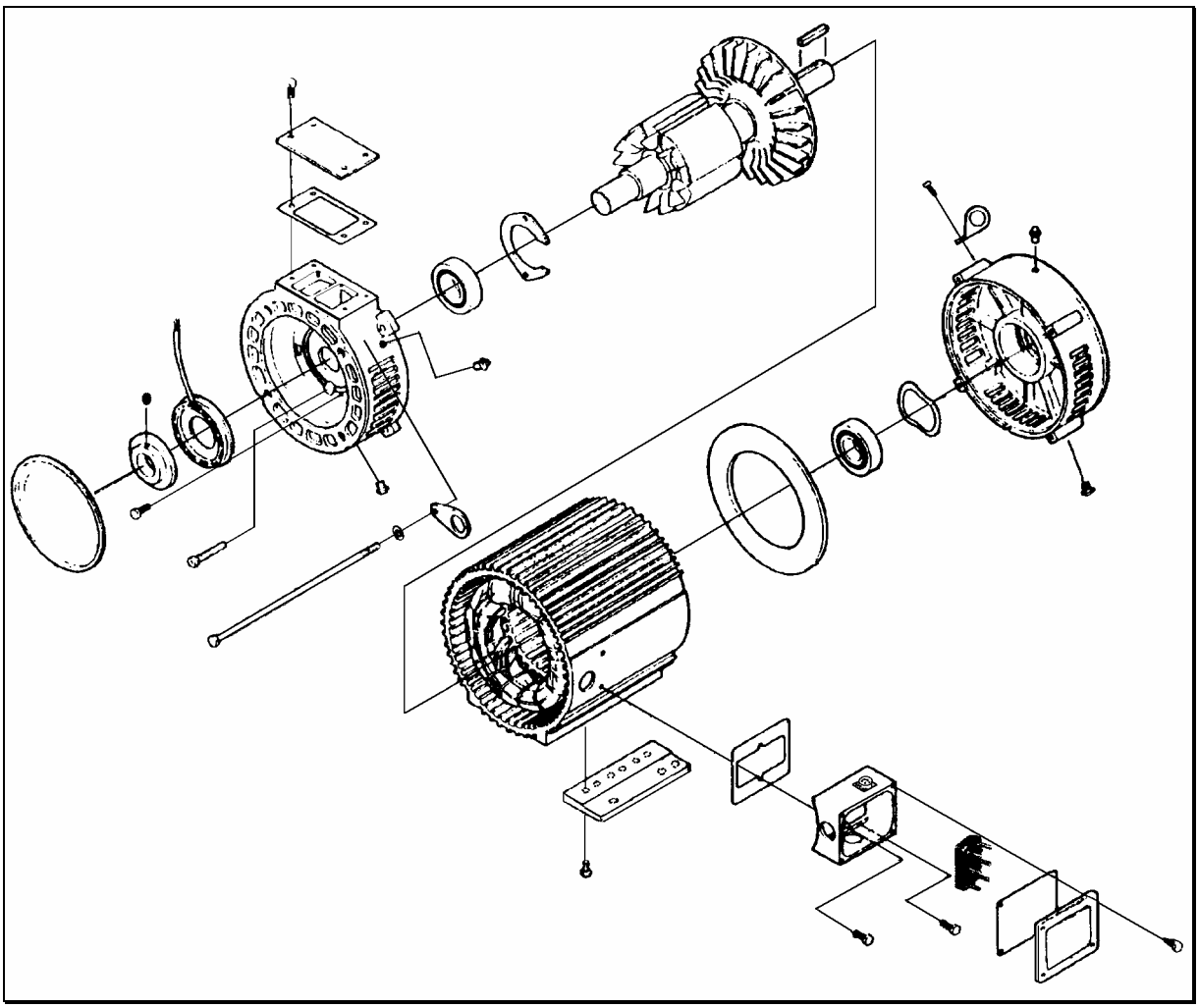
Brushless DC-Motors

Operating & Maintenance Manual

Frame BL-71...200

Brushless



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> ***Caution:***
>
> As with any form of electrical equipment, there is always a risk involved in the handling of electrical machinery. The greatest care must always be exercised during installation and maintenance, and it is recommended that this will be carried out by authorized personnel only.

1.0 Check List

1.1 Receiving

The motors are thoroughly tested, and the motors and their packaging are inspected before shipment. When you receive it, carefully inspect the motor for any electrical or mechanical damage incurred during shipment. Report damage to the freight carrier first, and then notify TAE Antriebstechnik for assistance in assessing the damage.

1.2 Storage

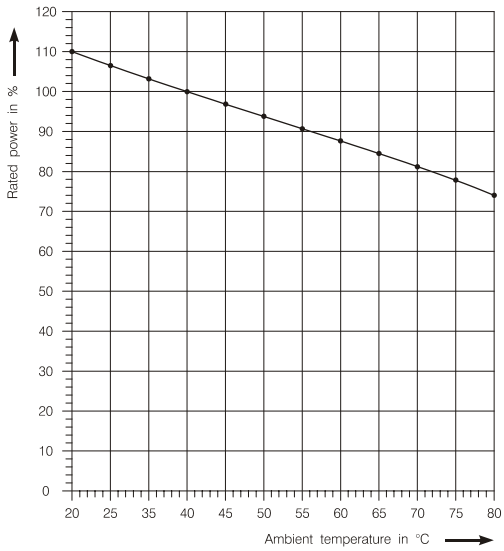
Store the motor in a clean and dry location which is protected from extremes in temperature and humidity. You should rotate the shaft of a stored motor monthly, so that the grease does not settle in the bottom of the bearings.

1.3 Handling

Use care in handling the motor to avoid dropping it and to prevent sudden impacts, particularly on the shaft. Prior to installation, remove the rust prevention coating (cosmoline), which was applied to the motor shaft before shipment, with a suitable solvent.

1.4 Environment

Install the motor according to the sort of protection, and well ventilated area away from extreme heat sources. Maximum ambient temperature should not exceed 40°C (104° Fahrenheit). For higher ambient temperatures or altitude higher than 1000 meters (3300 feet), the power of the motor has to be reduced.



Example: The power of a brushless DC Motor with 100 kW should be calculated on ambient temperature of 65°C. The graph above shows that the power has to be reduced to 87% an a ambient temperature of 65°C.

$$kW\ (65°C) = \frac{87\%}{100\%} kW\ (40°C)$$

$$= 0{,}87 \times 100 = 87\ kW$$

1.5 Alignment

Alignment on direct coupled applications is extremely important. The coupling device specifications determine the tolerances allowed in alignment. If the motor is not aligned properly at installation, excessive vibration will cause damage to the coupling, bearings, rotor and accessory devices.

1.6 Mounting

Motors can be mounted in any shaft orientation as long as radial and thrust loads are kept within specified limits. Foot mount machines should be mounted to a rigid foundation. Feet, frame and bearings should not be subjected to undue stresses due to poor mounting practices.
Frame operating temperatures may be high enough to cause burns. Keep all combustible materials away from the motor.

1.7 General Mechanical Inspection

Before installation, verify that the motor shaft is free to turn and that all mechanical parts are in their proper position. Turn the motor shaft by hand to be sure it is not damaged.
The motor shaft will not turn if the power leads are shorted together in the junction box.

After installation, make sure that all bolts and nuts are tightened which hold the motor in place. If damage to the equipment will result from the motor turning the wrong way, verify motor direction before connecting the load. Check the direction of rotation before you connect the motor with the machine. After the above mounting and alignment procedures have been followed, the electrical connections may be made. The connection diagrams for the motor must be followed exactly. You should monitor the motor current during the first operation of the motor and compare it to the nameplate.

1.8 Maintenance

Proper preventative maintenance requires regular inspection of the motor. The first maintenance inspection should take place within a few hours of the motor being placed in service to catch problems caused by installation. Later inspections should be made at progressively longer intervals, but never longer than one month apart.
Periodic checks should be made for excess vibration, loosening of mounting bolts and belts, unusual noises (a steady hum is normal), and operating temperature.

2.0 Routine Maintenance

2.1 Vibration

Check for signs of excessive vibration. This may be caused by poor alignment, worn or loose couplings or sheaves, damaged bearings, or improperly designed base. Excess vibration causes damage to the bearings, shaft, mounting feet and accessories.

2.2 Noise

Listen for unusual noises, particularly in the area of the bearing housings. Any rubbing or rumbling noises may be a sign of internal damage. A steady high pitched hum is normal in a Brushless DC motor, and there may be short interruptions of this hum under no load conditions. If a growling or erratic hum is heard at speed above 20 RPM, the settings of the power supply should be checked. Improper adjustment or malfunction of the drive can cause overheating.

2.3 Temperature

Motors from the protection- and cooling classes IP23 with IC 01/IC 06 and IP44/IP54/IP55 with IC 06 41 may run with surface temperatures in excess of 85°C and be normal. Motors from the S classes IP44/54 with IC 00 41/IC 01 41 may operate with surface temperatures as high as 100°C. Before checking the temperature of a motor, check the load on the motor.

Caution!

Do not check the motor temperature with your bare hands !
These temperatures may cause burns !

Use a temperature probe for an objective reading. If you find excess temperature, check the cooling apparatus and the motor current.

2.4 Cooling Facilities

The cooling blowers to the alien ventilated motors, are blowers which require little maintenance. The blower motor bearings are lubricated 15000 to 40000 operating hours. The filter and blower impeller are the main concern.

- ❍ Be sure the blower motor is running in the correct rotation. Air should be drawn into the filter, not blown out of it. The correct direction is in the direction of the blower scroll.
- ❍ The filters should in regular cycle dependent on the impurification degree be cleaned or replaced.
- ❍ Before remounting the filter, be sure that impeller is free to turn with no build-up material inside or on the blades of the impeller.

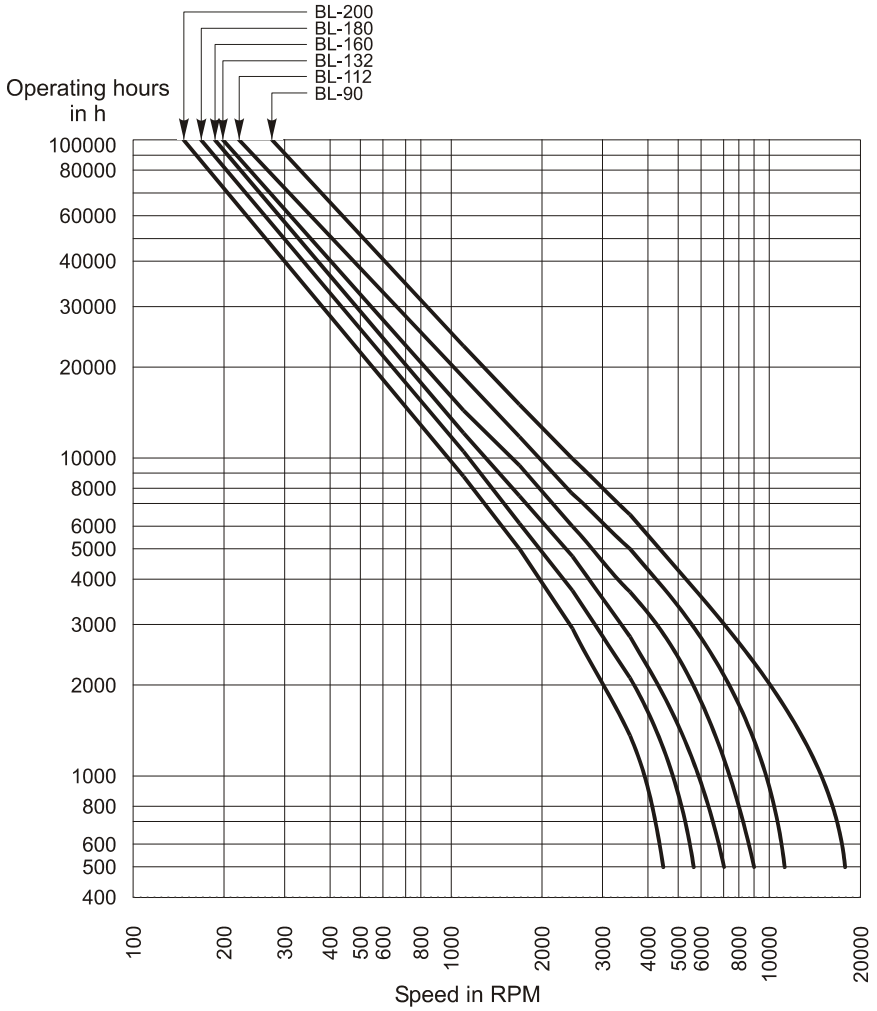
2.5 Bearings

The motors frame BL-90 and BL-112 have single row, single width, double shielded, permanently lubricated bearings. These require no maintenance other than regular inspection of the motor for noise or excessive vibration. Damaged or worn bearings should be replaced immediately.

2.5.1 Bearing Lubrication Intervals

The motors frame BL-90 and BL-112 are delivered without lubrication nipples.
The motor frame BL-132 and larger require periodic lubrication with „Retinax LX2“ Shell, Temperature range -30°C to 175°C. High speed motors (>3600 RPM) use „Mobil SHC15“ or „Mobiltemp SHC100“-.

Illustration lubrication interval



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2.5.2 Maximum Shaft Radial Loads

The maximum radial load on the drive shaft is a result from the life time of the used bearings, The target of the strength on the shaft and the operating speed of the motor. The radial loads indicated in the table (F_r), Refer to the middle of the line E, the measure E is the length of our of standard shaft.
(See illustration 1 target of the strength Fr and table 1 permitted radial loads)

All details refer only to the normal drive end and shaft mounting type B3. Axial loads reduce permitted radial loads. Axial loads are ignored in the following table. We can inform you about axial forces on request.

Standard BL-90 to 200 frame motors are equipped with ball bearings. On the drive end the motor has a loose bearing turned on with a wave spring washer and on the encoder end a tight bearing. At great radial loads by straps or pinion drive etc. the drive end side can be fitted with a roller bearing on wish.

Illustration target of the strength F_r

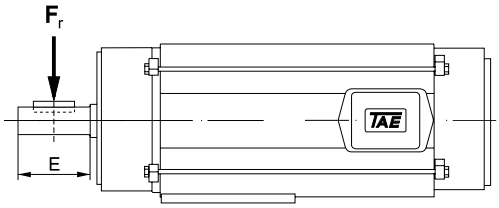


Table permitted radial forces

Motor type	Ball bearings NTN (Standard) drive- & encoder- end		Roller bearings NTN (On wish on drive end)			
	Bearing	Permissible radial load in N at 2000 min^{-1}	Bearing normal type	Permissible radial load in N at 2000 min^{-1}	Bearing *) E-type	Permissible radial load in N at 2000 min^{-1}
BL-90A	6205 ZZ C3	755	NU205 C3	1310	NU205E C3	2040
BL-90B		825		1435		2230
BL-90C		860		1495		2330
BL-112A	6207 ZZ C3	1645	NU207 C3	2940	NU207E C3	4180
BL-112B		1695		3030		4310
BL-132A	6209 ZZ C3	2125	NU209 C3	3895	NU209E C3	5330
BL-132B		2170		3975		5445
BL-160A	6211 ZZ C3	2540	NU211 C3	4615	NU211E C3	6240
BL-160B		2660		4830		6530
BL-160C		2740		4980		6735
BL-180A	6313 ZZ C3	5455	NU313 C3	10310	NU313E C3	13824
BL-180B		5660		10705		14355
BL-180C		5810		10990		14730
BL-180D		5930		11210		15030
BL-200A	6313 ZZ C3/ 6315 ZZ C3 1)	7180	NU315 C3	15640	NU315E C3	19755
BL-200B		7350		16015		20230
BL-200C		7480		16300		20590
	Bearing life time 20 000 h		Bearing life time 50 000 h			

*) The dimensions of the roller bearings in E type is the same like the normal type. By enlargement of the roll diameter and roll length as well as the roll number the is the permissible radial load of the bearing in the E type clearly higher. 1) At frame 200 the drive end of the motor have the bearing 6315 ZZ C3 and the encoder end have the bearing 6313 ZZ C3 as standard.

2.6 Position and Speed Encoder

The encoder is mounted internally, and requires no maintenance as long as the motor is not disassembled.

2.7 Externally Speed Encoder

If there is an externally mounted encoder (for servo or other high resolution applications), the coupling and alignment should be checked periodically, and mounting bolts checked for tightness.

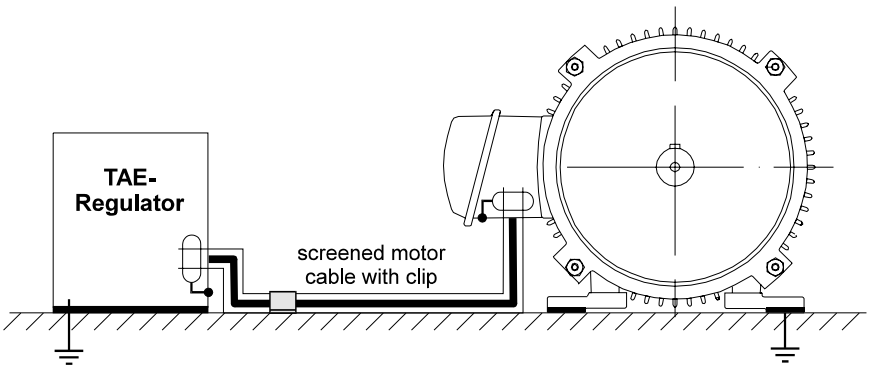
3.0 Electrical Connections

3.1 Arrangement of Wires

The supply cable should be a stranded conductor and not a solid conductor type to achieve proper connection inside the terminal block. Rails for high current with their screw connection are also suited. Cable lengths inside the wiring cabinet should be kept to a minimum.

The supply cables, motor cables and control cables should never run together in the same trunking or conduit. If the cables are put together in cable trees then the wires of the control cables have to be twisted. Keep the electronic control cables separated from the power control cables to avoid feedback. The distance should be least 20 cm. For the digital and analog reference and feedback cables screened cable has to be used in general.
Since the cable between regulator and motor is the major source of radiated and conducted interference, it should be screened type and as short as possible.

Illustration Arrangement of wires



3.2 Conditions for Grounding

All metal frames have to be connected to ground by their own. Make a well defined path for high ground currents. For short circuits to frame and leakage currents of filter components exists minimum cross-sections.

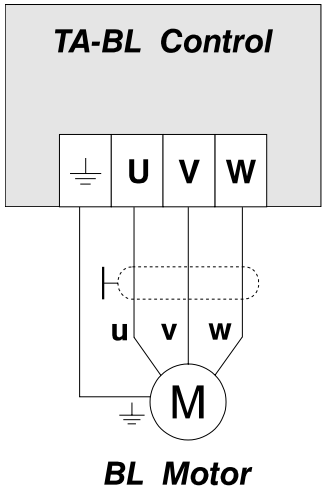
All grounding leads should be short as possible. Poor connections and loops of cable will act as aerials and pick up stray radiated emissions. The screen should be connected to ground by removing the coat pressing the screen with a clip to the backplate bonded ground. Do not use a „pig tail“ to connect the screen of the cable. The screen should lead into the device. On the motor it is possible to connect the screen with screwing. The screen will be slipped over the screwing and fastened by a clip.

3.3 Power Leads

> ***Caution !***
>
> Do not connect the motor directly to mains.
> The motor would immediately be demagnetized and the windings destroyed.

Whatever the connections, the U lead of the motor must be connected to U on the motor control, V of the motor must be connected to V on the motor control, and W of the motor must be connected to W on the motor control.

It is very important to connect a ground wire between the bolt in the motors junction box to the ground bolt of the motor control.



> ***Caution !***
>
> Please take care that the motor and motor control is grounded correctly, otherwise there exists a danger that both components can be damaged.

The connection (1Y, 1D, 2Y, 2D) and speed, voltage and power is listed on the nameplate of the motor.

Illustration motor connections till approx. 150 kW

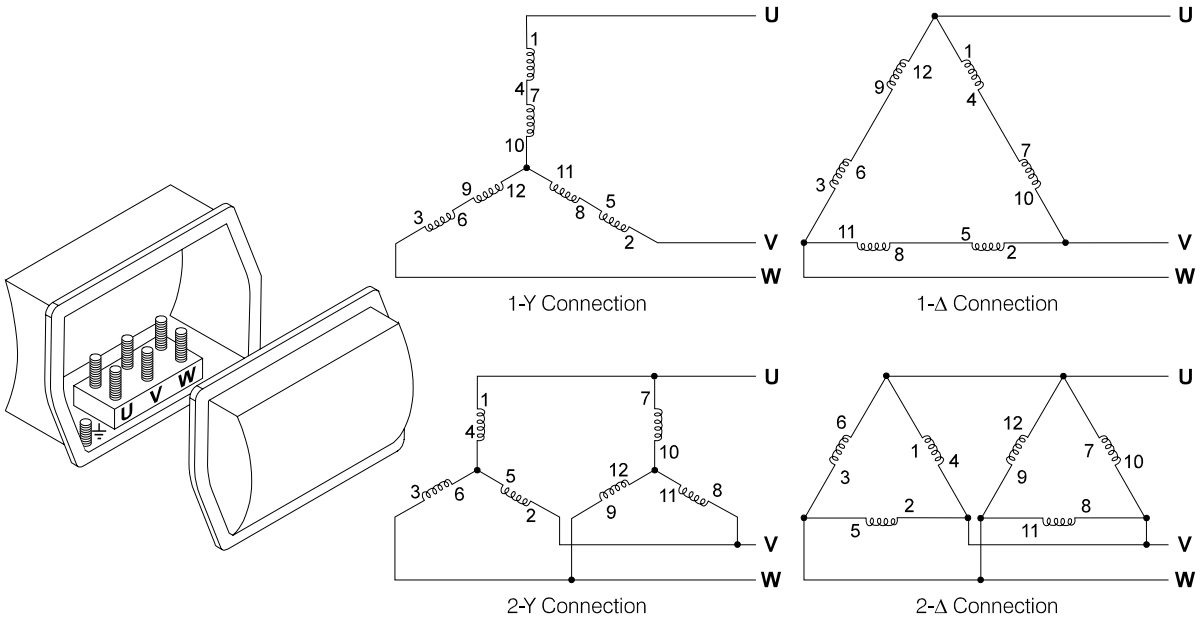
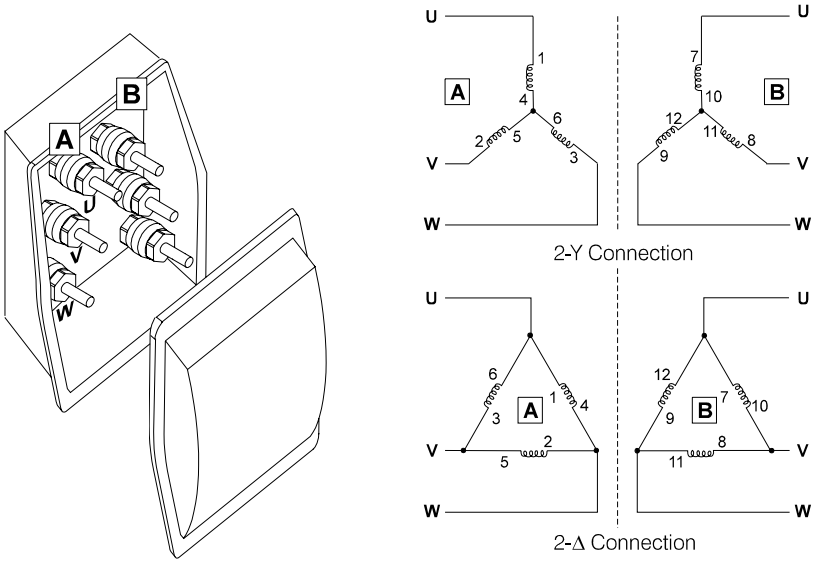


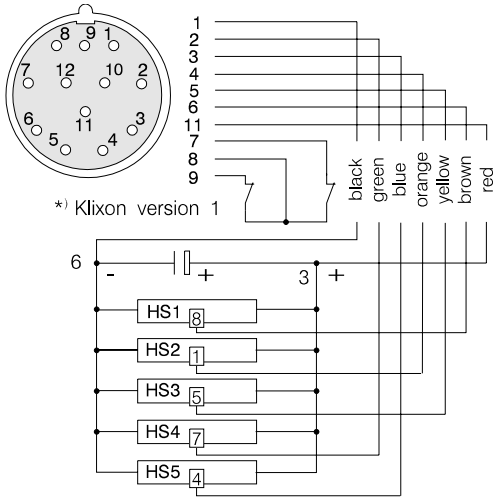
Illustration motor connection of approx. 150 kW



3.4 Position and Speed Encoder Connections

Pin	Color	Description
1	black	Common 0V
2	green	Speed encoder
3	blue	Speed encoder
4	orange	Hallsensor 2
5	yellow	Hallsensor 3
6	brown	Hallsensor 1
7	-	Thermal switch for switching off
8	-	Common switch connection
9	-	Thermal switch for warning
10	-	Reserved
11	red	+5 Voltage
12	-	Reserved

Illustration pin connection



Maximum contact load 48VDC/500mA or 48VAC/100mA

The encoder connections must be run in a shielded cable. There are three connections to evaluate the thermal protection of the motor next to the seven connections in the encoder allocation cable. The sensor line is combined with the motor and connected to the 12-pole plug at motor junction box.

The terminal connections at the controller can be taken from the instruction and operating manual of the appropriate controller. Pay attention to the correct grounding. Connect the screen from the motor cable at the controller.

3.5 Connection of Motor Thermal

For a safe operation of the drive the evaluation of the thermal supervision is absolutely necessary. Failure to use this thermal switches may result in damage to the motor.
The thermal supervision of the Brushless DC Motor consists of two thermal switches. One to the early warning and one to the switching off.

Table switching temperature of the thermo switches

Motor Protection	warning temperature	switch off temperature
IP 23	120°C	130°C
IP 44 / IP 54	130°C	145°C

The thermal supervision of the Brushless DC Motor works better than supervision of other motors. Because the thermal switches are inserted in the stator windings, where all the heat is produced.

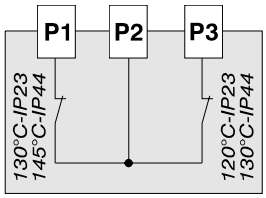
3.5.1 Connection Type 1

The thermal switches is connected to the 12-pole plug at the motor junction box and connected to the controller with the sensor line cable. The exactly plug connection see page 10 point 3.4,
The max. load of the plug and the terminal strips is 48VDC/500mA or 48VAC/100mA.

3.5.2 Connection Type 2

If you need 230VAC at the thermal connection, the thermal switch must be connected on terminal strip in the motor junction box and be wired separately with suitable cable.

Terminal P1 = Switch off
Terminal P2 = Common thermal connection
Terminal P3 = Warning



max. contact load 250V/1A

3.6 Connection Blower

The motors with the cooling type IC 06 and IC 06 41 have their own external blower. The connections are located in their own box on the blower motor. The blowers must show the following specifications:

Cooling Type	IP 23 IC 06			IP 54/55 IC 06 41	
Motor Type	Cool stream of air min. V in m^3/h	Complete pressure difference in Pa	Blower Type	Cool stream of air min. V in m^3/h	Blower Type
BL-112	245	335	2	600	10
BL-132	689	572	3	600	11
BL-160	1320	730	4	995	12
BL-180A	1320	730	4	1600	13
BL-180 B,C,D	1620	1050	5	1600	13
BL-200 A+B	810	2200	6	1600	14
BL-200 C	1320	2500	7	1600	14

You must check the blower motor nameplate for nominal voltages , phase, current and the correct connection. The blower motors must be in accordance with the VDE determinations with overcurrent protection facilities.

Caution! Requirements before initial operation

1. That possible protection orders (thermal switches) appear against overheat.
2. That external blower have the correct direction of rotation (Arrow at the case of the blower).
3. That cooling air can come in and out.
4. Correct assembly of the cover sheets, that the lamellas point below see page 17.

4.0 Motor Service Procedure

Brushless DC motors may be serviced by any competent motor shop which can overhaul AC induction motors. There are a few differences which must be observed in the permanent magnet rotor, the encoder and the bearings.

Caution !

At dismantling of the motor, do not work with a watch in the proximity of the rotor.

Permanent magnets used in the TAE Antriebstechnik Brushless DC motor are constructed of a highly stable material and will not demagnetize under normal operating conditions. The motors can be disassembled and reassembled without affecting the strength of the magnets. Handling of the rotor must be done with great care since the magnets are brittle and can be damaged if dropped.

Encoder: The encoder consists of two parts: a magnetic wheel mounted on the shaft and the feedback assembly attached to the motors end bell at the non-drive end. These two components must line up properly if the motor is to operate correctly.

Bearings: Bearings are press-fit on the rotor shaft. The rear (non-drive end) bearings is fixed in place by a bearing retainer plate, and both bearings are slip fit into their housings. When replacing bearings, they must be positioned up against the bearing shoulder on the shaft.

4.1 Dis-assembly of the motor

Refer to exploded view drawing and parts list in Chapter 10. This is a general drawing, and not all details are shown.

1. Before disassembling the motor, remove the rear cover (#19) from the non-drive end bracket (#14) to expose the encoder.
2. Make sure that there are marks on the end bells (#14 and #22), frame (#25), encoder assembly (#15), magnetic wheel (#17), and motor shaft (#2) to locate parts when the motor is reassembled. Be sure those marks will not be obscured in the process.
3. Remove the encoder wheel (#17) from the rotor shaft. It is secured by two set screws (#16) 90° apart on the hub.
4. Remove the two bearing retainer plate screws (#13) in the non-drive end. In some cases this may require loosening the two set screws (#18) holding the encoder assembly (#15) and moving the encoder assembly out of the way. This releases the rear bearing (#4) and allows the removal of the shaft or the end bell.
5. Remove four bolts or eight screws (#11) that hold the drive end bracket (#22) on. Some motors have hex nuts on overbolts which run the length of the motor. Note the location of the lifting lugs (#21).

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6. Carefully slide the drive end bracket (#22) off of the shaft (#2). Don't allow the end bell to scrape the shaft as it is removed. Note carefully the location of parts which come loose as the end bell is removed, such as the wave washer (#23) in the front bearing housing. The rotor stays in the frame and stator assembly.
7. The rotor (#2) may now be removed by sliding it slowly out. The banding will protect the magnets against damage while sliding out straight. A void jerky side to side movements. Caution before large magnetic strengths at one and removal of the rotor. The rotor can execute enforceable movements. Hands and fingers must be protected and may not reach danger range. The magnetic pull all containing iron objects on like. screws, nuts, hammer, and screwdrivers etc. Never put the rotor on a steel underground. the best is a lumbering pallet or lumbering table.
8. If only the rotor assembly is to be serviced, it is not necessary to remove the encoder end bracket (#14). If the motor stator is to be rewound, then the encoder end bracket should be removed. Remove the two set screws (#18) holding the encoder assembly (#15) in place. Before removing the encoder assembly, disconnect the wires from the connection block (#31) in the terminal box (motor junction box) and tie a string onto the wires. This will help reinstallation of the cable. Remove the assembly. Do not pull on the wires of the cable or on the assembly. Pull on the outside cable jacket only.

4.2 Re-assembly of the Motor

1. Make sure the inside surface of the stator is smooth with no foreign material (such as metal shavings) in the rotor area. Also check the rotor assembly for foreign matter (like metals).
2. Carefully slide the rotor (#2) into the stator assembly (#25) slowly, being very careful to avoid injury to the hands or arms. Make sure you insert the rotor from the drive end of the frame.
3. Once the rotor is inside the stator assembly, the encoder end bracket (#14) may be installed. Make sure the marks made before disassembly line up properly. Use long screws to initially position the bearing retainer plate before pushing the end bell in. Replace the bearing retainer plate screws (#13).
4. Position the air baffle (#24 - not on IP23 IC01 motors), and place the wave washer (#23) in position in the front housing. Replace the drive end bracket (#22) according to the marks made before disassembly, being careful not to scratch the shaft.
5. Reinsert the four bolts (#11) into the holes in the end bells of the motor (don't forget the lifting lugs #21), making sure that the end bells are seated properly in the ends of the frame.
6. Install the encoder assembly (#15) according to the orientation marks and connect cable leads to the block in the junction box (#31) according to chapter 3.4.
7. Reinstall the xolox wheel (#17) on the motor shaft according to the marks. The spacing between the shaft mounted wheel and the sensors on the encoder ring should be about 1mm.
8. Turn the motor by hand to check for rubbing, scraping, and make sure the shaft turns freely. Check for lengthwise and sideways movement of the shaft.
9. Torque down all bolts and screws, and proceed to motor encoder alignment

5.0 Adjustment of the Position Encoder

If it is necessary to dismantle the encoder, mark before dismantling the position of the magnet (encoder wheel) with reference to the motor's rotor. Furthermore mark the position of the encoder sensor board with reference to the encoder-end bracket.
If the motor gets assembled, it's important that the encoder rotor and the sensor board get assembled in the same position where they were taken apart from.

If the encoder was exchanged or the motor was winding recently, a new adjustment of the encoder is necessary.

1. Connect the motor to the drive according to the instruction manual. Before you enable the drive, reduce the motoring with the parameter *1/07* (current limit potentiometer VR4) and regeneration current limit with parameter *1/09* (current limit potentiometer VR3) to minimum value. Remove the connecting leads of the sensor cable from terminals 26 (17), 27 (18), 28 (19)*) of the control board. Then short-circuit the terminal 28 (19)*) with terminal 23 (14)*) or with the casing.
   Enable the drive in clockwise (cw) direction and set the speed reference value to 10%. Increase the current limit with the parameter *1/07* (current limit potentiometer VR4)*) until the motor turns to the next pole. Disable the drive and reconnect the sensor wires to the right terminals. Be sure that the rotor stands still and that the position of the rotor doesn't change.
2. Switch on the power supply without enabling the drive. The LED's HS1 to HS3 indicate the status of the hall effect sensors of the encoder.
   Now turn the encoder wheel without changing the position of the rotor until HS3 (LED 19) lightens, HS2 (LED 20)*) does not lighten and HS1 (LED 18)*) just starts to lighten.
   (If the encoder wheel is fixed to the rotor with a key, turn the encoder sensor board in counter clockwise (ccw)) direction.
   Then fix the encoder wheel with the screw. The distance between encoder wheel and encoder sensor board should be about 1 mm. It's important that the encoder wheel does not have any contact with the encoder sensor board.

*) *The LED's and terminal descriptions in brackets are valid for the digital TA-BL drives (control board TA-BL /E91, part# 38243)*

The LED's and terminal descriptions without brackets are valid for the programmable TA-BL/P drives.

6.0 Troubleshooting

When a motor does not operate as expected, there may be a valid reason other than that the motor is bad. **Troubleshooting involves looking at the entire system of motor, control and environment.** Problems which occur when a motor is first put into service are most likely caused by misapplication, improper connection or misunderstanding. Problems which occur after a motor has been in service for some time period may be due to motor, control or environment.

The following troubleshooting chart covers problems which have been seen in the past plus other possibilities.

Problem: Shaft rocks back and forth

1. Motor leads U, V and W are not connected to the corresponding terminals on the motor control. U must be connected to U, V must be connected to V and W must be connected to W.
2. Encoder cable is connected to control improperly, or cables or sensor is defect. To the check disconnected the motor line at the motor control (do not disconnected the encoder cable). Switch only the line voltage on at the motor control and turn the motor shaft counter clockwise by your hand. With help of the LEDs 18 to 22 at the control board of the motor controller and the light diagram sequences check the correct operation of the hall-sensors.

Illustration position encoder

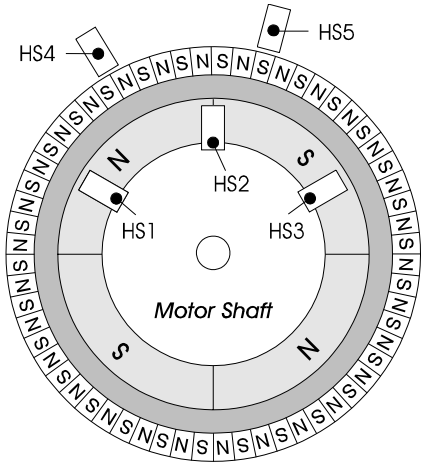
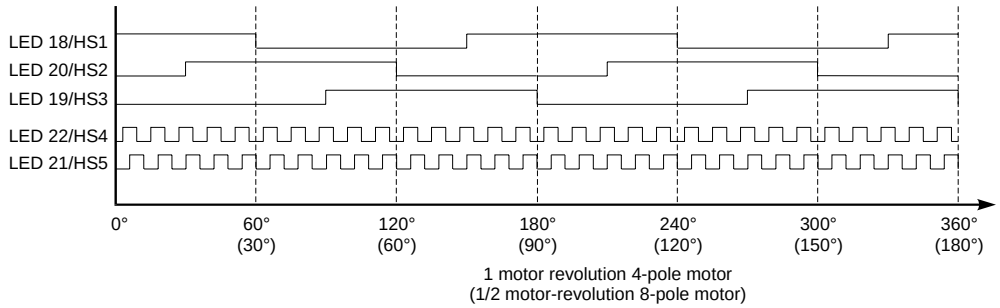


Illustration light sequence

At motor rotation counter clockwise (ccw) (look at output shaft)



Problem: Motor exhibits erratic speed

1. Encoder cable from motor to control is improperly shielded, run with power cables, or defective. To check, disconnected the motor line at the motor control (do not disconnect the encoder cable). Switch only the line voltage on at the motor control and turn the motor shaft counter clockwise by your hand. With help of the LEDs 18 to 22 at the control board of the motor controller and the light diagram sequences check the correct operation of the hall-sensors.
2. Encoder signals are improper or missing. Check the correct operation of the hall-sensors.
3. Bearings are worn. This will more likely show up as increase current and a motor which overheats, but severe bearing problems may affect the speed control.
4. Severe load variations, such as high inertia load changing speeds quickly may result in speed being erratic.

Problem: Excessive axial play of shaft

Make sure that the motor does not have an excessive thrust loading on the shaft.

1. Check the tightness of the bearing retainer plate by checking the bearing retainer plate screws on the non-drive end. (On some motors, these screws may be partially or completely hidden by the feedback assembly.
2. The bearings may be excessively worn.
3. The shaft bearing journals may be worn excessively.

Problem: Excessive radial play of shaft

Make sure the radial loading on the shaft is not excessive. See Chapter. 2.5.2.

1. The shaft may be loose in the bearing I.D.
2. There may be excessively worn bearings.
3. The bearing housing may be worn.

Problem: Excessive vibration of the motor

1. The load may be out of balance. Check the load balance.
2. The mounting bolts may be loose. Check for tightness.
3. The rotor may be unbalanced. Run the motor unloaded without a belt pulley and with a half key on the shaft.
4. There may be excessive radial play. See above.
5. The bearings may be worn. Listen for bearing noise.
6. Stator winding may be open or shorted. Check currents.

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Problem: Motor runs hot loaded

Attention !
Do not judge motor temperature by touch.
Use a temperature measuring device !

1. Check ambient temperature. Must be less than (40°C). Taking into account that the installation place must be lower than 1000m NN.
2. Check load on the motor. Do not exceed rated current.
3. Check duty cycle of motor. May not exceed 100% RMS.
4. The brake may not be releasing. Check the brake.
5. The bearings may be worn. Run motor unloaded.
6. The rotor may be rubbing the stator. Listen for noise.
7. There may be shorted windings. Run motor unloaded. Measure the inductive reactance of the windings U-V; U-W; V-W the tolerance should be less than 5%.

Problem: Motor runs hot unloaded

1. Check all items under „motor runs hot loaded“
2. The encoder may be improperly set up. Check the encoder.
3. The position encoder is adjusted wrongly see chapter. 5.
4. Motor may be demagnetized. Check terminal voltages (EMF).
5. The pre-load on the bearings may be excessive.

Problem: Motor runs too fast

1. Check maximum speed setting on motor control.
2. HS4 and HS5 on encoder signals may be swapped.
3. If running on Digitmaster DGM 2000 try slow speed.

Problem: Low torque at rated current

1. Motor control may be misadjusted. LED 2 1Q and LED 4 4Q flickers permanently.
2. Open power connection
3. Open or shorted stator windings. Measure the inductive reactance of the windings U-V; U-W; V-W the tolerance should be less than 5%.
4. Motor may be demagnetized. Check terminal voltages (EMF).

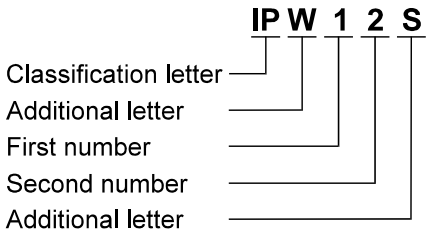
7.0 Type of Protection and Cooling

The degree of electrical engines protection is after DIN 40050 and IEC 34-5 with two code numbers. The first number after the classification letter IP is protection against contact and solid foreign matter and the second number is the protection against water.

Usual protection:

Degree of protection	1. Number	2. Number
IP 00	No special protection against touch and foreign elements.	No protection against water.
IP 11	Protection against large-area touch of voltage-carrying or choppy parts and against solid bodies larger than 50 mm.	Protection against dripping water (vertical)
IP 23	Protection against touch with the fingers and against solid bodies larger than 12 mm.	Protection against spray water from 30° over horizontal.
IP 44	Protection against solid bodies larger than 1 mm.	Protection against spray water from all directions.
IP 54	Protection against dust deposits.	Protection against spray water from all directions.
IP 55	Protection against dust deposits.	Protection against water by a nozzle from all directions.
IP 65	Protection against dust entry.	Protection against water by a nozzle from all directions.

Example for designation of type protection:



Additional letter

The letters R and W between IP and the two code numbers; The letters of S and M stand behind the two code numbers. Being missing the letters S or M means, that the check of water protection is executed on no-running and running engine.

Without for additional letter see table above, *„usual protection“*

R for engines with pipe connection,

W for weather-protected engines,

S for engines where the water protection is checked on no-running,

M for engines where the water protection is checked on running,

Type of protection and cooling of a motor a narrow coherence. The type of protection is determined by the way of the cooling. It matters if the cooling only happens with the help by convection to the ambient air around it, or by air moving through it, or by air moving over it. Constant torque about the indicated rotational speed correcting range can be reached only at corresponding cooling. At rotational speeds under 20min^{-1} it can come for a restless round run of the motor, special if the load is very low. The motor can however get fully loaded. Blockings and very low rotational speeds with the whole moment possibly are (nominal current). This state mustn't stop however on duration, since otherwise thermal damage are the consequence. The motor current is in the blocked state about 1,6 times more largely.

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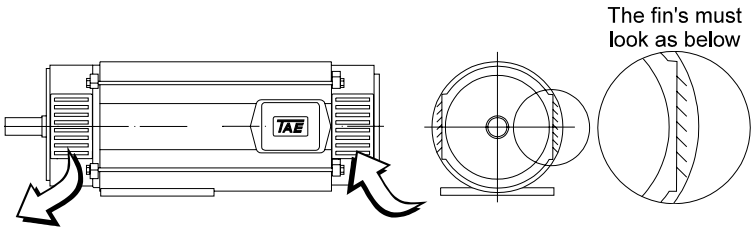
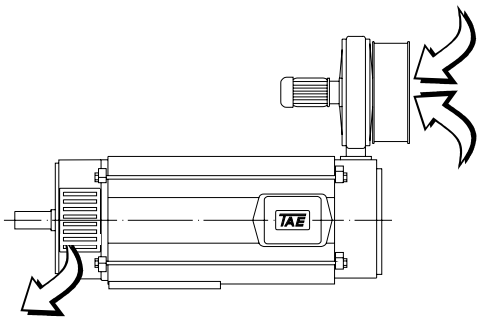
The following protection and cooling types are possible:

Type of protection: IP23; type of cooling: IC 01



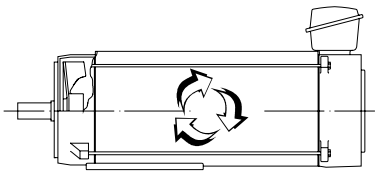
The drip proof, fully guarded motor moves air through the motor by means of an internal fan. Louvred covers in the front and rear of the motor prevent water and other foreign matter from entering the motor when dropped from above or an angle of up to 18° from the vertical.
The constant torque speed range of motor may be 2:1 or 100:1, depending upon the frame size. Check the nameplate of the motor for the speed range.

Type of protection: IP23; type of cooling: IC 06



The drip proof, blower ventilated motor uses an external blower to force air through the motor to cool it. The blower is generally mounted in the rear of the motor (at the non-drive end) and the forced air is exhausted out the front of the motor. The blower is separately powered. The constant torque speed range of the motor is normally 100:1.

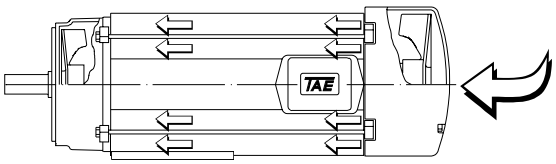
Type of protection: IP44/54/IP55; type of cooling: IC 00 41



The totally enclosed non-ventilated motor is dust-tight with no openings to the ambient air. The motor is cooled by natural convection and radiation.

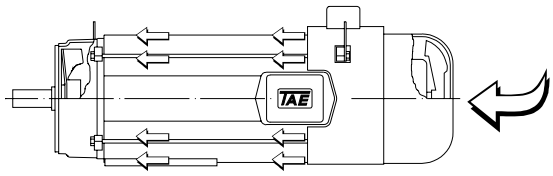
The constant torque speed range of the motor is 100:1, but the horsepower range is limited to smaller sizes.

Type of protection: IP44/54/IP55; type of cooling: IC 01 41



The totally enclosed fan cooled motor is dust-tight with no openings to the ambient air. The motor is cooled by a motor shaft mounted fan on the non-drive end of the motor. This allows higher power than IC0041. At slower speeds, the fan cannot move enough air to cool the motor, so the constant torque speed range of the motor is limited to 2:1

Type of protection: IP44/54/55; type of cooling: IC 06 41



If a totally enclosed applications requires a wider speed range and more power, the totally enclosed, air over motor has a constant speed fan, which blows air over the motor to cool it. Since the air volume is constant with speed, the constant torque speed range of the motor is 100:1. Water-cooled engines in this protection type IP55 is also disposal.

8.0 Type of Construction and Mounting Arrangement of Motor

Usual forms and short name after IEC 34-7 and DIN 42950 is represented in the following illustrations. Other type of construction and mounting arrangement on request.

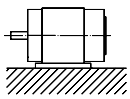
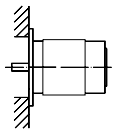
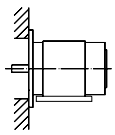
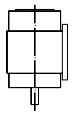
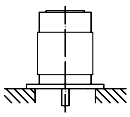
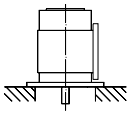
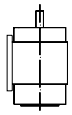
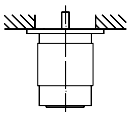
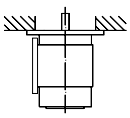
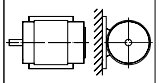
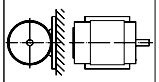
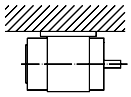
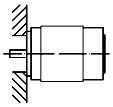
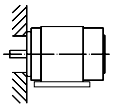
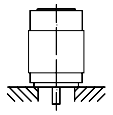
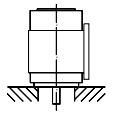
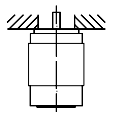
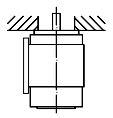
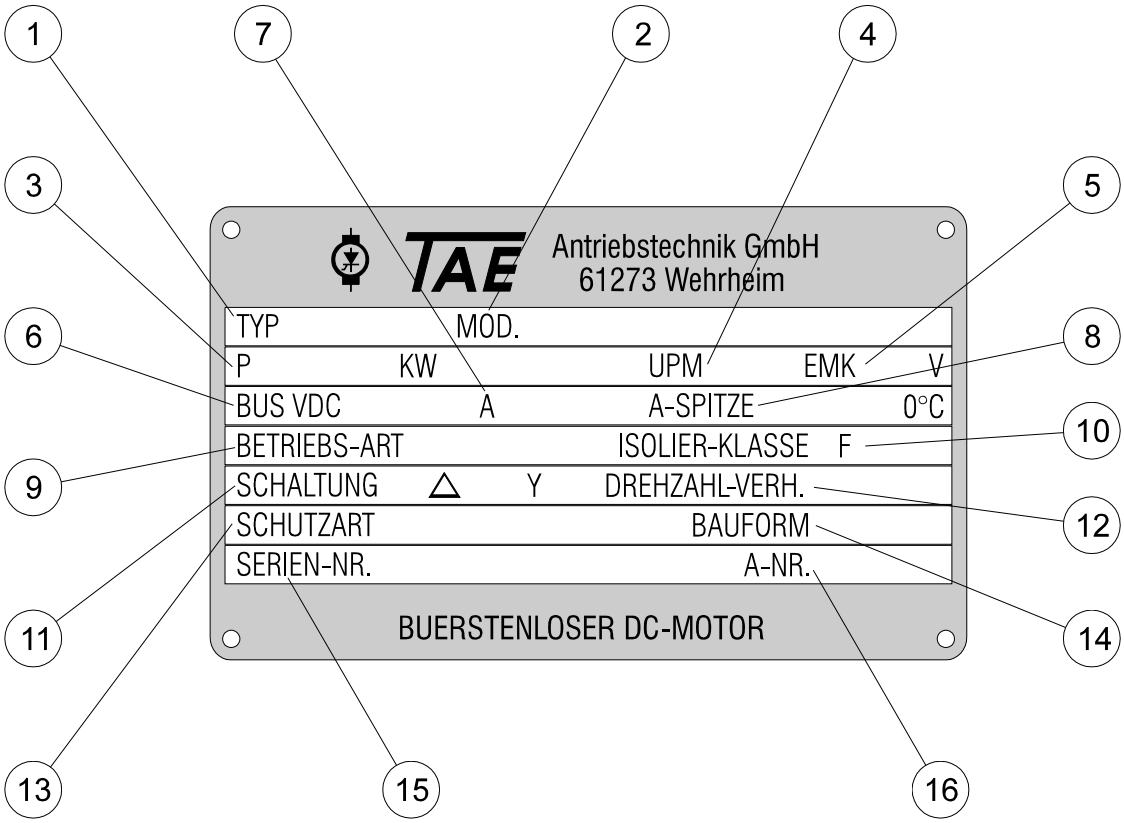
Figure	Name DIN IEC	Description
	B3 IM 1001	Shaft horizontal with feet
	B5 IM 3001	Shaft horizontal flange mounted with hole and without feet
	B3/B5 IM 2001	Shaft horizontal flange mounted with hole and with feet
	V5 IM 1011	Shaft vertical with feet
	V1 IM 3011	Shaft vertical flange mounted with hole and without feet
	V1/V5 IM 2011	Shaft horizontal flange mounted with hole and with feet
	V6 IM 1031	Shaft vertical with feet
	V3 IM 3031	Shaft vertical flange mounted with hole and without feet
	V3/V6 IM 2031	Shaft vertical flange mounted with hole and with feet

Figure	Name DIN IEC	Description
	B6 IM 1051	Shaft horizontal mounted on a wall. Feet to the left viewing from drive end.
	B7 IM 1061	Shaft horizontal mounted on a wall. Feet to the right viewing from drive end.
	B8 IM 1071	Shaft horizontal with feet. Mounted on the ceiling.
	B14 IM 3601	Shaft horizontal flange mounted with thread. Without feet.
	B3/B14 IM 2101	Shaft horizontal flange mounted with thread. With feet.
	V18 IM 3611	Shaft vertical flange mounted with thread. Without feet.
	V5/V18 IM 2111	Shaft vertical flange mounted with thread. With feet.
	V19 IM 3631	Shaft vertical flange mounted with thread. Without feet.
	V6/V19 IM 2131	Shaft vertical flange mounted with thread. With feet.

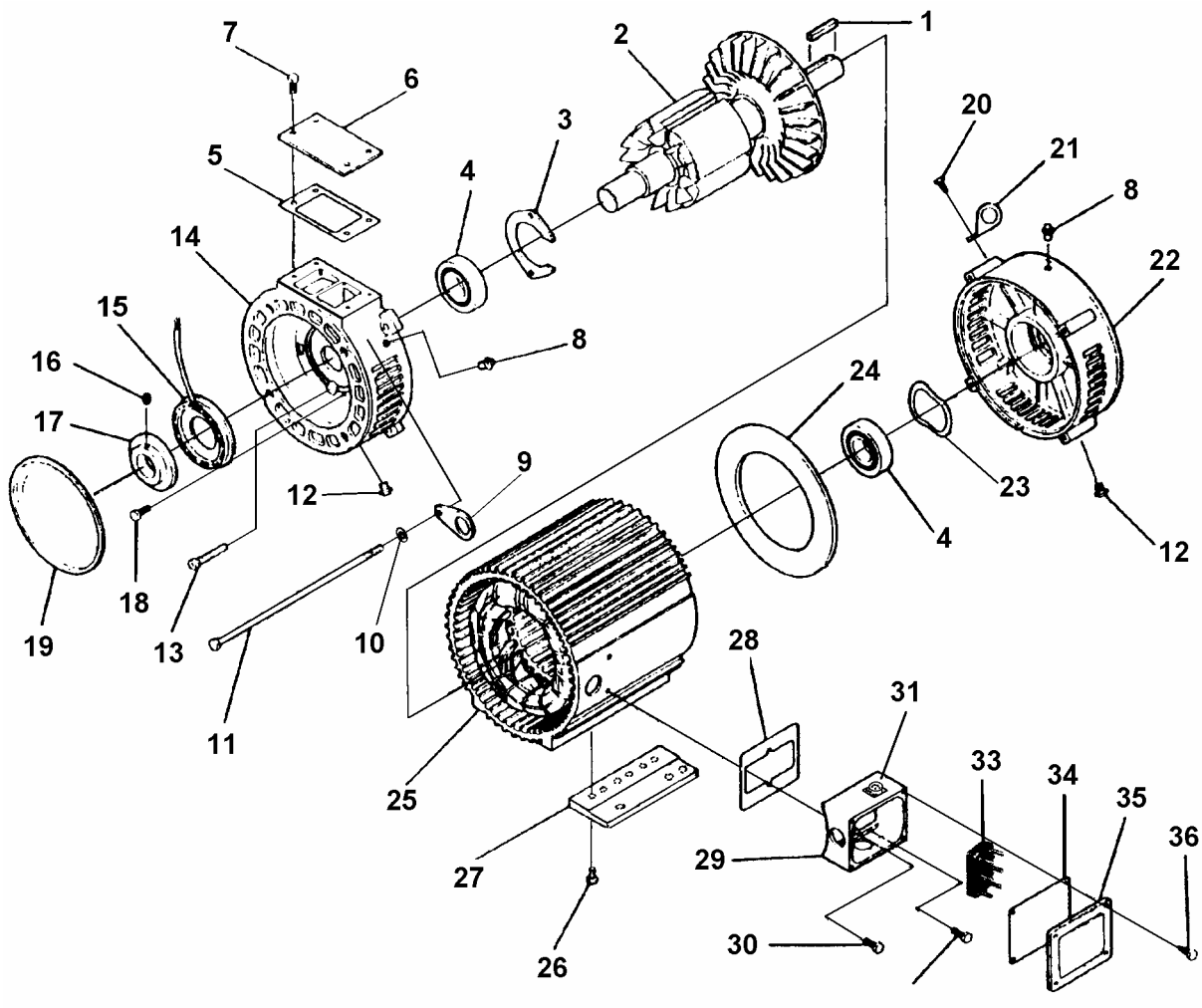
9.0 Name Plate



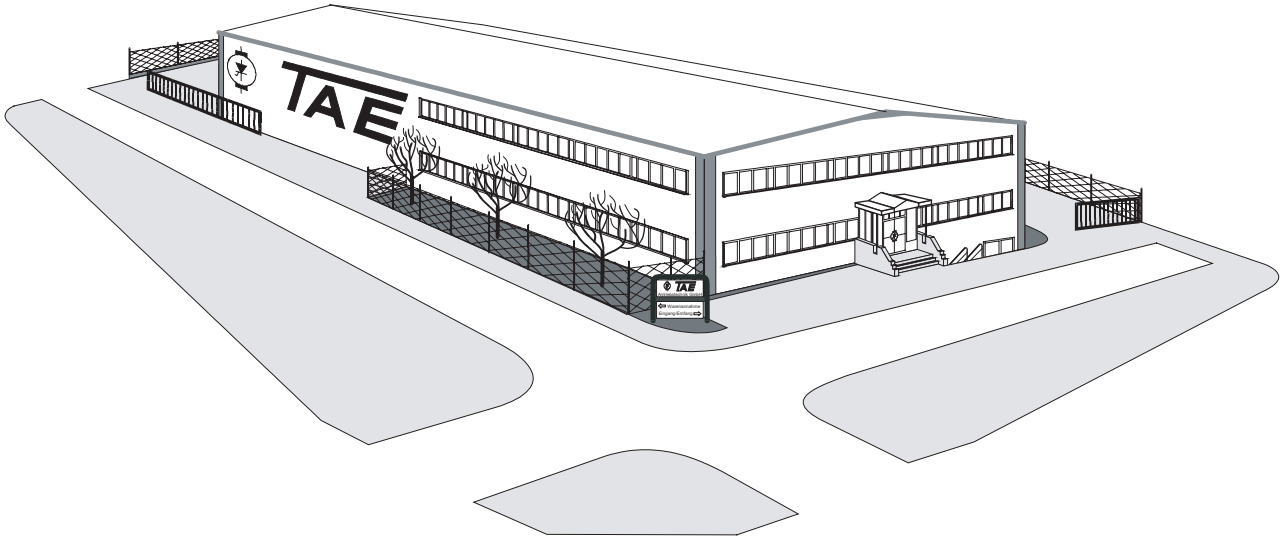
1) Type
2) Model number
3) Rated output power in kW
4) Base speed
5) The RMS Voltage (EMF) when the motor is turning 1000 RPM at room temperature 25 ° C
6) Supply voltage
7) Rated current (Effective worth lowerly calling data)
8) Peak current (Do not exceed this value at any time. This is the maximum safe current which will not affect the permanent magnets.)
9) Operation Mode (VDE 0530)
10) Insulation class (VDE 0530)
11) Connection of the windings
12) Regulation area at rated data
13) Protection class (IP23, IP44, IP54 or IP 55) (IEC 34-5 and DIN 40 050)
14) Type of Construction and Mounting arrangement (B3, B5, or B14) (IEC 34-7 and DIN 42950)
15) Serial number
16) A-Nr. TAE-article number

Frame BL-71...200

10.0 Overview Drawing and Spare Part List



1 .....Key
2 .....Rotor Assembly
3 .....Bearing Retainer
4 .....Bearing
5 .....Cover Gasket
6 .....Cover
7 .....Hex Head Screw
8 .....Grease Fitting
9 .....Lifting Lug
10 ...Flat Washer
11 ...Hex Head Screw
12 ...Grease Fitting
13 ...Socket Head Screw
14 ...Encoder End Bracket
15 ...Encoder Assembly
16 ...Set Screw
17 ...Encoder Wheel Assembly
18 Hex Washer-Head Tapping Screw
19 ...Stamped Rear Cover
20 ...Hex Head Tapping Screw
21 ...Lifting Lug
22 ...Drive End Bracket
23 ...Wave Washer
24 ...Air Baffle
25 ...Frame/Wound Stator Assembly
26 .. Hex Washer-Head Screw
27 .. Base
28 .. Terminal Box Gasket
29 .. Terminal Box
30 .. Hex Washer-Head Screw
31 .. Cable Termination Strip
32 .. Hex Washer-Head Screw
33 .. Terminal Strip
34 .. Terminal Box Cover Gasket
35 .. Terminal Box Cover
36 .. Hex-Head Tapping Screw



Head Office and Representatives

Head Office

Germany

Shipping adress:

TAE Antriebstechnik GmbH
Am Kappengraben 20
D-61273 Wehrheim

P.O. Box address:

TAE Antriebstechnik GmbH
Postfach 1163
D-61268 Wehrheim

E-mail:

info@tae-antriebstechnik.de

Internet:

http://www.tae-antriebstechnik.de

Telephone: +49 60 81 95 13-0
Fax purchase dept.: +49 60 81 5 94 72
Fax sales dept.: +49 60 81 980052

Representatives - Germany

Erhardt Antriebstechnik GmbH
Silcherstraße 8
D-71691 Freiberg a.N.
Telephone: +49 71 48 16 16 64
Fax: +49 71 48 16 16 65

International Sales Representatives

Belgium

ESCO drives & automation
Kouterveld Culliganlaan 3
B-1831 Diegem
Telephone: +32 2 717 64 30
Fax: +32 2 717 64 31

Denmark

Thrige Electric A/S
Energivej 25
DK-5260 Odense S
Telephone: +45 63 95 11 11
Fax: +45 63 95 11 12

Finland

Finndrive Qy
Sirrikuja 4 E
FIN-00940 Helsinki
Telephone: +358 9 342 1543
Fax: +358 9 342 1548

France

SB Automation
ZAE les Glaises
3, allée des garays
F-91872 Palaiseau Cedex
Telephone: +33 1 69 32 01 03
Fax: +33 1 69 32 01 04

Netherlands

Elektro Drive B.V.
1e Dwarstocht 14
NL-1500 EB Zaandam
Telephone: +31 75 61 66 656
Fax: +31 75 61 79 500

Switzerland

Hardmeier Electronics AG
Weststrasse 115
CH-8408 Winterthur
Telephone: +41 52 355 12 12
Fax: +41 52 355 12 11

Taiwan

An Fam Enterprise Co., Ltd.
Address: 6F.-11, No.351, Sec.2,
Zhongshan Rd., Zhonghe City 235,
Taipei Taiwan, R.O.C.
Telephone: 886-2-8221-8716
Fax: 886-2-8221-8718

USA

MSI - Motor Systems, Inc
501 TechneCenter Drive
Milford Ohio 45150
Telephone: +1 513 576 1725
Fax: +1 513 576 1915