</b> If there is no reference cam, the search for reference immediately starts with the axis traversing to the zero mark. Refer to p2604, p2609							
	<b>Caution:</b> If the reference cam is not adjusted so that at each search for reference the same zero mark for synchronization is detected, then an "incorrect" axis reference point is obtained. After the reference cam has been left, the search for the zero mark is activated with a time delay due to internal factors. This is the reason that the reference cam should be adjusted in this center between two zero marks and the approach velocity should be adapted to the distance between two zero marks.							
	<b>Note:</b> The velocity override is not effective when traversing to the zero mark.							
p2609	EPOS search for reference max. distance ref. cam and zero mark	0	2147482647	20000	LU	U32	IM	T, U
	<b>Description:</b> Sets the maximum distance after leaving the reference cam when traversing to the zero mark.							
	<b>Dependency:</b> Refer to p2604, p2608, F07459							
p2611	EPOS search for reference approach velocity reference point	1	40000000	300	100 0 LU/ min	U32	IM	T, U
	<b>Description:</b> Sets the approach velocity after detecting the zero mark to approach the reference point.							
	<b>Dependency:</b> Refer to p2604, p2609							
	<b>Note:</b> When traversing to the reference point, the velocity override is not effective.							
p2617[0...7]	EPOS traversing block position	-2147482648	2147482647	0	LU	I32	IM	T, U
	<b>Description:</b> Sets the target position for the traversing block.							
	<b>Dependency:</b> Refer to p2618 <b>Note:</b> The target position is approached in either relative or absolute terms depending on p29241.							
p2618[0...7]	EPOS traversing block velocity	1	40000000	600	100 0 LU/ min	I32	IM	T, U
	<b>Description:</b> Sets the velocity for the traversing block.							
	<b>Dependency:</b> Refer to p2617							
	<b>Note:</b> The velocity can be influenced using the velocity override (p2646).							

## 10.2 Parameter list

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p2691	MDI speed fixed setpoint	1	40000000	600	1000 LU/min	U32	IM	T, U
	<b>Description:</b> Sets a fixed setpoint for the speed.							
p2692	MDI acceleration override, fixed setpoint	0.100	100.000	100.000	%	Float	IM	T, U
	<b>Description:</b> Sets a fixed setpoint for the acceleration override.							
	<b>Note:</b> The percentage value refers to the maximum acceleration (p2572).							
p2693	MDI deceleration override, fixed setpoint	0.100	100.000	100.000	%	Float	IM	T, U
	<b>Description:</b> Sets a fixed setpoint for the deceleration override.							
	<b>Note:</b> The percentage value refers to the maximum deceleration (p2573).							
p29000 *	Motor ID	0	65535	0	-	U16	IM	T
	<p><b>Description:</b> Motor type number is printed on the motor rating plate as motor ID.</p> <p>For a motor with an incremental encoder, users need to manually input the parameter value. The range of high inertia motor is 18 to 39; the range of low inertia motor is 42 to 71.</p> <p>For a motor with an absolute encoder, the drive automatically reads the parameter value. The range of high inertia motor with multi-turn encoder is 10009 to 10048.</p>							
p29001	Reversal of motor direction	0	1	0	-	I16	IM	T
	<p><b>Description:</b> Reversal of motor running direction. By default, CW is the positive direction while CCW the negative direction. After changing of p29001, reference point will lost, A7461 will remind user to referencing again.</p> <ul style="list-style-type: none"> <li>• 0: No reversal</li> <li>• 1: Reverse</li> </ul>							
p29002	BOP display selection	0	4	0	-	I16	IM	T, U
	<p><b>Description:</b> Selection of BOP operating display.</p> <ul style="list-style-type: none"> <li>• 0: Actual speed (default)</li> <li>• 1: DC voltage</li> <li>• 2: Actual torque</li> <li>• 3: Actual position</li> <li>• 4: Position following error</li> </ul>							
p29003	Control mode	0	8	0	-	U16	RE	T
	<p><b>Description:</b> Selection of control mode.</p> <ul style="list-style-type: none"> <li>• 0: Position control with pulse train input (PTI)</li> <li>• 1: Internal position control (IPos)</li> <li>• 2: Speed control (S)</li> <li>• 3: Torque control (T)</li> <li>• 4: Control change mode: PTI/S</li> <li>• 5: Control change mode: IPos/S</li> <li>• 6: Control change mode: PTI/T</li> <li>• 7: Control change mode: IPos/T</li> <li>• 8: Control change mode: S/T</li> </ul>							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
	<b>Note:</b> The compound control mode can be controlled by the digital input signal C-MODE. When DI10 (C-MODE) is 0, the first control mode of control change mode is selected; otherwise, the second one is selected.							
p29004	RS485 address	1	31	1	-	U16	RE	T
	<b>Description:</b> Configuration of the RS485 bus address. The RS485 bus is used to transfer current absolute position of the servo drive to the controller/PLC.							
	<b>Note:</b> Changes only become effective after power on. The parameter isn't influenced by default function.							
p29005	Braking resistor capacity percentage alarm threshold	1	100	100	%	Float	IM	T
	<b>Description:</b> Alarm triggering threshold for the capacity of the internal braking resistor. Alarm number: A52901							
p29006	Line supply voltage	200	480	400	V	U16	IM	T
	<b>Description:</b> Nominal Line supply voltage, effective value of line to line voltage. Drive can operate within -15% to +10% error. For V90 400 V variant, the value range is 380 V to 480 V, default value is 400 V. For V90 200 V variant, the value range is 200 V to 240 V, default value is 230 V.							
p29007	RS485 protocol	0	2	1	-	I16	RE	T
	<b>Description:</b> Set the communication protocol for the field bus interface: <ul style="list-style-type: none"> <li>• 0: No protocol</li> <li>• 1: USS</li> <li>• 2: Modbus</li> </ul>							
	<b>Note:</b> Changes only become effective after power on. The parameter isn't influenced by default function.							
p29008	Modbus control source	1	2	2	-	I16	RE	T
	<b>Description:</b> Select the Modbus control source: <ul style="list-style-type: none"> <li>• 1: Setpoint and control word from Modbus PZD</li> <li>• 2: No control word <ul style="list-style-type: none"> <li>– No setpoint and control word from Modbus PZD</li> </ul> </li> </ul>							
	<b>Note:</b> Changes only become effective after power on.							
p29009	RS485 baud rate	5	13	8	-	I16	RE	T
	<b>Description:</b> Set the baud rate for the RS485 interface: <ul style="list-style-type: none"> <li>• 5: 4800 baud</li> <li>• 6: 9600 baud</li> <li>• 7: 19200 baud</li> <li>• 8: 38400 baud</li> <li>• 9: 57600 baud</li> <li>• 10: 76800 baud</li> <li>• 11: 93750 baud</li> <li>• 12: 115200 baud</li> <li>• 13: 187500 baud</li> </ul>							
	<b>Note:</b> The change only becomes effective after power on. The parameter is not influenced by default function.							

## 10.2 Parameter list

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29010	PTI: Selection of input pulse form	0	3	0	-	U16	RE	T
	<p><b>Description:</b> Selection of setpoint pulse train input form. After changing of p29010, reference point will lost, A7461 will remind user to referencing again.</p> <ul style="list-style-type: none"> <li>0: Pulse + direction, positive logic</li> <li>1: AB phase, positive logic</li> <li>2: Pulse + direction, negative logic</li> <li>3: AB phase, negative logic</li> </ul>							
p29011	PTI: Number of Setpoint Pulse Per Revolution	0	16777215	0	-	U32	IM	T
	<p><b>Description:</b> The number of setpoint pulses per motor revolution. The servo motor rotates for one revolution when the number of the setpoint pulses reaches this value.</p> <p>When this value is 0, the number of required setpoint pulses is decided by the electronic gear ratio.</p>							
p29012[0..3]	PTI: Numerator of Electronic Gear	1	10000	1	-	U32	IM	T
	<p><b>Description:</b> The numerator of the electronic gear ratio for the setpoint pulses. For the servo system with an absolute encoder, the value range of p29012 is 1 to 10000.</p> <p>Four numerators in total are available. You can select one of the numerators by configuring the digital input signal EGEAR.</p> <p>For detailed information about the calculation of a numerator, refer to the SINAMICS V90 Operating Instructions or use SINAMICS V-ASSISTANT to do the calculation.</p>							
p29013	PTI: Denominator of Electronic Gear	1	10000	1	-	U32	IM	T
	<p><b>Description:</b> The denominator of the electronic gear for the setpoint pulses.</p>							
p29014	PTI: Selection of Pulse input Electrical Level	0	1	1	-	I16	IM	T
	<p><b>Description:</b> Selection of a logic level for the setpoint pulses.</p> <ul style="list-style-type: none"> <li>0: 5 V</li> <li>1: 24 V</li> </ul>							
p29016	PTI: Pulse Input Filter	0	1	[0] 0	-	I16	IM	T
	<p><b>Description:</b> Select filter for PTI input to get better EMC performance, 0 for low frequency PTI input, 1 for high frequency PTI input.</p>							
p29019	RS485 monitor time	0	1999999	0	ms	Float	IM	T
	<p><b>Description:</b> Sets the monitoring time to monitor the process data received via the RS485 bus interface. If no process data is received within this time, then an appropriate message is output.</p>							
	<p><b>Note:</b> If p29019 = 0, monitoring is deactivated.</p>							
p29020[0..1]	Tuning: Dynamic factor	1	35	18	-	U16	IM	T, U
	<p><b>Description:</b> The dynamic factor of auto tuning. 35 dynamic factors in total are available.</p>							
	<p>Index:</p> <ul style="list-style-type: none"> <li>[0]: Dynamic factor for one-button auto tuning</li> <li>[1]: Dynamic factor for real-time auto tuning</li> </ul>							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29021	Tuning: Mode Selection	0	5	0	-	I16	IM	T
	<b>Description:</b> Selection of a tuning mode. <ul style="list-style-type: none"> <li>• 0: Disabled</li> <li>• 1: One-button auto tuning</li> <li>• 3: Real-time auto tuning</li> <li>• 5: Disable with default controller parameters</li> </ul>							
p29022	Tuning: Ratio of Total Inertia Moment to Motor Inertia Moment	1.00	10000.00	1.00	-	Float	IM	T, U
	<b>Description:</b> Ratio of total inertia moment to servo motor inertia moment.							
p29023	Tuning: One-button auto tuning configuration	0	0xffff	0x0007	-	U16	IM	T, U
	<b>Description:</b> One-button auto tuning configuration. <ul style="list-style-type: none"> <li>• Bit 0: The speed controller gain is determined and set using a noise signal.</li> <li>• Bit 1: Possible required current setpoint filters are determined and set using a noise signal. As a consequence, a higher dynamic performance can be achieved in the speed control loop.</li> <li>• Bit 2: The inertia moment ratio (p29022) can be measured after this function is running. If not set, the inertia moment ratio must be set manually with p29022.</li> <li>• Bit 7: With this bit set, multi-axes are adapted to the dynamic response set in p29028. This is necessary for interpolating axes. The time in p29028 should be set according to the axis with the lowest dynamic response.</li> </ul>							
p29024	Tuning: Real-time auto tuning configuration	0	0xffff	0x004c	-	U16	IM	T
	<b>Description:</b> Real-time auto tuning configuration. <ul style="list-style-type: none"> <li>• Bit 2: The inertia moment ratio (p29022) is estimated while the motor is running, if not set, the inertia moment ratio must be set manually with p29022.</li> <li>• Bit 3: If not set, the inertia moment ratio (p29022) is estimated only once and the inertia estimator is deactivated automatically after the estimation is completed. If the bit is set to 1, the inertia moment ratio is estimated in real time and the controller adapts the parameters continuously. You are recommended to save the parameters when the estimation result is satisfied. After that, when you power on the drive next time, the controller will be started with the optimized parameters.</li> <li>• Bit 6: The adaption of current setpoint filter. This adaption may be necessary if a mechanical resonance frequency changes in operation. It can also be used to dampen a fixed resonance frequency. Once the control loop has stabilized, this bit should be deactivated and to save parameters in a non-volatile memory.</li> <li>• Bit 7: With this bit set, multi-axes are adapted to the dynamic response set in p29028. This is necessary for interpolating axes. The time in p29028 should be set according to the axis with the lowest dynamic response.</li> </ul>							

## 10.2 Parameter list

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29025	Tuning: Configuration overall	0	0x003f	0x0004	-	U16	IM	T, U
<p><b>Description:</b> Overall configuration of auto tuning, apply for both one-button and real-time auto tuning.</p> <ul style="list-style-type: none"> <li>• Bit 0: For significant differences between the motor and load moment of inertia, or for low dynamic performance of the controller, then the P controller becomes a PD controller in the position control loop. As a consequence, the dynamic performance of the position controller is increased. This function should only be set when the speed pre-control (bit 3 = 1) or the torque pre-control (bit 4 = 1) is active.</li> <li>• Bit 1: At low speeds, the controller gain factors are automatically reduced in order to avoid noise and oscillation at standstill. This setting is recommended for incremental encoders.</li> <li>• Bit 2: The estimated load moment of inertia is taken into account for the speed controller gain.</li> <li>• Bit 3: Activates the speed pre-control for the position controller.</li> <li>• Bit 4: Activates the torque pre-control for the position controller.</li> <li>• Bit 5: Adapts acceleration limit.</li> </ul>								
p29026	Tuning: Test signal duration	0	5000	2000	ms	U32	IM	T
<p><b>Description:</b> The duration time of the one-button auto tuning test signal.</p>								
p29027	Tuning: Limit rotation of motor	0	3000	0	°	U32	IM	T
<p><b>Description:</b> The limit position with motor rotations during one-button auto tuning. The traversing range is limited within +/- p29027 degrees (motor run one revolution is 360 degree).</p>								
p29028	Tuning: Pre-control time constant	0.0	60.0	7.5	ms	Float	IM	T, U
<p><b>Description:</b> Sets the time constant for the pre-control symmetrization for auto tuning. As a consequence, the drive is allocated a defined, dynamic response via its pre-control. For drives, which must interpolate with one another, the same value must be entered. The higher this time constant is, the smoother the drive will follow the position set point.</p> <p><b>Note:</b> This time constant is only effective when multi-axis interpolation is selected (bit 7 of p29023 and p29024).</p>								
p29030	PTO: Number of pulse per revolution	0, 30	16384	1000	-	U32	IM	T
<p><b>Description:</b> Number of output pulses per motor revolution. If this value is 0, the number of required output pulses is decided by the electronic gear ratio.</p>								
p29031	PTO: Numerator of electronic gear	1	214700000 0	1	-	U32	IM	T
<p><b>Description:</b> The numerator of the electronic gear ratio for the output pulses. For detailed information about the calculation of a numerator, refer to the SINAMICS V90 Operating Instructions or use the SINAMICS V-ASSISTANT to do the calculation.</p>								
p29032	PTO: Denominator electronic gear	1	214700000 0	1	-	U32	IM	T
<p><b>Description:</b> The denominator of the electronic gear ratio for the output pulses. For detailed information about the calculation of a denominator, refer to the SINAMICS V90 Operating Instructions or use the SINAMICS V-ASSISTANT to do the calculation.</p>								

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29033	PTO: Direction change	0	1	0	-	I16	IM	T
	<p><b>Description:</b> Select the PTO direction.</p> <ul style="list-style-type: none"> <li>0: PTO positive PTO direction does not change. PTO A leads PTO B with 90 degrees when the motor rotates in clockwise direction. PTO B leads PTO A with 90 degrees when the motor rotates in counter-clockwise direction.</li> <li>1: PTO negative PTO direction changes. PTO A leads PTO B with 90 degrees when the motor rotates in counter-clockwise direction. PTO B leads PTO A with 90 degrees when the motor rotates in clockwise direction.</li> </ul>							
p29035	VIBSUP activation	0	1	0	-	I16	IM	T
	<p><b>Description:</b> Select the VIBSUP on/off. Position setpoint filter can be activated (p29035) for IPos control mode.</p> <ul style="list-style-type: none"> <li>0: Disable Filter is not activated.</li> <li>1: Enable Filter is activated.</li> </ul>							
p29041[0..1]	Torque Scaling	0	[0] 100 [1] 300	[0] 100 [1] 300	%	Float	IM	T
	<p><b>Description:</b></p> <ul style="list-style-type: none"> <li>[0]The scaling for the analog torque setpoint. With this parameter, you can specify the torque setpoint corresponding to full analog input (10 V).</li> <li>[1]The scaling for the analog torque limit. With this parameter, you can specify the torque limit corresponding to full analog input (10 V).</li> </ul> <p>You can select the internal parameters or the analog input as the source of the torque limit with the combination of the digital input signals TLIM1 and TLIM2.</p>							
	<p><b>Index:</b> [0]: Torque set scale [1]: Torque limit scale</p>							
p29042	Offset Adjustment for Analog input 2	-0.50	0.50	0.00	V	Float	IM	T
	<p><b>Description:</b> Offset adjustment for the analog input 2.</p>							
p29043	Fixed Torque Setpoint	-100	100	0	%	Float	IM	U, T
	<p><b>Description:</b> Fixed torque setpoint. You can select the internal parameters or the analog input as the source of the torque setpoint by configuring the digital input signal TSET.</p>							
p29050[0..2]	Torque limit upper	-150	300	300	%	Float	IM	T
	<p><b>Description:</b> Positive torque limit. Three internal torque limits in total are available. You can select the internal parameters or the analog input as the source of the torque limit with the combination of the digital input signals TLIM1 and TLIM2.</p>							

## 10.2 Parameter list

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29051[0..2]	Torque limit lower	-300	150	-300	%	Float	IM	T
	<b>Description:</b> Negative torque limit. Three internal torque limits in total are available. You can select the internal parameters or the analog input as the source of the torque limit with the combination of the digital input signals TLIM1 and TLIM2.							
p29060 *	Speed Scaling	6	210000	3000	rpm	Float	IM	T
	<b>Description:</b> The scaling for the analog speed setpoint. With this parameter, you can specify the speed setpoint corresponding to full analog input (10 V).							
p29061	Offset Adjustment for Analog input 1	-0.50	0.50	0.00	V	Float	IM	T
	<b>Description:</b> Offset adjustment for the analog input 1.							
p29070[0..2] *	Speed limit positive	0	210000	210000	rpm	Float	IM	T
	<b>Description:</b> Positive speed limit. Three internal speed limits in total are available. You can select the internal parameters or the analog input as the source of the speed limit with the combination of the digital input signals SLIM1 and SLIM2.							
p29071[0..2] *	Speed limit negative	-210000	0	-210000	rpm	Float	IM	T
	<b>Description:</b> Negative speed limit. Three internal speed limits in total are available. You can select the internal parameters or the analog input as the source of the speed limit with the combination of the digital input signals SLIM1 and SLIM2.							
p29075	Speed Clamp Threshold	0	200	200	rpm	Float	IM	T
	<b>Description:</b> The threshold for the zero speed clamp. If the function of zero speed clamp has been enabled under the speed control mode, the motor speed is clamped to 0 when both the setpoint speed and the actual speed are below this threshold.							
p29078	Speed Reach Threshold	0.0	100.0	10	rpm	Float	IM	T
	<b>Description:</b> Speed reached range (deviation between setpoint and motor speed)							
p29080	Overload Threshold for Output Signal Triggering	10	300	100	%	Float	IM	T
	<b>Description:</b> Overload threshold for the output power.							
p29090	Offset Adjustment for Analog output 1	-0.50	0.50	0.00	V	Float	IM	T
	<b>Description:</b> Offset adjustment for analog output 1.							
p29091	Offset Adjustment for Analog output 2	-0.50	0.50	0.00	V	Float	IM	T
	<b>Description:</b> Offset adjustment for analog output 2.							
p29110[0..1] **	Position Loop Gain	0.000	300.000	[0] Motor dependent [1] 1.000	1000/min	Float	IM	T, U



Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
	<p><b>Description:</b> Position loop gain. Two position loop gains in total are available. You can switch between these two gains by configuring the digital input signal G-CHANGE or setting relevant condition parameters. The first position loop gain is the default setting.</p> <p><b>Dependency:</b> The parameter value will be set to default after configuring a new motor ID (p29000).</p>							
p29111	Speed Pre-control Factor (Feed Forward)	0.00	200.00	0.00	%	Float	IM	T, U
	<p><b>Description:</b> Setting to activate and weight the speed pre-control value. Value = 0 % --&gt; The pre-control is deactivated.</p>							
p29120[0..1]**	Speed Loop Gain	0.00	999999.00	[0] Motor dependent [1] 0.30	Nms /rad	Float	IM	T, U
	<p><b>Description:</b> Speed loop gain. Two speed loop gains in total are available. You can switch between these two gains by configuring the digital input signal G-CHANGE or setting relevant condition parameters. The first speed loop gain is the default setting.</p> <p><b>Dependency:</b> The parameter value will be set to default after configuring a new motor ID (p29000).</p>							
p29121[0..1]*	Speed Loop Integral time	0.00	100000.00	[0] 15 [1] 20	ms	Float	IM	T, U
	<p><b>Description:</b> Speed loop integral time. Two speed loop integral time values in total are available. You can switch between these two time values by configuring the digital input signal G-CHANGE or setting relevant condition parameters. The first speed loop integral time is the default setting.</p> <p><b>Dependency:</b> The parameter value will be set to default after configuring a new motor ID (p29000).</p>							
p29130	Gain Switching: Mode Selection	0	4	0	-	I16	IM	T
	<p><b>Description:</b> Selects gain switching mode.</p> <ul style="list-style-type: none"> <li>• 0: Disabled</li> <li>• 1: Switch through DI-G-CHANG</li> <li>• 2: Position deviation as switch condition</li> <li>• 3: Pulse input frequency as switch condition</li> <li>• 4: Actual speed as switch condition</li> </ul> <p><b>Note:</b> Only when the auto tuning function (p20021=0) is disabled can the gain switching function be used.</p>							
p29131	Gain Switching Condition: Pulse Deviation	0	2147483647	100	LU	I32	IM	T
	<p><b>Description:</b> Triggers position deviation threshold for gain switching. If the gain switching function is enabled and this condition is selected:</p> <ul style="list-style-type: none"> <li>• Switch from the first group of control parameters to the second group when the position deviation is larger than the threshold.</li> <li>• Switch from the second group of control parameters to the first group when the position deviation is smaller than the threshold.</li> </ul>							

## 10.2 Parameter list

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29132	Gain Switching Condition: Position Setpoint Frequency	0	2147000064	100	1000 LU/min	Float	IM	T
	<p><b>Description:</b> Triggers pulse input frequency (PTI) threshold or internal position speed (IPos) threshold for gain switching. If the gain switching function is enabled and this condition is selected:</p> <ol style="list-style-type: none"> <li>1. PTI <ul style="list-style-type: none"> <li>– Switch from the first group of control parameters to the second group when the pulse train input pulse is higher than the threshold.</li> <li>– Switch from the second group of control parameters to the first group when the pulse train input is lower than the threshold.</li> </ul> </li> <li>2. IPos <ul style="list-style-type: none"> <li>– Switch from the first group of control parameters to the second group when the speed of fixed position setpoint is larger than the threshold.</li> <li>– Switch from the second group of control parameters to the first group when the IPos is smaller than the threshold.</li> </ul> </li> </ol>							
p29133	Gain Switching Condition: Actual Speed	0	2147000064	100	rpm	Float	IM	T
	<p><b>Description:</b> Triggers speed threshold for gain switching. If the gain switching function is enabled and this condition is selected:</p> <ul style="list-style-type: none"> <li>• Switch from the first group of control parameters to the second group when the actual motor speed is larger than the threshold.</li> <li>• Switch from the second group of control parameters to the first group when the actual motor speed is smaller than the threshold.</li> </ul>							
p29139	Gain switching Time Constant	8	1000	20	ms	Float	IM	T
	<p><b>Description:</b> Time constant for gain switching. Set this parameter to avoid frequent gain switches that reduces system reliability.</p>							
p29140	PI to P: Mode Selection	0	5	0	-	U16	IM	T
	<p><b>Description:</b> Selects a condition for the switch from PI control to P control under the speed loop.</p> <ul style="list-style-type: none"> <li>• 0: Disabled</li> <li>• 1: Torque is higher than a parameterizable setting value.</li> <li>• 2: Using the digital input signal (G-CHANGE).</li> <li>• 3: Speed is higher than a parameterizable setting value.</li> <li>• 4: Acceleration is higher than a parameterizable setting value.</li> <li>• 5: Pulse deviation is higher than a parameterizable setting value.</li> </ul> <p><b>Note:</b> Only when the auto tuning function (p29021=0) and gain switching function are both disabled can the PI/P switching function be used.</p>							
p29141	PI to P Switching Condition: Torque	0	300	200	%	Float	IM	T
	<p><b>Description:</b> Triggers torque threshold for PI/P switching. If the PI/P switching function is enabled and this condition is selected:</p> <ul style="list-style-type: none"> <li>• Switch from the PI control to the P control when the actual torque is larger than the threshold.</li> <li>• Switch from the P control to the PI control when the actual torque is smaller than the threshold.</li> </ul>							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29142	PI to P Switching Condition: Speed	0	210000	2000	rpm	Float	IM	T
	<b>Description:</b> Triggers speed threshold for PI/P switching. If the PI/P switching function is enabled and this condition is selected: <ul style="list-style-type: none"> <li>• Switch from the PI control to the P control when the actual speed is larger than the threshold.</li> <li>• Switch from the P control to the PI control when the actual speed is smaller than the threshold.</li> </ul>							
p29143	PI to P Switching Condition: Acceleration	0	30000	20	rev/s <sup>2</sup>	Float	IM	T
	<b>Description:</b> Triggers acceleration threshold for PI/P switching. If the PI/P switching function is enabled and this condition is selected: <ul style="list-style-type: none"> <li>• Switch from the PI control to the P control when the actual acceleration is larger than the threshold.</li> <li>• Switch from the P control to the PI control when the actual acceleration is smaller than the threshold.</li> </ul>							
p29144	PI to P Switching Condition: Pulse Deviation	0	2147483647	30000	LU	U32	IM	T
	<b>Description:</b> Triggers pulse deviation threshold for PI/P switching. If the PI/P switching function is enabled and this condition is selected: <ul style="list-style-type: none"> <li>• Switch from the PI control to the P control when the actual pulse deviation is larger than the threshold.</li> <li>• Switch from the P control to the PI control when the actual pulse deviation is smaller than the threshold.</li> </ul>							
p29230	MDI direction selection	0	2	0	-	I16	IM	T
	<b>Description:</b> MDI direction selection: <ul style="list-style-type: none"> <li>• 0: absolute positioning through the shortest distance</li> <li>• 1: absolute positioning through the positive direction</li> <li>• 2: absolute positioning through the negative direction</li> </ul>							
p29240	Select Referencing Mode	0	4	1	-	I16	IM	T
	<b>Description:</b> Selects referencing mode. <ul style="list-style-type: none"> <li>• 0: referencing with external signal REF</li> <li>• 1: referencing with external reference cam (signal REF)</li> <li>• 2: referencing with zero mark only</li> <li>• 3: referencing with external reference cam (CCWL) and zero mark</li> <li>• 4: referencing with external reference cam (CWL) and zero mark</li> </ul>							
p29241	Motion Mode	0	3	0	-	U16	IM	T
	<b>Description:</b> Moves mode set for IPos: <ul style="list-style-type: none"> <li>• 0: means relative moving</li> <li>• 1: means abs moving</li> <li>• 2: POS Mod</li> <li>• 3: NEG Mod</li> </ul>							
p29242	CLR Pulse Mode	0	2	0	-	U16	IM	T
	<b>Description:</b> Select clear pulse mode <ul style="list-style-type: none"> <li>• 0: disabled</li> <li>• 1: means clear pulse on high level</li> <li>• 2: means clear pulse on rising edge</li> </ul>							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29243	Positioning tracking activate	0	1	0	-	I16	IM	T
<b>Description:</b> Activation of position tracking. <ul style="list-style-type: none"> <li>• 0: deactivated</li> <li>• 1: activated</li> </ul>								
p29244	Absolute encoder virtual rotary revolutions	0	4096	0	-	U32	IM	T
<b>Description:</b> Sets the number of rotations that can be resolved for an encoder with activated position tracking function (p29243 = 1).								
p29245	Axis mode state	0	1	0	-	U32	IM	T
<b>Description:</b> Linear/modulo mode <ul style="list-style-type: none"> <li>• 0: linear axis</li> <li>• 1: modulo axis</li> </ul>								
p29246 *	EPOS modulo correction module range	1	214748264 7	360000	LU	U32	IM	T
<b>Description:</b> Sets the modulo range for axes with modulo correction.								
p29247 *	Mechanical gear: pulse per revolution	1	214748364 7	10000	-	U32	IM	T
<b>Description:</b> LU per load revolution								
p29248 *	Mechanical gear: numerator	1	1048576	1	-	U32	IM	T
<b>Description:</b> (Load/Motor) Load revolutions								
p29249 *	Mechanical gear: denominator	1	1048576	1	-	U32	IM	T
<b>Description:</b> (Load/Motor) Motor revolutions								
p29250	PTI Absolute Position Mode Enable	0	1	0	-	U32	RE	T
<b>Description:</b> Absolute Position Mode Enable. <ul style="list-style-type: none"> <li>• =1 Enable Absolute Mode</li> <li>• =0 Disable Absolute Mode</li> </ul>								
p29300	Digital Input Forced Signals	0	127	0	-	U32	IM	T, U
<b>Description:</b> Input signals are forced to be high. 7 bits in total. <ul style="list-style-type: none"> <li>• Bit 0: SON</li> <li>• Bit 1: CWL</li> <li>• Bit 2: CCWL</li> <li>• Bit 3: TLIM1</li> <li>• Bit 4: SPD1</li> <li>• Bit 5: TSET</li> <li>• Bit 6: EMGS</li> </ul> <p>If one or more bits are set to be high, the corresponding input signals are forced to be logical high signals.</p>								
<b>Note:</b> The drive unit displays the value in hex format. To know the logic (high/low) assignment to each bit, you must convert the hex number to the binary number, for example, FF (hex) = 11111111 (bin).								

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29301[0..3]	Digital Input 1 Assignment	0	28	1	-	l16	IM	T
<p><b>Description:</b> Defines the function of digital input signal DI1 (PTI mode)</p> <ul style="list-style-type: none"> <li>• SON 1</li> <li>• RESET 2</li> <li>• CWL 3</li> <li>• CCWL 4</li> <li>• G-CHANGE 5</li> <li>• P-TRG 6</li> <li>• CLR 7</li> <li>• EGEAR1 8</li> <li>• EGEAR2 9</li> <li>• TLIMIT1 10</li> <li>• TLIMIT2 11</li> <li>• CWE 12</li> <li>• CCWE 13</li> <li>• ZSCLAMP 14</li> <li>• SPD1 15</li> <li>• SPD2 16</li> <li>• SPD3 17</li> <li>• TSET 18</li> <li>• SLIMIT1 19</li> <li>• SLIMIT2 20</li> <li>• POS1 21</li> <li>• POS2 22</li> <li>• POS3 23</li> <li>• REF 24</li> <li>• SREF 25</li> <li>• STEPF 26</li> <li>• STEPB 27</li> <li>• STEPH 28</li> </ul> <p><b>Index:</b></p> <ul style="list-style-type: none"> <li>• [0]: DI1 for Control mode 0</li> <li>• [1]: DI1 for Control mode 1</li> <li>• [2]: DI1 for Control mode 2</li> <li>• [3]: DI1 for Control mode 3</li> </ul>								
p29302[0..3]	Digital Input 2 Assignment	0	28	2	-	l16	IM	T
<p><b>Description:</b> Defines the function of digital input signal DI2</p>								

## 10.2 Parameter list

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
	<b>Index:</b> <ul style="list-style-type: none"> <li>[0]: DI2 for Control mode 0</li> <li>[1]: DI2 for Control mode 1</li> <li>[2]: DI2 for Control mode 2</li> <li>[3]: DI2 for Control mode 3</li> </ul>							
p29303[0..3]	Digital Input 3 Assignment	0	28	3	-	I16	IM	T
	<b>Description:</b> Defines the function of digital input signal DI3							
	<b>Index:</b> <ul style="list-style-type: none"> <li>[0]: DI3 for Control mode 0</li> <li>[1]: DI3 for Control mode 1</li> <li>[2]: DI3 for Control mode 2</li> <li>[3]: DI3 for Control mode 3</li> </ul>							
p29304[0..3]	Digital Input 4 Assignment	0	28	4	-	I16	IM	T
	<b>Description:</b> Defines the function of digital input signal DI4							
	<b>Index:</b> <ul style="list-style-type: none"> <li>[0]: DI4 for Control mode 0</li> <li>[1]: DI4 for Control mode 1</li> <li>[2]: DI4 for Control mode 2</li> <li>[3]: DI4 for Control mode 3</li> </ul>							
p29305[0..3]	Digital Input 5 Assignment	0	28	[0] 5; [1] 5; [2] 12; [3] 12	-	I16	IM	T
	<b>Description:</b> Defines the function of digital input signal DI5							
	<b>Index:</b> <ul style="list-style-type: none"> <li>[0]: DI5 for Control mode 0</li> <li>[1]: DI5 for Control mode 1</li> <li>[2]: DI5 for Control mode 2</li> <li>[3]: DI5 for Control mode 3</li> </ul>							
p29306[0..3]	Digital Input 6 Assignment	0	28	[0] 6; [1] 6; [2] 13; [3] 13	-	I16	IM	T
	<b>Description:</b> Defines the function of digital input signal DI6							
	<b>Index:</b> <ul style="list-style-type: none"> <li>[0]: DI6 for Control mode 0</li> <li>[1]: DI6 for Control mode 1</li> <li>[2]: DI6 for Control mode 2</li> <li>[3]: DI6 for Control mode 3</li> </ul>							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29307[0..3]	Digital Input 7 Assignment	0	28	[0] 7; [1] 21; [2] 15; [3] 18	-	l16	IM	T
	<b>Description:</b> Defines the function of digital input signal DI7 <b>Index:</b> <ul style="list-style-type: none"> <li>• [0]: DI7 for Control mode 0</li> <li>• [1]: DI7 for Control mode 1</li> <li>• [2]: DI7 for Control mode 2</li> <li>• [3]: DI7 for Control mode 3</li> </ul>							
p29308[0..3]	Digital Input 8 Assignment	0	28	[0] 10; [1] 22; [2] 16; [3] 19	-	l16	IM	T
	<b>Description:</b> Defines the function of digital input signal DI8 <b>Index:</b> <ul style="list-style-type: none"> <li>• [0]: DI8 for Control mode 0</li> <li>• [1]: DI8 for Control mode 1</li> <li>• [2]: DI8 for Control mode 2</li> <li>• [3]: DI8 for Control mode 3</li> </ul>							
p29330	Digital Output 1 Assignment	1	14	1	-	l16	IM	T
	<b>Description:</b> Defines the function of digital output signal DO1 <ul style="list-style-type: none"> <li>• 1: RDY</li> <li>• 2: FAULT</li> <li>• 3: INP</li> <li>• 4: ZSP</li> <li>• 5: SPDR</li> <li>• 6: TLR</li> <li>• 7: SPLR</li> <li>• 8: MBR</li> <li>• 9: OLL</li> <li>• 10: WARNING1</li> <li>• 11: WARNING2</li> <li>• 12: REFOK</li> <li>• 13: CM_STA</li> <li>• 14: RDY_ON</li> </ul>							
p29331	Digital Output 2 Assignment	1	14	2	-	l16	IM	T
	<b>Description:</b> Defines the function of digital output signal DO2							
p29332	Digital Output 3 Assignment	1	14	3	-	l16	IM	T
	<b>Description:</b> Defines the function of digital output signal DO3							

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29333	Digital Output 4 Assignment	1	14	5	-	I16	IM	T
<b>Description:</b> Defines the function of digital output signal DO4								
p29334	Digital Output 5 Assignment	1	14	6	-	I16	IM	T
<b>Description:</b> Defines the function of digital output signal DO5								
p29335	Digital Output 6 Assignment	1	14	8	-	I16	IM	T
<b>Description:</b> Defines the function of digital output signal DO6								
p29340	Warning 1 Assigned for Digital Output	1	6	1	-	U16	IM	T
<b>Description:</b> Defines conditions for WRN1. <ul style="list-style-type: none"> <li>• 1: Motor overload protection warning: 85% of overload threshold has been reached.</li> <li>• 2: Holding brake power overload warning: 85% of overload threshold has been reached.</li> <li>• 3: Fan warning: fan has stopped for more than 1 s.</li> <li>• 4: Encoder warning</li> <li>• 5: Motor overtemperature warning: 85% of overtemperature threshold has been reached.</li> <li>• 6: Capacitor service life warning: The capacitor has reached its expiry, so replace it.</li> </ul>								
p29341	Warning 2 Assigned for Digital Output	1	6	2	-	U16	IM	T
<b>Description:</b> Defines conditions for WARNING2. <ul style="list-style-type: none"> <li>• 1: Motor overload protection warning: 85% of overload threshold has been reached.</li> <li>• 2: Holding brake power overload warning: 85% of overload threshold has been reached.</li> <li>• 3: Fan warning: life time of fan expired (40000 hours), replacement of fan needed.</li> <li>• 4: Encoder warning</li> <li>• 5: Motor overtemperature warning: 85% of overtemperature threshold has been reached.</li> <li>• 6: Capacitor service life warning: The capacitor has reached its expiry, so replace it.</li> </ul>								



Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p29350	Select sources for analog output 1	0	12	0	-	U16	IM	T
<p><b>Description:</b> Selects signal source for analog output 1.</p> <ul style="list-style-type: none"> <li>• 0: Actual speed (reference p29060)</li> <li>• 1: Actual torque (reference 3 × r0333)</li> <li>• 2: Speed setpoint (reference p29060)</li> <li>• 3: Torque setpoint (reference 3 × r0333)</li> <li>• 4: DC bus voltage (reference 1000 V)</li> <li>• 5: Pulse input frequency (reference 1k)</li> <li>• 6: Pulse input frequency (reference 10k)</li> <li>• 7: Pulse input frequency (reference 100k)</li> <li>• 8: Pulse input frequency (reference 1000k)</li> <li>• 9: Remaining number of pulses (reference 1k)</li> <li>• 10: Remaining number of pulses (reference 10k)</li> <li>• 11: Remaining number of pulses (reference 100k)</li> <li>• 12: Remaining number of pulses (reference 1000k)</li> </ul>								
p29351	Select Signal Source for Analog 2	0	12	1	-	U16	IM	T
<p><b>Description:</b> Selects signals for analog output 2.</p> <ul style="list-style-type: none"> <li>• 0: Actual speed (reference p29060)</li> <li>• 1: Actual torque (reference 3 × r0333)</li> <li>• 2: Speed setpoint (reference p29060)</li> <li>• 3: Torque setpoint (reference 3 × r0333)</li> <li>• 4: DC bus voltage (reference 1000 V)</li> <li>• 5: Pulse input frequency (reference 1k)</li> <li>• 6: Pulse input frequency (reference 10k)</li> <li>• 7: Pulse input frequency (reference 100k)</li> <li>• 8: Pulse input frequency (reference 1000k)</li> <li>• 9: Remaining number of pulses (reference 1k)</li> <li>• 10: Remaining number of pulses (reference 10k)</li> <li>• 11: Remaining number of pulses (reference 100k)</li> <li>• 12: Remaining number of pulses (reference 1000k)</li> </ul>								
p31581	VIBSUP: Filter type	0	1	0	-	I16	IM	T
<p><b>Description:</b> Sets the filter type for VIBSUP. Depending on the selected filter type, the VIBSUP filter results in motion sequences that take somewhat longer.</p> <ul style="list-style-type: none"> <li>• 0: The rugged VIBSUP filter has a lower sensitivity to frequency offsets compared with the sensitive filter type, but results in a higher delay of the motion sequence. The total motion sequence is extended by the time period <math>T_d</math> (<math>T_d = 1/f_d</math>).</li> <li>• 1: The sensitive VIBSUP filter has a higher sensitivity to frequency offsets compared with the rugged filter type, but results in a lower delay of the motion sequence. The total motion sequence is extended by half the time period <math>T_d/2</math> (<math>T_d = 1/f_d</math>).</li> </ul>								

Par. No.	Name	Min	Max	Factory Setting	Unit	Data type	Effective	Can be changed
p31585	VIBSUP: Filter frequency $f_d$	0.5	62.5	1	Hz	Float 32	IM	T
	<b>Description:</b> Sets the frequency of the damped natural vibration of the mechanical system. This frequency can be determined by making the appropriate measurements.							
	<b>Note:</b> The maximum frequency that can be set depends on the filter sampling time.							
p31586	VIBSUP: Filter damping	0.00	0.99	0.03	-	Float 32	IM	T
	<b>Description:</b> Sets the value for the damping of the natural mechanical vibration to be filtered. Typically, the damping value is about 0.03, and can be optimized by performing the appropriate positioning tests.							

## Read-only parameters

Par. No.	Name	Unit	Data type
r0020	Speed setpoint smoothed	rpm	Float
	<b>Description:</b> Displays the currently smoothed speed setpoint at the input of the speed controller or U/f characteristic (after the interpolator).		
	<b>Note:</b> Smoothing time constant = 100 ms The signal is not suitable as a process quantity and may only be used as a display quantity. The speed setpoint is available smoothed (r0020) and unsmoothed.		
r0021	Actual speed smoothed	rpm	Float
	<b>Description:</b> Displays the smoothed actual value of the motor speed.		
	<b>Note:</b> Smoothing time constant = 100 ms The signal is not suitable as a process quantity and may only be used as a display quantity. The speed actual value is available smoothed (r0021) and unsmoothed.		
r0026	DC link voltage smoothed	V	Float
	<b>Description:</b> Displays the smoothed actual value of the DC link voltage.		
	<b>Notice:</b> When measuring a DC link voltage < 200 V, for the Power Module (e.g. PM340) a valid measured value is not supplied. In this case, when an external 24 V power supply is connected, a value of approx. 24 V is displayed in the display parameter. <b>Note:</b> Smoothing time constant = 100 ms The signal is not suitable as a process quantity and may only be used as a display quantity. The DC link voltage is available smoothed (r0026) and unsmoothed.		
r0027	Absolute actual current smoothed	Arms	Float
	<b>Description:</b> Displays the smoothed absolute actual current value.		
	<b>Notice:</b> This smoothed signal is not suitable for diagnostics or evaluation of dynamic operations. In this case, the unsmoothed value should be used. <b>Note:</b> Smoothing time constant = 100 ms The signal is not suitable as a process quantity and may only be used as a display quantity. The absolute current actual value is available smoothed (r0027) and unsmoothed.		
r0029	Current actual value field-generating smoothed	Arms	Float
	<b>Description:</b> Displays the smoothed field-generating actual current.		
	<b>Note:</b> Smoothing time constant = 100 ms The signal is not suitable as a process quantity and may only be used as a display quantity. The field-generating current actual value is available smoothed (r0029) and unsmoothed.		

Par. No.	Name	Unit	Data type
r0030	Current actual value torque-generating smoothed	Arms	Float
	<b>Description:</b> Displays the smoothed torque-generating actual current.		
	<b>Note:</b> Smoothing time constant = 100 ms The signal is not suitable as a process quantity and may only be used as a display quantity. The torque-generating current actual value is available smoothed.		
r0031	Actual torque smoothed	Nm	Float
	<b>Description:</b> Displays the smoothed torque actual value.		
	<b>Note:</b> Smoothing time constant = 100 ms The signal is not suitable as a process quantity and may only be used as a display quantity. The torque actual value is available smoothed (r0031) and unsmoothed.		
r0032	Active power actual value smoothed	kW	Float
	<b>Description:</b> Displays the smoothed actual value of the active power.		
r0033	Torque utilization smoothed	%	Float
	<b>Description:</b> Displays the smoothed torque utilization as a percentage. The torque utilization is obtained from the required smoothed torque in reference to the torque limit, scaled using p2196.		
	<b>Note:</b> Smoothing time constant = 100 ms The signal is not suitable as a process quantity and may only be used as a display quantity. The torque utilization is available smoothed (r0033) and unsmoothed. For $M_{set\ total} (r0079) > M_{max\ offset}$ , the following applies: <ul style="list-style-type: none"> <li>• demanded torque = <math>M_{set\ total} - M_{max\ offset}</math></li> <li>• actual torque limit = <math>M_{max\ upper\ effective} - M_{max\ offset}</math></li> </ul> For $M_{set\ total} (r0079) \leq M_{max\ offset} (p1532)$ , the following applies: <ul style="list-style-type: none"> <li>• demanded torque = <math>M_{max\ offset} - M_{set\ total}</math></li> <li>• actual torque limit = <math>M_{max\ offset} - M_{max\ lower\ effective}</math></li> </ul> For the actual torque limit = 0, the following applies: r0033 = 100 % For the actual torque limit < 0, the following applies: r0033 = 0 %		
r0034	Motor utilization thermal	%	Float
	<b>Description:</b> Displays the motor utilization from motor temperature model 1 (I <sup>2</sup> t) or 3.		

Par. No.	Name	Unit	Data type
r0037[0...19]	Power unit temperatures	°C	Float
	<b>Description:</b> Displays the temperatures in the power unit.		
	<b>Index:</b>		
	<ul style="list-style-type: none"> <li>• [0]: Inverter maximum value</li> <li>• [1]: Depletion layer maximum value</li> <li>• [2]: Rectifier maximum value</li> <li>• [3]: Air intake</li> <li>• [4]: Interior of power unit</li> <li>• [5]: Inverter 1</li> <li>• [6]: Inverter 2</li> <li>• [7]: Inverter 3</li> <li>• [8]: Inverter 4</li> <li>• [9]: Inverter 5</li> <li>• [10]: Inverter 6</li> <li>• [11]: Rectifier 1</li> <li>• [12]: Rectifier 2</li> <li>• [13]: Depletion layer 1</li> <li>• [14]: Depletion layer 2</li> <li>• [15]: Depletion layer 3</li> <li>• [16]: Depletion layer 4</li> <li>• [17]: Depletion layer 5</li> <li>• [18]: Depletion layer 6</li> <li>• [19]: Cooling unit liquid intake</li> </ul>		
	<b>Dependency:</b> Refer to A01009		
	<b>Notice:</b> Only for internal Siemens troubleshooting. <b>Note:</b> The value of -200 indicates that there is no measuring signal. <ul style="list-style-type: none"> <li>• r0037[0]: Maximum value of the inverter temperatures (r0037[5...10]).</li> <li>• r0037[1]: Maximum value of the depletion layer temperatures (r0037[13...18]).</li> <li>• r0037[2]: Maximum value of the rectifier temperatures (r0037[11...12]).</li> </ul> The maximum value is the temperature of the hottest inverter, depletion layer, or rectifier.		
r0079[0...1]	Torque setpoint total	Nm	Float
	<b>Description:</b> Displays and connector output for the torque setpoint at the output of the speed controller (before clock cycle interpolation). <b>Index:</b> <ul style="list-style-type: none"> <li>• [0]: Unsmoothed</li> <li>• [1]: Smoothed</li> </ul>		
r0296	DC link voltage undervoltage threshold	V	U16
	<b>Description:</b> Threshold to detect a DC link undervoltage. If the DC link voltage falls below this threshold, the drive unit is tripped due to a DC link undervoltage condition. <b>Note:</b> The value depends on the device type and the selected device rated voltage.		

Par. No.	Name	Unit	Data type
r0297	DC link voltage overvoltage threshold	V	U16
	<b>Description:</b> If the DC link voltage exceeds the threshold specified here, the drive unit is tripped due to DC link overvoltage.		
	<b>Dependency:</b> Refer to F30002.		
r0311	Rated motor speed	rpm	Float
	<b>Description:</b> Displays the rated motor speed (rating plate).		
r0333	Rated motor torque	Nm	Float
	<b>Description:</b> Displays the rated motor torque.		
	IEC drive: unit Nm NEMA drive: unit lbf ft		
r0482[0... 2]	Encoder actual position value Gn_XIST1	-	U32
	<b>Description:</b> Displays the encoder actual position value Gn_XIST1.		
	<b>Index:</b>		
	<ul style="list-style-type: none"> <li>• [0]: Encoder 1</li> <li>• [1]: Encoder 2</li> <li>• [2]: Reserved</li> </ul>		
<b>Note:</b>			
<ul style="list-style-type: none"> <li>• In this value, the measuring gear is only taken into account when the position tracking is activated.</li> <li>• The update time for the position control (EPOS) corresponds to the position controller clock cycle.</li> <li>• The update time in isochronous operation corresponds to the bus cycle time.</li> <li>• The update time in isochronous operation and with position control (EPOS) corresponds to the position controller clock cycle.</li> <li>• The update time in non-isochronous operation or without position control (EPOS) comprises the following: <ul style="list-style-type: none"> <li>– Update time = 4 * least common multiple (LCM) of all current controller clock cycles in the drive group (infeed + drives). The minimum update time is 1 ms.</li> <li>– Example 1: infeed, servo Update time = 4 * LCM(250 µs, 125 µs) = 4 * 250 µs = 1 ms</li> <li>– Example 2: infeed, servo, vector Update time = 4 * LCM(250 µs, 125 µs, 500 µs) = 4 * 500 µs = 2 ms</li> </ul> </li> </ul>			
r0632	Motor temperature model, stator winding temperature	°C	Float
	<b>Description:</b> Displays the stator winding temperature of the motor temperature model.		
r0722	CU digital inputs status	-	U32
	<b>Description:</b> Displays the status of the digital inputs.		
	<b>Note:</b> DI: Digital Input DI/DO: Bidirectional Digital Input/Output The drive unit displays the value in hex format. You can convert the hex number to the binary number, for example, FF (hex) = 11111111 (bin).		
r0747	CU digital outputs status	-	U32
	<b>Description:</b> Displays the status of digital outputs.		
	<b>Note:</b> DI/DO: Bidirectional Digital Input/Output The drive unit displays the value in hex format. You can convert the hex number to the binary number, for example, FF (hex) = 11111111 (bin).		

Par. No.	Name	Unit	Data type
r0807.0	Master control active	-	U8
	<b>Description:</b> Displays what has the master control. The drive can be controlled via the internal interconnection or from external.		
r2050 [0...19]	MODBUS PZD receive word	-	I16
	<b>Description:</b> Modbus PZD (setpoints) with word format received from the host controller.		
	<b>Index:</b> Index 0 to index 19 stand for PZD1 to PZD20 correspondingly. <ul style="list-style-type: none"> <li>• [0]: Control word from host controller, the definition of control word refer to r2090.</li> <li>• [1]: In speed control mode, means speed setpoint from host controller.</li> <li>• [2] and [3]: In internal position control mode, means position setpoint(Hword/Lword) from host controller</li> <li>• [4] to [19]: Reserved.</li> </ul>		
r2090.0... 15	MODBUS PZD1 receive bit-serial	-	U16
	<b>Description:</b> Bit-serial description of PZD1 (normally control word 1) received from the host controller. If the value of the bit equals to 0, it means the function of this bit is deactivated. If the value of the bit equals to 1, it means the function of this bit is activated.		
r2521[0... 3]	LR position actual value	LU	I32
	<b>Description:</b> Displays the actual position actual value determined by the position actual value preprocessing. <b>Index:</b> <ul style="list-style-type: none"> <li>• [0]: CI-loop position control</li> <li>• [1]: Encoder 1</li> <li>• [2]: Encoder 2</li> <li>• [3]: Reserved</li> </ul>		
r2556	LR position setpoint after setpoint smoothing	LU	I32
	<b>Description:</b> Display and connector output for the position setpoint after setpoint smoothing.		
r2563	LR following error dynamic model	LU	I32
	<b>Description:</b> Displays the dynamic following error. This value is the deviation, corrected by the velocity-dependent component, between the position setpoint and the position actual value.		
r2665	EPOS position setpoint	LU	I32
	<b>Description:</b> Displays the actual absolute position setpoint.		
r29015	PTI: Pulse input frequency	Hz	Float
	<b>Description:</b> Displays the PTI input pulse frequency.		
r29018[0.. .1]	OA version	-	Float
	<b>Description:</b> Displays the OA version.		
	<b>Index:</b> <ul style="list-style-type: none"> <li>• [0]: Firmware version</li> <li>• [1]: Build increment number</li> </ul>		
r29400	Internal Control Signal Status Indicating	-	U32
	<b>Description:</b> Control signal status identifiers Bit00 SON Bit01 RESET Bit02 CWL Bit03 CCWL Bit04 G-CHANGE Bit05 P-TRG Bit06 CLR Bit07 EGEAR1 Bit08 EGEAR2 Bit09 TLIMIT1 Bit10 TLIMIT2 Bit11 CWE Bit12 CCWE Bit13 ZSCLAMP Bit14 SPD1 Bit15 SPD2 Bit16 SPD3 Bit17 TSET Bit18 SLIMIT1 Bit19 SLIMIT2 Bit20 POS1 Bit21 POS2 Bit22 POS3 Bit23 REF Bit24 SREF Bit25 STEPF Bit26 STEPB Bit27 STEPH Bit28 EMGS Bit29 C-MODE		

Par. No.	Name	Unit	Data type
r29942	DO signals status indicating	-	U32
	<p><b>Description:</b> Indicates the status of DO signals.</p> <ul style="list-style-type: none"> <li>• Bit 0: RDY</li> <li>• Bit 1: FAULT</li> <li>• Bit 2: INP</li> <li>• Bit 3: ZSP</li> <li>• Bit 4: SPDR</li> <li>• Bit 5: TLR</li> <li>• Bit 6: SPLR</li> <li>• Bit 7: MBR</li> <li>• Bit 8: OLL</li> <li>• Bit 9: WARNING1</li> <li>• Bit 10: WARNING2</li> <li>• Bit 11: REFOK</li> <li>• Bit 12: CM_STA</li> <li>• Bit 13: RDY_ON</li> </ul>		
r29979	PStatus	-	U32
	<p><b>Description:</b> Displays the status of position loop.</p> <ul style="list-style-type: none"> <li>• Bit 0 - Bit 1: actual EGear index</li> </ul>		





# Diagnostics

## 11.1 Overview

### General information about faults and alarms

The errors and states detected by the individual components of the drive system are indicated by messages.

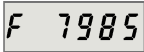

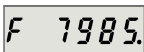


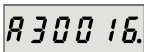
The messages are categorized into faults and alarms.

### Properties of faults and alarms

- Faults
  - Are identified by Fxxxxx.
  - Can lead to a fault reaction.
  - Must be acknowledged once the cause has been remedied.
  - Status via control unit and LED RDY.
  - Status via MODBUS status word PZD1.1 (fault status).
  - Entry in the fault buffer.
- Alarms
  - Are identified by Axxxxx.
  - Have no further effect on the drive.
  - The alarms are automatically reset once the cause has been remedied. No acknowledgement is required.
  - Status via Control Unit and LED RDY.
  - Entry in the alarm buffer.
- General properties of faults and alarms
  - Triggering on selected messages possible.
  - Contain the component number for identifying the affected SINAMICS component.
  - Contain diagnostic information on the relevant message.

### Differences between faults and alarms

The differences between faults and alarms are shown as follows:

Type	BOP display (example)		Status indicator		Reaction	Acknowledgement
			RDY	COM		
Fault		Single fault	Slow flashing in red	-	<ul style="list-style-type: none"> <li><b>NONE:</b> no reaction</li> <li><b>OFF1:</b> servo motor ramps down</li> <li><b>OFF2:</b> servo motor coasts down</li> <li><b>OFF3:</b> servo motor stops quickly (emergency stop)</li> <li><b>ENOCDER:</b> Encoder fault causes OFF2.</li> </ul>	<ul style="list-style-type: none"> <li><b>POWER ON:</b> re-power on the servo drive to clear a fault after eliminating its cause.</li> <li><b>IMMEDIATELY:</b> the fault disappears immediately after eliminating its cause.</li> <li><b>PULSE INHIBIT:</b> The fault can only be acknowledged with a pulse inhibit. The same options are available for acknowledging as described under acknowledgment with IMMEDIATELY.</li> </ul>
		The first fault in the case of multiple faults				
		Non-first fault in the case of multiple faults				
Alarm		Single alarm	Slow flashing in red	-	<ul style="list-style-type: none"> <li><b>NONE:</b> no reaction</li> </ul>	Self-acknowledgement
		The first alarm in the case of multiple alarms				
		Non-first alarm in the case of multiple alarms				

**NOTICE**

**Faults have higher display priority than alarms**

In the case that both faults and alarms occur, only faults are displayed until they have been acknowledged.

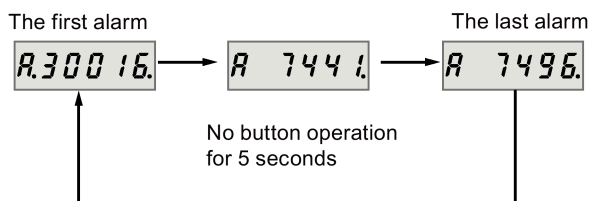
## BOP operations for faults and alarms

To view faults or alarms, proceed as follows:

- Faults

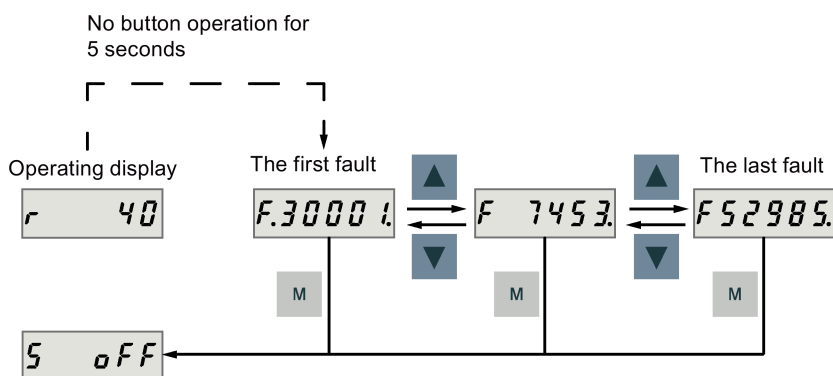


- Alarms

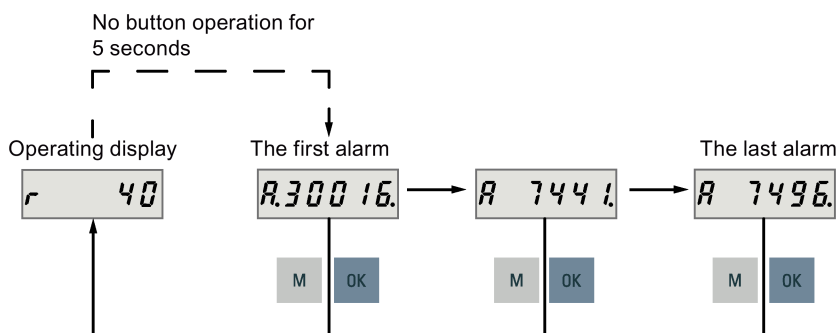


To exit from fault or alarm display, proceed as follows:

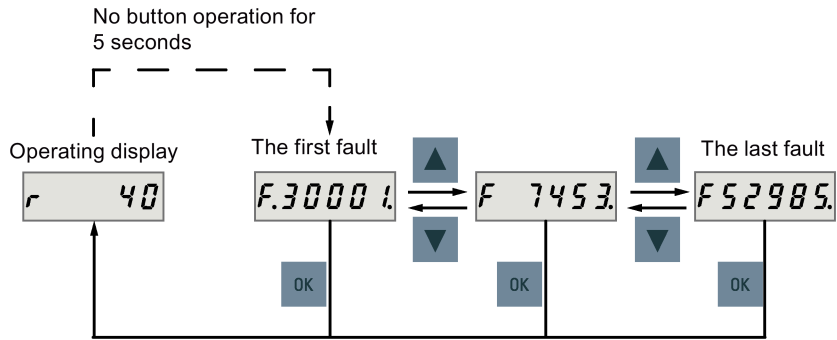
- Faults



- Alarms



To acknowledge faults, proceed as follows:

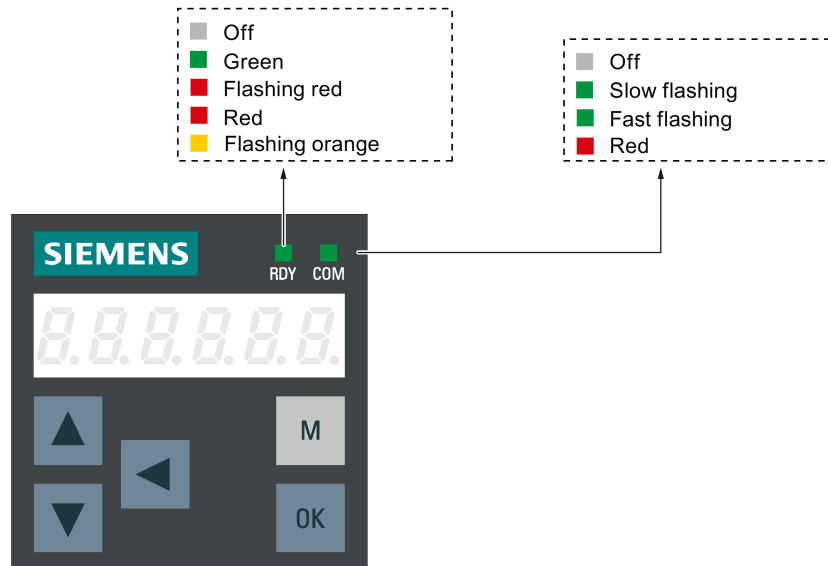


---

**Note**

- If you do not eliminate the cause(s) of the fault, it can appear again after no button operation for five seconds. Make sure that you have eliminated the cause(s) of the fault.
  - You can acknowledge faults using RESET signal. For details of the signal, refer to DIs (Page 92).
  - You can acknowledge faults on the SINAMICS V-ASSISTANT. For details, refer to SINAMICS V-ASSISTANT Online Help.
-

Two LED status indicators (RDY and COM) are available to indicate drive status. Both LEDs are dual color (green/red).



You can find detailed information about the status indications in the table below:

Status indicator	Color	Status	Description
RDY	-	Off	24 V control board power supply is missing
	Green	Continuously lit	The drive is in the servo on state
	Red	Continuously lit	The drive is in the servo off state or in the startup state
Flash at 1 Hz		Alarms or faults occurs	
COM	-	Off	Communication with PC is not active
	Green	Flash at 0.5 Hz	Communication with PC is active
		Flash at 2 Hz	Micro SD card/SD card operating (read or write)
	Red	Continuously lit	Communication with PC is in error

## 11.2 List of faults and alarms

### Fault list

Fault	Cause	Remedy
<b>F1000: Internal software error</b> Reaction: OFF2 Acknowledgement: POWER ON	An internal software error has occurred.	<ul style="list-style-type: none"> <li>Evaluate fault buffer.</li> <li>Carry out a POWER ON (power off/on) for all components.</li> <li>Upgrade firmware to later version.</li> <li>Contact the Hotline.</li> <li>Replace the Control Unit.</li> </ul>
<b>F1001: FloatingPoint exception</b> Reaction: OFF2 Acknowledgement: POWER ON	An exception occurred during an operation with the FloatingPoint data type.	<ul style="list-style-type: none"> <li>Carry out a POWER ON (power off/on) for all components.</li> <li>Upgrade firmware to the latest version.</li> <li>Contact the Hotline.</li> </ul>
<b>F1002: Internal software error</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	An internal software error has occurred.	<ul style="list-style-type: none"> <li>Carry out a POWER ON (power off/on) for all components.</li> <li>Upgrade firmware to the latest version.</li> <li>Contact the Hotline.</li> </ul>
<b>F1003: Acknowledgement delay when accessing the memory</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	A memory area was accessed that does not return a "READY".	<ul style="list-style-type: none"> <li>Carry out a POWER ON (power off/on).</li> <li>Contact the Hotline.</li> </ul>
<b>F1015: Internal software error</b> Reaction: OFF2 Acknowledgement: POWER ON	An internal software error has occurred.	<ul style="list-style-type: none"> <li>Carry out a POWER ON (power off/on) for all components.</li> <li>Upgrade firmware to the latest version.</li> <li>Contact the Hotline.</li> </ul>
<b>F1018: Booting has been interrupted several times</b> Reaction: NONE Acknowledgement: POWER ON	<p>Module booting was interrupted several times. As a consequence, the module boots with the factory setting.</p> <p>Possible reasons for booting being interrupted:</p> <ul style="list-style-type: none"> <li>Power supply interrupted.</li> <li>CPU crashed.</li> <li>Parameterization invalid.</li> </ul> <p>After this fault is output, then the module is booted with the factory settings.</p>	<ul style="list-style-type: none"> <li>Carry out a POWER ON (power off/on). After switching on, the module reboots from the valid parameterization (if available).</li> <li>Restore the valid parameterization</li> </ul> <p>Examples:</p> <ul style="list-style-type: none"> <li>Carry out a first commissioning, save, carry out a POWER ON (switch-off/switch-on).</li> <li>Load another valid parameter backup (e.g. from the memory card), save, carry out a POWER ON (switch-off/switch-on).</li> </ul> <p>Note:</p> <p>If the fault situation is repeated, then this fault is again output after several interrupted boots.</p>

Fault	Cause	Remedy
<b>F1030: Sign-of-life failure for master control</b> Reaction: OFF3 Acknowledgement: IMMEDIATELY	For active PC master control, no sign-of-life was received within the monitoring time.	Contact the Hotline.
<b>F1611: SI CU: Defect detected</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	The drive-integrated "Safety Integrated" (SI) function on the Control Unit (CU) has detected an error and initiated an STO	<ul style="list-style-type: none"> <li>• Carry out a POWER ON (power off/on) for all components.</li> <li>• Upgrade software.</li> <li>• Replace the Control Unit.</li> </ul>
<b>F1910: Fieldbus: setpoint timeout</b> Reaction: OFF3 Acknowledgement: IMMEDIATELY	The reception of setpoints from the fieldbus interface (Modbus/USS) has been interrupted. <ul style="list-style-type: none"> <li>• Bus connection interrupted.</li> <li>• Controller switched off.</li> <li>• Controller set into the STOP state.</li> </ul>	Restore the bus connection and set the controller to RUN.
<b>F7011: Motor overtemperature</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	<ul style="list-style-type: none"> <li>• Motor overloaded</li> <li>• Motor surrounding temperature too high</li> <li>• Wire breakage or sensor not connected</li> <li>• Motor temperature model incorrectly parameterized</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce the motor load.</li> <li>• Check the surrounding temperature and the motor ventilation.</li> <li>• Check the wiring and the connection.</li> <li>• Check the motor temperature model parameters.</li> </ul>
<b>F7085: Open-loop/closed-loop control parameters changed</b> Reaction: NONE Acknowledgement: IMMEDIATELY	Open-loop/closed-loop control parameters have had to be changed for the following reasons: <ul style="list-style-type: none"> <li>• As a result of other parameters, they have exceeded the dynamic limits.</li> <li>• They cannot be used due to the fact that the hardware detected not having certain features.</li> </ul>	It is not necessary to change the parameters as they have already been correctly limited.
<b>F7093: Drive: Test signal error</b> Reaction: NONE Acknowledgement: IMMEDIATELY	The limit rotation of the motor (p29027) is inappropriate.	Modify the value of parameter p29027.
<b>F7220: Drive: Master control by PLC missing</b> Reaction: OFF1 Acknowledgement: IMMEDIATELY	The "master control by PLC" signal was missing in operation. <ul style="list-style-type: none"> <li>• Input for "master control by PLC" is incorrect.</li> <li>• The higher-level control has withdrawn the "master control by PLC" signal.</li> <li>• Data transfer via the fieldbus (master/drive) was interrupted.</li> </ul>	<ul style="list-style-type: none"> <li>• Check the input for "master control by PLC".</li> <li>• Check the "master control by PLC" signal and, if required, switch in.</li> <li>• Check the data transfer via the fieldbus (master/drive).</li> </ul>

11.2 List of faults and alarms

Fault	Cause	Remedy
<p><b>F7403: Lower DC link voltage threshold reached</b>                      Reaction: OFF1                      Acknowledgement: IMMEDIATELY</p>	<p>The DC link voltage monitoring is active and the lower DC link voltage threshold was reached in the "Operation" state.</p>	<ul style="list-style-type: none"> <li>• Check the line supply voltage.</li> <li>• Check the infeed.</li> <li>• Reduce the lower DC link threshold.</li> <li>• Switch out (disable) the DC link voltage monitoring.</li> </ul>
<p><b>F7404: Upper DC link voltage threshold reached</b>                      Reaction: OFF2                      Acknowledgement: IMMEDIATELY</p>	<p>The DC link voltage monitoring is active and the upper DC link voltage threshold was reached in the "Operation" state.</p>	<ul style="list-style-type: none"> <li>• Check the line supply voltage.</li> <li>• Check the infeed module or the brake module.</li> <li>• Increase the upper DC link voltage threshold.</li> <li>• Switch out (disable) the DC link voltage monitoring.</li> </ul>
<p><b>F7410: Current controller output limited</b>                      Reaction: OFF2                      Acknowledgement: IMMEDIATELY</p>	<p>The condition "<math>I_{act} = 0</math> and <math>U_q_{set\_1}</math> longer than 16 ms at its limit" is present and can be caused by the following:</p> <ul style="list-style-type: none"> <li>• Motor not connected or motor contactor open.</li> <li>• No DC link voltage present.</li> <li>• Motor Module defective.</li> </ul>	<ul style="list-style-type: none"> <li>• Connect the motor or check the motor contactor.</li> <li>• Check the DC link voltage.</li> <li>• Check the Motor Module.</li> </ul>
<p><b>F7412: Commutation angle incorrect (motor model)</b>                      Reaction: ENCODER                      Acknowledgement: IMMEDIATELY</p>	<p>An incorrect commutation angle was detected that can result in a positive coupling in the speed controller.                      Possible causes:</p> <ul style="list-style-type: none"> <li>• The motor encoder is incorrectly adjusted with respect to the magnet position.</li> <li>• The motor encoder is damaged.</li> <li>• Data to calculate the motor model has been incorrectly set.</li> <li>• Pole position identification might have calculated an incorrect value when activated.</li> <li>• The motor encoder speed signal is faulted.</li> <li>• The control loop is instable due to incorrect parameterization.</li> </ul>	<ul style="list-style-type: none"> <li>• If the encoder mounting was changed, re-adjust the encoder.</li> <li>• Replace the defective motor encoder.</li> <li>• Correctly set the motor stator resistance, cable resistance and motor-stator leakage inductance.                      Calculate the cable resistance from the cross-section and length, check the inductance and stator resistance using the motor data sheet, measure the stator resistance, e.g. using a multimeter - and if required, again identify the values using the stationary motor data identification.</li> <li>• With pole position identification activated, check the procedure for pole position identification and force a new pole position identification procedure by means of de-selection followed by selection.</li> </ul>
<p><b>F7420: Drive: Current setpoint filter natural frequency &gt; Shannon frequency</b></p>	<p>One of the filter natural frequencies is greater than the Shannon frequency.</p>	<ul style="list-style-type: none"> <li>• Reduce the numerator or denominator natural frequency of the current setpoint filter involved.</li> <li>• Switch out the filter involved (p1656).</li> </ul>



Fault	Cause	Remedy
<b>F7430: Changeover to open-loop torque controlled operation not possible</b> Reaction: OFF2 Acknowledgement: POWER ON	For encoderless operation, the converter cannot change over to closed-loop torque-controlled operation.	<ul style="list-style-type: none"> <li>Do not attempt to change over to closed-loop torque-controlled operation.</li> <li>Check the encoder cable connection.</li> </ul>
<b>F7431: Changeover to encoderless operation not possible</b> Reaction: OFF2 Acknowledgement: POWER ON	For closed-loop torque control, the converter cannot change over to encoderless operation.	<ul style="list-style-type: none"> <li>Do not attempt to change over to encoderless operation.</li> <li>Check the encoder cable connection.</li> </ul>
<b>F7442: LR: Multiturn does not match the modulo range</b> Reaction: OFF1 (OFF2, OFF3) Acknowledgement: IMMEDIATELY	The ratio between the multiturn resolution and the modulo range (p29246) is not an integer number. This results in the adjustment being set back, as the position actual value cannot be reproduced after power-off/power-on.	Make the ration between the multiturn resolution and the modulo range an integer number. The ratio $v$ is calculated as follows: <ul style="list-style-type: none"> <li>Motor encoder without position tracking (p29243 = 0):  <math display="block">v = (4096 * p29247 * p29248)/(p29249 * p29246)</math> </li> <li>Motor encoder with position tracking (p29243 = 1):  <math display="block">v = (p29244 * 29247)/p29246</math> </li> </ul>
<b>F7443: Reference point coordinate not in the permissible range</b> Reaction: OFF1 (OFF2, OFF3) Acknowledgement: IMMEDIATELY	The reference point coordinate received when adjusting the encoder via connector input p2599 lies outside the half of the encoder range and cannot be set as actual axis position.	Set the reference point coordinate to a lower value than specified in the fault value. See also: p2599 (EPOS reference point coordinate value). For a motor with an absolute encoder, the maximum permissible encoder range is calculated by the formula $(4096 * p29247)/2$ .
<b>F7450: Standstill monitoring has responded</b> Reaction: OFF1 Acknowledgement: IMMEDIATELY	After the standstill monitoring time expired, the drive left the standstill window. <ul style="list-style-type: none"> <li>Position loop gain too low.</li> <li>Position loop gain too high (instability/oscillation).</li> <li>Mechanical overload.</li> <li>Connecting cable, motor/drive converter incorrect (phase missing, interchange).</li> </ul>	Check the causes and resolve.

11.2 List of faults and alarms

Fault	Cause	Remedy
<p><b>F7451: Position monitoring has responded</b>                      Reaction: OFF1                      Acknowledgement: IMMEDIATELY</p>	<p>When the position monitoring time (p2545) expired, the drive had still not reached the positioning window (p2544).</p> <ul style="list-style-type: none"> <li>• Positioning window parameterized too small (p2544).</li> <li>• Position monitoring time parameterized too short (p2545).</li> <li>• Position loop gain is too low.</li> <li>• Position loop gain is too high (instability/oscillation).</li> <li>• Drive mechanically locked.</li> </ul>	<p>Check the causes and resolve.</p>
<p><b>F7452: Following error too high</b>                      Reaction: OFF1                      Acknowledgement: IMMEDIATELY</p>	<p>The difference between the position setpoint and position actual value (following error dynamic model) is greater than the tolerance (p2546).</p> <ul style="list-style-type: none"> <li>• The value of p2546 is too small.</li> <li>• The gain of position loop is too small.</li> <li>• The drive torque or accelerating capacity exceeded.</li> <li>• Position measuring system fault.</li> <li>• Position control sense incorrect.</li> <li>• Mechanical system locked.</li> <li>• Excessively high traversing velocity or excessively high position reference value (setpoint) differences.</li> </ul>	<p>Check the causes and resolve.</p>
<p><b>F7453: Position actual value preprocessing error</b>                      Reaction: OFF1                      Acknowledgement: IMMEDIATELY</p>	<p>An error has occurred during the position actual value preprocessing.</p>	<p>Check the encoder for the position actual value preprocessing.</p>
<p><b>F7458: EPOS: Reference cam not found</b>                      Reaction: OFF1 (OFF2, OFF3)                      Acknowledgement: IMMEDIATELY</p>	<p>After starting the search for reference, the axis moved through the maximum permissible distance to search for the reference cam without actually finding the reference cam.</p>	<ul style="list-style-type: none"> <li>• Check the "reference cam" input.</li> <li>• Check the maximum permissible distance to the reference cam (p2606).</li> </ul> <p>See also: p2606 (EPOS search for reference reference cam maximum distance)</p>
<p><b>F7459: Zero mark not detected</b>                      Reaction: OFF1                      Acknowledgement: IMMEDIATELY</p>	<p>After leaving the reference cam, the axis has traversed the maximum permissible distance (p2609) between the reference cam and the zero mark without finding the zero mark.</p>	<ul style="list-style-type: none"> <li>• Check the encoder regarding zero mark.</li> <li>• Check the maximum permissible distance between the reference cam and zero mark (p2609).</li> <li>• Use an external encoder zero mark (equivalent zero mark).</li> </ul>

Fault	Cause	Remedy
<b>F7460: EPOS: End of reference cam not found</b> Reaction: OFF1 (OFF2, OFF3) Acknowledgement: IMMEDIATELY	During the search for reference, when the axis reached the zero mark it also reached the end of the traversing range without detecting an edge at the binector input "reference cam".  Maximum traversing range: -2147483648 [LU] ... -2147483647 [LU]	<ul style="list-style-type: none"> <li>• Check the "reference cam" input.</li> <li>• Repeat the search for reference.</li> </ul>
<b>F7464: EPOS: Traversing block is inconsistent</b> Reaction: OFF1 (OFF2, OFF3) Acknowledgement: IMMEDIATELY	The traversing block does not contain valid information.  Alarm value: Number of the traversing block with invalid information.	Check the traversing block and where relevant, take into consideration alarms that are present.
<b>F7475: EPOS: Target position &lt; start of traversing range</b> Reaction: OFF1 (OFF2, OFF3) Acknowledgement: IMMEDIATELY	The target position for relative traversing lies outside the traversing range.	Correct the target position.
<b>F7476: EPOS: Target position &gt; end of the traversing range</b> Reaction: OFF1 (OFF2, OFF3) Acknowledgement: IMMEDIATELY	The target position for relative traversing lies outside the traversing range.	Correct the target position.
<b>F7481: EPOS: Axis position &lt; software limit switch minus</b> Reaction: OFF1 (OFF2, OFF3) Acknowledgement: IMMEDIATELY	The actual position of the axis is less than the position of the software limit switch minus.	<ul style="list-style-type: none"> <li>• Correct the target position.</li> <li>• Change software limit switch minus (CI: p2580).</li> </ul>
<b>F7482: EPOS: Axis position &gt; software limit switch plus</b> Reaction: OFF1 (OFF2, OFF3) Acknowledgement: IMMEDIATELY	The actual position of the axis is greater than the position of the software limit switch plus.	<ul style="list-style-type: none"> <li>• Correct the target position.</li> <li>• Change software limit switch plus (CI: p2581).</li> </ul>
<b>F7488: EPOS: Relative positioning not possible</b> Reaction: OFF1 (OFF2, OFF3) Acknowledgement: IMMEDIATELY	In the mode "direct setpoint input/MDI", for continuous transfer relative positioning was selected.	Check the control.

11.2 List of faults and alarms

Fault	Cause	Remedy
<p><b>F7490: Enable signal withdrawn while traversing</b>                      Reaction: OFF1                      Acknowledgement: IMMEDIATELY</p>	<ul style="list-style-type: none"> <li>For a standard assignment, another fault may have occurred as a result of withdrawing the enable signals.</li> <li>The drive is in the "switching on inhibited" state (for a standard assignment).</li> </ul>	<ul style="list-style-type: none"> <li>Set the enable signals or check the cause of the fault that first occurred and then result (for a standard assignment).</li> <li>Check the assignment to enable the basic positioning function.</li> </ul>
<p><b>F7491: STOP cam minus reached</b>                      Reaction: OFF3                      Acknowledgement: IMMEDIATELY</p>	<p>The STOP cam minus was reached. For a positive traversing direction, the STOP cam minus was reached, i.e. the wiring of the STOP cam is incorrect.</p>	<ul style="list-style-type: none"> <li>Leave the STOP cam minus in the positive traversing direction and return the axis to the valid traversing range.</li> <li>Check the wiring of the STOP cam.</li> </ul>
<p><b>F7492: STOP cam plus reached</b>                      Reaction: OFF3                      Acknowledgement: IMMEDIATELY</p>	<p>The STOP cam plus was reached. For a negative traversing direction, the STOP cam plus was reached, i.e. the wiring of the STOP cam is incorrect.</p>	<ul style="list-style-type: none"> <li>Leave the STOP cam plus in the negative traversing direction and return the axis to the valid traversing range.</li> <li>Check the wiring of the STOP cam.</li> </ul>
<p><b>F7493: LR: Overflow of the value range for position actual value</b>                      Reaction: OFF1 (OFF2, OFF3)                      Acknowledgement: IMMEDIATELY</p>	<p>The value range (-2147483648 ... 2147483647) for the position actual value representation was exceeded. When the overflow occurs, the "referenced" or "adjustment absolute measuring system" status is reset.</p> <ul style="list-style-type: none"> <li>The position actual value (r2521) has exceeded the value range.</li> <li>The encoder position actual value has exceeded the value range.</li> <li>The maximum encoder value times the factor to convert the absolute position from increments to length units (LU) has exceeded the value range for displaying the position actual value.</li> </ul>	<p>If required, reduce the traversing range or position resolution p29247.                      Note for case = 3:                      If the value for the maximum possible absolute position (LU) is greater than 4294967296, then it is not possible to make an adjustment due to an overflow.                      For rotary encoders, the maximum possible absolute position (LU) is calculated as follows:                      Motor encoder without position tracking:</p> <ul style="list-style-type: none"> <li>IPos: <math>p29247 * p29248 * 4096 / p29249</math> for multiturn encoders</li> <li>PTI: <math>1048576 * p29012[X] * 4096 / p29013</math> for multiturn encoders</li> </ul>
<p><b>F7599: Encoder 1: Adjustment not possible</b>                      Reaction: OFF1 (NONE, OFF2, OFF3)                      Acknowledgement: IMMEDIATELY</p>	<p>The maximum encoder value times the factor to convert the absolute position from increments to length units (LU) has exceeded the value range (-2147483648 ... 2147483647) for displaying the position actual value.</p>	<p>If the value for the maximum possible absolute position (LU) is greater than 4294967296, then it is not possible to make an adjustment due to an overflow.                      For rotary encoders, the maximum possible absolute position (LU) is calculated as follows:                      Motor encoder without position tracking:</p> <ul style="list-style-type: none"> <li>IPos: <math>p29247 * p29248 * 4096 / p29249</math> for multiturn encoders</li> <li>PTI: <math>1048576 * p29012[X] * 4096 / p29013</math> for multiturn encoders</li> </ul>
<p><b>F7800 Drive: No power unit present</b>                      Reaction: NONE                      Acknowledgement: IMMEDIATELY</p>	<p>The power unit parameters cannot be read or no parameters are stored in the power unit.</p>	<ul style="list-style-type: none"> <li>Carry out a POWER ON (power off/on) for all components.</li> <li>Change the module.</li> </ul>

Fault	Cause	Remedy
<b>F7801: Motor overcurrent</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	The permissible motor limit current was exceeded. <ul style="list-style-type: none"> <li>• Effective current limit set too low.</li> <li>• Current controller not correctly set.</li> <li>• Motor was braked with an excessively high stall torque correction factor.</li> <li>• Up ramp was set too short or the load is too high.</li> <li>• Short-circuit in the motor cable or ground fault.</li> <li>• Motor current does not match the current of Motor Module.</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce the stall torque correction factor.</li> <li>• Increase the up ramp or reduce the load.</li> <li>• Check the motor and motor cables for short-circuit and ground fault.</li> <li>• Check the Motor Module and motor combination.</li> </ul>
<b>F7802: Infeed or power unit not ready</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	After an internal power-on command, the infeed or drive does not signal ready because of one of the following reasons: <ul style="list-style-type: none"> <li>• Monitoring time is too short.</li> <li>• DC link voltage is not present.</li> <li>• Associated infeed or drive of the signaling component is defective.</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure that there is a DC link voltage. Check the DC link busbar. Enable the infeed.</li> <li>• Replace the associated infeed or drive of the signaling component.</li> </ul>
<b>F7815: Power unit has been changed</b> Reaction: NONE Acknowledgement: IMMEDIATELY	The code number of the actual power unit does not match the saved number.	Connect the original power unit and power up the Control Unit again (POWER ON).
<b>F7900: Motor blocked/speed controller at its limit</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	The servo motor has been operating at the torque limit longer than 1s and below the speed threshold of 120 rpm .  This signal can also be initiated if the speed actual value is oscillating and the speed controller output repeatedly goes to its limit.	<ul style="list-style-type: none"> <li>• Check whether the servo motor can rotate freely or not.</li> <li>• Check the torque limit.</li> <li>• Check the inversion of the actual value.</li> <li>• Check the motor encoder connection.</li> <li>• Check the encoder pulse number.</li> </ul>
<b>F7901: Motor overspeed</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	The maximumly permissible speed has been exceeded.	Check and correct the maximum speed (p1082).  Check if there are any peaks of actual speed. If the value of the peak is especially large, contact the hotline.
<b>F7995: Motor identification failure</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	For incremental motor, needs pole position identification when first SON. If motor already in run (i.e. by external force) position identification may failure.	Stop motor before SON.

Fault	Cause	Remedy
<p><b>F30001: Power unit: Overcurrent</b>                      Reaction: OFF2                      Acknowledgement: IMMEDIATELY</p>	<p>The power unit has detected an overcurrent condition.</p> <ul style="list-style-type: none"> <li>• Closed-loop control is incorrectly parameterized.</li> <li>• Controller parameters are not proper.</li> <li>• Motor has a short-circuit or fault to ground (frame).</li> <li>• Power cables are not correctly connected.</li> <li>• Power cables exceed the maximum permissible length.</li> <li>• Power unit defective.</li> <li>• Line phase interrupted.</li> </ul>	<ul style="list-style-type: none"> <li>• Check the motor data - if required, carry out commissioning.</li> <li>• Modify speed loop Kp (p29120), position loop Kv (p29110).</li> <li>• Check the motor circuit configuration (star-delta).</li> <li>• Check the power cable connections.</li> <li>• Check the power cables for short-circuit or ground fault.</li> <li>• Check the length of the power cables.</li> <li>• Replace power unit.</li> <li>• Check the line supply phases.</li> <li>• Check the external braking resistor connection.</li> </ul>
<p><b>F30002: DC link voltage, overvoltage</b>                      Reaction: OFF2                      Acknowledgement: IMMEDIATELY</p>	<p>The power unit has detected overvoltage in the DC link.</p> <ul style="list-style-type: none"> <li>• Motor regenerates too much energy.</li> <li>• Device connection voltage too high.</li> <li>• Line phase interrupted.</li> </ul>	<ul style="list-style-type: none"> <li>• Increase the ramp-down time.</li> <li>• Activate the DC link voltage controller.</li> <li>• Use a braking resistor.</li> <li>• Increase the current limit of the infeed or use a larger module.</li> <li>• Check the device supply voltage.</li> <li>• Check the line supply phases.</li> </ul>
<p><b>F30003: DC link voltage, undervoltage</b>                      Reaction: OFF2                      Acknowledgement: IMMEDIATELY</p>	<p>The power unit has detected an undervoltage condition in the DC link.</p> <ul style="list-style-type: none"> <li>• Line supply failure</li> <li>• Line supply voltage below the permissible value.</li> <li>• Line supply infeed failed or interrupted.</li> <li>• Line phase interrupted.</li> </ul>	<ul style="list-style-type: none"> <li>• Check the line supply voltage</li> <li>• Check the line supply infeed and observe the fault messages relating to it (if there are any)</li> <li>• Check the line supply phases.</li> <li>• Check the line supply voltage setting.</li> </ul>
<p><b>F30004: Drive heat sink over-temperature</b>                      Reaction: OFF2                      Acknowledgement: IMMEDIATELY</p>	<p>The temperature of the power unit heat sink has exceeded the permissible limit value.</p> <ul style="list-style-type: none"> <li>• Insufficient cooling, fan failure.</li> <li>• Overload.</li> <li>• Surrounding temperature too high.</li> <li>• Pulse frequency too high.</li> </ul>	<ul style="list-style-type: none"> <li>• Check whether the fan is running.</li> <li>• Check the fan elements.</li> <li>• Check whether the surrounding temperature is in the permissible range.</li> <li>• Check the motor load.</li> <li>• Reduce the pulse frequency if this is higher than the rated pulse frequency.</li> </ul>
<p><b>F30005: Power unit: Overload I<sup>2</sup>t</b>                      Reaction: OFF2                      Acknowledgement: IMMEDIATELY</p>	<p>The power unit was overloaded.</p> <ul style="list-style-type: none"> <li>• The permissible rated power unit current was exceeded for an inadmissibly long time.</li> <li>• The permissible load duty cycle was not maintained.</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce the continuous load.</li> <li>• Adapt the load duty cycle.</li> <li>• Check the motor and power unit rated currents.</li> </ul>

Fault	Cause	Remedy
<b>F30011: Line phase failure in main circuit</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	At the power unit, the DC link voltage ripple has exceeded the permissible limit value. Possible causes: <ul style="list-style-type: none"> <li>• A line phase has failed.</li> <li>• The 3 line phases are inadmissibly unsymmetrical.</li> <li>• The fuse of a phase of a main circuit has ruptured.</li> <li>• A motor phase has failed.</li> </ul>	<ul style="list-style-type: none"> <li>• Check the main circuit fuses.</li> <li>• Check whether a single-phase load is distorting the line voltages.</li> <li>• Check the motor feeder cables.</li> </ul>
<b>F30015: Phase failure motor cable</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	A phase failure in the motor feeder cable was detected. The signal can also be output in the following case: The motor is correctly connected, however the closed-speed control is unstable and therefore an oscillating torque is generated.	<ul style="list-style-type: none"> <li>• Check the motor feeder cables.</li> <li>• Check the speed controller settings.</li> </ul>
<b>F30021: Ground fault</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	Power unit has detected a ground fault. <ul style="list-style-type: none"> <li>• Ground fault in the power cables.</li> <li>• Winding fault or ground fault at the motor.</li> </ul>	<ul style="list-style-type: none"> <li>• Check the power cable connections.</li> <li>• Check the motor.</li> </ul>
<b>F30027: Precharging DC link time monitoring</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	<ul style="list-style-type: none"> <li>• The power unit DC link was not able to be pre-charged within the expected time. There is no line supply voltage connected.</li> <li>• The line contactor/line side switch has not been closed.</li> <li>• The line supply voltage is too low.</li> <li>• The pre-charging resistors are overheated as there were too many pre-charging operations per time unit</li> <li>• The pre-charging resistors are overheated as the DC link capacitance is too high.</li> <li>• The pre-charging resistors are overheated.</li> <li>• The pre-charging resistors are overheated as the line contactor was closed during the DC link fast discharge through the Braking Module.</li> <li>• The DC link has either a ground fault or a short-circuit.</li> <li>• The pre-charging circuit is possibly defective.</li> </ul>	Check the line supply voltage at the input terminals.

11.2 List of faults and alarms

Fault	Cause	Remedy
<p><b>F30036: Internal overtemperature</b>                      Reaction: OFF2                      Acknowledgement: IMMEDIATELY</p>	<p>The temperature inside the drive converter has exceeded the permissible temperature limit.</p> <ul style="list-style-type: none"> <li>Insufficient cooling, fan failure.</li> <li>Overload.</li> <li>Surrounding temperature too high.</li> </ul>	<ul style="list-style-type: none"> <li>Check whether the fan is running.</li> <li>Check the fan elements.</li> <li>Check whether the surrounding temperature is in the permissible range.</li> </ul> <p>Notice:                      This fault can only be acknowledged once the permissible temperature limit minus 5 K has been fallen below.</p>
<p><b>F30050: 24 V supply overvoltage</b>                      Reaction: OFF2                      Acknowledgement: POWER ON</p>	<p>The voltage monitor signals an overvoltage fault on the module.</p>	<ul style="list-style-type: none"> <li>Check the 24 V power supply.</li> <li>Replace the module if necessary.</li> </ul>
<p><b>F31100: Zero mark distance error</b>                      Reaction: ENCODER                      Acknowledgement: PULSE INHIBIT</p>	<p>The measured zero mark distance does not correspond to the parameterized zero mark distance.                      For distance-coded encoders, the zero mark distance is determined from zero marks detected pairs. This means that if a zero mark is missing, depending on the pair generation, this cannot result in a fault and also has no effect in the system.</p>	<ul style="list-style-type: none"> <li>Check that the encoder cables are routed in compliance with EMC.</li> <li>Check the plug connections</li> <li>Replace the encoder or encoder cable</li> </ul>
<p><b>F31101: Zero mark failed</b>                      Reaction: ENCODER                      Acknowledgement: PULSE INHIBIT</p>	<p>The 1.5 x parameterized zero mark distance was exceeded.</p>	<ul style="list-style-type: none"> <li>Check that the encoder cables are routed in compliance with EMC.</li> <li>Check the plug connections.</li> <li>Replace the encoder or encoder cable.</li> </ul>
<p><b>F31110: Serial communications error</b>                      Reaction: ENCODER                      Acknowledgement: PULSE INHIBIT</p>	<p>Serial communication protocol transfer error between the encoder and evaluation module.</p>	<ul style="list-style-type: none"> <li>Check the encoder cable and shielding connection.</li> <li>Replace the encoder cable/encoder.</li> </ul>
<p><b>F31112: Error bit set in the serial protocol</b>                      Reaction: ENCODER                      Acknowledgement: PULSE INHIBIT</p>	<p>The encoder sends a set error bit via the serial protocol.</p>	<ul style="list-style-type: none"> <li>Check the encoder cable and shielding connection.</li> <li>Replace the encoder cable/encoder.</li> </ul>
<p><b>F31117: Inversion error signals A/B/R</b>                      Reaction: ENCODER                      Acknowledgement: PULSE INHIBIT</p>	<p>For a square-wave encoder (bipolar, double ended) signals A*, B* and R* are not inverted with respect to signals A, B and R.</p>	<ul style="list-style-type: none"> <li>Check the encoder and cable and the connection of them.</li> <li>Does the encoder supply signals and the associated inverted signals?</li> </ul>



Fault	Cause	Remedy
<b>F31130: Zero mark and position error from the coarse synchronization</b> Reaction: ENCODER Acknowledgement: PULSE INHIBIT	After initializing the pole position using track C/D, Hall signals or pole position identification routine, the zero mark was detected outside the permissible range. For distance-coded encoders, the test is carried out after passing 2 zero marks. Fine synchronization was not carried out.	<ul style="list-style-type: none"> <li>• Check that the encoder cables are routed in compliance with EMC.</li> <li>• Check the plug connections</li> <li>• If the Hall sensor is used as an equivalent for track C/D, check the connection.</li> <li>• Check the connection of track C or D.</li> <li>• Replace the encoder or encoder cable.</li> </ul>
<b>F31150: Initialization error</b> Reaction: ENCODER Acknowledgement: PULSE INHIBIT	Encoder functionality is not operating correctly.	<ul style="list-style-type: none"> <li>• Check the encoder type used (incremental/absolute) and the encoder cable.</li> <li>• If relevant, note additional fault messages that describe the fault in detail.</li> </ul>
<b>F52903: Fault inconsistency between fault status and fault buffer</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	Fault status and fault number buffer are inconsistent.	Repower on.
<b>F52904: Control mode change</b> Reaction: OFF2 Acknowledgement: POWER ON	When the control mode is changed, the drive must be saved and restarted.	Save and restart the drive.
<b>F52911: Positive torque limitation value error</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	One of positive torque limitation values (P29050) becomes less than 0.	Configure all of positive torque limitation values (P29050) not less than 0.
<b>F52912: Negative torque limitation value error</b> Reaction: OFF2 Acknowledgement: IMMEDIATELY	One of negative torque limitation values (P29051) becomes greater than 0.	Configure all of negative torque limitation values (P29051) not greater than 0.
<b>F52931: Gear box limit</b> Reaction: OFF1 Acknowledgement: IMMEDIATELY	The electronic gear ratio (p29012[x] / p29013[x]) exceeds the range from 0.02 to 200.	Adjust the electronic gear ratio within the permissible range from 0.02 to 200.
<b>F52933: PTO gear box limit</b> Reaction: OFF1 Acknowledgement: IMMEDIATELY	The electronic gear ratio (p29031[0] / p29032[0]) exceeds the range from 0.02 to 200.	Adjust the electronic gear ratio within the permissible range from 0.02 to 200.
<b>F52980: Absolute encoder motor changed</b> Reaction: OFF1 Acknowledgement: IMMEDIATELY	The servo motor with absolute encoder is changed. Actual motor ID is different from commissioned motor ID.	The servo motor will be automatically configured after the acknowledgement of this fault.

11.2 List of faults and alarms

Fault	Cause	Remedy
<b>F52981: Absolute encoder motor mismatched</b> Reaction: OFF1 Acknowledgement: IMMEDIATELY	Connected absolute encoder motor cannot be operated. The servo drive in use does not support the Motor ID.	Use a suitable absolute encoder motor.
<b>F52983: No encoder detected</b> Reaction: OFF1 Acknowledgement: IMMEDIATELY	The servo drive in use does not support encoderless operation.	<ul style="list-style-type: none"> <li>• Check the encoder cable connection between the servo drive and the servo motor.</li> <li>• Use a servo motor with encoder.</li> </ul>
<b>F52984: Incremental encoder motor not configured</b> Reaction: OFF1 Acknowledgement: IMMEDIATELY	<ul style="list-style-type: none"> <li>• Commissioning of the servo motor has failed.</li> <li>• The incremental encoder motor is connected but fails to commission.</li> </ul>	Configure the motor ID by setting the parameter p29000.
<b>F52985: Absolute encoder motor wrong</b> Reaction: OFF1 Acknowledgement: IMMEDIATELY	<ul style="list-style-type: none"> <li>• Motor ID is downloaded wrong during manufacture.</li> <li>• The firmware of the servo drive does not support the Motor ID.</li> </ul>	<ul style="list-style-type: none"> <li>• Update the firmware.</li> <li>• Use a correct absolute encoder motor.</li> </ul>
<b>F52987: Absolute encoder replaced</b> Reaction: OFF1 Acknowledgement: IMMEDIATELY	Incorrect absolute encoder data.	Contact the Hotline.

Alarm list

Alarm	Cause	Remedy
<b>A1009: Control module over-temperature</b>	The temperature of the control module (Control Unit) has exceeded the specified limit value.	<ul style="list-style-type: none"> <li>• Check the air intake for the Control Unit.</li> <li>• Check the Control Unit fan.</li> </ul> <p>Note: The alarm automatically disappears after the limit value has been undershot.</p>
<b>A1019: Writing to the removable data medium unsuccessful</b>	The write access to the removable data medium was unsuccessful.	Remove and check the removable data medium. Then run the data backup again.
<b>A1032: All parameters must be saved</b>	The parameters of an individual drive object were saved, although there is still no backup of all drive system parameters. The saved object-specific parameters are not loaded the next time that the system powers up. For the system to successfully power up, all of the parameters must have been completely backed up.	Save all parameters.

Alarm	Cause	Remedy
<b>A1045: Configuring data invalid</b>	An error was detected when evaluating the parameter files saved in the non-volatile memory. Because of this, under certain circumstances, several of the saved parameter values were not able to be accepted.	Save the parameterization in SINAMICS V-ASSISTANT using the "Copy RAM to ROM" function or on the BOP. This overwrites the incorrect parameter files in the non-volatile memory – and the alarm is withdrawn.
<b>A1920: Drive Bus: Receive setpoints after To</b>	Output data of Drive Bus master (set-points) received at the incorrect instant in time within the Drive Bus clock cycle.	<ul style="list-style-type: none"> <li>• Check bus configuration.</li> <li>• Check parameters for clock cycle synchronization (ensure <math>T_o &gt; T_{dx}</math>).</li> </ul> Note: To: Time of setpoint acceptance Tdx: Data exchange time
<b>A1932: Drive Bus clock cycle synchronization missing for DSC</b>	There is no clock synchronization or clock synchronous sign of life and DSC is selected.  Note: DSC: Dynamic Servo Control	Set clock synchronization across the bus configuration and transfer clock synchronous sign-of-life.
<b>A5000: Drive heat sink over-temperature</b>	The alarm threshold for overtemperature at the inverter heat sink has been reached.  If the temperature of the heat sink increases by an additional 5 K, then fault F30004 is initiated.	Check the following: <ul style="list-style-type: none"> <li>• Is the surrounding temperature within the defined limit values?</li> <li>• Have the load conditions and the load duty cycle been appropriately dimensioned?</li> <li>• Has the cooling failed?</li> </ul>
<b>A7012: Motor temperature model 1/3 overtemperature</b>	The motor temperature model 1/3 identified that the alarm threshold was exceeded.	<ul style="list-style-type: none"> <li>• Check the motor load and reduce it if required.</li> <li>• Check the motor surrounding temperature.</li> </ul>
<b>A7441: LR: Save the position offset of the absolute encoder adjustment</b>	The status of the absolute encoder adjustment has changed.  In order to permanently save the determined position offset (p2525) it must be saved.	Not necessary. This alarm automatically disappears after the offset has been saved.
<b>A7454: LR: Position value preprocessing does not have a valid encoder</b>	The parameter configuration of encoder is incorrect.	Default the drive and re-configure the parameters.
<b>A7455: EPOS: Maximum velocity limited</b>	The maximum velocity (p2571) is too high to correctly calculate the modulo correction.  Within the sampling time for positioning, with the maximum velocity, a maximum of the half modulo length must be moved through. p2571 was limited to this value.	Reduce the maximum velocity (p2571).
<b>A7456: EPOS: Setpoint velocity limited</b>	The actual setpoint velocity is greater than the parameterized maximum velocity and is therefore limited.	Decrease the actual setpoint velocity.
<b>A7461: EPOS: Reference point not set</b>	When starting a traversing block/direct setpoint input, a reference point is not set.	Reference the system (search for reference, flying referencing, set reference point).

11.2 List of faults and alarms

Alarm	Cause	Remedy
<b>A7469: EPOS: Traversing block &lt; target position &lt; software limit switch minus</b>	In the traversing block the specified absolute target position lies outside the range limited by the software limit switch minus.	<ul style="list-style-type: none"> <li>Correct the traversing block.</li> <li>Change software limit switch minus (p2580).</li> </ul>
<b>A7470: EPOS: Traversing block &gt; target position &gt; software limit switch plus</b>	In the traversing block the specified absolute target position lies outside the range limited by the software limit switch plus.	<ul style="list-style-type: none"> <li>Correct the traversing block.</li> <li>Change software limit switch plus (p2581).</li> </ul>
<b>A7471: EPOS: Traversing block target position outside the modulo range</b>	In the traversing block the target position lies outside the modulo range.	<ul style="list-style-type: none"> <li>In the traversing block, correct the target position.</li> <li>Change the modulo range (p29246).</li> </ul>
<b>A7472: EPOS: Traversing block ABS_POS/ABS_NEG not possible</b>	In the traversing block the positioning mode ABS_POS or ABS_NEG were parameterized with the modulo correction not activated.	Correct the traversing block.
<b>A7473: EPOS: Beginning of traversing range reached</b>	When traversing, the axis has moved to the traversing range limit.	Move away in the positive direction.
<b>A7474: EPOS: End of traversing range reached</b>	When traversing, the axis has moved to the traversing range limit.	Move away in the negative direction.
<b>A7477: EPOS: Target position &lt; software limit switch minus</b>	In the actual traversing operation, the target position is less than the software limit switch minus.	<ul style="list-style-type: none"> <li>Correct the target position.</li> <li>Change software limit switch minus (CI: p2580).</li> </ul>
<b>A7478: EPOS: Target position &gt; software limit switch plus</b>	In the actual traversing operation, the target position is greater than the software limit switch plus.	<ul style="list-style-type: none"> <li>Correct the target position.</li> <li>Change software limit switch plus (CI: p2581).</li> </ul>
<b>A7479: EPOS: Software limit switch minus reached</b>	The axis is at the position of the software limit switch minus. An active traversing block was interrupted.	<ul style="list-style-type: none"> <li>Correct the target position.</li> <li>Change software limit switch minus (CI: p2580).</li> </ul>
<b>A7480: EPOS: Software limit switch plus reached</b>	The axis is at the position of the software limit switch plus. An active traversing block was interrupted.	<ul style="list-style-type: none"> <li>Correct the target position.</li> <li>Change software limit switch plus (CI: p2581).</li> </ul>
<b>A7496: SON enable missing</b>	<ul style="list-style-type: none"> <li>In the IPos control mode or a compound control mode with IPos, no servo on command is sent to the drive via Modbus when p29008 = 1.</li> <li>In the IPos control mode, rising edge is triggered for the P-TRG signal when the drive is in servo off status.</li> <li>In the PTI control mode, any faults which is caused by implementing the "Enable trial run" operation with the V-ASSISTANT lead to A7496.</li> </ul>	<ul style="list-style-type: none"> <li>Send servo on command to the drive via Modbus</li> <li>Set the drive to servo on status firstly and trigger a rising edge for the P-TRG signal.</li> <li>Acknowledge the faults firstly and implement "Enable trial run" again.</li> </ul>
<b>A7576: Encoderless operation due to a fault active</b>	Encoderless operation is active due to a fault.	<ul style="list-style-type: none"> <li>Remove the cause of a possible encoder fault.</li> <li>Carry out a POWER ON (power off/on) for all components.</li> </ul>

Alarm	Cause	Remedy
<b>A7582: Position actual value preprocessing error</b>	An error has occurred during the position actual value preprocessing.	Check the encoder for the position actual value preprocessing. Refer to F52931.
<b>A7585: P-TRG or CLR active</b>	In the PTI mode or a compound mode with PTI, the P-TRG or CLR function is activated.	In the PTI mode, deactivate the P-TRG or CLR function; in the compound mode with PTI, do not switch to other modes.
<b>A7588: Encoder 2: Position value preprocessing does not have a valid encoder</b>	The parameter configuration of PTI counter is incorrect.	Default the drive and re-configure the parameters.
<b>A7805: Power unit overload I<sup>2</sup>t</b>	Alarm threshold for I <sup>2</sup> t overload of the power unit exceeded.	<ul style="list-style-type: none"> <li>• Reduce the continuous load.</li> <li>• Adapt the load duty cycle.</li> <li>• Check the assignment of the rated currents of the motor and motor module.</li> </ul>
<b>A7965: Save required</b>	The angular commutation offset was re-defined and has still not been saved. In order to permanently accept the new value, it must be saved in a non-volatile fashion.	This alarm automatically disappears after the data has been saved.
<b>A7971: Angular commutation offset determination activated</b>	The automatic determination of the angular commutation offset (encoder adjustment) is activated.  The automatic determination is carried out at the next power-on command.	The alarm automatically disappears after determination.
<b>A7991: Motor data identification activated</b>	The motor data ident. routine is activated. The motor data identification routine is carried out at the next power-on command.	The alarm automatically disappears after the motor data identification routine has been successfully completed.  If a POWER ON or a warm restart is performed with motor data identification selected, the motor data identification request will be lost. If motor data identification is required, it will need to be selected again manually following ramp-up.
<b>A30016: Load supply switched off</b>	The DC link voltage is too low.	<ul style="list-style-type: none"> <li>• Switch on the load supply.</li> <li>• Check the line supply if necessary.</li> </ul>

11.2 List of faults and alarms

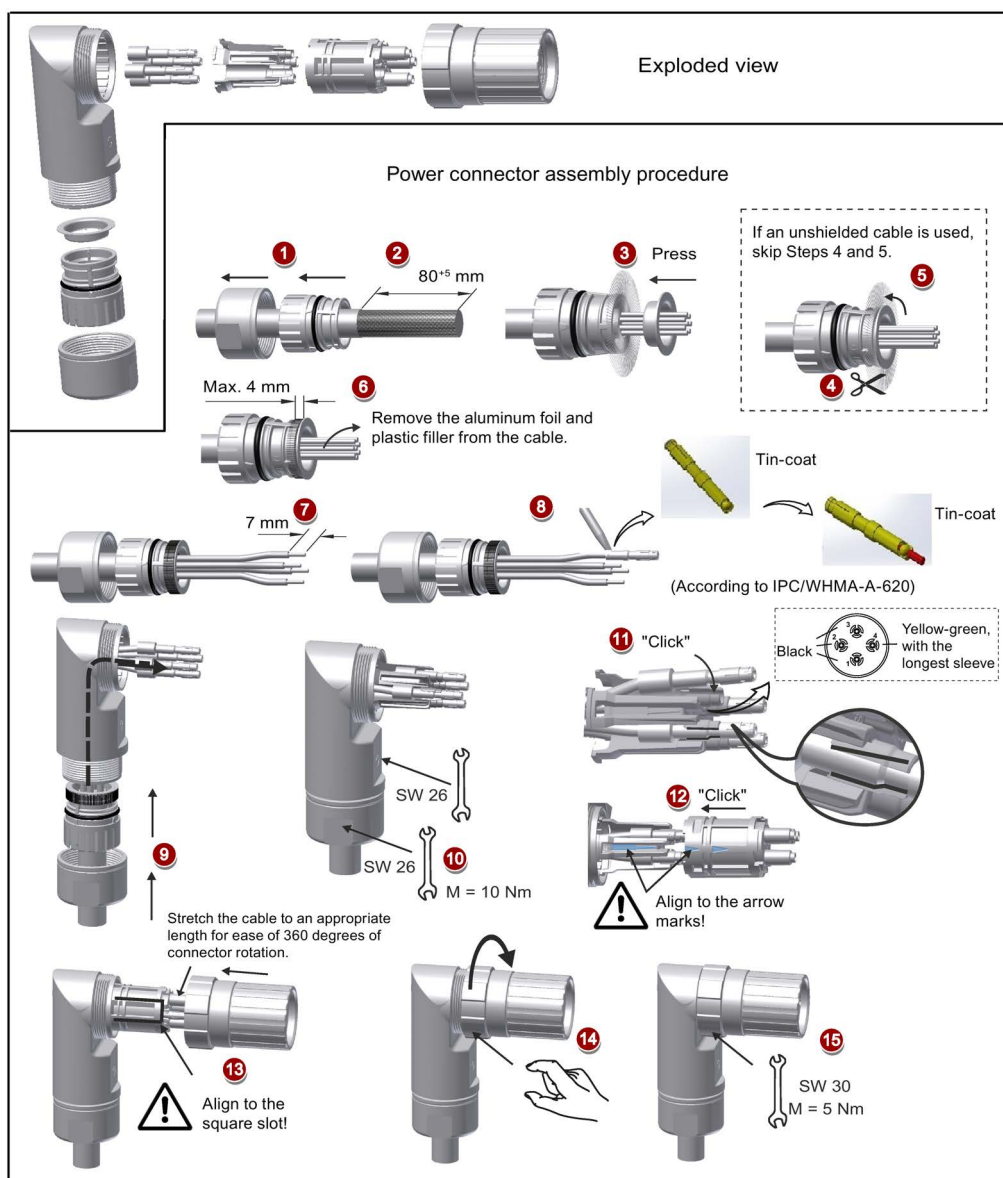
Alarm	Cause	Remedy
<b>A30031: Hardware current limiting in phase U</b>	Hardware current limit for phase U responded. The pulsing in this phase is inhibited for one pulse period. <ul style="list-style-type: none"> <li>• Closed-loop control is incorrectly parameterized.</li> <li>• Fault in the motor or in the power cables.</li> <li>• The power cables exceed the maximum permissible length.</li> <li>• Motor load too high.</li> <li>• Power unit defective.</li> </ul> Note: Alarm A30031 is always output if, for a Power Module, the hardware current limiting of phase U, V or W responds.	Check the motor data. As an alternative, run a motor data identification. <ul style="list-style-type: none"> <li>• Check the motor circuit configuration (star-delta)</li> <li>• Check the motor load.</li> <li>• Check the power cable connections.</li> <li>• Check the power cables for short-circuit or ground fault.</li> <li>• Check the length of the power cables.</li> </ul>
<b>A31411: Absolute encoder signals internal alarms</b>	The absolute encoder fault word includes alarm bits that have been set.	Replace the encoder.
<b>A31412: Error bit set in the serial protocol</b>	The encoder sends a set error bit via the serial protocol.	<ul style="list-style-type: none"> <li>• Carry out a POWER ON (power off/on) for all components.</li> <li>• Check that the encoder cables are routed in compliance with EMC.</li> <li>• Check the plug connections.</li> <li>• Replace the encoder.</li> </ul>
<b>A52900: Failure during data copying</b>	<ul style="list-style-type: none"> <li>• Copying is halted.</li> <li>• The micro SD card/SD card was plugged out.</li> <li>• The drive is not in the stop state.</li> </ul>	<ul style="list-style-type: none"> <li>• Re-plug in the micro SD card/SD card.</li> <li>• Make sure the drive is in the stop state.</li> </ul>
<b>A52901: Braking resistor reaches alarm threshold</b>	The heat capacity reaches the threshold (p29005) of the braking resistor capacity.	<ul style="list-style-type: none"> <li>• Change the external braking resistor.</li> <li>• Increase deceleration time.</li> </ul>
<b>A52902: Emergency missing</b>	Implement servo on when the emergency input (EMGS) is switched off.	Switch on the emergency input (EMGS) and then implement servo on.
<b>A52932: PTO max limit</b>	For incremental encoder, when PTO frequency exceeds 280K, drive will output A52932 to remind that exceed limitation.  For absolute encoder, when PTO frequency exceeds 120K, drive will output A52932 to remind that exceed limitation.	Change PTO ratio.

## Appendix

The assembly methods of the power cable connector, encoder cable connector and brake cable connector in motor side which are introduced in this chapter are for low inertia motor with shaft-height 50 mm and high inertia motor.

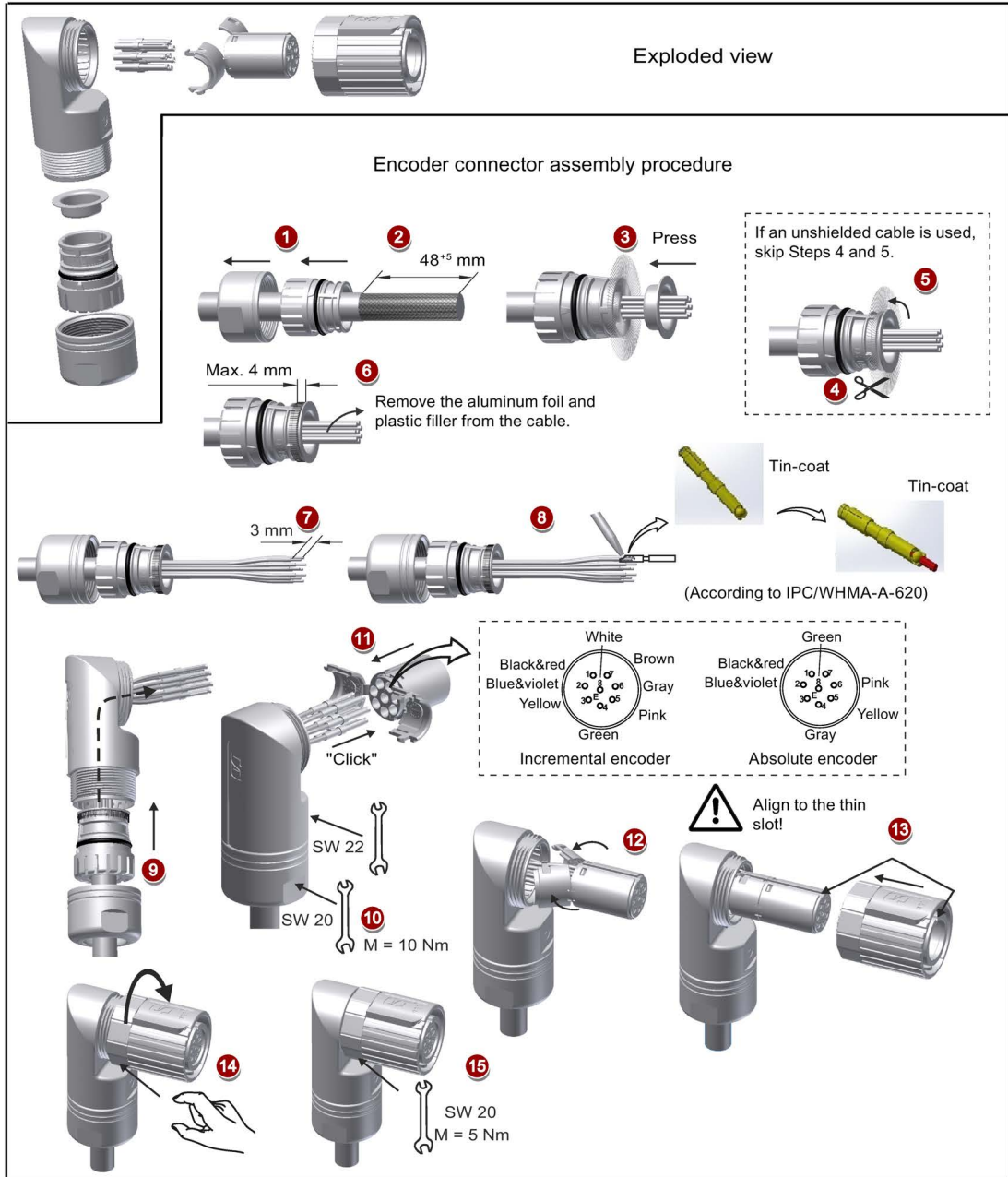
### A.1 Assembly of cable connectors on the motor side

#### Power connector assembly



### Encoder connector assembly

The connector assembly procedures for incremental and absolute encoders are the same.



### Brake connector assembly

The assembly of a brake connector follows the procedure as described in the figure above for an encoder connector.



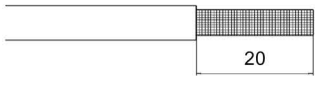
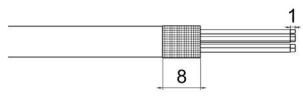
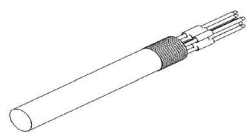
## A.2 Assembly of cable terminals on the drive side

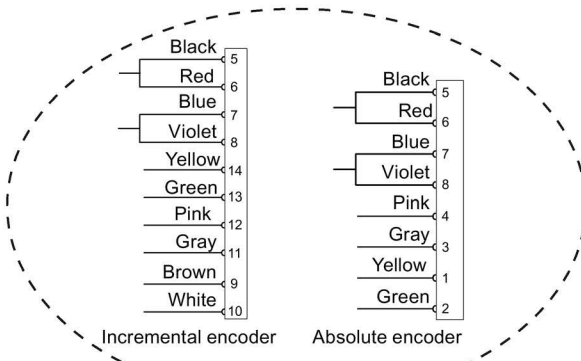
### Power terminal assembly

Drive type	Procedure	Illustration
SINAMICS V90 200 V variant: FSA/FSB/FSC/FSD  SINAMICS V90 400 V variant: FSAA/FSA	Terminal assembly procedure: 1. Remove the outer sheath of the cable. 2. Remove the insulation from the wire. 3. Insert the stripped end into the cable end sleeve. 4. Crimp the cable end sleeve using a crimp tool for end sleeves.	<p>1. Cable with 120±5 mm sleeve and 10±2 mm wire length.</p> <p>2. Sleeve length <math>a &gt; 11 \text{ mm}</math>, wire length <math>b = 10 \text{ mm}</math>.</p> <p>3. Sleeve length <math>c &gt; 1 \text{ mm}</math>.</p> <p>4. Sleeve length <math>d = 8 \text{ mm}</math>.</p>
SINAMICS V90 400 V variant: FSB/FSC	Terminal assembly procedure: 1. Remove the outer sheath of the cable. 2. Remove the insulation from the wire. 3. Insert the stripped end into the spade terminal. 4. Crimp the spade terminal using a crimp tool for cable lugs. (Note: Coat any exposed wires with tin.)	<p>1. Cable with 120±5 mm sleeve and 200±5 mm wire length.</p> <p>2. Sleeve length <math>a = 6 \text{ mm}</math>, wire length <math>b = 10.7 \text{ mm}</math>.</p> <p>3. Wire inserted into spade terminal.</p> <p>4. Crimped spade terminal.</p>

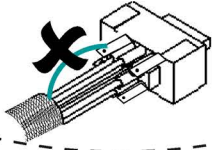
### Encoder terminal assembly

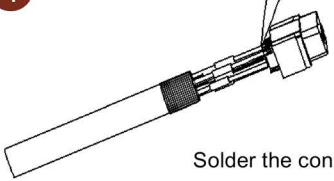
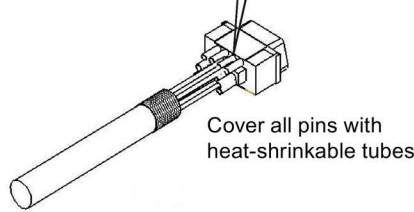
The terminal assembly procedures for incremental and absolute encoders are the same.

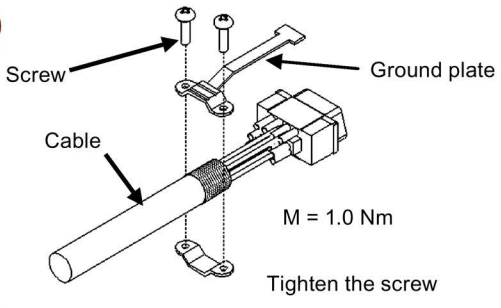
- 1  Remove the sheath of the cable 20 mm
- 2  Remove the insulation from the wire 1 mm  
Turn up the shielding wire 8 mm
- 3  Pre-assemble heat-shrinkable tubes

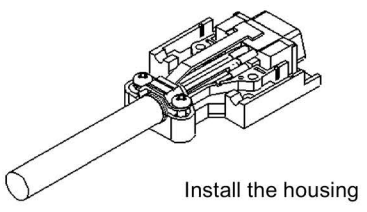
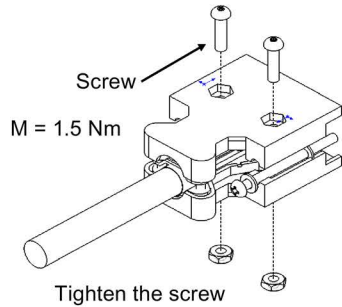


**NOTICE**  
**Drive damage caused by short-circuiting between the shielding wire and the unused pin on the encoder connector**  
 The shielding wire may inadvertently be short-circuited to the unused pin on the to-be-assembled encoder connector. This can cause damage to the drive.  
 Exercise caution when connecting the shielding cable to the encoder connector.



- 4  Solder the connector
- 5  Cover all pins with heat-shrinkable tubes

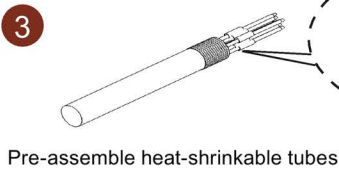
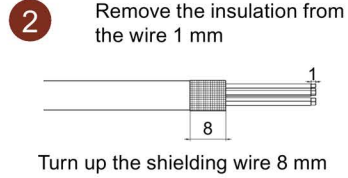
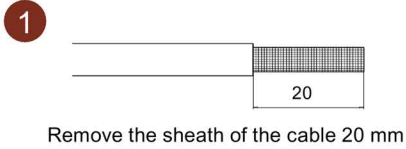
- 6  Screw  
Ground plate  
Cable  
M = 1.0 Nm  
Tighten the screw

- 7  Install the housing
- 8  Screw  
M = 1.5 Nm  
Tighten the screw

### Brake terminal assembly

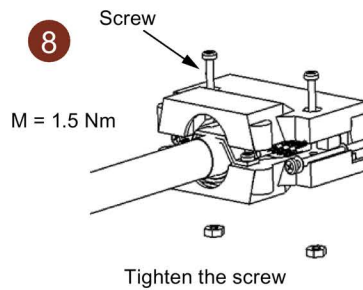
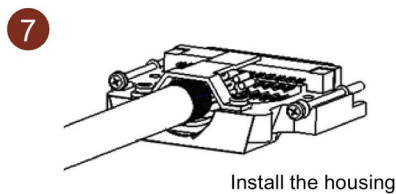
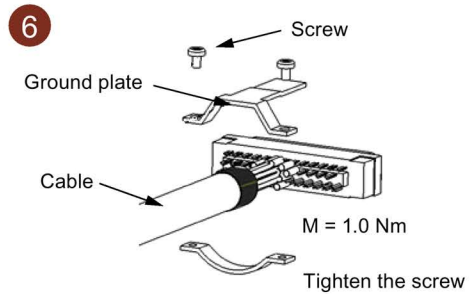
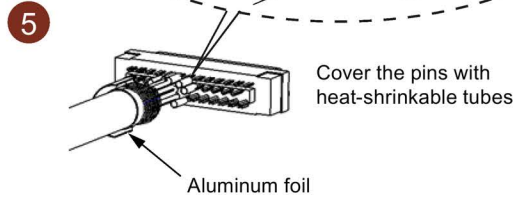
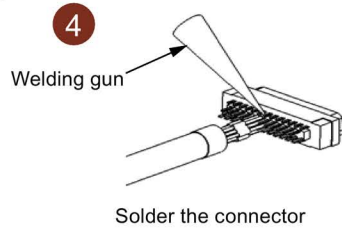
The assembly of a brake terminal follows the procedure as described in the figure above for a power terminal.

### Setpoint connector assembly



**NOTICE**  
You are recommended to assemble the heat-shrinkable tubes to all the used pins. The following pins of the setpoint cable connector must be assembled with heat-shrinkable tubes no matter whether they are used or not. They are pin 15, pin 16, pin 40, pin 41, pin 42, and pin 43.

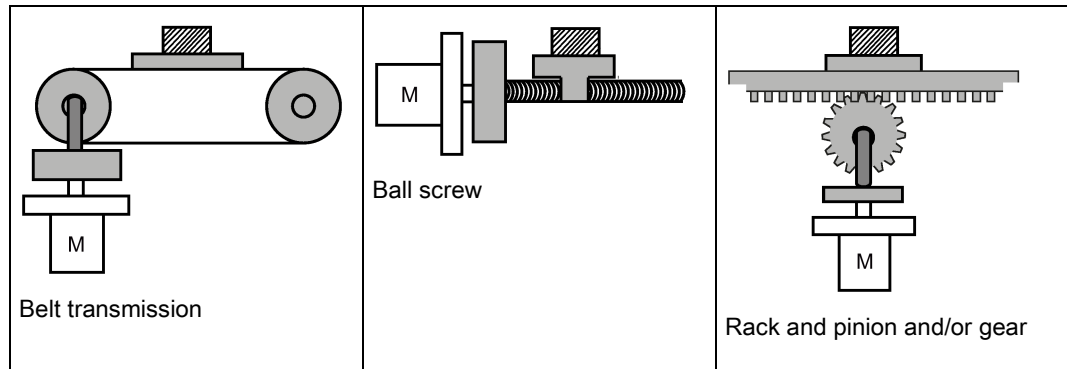
**NOTICE**  
**Drive damage caused by short-circuiting between the shielding wire and the above pins on the setpoint cable connector**  
The shielding wire may inadvertently be short-circuited to the above pins on the to-be-assembled setpoint cable connector. This can cause damage to the drive.  
Exercise caution when connecting the shielding cable to the setpoint cable connector.



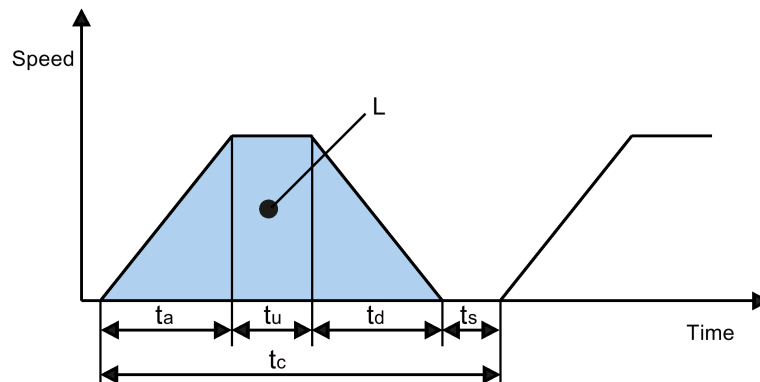
## A.3 Motor selection

### A.3.1 Selection procedure

1. Determine the mechanism type as well as the detailed data of the related mechanical parts, such as ball screw lead, diameter, lead, and gear diameter. Three mechanism types are shown below:



2. Determine the operation pattern including such parameters as acceleration time ( $t_a$ ), constant motion time ( $t_u$ ), deceleration time ( $t_d$ ), stopping time ( $t_s$ ), cycle time ( $t_c$ ), and travel distance ( $L$ ).



3. Calculate load inertia and inertia ratio.  
The inertia ratio can be obtained by dividing the load inertia by the rotor inertia of the selected motor. The unit of inertia is  $\times 10^{-4} \text{ kg}\cdot\text{m}^2$ .
4. Calculate the speed.  
Calculate the speed according to the travel distance, acceleration time, deceleration time, and constant motion time.

5. Calculate the torque.  
Calculate the torque according to the load inertia, acceleration time, deceleration time, and constant motion time.
6. Select the motor.  
Select the motor that matches the data in step 3 to step 5.

## A.3.2 Parameter description

### Torque

- Summit torque: It refers to the maximum torque required by a motor in operation, which is generally less than 80% of the motor's maximum torque. When the torque is a negative value, regenerative resistors may be needed.
- Moving torque and hold torque in standstill: It refers to the torque required by a motor in long-term operation, which is generally less than 80% of the motor's rated torque. When the torque is a negative value, regenerative resistors may be needed.  
Torque calculation methods of two major mechanism types:

$$T_m = \frac{P_b}{2\pi\eta} (\mu g W + F)$$

W: Mass [kg]

P<sub>b</sub>: Ball screw lead [m]

F: External force [N]

η: Mechanical efficiency

μ: Friction coefficient

g: Gravitational acceleration 9.8 [m/s<sup>2</sup>]

$$T_m = \frac{P_d}{2\eta} (\mu g W + F)$$

W: Mass [kg]

P<sub>d</sub>: Belt transmission lead [m]

F: External force [N]

η: Mechanical efficiency

μ: Friction coefficient

g: Gravitational acceleration 9.8 [m/s<sup>2</sup>]

- Effective torque: It refers to the continuous effective load torque converted into the equivalent value on the servo motor shaft, which is generally less than 80% of the motor's rated torque.

$$T_{rms} = \sqrt{\frac{T_a^2 \times t_a + T_m^2 \times t_u + T_d^2 \times t_d}{t_c}}$$

T<sub>a</sub>: Acceleration torque [N·m]    t<sub>a</sub>: Acceleration time [s]

T<sub>m</sub>: Moving torque [N·m]    t<sub>u</sub>: Constant motion time [s]

T<sub>d</sub>: Deceleration torque [N·m]    t<sub>d</sub>: Deceleration time [s]

t<sub>c</sub>: Cycle time [s]

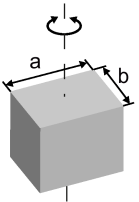
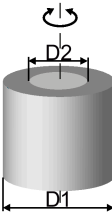
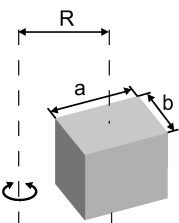
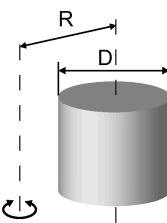
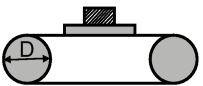
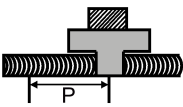
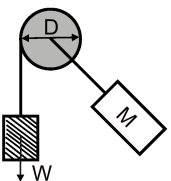
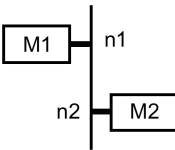
**Speed**

Maximum speed: It refers to the motor's maximum speed in operation, which is generally lower than the rated speed. When a motor operating at the maximum speed, pay attention to its torque and temperature rise.

**Inertia and inertia ratio**

Inertia refers to the force required to keep a certain physical state. Inertia ratio indicates dynamic response performance of motors. The smaller the inertia ratio is the better response performance a motor has.

**Typical load inertia equations**

Mechanism	Equation	Mechanism	Equation
 <p>Axis of rotation on center</p>	$J = \frac{W}{12} (a^2 + b^2)$ <p>W: Mass (kg) a: Length (m) b: Width (m)</p>	 <p>Axis of rotation on center</p>	$J = \frac{W}{8} (D_1^2 + D_2^2)$ <p>W: Mass (kg) D<sub>1</sub>: External diameter (m) D<sub>2</sub>: Internal diameter (m)</p>
 <p>Axis of rotation off center</p>	$J = W \cdot \left( \frac{a^2 + b^2}{3} + R^2 \right)$ <p>W: Mass (kg) a: Length (m) b: Width (m) R: Rotational diameter (m)</p>	 <p>Axis of rotation off center</p>	$J = \frac{W}{8} (D^2 + 8R^2)$ <p>W: Mass (kg) D: Workpiece diameter (m) R: Rotational diameter (m)</p>
 <p>Conveyor</p>	$J = \frac{W \cdot D^2}{4}$ <p>W: Mass (kg) D: Pulley wheel diameter (m)</p>	 <p>Ball screw</p>	$J = \frac{W \cdot P^2}{4\pi^2} + J_b$ <p>W: Mass (kg) P: Lead (m) J<sub>b</sub>: Ball screw inertia (kg·m<sup>2</sup>)</p>
 <p>Object hung with pulley</p>	$J = W \cdot \left( \frac{D}{2} \right)^2 + J_p$ <p>W: Mass (kg) D: Pulley wheel diameter (m) J<sub>p</sub>: Pulley inertia (kg·m<sup>2</sup>)</p>	 <p>Reducer</p>	$J = J_1 \cdot \frac{n_1^2}{n_2^2} \cdot J_2$ <p>W: Mass (kg) n<sub>1</sub>/n<sub>2</sub>: Speed of each motor (rpm) J<sub>1</sub> / J<sub>2</sub>: Inertia of each motor (kg·m<sup>2</sup>)</p>

### A.3.3 Selection examples

This section uses a ball screw mechanism as an example to illustrate the motor selection procedure.

#### Exemplary data

The following table lists the data related to the ball screw mechanism and operation pattern.

Mechanism		Operation pattern	
Workpiece weight (W)	40 kg	Acceleration time (t <sub>a</sub> )	0.15 s
Ball screw length (B <sub>l</sub> )	2 m	Constant motion time (t <sub>u</sub> )	0.7 s
Ball screw diameter (B <sub>d</sub> )	0.04 m	Deceleration time (t <sub>d</sub> )	0.15 s
Ball screw pitch (B <sub>p</sub> )	0.04 m	Cycle time (t <sub>c</sub> )	2 s
Mechanical efficiency (B <sub>η</sub> )	0.9	Travel distance (L)	0.5 m
Coupler inertia (J <sub>c</sub> )	20 x 10 <sup>-6</sup> kg·m <sup>2</sup> (refer to the supplier's product catalog)	-	

#### 1. Ball screw weight

$$B_w = \rho \times \pi \times (B_d/2)^2 \times B_l = 19.85 \text{ kg}$$

#### 2. Load inertia

$$J_l = J_c + J_b = J_c + 1/8 \times B_w \times B_d^2 + W \times B_p^2 / 4\pi^2 = 5.61 \times 10^{-3} \text{ kg}\cdot\text{m}^2$$

#### 3. Preselection

$$\text{If a 1000 W motor is selected, } J_m \text{ (motor inertia) } = 1.57 \times 10^{-3} \text{ kg}\cdot\text{m}^2$$

$$\text{Therefore, } J_l / J_m \text{ (inertia ratio) } = 3.57 < 5 \text{ times}$$

#### 4. Maximum rotational speed

$$V_{\max} \text{ (maximum travelling speed) } = 2L / (t_a + 2t_u + t_d) = 5.89 \text{ m/s}$$

$$N_{\max} \text{ (maximum rotational speed) } = 60 \times V_{\max} / B_p = 882 \text{ rpm} < 2000 \text{ rpm (rated speed)}$$

#### 5. Effective torque

$$T_m \text{ (moving torque) } = (\mu gW + F) \times B_p / 2\pi B_\eta = 0.069 \text{ Nm}$$

$$T_a \text{ (acceleration torque) } = [(J_l + J_m) \times 2\pi N / T_a] + T_m = 4.49 \text{ Nm}$$

$$T_d \text{ (deceleration torque) } = [(J_l + J_m) \times 2\pi N / T_d] - T_m = 4.35 \text{ Nm}$$

$$\text{Therefore, } T_{\text{rms}} \text{ (effective torque) } = \sqrt{(T_a^2 \times t_a + T_m^2 \times t_b + T_d^2 \times t_d) / t_c} = 1.71 \text{ Nm} < 4.78 \text{ Nm (rated torque)}$$

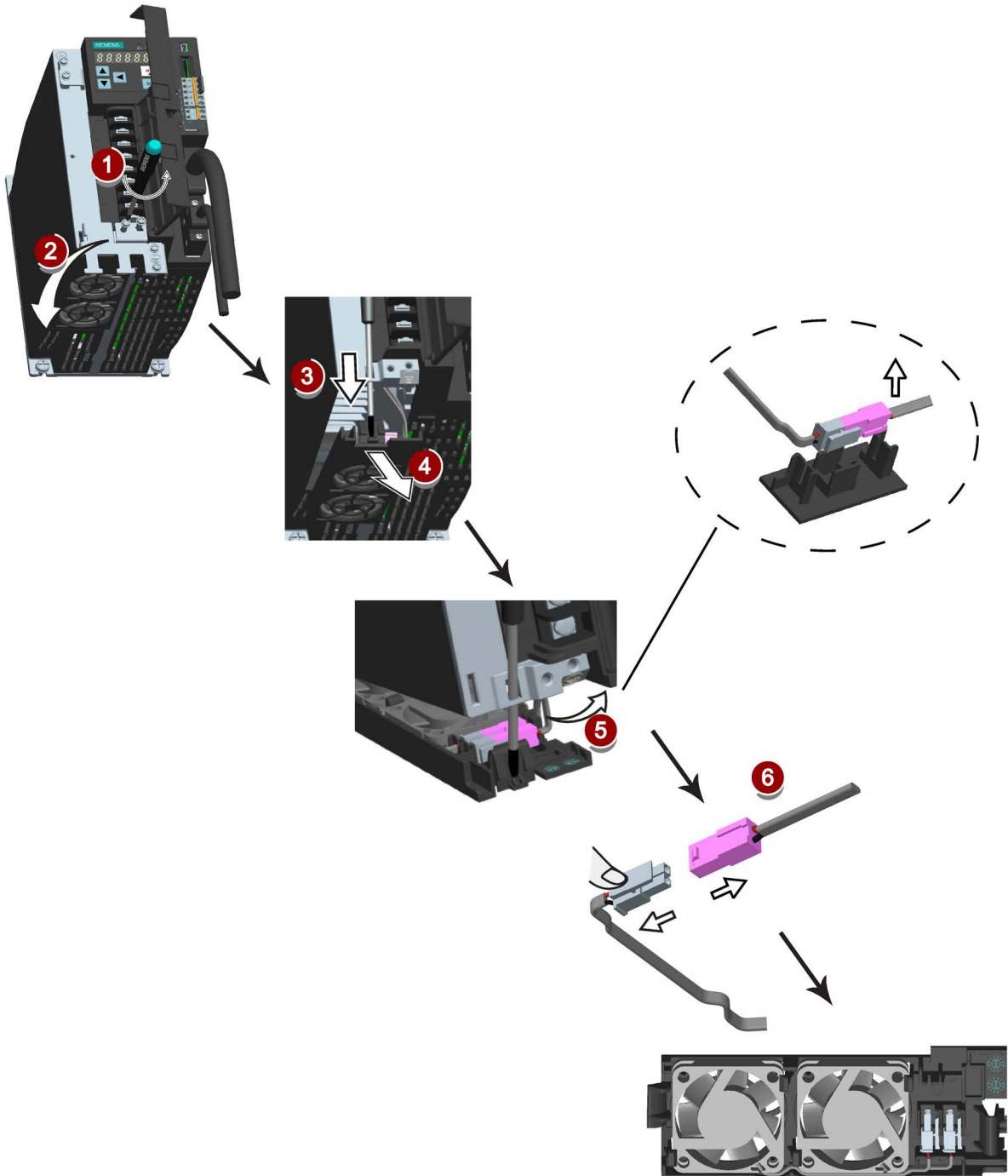
#### 6. Final selection

According to the above calculated speed, torque, and inertia ratio, you are recommended to select 1000 W motors, i.e. 1FL6062.

## A.4 Replacing fans

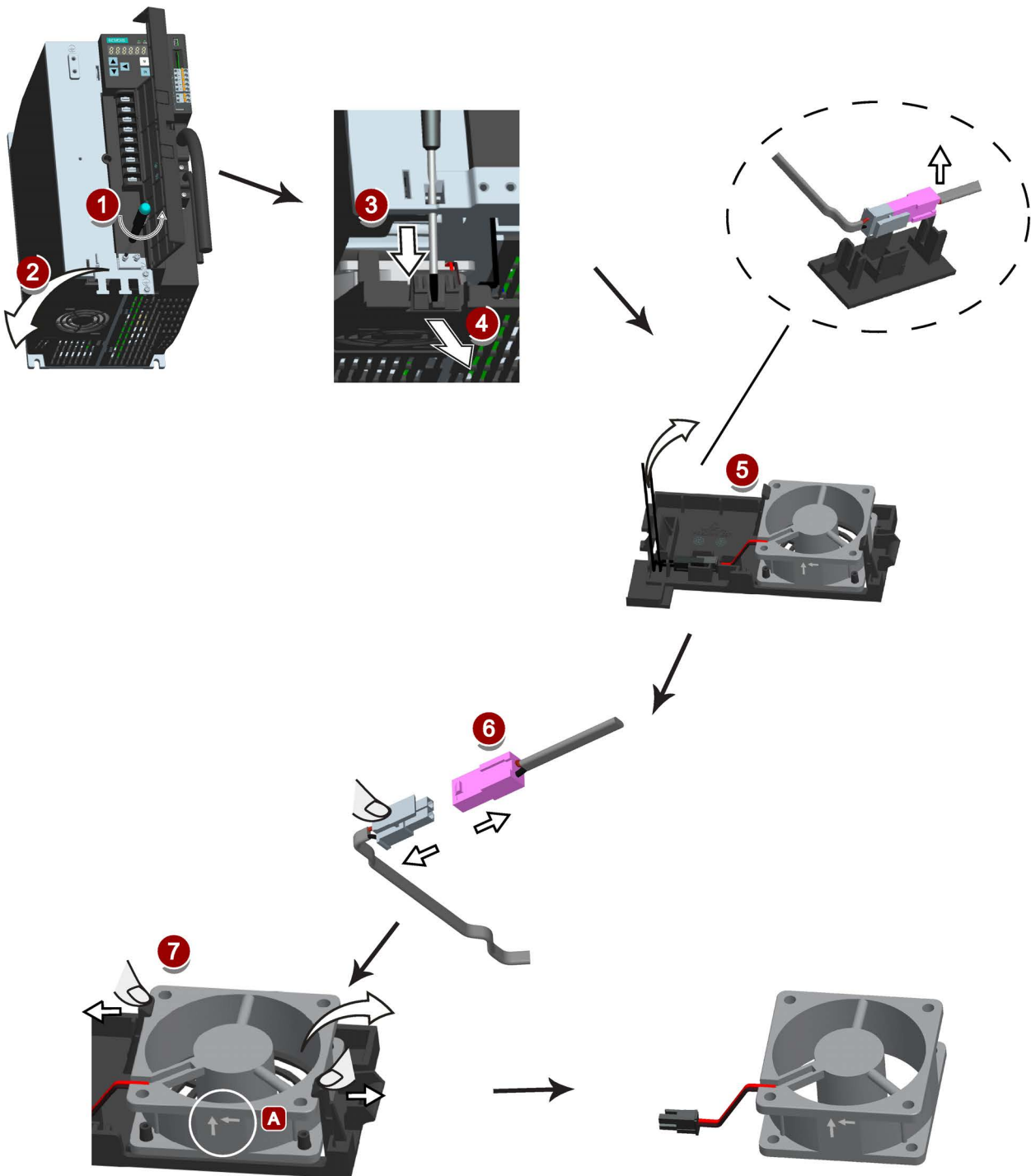
Proceed as illustrated below to remove the fan from the SINAMICS V90 drive. To re-assemble the fan, proceed in reverse order. When re-assembling the fan for FSC, make sure that the arrow symbol ("A" in the illustration) on the fan points to the drive rather than the fan housing.

### Replacing the fans from frame size B





### Replacing the fan from frame size C





# Index

## A

### Accessories

- Braking resistor, 46
- Cables and connectors, 42
- External 24 VDC power supply, 45
- Filter, 47
- Fuse/Circuit breaker, 45
- SD card/Micro SD card, 51

### Aims, 227

### Ajust AI offset, 159

### analog inputs, 101

### Analog inputs

- Command voltage, 102

### analog outputs, 102

### Analog outputs

- Parameterization, 102
- Wiring, 103

### ANSI B11, 238

## B

### Backlash compensation, 189

### BOP operations

- Button functions, 146

### BOP operations for faults and alarms, 315

- Acknowledging faults, 316
- Exiting from alarm display, 315
- Exiting from fault display, 315
- Viewing alarms, 315
- Viewing faults, 315

### BOP overview, 143

## C

### Certification, 240

### Change a parameter value, 149

- Parameter setting with shift function, 151

### Commissioning

- Initial commissioning, 132

### Connecting 24 V power supply/STO, 124

### Connecting an external braking resistor, 129

### Connecting the RS485 interface, 130

### Connecting the SIMATIC S7-1200

- For internal position control (IPos), 121
- For pulse train input position control (PTI), 120

For speed control (S), 122

For torque control (T), 123

### Connecting the SIMATIC S7-200

For internal position control (IPos), 117

For pulse train input position control (PTI), 116

For speed control, 118

For torque control, 119

### Connecting the SIMATIC S7-200 SMART

For internal position control (IPos), 113

For pulse train input position control (PTI), 112

For speed control (S), 114

For torque control (T), 115

### Copy parameter set from a micro SD card/SD card to drive, 157

### Copy parameters from the servo drive to a micro SD card/SD card, 156

## D

### Device combination, 33

### Differences between faults and alarms, 314

### Digital inputs, 92

Direct signal map, 96

Wiring, 96

### Digital outputs, 97

Assigning warning signals to digital outputs, 99

### DIN EN ISO 13849-1, 231

### Direction of motor rotation, 163

### Drive rating plate, 29

## E

### EN 61508, 234

### EN 62061, 232

### Equipment regulations, 239

## F

### Function list, 52

### Functional safety, 228

## G

### Gain switch, 264

### Gain switching using actual speed, 267

Gain switching using an external digital input signal, 265  
 Gain switching using position deviation, 266  
 Gain switching using position setpoint frequency, 267  
 General information about faults and alarms, 313

## H

Harmonized European Standards, 229

## I

Internal position control mode (IPos)  
     Linear/modular axis, 189  
     Position setpoint, 186  
     Selecting a fixed position setpoint and starting positioning, 199  
     Selecting a positioning mode, 188  
     Setting mechanical system, 185  
     Software position limit, 198  
 Iterative process for achieving safety, 235

## J

Jog function, 154  
     Jog in speed, 154  
     Jog in torque, 154

## L

LED status indicators, 317

## M

Machine safety in Japan, 239  
 Machine safety in the USA, 236  
 Machinery directive, 228  
 Main circuit wirings  
     Connecting the motor power - U, V, W, 87  
 Motor holding brake, 165  
     Relevant parameters, 168  
     Signal status, 166  
 Motor rating plate, 32  
 Motor selection method, 340  
 Mounting the motor  
     Motor dimensions, 75  
     Mounting orientation, 72

## N

NFPA 79, 237  
 NRTL, 237

## O

Operating display, 148  
 OSHA, 236  
 Over-travel, 164  
 Overview of absolute position system, 224  
     Restrictions, 225  
 Overview of SINAMICS V90 BOP functions, 153

## P

PI to P switching using torque setpoint, 270  
 PI/P switching, 268  
 PI/P switching using acceleration setpoint, 272  
 PI/P switching using an external digital input signal, 270  
 PI/P switching using pulse deviation, 273  
 PI/P switching using speed setpoint, 271  
 Preface  
     Documentation components, 3  
     Target group, 3  
     Technical support, 3  
 Probability of failure, 242  
 PTO  
     Wiring, 101  
 Pulse train encoder outputs, 101  
 Pulse train input position control mode (PTI)  
     Calculating electronic gear ratio, 174  
     Clearing droop pulses, 182  
     In position (INP), 172  
     P-TRG, 177  
     Selecting a setpoint pulse train input channel, 171  
     Selecting a setpoint pulse train input form, 172  
     Smoothing function, 173  
 Pulse train inputs  
     Wiring, 100

## R

Referencing  
     Referencing modes, 190  
 Residual risk, 236  
 Resonance suppression, 260  
     Activate the resonance suppression function, 261  
     Manual tuning with resonance suppression (p29021=0), 262

- One-button auto tuning with resonance suppression (p29023.1=1), 261
- Real-time auto tuning with resonance suppression (p29024.6=1), 262
- Response time, 243
- Risk analysis, 234
- Risk reduction, 236

## S

- Safe Torque Off
  - functional features, 243
  - response time, 245
  - selecting/deselecting STO, 245
- Safety Integrated function, 240
- Safety of machinery in Europe, 228
- Save parameters in the servo drive, 155
- Search a parameter in "P ALL" menu, 152
- Selection of control mode
  - Control mode change for a compound control mode, 161
  - Control modes, 161
  - Selection of a basic control mode, 161
- Servo ON signal, 162
  - Relevant parameter settings, 163
- Set parameter set to default, 155
- Set zero position, 160
- Speed control mode
  - Direction and stop, 204
  - External speed setpoint, 202
  - Offset adjustment, 203
  - Parameter settings for fixed speed setpoint, 203
  - Ramp-function generator, 205
  - Speed setpoint, 201
  - Zero speed clamp, 204
- Speed limit, 178
  - Overall speed limit, 178
- Standards for implementing safety-related controllers, 230
- Stopping method at servo OFF, 169
  - Coast-down, 170
  - Emergency stop, 170
  - Ramp-down (OFF1), 170
- System connection, 81

## T

- Technical data
  - Cables, 66
- Torque control mode
  - 300% overload capacity, 207

- Direction and stop, 209
- External analog torque setpoint, 208
- External speed limit, 179
- Internal speed limit, 179
- Offset adjustment, 208
- Torque control with fixed setpoint, 209
- Torque setpoint, 208
- Torque limit, 179
  - External torque limit, 181
  - Internal torque limit, 180
  - Overall torque limit, 180
  - Torque limit reached (TLR), 182
- Transmitting sequence for the absolute position data, 225
- Tuning
  - Configuration of dynamic factor, 252, 256
  - Manual tuning, 259
  - Real-time auto tuning, 255
  - Servo gains, 248
  - Tuning methods, 249
  - Tuning with SINAMICS V-ASSISTANT, 250

## U

- Update firmware, 157
- Usage of the shielding plate, 85
- USS
  - Telegram format, 210

## W

- Wiring and connecting
  - Adjusting cable orientations, 86
- Wiring and connection
  - Connecting the motor holding brake - X7, 129