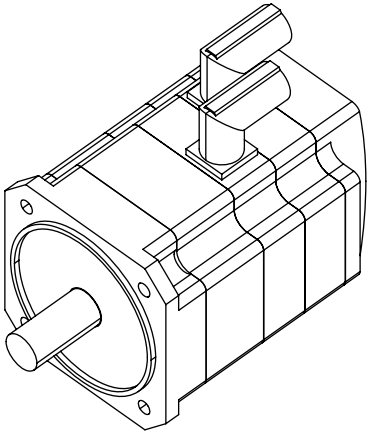
SIEMENS

Synchronous motors
1FK7 01. - 1FK7 10.

Instructions **Edition 10/2007**

Synchronmotoren
Moteurs synchrones
Motores sincrónicos
Motori sincroni



610.40 700.21

CONTENTS

This manual contains notes which you should observe to ensure your own personal safety, as well to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows to the level of danger. They are shown as follows according to the degree of danger involved.

⚠ DANGER!	
Pictogram	indicates an imminently hazardous situation which, if not avoided by the appropriate precautionary measures, will result in death, serious injury or substantial material damage.

⚠ WARNING	
Pictogram	indicates an imminently hazardous situation which, if not avoided by the appropriate precautionary measures, could result in death, serious injury or substantial material damage.

⚠ CAUTION	
Pictogram	used with the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION
used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in damage to property.

NOTICE
indicates a potential situation which, if not avoided, may result in an undesirable result or state.

Qualified Personnel

The device/system may only be set up and operated in conjunction with this manual. Only qualified personnel should be allowed to install and work on the this equipment. Qualified persons are defined as persons who are authorized to commission, to ground, and to bag circuits, equipment, and systems in accordance with established safety practices and standards.

Intended Usage

Please note the following:
This device and its components may only be used for the applications described in the catalog or technical description, and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens.
This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended.

Disclaimer of Liability

We have checked the contents of this manual. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in the manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvement are welcomed.

Siemens AG
Bereich Automatisierungs- und Antriebstechnik
Geschäftsgebiet Motion Control Systeme (MC)
D-97615 Bad Neustadt an der Saale

1 General safety instructions

The synchronous motors correspond to the harmonized standards of the EN 60034 and EN 60204-1 and there is conformity with the 73/23/EEC Low Voltage Directive.

Standard motors conform to UL regulations. The rating plates of these motors are marked with UR.

Ensure that your end product conforms to all currently valid legal requirements. Follow the compulsory national, local and installation-specific regulations.

EU Manufacturer`s Declaration According to Article 4 Paragraph 2 of the EU Directive 98/37/EU:

- The products supplied fulfill the requirements of standard EN 60204-1.
- The products supplied are intended exclusively for installation in a machine.
- Commissioning is prohibited it has until been established that the end product conforms with the Directive 98/37/EU.
- All safety instructions in the associated product documentation must be observed and given to the end user for his/her information.
- This declaration contains no condition and durability guarantee to § 443 BGB.

The operating manual applies in conjunction with the SIEMENS Configuration Manual, see table.

Configuration Manual

Code	Titel	Order No.
/PFK7S/	Synchronous motors 1FK7 for SINAMICS	6SN1197-0AD16-0BP1
/PFK7/	Synchronous motors 1FK7 for SIMODRIVE/MASTERDRIVES	6SN1197-0AD06-0BP1

All safety instructions must be observed during the transport, storage, assembly, disassembly and operation of the synchronous motors!

Failure to observe the instructions can lead to serious personal injuries or property damage.

The motors' rotors contain permanent magnets with high magnetic flux densities which exert strong attractive forces on ferromagnetic bodies.
People fitted with a heart pacemaker are at risk in the vicinity of a disassembled rotor.
Data stored on electronic data media may be destroyed.

It is forbidden to use the motors in areas at risk of explosion, unless expressly stated.

Thermal hazards

The temperatures of motor surfaces can reach more than 100 °C (212 °F).

Do not touch hot surfaces!

Temperature-sensitive components (electric lines, electronic components) must not touch hot surfaces.

Overheating in the motors may destroy the windings and bearings, and demagnetize the permanent magnets.

Only operate the motors with effective temperature control.

Intended use

Usage for the intended purpose includes observing all the specifications in the operating manual and the Configuration Manual "Synchronous motors".

2 Product information

2.1 Product description

Motors of 1FK7 series are permanent magnet excited, synchronous motors for operating with indirect a.c. converters according to the sinusoidal current principle.

The motors are intended for driving and positioning machine tools, production machines, robots and handling devices.

2.2 Scope of delivery

The drive systems are arranged individually. Immediately upon receipt of delivery, check whether the scope of delivery corresponds with the consignment notes. SIEMENS cannot accept any liability for any shortages or deficiencies reported at a later date.

Complaint instructions:

- Report detectable transport damage immediately to the carrier.
- Report detectable defects / incomplete delivery immediately to the responsible SIEMENS representative.

The operating manual is part of the scope of delivery and shall therefore be kept in an accessible place.
As the delivery includes a separate type plate, the motor data must also be kept on or near the machine or system.

3 Technical data

3.1 Rating plate

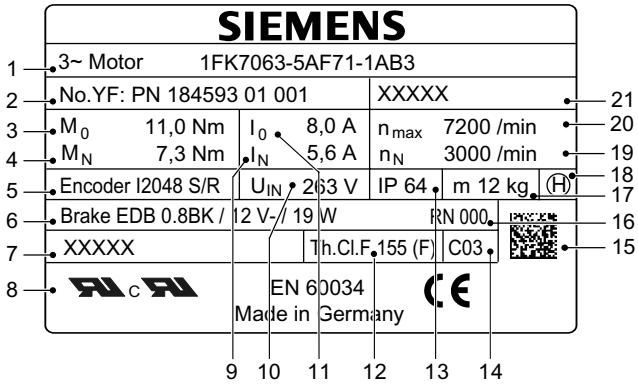


Fig. 1 Rating plate

1 SIEMENS motor type / designation
2 IID No., production number
3 Zero speed torque M_0 [Nm]
4 Rated torque M_N [Nm]
5 Encoder type
6 Holding brake data:
Type, voltage, power consumption
7 Customer specifications
8 Standards and regulations
9 Rated current I_N [A]
10 Induced voltage U_{IN} [V]
11 Zero-speed current I_0 [A]
12 Temperature class
13 Degree of protection
14 Encoder version
15 Bar code
16 Motor version
17 Motor weight m [kg]
18 Balancing method marked
19 Rated speed n_N [rpm]
20 Maximum speed n_{max} [rpm]
21 Order options

The type plate is covered by a yellow protective foil for motors without paint finish. This foil should be removed unless the motor will be painted over again.

3.2 Features

Types of construction (EN 60034-7)	IM B5 (IM V1, IM V3)
Degree of protection (EN 60034-5)	IP64 (1FK701.: IP54)
Cooling (EN 60034-6)	Self-cooling
A-grade sound pressure level (EN 60034-9) for speed range up to 3,000 rpm	
1FK701. - 1FK704.	approx. 55 dB(A)
1FK706.	approx. 65 dB(A)
1FK708., 1FK710.	approx. 70 dB(A)
Thermal motor protection (EN 60034-11)	Temperature sensor KTY84 in the stator winding
Shaft end (DIN 748-3; IEC 60072-1)	cylindrical; without keyway, Tolerance range k6 (1FK701.: h6)
true running, coaxiality, axial run-out deviation (DIN 42955; IEC 60072-1)	Tolerance N
Oscillating quantity level (N 60034-14)	level A (up to rated speed)
Bearing design	Rolling contact bearing with permanent grease lubrication (lifetime lubrication) fixed bearing on non-drive end
Service life of bearing	20000 h (guideline)
Winding insulation (EN 60034-1)	Temperature class 155 °C (311 °F) (F)
Ambient temperatures	-15 °C to +40 °C (5 °F to 104 °F) otherwise the rated data are reduced (see Configuration Manual)
Installation altitude (EN 60034-1)	up to 1000 m a.s.l, otherwise the rated data are reduced (see Configuration Manual)
Magnetic material	Rare-earth material
Electrical connections	Revolving plug for output and encoder signals
Encoder system	fitted encoder - speed recording - recording the rotor position - indirect positional recording

Options/expansions

Low inertia series	HD (High Dynamic)
Type of protection (EN 60034-5)	IP65; additional drive end flange IP67
Fitted/mounted elements	- closed current holding brake (DIN VDE 0580) Supply voltage 24 V DC ±10% - planetary gearing
Encoder system	- incremental encoder sin/cos 1 V_{PP} - absolute value encoder EnDat - simple, absolute value encoder - resolver
Encoder system without DRIVE-CLiQ Interface	- I2048S/R = incremental encoder sin/cos 1 V_{PP} 2048 S/R - AM2048S/R = absolute value encoder EnDat - AM512S/R = absolute value encoder EnDat - AM32S/R = absolute value encoder EnDat - AM16S/R = absolute value encoder EnDat - resolver

Encoder system with DRIVE-CLiQ Interface	- I22DQ = incremental encoder 22 bit - AM22DQ = absolute value encoder 22 bit Singleturn + 12 bit Multiturn - AM20DQ = absolute value encoder 20 bit Singleturn + 12 bit Multiturn - AM16DQ = absolute value encoder 16 bit Singleturn + 12 bit Multiturn - AM15DQ = absolute value encoder 15 bit Singleturn + 12 bit Multiturn - Resolver 15 bit - Resolver 14 bit
Shaft end (DIN 748-3; IEC 60072-1)	cylindrical with keyway and feather key; Tolerance range k6 (balancing with half feather key)

You will find more technical details, e.g. motor dimensions, in the catalogs NC 60, NC 61, D 21.1 or Configuration Manual.

4 Transport, Installation and Assembly

4.1 Transport, Storage

⚠ WARNING

Danger during lifting and transporting procedures!
Improper handling, unsuitable or defective devices, tools etc. can cause injuries and/or property damage.
Lifting devices, ground conveyors and lifting tackle must correspond to the valid regulations.

Observe the transport regulations applying in the country/countries concerned.

Use suitable load suspension devices for transport and assembly.

Use lifting eyes for transporting the motors where these are provided by the manufacturer.

Lifting tackle as per 98/37/EU Directive for Machines, Appendix I.

The motor weight is indicated on the rating plate.

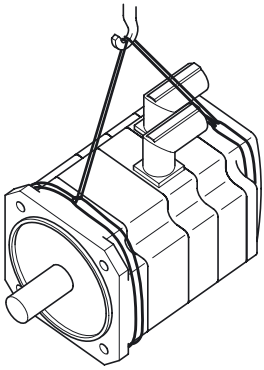


Fig. 2 Lift and transport with suspension bands

The motors should be stored indoors in dry, low-dust and low-vibration (v_{eff} < 0,2 mm/s) rooms. The motors should not be stored longer than two years at room temperature (+5 °C to +40 °C) (41 °F to 104 °F) to retain the service life of the grease.

4.2 Installation

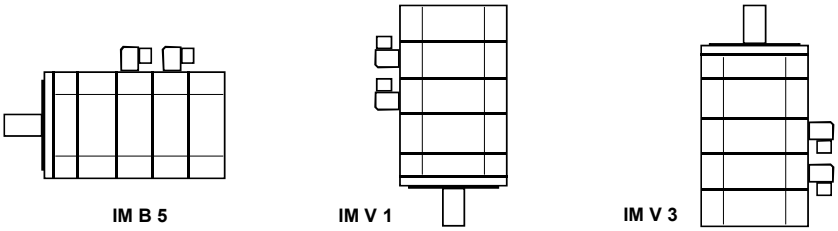


Fig. 3 Types of construction

- Take note of and observe the information on the rating plate and warning and informative notices on the motor.
- Observe the permitted transverse and axial forces (see project planning instructions). Axial forces are not permitted on motors with an integrated brake.
- Check for compliance with the conditions (e.g. temperature, site altitude) at the assembly site (see Section 3.2).
- It is forbidden to use them in areas at risk of explosion.
- Remove all anti-corrosion agents from the shaft end (use commercially available solvent).
- Ensure that waste heat is adequately dissipated.
  It is recommended to maintain a clearance of 100 mm from adjacent parts on at least three sides.
- Tighten the flanges equally, avoid distortions when tightening the fixing screws. Use hexagon socket head cap screws, strength class at least 8.8.
- In the case of a vertical installation with the shaft end at the top, ensure that no fluid penetrates into the upper bearing.
- Lifting eye-bolts which have been screwed in may be removed after the motor has been installed.
- Turn the output elements by hand. If grinding noises occur, eliminate the cause or contact the manufacturer.
- Please observe the tightening torques to be applied to the motor flange fastening screws:

Motor	ISO 4762 screw	ISO 7092 washer	Tightening torque for screws (not for electrical connections) in Nm
1FK701.	M4	4 (d2 = 8)	2,2
1FK702.	M5	5 (d2 = 9)	4
1FK703.	M6	6 (d2 = 11)	8
1FK704.	M6	6 (d2 = 11)	8
1FK706.	M8	8 (d2 = 15)	20
1FK708.	M10	10 (d2 = 18)	35
1FK710.	M12	12 (d2 = 20)	60

Vibrations, balancing

Motors with a keyway are balanced by the manufacturer with a half feather key.

The site vibration response of the system is determined by the output elements, the mounting conditions, the alignment, the installation and the effects of external vibrations. This may cause a modification of the motor vibration values.

Output elements

NOTICE

Do not strike the shaft or bearings of the motors.
Do not exceed the permissible axial and radial forces on the shaft end stated in the configuration specification.
Axial forces are not permitted on motors with an integrated brake.

Suitable devices should always be used to push on or pull off the output elements (e.g. the coupler, gear wheel, belt pulley, Fig. 4).

- Use the tapped hole in the shaft end.
- Heat up the output elements if necessary.
- Use a shim to protect the centering in the shaft end when pulling output elements off.
- If necessary, fully balance the motor with the output elements according to ISO1940

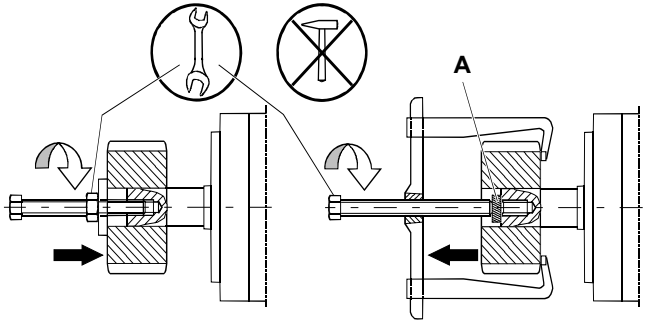


Fig. 4 Pulling off and putting on output elements.
A Shim (protects the centering in the shaft end)

5 Electrical connections

5.1 Important instructions

⚠ DANGER!

Electric shock hazard!
When the rotor is rotating, the motor terminals carry a voltage of up to approx. 300 V.
Stop the motor before commencing any electrical work.
Only use trained, qualified personnel for assembly work on the converters and plugs.
Observe the regulations for working in electrotechnical plants.
Do not plug or unplug any connectors unless they are in a de-energized condition.

Safety rules for working in electrical installations as per
EN 50110-1 (DIN VDE 0105-100):

- Work always with the equipment electrically dead.
- Isolate from electrical supply.
- Secure against switching on again.
- Check electrical deadness.
- Earth and short-circuit.
- Cover or cordon off adjacent parts which are electrically live.
- Release for work.
- Connect the PE conductor to ⏚

Assembly requirements

CAUTION

Warning of motor damage!
Connecting the motor directly to a three-phase system will destroy it.
Motors may only be driven with configured converters!
Ensure that the phase sequence is correct.
Encoder systems and temperature sensor contain electrostatically endangered components (EEC).
Do not touch the connections with your hands or tools which could be electrostatically charged!

Pre-assembled cables from SIEMENS are recommended (not included in scope of delivery). These cables reduce the assembly time and increase operational safety (see project planning instructions).

- Proper installation is the responsibility of the manufacturer of the system / machine.
- Observe the data on the type plate (Section 3.1)and the information in the wiring diagrams (Fig. 5).
- Connecting leads must be suitable for the type of application and for the anticipated currents and voltages.
- If the motor is supplied by means of converters, high-frequency current and voltage harmonics in the motor supply leads can cause electromagnetic interference to be emitted.
  Use shielded power and signal lines.
  Observe the EMC instructions of the converter manufacturer.
- The inside of the plug must be kept clean and free from cable residues and moisture.
- Avoid protruding wire ends.
- Check the seals and sealing surfaces of plug to ensure that the degree of protection is maintained.
- The connecting leads are to be equipped with the strain relief device and the devices which protect against rotation and transverse forces, and must be prevented from kinking. The plugs must not be subjected to continuous forces.
- The coding slot on the plug connector must be aligned when inserted into the female connector in each case, and the union nut tightened up to the stop by hand.

The protective function with a fitted temperature sensor is inadequate for high thermal loads, e.g. overload with the motor at a standstill. Additional protective measures are to be provided for such cases, e.g. a i^2t monitoring.

5.2 Plug design

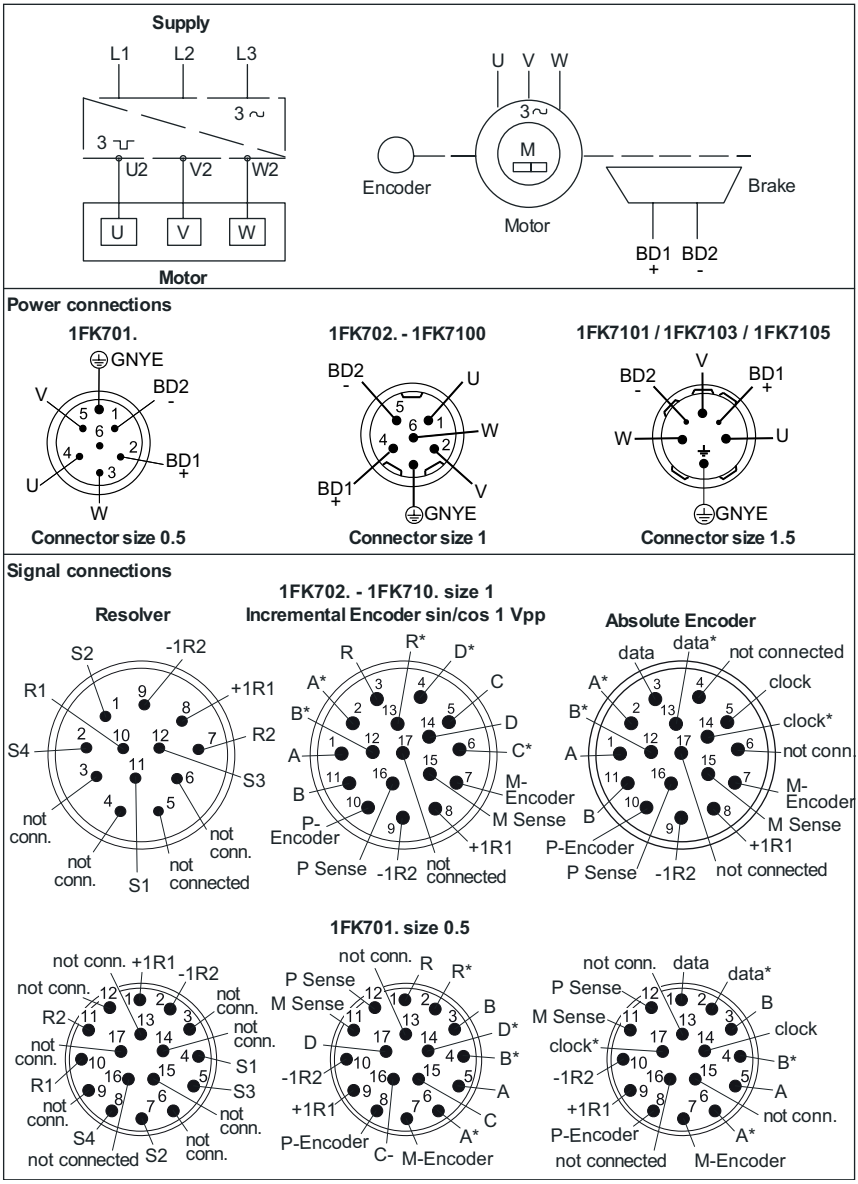


Fig. 5 Connection configurations and pin assignment of the connectors

⚠ WARNING

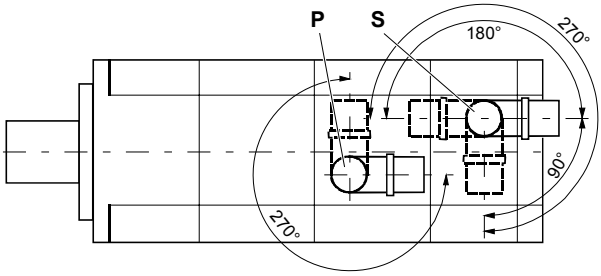
Improper change of the plug output direction leads to damage to the connecting cables.
Do not exceed the permissible twisting moments as per Fig. 6.
A maximum of ten changes to the plug output direction are permissible up to the stop with the attached, matching, mating plug.

Power plug

1. Use plug size 0.5 / 1 or 1.5.
2. Assign the plugs according to figure Fig. 5 Connect the PE conductor.
3. Connect the brake via Fig. 5 the power plug. The polarity must be carefully observed.

Signal plug for the encoder system and temperature sensor.

1. Use an appropriate plug.
2. Assign the plugs according to Fig. 5.



P Power plug **S** Signal plug

Fig. 6 Degree of rotation of plugs

A suitable socket plug may be used for twisting the right-angle plug. Unscrew to open the socket plug completely and avoid any damage to the pin contacts.

Maximum permissible twisting moments M_{max}

Plug	Motor	Plug size	M_{max}
Power plug	1FK701.	0.5	M_{max} = 5 Nm
	1FK702. - 1FK7100	1	M_{max} = 12 Nm
	1FK7101 - 1FK7105	1.5	M_{max} = 20 Nm
Signal plug	1FK7.		M_{max} = 12 Nm

5.3 Motors with DRIVE-CLiQ interface

Motors for the SINAMICS S120 drive system are equipped with a sensor module (electronic module) which contains the encoder and temperature evaluation and an electronic rating plate. This sensor module is mounted instead of the signal connector, and has a 10-pole RJ45plus socket that is known as the DRIVE-CLiQ interface. The pin assignment is independent of the encoder inside the motor.

⚠ WARNING

The motor must not be lifted or transported by the sensor module.

CAUTION

The sensor module has direct contact to electrostatically sensitive devices (ESD). Do not touch the connections with your hands or tools which could be electrostatically charged!

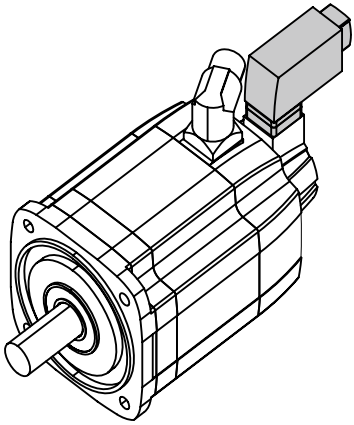


Fig. 7 Motor with sensor modul (example)

The signal link between motor and converter is made by a DRIVE-CLiQ cable MOTION-CONNECT. Only SIEMENS pre-assembled cables may be used. These cables reduce the assembly time and increase operational safety.

The plug of the DRIVE-CLiQ cable must be pushed on until the catch springs slot in, pay attention to the plug coding.

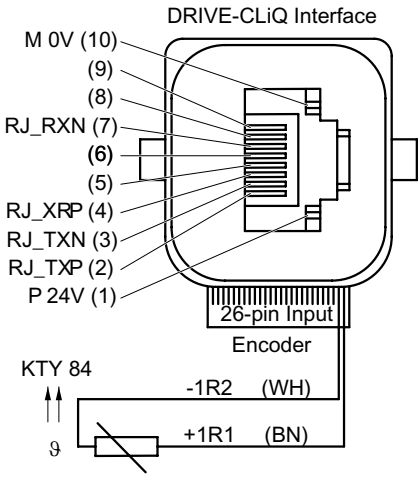


Fig. 8 Pin assignment of DRIVE-CLiQ

Cable outlet direction

The sensor module is mounted on the motor instead of the signal connector. It can be turned through about 270° or 180°. The turning range is shown in the following illustrations. The typical twisting torque is 4...8 Nm. **The sensor module may only be turned by hand. Pipe wrenches, hammers and the like must not be used.**

CAUTION
Improper change of the cable output direction leads to damage to the connecting cables. The permissible twisting range must not be exceeded. Only a maximum of ten changes to the rotational angle of the sensor module are permitted within the rotational range.

6 Commissioning

⚠ CAUTION	
	**Thermal hazard from hot surfaces!** **The temperatures of motor surfaces can reach more than 100 °C (212 °F). Do not touch hot surfaces!** **Protection must be provided against accidental contact if necessary. Temperature-sensitive components (electric lines, electronic components) must not touch hot surfaces.**

6.1 Checks before starting up

Before starting up, ensure that

- all connections have been properly made, and the plug connectors are secured against working loose.
- all motor protection devices are active,
- the drive is not blocked,
- no other possible sources of danger are present,
- the drive is undamaged (no damage from transport/storage),
- the feather keys in the shaft end (if present) are secured against being thrown out.

6.2 Commissioning procedure

Observe the start up and commissioning instructions for the converter (e.g. SIMODRIVE, MASTERDRIVES MC, SINAMICS).

⚠ WARNING

Hazard from rotating rotor!
Protect the output elements against accidental contact!
Secure feather key (if present) against being thrown out.

NOTICE

The brake is designed as a holding brake. Emergency stops are permitted; see project planning instructions.
It is not permitted to be used as a working brake.

1. Release brake, in as far as this is necessary.
2. Check the brake function (open and close).
   Apply 24 V DC ±10% to the pins +BD1, -BD2 (Fig. 5), and ensure that the rotor is running freely (no rubbing noises).
3. Check the mounting, seating and alignment of the motor.
4. Check the suitability and setting of the output elements for the intended conditions of use, for example belt tension.
5. Check the power and signal plug connections.
6. Check the functional condition of the auxiliary devices present.
7. Check the protection against accidental contact with moving and live parts.
8. Bring the drive system into operation in accordance with the operating manual for the converter or inverse rectifier.
9. Check that the maximum permissible speed n_{max} is observed (see type plate for details). The maximum permissible speed is the highest permissible, short-term operating speed.
10. The fitted temperature sensor cannot cater for all possible faults (note the instructions in the Configuration Manual).

7 Instructions in case of faults

In case of deviation from normal operation or faults, proceed first according to the following list:
In this connection, please also refer to the relevant section of the operating manual for the components of the entire drive system.
Do not disable the protective devices, even in trial operation.

Consult the manufacturer or the SIEMENS service center when necessary.

For start up, system motor converter: A&D Hotline +49 180 50 50 222

For motor / motor components: Contact in the works +49 174-3110669

Fault	Cause	Remedy
Irregular running	Inadequate screening of the motor or encoder cable.	Check screening and grounding (see Section 5.1)
	Amplification of the drive controller too high	Adjust controller (see converter operating manual)
Vibrations	Coupling elements or driven machine are badly balanced	Rebalance
	Inadequate alignment of the drive train	Realign the machine set
	Fixing screws are loose	Check and tighten screw connections
Running noises	Foreign bodies inside the motor	Repair by the manufacturer
	Bearing damage	Repair by the manufacturer
Motor overheats (surface temperature > 140 °C (284 °F)) Temperature monitoring responds	Drive overloaded	Check load (see type plate)
	Heat dissipation impaired by deposits	Clean surface of drives. Ensure that the cooling air can flow freely in and out

8 Inspection, maintenance, disposal

Clean according to the degree of local contamination in order to ensure that the waste heat is adequately dissipated.

As the operating conditions vary greatly, one can only cite general intervals for fault-free operation.

Also replace the encoders whenever the motor ball bearings are replaced as the encoder bearings wear out too.

Guidelines:

- Bearing service life 25 000 hours
- Radial shaft seals approx. 10 000 hours with oil lubrication.

⚠ WARNING

Motor servicing is prohibited unless performed by an approved service workshop.

Motors must be disposed of carefully taking into account domestic and local regulations in the normal recycling process or by returning to the manufacturer.

The following must be taken into account when disposing of the motor:

- Oil according to the regulations for disposing of old oil
- Not mixed with solvents, cold cleaning agents of remains of paint
- Components that are to be recycled should be separated according to:
  - -. Electronics waste (e.g. sensor electronics, sensor modules)
  - -. Iron to be recycled
  - -. Aluminum
  - -. Non-ferrous metal (gearwheels, motor windings)