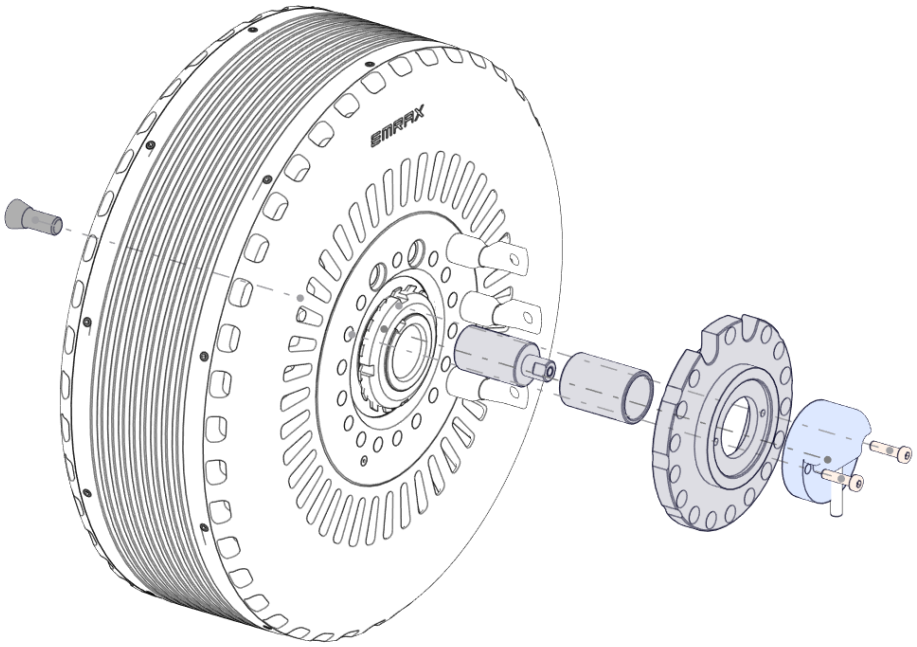
EMRAX d.o.o.
Molkova pot 5
1241 Kamnik
Slovenija, EU

INNOVATIVE E-DRIVES

Motor Installation and Maintenance Manual



For additional information's turn to: *support@emrax.com*

Notes:

Contents

1. General information

1.1. How to properly use this manual

This installation and maintenance manual has been written to assist the user with proper procedures when handling, installing, operating, and maintaining the equipment. All the safety warnings and instructions in this book must be followed to prevent injury to personnel.
This manual must be kept for future reference during installation, operation, and maintenance.

1.2. Safe motor operation information

WARNINGS: High voltage and rotating parts can cause serious or fatal injuries. Qualified personnel should perform installation, operation, and maintenance of electrical machinery. For equipment covered by this instruction book, it is important to observe safety precautions to protect personnel from possible injury. Be sure to keep the installation and maintenance information for future reference. All warning and cautions must be followed.

Installation
• Avoid contact with energized circuits and rotating parts.
• Avoid bypassing or rendering any inoperative safeguards or protective devices.
• Avoid use of automatic-reset thermal protection where unexpected starting of equipment might be hazardous to personnel.
• Avoid contact with capacitors until safe discharge procedures have been followed.
• Be sure the motor shaft key is captive before the motor is energized.
• Avoid long exposure near machinery with high noise levels.
• When the motor is coupled to equipment, ensure that system vibrations are within acceptable limits (per ISO 10816-1) to avoid failure of the motor.
• Use proper protective gear, care, and procedures when handling, lifting, installing, operating, and maintaining the motor.
• If eyebolts are used for lifting motors, they must be securely tightened, and the direction of the lift must not exceed a 15° angle from the shank of the eyebolt.
• Do not use the motor shaft as a means for lifting.
• Do not lift both the motor and driven equipment with the motor lifting means.
• Do not stand on or place objects on the motor.

Maintenance
Safe maintenance practices performed by qualified personnel are imperative. Before starting maintenance procedures, be positive that:
• Equipment connected to the shaft will not cause mechanical rotation.
• Main motor windings and all accessory devices associated with the work area are disconnected from electrical power sources.
• The motor has been given time to cool down.

Failure to properly ground the frame of the motor can cause serious injury to personnel. Grounding should be in accordance with National and local Standards and consistent with sound practice.

These instructions do not purport to cover all the details in motors nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired, or should problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to EMRAX directly.

1.3. EMRAX motors

EMRAX motors are **Outrunner Axial Flux Brushless Permanent Magnet Synchronous Motors (AFM, PMSM)**. The motors require an **Electronic Speed Controller (ESC),** which transforms DC current from a DC power supply into a precisely synchronized **(Field Oriented Control - FOC)** AC current delivered to the motor's 3 (or 2 x 3) phases. Literature often uses the term "BLDC motor" when referring to EMRAX motors, especially when more primitive forms of control are implemented. The rotor is located on the outside (coloured black in all Figures), which enables higher torque density and easier cooling of the rotor, hence outrunner.

Back side of the motor is defined as the side where the phase connections and cooling pipes are located, while the opposite side is the front side of the motor.

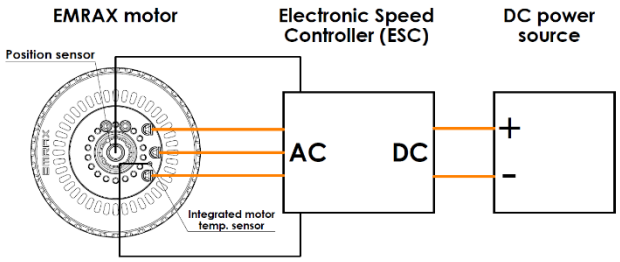


Figure 1: Simple schematic including key electric powertrain components

1.4. Intended use

Electrical motor will convert electrical energy into mechanical rotating energy or vice versa. Its most common usage is found in aviation, marine and traction application (mainly motorsport), but not limited to. The motors can also be used for energy recuperation. If your intended use differs from standard applications seen on company website, please contact EMRAX support about its appropriate usage.

1.5. Operating ceiling

The electric motor can operate in ambient temperatures between -40 to +60ºC. The maximum motor temperature allowed as recorded by internal temperature sensor is 100ºC, maximum allowed temperature of any motor part (integrated temperature indicators) is 120 ºC.

See motor technical tables for continuous and peak power ratings.

The maximum service ceiling is 6500 m (21,300 ft).

1.6. Description of nameplate

Motor rating and identification data are furnished on labels and nameplates. Nameplates provide a permanent record of motor characteristics, plant identification and date of manufacture. Below is an example of a label that is found on each motor:

268 – Motor type (188, 208, 228, 268, 348)

MV – Voltage version of the motor
(LV - low voltage, MV - medium voltage, HV - high voltage)

1025 – Serial number of the motor

23 – Year of production (23-2023)

IP66 – IP rating

Take a picture or write down the data from the nameplate to not lose the information in case the nameplate gets damaged.

1.7. Serial number

Every motor that is manufactured by EMRAX has a model and a serial number, which are permanently marked on the motor nameplate. When contacting EMRAX please provide the serial number and configuration of the motor.

1.8. Delivery

Prior to shipment, all motors are factory-tested and balanced. They are wrapped in protective wrap and packed in boxes or bolted to a wooden base. Upon receipt, we recommend careful handling and a physical examination for damage which may have occurred during the transportation.

In the event of damaged goods, notify EMRAX support (**support@emrax.com**) with picture evidence, without delay, in order to obtain insurance coverage.

1.9. Storage

When motors are not immediately installed, they should be stored in a dry, temperature-controlled place, free of dust, gasses, and corrosive atmospheres. Other objects should not be place on or against them. Motors stored over long periods are subject to loss of insulation resistance and oxidation of the bearings.

Bearings deserve special attention during prolonged periods of storage. Depending on the length and conditions of storage it may be necessary to change rusted bearings. The weight of the rotor in an inactive motor tends to expel grease from between the bearing surfaces thereby removing the protective film that impedes metal-to-metal contact. As a preventive measure against the formation of corrosion by contact, motors should not be stored near machines which cause vibrations, and every 3 month their shafts should be rotated manually. Check the motor for smoothness of operation before first start, if necessary, contact EMRAX support.

Insulation resistance fluctuates widely with temperature and humidity variations and the cleanliness of components. When a motor is not immediately put into service it should be protected against moisture, high temperatures and impurities, thus avoiding damage to insulation resistance.
If the motor has been in storage for more than six months or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with an insulation tester.
If the resistance is lower than 1 GΩ the windings should be dried in one of the two following ways:

1) Dry the motor in oven at temperatures not exceeding 90 ºC until insulation resistance becomes constant.

2) With rotor locked, apply low voltage, and gradually increase current through windings until temperature measured with thermometer reaches 90 ºC. Do not exceed this temperature.

If the motor is stored for an extensive period, the rotor must be periodically rotated. In case the ambient conditions are very humid, periodical inspection is recommended during storage.

When storing the motor, please ensure that the motor is covered, so as not to permit any metal particles or dust to collect inside the motor. This is especially important when dealing with either the air (AC) or combined (CC) cooled motor.

1.10. Handling

Raising and moving of the motors should be steady and jointless, otherwise bearings may be harmed. Motor connectors, moving parts or cables, should not be used to lift the motor. The motor should be lifted by a sling around the rotor, or via an X-bracket attached to it. Take care, not to damage the sensors or connectors during manipulation.

When dealing with a motor, with a weight over 25 kg, please use lifting accessories (cranes, fork lifts,…).

In case of unbalanced loads (such as couplings or other attachments), additional slings or other effective means should be used to prevent tipping.

2. Position sensor mounting

Position sensor is required for most applications. EMRAX offers a variety of different positioning sensors that can be supplied together with the motor. This chapter will cover their installation. The specific type of positioning sensor required is determined by the ESC manufacturer. Please turn to their respectful manufacturers to get the required info on wiring, shielding and colour codes.

2.1. RLS RM44 encoder installation

Required parts:

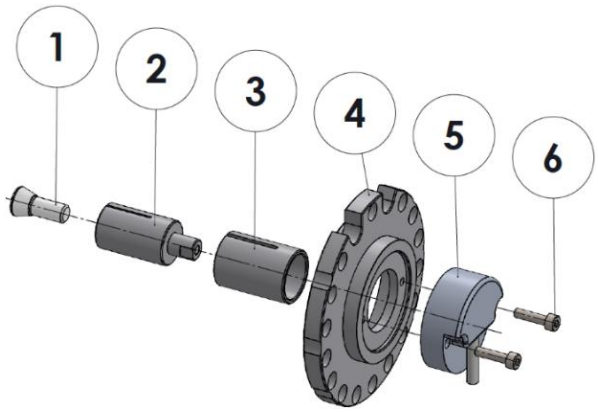


Figure 2: Required mounting parts

Description	Note	ID	Qty.
Tapered bolt	/	1	1
Encoder magnet set	/	2	1
Adapter	268, 348 only	3	1
Encoder bracket	/	4	1
RLS RM44 encoder	/	5	1
M4x16 bolt	/	6	2

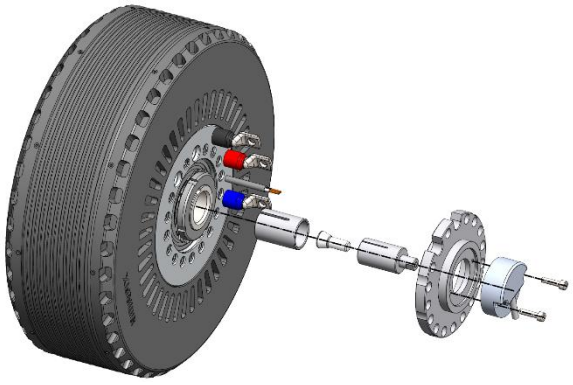


Figure 3: Encoder assembly

1. Place the adapter (3) inside the motor shaft (this step is only required for the 268 and 348 motor types). Before inserting the part use threadlocker glue on the faces, where the parts are mated.
2. Insert the tapered bolt (1) into the encoder magnet set (2) and lightly tighten it. Using threadlocker glue supplied with the kit on the threads is recommended.
3. Insert the encoder magnet set (2) into the backside of the motor (as shown on *Figure 3* – magnet facing outwards), inside the motor shaft. Before inserting the part use threadlocker glue on the faces, where the parts are mated.
4. Mount the encoder bracket (4) on the back of the motor (as shown on *Figure 3*). Make sure that it is seated in its position, if necessary, use temporary bolts to tighten it to the motor (If the motor is liquid or combined cooled, please make sure that the coolant fittings are inserted, before mounting the encoder bracket, please refer to 3.5).
5. Align the encoder magnet set (2) to the sensor mounting flange (see Figure 4, highlighted in blue) of the encoder bracket (4).

Use an object with a flat face and make sure that the encoder magnet and the mounting face of the bracket are perfectly colinearly (in same line) aligned.

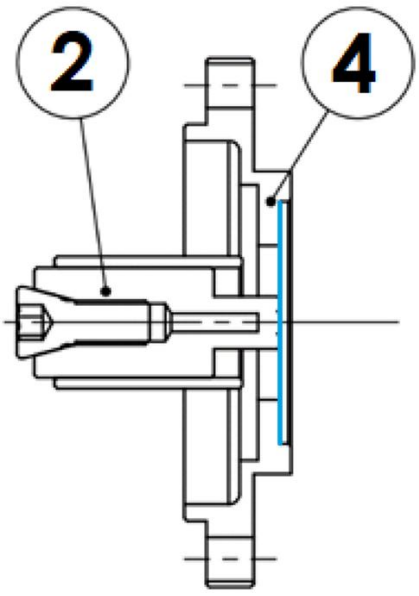


Figure 4: Magnet alignment

6. Tighten the tapered bolt (1).
7. Mount the RLS RM44 encoder (5), to the mounting flange of the encoder bracket (4). Use the supplied M4x16 bolts (6), to mount the encoder. Using threadlocker glue on the threads is recommended.

Thread (Metric)	Recommended Torque [Nm]	
	Dry	Lubed
M4x0.7	4	3
M6x1	16	13
M8x1.25	40	32

2.2. TAMAGAWA resolver installation

Required parts:

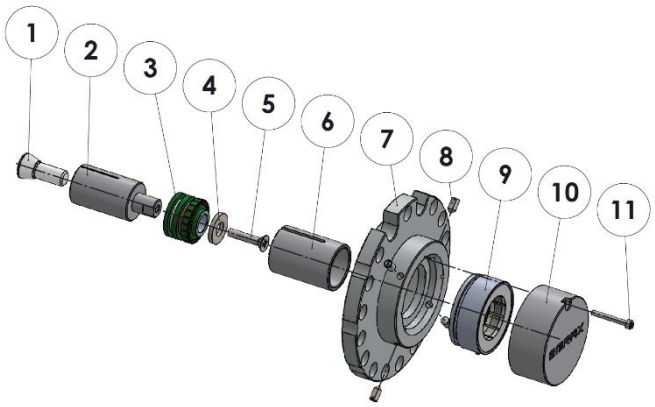


Figure 5: Required mounting parts

Description	Note	ID	Qty.
Tapered bolt	/	1	1
Rotor holder	/	2	1
Resolver rotor	/	3	1
Washer	/	4	1
M4x20 bolt	/	5	1
Adapter	268, 348 only	6	1
Resolver bracket	/	7	1
DIN914 set screw	/	8	4
Resolver stator	/	9	1
Resolver cover	/	10	1
DIN912 M2.5x20 bolt	/	11	1

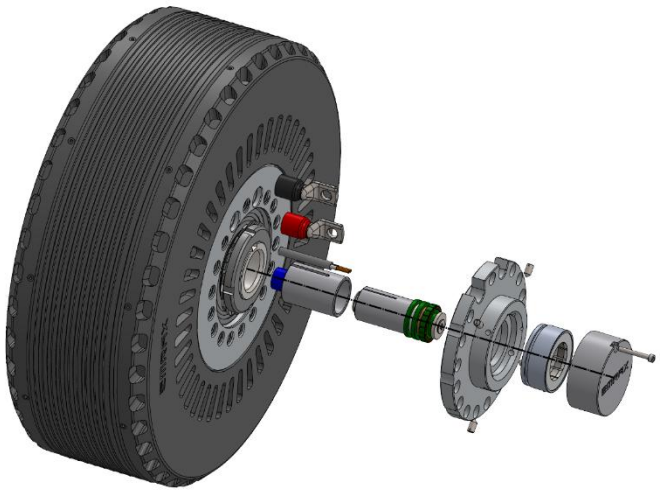


Figure 6: Resolver assembly

1. Place the adapter shaft (6) inside the motor shaft (this step is only required for the 268 and 348 motor types). Before inserting the part use threadlocker glue on the faces, where the parts are mated.
2. Assemble the rotor of the resolver. Start by applying threadlocker glue on the mating surfaces of the resolver rotor (3) and rotor holder (2) and pressing the parts together. Then insert the tapered bolt (1) into the rotor holder (2) and lightly tighten it. Using threadlocker glue supplied with the kit on the threads is recommended. Continue by screwing the resolver rotor (3) onto the rotor holder (2) by using the washer (4) and bolt (5) supplied with the kit.

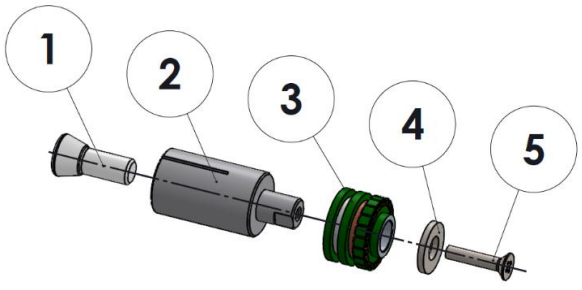


Figure 7: Resolver rotor assembly

3. Insert the rotor assembly into the backside of the motor, inside the motor shaft (as shown on *Figure 6*). Before inserting the part use threadlocker glue on the faces, where the parts are mated.
4. If case of liquid or combined cooled motor, insert the coolant fittings into the stator (please refer to *Chapter 3.6.)*. Mount the

resolver bracket (7) on the back of the motor. Make sure that it is seated in its position, if necessary, use temporary bolts to tighten it to the motor.

5. Mount the resolver stator (3) to the mounting flange of the resolver bracket (7). While holding the resolver stator (9) down, use DIN 914 set screws (8) to bolt it down from the side. Using threadlocker glue supplied with the kit on the threads is recommended.
6. Make sure all the highlighted surfaces (blue) in *Figure 8* are aligned in one plane.

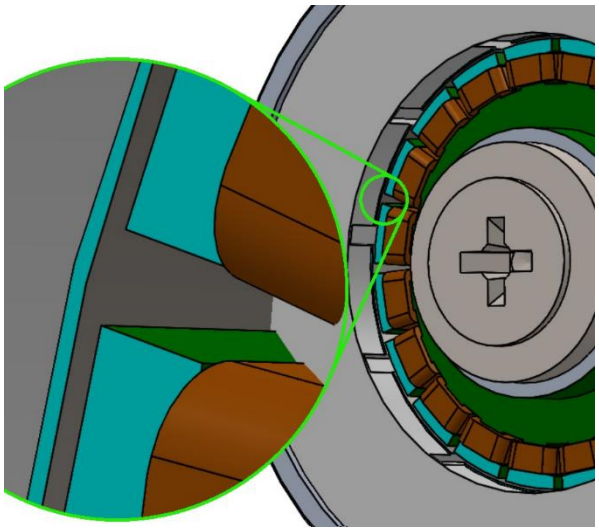


Figure 8: Resolver rotor alignment

7. Tighten the tapered sensor bolt (1).
8. Mount the resolver cover (10) on the back of the resolver stator (9). Use threadlocker glue on the faces, where the parts are mated. Use M2.5x20 bolt (11) to secure it in place. Apply theadlocker glue on the threads.

Thread (Metric)	Recommended Torque [Nm]	
	Dry	Lubed
M2.5x0.45	1.5	1
M4x0.7	4	3
M6x1	16	13
M8x1.25	40	32

2.3. TAMAGAWA tandem resolver installation

Required parts:

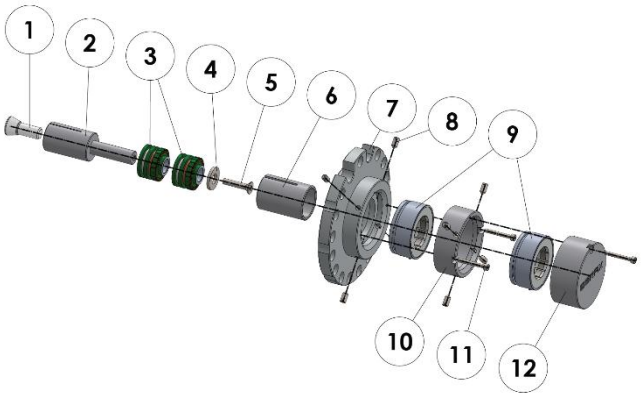


Figure 9: Required mounting parts

Description	Note	ID	Qty.
Tapered bolt	/	1	1
Rotor holder	/	2	1
Resolver rotor	/	3	2
Washer	/	4	1
M4x20 bolt	/	5	1
Adapter	268, 348 only	6	1
Resolver bracket	/	7	1
DIN 914 set screw	/	8	8
Resolver stator	/	9	2
Tandem bracket	/	10	1
DIN912 M2.5x20	/	11	3
Resolver cover	/	12	1

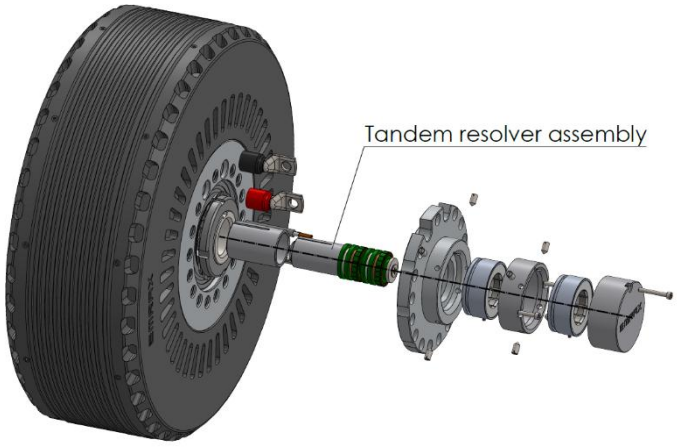


Figure 10: Tandem resolver assembly

1. Place the adapter shaft (6) inside the motor shaft (this step is only required for the 268 and 348 motor types). Before inserting the part use threadlocker glue on the faces, where the parts are mated.
2. Assemble the two rotors of the resolver. Start by applying threadlocker glue on the mating surfaces of the resolver rotor (3) and rotor holder (2) and pressing the parts together. Then insert the tapered bolt (1) into the rotor holder (2) and lightly tighten it. Using threadlocker glue supplied with the kit on the threads is recommended. Continue by screwing the resolver rotor (3) onto the rotor holder (2) by using the washer (4) and bolt (5) supplied with the kit.

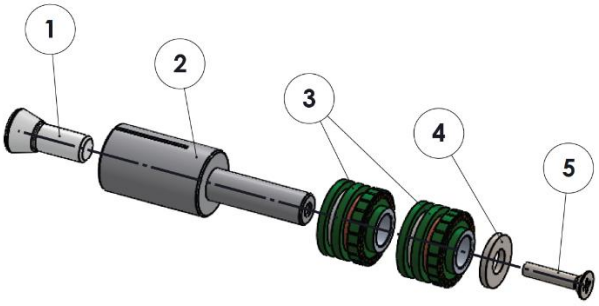


Figure 11: Tandem resolver rotor assembly

3. Insert the rotor assembly into the backside of the motor, inside the motor shaft (as shown on *Figure 10*). Before inserting the part use threadlocker glue on the faces, where the parts are mated.
4. If case of liquid or combined cooled motor, insert the coolant fittings into the stator (please refer to *Chapter 3.6.).* Mount the resolver bracket (7) on the back of the motor. Make sure that it is seated in its position, if necessary, use temporary bolts to tighten it to the motor.
5. Mount the first resolver stator (9) to the mounting flange of the resolver bracket (7). While holding the resolver stator (9) down, use DIN 914 set screws (8) to bolt it down from the side. Using threadlocker glue supplied with the kit on the threads is recommended.
6. Make sure all the highlighted surfaces (blue) in *Figure 12* are aligned in one plane.

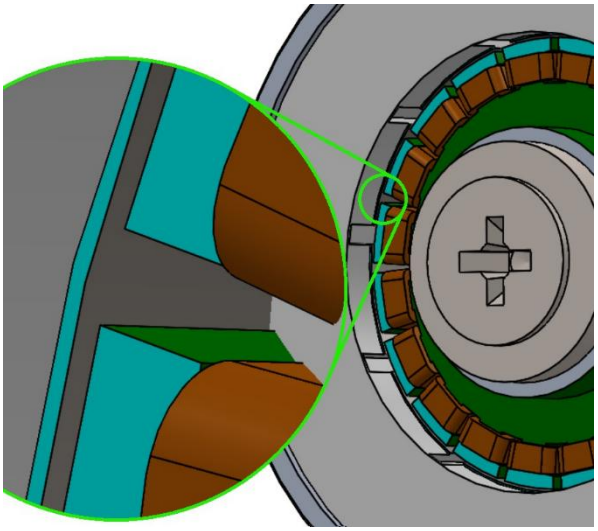


Figure 12: Resolver rotor alignment

7. Tighten the tapered sensor bolt (1).
8. Mount the tandem bracket (10) to the first resolver stator (9). Bolt it down with the supplied DIN912 M2.5x20 bolts (11). Using threadlocker glue supplied with the kit on the threads is recommended.
9. Mount the second resolver stator (9) to the mounting flange of tandem bracket (10). While holding the resolver stator (9) down, use DIN 914 set screws (8) to bolt it down from the side. Using threadlocker glue supplied with the kit on the threads is recommended.
10. Mount the resolver cover (12) on the back of the resolver stator (9). Use threadlocker glue on the faces, where the parts are mated. Use M2.5x20 bolt (11) to secure it in place. Apply theadlocker glue on the threads.

Thread (Metric)	Recommended Torque [Nm]	
	Dry	Lubed
M2.5x0.45	1.5	1
M4x0.7	4	3
M6x1	16	13
M8x1.25	40	32

3. Motor installation

3.1. General space requirements

Electric machines should be installed to allow an easy access for inspection and maintenance. Should the surrounding atmosphere be humid, corrosive or contain flammable substances or particles, it is essential to ensure an adequate degree of protection. The installation of motors in environments where there are vapours, gases or dusts, flammable, or combustible materials, subject to fire or explosion, should be undertaken according to appropriate and governing codes, such as NEC Art. 500 (National Electrical Code) and UL-674 (Underwriters Laboratories, Inc.) Standards.

Under no circumstances can motors be enclosed in boxes or covered in a way which may impede or reduce the free circulation of ventilating air. The place of installation should allow for air renewal at a rate of **0.4 m³/min per 1 kW** of motor output power (please ensure that the ambient temperature of surrounding air remains stable during motor operation). The opening for the entry and exit of air flow should never be obstructed or reduced by conductors, pipes, or other objects.

See cooling details for each motor cooling type under Chapter 3.6.

3.2. Mounting the motor

The motor can be orientated in any direction and mounted with:

a) a factory X bracket (*Figure 13*) on a firm flat base with 4 bolts (highlighted in blue).

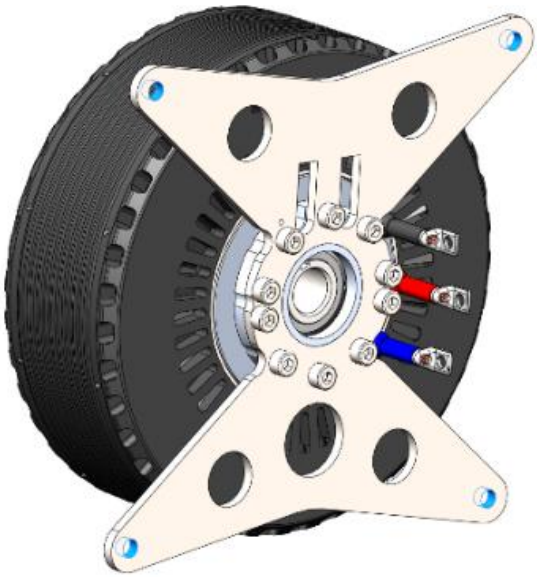


Figure 13: X bracket

b) a structurally equivalent or better custom mounting bracket through the back flange of the motor utilizing a stator-spacer or positioning sensor bracket supplied with the motor (*Figure 14*). Centering surfaces are highlighted in blue.

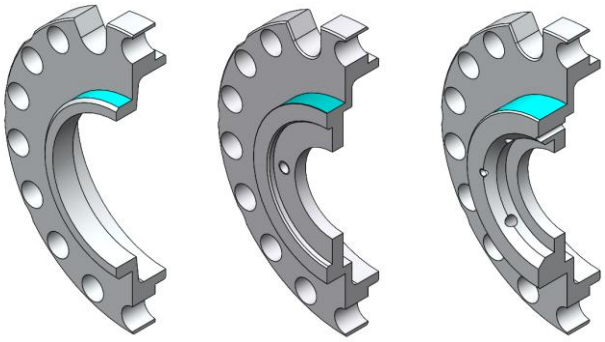


Figure 14: Left to right: Stator spacer, encoder bracket, resolver bracket

Figure 15: Mounting plate highlighted in blue

The table below shows the appropriate bolt length for mounting the motor. The given length tells us the length of the bolt protruding into the motor after the highlighted surface on *Figure 15* and *Figure 16.* Using a thread-locking adhesive and securing the bolts with a safety wire/wedge locking washers is advised. Bolts must be of grade 10.9. Use the below prescribed torques when bolting the motor.

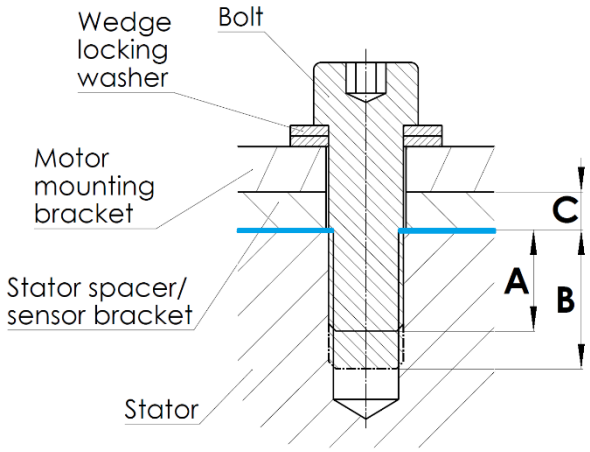


Figure 16: Bolt length definition, mounting plate highlighted in blue

Motor type	Thread (Metric)	Length of thread protruding into the motor [mm] (See *Figure 16*)		Recommended torque [Nm]	
		Min. **(A)**	Max. **(B)**	Dry	Lubed
188	M6x1	10	22	16	13
208	M8x1.25	16	22	40	32
228	M8x1.25	16	22	40	32
268	M8x1.25	16	22	40	32
348	M8x1.25	16	30	40	32

Motor type	Sensor bracket / Stator spacer flange thickness [mm] (see *Figure 16 – dimension **C***)
188	3
208	5,5
228	5,5
268	8,5
348	9

A minimum of 6 bolts, evenly spaced around the flange should be used. The bolts must be of grade 10.9.

Please make sure to not overload the motor bearings with excessive external forces. Additional supports of shafts connected to the motor may be necessary. In the table below you can find which bearings are used in each motor. For positioning of the bearings, please refer to CAD model found on our website or contact EMRAX support.

Motor type	Bearing	
	Front	Back
188	6205	3204
208	6206	3206
228	6206	3206
268	6208	3207
348	6210	3208

3.3. Motor output

Motor output options:

a) Motor flange on the front of the motor (standard shaft), see *Figure 17*.
b) Extended shaft with outer splines - ESO (optional) on the back of the motor, see *Figure 18*.

When using an extended shaft with outer splines, standard position sensor mounting kits are not compatible.

c) Both a) and b) simultaneously.

Figure 17: Option a), output surface highlighted in blue

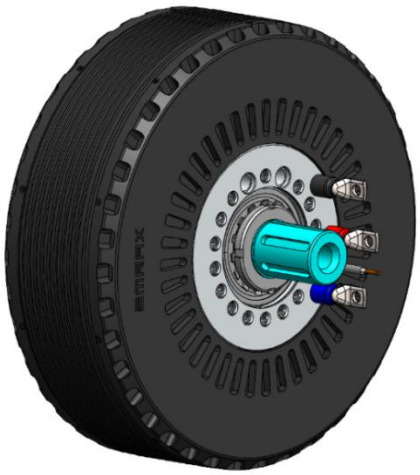


Figure 18: Option b), output surface highlighted in blue

When using the front side of the motor as an output, you can utilize:

a) A factory flanged shaft with inner splines (FSI), see *Figure 19*.

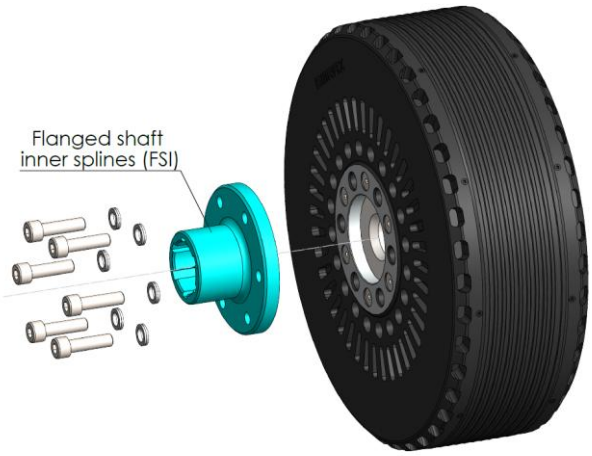


Figure 19: FSI assembly, FSI marked in blue

Use all 6 bolts (grade 10.9) and wedge locking washers included in the FSI package. Tighten in star pattern to torque specified in the table below.

Motor type	Bolt size and length (grade 10.9)	Torque [Nm]	Qty.	FSI flange thickness [mm]
188	M6x20	16	6	5
208	M8x25	40	6	7
228	M8x25	40	6	7
268	M10x30	75	6	10
348	M12x35	130	6	8

Bolt lengths apply only when considering the factory flanged shaft with inner splines (FSI) thickness.

b) **A custom flanged shaft. The flange thickness must be the same as the factory FSI (see table above). 6 bolts of grade 10.9 must be used to secure it to the motor. The bolts' length should match the specifications provided in the table above. Washers must be used with each bolt. Positive locking must be used to prevent loosening of bolts. We recommend using wedge locking washers. Use table above for torque specifications.**

Bolts must not protrude inside the motor. After installation, check for smoothness of rotation by turning the motor by hand.

If custom flanged shaft is used, it should be designed to align with the inner bore of the motor flange (see *Figure 17*, highlighted in blue). The tolerance of the shaft where in contact with the bore should be **g6**.

The electric motor should be accurately aligned with the driven machine. An incorrect alignment can cause bearing failure vibrations and even shaft rupture.

It is recommended to use a misalignment coupling between the motor and the driven shaft. In case of hybrid (ICE + EMRAX) applications, you must use an anti-vibration coupling.

The best way to ensure correct alignment is to use dial gauges placed on each coupling half:

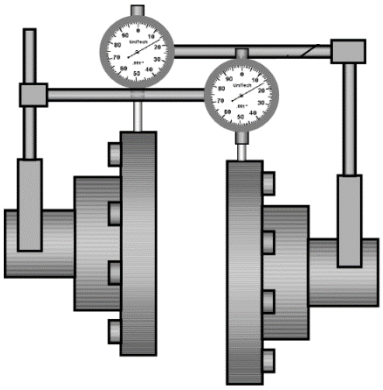


Figure 20: Alignment measurement

The space between coupling hubs should be maintained as recommended by the coupling manufacturer. Shaft offset should not exceed 0.03 mm. Angular misalignment should be less than that recommended by the coupling manufacturer. An alternative would be to use misalignment coupling that allows bigger offsets.

Hammers should be avoided during the fitting of shaft flanges or pulleys to the motor. The fitting with the aid of hammers leaves blemishes on the bearing faces. These initially small flaws increase with usage and can develop to a stage that completely impairs the bearing.

3.4. Windings

EMRAX motors have two general windings options:

a) 1 x UVW

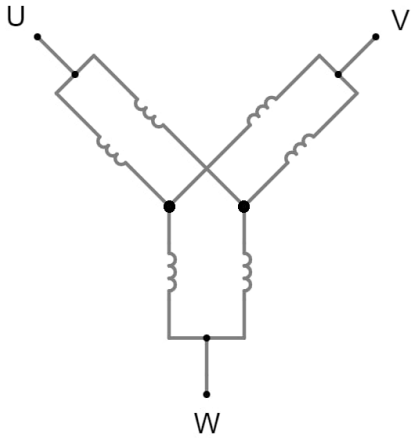


Figure 21: 1 x UVW windings electrical schematic

b) 2 x UVW

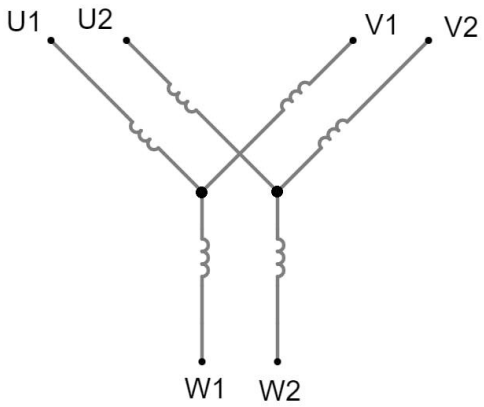


Figure 22: 2 x UVW windings electrical schematic

2 x UVW is usually utilized when either redundancy is needed, or when powering one motor with two less powerful ESCs, splitting the workload. 2 x UVW has two temperature sensors (see *Chapter 3.8.*).

Due to sensor positioning, the two temperature sensor will always read two slightly different temperatures. Always refer to the higher one.

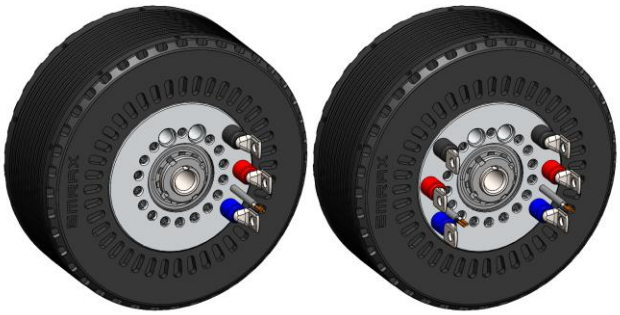


Figure 23: left – 1 x UVW, right - 2 x UVW (black – U, red – V, blue – W)

3.5. Twin motor assembly

Two identical EMRAX motors can be combined into a twin configuration.

> Only liquid cooled motors can be used to form a twin configuration.

Twin motor configuration consists of two motors:

- Motor with extended shaft (ESO) (front motor)
- Motor with standard shaft + addition of FSI (rear motor)

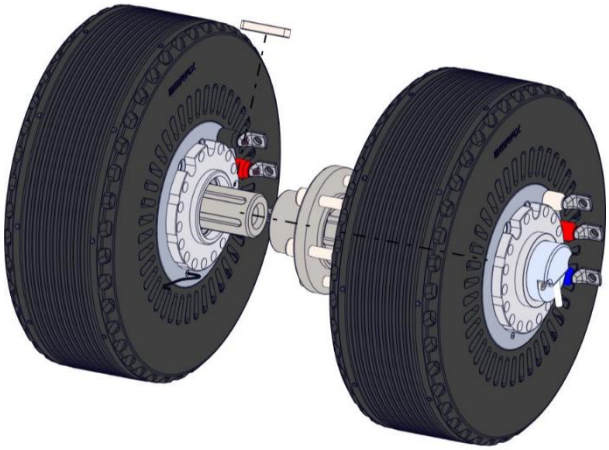


Figure 24: Twin assembly (left: front motor, right: rear motor)

Mounting the motors together:

1. Mount the FSI to the rear motor (see chapter 3.3.). After the FSI is secured to the motor, check for smoothness of operation.

2. Insert keys into key slots on the ESO shaft on the front motor.

Motor type	Key used (DIN 6885)	Qty.
188	A4x4x32	4
208	A5x5x40	6
228	A5x5x40	6
268	A6x6x40	6
348	A6x6x50	6

3. Slide the two motors together. It is prohibited to use excessive force or hammer during this step. The distance between the two motors (see *Figure 25*) must be as specified in the next table.

Motor type	Distance X [mm] (*Figure 25*)
188	52±1
208	58±1
228	56±1
268	57±1,5
348	63±2

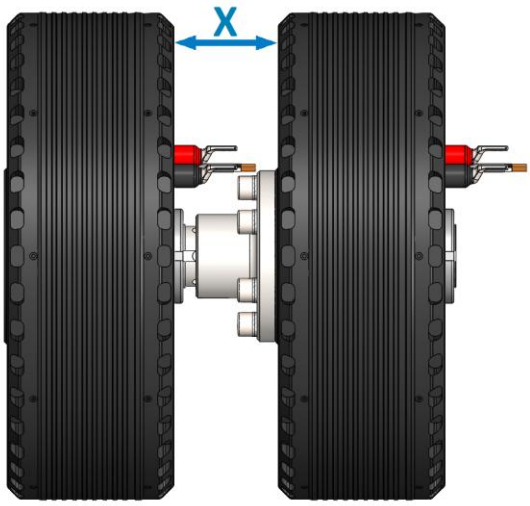


Figure 25: Distance between the motors

When sliding the two motors together, you must align the two EMRAX logos on the rotors as shown in *Figure 26*, highlighted in blue.

Figure 26: EMRAX logos alignment

Take note that it is only possible to use a positioning sensor on the rear motor. A single encoder with an encoder signal splitter device, that can then feed

multiple ESC's, or a tandem resolver configuration can be used.

If twin configuration will be ordered from factory, it will come mounted as seen on *Figure 27*.

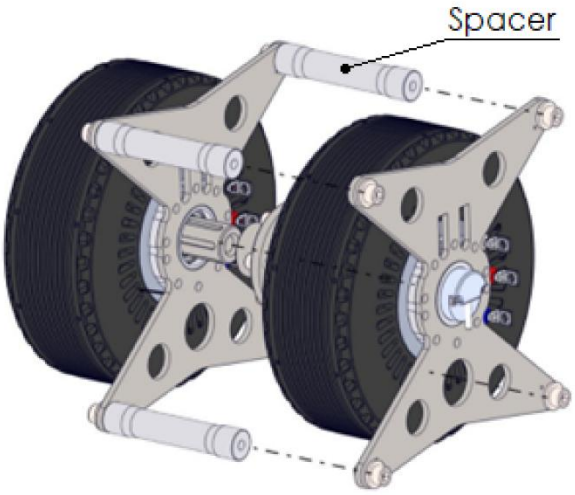


Figure 27: Twin assembly with accessories

The spacers seen in *Figure 27* are only for transportation purposes, they are **not** designed as a primary stress member.

Both motors must be secured (bolted) to the structure when using the twin configuration. Make sure that when bolting the two motors, you are not imposing any radial or axial force.

3.6. Motor cooling

Under no circumstances can motors be enclosed in boxes or covered in a way which may impede or reduce the free circulation of ventilating air. The opening for the entry and exit of air flow should never be obstructed or reduced by conductors, pipes, or other objects.

The maximum motor temperature recorded by internal temperature sensor **must never exceed 120ºC**. Power derating is recommended as needed to ensure the motor remains within the specified temperature limits.

EMRAX motors have three cooling options:

a) Air cooled (AC):

Stator and rotor are air cooled. Air cooled motors were originally designed for aviation applications, where there is a sustained velocity of air circulating the motor. **The parameters found in motor datasheets are measured with an unobstructed air flow speed of 20 m/s at 20 ºC.** When AC motors are exposed to lower air flow rate and/or higher ambient temperatures, continuous performance can decrease significantly. Please refer to EMRAX support on advice regarding your application.

IP21! Take care not to drop ferromagnetic particles into the motor through the cooling holes. Motor must be protected from small ferromagnetic and abrasive particles.

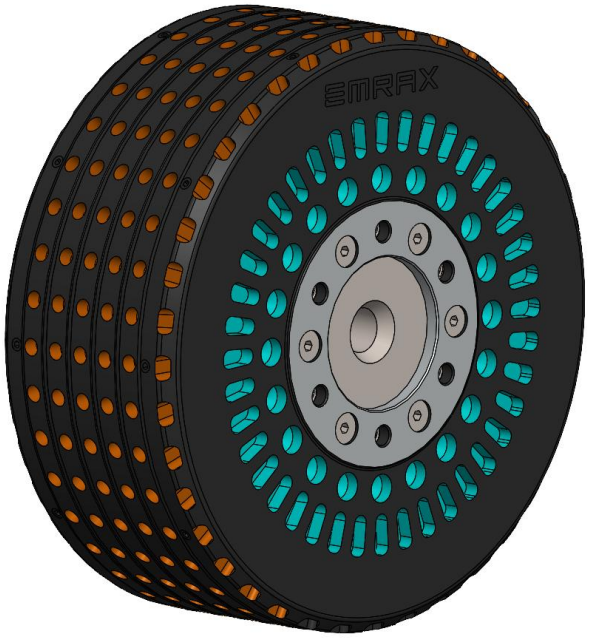


Figure 28: AC/CC motor front side, air cooling inlets (blue) and outlets (orange)

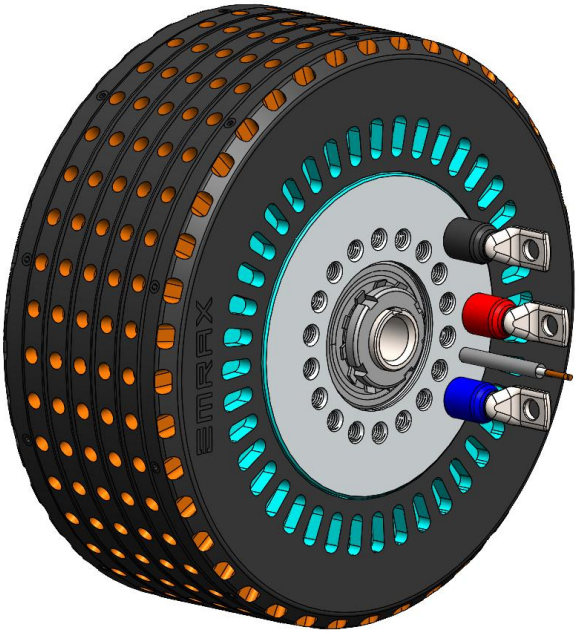


Figure 29: AC/CC motor back side, air cooling inlets (blue) and outlets (orange)

b) <u>Liquid cooled (LC):</u>

Stator is liquid cooled, rotor is partially air cooled. Approximately 1/3 of heat losses are dissipated through the air cooling of the rotor. The rotation of the rotor allows air to pass through, effectively cooling it.

The place of installation should allow for air renewal at a rate of **0.4 m^3/min per 1 kW** of motor output power (please ensure that the ambient temperature of surrounding air remains under 60°C during motor operation).

Figure 30: Rotor cooling vents on LC motor, blue inlets and orange outlets

Coolant needs to be supplied to the motor at rates given in the bellow table.

Motor type	Min./Max. flow rate [l/min]	Pressure drop at 6 l/min	Coolant volume inside motor [ml]	Coolant contact area [mm^2]
188	6/11	0.2 bar	80	44000
208	6/11	0.5 bar	100	53000
228	6/11	0.5 bar	100	57000
268	6/11	0.5 bar	100	59000
348	6/12	0.3 bar	140	97000

Stated power in datasheets is achieved when inlet coolant temperature does not exceed 50°C.

Please note that with higher inlet coolant temperatures, continuous motor power is reduced.

Maximum inlet pressure should not exceed 2 bar(g). No particles greater than 50 µm are permitted.

Cooling inlet and cooling outlet are defined as seen on *Figure 31*. The outlet is closer to the phase connectors. It's important to deaerate the motor when connecting to coolant supply. The preferred way is using a vacuum on the outlet.

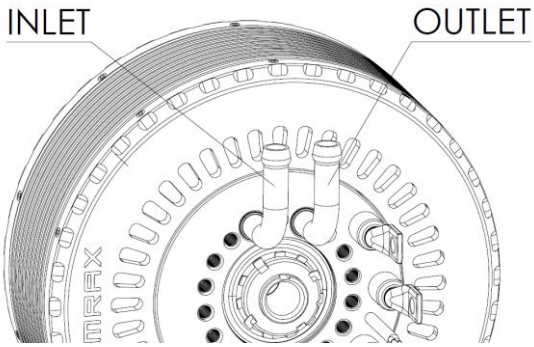


Figure 31: Coolant inlet and outlet

Coolant liquid must never freeze inside the motor.

Demineralized water or glycol mixture (sub 0°C environments) are the preferred coolant options. Do not expose the motor directly to salt water, as internal damage may occur. Any coolant compatible with raw aluminium and VMQ70 (O-rings material).

Rubber hose of inner diameter 10mm should be installed and secured with a clamp on the coolant fittings.

c) Combined cooling (CC):

Stator is both liquid and air cooled, rotor is air cooled.

> **IP21**! Take care not to drop ferromagnetic particles into the motor through the cooling holes. Motor must be protected from small ferromagnetic and abrasive particles.

Both LC and AC cooling requirements should be satisfied. Air cooling vents are the same as on AC motor (see *Figure 28* and *Figure 29*).

3.7. Coolant fittings replacement

Coolant fittings are fitted in place and secured with either the encoder or sensor bracket, or the stator spacer (see *Figure 14*).

Sealing is done with O-rings. The standard O-rings are VMQ70 9x1.5.

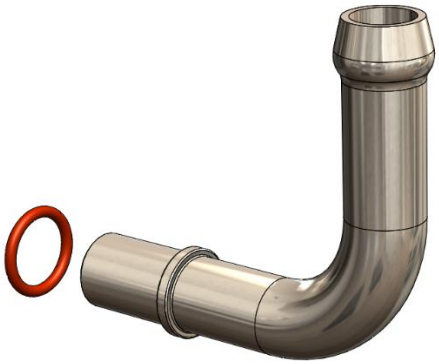


Figure 32: Required mounting parts

To install the fittings to the motor:

1. Grease and install the O-ring onto the coolant fitting.
2. Press the fitting into the cooling channels of the motor, while gently rotating it from side to side. Take care to not pinch the O-ring.

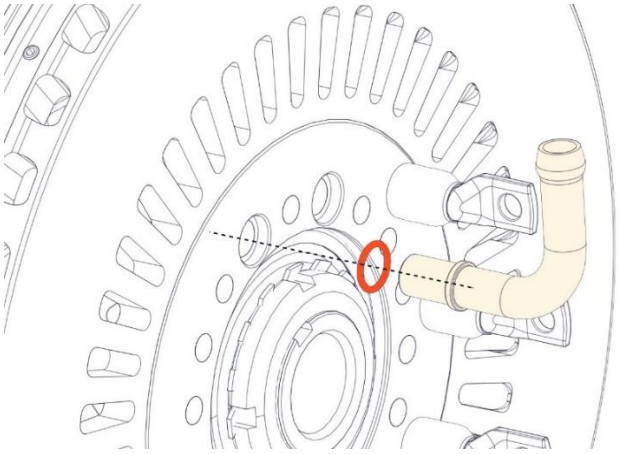


Figure 33: O-ring mounting

3.8. Temperature sensor connection

The default temperature sensor built into the motor is type KTY 81-210. The wires are unterminated.

> Take great care to not damage the temperature sensor cable. Make sure to protect it from moving parts and/or tools used during motor installation.

3.9. Power supply and connections

Refer to motor datasheet to find suitable data on the voltage and current required by the electric drive.

The power cables must comply with established practice and standards and be properly insulated and rated for the current draw; the connection cabling and cable cross sections must comply with EN 60204.

> When dealing with electrical connections, ensure that the system is not under voltage.

The use of electro-insulating gloves is recommended when dealing with high voltage electrical connections.

Using an IMD (insulation monitoring device), when using voltages higher than 48 V is advisable.

Check that the phase cables are properly tightened down to the cable shoes with positive locking (DIN 980, locking washers or similar).

Ensure insulation on motor connections by using heat shrinks or similar. For watertight connection we recommend using adhesive lined heat shrink tubing.

Motor mounting point and the phase cables shields (one side only) should be connected to the main ground of the system.

Power cables must be supported at a maximum distance of 200 mm from the connection. Resting the weight of the cable on the motor connections can result in their dynamic failure.

Figure 34: Cable support example (not provided by EMRAX)

Take care to separate the high current path cables from any low voltage/communications cables to avoid electromagnetic interferences.

Make sure to not bend or twist the phase terminals when tightening the bolts. Hold down the bolt and the nut when tightening.

When routing the wiring harness ensure as much distance between the HV cables and the LV cables as possible. If they must cross, make sure the crossing is done at or as close to 90° as possible (see *Figure 35*).

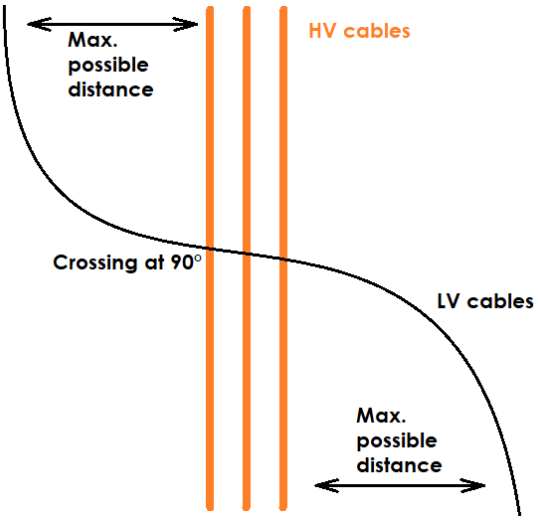


Figure 35: HV and LV cables crossing

4. Steps prior to starting

4.1. Steps prior to starting

WARNING:
If the motor has been in a damp location, dry it out thoroughly before operating. Before energizing the motor for the first time or after an extended shut down, it is advisable to check the insulation resistance, power supply and mechanical freedom of the motor.

4.2. Initial start

WARNING:
Do not touch or reach into moving parts, while the motor is operating!

Before any voltage is applied to the motor, turn the rotor by hand to make sure it rotates freely. Listen to any unusual noise or any debris that could be inside.

Check all connections with the connection diagram. Check all accessible factory made connections for tightness to make sure none has become loose during shipment.

When the driven load is likely to be damaged by the wrong direction of rotation, it is best to uncouple the motor from its load during the initial start and make certain it rotates in the correct direction.

After inspecting the motor carefully, make the initial start by following the regular sequence of starting operations as prescribed by motor controller manufacturer.

In the event of excessive vibration or unusual noise disconnects the motor from the load and check the mounting and alignment. If the issue is not resolved, please contact EMRAX support for further instructions.

5. Maintenance

5.1. General

When the motor is in operation, examine the motor at regular intervals depending on the service. Check the following items:

- Make sure the ventilation openings are clear and unobstructed.
- General cleanliness.
- Check the condition of shaft seals
- Check the condition of connections and mounting/assembly bolts.
- Check the bearing condition by listening for any unusual noise, vibration measurement, bearing temperature, inspection of spent grease or SPM bearing monitoring.

5.2. General cleanliness

Motors should be kept clean, free of dust, debris, and oil. Soft brushes or clean cotton rags should be used for cleaning. A jet of compressed air should be used to remove non-abrasive dust and any accumulated grime. Oil or damp impregnated impurities can be removed with rags soaked in a suitable solvent.

Air cooled and combined cooling motors should have their cooling vents (see *Figure 28* and *Figure 29*) covered when the motor is not in operation.

5.3. Vacuum and compressed air cleaning

Compressed air or suction should be used to remove loose dirt and dust from air and coolant passages.

Care must be taken to make sure the air is dry and that the pressure of not more than 2 bar(g) is used.

5.4. Cleaning with water and detergent

Water-solvent mixture is a very effective way in cleaning coolant channels against accumulated dirt.

Care must be taken to make sure that the pressure of not more than 2 bar(g) is used, and that the temperature never exceeds 90 °C.

5.5. Bearings

Bearings are assembled and pretensioned in factory and are greased for its entire life cycle. Their appropriate life cycle is to be determined by a customer using their boundary conditions. In case of bearing failure, please contact EMRAX support for inspection or possible replacement.

5.6. Failure

WARNING: An extreme overload or electrical failure may result in heating or arcing which can cause the insulation to give off noxious fumes. All power should be removed from the motor circuit as a precaution even though the circuit has overload protection. Personnel should not approach the motor until adequate ventilation of the area has purged the air of fumes. When covers of the motor are removed after a failure, care should be observed to avoid breathing fumes from inside the motor. Preferably, time should be allowed for the motor to cool before attempting any examination.

WARNING: Water should not be applied to any electrically energized equipment because electric shock could result in serious or fatal injury. In case of fire, disconnect all power and use a carbon dioxide extinguisher to quench the flame. Before operating any motor after a suspected failure, it should be inspected for damage.

5.7. Repair

If suspecting motor failure, please contact EMRAX representative or contact EMRAX support directly for further instructions regarding the motor repair. The following must be sent to EMRAX to process a motor repair:

• Original nameplate from the failed motor.
• Copy of the original invoice or invoice # for the failed motor.
• Brief description of the failure for quality control purposes.
• Please send request no later than 30 days after failure.

Any unauthorized attempts in disassembling the motor will result in warranty void, and further damage to the motor may occur.

5.8. Warranty

EMRAX provides a limited warranty on our products against defects in materials and workmanship for a period of twelve (12) months, from the date of delivery.

During the warranty period, EMRAX will repair or replace, at no charge, products or parts of a product that proves defective because of improper material or workmanship, under normal use and maintenance. Repaired or replaced product will have a warranty extended for a period of twelve (12) months from the date of delivery.

The warranty shall be void and of no effect if the following are performed & found on the motor:

(1) The motor has been subjected to improper installation, storage, or handling; as well as any abuse unsuitable for the motor;
(2) The motor was subjected to an unauthorized repair.
(3) The motor was subject to any water damage;
(4) The motor was engaged above its rated load;
(5) The motor lacked reasonable & necessary maintenance.
(6) The motor usage was not according to its installation manual
(7) Improper packaging for return.
(8) Motor has been overheated past 120°C.

EMRAX does not cover the cost of installation, removal, or re-testing of the new or repaired products.

EMRAX will not be liable for any costs or damage incurred by its customers in the removal or replacement of defective products from units in which the products have been assembled. When processing a warranty claim, please contact EMRAX support and provide the following:

• Original nameplate from the failed motor.
• Copy of the original invoice or invoice # for the failed motor.
• Brief description of the warranty claim.
• Please send request no later than 30 days after failure.

Document Revision history:

Revision	Date	Author	Description
1.0	06/12/2021	U.K.	Initial version
1.1	22/12/2021	U.K.	Revised nameplate and motor cooling
1.2	21/02/2022	U.K.	Updated pressure drop values
1.3	09/03/2022	U.K.	Added warranty claim, revised 2.6 and 2.4
1.4	19/10/2022	U.K	Revised manual, added installation instructions
1.5	16/08/2023	U.K.	Added mounting instructions for tandem res.
1.6	26/04/2024	A.D. / B.V	Revised manual, added windings explanation
1.7	28/01/2026	M.F. / B.V	Revised manual, improved cooling instructions