Global Vehicle Motors
GVM Series

Safety Instruction and Installation Manual

PVD 3688_GB

EU DECLARATION OF CONFORMITY

We,

Parker Hannifin Manufacturing France SAS
Electromechanical & Drives Division Europe
Etablissement de Longvic
4 Boulevard Eiffel - CS40090
21604 LONGVIC Cedex - France

manufacturer, with brand name **Parker**, declare under our sole responsibility that the products

BRUSHLESS SERVOMOTORS TYPE GVM

satisfy the arrangements of the directives :

Directive 2014/35/EU : "Low Voltage Directive", LVD
Directive 2011/65/EU + delegated Directive (EU) 2015/863: "Restriction of Hazardous Substances", RoHS
Directive 2014/30/EU : "Electromagnetic Compatibility", EMC

and meet standards or normative document according to :

IEC 60034-1:2017 : Rotating electrical machines - Part 1 : Rating and performance.
IEC 60034-5:2000+A1:2006 : Rotating electrical machines - Part 5 : Degrees of protection provided by the integral design of rotating electrical machines (IP code) - Classification.
IEC 60204-1:2016 : Safety of machinery – Electrical equipment of machines – Part 1 : General requirements.

The product itself is not impacted by the modifications made on the latest directives.

The undersigned hereby certify that the above mentioned model is procured in accordance with the above directives and standards.

Further information :

The product must be installed in accordance with the instructions and recommendations contained in the operating instructions supplied with the product.

GVM142/GVM210 C.E. Marking : April 2014
GVM310 C.E. Marking : November 2020

Longvic, November 18th 2020

In the name of Parker
F. ALPIOVEZZA
Business Unit Manager

Ref : DCE-GVM-001rev3

Table of Content

1. INTRODUCTION

1.1. Purpose and intended audience

This manual contains information that must be observed to install, operate and maintain PARKER GVM motors.

Installation, operation and maintenance of the equipment should be carried out by qualified personnel. A qualified person is someone who is technically competent and familiar with all safety information and established safety practices; with the installation process, operation and maintenance of this equipment; and with all the hazards involved.

Reading and understanding the information described in this document is mandatory before carrying out any operation on the motors. If any malfunction or technical problem occurs, that has not been dealt with in this manual, please contact PARKER for technical assistance. In the case of missing information or doubts regarding the installation procedures, safety instructions or any other issue tackled in this manual, please contact PARKER directly.

PARKER's responsibility is limited to its GVM Motors and does not encompass the whole user's system. Data provided in this manual are for product description only and may not be guaranteed, unless expressly mentioned in a contract.

	DANGER: PARKER declines responsibility for any industrial accident or material damage that may arise, if the procedures and safety instructions described in this manual are not scrupulously followed.

1.2. Safety

1.2.1. Principle

For this equipment to work safely, it must be transported, stored, handled, installed and serviced correctly. Following the safety instructions described in each section of this document is mandatory. GVM Motors usage must also comply with all applicable standards, national directives and factory instructions in force.

	DANGER: Non-compliance with safety instructions, legal and technical regulations in force may lead to physical injuries or death, as well as damages to the property and the environment.

1.2.2. General Safety Rules

<table>
<tr>
<td>  </td>
<td>Generality
DANGER: The installation, commissioning and operation must be performed by qualified personnel, in conjunction with this documentation.

The qualified personnel must know the safety (C18510 authorization, standard VDE 0105 or IEC 0364 as an example) and local regulations.

They must be authorized to install, commission and operate in accordance with established practices and standards.</td>
</tr>
<tr>
<td>  </td>
<td>Electrical hazard
Inverters may contain non-insulated live AC or DC components. See the inverter commissioning manual. Users are advised to guard against access to live parts before installing the equipment.

Some parts of the motor or installation elements can be subject to dangerous voltages, especially when the motor is driven by the converter or when the motor rotor is manually rotated.

For measurements use only a meter to IEC 61010 (CAT III or higher). Always begin using the highest range. CAT I and CAT II meters must not be used on this product.

Even after the electrical system is de-energized, voltages may be present several minutes (see inverter technical manual) until the power capacitors have had time to discharge. Use specified meter capable of measuring up to 1000V DC & AC RMS to confirm that less than 50V is present between power terminals an earth. Check the inverter recommendations.

The continuity of the grounding circuit has to be checked on the complete circuit : the resistance between any conductive point and the grounding conductor shall not exceed more than100mΩ. To prevent any accidental contact with live components, it is necessary to check that cables are not damaged, stripped or not in contact with a rotational part of the machine and to study first of all the following points:
- Connector lug protection
- Correctly fitted protection and earthing features
- Workplace insulation (enclosure insulation humidity, etc.)
- Terminal box properly closed

General recommendations :
- Check the bonding circuit
- Lock the electrical system
- Use standardized equipment

Due to particular high current values, take care of specific hazards like burning or UV flashes during shorts.</td>
</tr>
</table>

	**Mechanical hazard** Brushless synchronous motors can accelerate in milliseconds. Running the motor can lead to other sections of the machine moving dangerously. Moving parts must be screened off to prevent operators coming into contact with them or to protect the people against a shaft failure. The working procedure must allow the operator to keep well clear of the danger area.
	**Burning Hazard** Always bear in mind that some parts of the surface of the motor can reach temperatures exceeding 100°C.

2. PRODUCT DESCRIPTION

2.1. Quick URL

All informations and datas are avaible on :
https://ph.parker.com/us/17607/en/gvm-global-vehicle-motors-for-mobile-applications

3. TECHNICAL DATA

3.1. Motor selection

3.1.1. Inverter selection

The Inverter selection depends on at first on the available voltage and then on its rated power, nominal current and maximum electrical frequency have to be achieved by the drive and by the flux weakening ratio.

	Please refer to the drive technical documentation for any further information and to select the best motor and drive association.

	In case of using a Low Voltage inverter that will bring high current levels, take care to the 3 phase cables cross-section and length that can affect the motor speed or its rated point.

	In flux weakening mode, please refer to the inverter technical documentation to select the appropriate inverter regarding maximum voltage and current ….

	Max back emf of the motor must be lower than the max voltage (from the motor) supported by the inverter Please refer to the drive technical documentation

	The inverter must be able to manage the flux weakening and must avoid voltage higher than the nominal motor voltage at the motor terminals. Please, check field weakening ratio supported by the inverter. Field weakening ratio = Max speed divided by the basis speed

	Due to the maximum electrical frequency able to be managed by the inverter, the motor has a speed limitation given as follows: $\text{Speed limitation}(\text{rpm}) = \frac{2 * \text{Max\_inverter\_frequency}(\text{Hz}) * 60}{\text{Number\_of\_poles}}$

	Please take care that the drive the GVM is connected to have a short enough dv/dt not to generate any transient current effect in the motor bearings.

3.1.2. Current limitation at stall conditions (i.e. speed < 3 rpm)

Recommended reduced current at speed < 3 rpm:

$$I_{reduced} = \frac{1}{\sqrt{2}} * I_0 \cong 0.7 * I_0$$

	Warning: The current must be limited to the prescribed values. If the nominal torque has to be maintained at stop or low speed (< 3 rpm), the current must not exceed 70% of I_0 (permanent current at low speed), in order to avoid any excessive overheating of the motor.

	Please refer to the inverter technical documentation for any further information and to choose functions to program the drive.

3.2. Motor mounting

3.2.1. Motor mounting environment

Ideally mount motors:

In a location away from, or shielded from other vehicle heat sources such as exhaust, or catalytic converters etc.

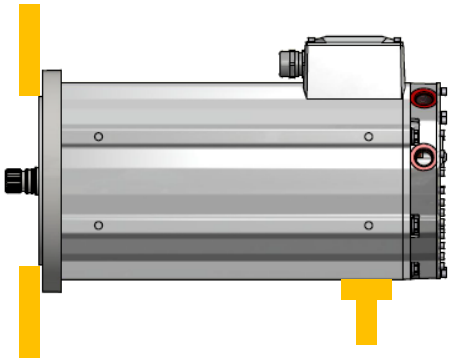
In a location that will benefit from air flow while the vehicle is in motion.

In location that is protected from flying rocks, debris, road salt, or other contaminants that could damage cabling and connections.

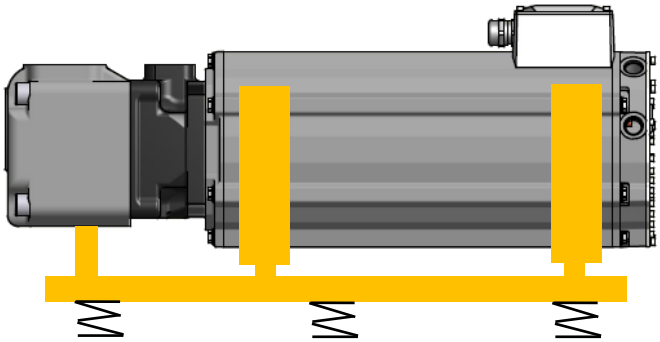
3.2.1. Motor mounting

For the screws tightening torque values, please see the board on page 88.

Traction mounting :



EHP mounting :



GVM motors have been designed for an horizontal mounting (see §4.2). Considering the above schematics, GVM motors have to be supported on their rear side.
For alternative mounting positions, please contact Parker.

For the Electro Hydraulic Pumps (EHP), it is better to place the EHP on a flat surface that will be able to support the GVM motor and the pump.
To reduce the noise level, this flat surface can be insulated from the vehicle frame using damping material.

	GVM motors have been designed for being assembled on gearboxes or hydraulic pumps and cannot support any axial / radial additional load on the shaft.
	Standard GVM motors dedicated to EHP applications have got a front lip seal able to provide an IP67 protection level which means that it cannot be put under pressure over 0.2 bar. For higher pressure (up to 5 bar) take the wet-spline coupling option for your GVM motor.

Mounting recommendation step by step:
- The mounting surfaces of the interfaces should be free from bumps and scratches, washed and lubricated with grease as detailed below before mounting.

- The coupling spline must be lubricated with a lithium molydisulfide grease, disulfide of molybdenum or similar lubricant.

- The mating motor spline should be free to float and find its own center:
  - Set up the equipment on the motor in vertical position.
  - Set up the equipment assembling screws, but do not tighten.
  - Rotate the motor between 1000 and 1500 rpm and gradually tighten the screws.
  - Torque the mounting screws of the equipment at the nominal torque (see page 88).

3.2.2. Frame recommendation

	Warning : The user has the entire responsibility to design and prepare the support, the coupling device, shaft line alignment, and shaft line balancing.

Frame supporting the GVM must be even, sufficiently rigid and shall be dimensioned in order to avoid vibrations due to resonances.

3.2.3. Pulley/belt

	Warning : The GVM motors are not designed to operate with pulley / belt systems. By limiting the speed and/or using specific bearing assemblies, it can be possible in some cases to use pulley / belt systems. It is mandatory to raise a request with the factory before doing so.

3.3. Bearings

	Other limitations can come from the winding or the drive (cf: §3.1.4-Drive selection)

	The bearing arrangement is made with 2 ball bearings (one on the shaft end + another on the rear). The rear bearing is blocked in axial translation and the front one is free in translation to avoid any stress from the shaft thermal expansion during the running. So, it is important not to block in translation the shaft expansion by any extra bearing or similar device.

3.4. Cooling

3.4.1. General recommendations

	Danger: It is compulsory to start the cooling system before starting the motor.
	Danger: The Inlet temperature and the water flow have to be monitored to avoid any damage.
	Caution: When motor is no more running, the cooling system has to be stopped 10 minutes after the motor shut down.
	Danger: If the water flow stops, the motor can be damaged or destroyed causing accidents.

3.4.2. Additives for water as cooling media

Please refer to motor technical data for coolant flow rates.

The absolute inlet pressure of the cooling liquid must not exceed **5 bars**.

	Caution: To avoid the corrosion of the motor cooling system (aluminum or copper), the water must have anti-corrosion additive (as Glycol).

The GVM motors can be water cooled. Corrosion inhibitors must be added to the water to avoid the corrosion. The complete cooling system must be considered to choose the right additive, this includes: the different materials in the cooling circuit, the chiller manufacturer recommendations, the quality of the water…
The right additive solution is the responsibility of the user. Some additives like TYFOCOR or GLYSANTIN G48 correctly used have demonstrated their ability to prevent corrosion in a closed cooling circuit

For example : Glysantin G48 recommendations are :

- Water hardness: 0 to 20°dH (0 – 3.6 mmol/l)
- Chloride content: max. 100ppm
- Sulphate content: max. 100ppm

	Caution: The water quality is very important and must comply with supplier recommendations. The additive quantity and periodic replacement must respect the same supplier recommendations.

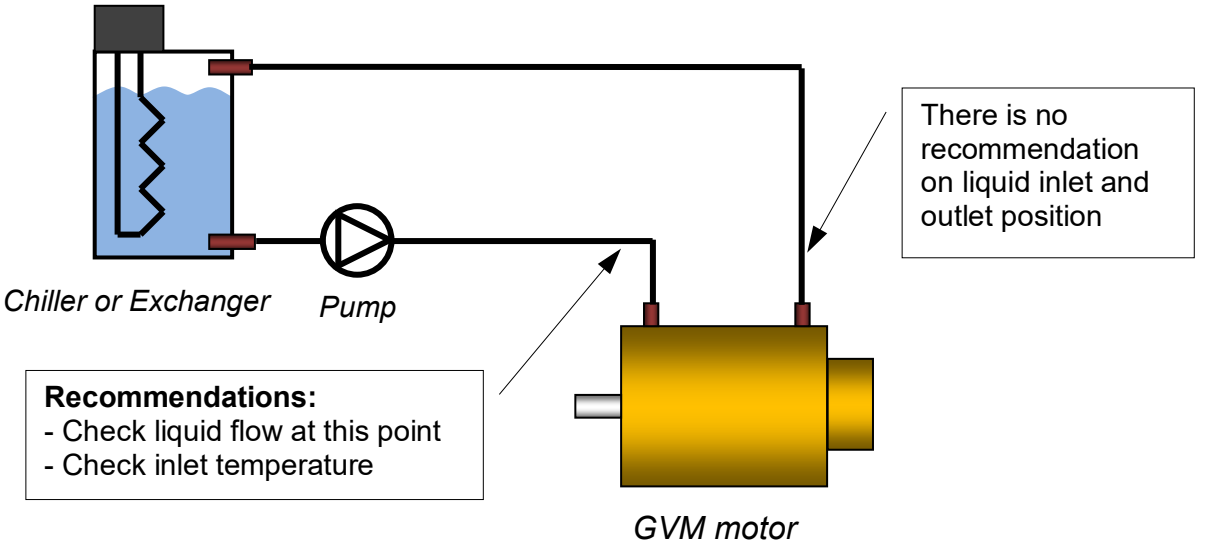
	Caution: The additive choice must take into account the complete cooling system (chiller or water exchanger recommendations…).

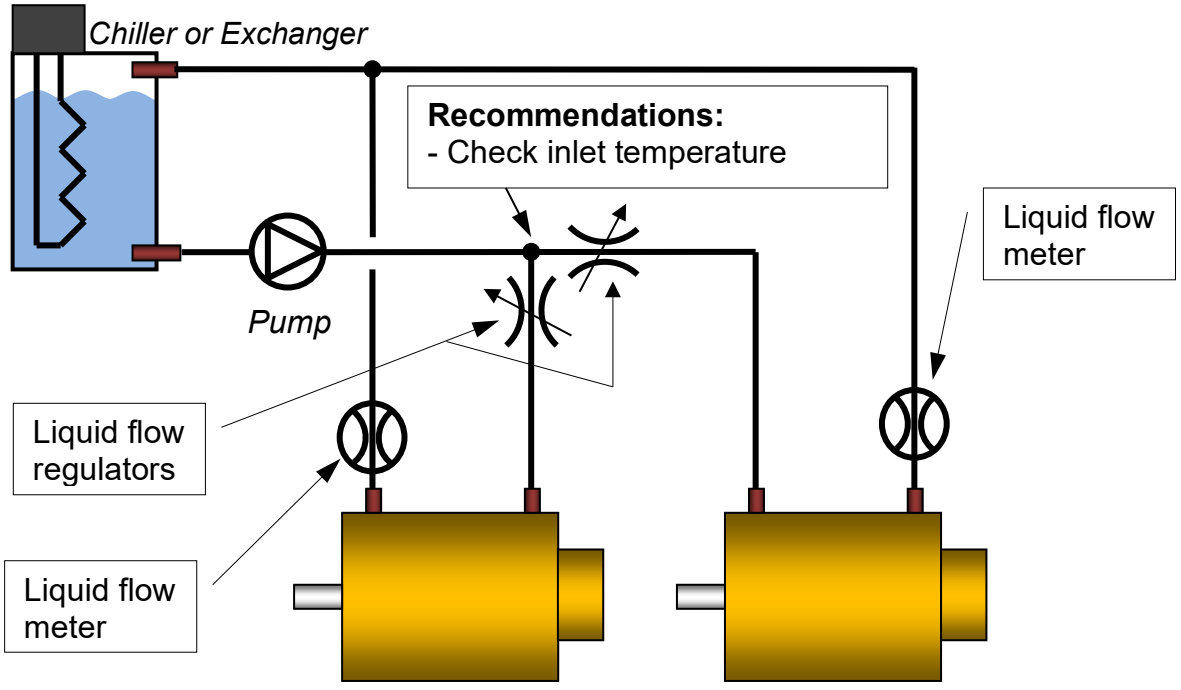
	Select carefully the materials of all the cooling system parts (chiller, exchanger, hoses, adapters and fittings) because the difference between material galvanic potential can generate corrosion.

3.4.3. Liquid cooling diagram

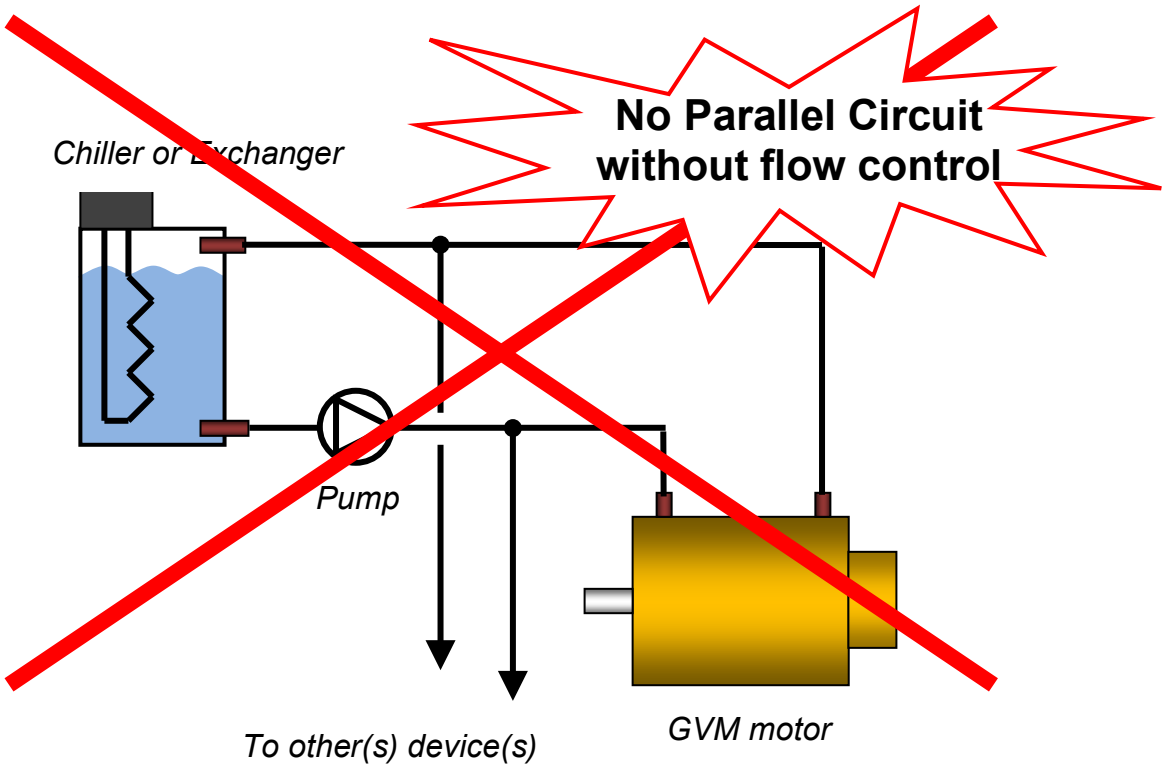
	Recommendation: The use of a filter allows reducing the presence of impurities or chips in the liquid circuit in order to prevent any obstruction.

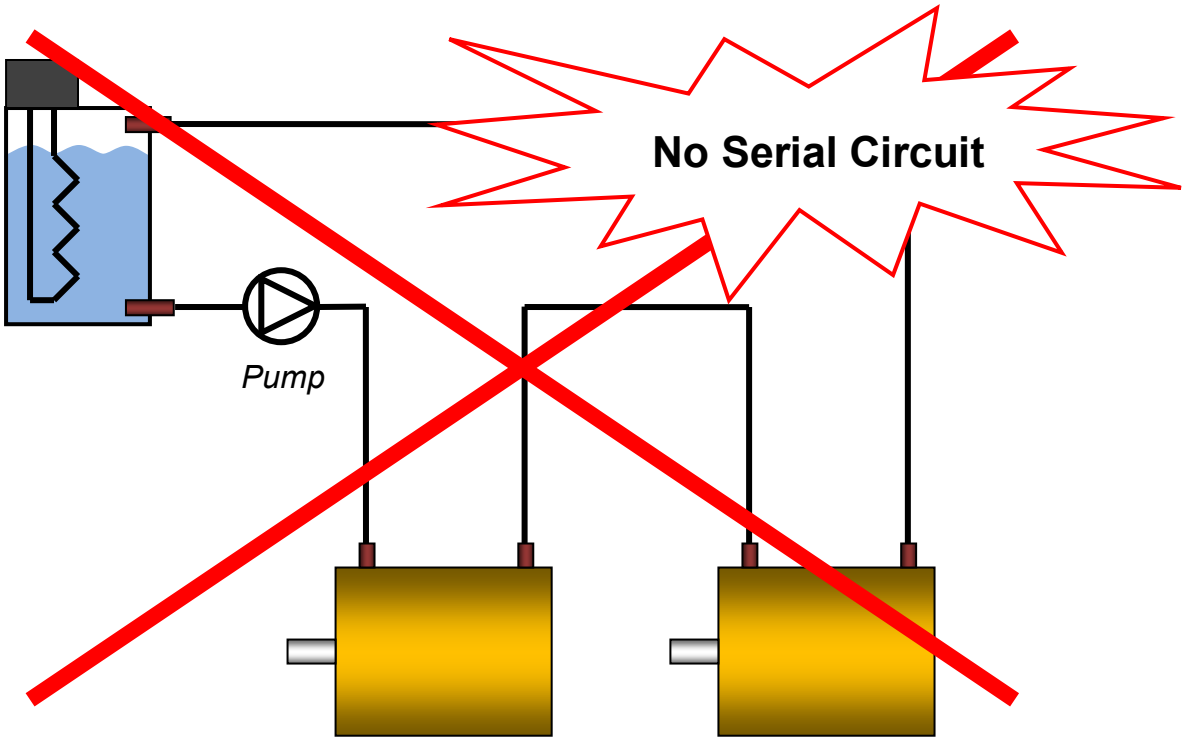
This section shows typical liquid cooling diagram:





Any other cooling circuit system is fully under customer responsibility.


No Parallel Circuit
without flow control
Chiller or Exchanger
Pump
To other(s) device(s)
GVM motor


No Serial Circuit
Pump
GVM motors

3.5. Thermal Protection – Positive Temperature Coefficient sensors

Protection against thermal overloading of the motor is provided by three PTC thermistors and 1 linear temperature sensor PT1000 built into the stator winding as standard. Globally, the thermal sensors, due to their thermal inertia, are unable to follow very fast winding temperature variations. They achieve their thermal steady state after a few seconds.

	Warning: To protect correctly the motor against very fast overload, please refer to the GVM Technical Manual Peak current limitations

3.6. Power electrical connection

3.6.1. Cables sizes

	In every country, you must respect all the local electrical installation regulations and standards.

	Cable selection depends on the cable construction, so refer to the cable technical documentation to choose wire sizes

	Some drives have cable limitations or recommendations; please refer to the drive technical documentation for any further information.

Cable selection

	At standstill, the current must be limited at 80% of the low speed current I_o and the cable has to support the peak current for a long period. So, if the motor works at standstill, the current to select the right wire size is $\sqrt{2} \times 0.8\ Io \cong$ **$1{,}13 \times I_o$**.

3.6.2. Motor cable length

For motors windings which present low inductance values or low resistance values, the own cable inductance, respectively own resistance, in case of large cable length can greatly reduce the maximum speed of the motor. Please contact PARKER for further information.

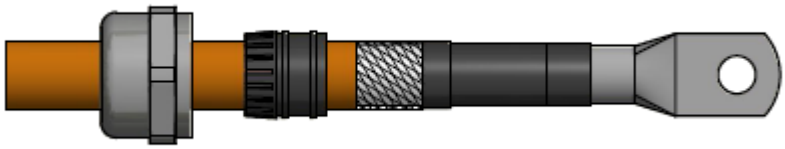
	Caution: It might be necessary to fit a filter at the servo-drive output if the length of the cable exceeds 5 m. Consult us.

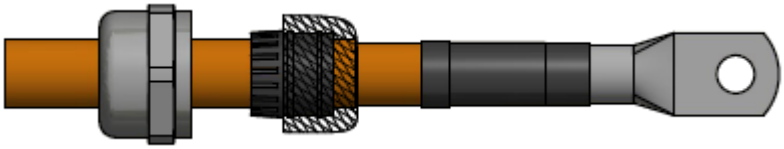
3.6.3. Mains supply connection diagrams

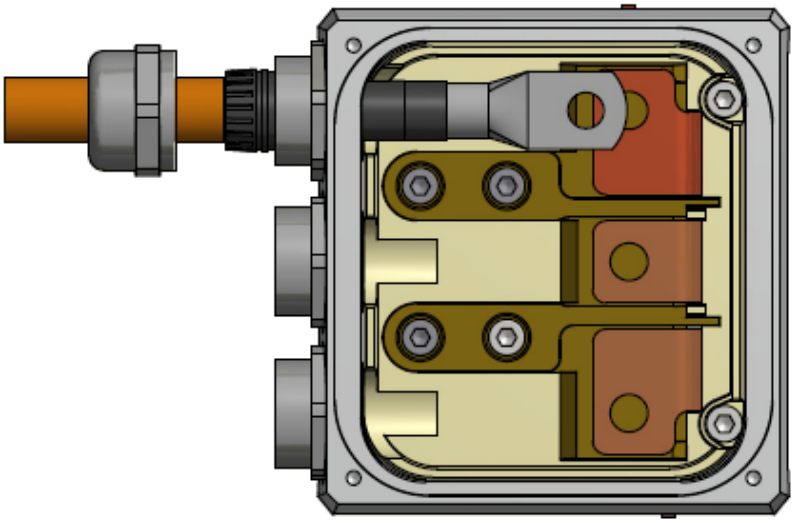
	Caution: A bad tightening on the cable or a too small cable section can generate an overheating and damage the motor.

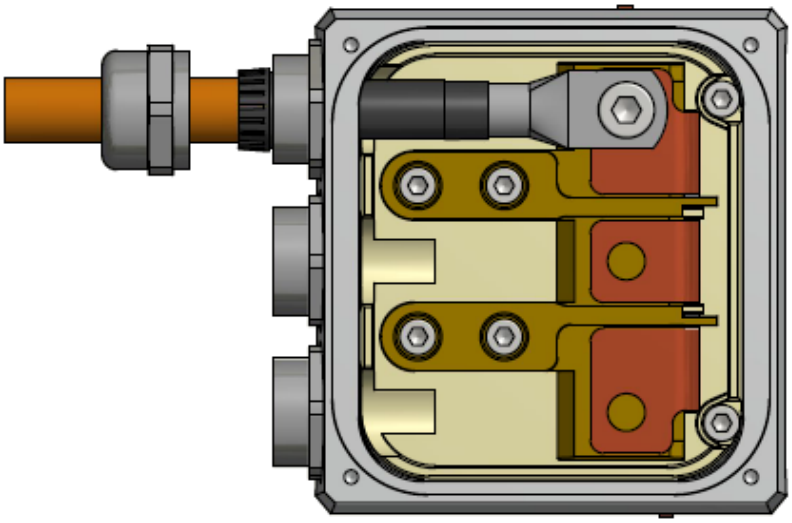
3.6.3.1. GVM142 & GVM210 Terminal Box motor power connection

For Parker High Power cables, please follow the next 5 steps :

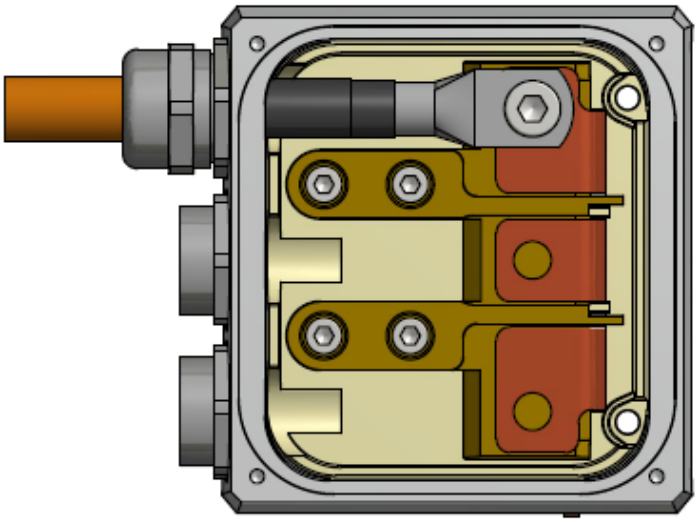






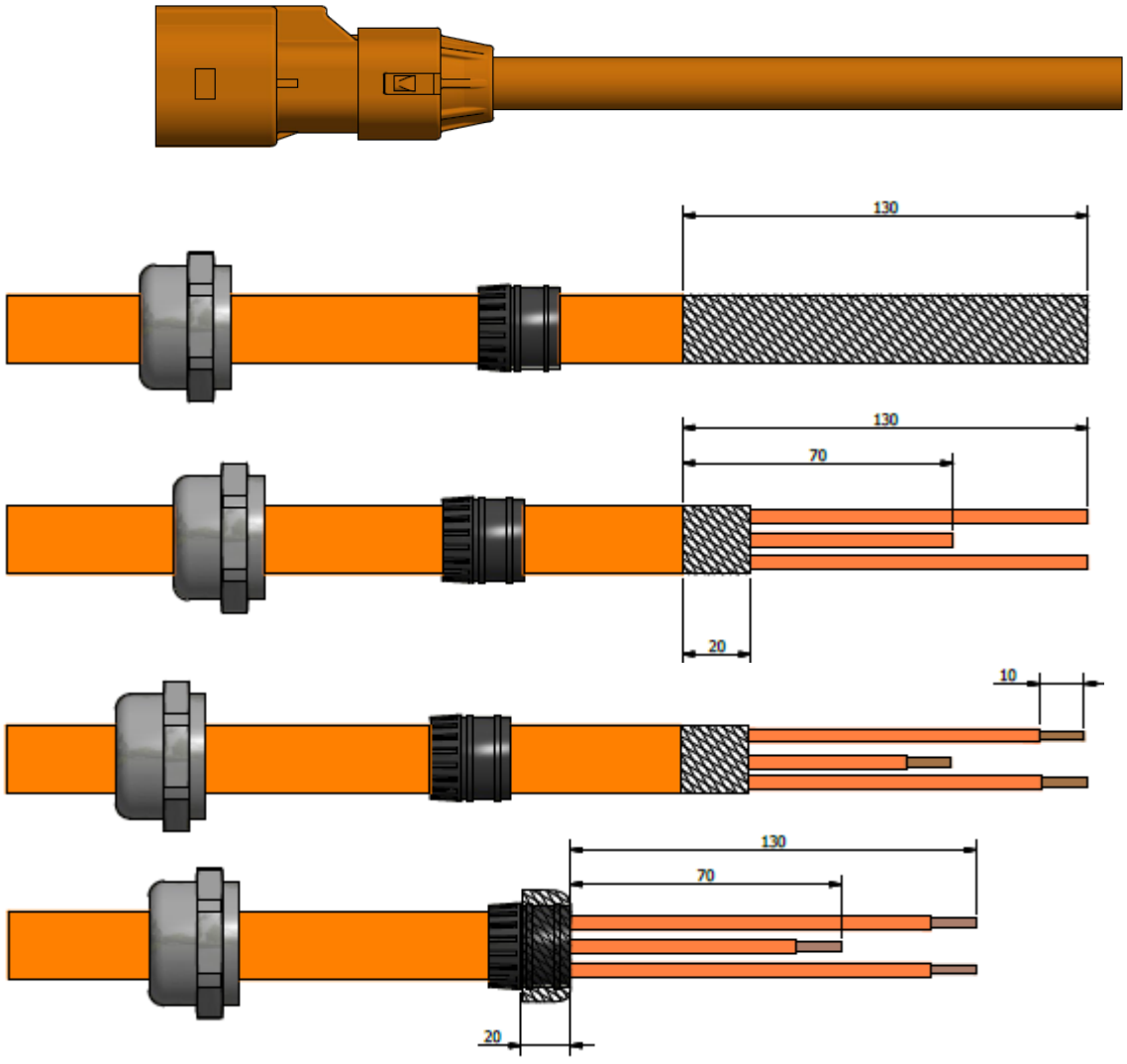


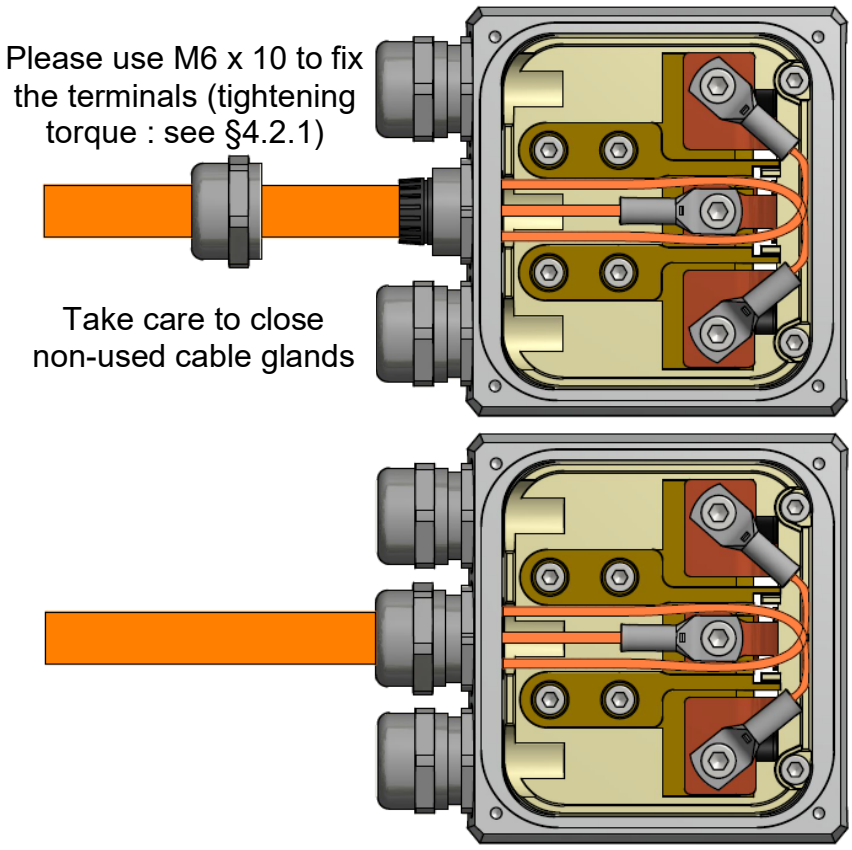
Please use M6 x 10 to fix the terminals (tightening torque : see p71)



For the specific case of High Voltage Low Power drives :
Parker can supply 4 meter length Power cable which part number is HVLP-D-M-CABLE.

To connect the motor, please follow the 7 next steps.





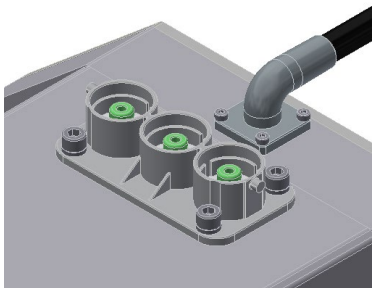
As previously, Parker can provide 4 meter length power cable to take place between the drive and the battery (with 2 interlock wires) which part number is HVLP-B-D-CABLE.

⚠	For High Voltage Low Power drives with multi core thin cables, the plastic insulator must not be damaged neither removed to insure insulation and safety protection.

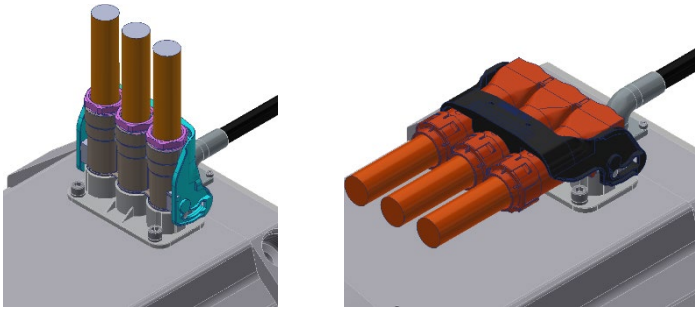
3.6.4. Amphenol Powerlok connectors

GVM motors can be provided with plug Amphenol Powerlok connectors with HVIL (High Voltage Interlock) device. Powerlok range exist in difference size depending of the level of current. Motors will included the well dimensioned connector as per the windings specification and motor power. See the list below of connectors available.

Single 3 positions Amphenol Powerlok 300

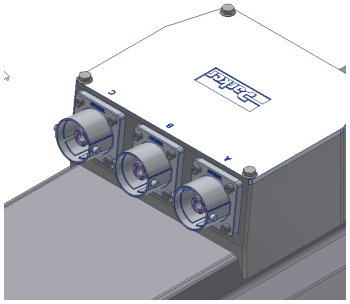


Please refer to supplier documents for cables mounting and safety recommendation.

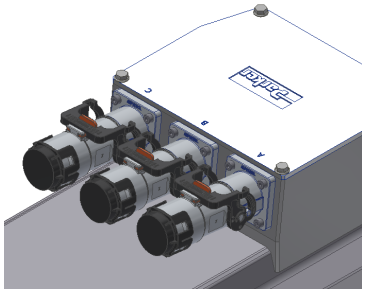


See cables recommendation for those connectors in the GVM Technical Manual.

Three 1 position Amphenol Powerlok 500



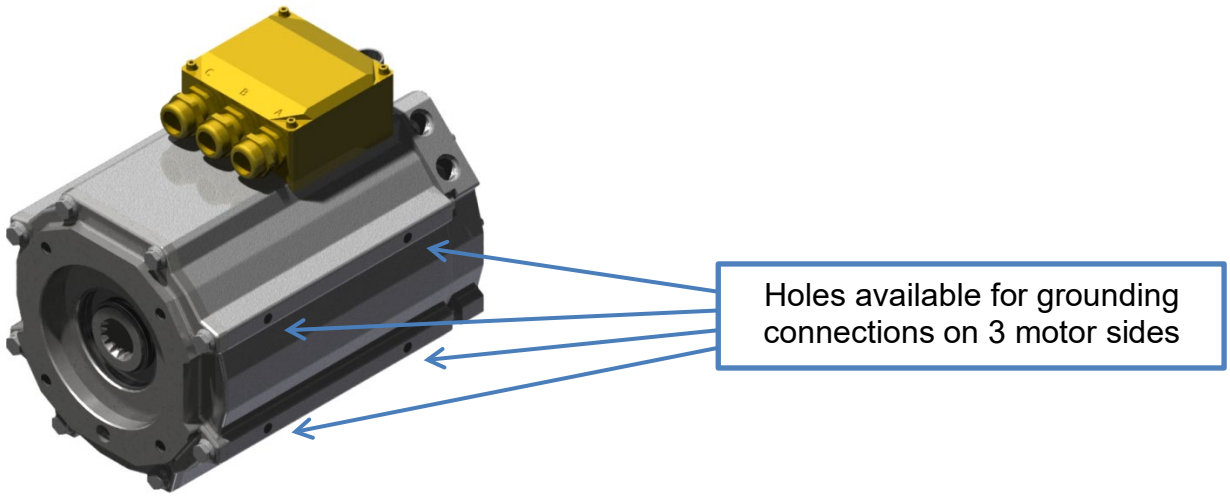
Please refer to supplier documents for cables mounting and safety recommendation.



See cables recommendation for those connectors in the GVM Technical Manual.

3.6.4.1. Vehicle chassis (ground) connection

Use one of the fitting holes for vehicle chassis connection as on the picture below.

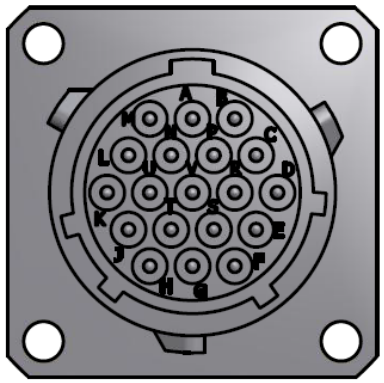


	In every country, you must respect all the local electrical installation regulations and standards to determine the vehicle chassis (ground) cable size.

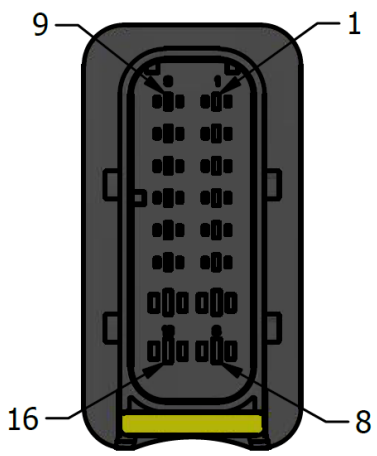
3.7. Feedback system

3.7.1. Resolver

Pin out Souriau connector

Resolver connector	PIN	Signal
	A	Ref Sin (-) S2
	B	Sin (+) S4
	J	Ref (+) R1
	K	Ref (-) Ground R2
	E	Ref Cos (-) S1
	F	Cos (+) S3
	C	PTC Therm Disconnect
	D	PTC Therm Disconnect
	G	Equivalent KTY Winding Therm
	H	Equivalent KTY Winding Therm
	L,M,N,P,R,S,T,U,V	Not Connected

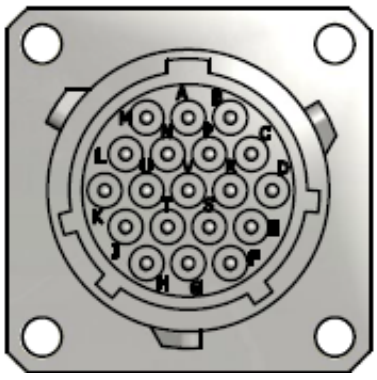
Pin out 16 pins Tyco connector

Resolver connector	PIN	Signal
	1	Ref Sin (-) S2
	2	Sin (+) S4
	3	Ref (+) R1
	4	Ref (-) Ground R2
	5	Ref Cos (-) S1
	6	Cos (+) S3
	7	PTC Therm Disconnect
	8	PTC Therm Disconnect
	9	PT1000
	10	PT1000
	11	HVIL
	12	HVIL
	13	Ground
	14, 15, 16	Not Conneted

3.7.2. Sin-Cos Encoder (low voltage application)

	In case of SinCos encoder, take care to connect the cable shield to the vehicle chassis. In any case the motor housing must be at the same potential than the drive body.

Pin out Souriau connector

Sin-Cos Encoder connector	PIN	Signal
	A	VA (Sin)
	J	VDD
	K	GND
	E	VB (Cos)
	C	PTC Therm Disconnect
	D	PTC Therm Disconnect
	G	Equivalent KTY Winding Therm
	H	Equivalent KTY Winding Therm
	L,M,N,P,R,S,T,U,V	Not Connected

4. COMMISSIONING, USE AND MAINTENANCE

4.1. Reception, handling, storage

4.1.1. Equipment delivery

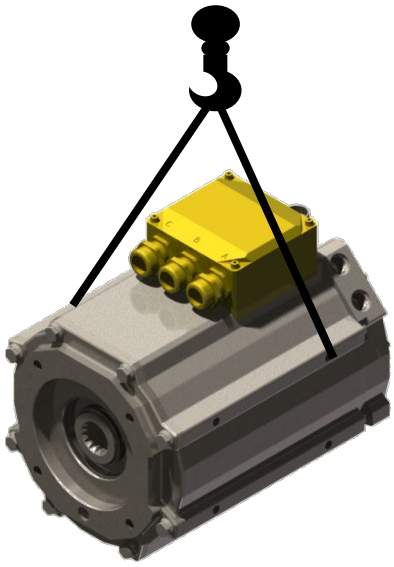
All the GVM motors are strictly controlled during manufacturing, prior to shipping.
Upon receipt it, it is necessary to verify the motor condition and confirm it has not been damaged during transit. Remove it carefully from its packaging. Verify that the data written on the label are the same as the ones on the acknowledgement of order, and that all documents or necessary accessories for user are present in the packaging.

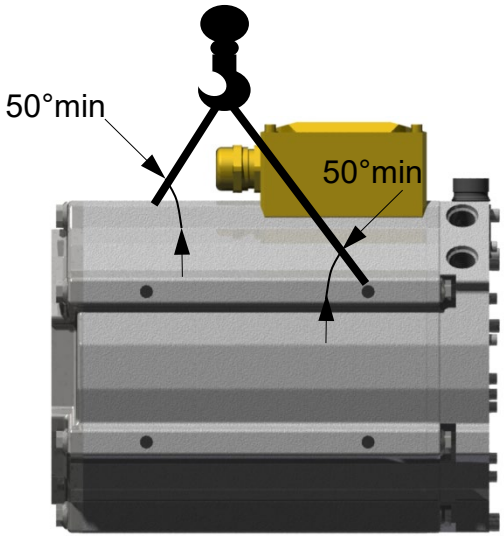
⚠	Warning : In case of damaged material during the transport, the recipient must **immediately** make representations to the carrier through a registered mail within 24 h.

4.1.2. Handling

The GVM motors are equipped with threaded holes on its housing for handling.

⚠	DANGER: Only use the threaded holes the GVM motors are equipped with for handling operations. Never use cables, connectors, input/output of cooling circuit, or any other inappropriate lifting device.





⚠	DANGER: Choose the correct slings for the motor weight. The two slings must be the same length and a minimum angle of 50° has to be respected between the motor axis and the slings.

4.1.3. Storage

Before being mounted, the motor has to be stored in a dry place, without rapid or significant temperature variations in order to avoid condensation.
If the GVM motor has to be stored for a long time, verify that the shaft end and the flange are coated with corrosion proof product.
After a long storage duration (more than 3 month), run the motor at low speed in both directions, in order to blend and spread the bearing grease.
The motor is delivered with caps for the water inlet and outlet to protect the cooling circuit. Keep them on place until the motor commissioning.

4.2. Installation

4.2.1. Mounting

Vehicle frame must be even, sufficiently rigid and shall be dimensioned in order to avoid vibrations due to resonance. Before tightening the motor's fittings, the foundation surface must be cleaned and checked in order to detect any excessive height difference between the fitting locations. In any case we recommend using shims to compensate small irregularities.

	Caution: The user bears the entire responsibility for the preparation of the foundation.

The table below gives the average tightening torques required regarding the fixing screw diameter. These values are valid for both motor's feet and flange bolting.

Screw diameter	Tightening torque
M2 x 0.35	0.35 N.m
M2.5 x 0.4	0.6 N.m
M3 x 0.5	1.1 N.m
M3.5 x 0.6	1.7 N.m
M4 x 0.7	2.5 N.m
M5 x 0.8	5 N.m
M6 x1	8.5 N.m
M7 x 1	14 N.m
M8 x 1.25	20 N.m

Screw diameter	Tightening torque
M9 x 1.25	31 N.m
M10 x 1.5	40 N.m
M11 x 1.5	56 N.m
M12 x 1.75	70 N.m
M14 x 2	111 N.m
M16 x 2	167 N.m
M18 x 2.5	228 N.m
M20 x 2.5	329 N.m
M22 x 2.5	437 N.m
M24 x 3	564 N.m

	Warning: After 15 days, check all tightening torques on all screws and nuts.

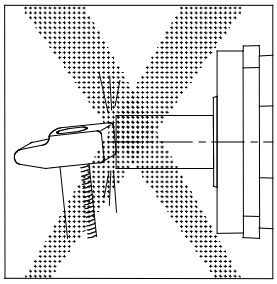
4.2.2. Preparation

Once the motor is installed, it must be possible to access to the wiring, and read the manufacturer's plate. Air must be able to circulate freely around the motor for cooling purposes.
Clean the shaft using a cloth soaked in white spirit or alcohol. Pay attention that the cleaning solution does not get on to the bearings.

The motor must be in a horizontal position during cleaning or running.

	Caution: Do not step on the motor, the connector or the terminal box
	Caution: Always bear in mind that some parts of the surface of the motor can reach or exceed 100°C

4.2.3. Mechanical assembly



The operational life of motor bearings largely depends on the care and attention given to this operation.

- Carefully check the alignment of the motor shaft with the driven machine to avoid vibrations, irregular rotations or applying too much strain on the shaft.

- Prohibit any impact on the shaft or press fitting which could mark the bearing tracks.

- In the event that the front bearing block is sealed by a lip seal which rubs on the rotating section, we recommend that you lubricate the seal with grease to extend its operational life.

	Warning : The user has the entire responsibility to prepare the support, the coupling device, shaft line alignment, and shaft line balancing.
	Warning : Parker will not be responsible for any motor shaft fatigue due to excessive strain on the shaft, a bad alignment or bad shaft line balancing .

4.3. Electrical connection

	Warning : Check that the power to the electrical inverter is safely off prior to make any connections.
	Warning : The wiring must comply with the inverter commissioning manual, with recommended cables, the standard and the local regulations
	Warning : The GVM motor must be grounded by connecting to an unpainted section of the motor.
	Warning : Do not open the terminal box under voltage or when the motor is rotating.
	Danger : After 15 days, check all tightening torques on cable connection. Bad connections can lead to overheating and fire.

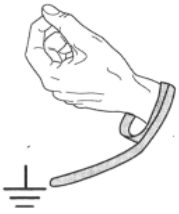
4.3.1. Cable connection

Please, read **§3.8 "Electrical connection"** in the GVM Technical Manual to have information about cable and terminal box.
A lot of information are already available in the inverter documentations.

4.3.2. Resolver / Encoder / Thermistor cable handling

	Danger: before any intervention the drive must be stopped in accordance with the procedure.

	Caution: It is forbidden to disconnect the Encoder cable under voltage (high risk of damage and sensor destruction).

	Warning: Always wear an antistatic wrist strap during encoder handling.
	Warning: Do not touch encoder contacts (risk of damage due to electrostatic discharges ESD.

4.4. Maintenance Operations

	**Generality** DANGER: The installation, commissioning and maintenance operations must be performed by qualified personnel, in conjunction with this documentation. The qualified personnel must know the safety local regulations. They must be authorized to install, commissioning and operate in accordance with established practices and standards. Please contact PARKER for technical assistance.

Operation	Periodicity	Section number
Cooling water quality inspection	Every year	§3.6
Check all tightening torques on all screws in the terminals box	Every year	§4.2
Check the bearings	Every year	§3.5
Clean the motor	Every year	
Inspect and lubricate shaft seals	Every year	§4.2.3
Inspect and lubricate shaft splines	Every year	
Inspect coolant fittings, and hoses	Every year	§3.6
Inspect power and feedback cables	Every year	§4.3

4.5. Troubleshooting

We provide hereunder a symptom list in regard with their possible cause. This is not an exhaustive list so in case of trouble, please refer to the associated inverter manual (the diagnostic board indications will help you investigating).

You note that the motor does not turn by hand when the motor is not connected to the drive.	• Check if the phases are not in short circuit. • Check if the rotor is externally blocked mechanically in rotation.
You have difficulty starting the motor or making it run	• If there is a thermal protector, check it and its connection and how it is set in the drive. • Check the servomotor insulation (in doubt, measure when the motor is hot and cold. The minimum insulation resistance measured under 500VDC max is 50 MΩ : - Between phase wire and housing, - Between thermal protector and housing, - Between resolver winding and housing.
You find that the motor speed is drifting	• Adjust the inverter offset.
You notice that the motor is racing	• Check the speed set-point of the inverter. • Check you are well and truly in speed regulation (and not in torque regulation). • Check the (feedback device) setting
You notice vibrations	• Check the (feedback device) connections, the earth connections (carefully) and the earthing of the earth wire, the setting of the inverter. • Check the stability of the secondary voltages. • Check the rigidity of the frame and motor support. • Check motor fixing on its base. • Check the balancing. • Check the alignment between motor and load.
You find that the motor is too noisy	Several possible explanations : - Unsatisfactory mechanical balancing, - Defective coupling, - Loosening of several pieces, - Poor adjustment of the inverter of the position loop: check rotation with the loop open. - Low drive switching frequency.