

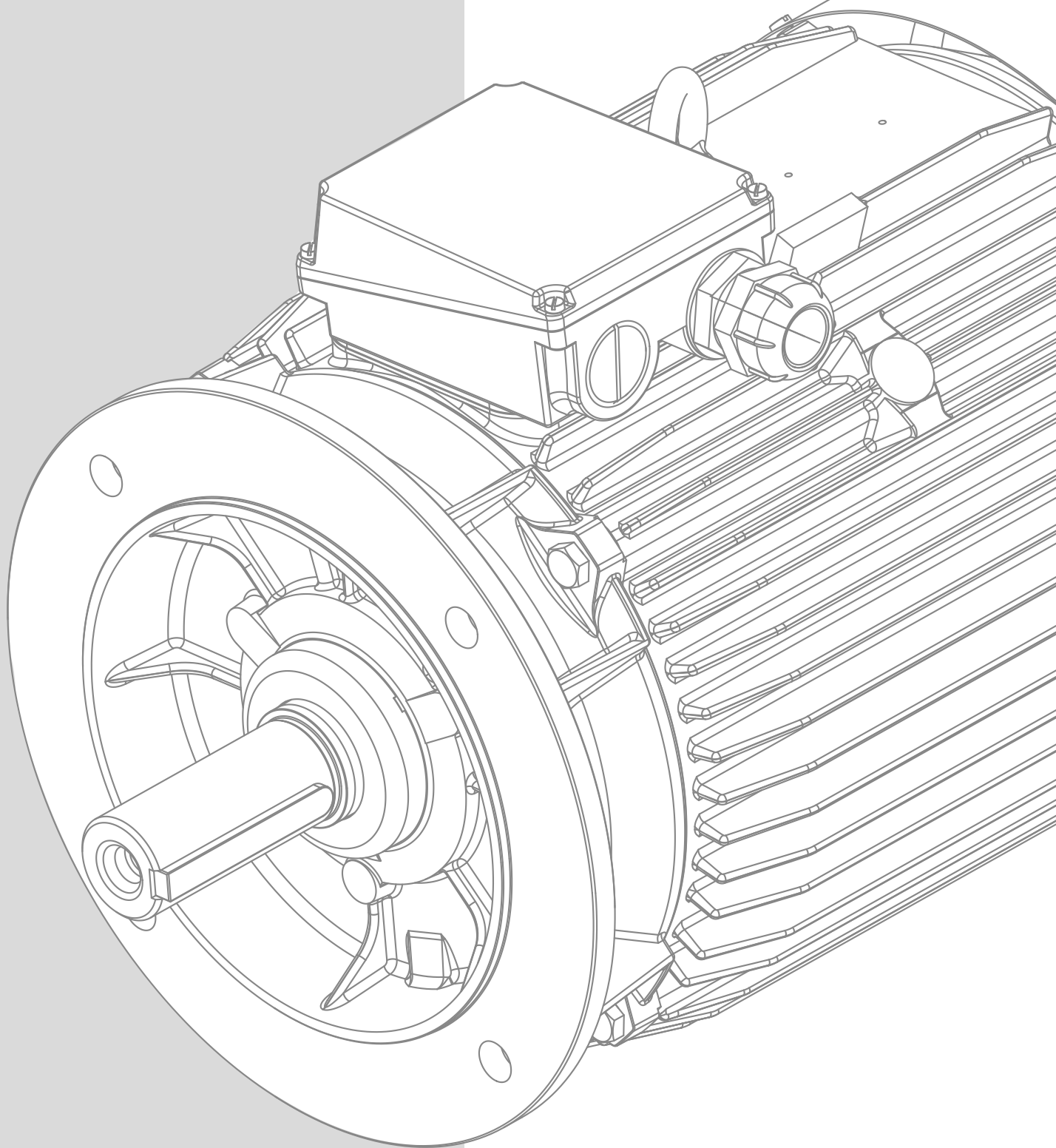
OPERATING MANUAL

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ISO 9001



SERVICE INSTRUCTION MANUAL FOR SQUIRREL - CAGE INDUCTION MOTOR TYPE

(2_3)SIE 90÷180 S,M

(2_3)SIEK 90÷180 S,M

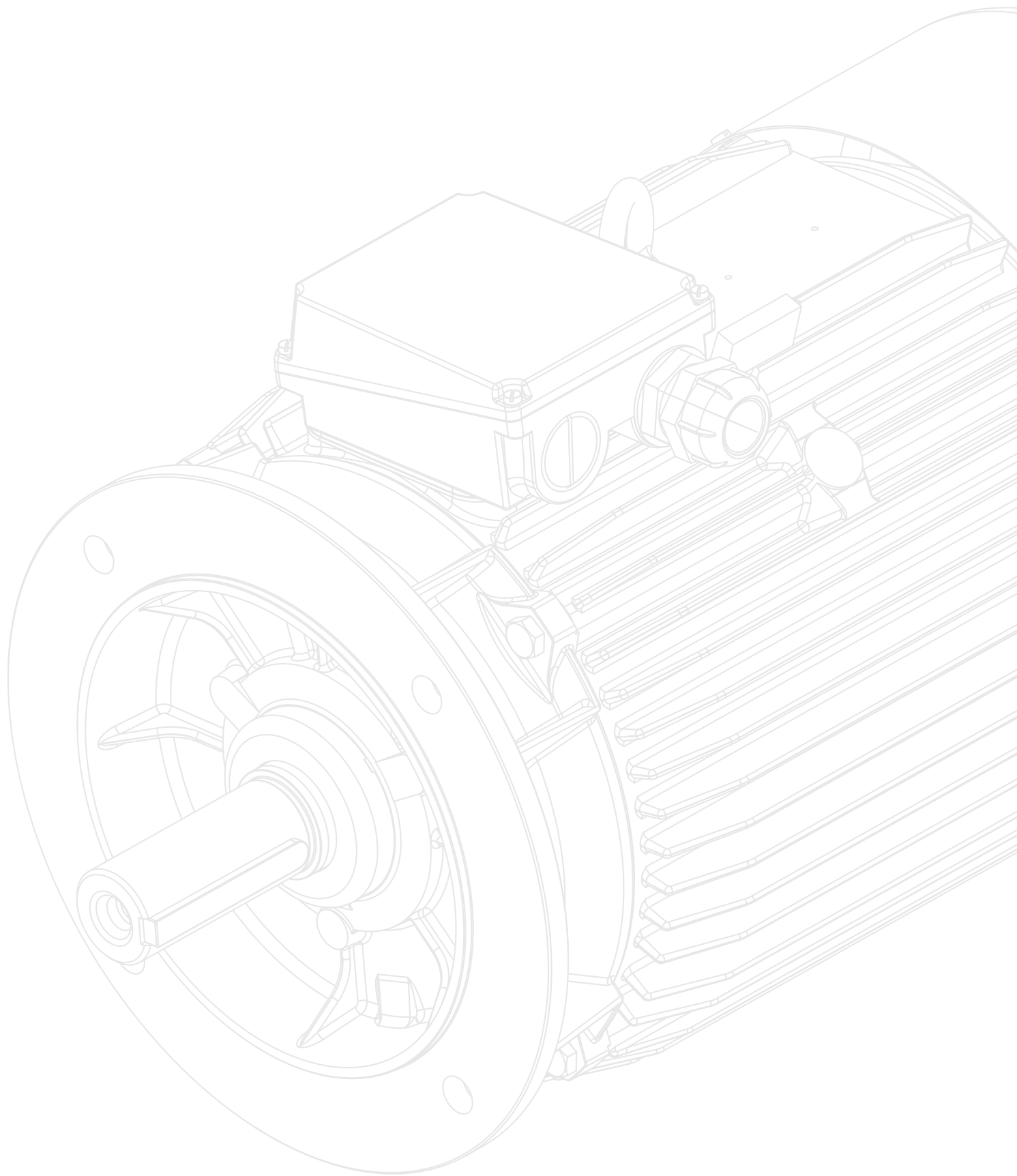
(2_3)SIEL 90÷180 S,M

OPERATING MANUAL

THREE-PHASE SQUIRREL-CAGE INDUCTION MOTORS MOTOR SIZE 90÷180

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1. SPECIFICATION AND USE

This operating manual has been created for three-phase squirrel-cage single and dual speed induction motors, with shaft height above the mounting feet's surface of: 80, 90, 100, 112, 132, 160, 180 and 200 mm, designed to drive various types of machines and appliances. The manual also describes special motors designed to be mated to a frequency converter with an external cooling unit and brakes.

Motors are adapted for indoor and outdoor use.

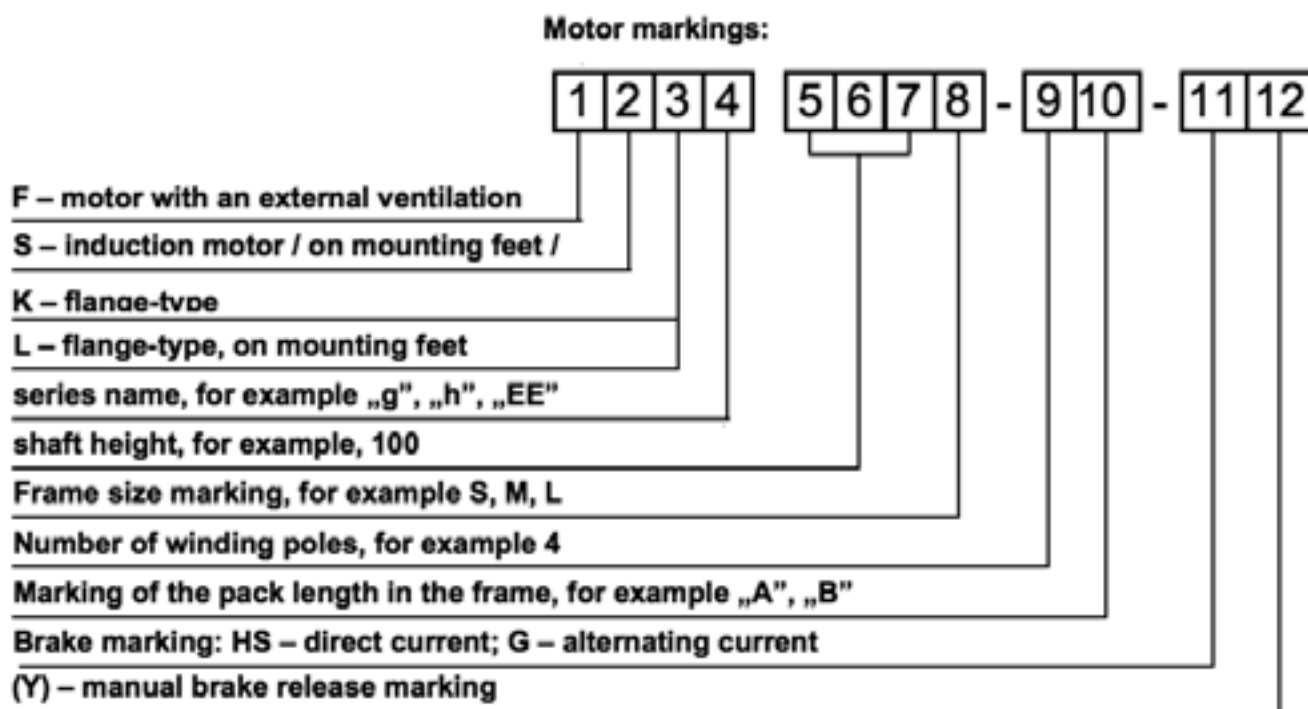
This manual is not valid for explosion-proof motors marked with the „Ex” symbol.

Design characteristics

Characteristic		Standard	Special order version
Type of operation		S1	S2, S3, S4, S6
Insulation class		F	H
Protection rating		IP 55	IP 65
Temperature range		-20 ÷ +40°	-40 ÷ +120°
Installation height		up to 1000 m above sea level	up to 4000 m above sea level
Relative humidity		95%	X
Frame material			
Motor size	80	aluminium	X
	90, 100, 112	aluminium	cast iron
	132, 160, 180, 200	cast iron	X
Bearing bracket material			
Motor size	90, 100	aluminium	cast iron
	80, 112, 132, 160, 180, 200	cast iron	X
Thermal protection		X	PTC resistor or thermocontact
Cooling system		internal: IC 411	external: IC 416
Terminal board		6	9 or 12
Greased bearings		X	Motor size 132-180
Gripped bearing	Motor size 90	X	All sizes and versions
	Motor size 100	Version with a brake	
	Motor size 112-180	Version with a brake 1011, 2011, 3011, 3611,	
BRAKE	direct current	1011, 2011, 3011, 3611,	All sizes and versions
	alternating current	X	
Drain bolt		Motor size 132-180	All sizes and versions
Featuring a casing with a roof		X	All sizes and versions
Number of cable inlets		1	2 and more
Terminal box location		top	right or left side
Rotating box		X	up to 90°
Climatic version		X	TA, TH, MT
Certificates		CE declaration	UL, CSA

X – not available





An example of a standard motor marking: **2SIEK 100L - 4A**

2 – Efficiency class

SIE – series name

K – flange-type,

100 – shaft height of 100 mm,

L – frame size marking,

4 – winding with 4 poles (for 50 Hz; 1500 rev/min),

A – pack length marking.

Electric motors are produced according to the current directives and norms:

Requirements	Norms	
	International marking	Polish marking
1. Low Voltage directive	2006/95/CE (LVD)	
2. Machinery Directive *	2006/42/CE (MD)	
3. Electromagnetic compatibility	2004/108/CE (EMC)	
4. Electric requirements	EN 60034-1	PN-EN 60034-1
	IEC 60072-1	PN-IEC 72-1
	EN 60034-2-1	PN-EN 60034-2-1
	EN 60034-9	PN-EN 60034-9
	EN 60034-12	PN-EN 60034-12
5. Mechanical requirements	IEC 60072-1, EN 50347	PN-IEC 72-1, PN-EN 50347
	EN 60034-5	PN-EN 60034-5
	EN 60034-6	PN-EN 60034-6
	EN 60034-7	PN-EN 60034-7
	EN 60034-14	PN-EN 60034-14
6. Environmental requirements	RoHS - UE Directive no. 2002/95/EC „Restriction on Hazardous Substances“	
7. Quality Management System (certificate no. 27992)	ISO 9001	PN-ISO 9001

* - by design the machines considered as components. Conformity to the requirements, provided that the installation is set up correctly by the tool's manufacturer.

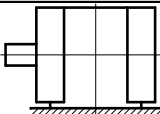
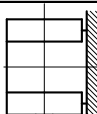
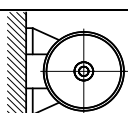
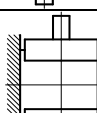
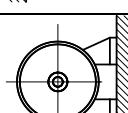
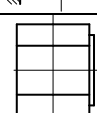
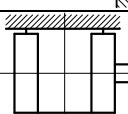
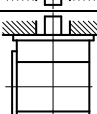
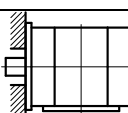
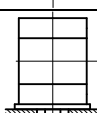
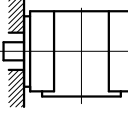
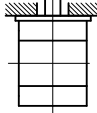
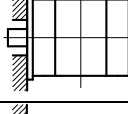
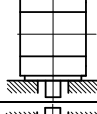
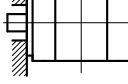
Explanation of the rating plate symbols.

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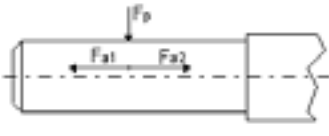
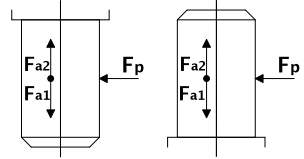
Name of manufacture		Type of operation S1		Insulation class / surrounding temp. if other than 40°C	
Motor number		IM 1001		Version	
Motor type		IP 55		Protection rating	
Rated voltage		V 50 Hz		Rated frequency	
Rated power		7,5 kW		Rated current	
Power coefficient		14,6/8,4 A		Rated efficiency	
Rated rotational speed		1450 1/min		Catalogue number	
Manufacture date Month/year		06/08			

Motor operating parameters and assembly dimensions are included in the specification sheet.

Rotating electrical machines manufactured according to PN –EN-60034-7.

Horizontal shaft			Vertical shaft		
	Marking			Marking	
	System II	System I		System II	System I
	IM 1001	IM B3		IM 1011	IM V5
	IM 1051	IM B6		IM 1031	IM V6
	IM 1061	IM B7		IM 2011	IM V15
	IM 1071	IM B8		IM 2031	IM V36
	IM 2001	IM B35		IM 3011	IM V1
	IM 2101	IM B34		IM 3031	IM V3
	IM 3001	IM B5		IM 3611	IM V18
	IM 3601	IM B14		IM 3631	IM V19

Force acting on the shaft extension should not exceed the permissible values included in the following chart.

Motor type Number of poles		Horizontal operation*		Vertical operation		
						
		F_p	$F_{a1} = F_{a2}$	F_p	F_{a1}	F_{a2}
2/3Sie 90	2	0.68	0.44	0.68	0.35	0.38
	4	0.78	0.44	0.78	0.35	0.38
	6	0.96	0.44	0.96	0.35	0.38
	8	1.05	0.44	1.10	0.35	0.38
2/3Sie 100	2	0.88	0.46	0.90	0.28	0.40
	4	1.06	0.46	0.98	0.38	0.40
	6	1.20	0.46	1.10	0.38	0.40
	8	1.43	0.46	1.30	0.38	0.40
2/3Sie 112	2	1.00	0.48	1.00	0.40	0.45
	4	1.45	0.48	1.40	0.40	0.45
	6	1.62	0.48	1.60	0.40	0.45
	8	1.85	0.48	1.90	0.40	0.45
2/3Sie 132	2	1.82	0.66	1.90	0.43	0.60
	4	2.10	0.66	2.20	0.45	0.60
	6	2.80	0.66	2.80	0.50	0.60
	8	2.90	0.66	2.95	0.50	0.60
2/3Sie 160	2	2.22	0.98	2.30	0.92	0.95
	4	2.40	0.98	2.40	0.92	0.95
	6	2.85	1.10	2.90	0.98	1.00
	8	3.20	1.10	3.20	0.98	1.00
2/3Sie 180	2	2.92	1.30	3.00	1.10	1.20
	4	3.60	1.30	3.60	1.10	1.30
	6	4.00	1.80	4.10	1.40	1.70
	8	4.45	1.80	4.50	1.50	1.80

* - forces listed in the chart and applied to the middle of the shaft neck's length.

2. TRANSPORTATION AND STORAGE



ATTENTION! When lifting drive units always use lifting handles designed for this purpose.

Motors should be transported packaged, in roofed vehicles, avoiding sudden shocks and impact, secured against mechanical damage and humidity. Packaging should adequately protect the motor from mechanical damage during transport.

When lifting the motor or moving it without the packaging, use the lifting eye bolt located at the top of the frame in the middle part of the motor. Do not attach the rope to motor elements which stick out, such as the terminal box, mounting feet, shaft neck, etc.

Motor should be stored in a storage space, where:

- dust, fumes and acid vapours and other aggressive chemical fumes which can damage the isolation or the cover cannot enter;
- maximum relative humidity does not exceed 80 at 20°C;
- in case of motors with heating or anti condensation elements, they can be plugged into mains,
- temperature of the surroundings is between -10°C and +40°C,
- no vibrations occur.

It is important to protect processed surfaces of motors in storage from atmospheric impact, by covering them with thick grease or easily removable anti-corrosion paint.

**ATTENTION!**

After storing a motor for a period of three years, its bearings should be replaced for new ones, or the greasing should be replaced.

3. MOTOR INSTALLATION

**ATTENTION!**

Prior to starting any work on the motor, make sure that it is unplugged from mains.

3.1 Inspecting the motor prior to the assembly

Before starting the motor, check:

- whether the motor complies with your order,
- whether the motor's rated voltage confirms with the network voltage,
- whether the motor hasn't been damaged during transportation or storage;
- whether the motor's rotor rotates freely (turn it manually),
- whether the surrounding temperature in the location of the motor's installation does not exceed + 40°C, (for maritime motors, +45°C or +50°C, according to the maritime association regulations),
- whether free flow of cooling air, necessary for proper operation of the motor, will be provided,

Minimal distance between the end the motor's frame and other elements:

- for shaft height 90 mm – 15 mm
- for shaft height 100 and 112 mm – 20 mm
- for shaft height 132, 160 and 180 mm – 40 mm
- tightness of all mounting screws on the motor.

3.2 Checking of the insulation resistance

Inspection of the insulation's condition should be done prior to starting the motor, if moistness of the winding is suspected, or after a lengthy standstill or storage period (about 6 months).

Insulation resistance should be measured using 500V direct current.

**ATTENTION!**

During, and directly after measuring the insulation resistance, harmful voltage is present in the terminals, therefore it is forbidden to touch them. In order to remove the threat of electrocution, it is necessary to discharge the winding.

The minimal value of the insulation resistance in regard to the frame or between phases in the temperature of 25°C ± 15°C for a new or repaired motor is 10 MΩ.

While the motor is in operation, the insulation resistance may drop, however, it cannot be below the **critical insulation resistance value, which is a product of inter-wire supply voltage and constant coefficient 0.5MΩ/kV**. In case of a motor powered by a frequency converter, the minimal value of the motor's insulation resistance is 1 MΩ. During the measurement, the winding should be in operating temperature.

An example of a motor powered from a 3 x 400V network: $0,4\text{kV} \times 0,5\text{M}\Omega/\text{kV} = 0,2\text{ M}\Omega$.

If the expected winding resistance falls below the level of the critical resistance value, the motor should be immediately taken out of service and the cause of the lowered resistance value - moistness, pollution, damage, etc - removed. After the repair or drying, the conditions of insulation should be checked again.

During the drying process, create conditions necessary to remove moisture from the winding, i.e. at least, take off the cover of the terminal box in order to make the exchange of air with the interior of the motor possible. For motor sizes 132, 160 and 180, there is a possibility to drain the condensate by unscrewing the drain plugs installed in the bearing brackets. The recommended drying temperature is 60 to 80°C. The motor should be dried until insulation resistance reaches its minimal value (2-8h).

In case of motors with heating elements, drying can be performed by connecting them to the mains. Another method of drying is single-phase powering of two out of the three motor outlets with a voltage with a value of about 0.2 of the rated voltage. This way, the motor will not spin, and the value of the input current will be from 25% to 35% of rated current. Heating the motor's winding using the heating elements or single-phase powering prevents the condensation of steam and can be done during the whole period of standstill.

3.3 Placing the geared pulley or half coupling on the motor's shaft extension

Prior to placing the geared pulley or the half coupling on the motor's shaft extension:

- remove any possible injury marks from the shaft extension,
- remove protective paint from the shaft extension,
- lightly cover the shaft extension with grease,
- clean anti-corrosion layer from the flange disc,

Placing the geared /wedged/ pulley or the half coupling should be done with the use of an appropriate tool, as shown in fig. 1 – using the threaded centre hole of the shaft extension.



Fig1

If necessary, heat up the coupling hub or the pulley /belt, geared/ to about 80°C.

In no special equipment is available, the heated up coupling or geared pulley can be hammered on using a suitable sleeve, simultaneously supporting the opposite shaft extension, so the force from the hits is transferred to the support, not the bearings.

After putting the belt, wedged, geared pulley or half coupling on the shaft extension, secure it from sliding off the shaft using a screw with a washer, screwed in the threaded centre hole of the shaft extension.

3.4 Motor orientation

Motor should be oriented in such a way so that it is structurally adapted as much as possible to have easy access for inspection and operations relating with its maintenance.

Motor on mounting legs can be mounted directly on anchor bolts or on take-ups allowing for belt tension adjustment.

When connecting the motor to the driven appliance using a coupling, particular attention needs to be given to the concentricity of shafts: the motor and of the driven machine's shafts – as shown in fig. 2.

For belt drives, it is recommended to use transmissions with wedge belts, which have:

- smaller slide,
- quieter operation,
- lower belt tension.

Lower belt tension results in a lower risk of damaging motor's bearing from the drive side.

Correct assembly and appropriately balanced coupling element have a significant effect on the drive's vibrations and quite operation.

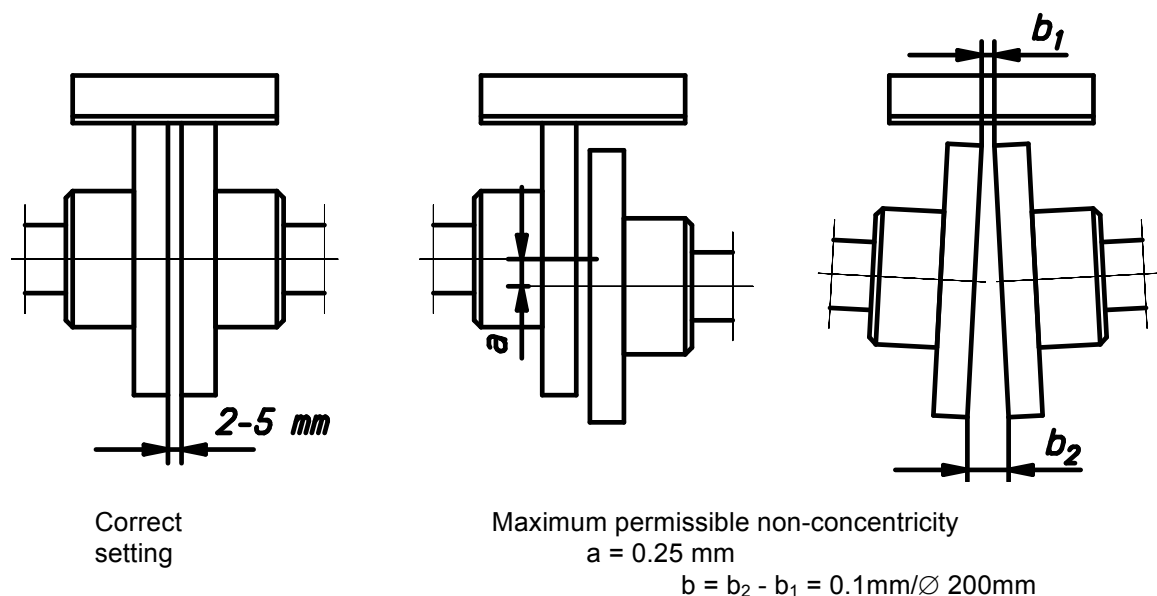


Fig.2 Motor orientation

3.5 Connecting the motor to the mains



ATTENTION!

The earthing or the protective conductor should be connected to the terminal marked with the earthing symbol  located in the terminal box or on the motor's frame. Earthing conductor profiles are specified in attachment no. 3.

Each motor has a rating plate attached to its frame. This rating plate includes information such as:

- supply voltage – permissible deviation $\pm 5\%$ not requiring decreasing the power;
- supply voltage frequency – permissible deviation $\pm 2\%$ not requiring decreasing the power;
- connection of the 3-phase winding in a star (Y) or a delta (Δ);
- input current at rated load.

The box contains a terminal board with 3 or 6 terminals. Power cables should be led in to the terminal box through stuffing boxes or glands. The screwed in cable inlets should prevent water and dust from entering the terminal box during operation. Stuffing box throttle range is included in attachment no. 1.

Power leads should have a cable tips. Torque values, with which the nuts and screws of the electric connections should be tightened, are listed in attachment no. 2.

Detailed rules regarding installing electric motors are given in PN-E-05012.

3.5.1 Direct (DOL) starting.

Each motor is adapted for direct starting.

In case of a 3-terminal board, motor is designed for one voltage, which is indicated on the rating plate. Direct start can take place by plugging directly into the mains, after making sure that the inter-wire voltage of the mains is equal to the rated voltage of the connected motor.

In case of a 6-terminal board, using the connectors supplied with the motor, create a correct phase match, meaning Y or Δ , and connect the power supply to the terminals in accordance to the connection diagram attached with the motor – attachment no. 4.

An example: motor marked 230/400Y V can be connected in two ways, depending on the supply network:

- in a Δ connection if inter-wire voltage is $3 \times 230V$ or
- in a Y connection if inter-wire voltage is $3 \times 400V$.

3.5.2 Indirect (0-Y- Δ) starting

0-Y- Δ start can take place only in motors with 6-terminal outlets from one winding, and supply voltage must be equal to the motor's rated voltage in a Δ connection. Connectors should be removed from the terminal board.

Indirect starting is used in order to limit the motor's starting current and large drops of voltage in the mains as an effect of high starting voltage. Remember that the motor with a nominal connection in Δ has a 3 times smaller starting torque in an Y connection, that's why the 0-Y- Δ start should be performed without load or with the lowest possible load. Start of the motor begins with the Y connection, and after achieving a stable rotational speed by the motor, switches to Δ . If the motor cannot start in the Y connection, instead of using the 0-Y- Δ start, use the direct start method. If start is still impossible, reanalyze the starting conditions and motor selection.

An example: starting a motor marked 400 Δ /690YV or 400 Δ V powered by a $3 \times 400V$ network:

- connection in Y – operation 10s,
- switch to Δ - constant operation,
- put the motor under load.

Detailed regulations regarding installing electric motors are given in PN-E-05012.

3.5.3 Direction of the motor's rotation

The standard direction of rotation is clockwise, as seen from the shaft extension's drive side, when the power supply phases L1, L2, L3 are connected according to the diagram attached with the motor – attachment no. 4. In order to change the rotation direction, change any two power supply phases.

3.5.4 Winding thermal protection – included upon request

Two types of thermal protection are used in motors:

- thermal bimetal,
- PTC-resistor.

Terminals of PTC-resistor temperature sensors should be connected with the appropriate input terminals on the resistance relay, and terminals of thermal bimetal NC temperature sensors can be connected directly to the motor's safety circuit (fig 4).

Motors, in which the stator's winding has buried thermal protection, have finishing leads of the beginnings and ends of temperature sensors, which are connected in series, connected to an additional terminal block, in the terminal boxes.

Thermocontact sensors

Three thermocontacts are located in the motor's winding, connected in series (fig. 3). Each one is placed in a different phase.

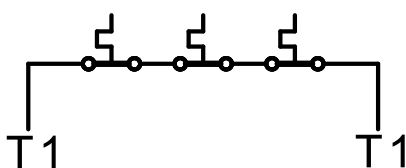


Fig. 3

An example of the power supply system of a motor with thermal protection using thermocontacts is presented in drawing 4a.

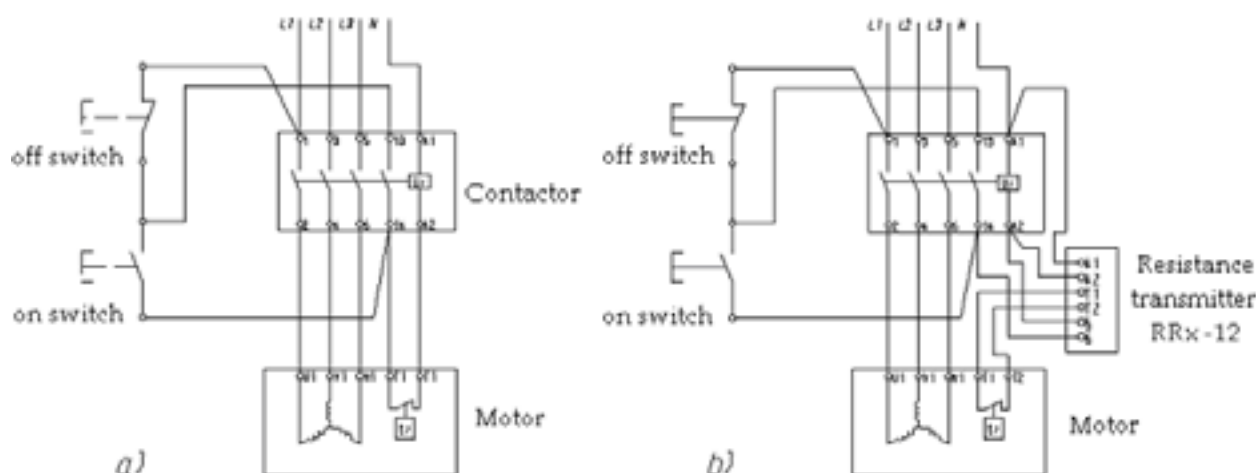


Fig. 4

Technical parameters of thermocontact S01.150.05:

- contact opening temperature - $150^{\circ}\text{C} \pm 5^{\circ}\text{C}$
- rated current - 250V, 50 ÷ 60Hz
- load:
- 2,5A at $\cos\varphi=1$
- 1,6A at $\cos\varphi=0,6$
- max load – 40.A at $\cos\varphi=1$
- contact system – normally closed
- electric resistance of the insulation – 2.0kV
- resistance - $<50\text{m}\Omega$

In bimetal temperature sensors with normally closed contact, the continuity of the circuit should be checked in cold state, with current not exceeding the sensor's operating current. Current higher than rated current can cause damage to the thermal protection of the winding.

PTC-resistor sensors.

Three PTC-resistors are located in the motor's winding, connected in series (Fig. 5). Each one is placed in a different phase.

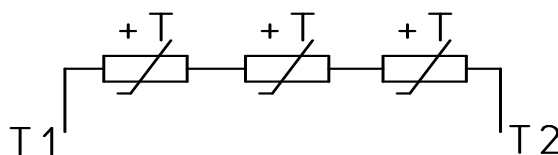


Fig. 5

Sensor outlets should not be connected directly to the contactor's terminals. They should be connected to the resistance relay's terminals (for example: RRx-12). An example of the power supply system of a motor with thermal protection using PTC-resistors is presented in drawing no. 4b.

Technical parameters of PTC-resistor STM 140 EK:

- resistance:
- $T_N = 140^{\circ}\text{C}$
- for temp 20°C to T_{N-20K} - $20\ \Omega$ to $250\ \Omega$
- for temp T_{N-5K} - $<550\ \Omega$
- for temp T_{N+K5} - $>1330\ \Omega$
- for temp T_{N+15K} - $>4000\ \Omega$
- rated current - $\leq 2,5\text{V}$ -
- max current – 30V-
- electric resistance of the insulation – 2.5kV

3.5.5 Anti-condensation heaters

Anti-condensation heaters are used in cases of a risk of steam condensation inside the motor. The effect of steam condensation can take place during long-term standstill of a cold motor in humid air. In such a case, turn on the heaters for a few hours prior to starting the motor, and after drying check the insulation resistance value as described in chapter 3.2 or keep the heaters turned on during the whole standstill period.

For motor sizes 132, 160 and 180, there is a possibility to drain the condensate by unscrewing the drain plugs installed in the bearing brackets.

Do not power the heaters while the motor is in operation.

Standard heaters: 2 heaters, 25W each, running on 230V current with three leads.

When connected parallel, the power supply current may amount to 200-240V, and connecting in series allows for powering the heaters with 400-480V current.

4. OPERATION AND USE OF THE ELECTRIC MOTOR

4.1 Operational safety regulations

In order to avoid unfortunate accidents while operating the motors, it is important to follow these rules:

- electric motor operators should be familiar with the operational safety regulations regarding electric devices and their operation, the motor cannot in any case be in operation without a functional earthing.

The quality of earthing or neutralization should be checked periodically for the reason that contacts may loosen or get corroded. Do not perform any repairs while the motor is in operation;

- maintenance, inspections or repairs of the motor can be performed only on a motor disconnected from the mains;
- the motor should be earthed or neutralized in accordance with current regulations in this regard. The quality of earthing (neutralization) should be inspected periodically;
- the motor cannot be operated without the cover of the external fan and without the cover of the coupling or the belt, fan or gear transmission, with elements leading current exposed,
- each location where the electric motion takes place should be equipped with a fire extinguisher filled with non-conducting extinguishing agent.
- safety devices preventing accidents from occurring should be present in the location of the installation, in accordance with local safety regulations.

4.2 Motor start and use

Prior to starting the previously prepared motor, as described in chapter 3, check the functionality of control circuit on an unloaded motor. Check whether the change of rotational speed takes place and whether the motor is spinning in the correct direction. Motor can be started by:

- connecting to the mains directly,
- an indirect 0-Y- Δ start.

Both methods are described in details in chapter 3.5.

The maximum number of consecutive starts is dependent on the degree of starting difficulty and limited by the maximum temperature increase for the given heat resistance class of insulation.

While the motor is in operation, systematically check the correctness of such operations as:

- the state of motor heating up on its frame – in some types of motors, the temperature increase of the frame can reach as much as 70K;
- correct functioning of bearings – which is manifested by quiet, even humming,
- whether there are no excessive vibrations of the motor,
- the condition of the motor's coupling with the powered machine,
- current input shouldn't exceed the nominal value.

Normal, stable work can take place with current fluctuation not exceeding $\pm 5\%$ of the rated current and $\pm 2\%$ of the rated frequency.

The motor should be turned off immediately in case of:

- smoke or fire, etc. coming out of the motor or the installation;
- excessive heating of the motor;
- significant decrease of rotational speed,



- damaging of the external fan;
 - damaging of the driven machine;
 - when, for any reason, further work of the motor and the driven machine is a threat to the surroundings.
- Switching on the motor and the appliance again can take place after all defects have been removed.

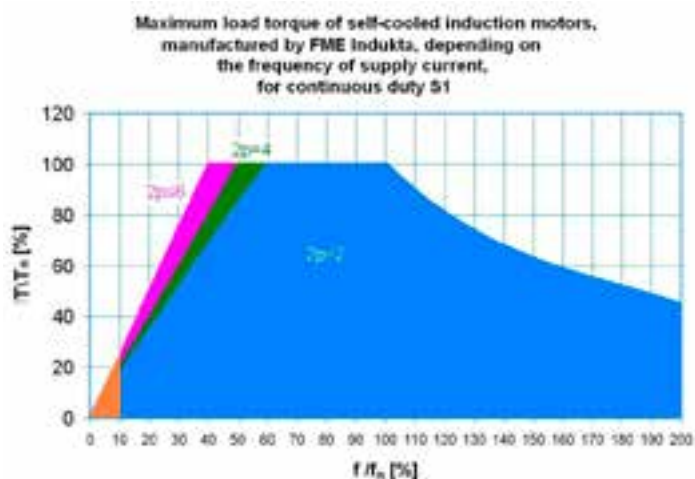
4.3 Mating the motor to a frequency converter

Standard motors powered with AC up to 400V, series Sg and Sh, manufactured by FME Indukta, have an insulation system making it possible to be powered through frequency converters. For heat factors, it is not recommended to power progressive Psg or PSh series motors through converters.

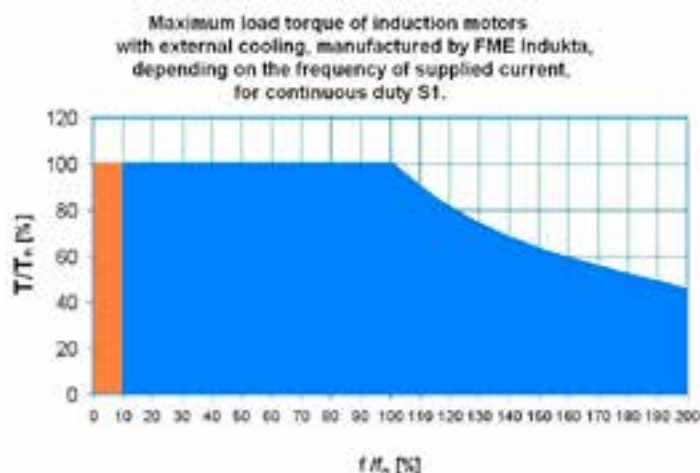
These converters allow for adjusting the motor's rotational speed. Do not exceed the maximum rotational speeds of the motor listed in the following chart:

Motor size	2p=2	2p=4	2p=6	2p=8
	rev/min			
90 ÷ 112	5200	3600	2400	2000
132 ÷ 180	4500	2700	2400	2000

La regolazione della velocità di rotazione, in base alla coppia, può avvenire solo nell'intervallo indicato nel grafico n. 1, mentre la coppia massima dei motori a induzione con ventilazione esterna, in base alla frequenza della corrente fornita, è indicata nel grafico n. 2. Il funzionamento nel campo arancione dipende dal tipo e dalle impostazioni del convertitore di frequenza.



Graph no. 1



Graph no. 2

$$M \text{ [Nm]} = \frac{9550 \cdot P \text{ [kW]}}{n \text{ [min}^{-1}\text{]}}$$

Analysing the formula: notice that the increase of rotational speed, while maintaining a constant torque, must be accompanied by an increase of power. With speeds exceeding the rated speed, the

increase of power would cause an increase of the current drawn by the motor, which causes motor overheating. For this reason, in rotational speed higher than the rated speed, the load torque on the shaft needs to be lowered. While operating the motor in rotational speed higher than the rated speed, pay attention to the current drawn by the motor, and make sure that it is not higher than the rated current.

While the motor is operated in speeds higher than the rated speed, the level of noise and vibrations increases, and the life span of bearings can be shorter. Attention: do not exceed the rotational speed listed in chart.

A method of eliminating these unfavourable effects can be:

- using dU/dt filters, which smooth out the rate of output voltage,
- blocking the frequencies in the inverter, in which the unfavourable effects take place,
- change of the carrier frequency (transistor keying),
- adjusting other inverter parameters.

The ratio of the output voltage to the frequency converter's output frequency, in the range up to the rated frequency, is constant, which is a condition of achieving constant torque on the motor's shaft. Above the rated frequency, the voltage value is constant, which results from the voltage value of the converter's power supply. A motor, whose the rated voltage when connected in a star is equal to the rated voltage of the frequency converter, can be connected in a delta. Its rated voltage will now be $\frac{U_{\text{converter}}}{\sqrt{3}} \approx 0,577 \times U_{\text{converter}}$. This will make it possible to extend the range of operation with a rated torque to 86.6 Hz. The new value of the motor's rated voltage should be entered into the frequency converter.

Attention: When making the connections described above, it is recommended to consult with the supplier of the converter in regard to the new frequency converter settings.

An example: Having a 230Δ/400Y motor, connected in a star and a frequency converter with output voltage $U_{\text{converter}} \leq 400V$ (ratio U/f=8), we can connect the motor in a delta ($U_n=230V$) and set this parameter in the converter (U/f=4.6). This way the adjustment range on the motor's shaft, with a constant torque, increases to 86.6Hz.

For example:

Rated voltage of motor	Rated frequency	Rated current	Rated output	Maximal output
400V Y (U/f=8)	50Hz	6,2A	3,0kW	3,0kW
230V Δ(U/f=4,6)	50Hz	10,7A	3,0kW	5,2kW (87Hz)

Withstand voltage stress of insulation.

Motors up to 400V AC have insulating system compatible with standard IEC TS 60034-17, resistant for voltage impulses 1.35kV at the impulse rise time $\geq 0,8\mu s$. When using converters without any reduction of voltage impulses such motors are suitable for drive systems **only up to 400V AC** supply voltage within a restricted range of cable length. When using filtering devices, such motors can be used for drive systems up to 690V supply voltage and without limits of cable length.

Recommended is using filters on inverter output, which eliminate considerably problems with overvoltage, acoustic effects, reduce current ripples. Filters protect motor isolation and elongate time of using the motors.

4.4 Defects in the work of a motor and their removal

Defects, which can be the reason of most frequent motor malfunctions, are listed in the following chart.



DEFECT	CAUSE	SOLUTION
Motor not moving or moves heavily when idling	Motor overloaded	Ridurre il carico.
	Incorrect power supply.	Controllare la tensione dei morsetti di alimentazione, la connessione dei cavi e l'impostazione del convertitore di frequenza; eliminare la causa.
	Incorrect connection system.	Controllare le connessioni in base allo schema in dotazione al motore
	Rotor damage.	Verificare se le barre o gli anelli sono danneggiati
	A short circuit in the motor's winding or incorrect winding connection.	Eliminare il cortocircuito, il collegamento errato o riavvolgere il motore.
	Blown fuses.	Sostituire i fusibili con altri dello stesso tipo e con valori nominali adeguati.
	Automatic switch-off caused by overloading.	Controllare le impostazioni dello starter.
	Broken power supply or control circuit.	Quando l'interruttore è chiuso, si sente un ronzio. Controllare che le connessioni dei cavi non siano allentate, controllare anche i contatti di controllo.
	Mechanical damage.	Controllare se il motore e l'azionamento ruotano regolarmente. Controllare i cuscinetti e la relativa lubrificazione.
Motor stalls	One of the phases may be open.	Controllare se nelle linee vi è una fase interrotta
	Bad motor selection.	Cambiare il tipo di motore o la grandezza. Contattare il fornitore o il costruttore del dispositivo.
	Overload.	Ridurre il carico
	Low voltage.	Controllare se è stata rispettata la tensione indicata sulla targa. Controllare la connessione.
	Open power supply or control circuit.	Fusibili bruciati, controllare relè carico, statore e tasti di controllo.
Motor braking doesn't take place despite switching off the power (regards motors with a brake)	The brake's air gap has exceeded its maximum value.	Regolare il traferro.
	Power supply voltage too low $U < 0,9U_{zn}$	Aumentare la tensione di alimentazione.
	Opening in the power supply circuit.	Controllare ed eliminare il guasto.
	Opening in the electromagnet coil.	Sostituire l'elettromagnete del freno.
Motor moves, then stops.	Power supply failure.	Check for a loose connection in the power supply line, fuses and control.

DEFECT	CAUSE	SOLUTION
Motor does not reach the given speed	Bad motor selection.	Contact the device's supplier or designer in order to determine an appropriate motor selection.
	Voltage on the motor's terminals is too low, caused by a voltage drop in the power supply cables.	Check whether the cables have an appropriate size.
	Incorrect power supply.	Check the voltage of the power cable terminals, check the power lead connection, check the setting on the frequency converter – remove the cause
	Initial motor load is too high.	Check the rated initial load value of the motor.
	A short circuit in the stator's winding or a short circuit to the frame (to the ground).	Find and remove the short circuit (rewind the motor).
	Cracked rotor bar or loose rotor.	Check for cracks near the ring In case of frequent repairs, a new rotor may be needed.
Overheating of the motor (with a brake)	Motor overloaded	Decrease the load
	Incorrect power supply.	Check the voltage of the power cable terminals, check the power lead connection, check the setting on the frequency converter – remove the cause.
	A short circuit in the stator's winding or a short circuit to the frame (to the ground).	Find and remove the short circuit (rewind the motor).
	A break in the motor's connection or winding.	Find and remove the break.
	Incorrect power supply connection.	Connect the motor according to the diagram.
	Too many starts per hour.	Increase the intervals in the motor operation, eventually decrease the number of switchings
	Too many starts per hour.	Increase the intervals in the motor operation, eventually decrease the number of switchings
	Ventilation openings in the ventilator's or console's cover may be blocked with dirt, preventing correct motor ventilation.	Clean the ventilation openings and check for the continuity of the air flow from the motor.
	The gap between the core and the shifted brake armature is higher than 0.06mm in places.	Remove any dirt and adjust.
	Axial run-out of the brake lock's front in relation to the shaft's axis is higher than 0.05mm.	Adjust the perpendicularity of the lock in relation to the shaft's axis through assembly or machining
	Brake power supply voltage too low (HZg, HYg) $U < 0.9U_{zn}$	Increase the power supply voltage.
	Small, obstructed flow of air cooling the brake.	Improve brake cooling.
	Brake's operation too intense.	Decrease the number of switchings per hour.



DEFECT	CAUSE	SOLUTION
Drop of the braking torque in the brake (regards motors with a brake).	The brake's air gap has exceeded its maximum value.	Adjust the gap.
	Brake pad lining worn out.	Replace the brake disk.
	Brake's friction surface polluted.	Clean, replace the greasy brake disk.
	Damaged brake springs.	Replace the springs.
Current intensity asymmetry in the power leads.	Asymmetry of the power supply voltage.	Check and remove the cause of the power supply voltage asymmetry.
	A short circuit in the stator's winding or a short circuit to the frame (to the ground).	Find and remove the short circuit (rewind the motor).
	A break in the motor's connection or winding.	Find and remove the break.
	Damage on the rotor cage.	Replace the rotor.
Motor takes too long to gain speed and/or draws too much current.	Overloading.	Decrease the load
	Low voltage during starting.	Check whether the leads have an appropriate size.
	Incorrect convertor settings.	Correct the settings.
	Squirrel-cage rotor damaged.	Replace the rotor for a new one.
	The voltage used is too low.	Contact the power supply company in order to increase the power level.
Incorrect direction of rotation.	Incorrect phase order.	Reverse the connections in the motor or on the switchboard.
Overcurrent releases are activated during the motor's start	The rotor or the ventilator seizes up.	Find and remove the mechanical damage (rotor, pulley, coupling, ventilator, and carefully balance).
	A short circuit with the frame (the ground).	Find and remove the short circuit (rewind the motor).
	A break in the motor's connection or winding.	Find and remove the break.
		Collegare il motore nel modo corretto.
	Incorrect connection system.	Connect the motor correctly.
Rate of rotation drop when under load (slip increases).	Motor overloaded	Decrease the load
	Incorrect power supply.	Check the voltage of the power cable terminals, check the power lead connection, check the setting on the frequency converter – remove the cause
	A short circuit in the stator's winding or a short circuit to the frame (to the ground).	Find and remove the short circuit (rewind the motor).
	A break in the motor's connection or winding.	Find and remove the break.
	Incorrect connection system.	Connect the motor correctly.
	Single-phase power supply.	Check the voltage of the power cable terminals, check the power lead connection.

DEFECT	CAUSE	SOLUTION
Overloaded thermal release turns the motor off during operation.	Motor overloaded	Decrease the load
	Incorrect power supply.	Check the voltage of the power cable terminals, check the power lead connection, check the setting on the frequency converter – remove the cause.
	Rotor damage.	Look for cracked bars or end rings
	A short circuit in the motor's winding or incorrect winding connection.	Remove the short circuit, remove the bad connection or rewind the motor.
	A break in the motor's connection or winding.	Find and remove the break.
	Incorrect connection system.	Connect the motor correctly.
	Incorrect overload range setting in the thermal release	Set the overload protection correctly.
	Single-phase power supply.	Check the voltage of the power cable terminals, check the power lead connection, check the setting on the frequency converter – remove the cause
Motor vibrates.	Motor badly aligned.	Re-align.
	Weak mounting.	Enforce the base.
	Unbalanced coupling.	Balance the coupling.
	Driven appliance unbalanced.	Balance the driven appliance.
	Bearings damaged.	Replace the bearing.
	Unaligned bearings.	Re-align correctly.
	Displaced balance weights.	Balance the motor.
	Unbalanced motor and coupling unit	Balance the unit.
	Multiphase motor operates in a single phase.	Check whether the motor has an open circuit.
	Excessive axial looseness	Adjust the bearing or add a washer
Grinding	The ventilator rubs against the cover.	Eliminate the friction.
	The fan is hitting the cover.	Clean the fan and the cover, check the fan's mounting on the shaft.
	Looseness on the base plate.	Tighten the clamping screws.
Noisy operation.	Uneven air gap.	Check and correct the bracket or bearing mounting.
	Spinning parts not balanced.	Find and remove the mechanical damage (rotor, pulley, coupling, ventilator, and carefully balance).
	Belt tension too high.	Adjust the motor orientation and belt tension
	Incorrect coupling of the motor with the driven machine.	Replace the bearings. Adjust the motor orientation and belt tension
Brake buzzing while switching the motor off	A break in the brake's electromagnet circuit.	Replace the electromagnet.
	Break in the lead supplying power to the brake.	Remove the damage.
	Brake's air gap has exceeded its maximum value.	Adjust the gap.
	Power supply voltage too low $U < 0,9U_{zn}$	Increase the voltage.

DEFECT	CAUSE	SOLUTION
Bearings heat up.	Bent or skipping shaft.	Straighten or replace the shaft.
	Belt tension too high.	Decrease the belt tension.
	Pulley is too far.	Move the pulley closer to the motor's bearings.
	Pulley diameter too low.	Use larger pulleys.
	Non-coaxiality.	Fix by aligning the drive again
	Low amount of grease in motors with greased bearings	Provide an appropriate grease quality in the bearings.
	Grease polluted or used up.	Replace the bearings or if possible, clean them and use new grease.
	Too much grease.	Decrease the amount of grease, bearing should not be filled more than half way
	Bearing overloaded.	Check the alignment, side thrust and end thrust.
	Cracked bearing balls or course channels.	Replace the bearing, accurately clean the cover first.
Motor seizes up.	Bearings damaged.	Replace the bearings.
	Screw mounting the disk to the frame is loosened.	Tighten all clamping screws.

5. MOTOR MAINTENANCE

In order to maintain the motor in full technical efficiency, it is necessary to remove all defects noticed during operation on an ongoing basis.

Regardless of the above, every working motor should be subjected to periodic maintenance inspections. Time periods between maintenances, running and major repairs, are dependent on the conditions of motor's work.



ATTENTION!

In order to attempt any type of work related with the motor or its elements, especially prior to taking off protective covers, prior to directly touching moving parts or parts which can be under current, unplug the motor and all additional and support circuits from the mains.

5.1 Periodic inspections

Customary time periods are as follows:

- running inspection every 6 months (for dust-laden room, every 3 months)
- main inspection – once every 30 months.

Running inspections – performed at the location of motor's installation, without a disassembly. This type of inspection can reveal a need to subject the motor to a main inspection.	Main inspections – include the following operations:
	
Running inspections include the following operations:	
• cleaning the motor and a visual inspection	• disassembly of the motor
• measuring the insulation resistance of the winding	• stator inspection
• examining the condition of power cables and the earthing cable	• inspection of the rotor
• checking the tightness of all mounting and contact screws	• inspection of bearings and bearing chambers
• removal of condensate in motors featuring drain plugs in the disks	• measurement of insulation resistance of the winding
	• inspection of the starting and protective devices

AFTER A MAIN INSPECTION AND ANY EVENTUAL REPAIRS OF THE MOTOR'S WINDING, CHECK THE CONDITION OF THE WINDING'S INSULATION AS DESCRIBED IN CHAPTER 3.2.

Additionally, in motors with brakes, inspect the brake elements. A detailed description of the brakes is included in attachment no. 5. In case of a large number of switchings, inspect the brakes more often than every 6 months. All defects noticed during the inspection should be removed, and worn out parts replaced with new ones. It is recommended to renew the protective layers.

5.2 Sizes and types of bearings

Size and type of bearings used in different types of motors:

2/3Sie(K, L) 90	-	6205-2Z-C3
2/3Sie(K, L) 100	-	6206-2Z-C3
2/3Sie(K, L) 112	-	6306-2Z-C3
2/3Sie(K, L) 132	-	6308-2Z-C3
2/3Sie(K, L)g 160	-	6309-2Z-C3
2/3Sie(K, L)g 180	-	6311-2Z-C3

5.3 Greased the bearings

Bearings closed on both sides /type 2Z/ are filled with grease by the manufacturer which lasts for their whole life span. The life span of standard bearings is 25 000 hours.

After the expiration of the motor's warranty it is recommended to replace the bearings for new ones.

Bearings in motors with buried grease nipples in bearing brackets (fig. 6) should be greased periodically. Greasing periods, type and amount of grease are listed in the following chart:

Motor size	Amount of refilled grease [g]	Grease refilling period [h]		Grease type
		n≥1500 rpm	3000 rpm	
90	4	2500	1500	
100	5	2500	1500	
112	7	2500	1500	
132	10	1500	1000	
160	12	1500	1000	
180	17	1500	1000	

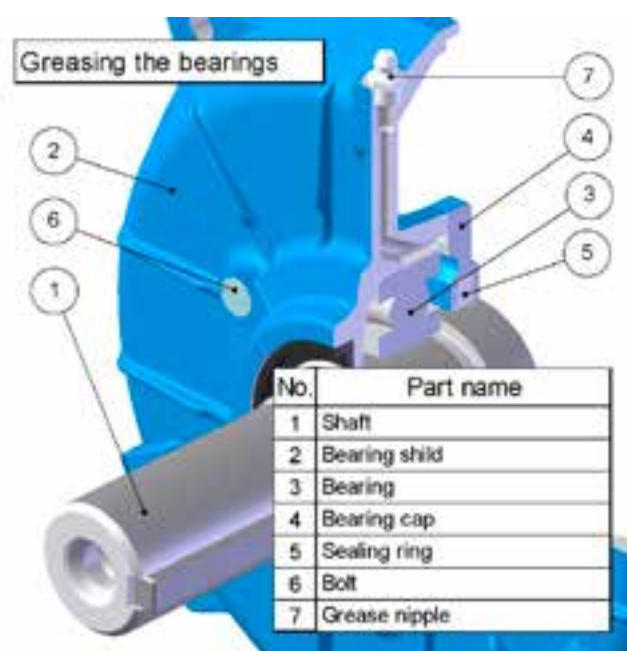


Fig. 6

5.4 Disassembly and assembly of the motor

By principle, motor disassembly should take place outside the place of its operation, in a specially prepared location. Tools required include a regular set of assembly tools and instruments. Prior to a correct disassembly, take off the motor pulley or the half coupling using a turnbuckle (fig. 8), remove the key (7) from the shaft extension, unscrew 4 screws (5) and remove the ventilator cover (13) (fig. 7). After unscrewing 4 screws (5) which mount the bearing brackets “P”, carefully remove the rotor (1) with the bearing brackets “P” (11) and the ventilator (8) from the stator, without damaging the winding. If it is necessary, or when replacing the grease, remove both bearings (17) using a turnbuckle.

Prior to removing the “P” bearing (), it is necessary to:

- remove the spring clip mounting the ventilator (10) and take off the ventilator (8) from the rotor’s shaft along with the key, using a turnbuckle;
 - remove the “P” bearing bracket (11) from the rotor’s shaft (1).
- After completing these steps, remove the “P” bearing (17) using a turnbuckle.

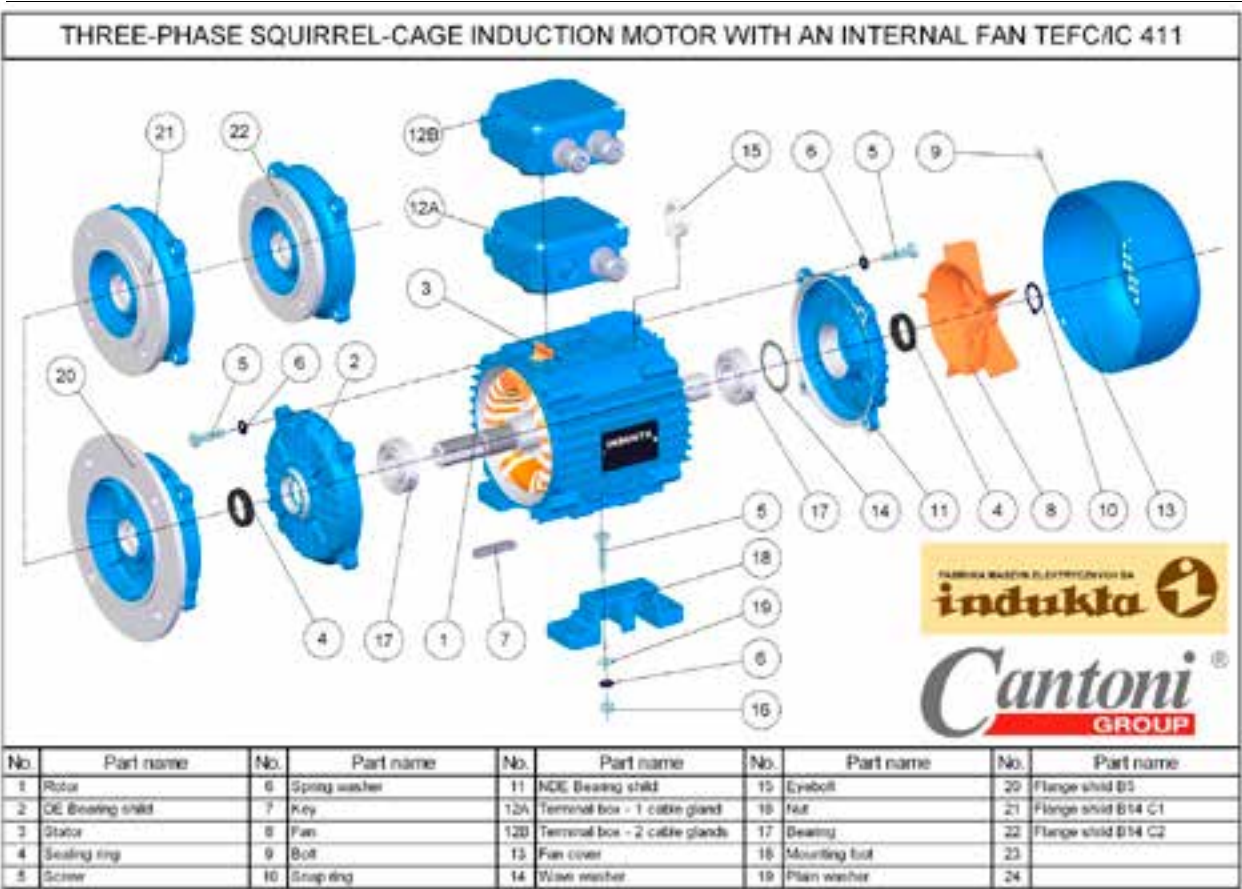


Fig. 7

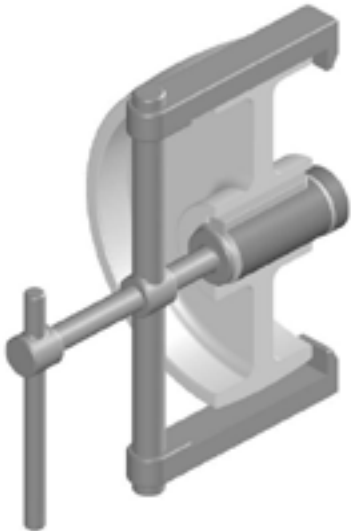


Fig. 8

Attention: For motors with a gripped bearing fig. 9 and 10, (also regards vertical motors), prior to the disassembly of the bearing it is necessary to:

- remove 3 screws mounting the bearing cover (4) and remove the rotor's spring clip (3) (this also regards motors with a closed bearing chamber - see fig. 9)
- remove the spring clip in the bearing brackets (3) and rotor (4) (this also regards motors with a open bearing chamber – see fig. 10).

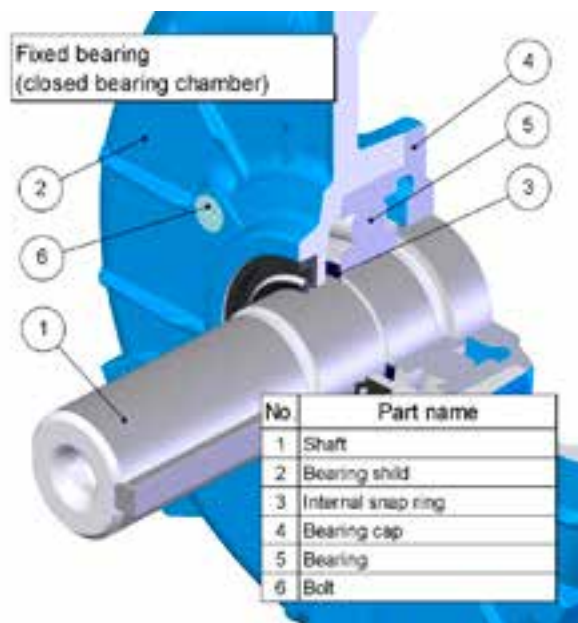


Fig. 9

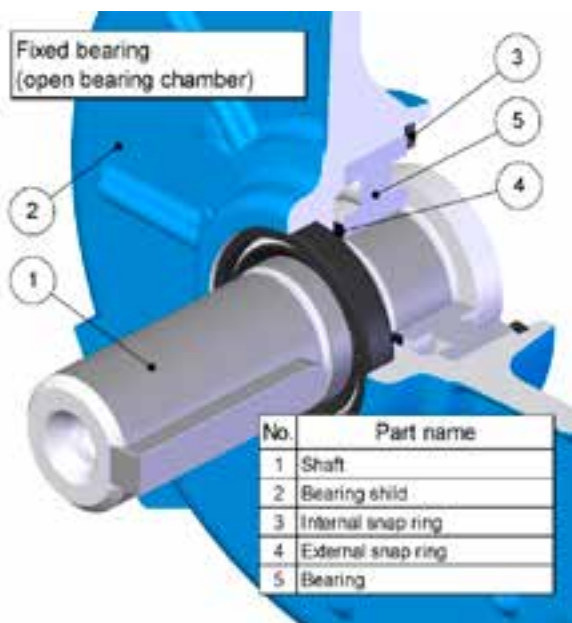


Fig. 10

In case of a motor with a brake (fig. 11), prior to the disassembly of the motor it is necessary to disassemble the brake (19).

In case of motors with an external ventilation system (fig. 12), external ventilation (10) is disassembled along with the cover.

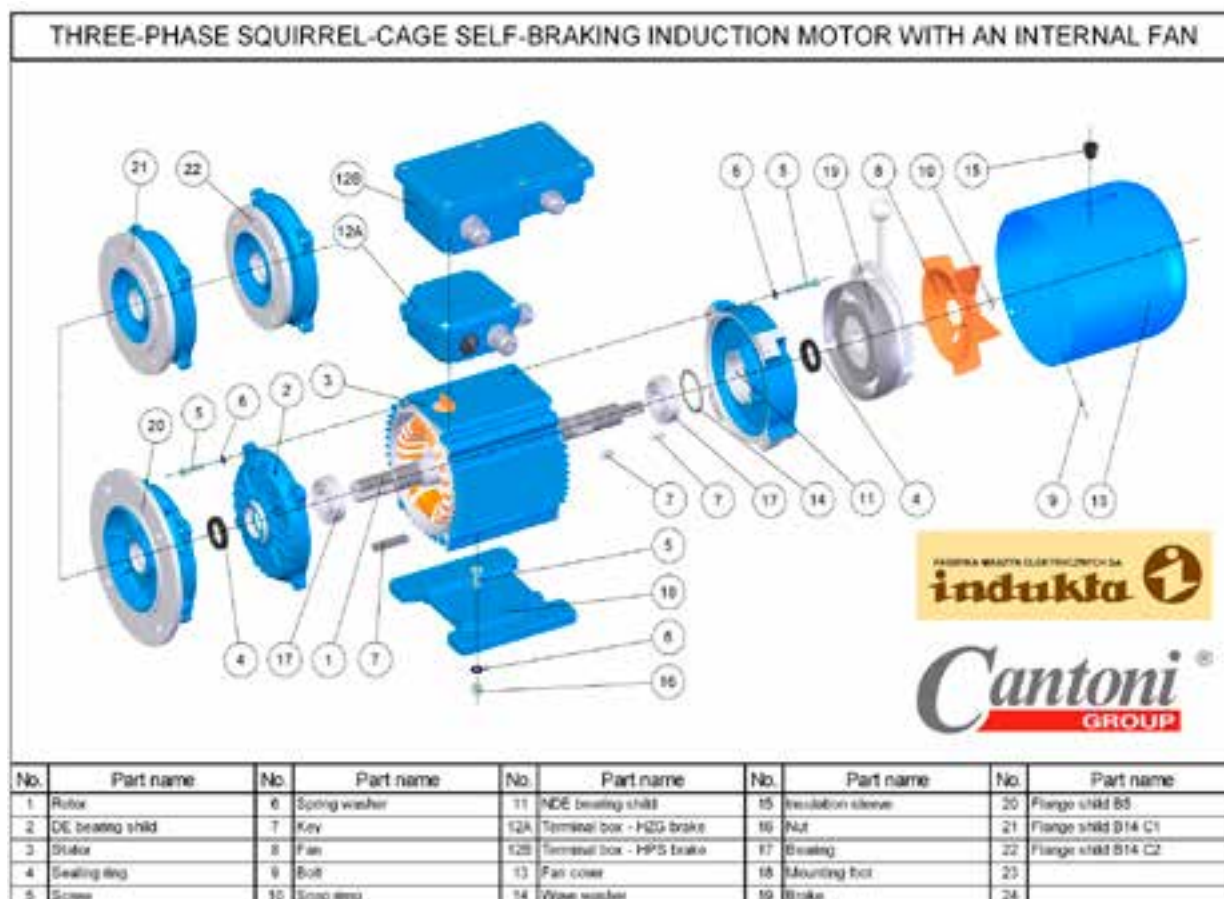


Fig. 11

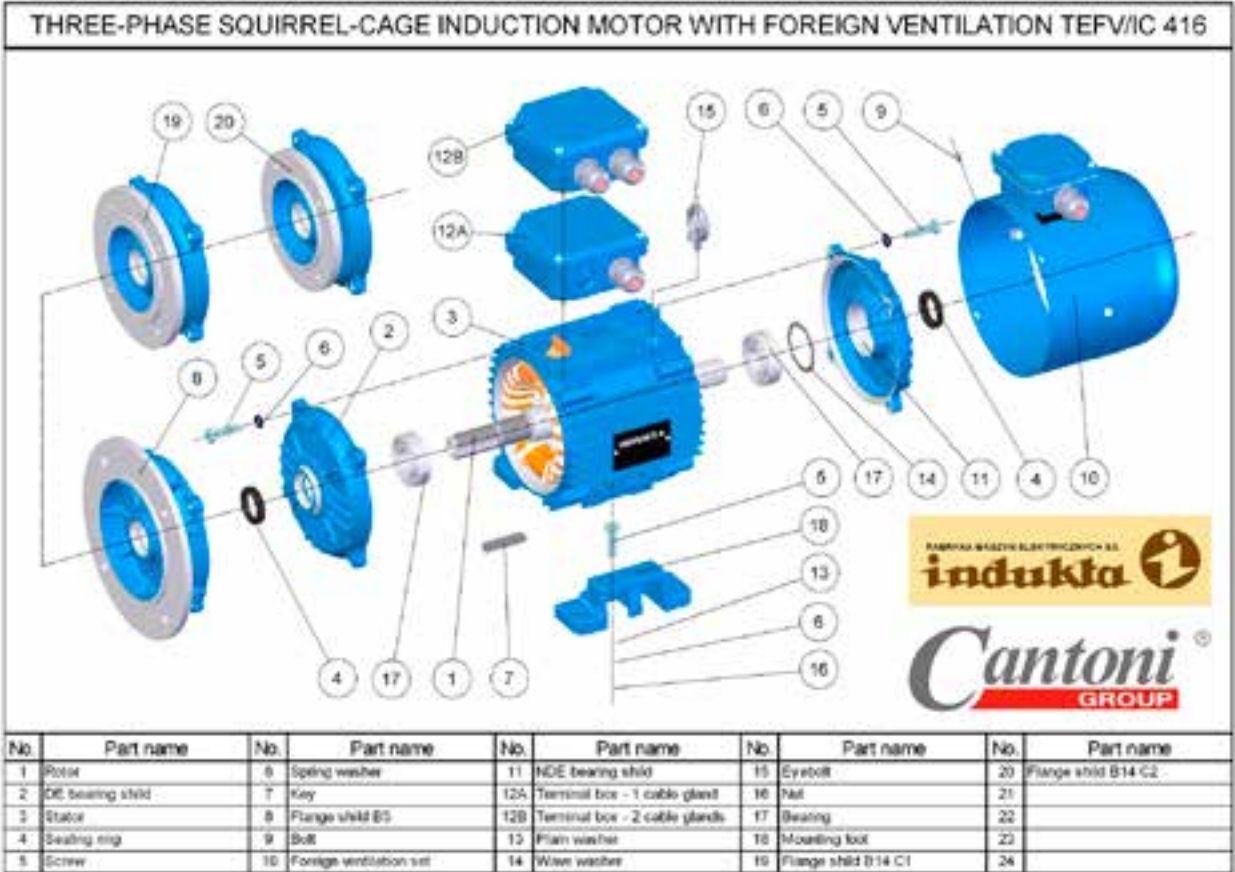


Fig. 12

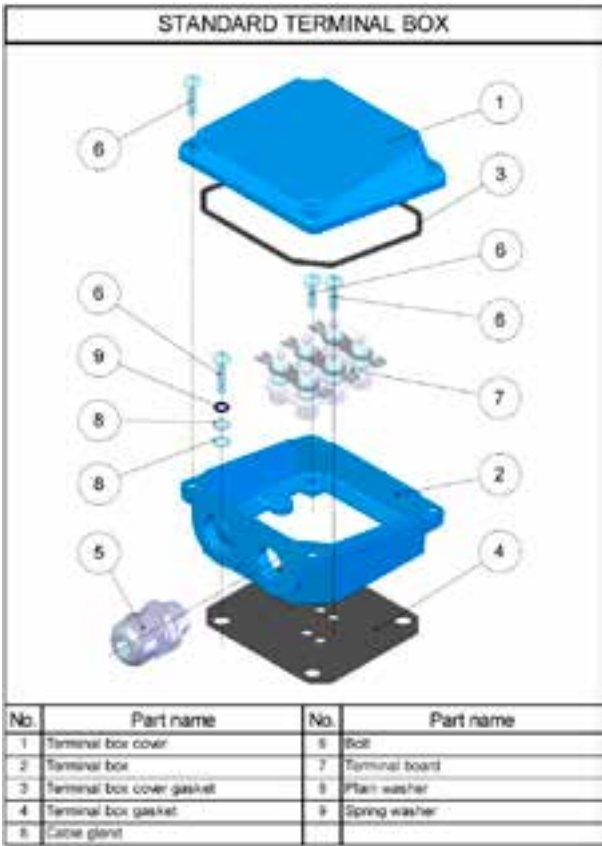


Fig. 13

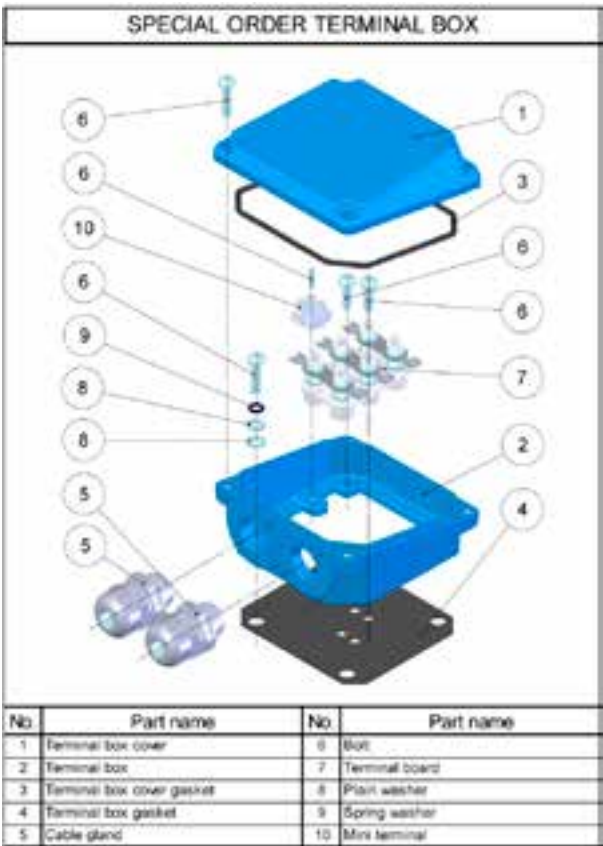


Fig. 14

Disassembly of the motor's terminal box is done in accordance with drawing no. 13. Depending on the type of motor, following terminal box settings are available:

- custom version (fig. 14)
- version with an HPS brake (fig. 15)
- version with an HZG brake (fig. 16)

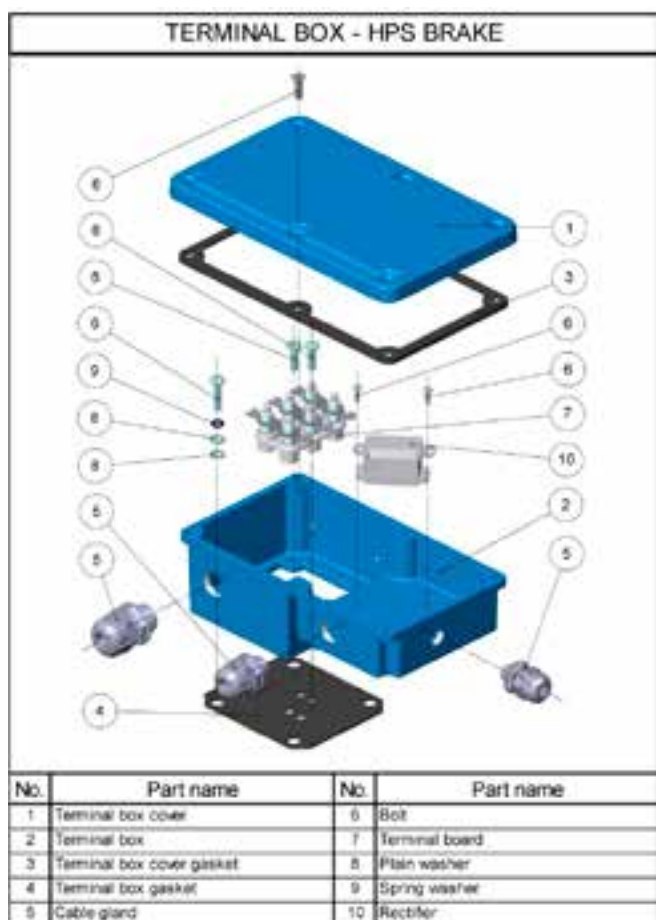


Fig. 15

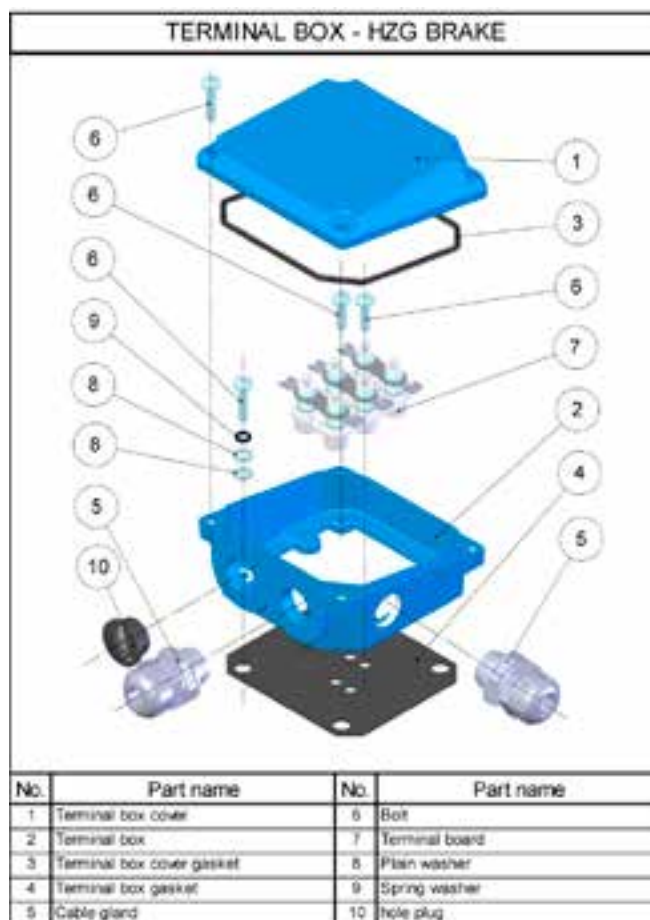


Fig. 16

Motor assembly should be done in reverse order.

After a correct assembly, the rotor should freely turn when spinning the shaft neck manually.

6. LIST OF REPLACEMENT PARTS

- Rotor set
- Bearing bracket N - machining
- Flange bracket - machining
- Gasket ring (V-ring)
- Spring washer
- Bearing N
- Bearing cover - machining
- Cover's felt ring
- Bearing bracket P - machining
- Bearing P
- Rotor's stopper ring
- Ventilator
- Ventilator cover
- Terminal box set

7. ATTACHMENTS

Attachment no. 1 Throttle range of cable glands.

Gland size	Throttle range in [mm]
M12	$3.5 \div 7$
M16	$4.5 \div 10$
M20	$7 \div 13$
M25	$9 \div 17$
M32	$11 \div 21$
M40	$19 \div 28$

Attachment no. 2. Torque values for the tightness of nuts and screws

Thread		M 4	M 5	M 6	M 8	M10	M12	M16
Torque value in [Nm]	Min.	0,8	1,8	2,7	5,5	9	14	27
	Max.	1,2	2,5	4	8	13	20	40

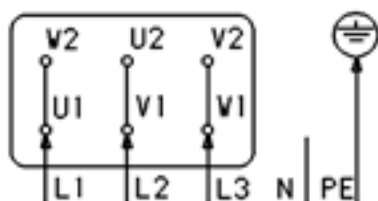
Attachment no. 3 Minimal earthing or protective lead profiles.

Live lead profile S [mm ²]	Earthing or protective conductor profile [mm ²]
$S \leq 25$	S
$25 < S \leq 50$	25
$S > 50$	0,5 S

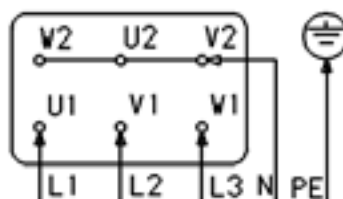
Attachment no. 4. Standard motor terminal connection diagrams.

1. 3-phase single-speed motors:

Connection in a Δ



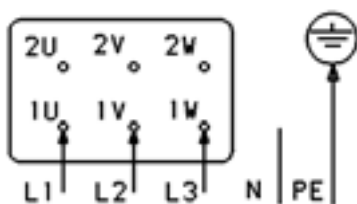
Connection in a Y



2. 3-phase dual-speed general use motors (single-winding), for example, $2p=4/2, 8/4$:

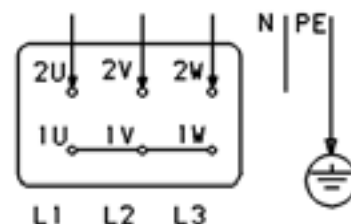
GEAR 1 $2p=4(8)(12)$

Connection in a Δ



GEAR 2 $2p=2(4)(6)$

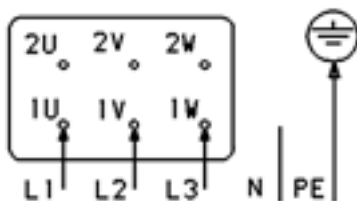
Connection in a YY



3. 3-phase dual-speed motors (double-winding), for example $2p=6/4, 8/6$:

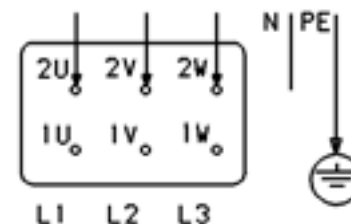
GEAR 1 $2p=4(8)(12)$

Connection in a Y



GEAR 2 $2p=2(4)(6)$

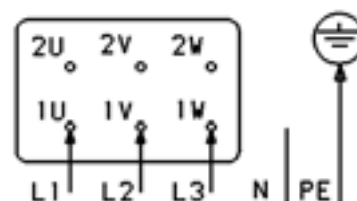
Connection in a Y



4. 3-phase dual-speed ventilator motor (single-winding), for example $2p=4/2W, 8/4W$ – motor marking ending in „W“:

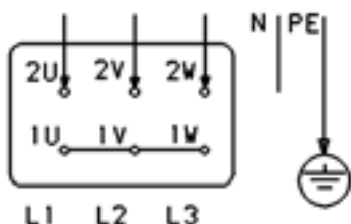
GEAR 1 $2p=4(8)(12)$

Connection in a Y



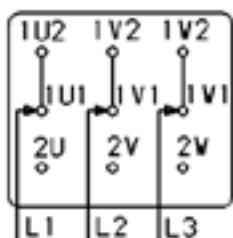
GEAR 2 $2p=2(4)(6)$

Connection in a YY

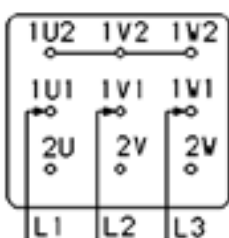


5. 3-phase dual-speed motors (nine terminals), for example $2p=4/2, 8/4$:

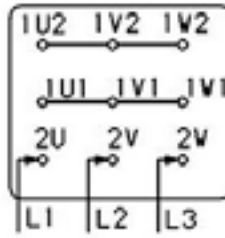
Connection in a Δ



Connection in a Y

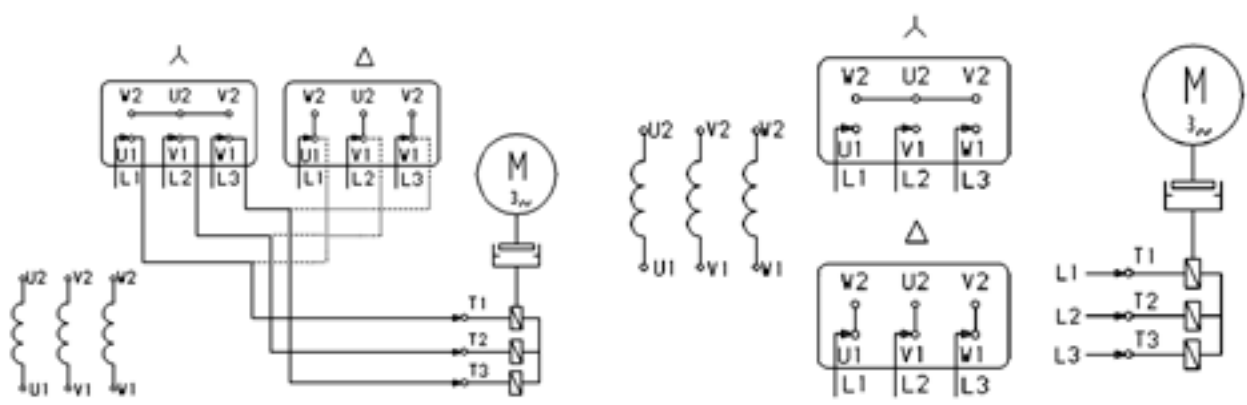


Connection in a YY

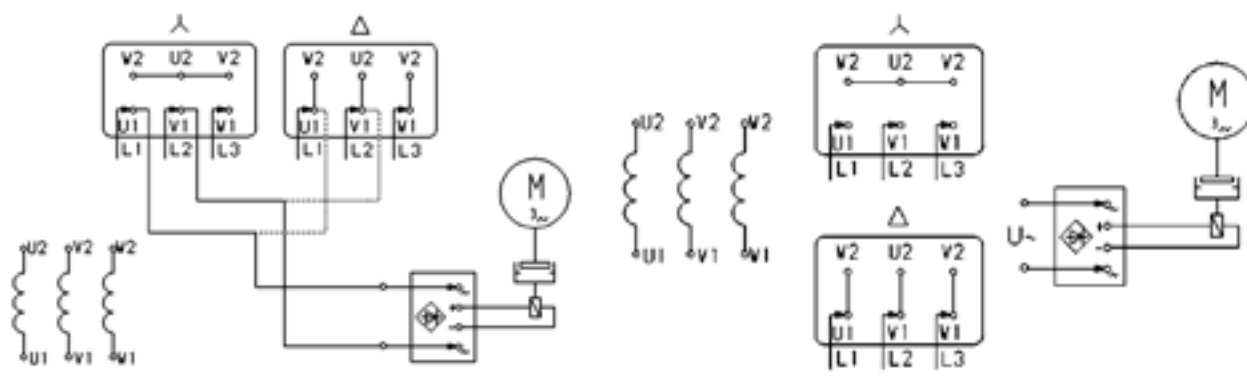


ATTENTION! Do not supply power to the external cooling or the brake using the frequency converter.

6. 3-phase single-speed motors:



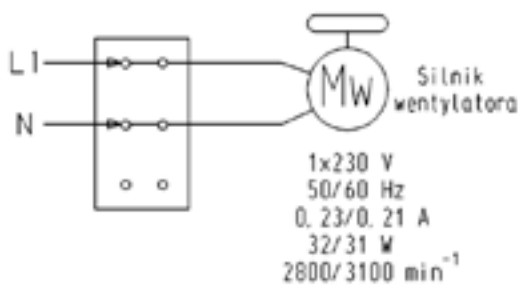
a) with an AC brake b) with an independently powered AC brake



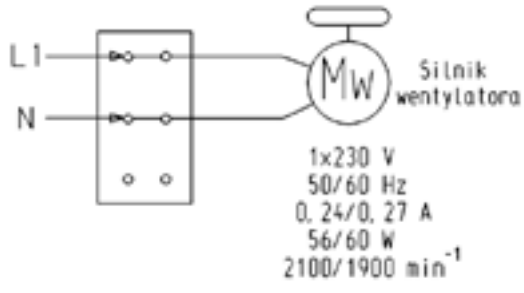
c) with a DC brake d) with an independently powered DC brake

7. Diagram of supplying power to external cooling – in standard versions, motors have a separate external cooling box.

Motor mechanical size 90÷112



Motor mechanical size 132÷180



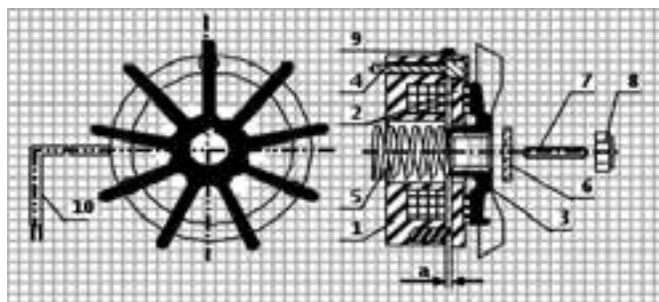
Attachment no. 5. Disk brakes type H, HPS and H(Z,Y)g.

1. Construction and principle of operation

a) type H brake

The electromagnetic DC brake type „H” consists of 3 main units: the electromagnet (1), the armature (2) and the cast iron fan (3).

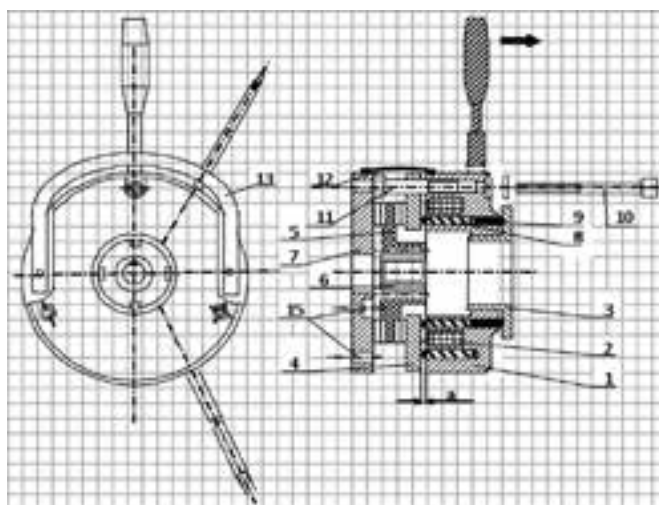
Switching on the electromagnet (1), supplying direct current from the motor through the rectifying circuit causes the armature (2) to be shifted, with a simultaneous release of the fan (3) and the brake is released. Switching off the electromagnet (1) causes the armature to be moved (2) through the springs until the torque is created and the brake lining is pressed against the ventilator. The brake is immobilized (halted).



b) HPS type brake

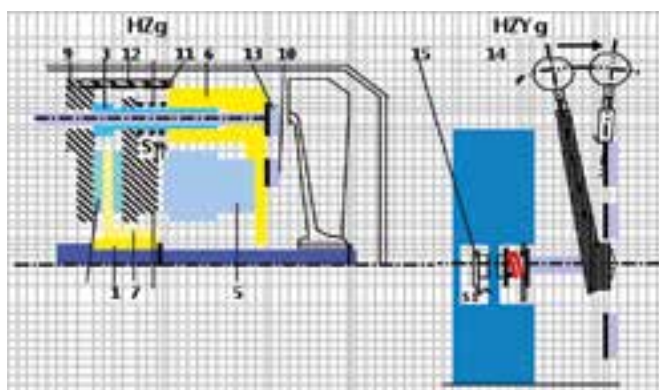
The construction of the brake is presented in the drawing. When no current is fed to the coil (2), the brake disk (5) with friction lining is pressed by the armature (4) to the mounting disk (5) or directly to the surface of the given device with the force of the springs (8), the brake is then in the 'on' state (it is braking). The braking torque is transferred by the brake disk (5) to the gear (6) located on the motor's shaft, or the device mated to the brake, protected from axial displacement with a spring clip. The torque size can be adjusted by screwing in the nut (3) or reducing the number of springs.

Direct current fed to the electromagnet's winding (2), through its excitation, causes the armature to be shifted ($a=0$), at the same time eliminating the pressure of the springs on the armature and the brake disk (5). The brake is released. If no voltage is present or a damaged electromagnet in the brake with a hand-release lever, it is possible to release the brake by moving the lever. Releasing the pressure on the lever causes its return and repeated braking. Adjustment screws (11) set the distance between the electromagnet and the mounting disk (5) or the motor's bearing brackets, regulating the size of the air gap. HPS type brakes are mounted to the motor's bearing brackets using clamping screws (10). The air gap „a” is factory set to the rated value; as the brake disk gets worn, the depth of the clamping screws' drive (11) is increased by the size of performed adjustments.



H(Z,Y)g type brake

The brake disk (7) has two friction linings (8) located between the mounting disk (9) and the armature (2). In brakes designed to be mounted directly to the motor's bearing bracket, or to the mated device, it serves the role of the second friction surface for the brake disk. Force caused by the pressure of the springs (4) acts on the armature, which is transferred to the brake disk (7) causing it to rub against the armature and the mounting disk, causing a braking torque this way. The size of the torque can be changed by reducing the number of springs. Alternating current fed to the electromagnet's winding (5) causes the $S = 0$ armature to be shifted, eliminating the pressure of the springs on the armature, releasing the brake. In case of brakes with a lever (14) it is possible to manually release the brake by moving the lever; releasing the pressure causes it to automatically return to the starting position and repeated braking. Adjustment screws (3) screwed into the bearing ring (6) set the distance of the electromagnet to the face surface of the mounting disk (motor's bearing bracket), setting the air gap S value.



Brakes are clamped using 3 screws (13) spaced every 120 degrees, and 3 screws (10) connect the brake's elements with the mounting disk. In case of a brake without the mounting disk, its assembly is done using 6 screws spaced every 60 degrees.

A rubber band (12), sealing the brake is placed on the brake's cover (11), which has openings allowing for adjusting the air gap. In new brakes, the air gap is set to the value S_{nom} . As the brake disk's friction lining gets worn with use, its value cannot exceed the value of S_{max} . Exceeding the maximum value will reduce the braking effect by lowering the braking torque which can cause damage to the electromagnet, which may fail to shift the armature and release the brake due to the exceeded maximum value of the air gap. Therefore it is necessary to adjust it by setting the s_{nom} value.

S_{nom} .. Maximum friction lining wear is 3 mm per side, which allows for multiple adjustments of the air gap. As the wear of the lining increases, the depth of clamping screws drive also increases (10) and (13), and with worn out lining it can reach 6 mm.

2. Assembly and disassembly of the brake

a) type H brake

A condition of correct functioning of the brake is to maintain perpendicularity of the surface on which the brake rests, in relation to the motor's axis.

Mounting the brake on the motor with an adapted bearing bracket and motor's shaft takes place using three clamping screws (4), spaced $3 \times 120^\circ$. Next, the shaft is put on the central spring (5), which is rested on the bearing's inner ring. Tightly screw in the clamping screw (7) to the motor's shaft and put on the fan (3), which is led on the internal diameter and a key channel.

Put the special washer (6) on the fan (3) and the clamping screw (7), and tighten the nut self-locking (8) until a 0.2 air gap is set (see chart 1).

Put on the gasket ring (9) between the frame (electromagnet (1)) and armature, then cover the brake with the motor's cover.

Chart 1

TYPE	H-63	H-71	H-80	H-90	H-100	H-112	H-132	H-160
rated gap „a”	0,2 ±0,05	0,2 ±0,05	0,2 ±0,05	0,2 ±0,05	0,2 ±0,1	0,2 ±0,1	0,2 ±0,1	0,2 ±0,1

b) HPS type brake

Brakes are very simple to assemble. Mount the gear (6) on the shaft and secure from axial displacement with a spring clip. After putting the brake disk (5) on the gear, mount the brake using clamping screws (10) to the motor's bearing cover, mounting plate (7) or wall of the mated device. If the brake has blocking elements (14), they should be removed after mounting the brake. Check the air gap „a” value, which should be equal to the „a nom” value listed in chart 2. In case of finding a discrepancy, adjust the gap as described in paragraph 3. Put on the brake cover.

Disassembly should be done in reverse order.

Chart 2

TYPE	HPS06	HPS08	HPS10	HPS12	HPS14	HPS16	HPS18	HPS20	HPS25
a nom.	0,2 ±0,05	0,2 ±0,05	0,2 ±0,05	0,3 ±0,05	0,3 ±0,05	0,3 ±0,05	0,3 ±0,05	0,3 ±0,05	0,3 ±0,05
a max.	0,5	0,5	0,5	0,7	0,8	1,0	1,0	1,2	1,4

c) H(Z,Y)g type brake

H(Z,Y)g brakes are very simple to assemble. Mount the gear (1) on the shaft and secure from axial displacement with a spring clip. After putting the brake disk (7) on the gear, mount the brake using clamping screws to the motor's bearing bracket or wall of the mated device. Use cast iron or steel as the friction surface. In case of difficulties creating a friction surface on the mated device, use a mounting plate (9).

Check the correctness of assembly, the air gap value, which guarantees a correct work of the brake; connect the brake to the mains, or a mated electric motor.

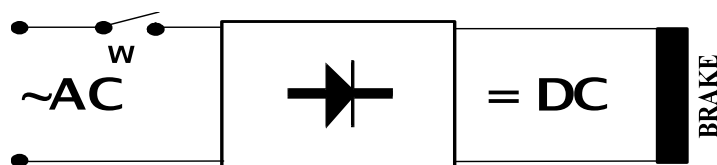
Disassembly of the brake should be done in reverse order.

3. Electric connection system

a) H type brake and HPS type brake

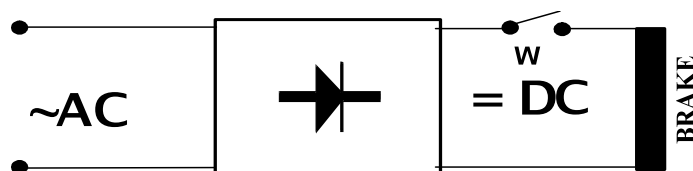
When the DC brake needs to be connected to an AC source, two rectifying circuits are used. The attachable coil of the brake's electromagnet circuit can be detached on the direct or alternating current side.

- SWITCHING OFF ON THE ALTERNATING CURRENT SIDE



When switching off the voltage, the magnetic field causes that the coil's current flows through the rectifying diode and falls slowly. Magnetic field is reduced gradually, which causes a lengthened period of the brake's operation, which means a delayed increase of the braking torque. If the working time is insignificant, the brake should be connected on the alternating current side, since no other protection for the coil and the contacts is needed. When being switched off, supply circuits act as unidirectional diodes.

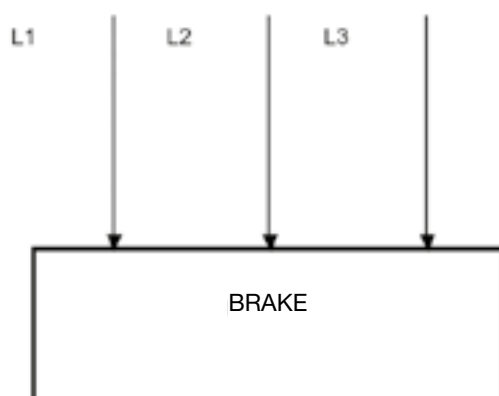
- SWITCHING OFF ON THE DIRECT CURRENT SIDE



Coil's current is broken between the coil and the power supply (rectifying) circuit. Magnetic field is reduced very quickly, brake's operation time is short, in consequence, the braking torque increases quickly. When tripping on the side of direct current in the coil, high peak voltage is generated causing faster wearing out of contacts due to sparking. In order to protect the coil against peak voltage and to protect the contacts from excessive wear, the rectifying circuits have protection allowing to connect the brake on the direct current side.

b) H(Z,Y)g type brake

Connecting the brake is done according to the above drawing.



4. Adjustment of the air gap

a) HPS type brake

Air gap „a” increases as a result of the brake disk (5) wearing out. The appropriate initial „a nom.” value of the gap can be restored by screwing in the adjustment screws (11) into the frame (1). When adjusting, loosen the clamping screws (10), use a gap gauge inserted between the armature and the frame by screwing in the adjustment screws (11), set the air gap to the rated value. Tighten the clamping screws (10) – total stiffening of the attachment point is achieved by countering it with adjustment screws, meaning by unscrewing them to the limit with the mounting plate of the surface of the mated device.

b) H(Z,Y)g type brake

Correct work of the brake is ensured when the S and S1 gaps have correct values.

Gap values:

$$S \text{ nom} = 0.4 \text{ mm}$$

$$S \text{ max} = 1.4 \text{ mm}$$

$$S 1 = 2 \text{ mm}$$

In case of exceeding the listed S max value, adjust the air gap immediately. In order to do this:

- remove the rubber band (12),
- loosen the screws (10) and (13) clamping the brake, unscrewing them half a turn,
- through openings in the cover (11), tighten the adjustment screws (3) to the bearing ring (6) by about 2 mm
- place a gap gauge with thickness of S nom +/- 0.05 mm in the gap between the electromagnet's core (5) and the armature (2).
- using clamping screws, press the core to the armature so that the gap gauge can be taken out with little resistance and with the same resistance insert it in gaps every 120 degrees from the place of initial measurement,
- unscrew adjustment screws so they rest on the mounting plate or the motor's bearing bracket, or another mated device,
- tighten the brake's clamping screws and check the size of gap S,
- in brakes with a manual release lever (14), self-locking nuts (15) must be set so that their distance from the armature plate S 1=2mm is maintained when the armature is shifted, i.e. when S = 0.

5. Periodic inspections

Each brake being used should be inspected at least once a year.

The work period, after which an inspection is required, depends on the intensity of motion and are listed in regulations for individual devices, for example for crane devices.

During the inspection (after removing the rubber band and the brake cover):

- remove dirt which has collected in the brake's interior,
- check the size of the gap using a gap gauge:
 - a) type H brake; adjust the air gap to the value listed in chart 1, using a self-locking nut (8).

The adjustment can be performed many times, until the brake lining is worn out. When the brake lining is completely worn out, replace the armature with the brake lining (2) for new ones;

b) HPS type brake; check the gap in accordance with paragraph 4 a) and chart 1; c) type H(Z,Y)g brake; S1 between the armature and castellated nuts. The sum of the measured gaps S + S 1 (in braking state) should amount to 1.8-2 mm; adjust if needed;

- perform few braking tests, check the effectiveness of braking.

If significant decrease in the effectiveness of braking is noticed in relation to the initial state, the brake should be disassembled in order to check the condition of friction lining, tracks and springs.

When the brake disk achieves its maximum wear, it should be replaced for a new one (the lining's working surface has levelled out with the aluminium bearing element of the brake disk). When replacing the brake disk, make sure that the friction surface of the disk, the armature and the elements mated with friction lining are free from grease and oil.

If the brake, despite correct assembly and appropriate adjustment, does not work:

- the electromagnet has been damaged – the coil burned out, power lead damaged
- the rectifying circuit (installed in the motor's terminal box or machine's control cabinet) has been damaged
- check the correctness and quality of electric connections

- replace damaged elements for new ones.

Check the electric units mentioned above and replace damaged ones.

Attachment no. 6. External cooling parameters.

EXTERNAL COOLING FAN SPECIFICATION

Motor size	Rated voltage	Frequency	Rated current	Input power	Speed	Air flow	Noise level	Type of protection
	[V]	[Hz]	[A]	[W]	[min ⁻¹]	[m ³ /min]	[dB]	
90/100/112	1 x 230	50/60	0,23/0,21	32/31	2800/3100	5,40/6,60	50/55	Impedance protection
132/160/180	1 x 230	50/60	0,24/0,27	56/60	2100/1900	24,0/21,8	57/55	Thermal protection

- surrounding temperature from -20 to +80[°C],
- installation height up to 1000 [m] above sea level,
- life span – 50 000 h in 25°C temperature,
- insulation class B,
- motor protection
- – thermal protection – automatic motor switch-off after achieving winding temperature of 110°C, automatic switch-on after the temperature decreases to 70°C,
- – impedance protection – motor can operate in abnormal conditions, such as rotor lockup.
- protection rating IP 55,
- ball bearings.



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