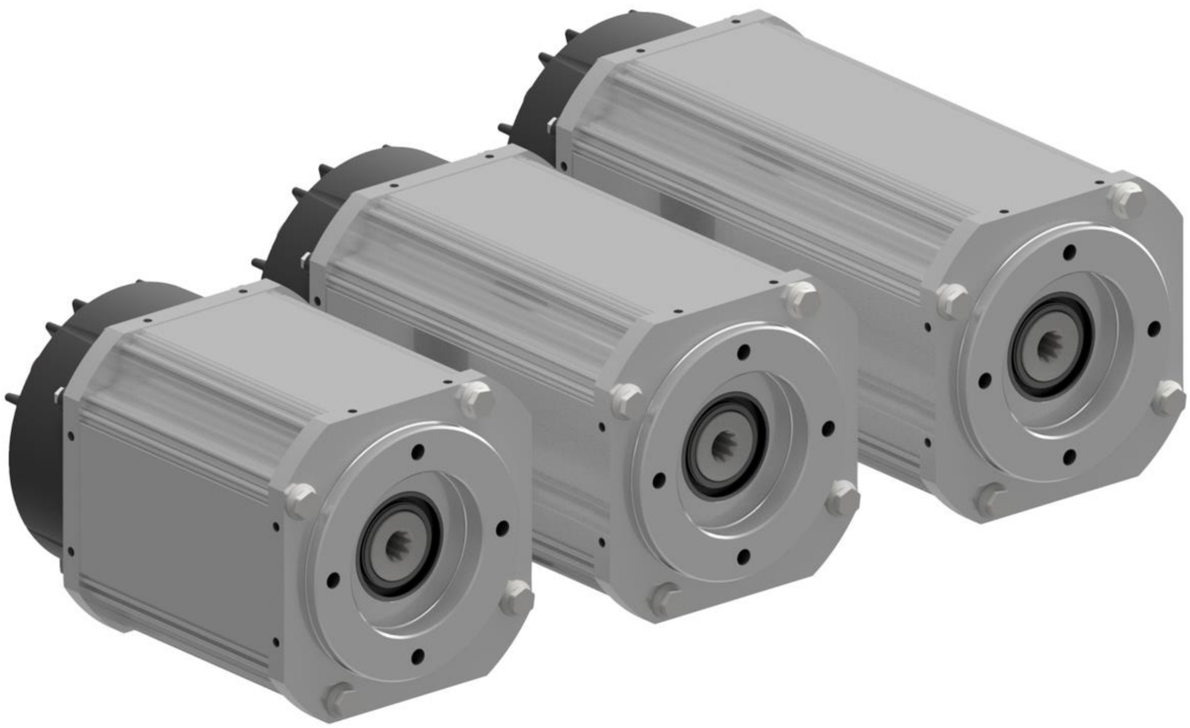
Servo motors

NX8xHM Series

Technical Manual

PVD 3691



EU DECLARATION OF CONFORMITY

We ,

Parker Hannifin Manufacturing France SAS
Electric Motion & Pneumatic Division
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 NX1 / NX2 / NX3 / NX4 / NX6 / NX8

satisfy the arrangements of the directives :

Directive 2014/35/EU : "Low Voltage Directive", LVD
Directive 2011/65/EU + delegated Directive (EU) 2015/863: RoHS 3 "Restriction of Hazardous Substances"
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 60034-5:2020 : 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 certify that the above mentioned model is procured in accordance with the above directives and standards.

Further information :

SERVOMOTORS shall be mounted on a mechanical support providing good heat conduction and not exceeding 40° C in the vicinity of the motor flange.

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

NX1 C.E. Marking : October 2004
NX2 C.E. Marking : November 2004
NX3 C.E. Marking : September 27th 2001

NX4 C.E. Marking : March 15th 2000
NX6 C.E. Marking : March 27th 2000
NX8 C.E. Marking : December 23th 2003

Longvic, June 11th 2021

In the name of Parker
R. WENDLING
Business Unit Manager

Raphael Wendling
Digital unterschrieben von Raphael Wendling
Datum: 2021.06.14 14:49:49 +02'00'

Ref : DCE-NX-001rev3

Table of Content

1. INTRODUCTION

1.1. Purpose and intended audience

This manual contains information that must be observed to select, install, operate and maintain PARKER NX8xHM servomotors.

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 case of missing information or doubts regarding the installation procedures, safety instructions or any other issue tackled in this manual, please contact PARKER as well.

PARKER's responsibility is limited to its servomotors 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

To operate safely, this equipment must be transported, stored, handled, installed and serviced correctly. Following the safety instructions described in each section of this document is mandatory. Servomotors 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

	**Generality** DANGER: The installation, commission 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) and local regulations. They must be authorized to install, commission and operate in accordance with established practices and standards.
	**Electrical hazard** Inverter may contain non-insulated live AC or DC components. Respect 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 subjected to dangerous voltages, when the motor is driven by the inverter , when the motor rotor is manually rotated, when the motor is driven by its load, when the motor is at standstill or stopped. 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. Allow at least 5 minutes for the inverter capacitors to discharge to safe voltage levels (<50V). Use the specified meter capable of measuring up to 1000V dc & ac rms to confirm that less than 50V is present between all power terminals and between power terminals and earth. The motor must be permanently connected to an appropriate safety earth.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 than 100mΩ 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 rotating part of the machine. The work place must be clean, dry. General recommendations : - Check the wiring circuit - Lock the electrical cabinets - Use standardized equipment
	**Mechanical hazard** Servomotors 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. 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 available on :
https://ph.parker.com/us/en/product-list/nx8hm-low-voltage-motor-for-electro-hydraulic-pump-applications

2.2. Overview

The NX8xHM motors from Parker are innovative solutions, specifically designed for low voltage low power Mobile applications like Electro Hydraulic Pump (EHP) or Auxiliary functions.

The NX8xHM motors are brushless synchronous servomotors, with permanent magnets, air cool motor and sincos speed sensor.
As there is no current in the rotor, the losses in the rotor are very low.

Advantages

- High power density
- High precision
- High motion quality
- Low inertia
- High dynamic performances
- Compact dimensions and robustness
- Large set of options and customization possibilities
- IP67 as standard

2.3. Applications

As these motors are dedicated for Mobile applications, they have been designed for rugged atmospheres and harsh environments for :

- Traction
- Pump
- Auxiliaries
- Steering

2.4. General Technical Data (to be update)

	NX8xHM
Motor type	Permanent-magnet synchronous motor
Magnets material	Neodymium Iron Boron
Number of poles	10
Degree of protection	IP67
Cooling	Natural convection
Rated voltage	Battery voltage from 24 to 96 Vdc
Insulation of the stator winding	Class H according to IEC 60034-1 with potting
Altitude	Up to 1000m (IEC 60034-1) (for higher altitude see §3.1.1 for derating)
Ambiant temperature	-20°C to +60°C Breathing membrane to avoid condensation
Storage temperature	-20… +85°C
Shaft	Female spline shaft SAE A
Connection	3 lugs for power connection TE HDSCS 12 pins for sensor connector
Marking	CE
Paint finish	Raw as a standard
Sensor	SinCos encoder
Thermal protection	PT1000

2.5. Product Code

Code	NX	8	6	H	M	S	C	A	6	G	00

Motor range
NX

Motor square size
8

Stack length module
2-4-6

Motor Thermal resistance
H : 180°C

Internal connection type
M: Mobile Low Voltage

Encoder
S : SinCos encoder

Winding choice
C-D-G…

Mechanical configuration
A: SAE-A
O: SAE A immersed in Oil

Power connection
6: Terminal + feedback connector TE

Thermal sensor
G: PT1000 on feedback connector

Customisation
00: Standard

Note: All assossiations are not possible – Contact Parker for checking.

3. TECHNICAL DATA

3.1. Motor selection

3.1.1. NX standard atmospheric conditions

NX motors are designed to operate on hybrid or electric vehicles.

3.1.2. Altitude derating

From 0 to 1000 m : no derating
1000 to 4000 m: torque derating of 10% for each step of 1000 m for air cooled
At hight altidude there is less air in the atmosphere, this reduce the cooling capacity of the motor so decrease its performance.

3.1.3. Temperature derating

3.1.3.1. Natural convection motor

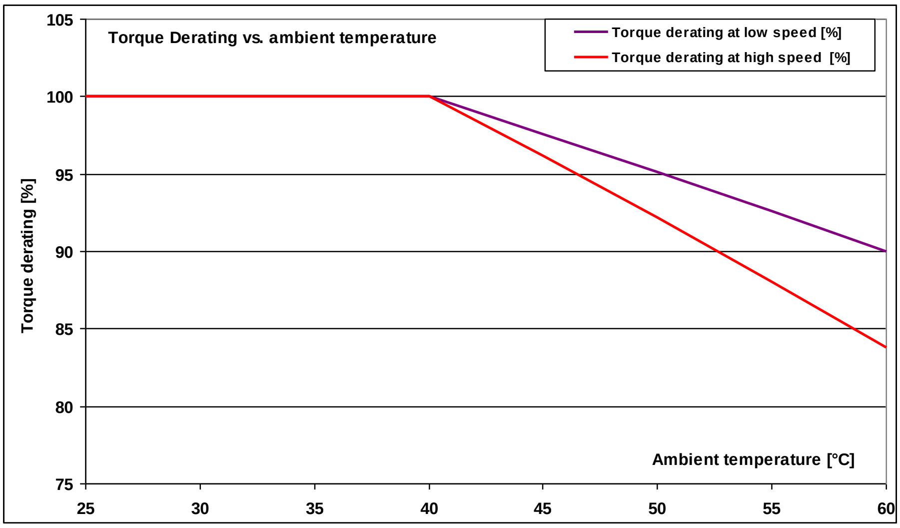
The maximal temperature for heat extraction through front flange is 60°C. But, it is possible to increase a little bit the ambient temperature above 60°C, with a torque reduction. The following formula gives an indicative about the torque derating at low speed. But in any case refer to PARKER technical department to know the exact values

At low speed (Below 50 rpm) the torque derating is given by the following formula for an ambient temperature > 60°C.

$$Torque\_derating[\%] = 100 * \sqrt{\frac{(145°C - Ambient\_temperature°C)}{105°C}}$$

	At high speed, the calculation is more complex, and the derating is much more important. Please refer to PARKER to know the precise data of Torque derating according to ambient temperature at high speed for a specific motor.

Illustration: Only for example given for the NX82HM :



3.1.4. Thermal equivalent torque (rms torque)

The selection of the right motor can be made through the calculation of the rms torque M_{rms} (i.e. root mean squared torque) (sometimes called equivalent torque).
This calculation does not take into account the thermal time constant. It can be used only if the overload time is much shorter than the copper thermal time constant.
The rms torque M_{rms} reflects the heating of the motor during its duty cycle.
Let us consider:
- the period of the cycle ***T*** *[s],*
- the successively samples of movements ***i*** characterized each ones by the maximal torque M_i *[Nm]* reached during the duration Δt_i *[s]*.

So, the rms torque M_{rms} can be calculated through the following basic formula:

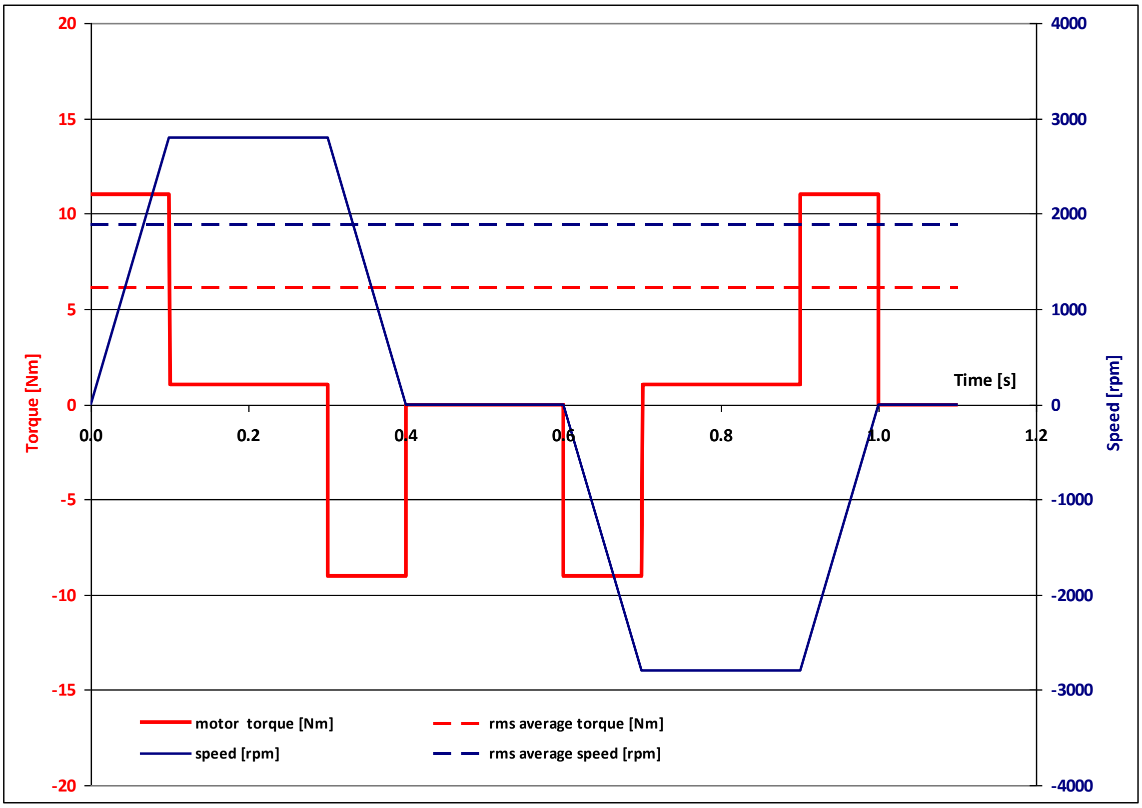
$$M_{rms} = \sqrt{\frac{1}{T} * \sum_{i=1}^{n} M_i^2 \Delta t_i}$$

Example:
For a cycle of 2s at 0 Nm and 2s at 10Nm and a period of 4 s, the rms torque is

$$M_{rms} = \sqrt{\frac{1}{4} * 10^2 * 2} = 7{,}07\,Nm$$

Illustration :

Acceleration-deceleration torque:	10 Nm for 0,1 s.
Resistant torque:	1 Nm during all the movement.
Max-min speed:	± 2800 rpm during 0,2 s.
Max torque provided by the motor:	11 Nm.
rms torque:	6 Nm.



The maximal torque M_i delivered by the motor at each segment ***i*** of movement is obtained by the algebric sum of the acceleration-deceleration torque and the resistant torque. Therefore, M_{max} corresponds to the maximal value of M_i.

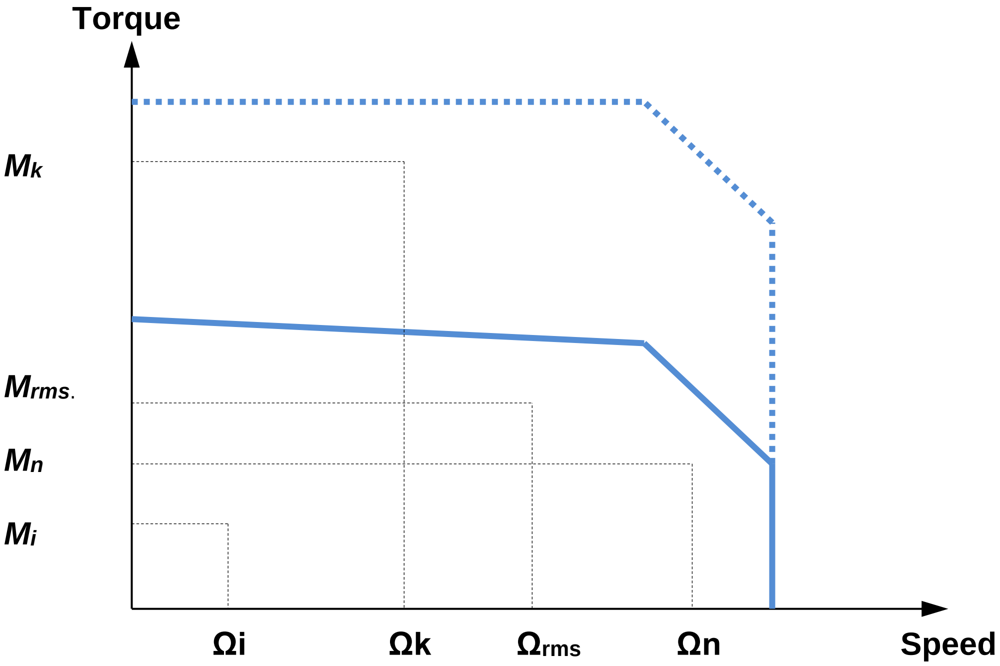
Selection of the motor :

The motor adapted to the duty cycle has to provide the rms torque M_{rms} at the average speed(*) without extra heating. This means that the permanent torque M_n available at the average speed presents a sufficient margin regarding the rms torque M_{rms}.

$$\Omega_{rms} = \sqrt{\frac{1}{T} * \sum_{i=1}^{n} \Omega_i^2 \Delta t_i}$$

(*) rms speed is calculated thanks to the same formula as that used for the rms torque. The mean speed cannot be used (in general mean speed is equal to zero).
Only use the rms speed.

Furthermore, each Mi and speed associated Ωi of the duty cycle has to be located in the operational area of the torque vs speed curve.



3.1.5. Inverter selection

The Inverter selection depends at first on the batery voltage and then on its rated and max available current values ; the maximal output frequency has to be checked as convenient depending on the desired maximum motor rotation speed (NX8xHM is a 10 poles motor).

Please refer to the inverter technical documentation for any further information and to select the best motor and inverter 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 inverter 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:

$$\text{Speed limitation}(\text{rpm}) = \frac{2 * \text{Max\_inverter\_frequency}(\text{Hz}) * 60}{\text{Number\_of\_poles}}$$

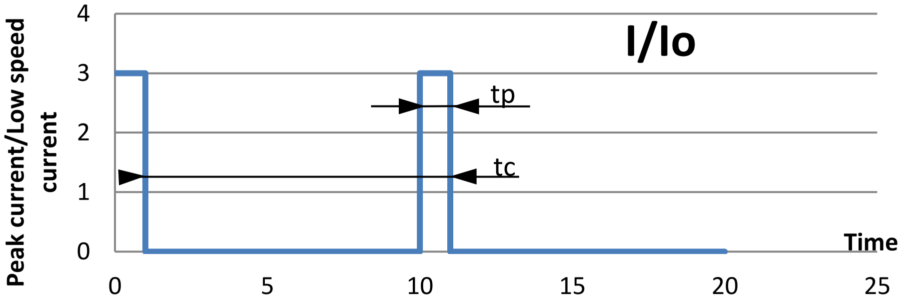
3.1.6. Current limitation at stall conditions (i.e. speed < 3 rpm)

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), imperatively limit the current to 70% of I_0 (permanent current at low speed), in order to avoid an excessive overheating of the motor.
	Please refer to the drive technical documentation for any further information and to choose functions to program the drive.

3.1.7. Peak current limitations



It is possible to use the NX8xHM motor with a current higher than the permanent current. But, to avoid any overheating, the following rules must be respected.

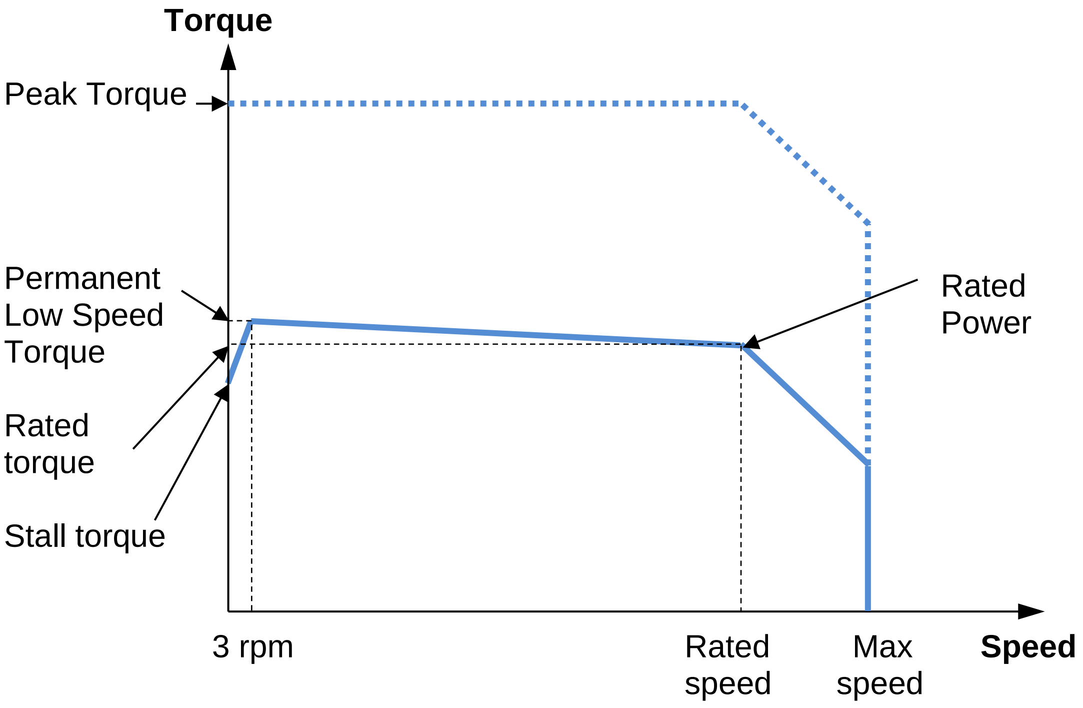
1) The peak currents and peak torques given in the data sheet must never be exceeded
2) The thermal equivalent torque must be respected (§3.1.3)
3) If 1) and 2) are respected (it can limit the peak current value or duration), the peak current duration (tp) must be limited, in addition, accordingly to the following table (Io is the permanent current at low speed):

Ipeak/In	Ip/Io =2	Ip/Io = 3	Ip/Io =4	Ip/Io >5
NX82HM	tp<1.5s	tp<0.6s	tp<0.3s	tp<0.2s
NX84HM				
NX86HM				

The peak current duration is calculated for a temperature rise of 3°C
Consult us for more demanding applications.

3.2. NX8xHM Characteristics and inverter association

The torque vs speed graph below explains different intrinsic values of the next tables.



3.2.1. NX8xHM datas

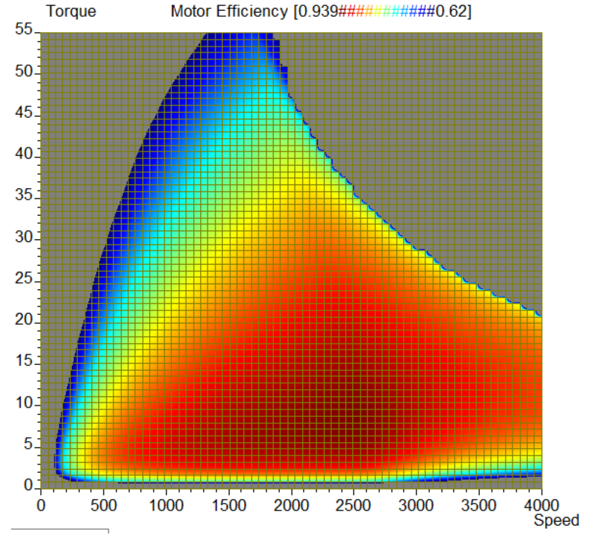
Inverter input voltage	Motor Type*	Max speed rpm	Rated torque N.m	Rated kW
24Vdc	NX82HMSC	4000	19.1	5.61
	NX84HMSC	2000	37.7	5.33
	NX86HMSC	1250	51.7	4.9
48Vdc	NX82HMSE	5000	18.2	6.66
	NX84HMSE	3000	35.1	7.99
	NX86HMSE	2600	46	9.09
96Vdc	NX82HMSM	4200	19.3	5.53
	NX84HMSM	3500	34.2	9.1
	NX86HMSM	3000	42.6	10.4

Motor data for standard air cooled with front flange surface exchange of 60°C
*other windings available on request. Please contact Parker.

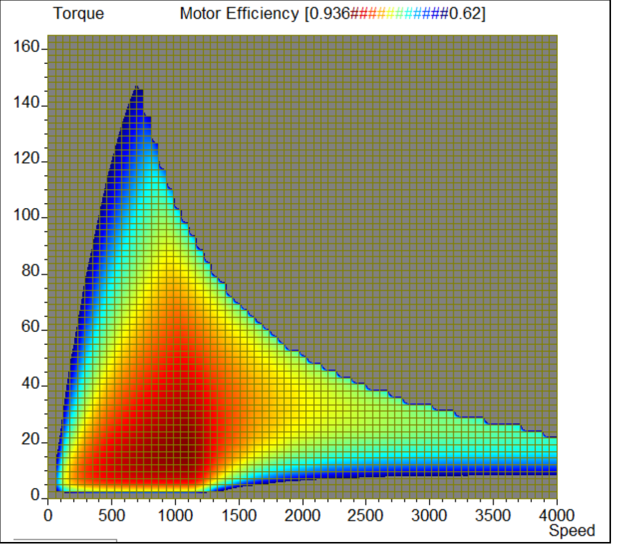
3.2.2. Efficiency curves

24Vdc :

NX82HMSD

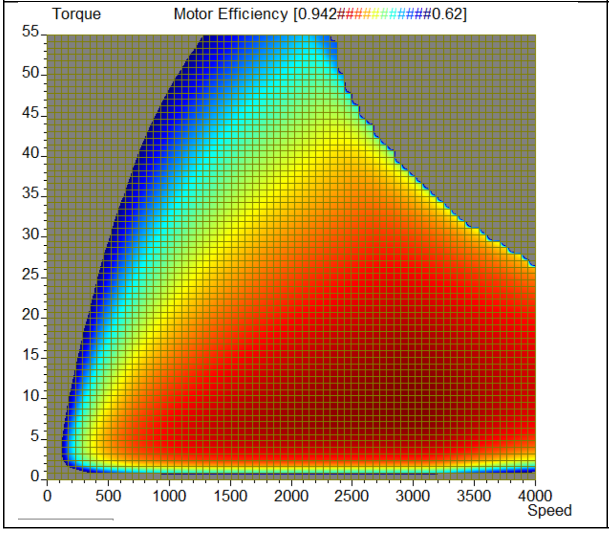


NX86HMSC

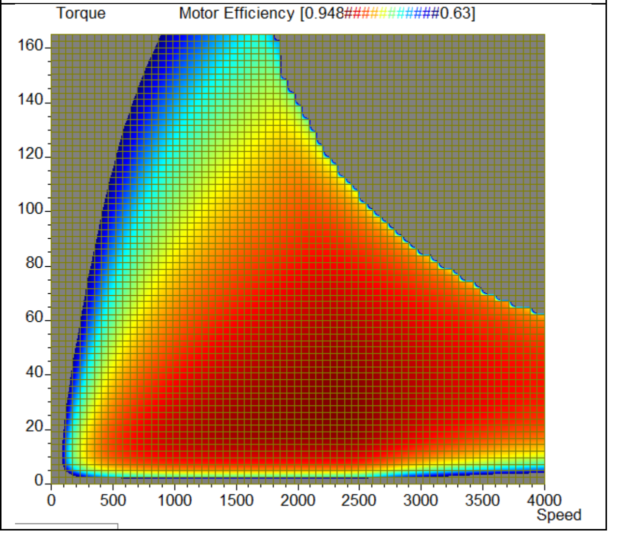


48Vdc :

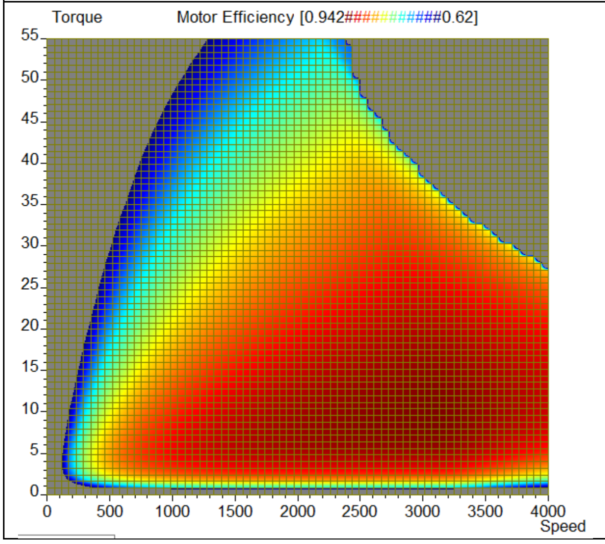
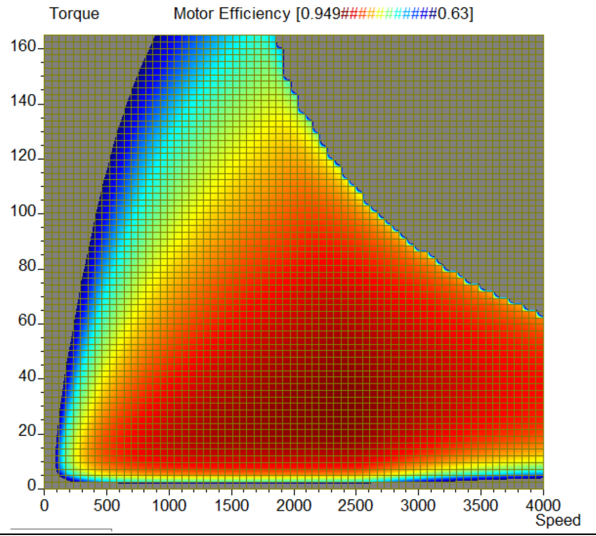
NX82HMSG



NX86HMSC



96Vdc :

NX82HMSN	NX86HMSF
	

Other efficiency curves available on request. Please contact Parker.

	<u>Caution:</u> The efficiency curves are typical values. They may vary from one motor to an other

	<u>Caution:</u> The efficiency curves are given for an optimal motor control (no voltage saturation and optimal phase between current and EMF)

	<u>Caution:</u> The efficiency curves are including the losses due to the switching frequency. (Curves without this losses available on request)

3.2.3. Electromagnetic losses

⚠	Caution: Following data result from our best estimations but are indicative. They can vary from one motor to another and with temperature. No responsibility will be accepted for direct or indirect losses or damages due to the use of these data.

(Following data are indicative)

Type	Tf [Nm]	Kd [Nm/1000rpm]
NX82HM	0.160	0.300
NX84HM	0.190	0.380
NX86HM	0.220	0.460

Torque losses = Tf + Kd x speed/1000

3.2.4. Time constants of the motor (update the example and data)

3.2.4.1. Electric time constant:

$$\tau_{elec} = \frac{L_{ph\_ph}}{R_{ph\_ph}}$$

With following values given in the motor data sheet
$\boldsymbol{L_{ph\_ph}}$ inductance of the motor phase to phase [H],
$\boldsymbol{R_{ph\_ph}}$ resistance of the motor phase to phase at 25°C [Ohm].

Example:
Motor series NX86HMAF
L_{ph_ph} = 0.226 mH or 0.226 .10^{-3} H
R_{ph_ph} at 25°C = 0.0182 Ohm
→ σ_{elec} = 0.226.10^{-3}/0.0182= **0.0124 s**

An overall summary of motor time constants is given a little further.

3.2.4.2. Mechanical time constant:

$$\tau_{mech} = \frac{R_{ph\_n} * J}{Kt * Ke_{ph\_n}} = \frac{0.5 * R_{ph\_ph} * J}{(3 * \frac{Ke_{ph\_ph}}{\sqrt{3}}) * \frac{Ke_{ph\_ph}}{\sqrt{3}}}$$

$$\tau_{mech} = \frac{0.5 * R_{ph\_ph} * J}{(Ke_{ph\_ph})^2}$$

With following values obtained from the motor data sheet:
$\boldsymbol{R_{ph\_ph}}$ resistance of the motor phase to phase at 25°C [Ohm],
J inertia of the rotor [kgm²],
$\boldsymbol{Ke_{ph\_ph}}$ back emf coefficient phase to phase [V_{rms}/rad/s].

The coefficient $\boldsymbol{Ke_{ph\_ph}}$ in the formula above is given in [V_{rms}/rad/s]
To calculate this coefficient from the datasheet, use the following relation:

$$Ke_{ph\_ph[V_{rms}/rad/s]} = \frac{Ke_{ph\_ph[V_{rms}/1000rpm]}}{\frac{2 * \pi * 1000}{60}}$$

Example:
Motor series NX86HMAF (at 96V)
R_{ph_ph} at 25°C = 0.0182 Ohm
J = 0.0092 kgm²
Ke_{ph_ph} [V_{rms}/1000rpm] = 26.2 [V_{rms}/1000rpm]
→ Ke_{ph_ph} [V_{rms}/rad/s] = 26.2/(2*π*1000/60) = 0.25 [V_{rms}/rad/s]
→ σ_{mech}=0.5*0.0182*0.0092 /(0.25²) = **0.0013s**

Remarks:

For the NX8xHM motor, the mechanical time constant σ_{mech} represents the duration needed to reach 63% of the final speed when applying a voltage step without any resistant torque. However this value makes sense only if the electric time constant σ_{elec} is much smaller than the mechanical time constant σ_{mech}.

An overall summary of motor time constants is given a further.

3.2.4.3. Thermal time constant of the copper:

$$\tau_{therm} = Rth_{copper\_iron} * Cth_{copper}$$

$$Cth_{copper[J/°K]} = Mass_{copper[Kg]} * 389_{[J/kg°K]}$$

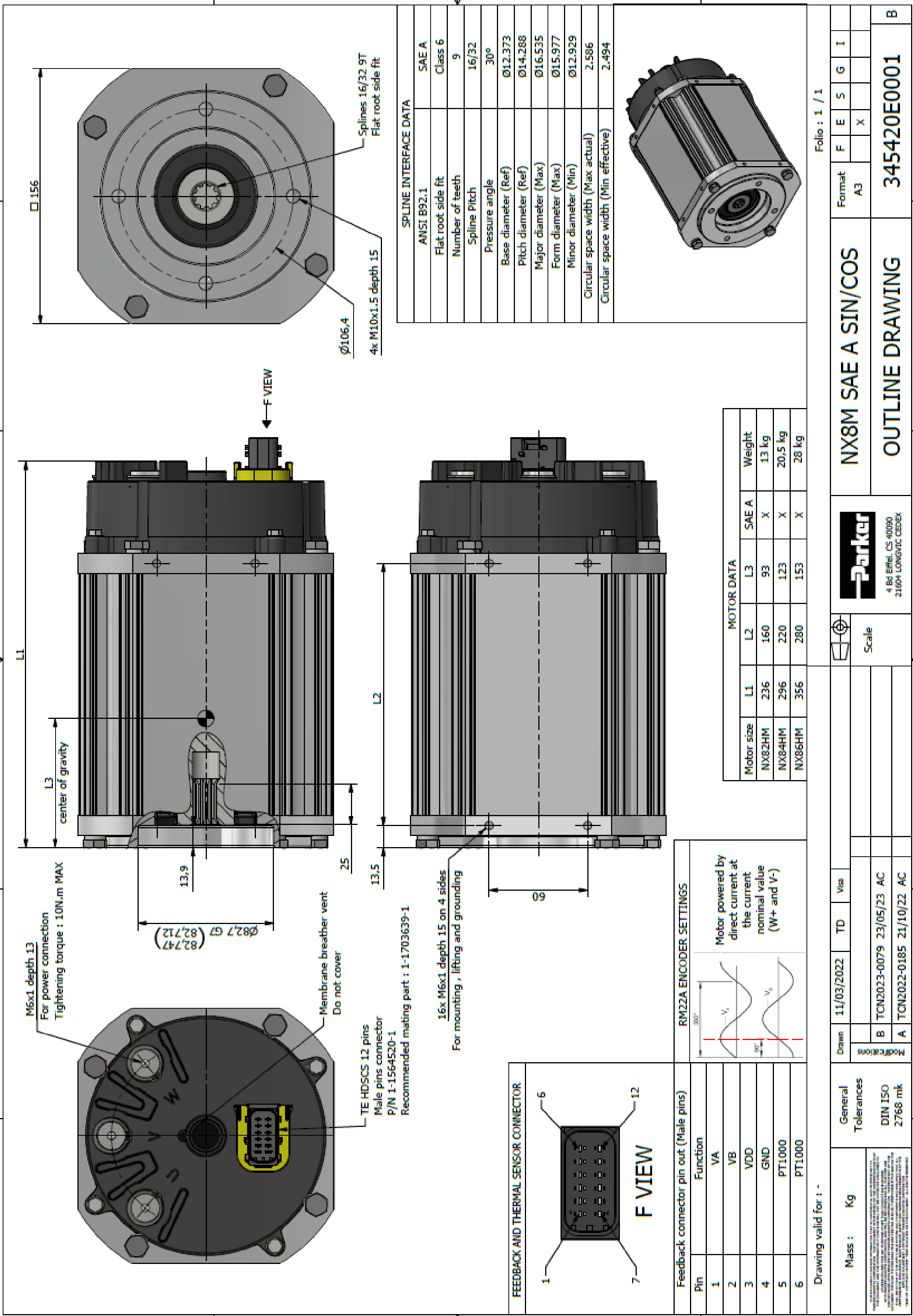
With:

***Rth**copper_iron* thermal resistance between copper and iron [°K/W]
***Cth**copper* thermal capacity of the copper [J/°K]
***Mass**copper* mass of the copper (winding) [kg]

Hereunder is given an overall summary of motor time constants:

Type	Electric time constant [ms]	Mechanical time constant [ms]	Thermal time constant of copper [s]
NX82HM	8.5	2.1	78.8
NX84HM	11.1	1.5	91.8
NX86HM	12.4	1.3	113

3.3. Dimension drawings



SPLINE INTERFACE DATA	
ANSI B92.1	SAE A
Flat root side fit	Class 6
Number of teeth	9
Spline Pitch	16/32
Pressure angle	30°
Base diameter (Ref)	Ø12.373
Pitch diameter (Ref)	Ø14.288
Major diameter (Max)	Ø16.535
Form diameter (Max)	Ø15.977
Minor diameter (Min)	Ø12.929
Circular space width (Max actual)	2.586
Circular space width (Min effective)	2.494

MOTOR DATA					
Motor size	L1	L2	L3	SAE A	Weight
NX82HM	236	160	93	X	13 kg
NX84HM	296	220	123	X	20,5 kg
NX86HM	356	280	153	X	28 kg

Feedback connector pin out (Male pins)	
Pin	Function
1	VA
2	VB
3	VDD
4	GND
5	PT1000
6	PT1000

Motor size	L1 [mm]	L2 [mm]	SAE A	Weight [kg]
NX82HM	235.5	160	X	13
NX84HM	295.5	220	X	20.5
NX86HM	355.5	280	X	28

3.4. Motor Mounting

3.4.1. Motor mounting environment

Ideal mounting areas for motors:

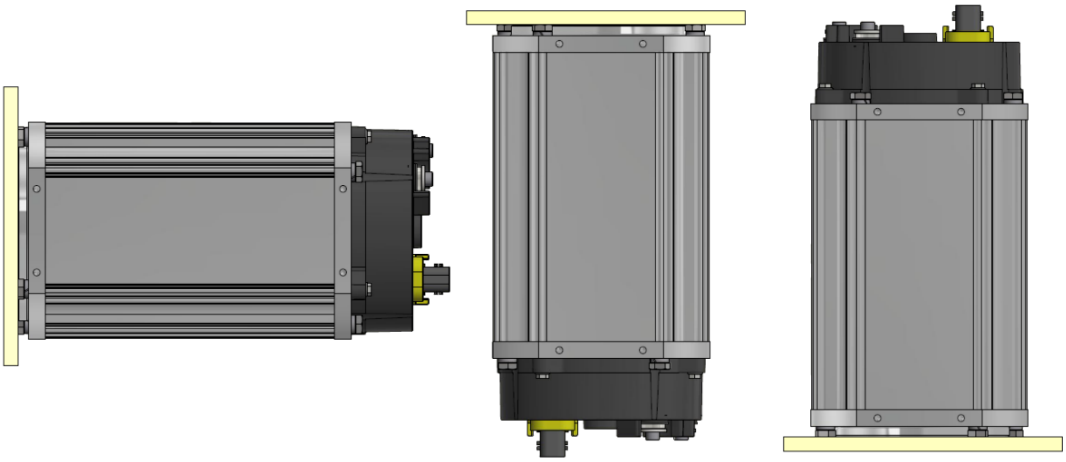
In a location away or shielded from other vehicle heat sources such as exhaust, or catalytic converters etc.

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

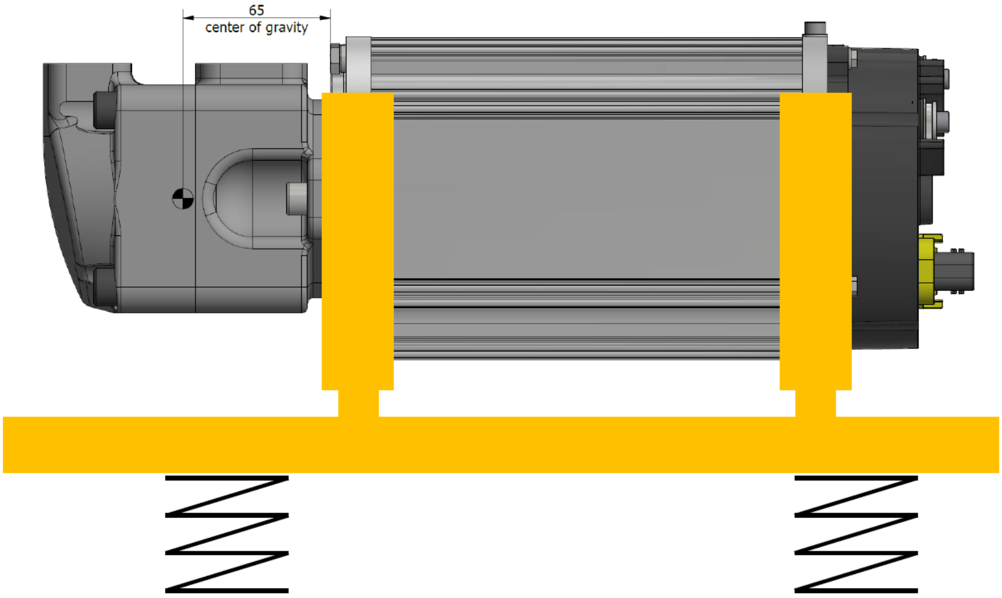
In a location that is protected from flying rocks, debris, road salt, or other contaminants that could damage cabling and connections.

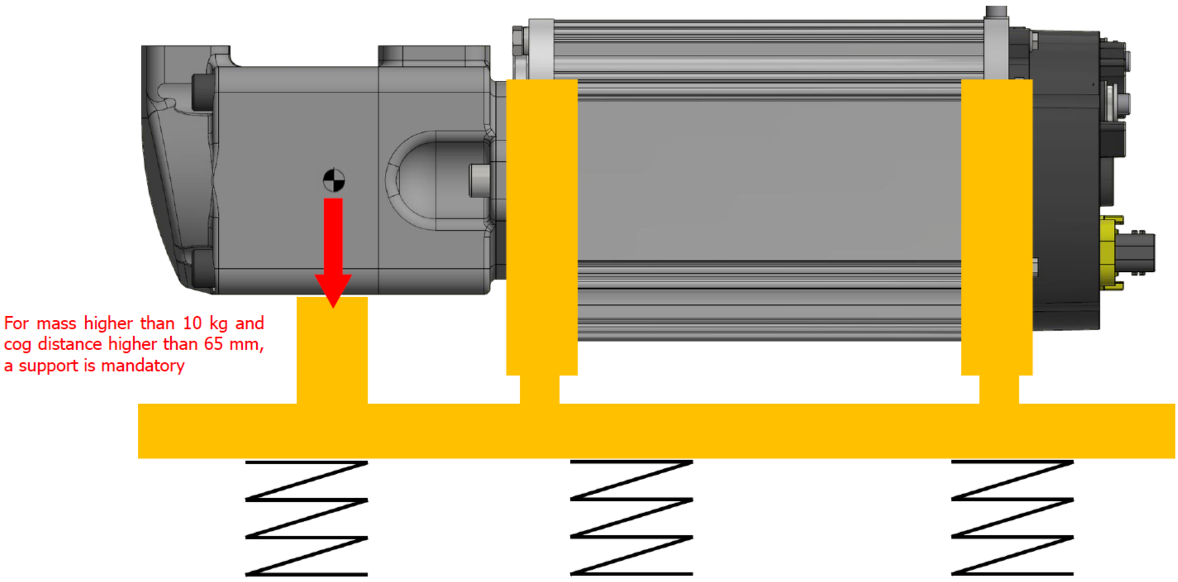
3.4.2. Motor mounting

By flange in any direction



For the Electro Hydraulic Pumps (EHP), it is better to place the EHP on a flat surface that will be able to support the NX8xHM motor and the pump. The maximum overhang mass supported by the NX8xHM depends on the weight and centre of gravity of the pump as well as the shock and vibration level it will be submitted to. To reduce the noise level, this flat surface can be insulated from the vehicle chassis using damping material.





	NX8xHM motors have been designed for being assembled on hydraulic pumps and cannot support any axial / radial additional load on the shaft.
	NX8xHM 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.

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 it.
  - Rotate the motor at low speed (between 10 and 15 rpm as an example) and gradually tighten the screws.
  - The tightening torque of the mounting screws of the equipment is indicated §4.2.1

3.4.1. 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 NX8xHM must be even, sufficiently rigid and shall be dimensioned in order to avoid vibrations due to resonances.

3.5. Oil Immersion

If you use the NX8xHM with a hydraulic pump, it is possible to put it inside an Hydraulic Mobil DTE™ 20 Series Oil tank – for other oil types, please contact Parker.

Because the oil gets inside the motor (no more breathing membrane neither front lip seal), the current will increase slightly to counteract the friction of the oil.

Benefits :

- Cooling : the motor will have a better cooling than air due to the better property of the hydraulic oil.

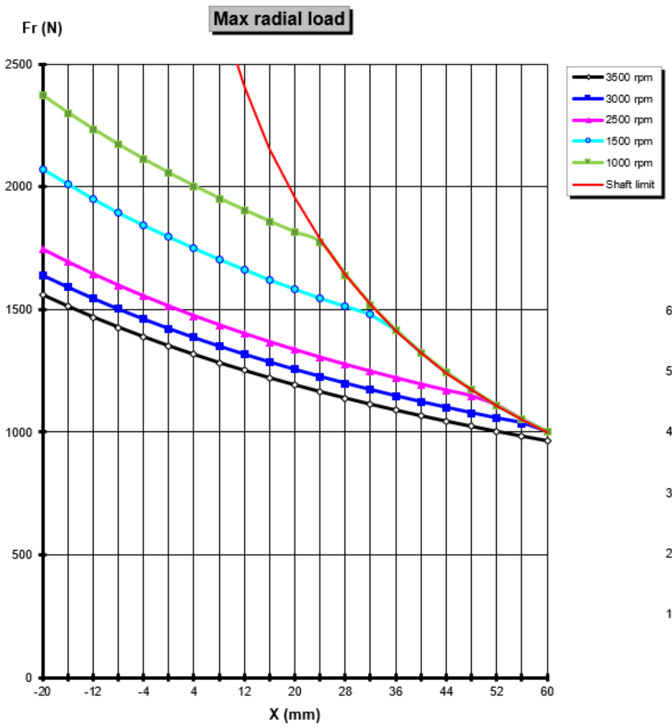
- Silent : the oil immersion will drastically decrease the sound level

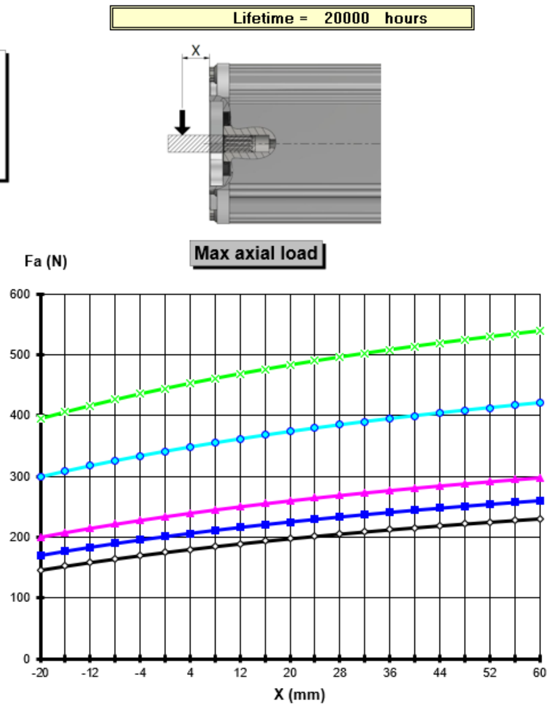
3.6. Shaft Loads / Bearings

3.6.1. Motors life time for horizontal mounting

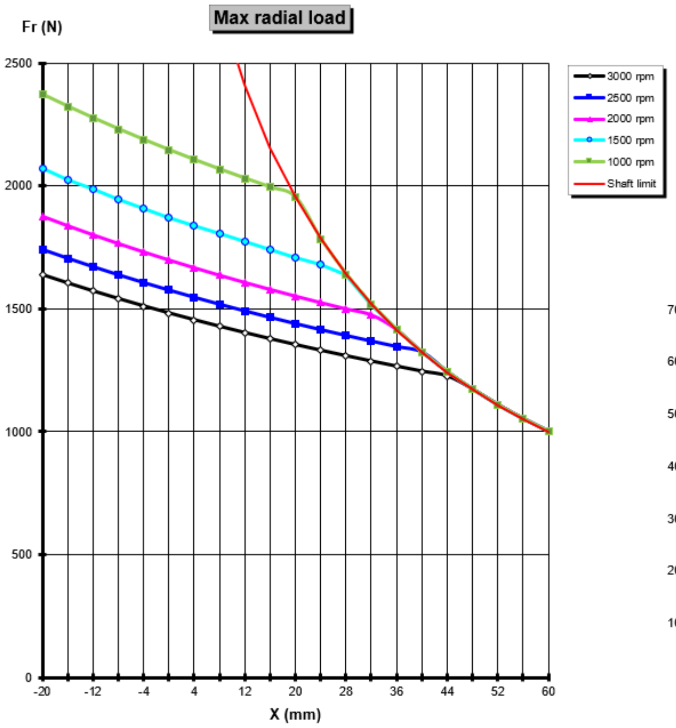
	The bearing arrangement is made with 2 ball bearings (one on the shaft end + another on the rear). The rear bearing is blocked in axial translation and the front one is free in translation to avoid any stress from the shaft thermal expansion during the running. So, it is important not to block in translation the shaft expansion by any extra bearing or similar device.
	Notice: Curves below are valid only for horizontal mounting and a life time L10 of 20 000h at constant speed in accordance with ISO281. Notice: Radial and Axial Loads are not additive

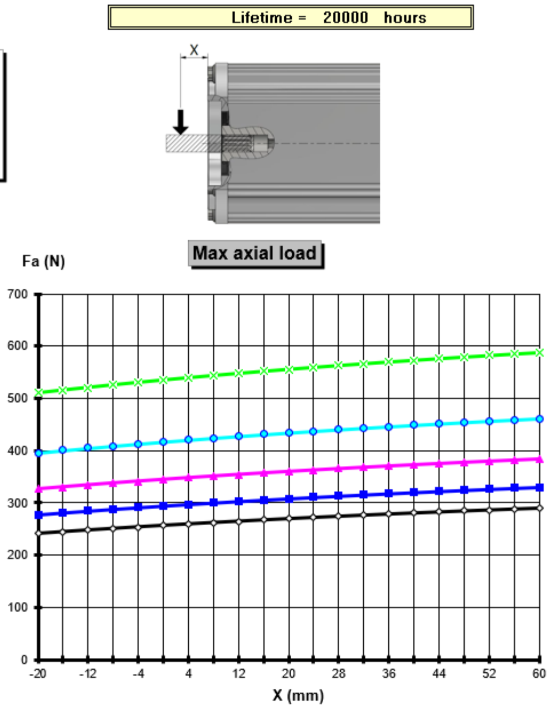
3.6.1.1. NX82HM



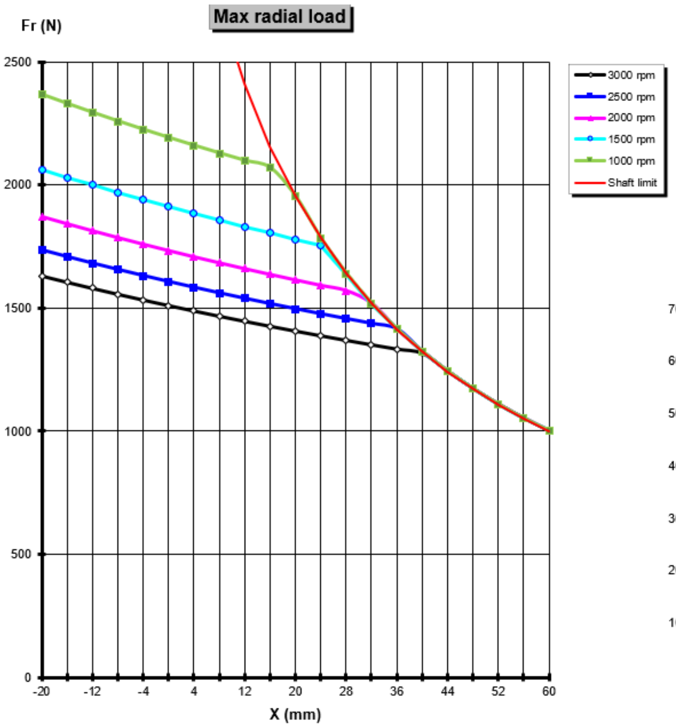


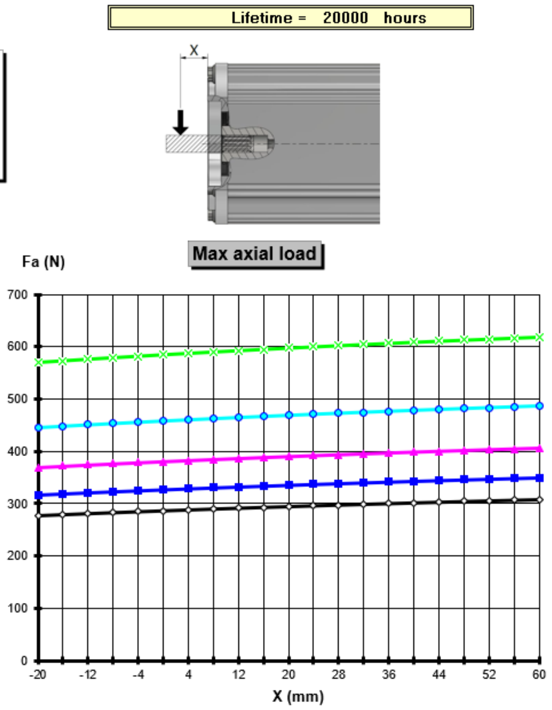
3.6.1.2. NX84HM





3.6.1.3. NX86HM





3.7. Cooling

In compliance with the IEC 60034-1 standards:

3.7.1. Natural convection cooling

The ambient air temperature shall not be less than **-20°C** and more than **60°C.**

It is possible to use the motors in an higher ambient temperature but with an associated derating to the motor performances.

Warning: To reach the motor performances calculated, the motor must be thermally well connected to a flange with a temperature below 60°C

Caution: the ambient air temperature shall not exceed 60°C in the vicinity of the motor flange

Warning: A significant part of the heat produced by the motor is evacuated through the flange.

- if the air is not able to circulate freely around the motor,
- if the motor is mounted on a surface that dissipates not well the heating (surface with little dimensions for instance),
- if the motor is thermally isolated,
- if the motor is mounted on a warm surface (mounted on a gearbox for instance),

then the motor has to be used at lower torque value than the rated one.

3.8. Thermal Protection

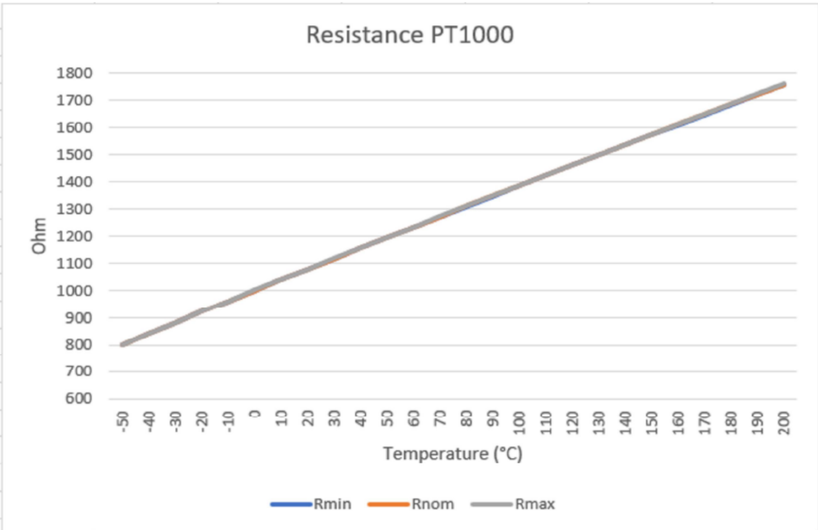
The NX8xHM include protection against thermal overloading of the motor with a PT 1000 thermistor built into the stator winding.
The thermal sensors, due to their thermal inertia, are unable to follow very fast winding temperature variations. They acheive their thermal steady state after a few minutes.

	Warning: To protect correctly the motor against very fast overload, please refer to 3.1.6. Peak current limitations

3.8.1. Temperature measurement with PT1000 sensors :

Motor temperature can also be continuously monitored by the drive using a PT 1000 thermal sensor built in to the stator winding. PT 1000 sensors are semiconductor sensors that change their resistance according to an approximately linear characteristic. The required temperature limits for alarm and tripping can be set in the drive.

The graph below shows PT1000 resistance vs temperature:



Temperature	Rmin	Rnom	Rmax
-50	803	803	803
-40	843	843	843
-30	882	882	882
-20	921	922	922
-10	961	961	961
0	1000	1000	1000
10	1039	1039	1039
20	1078	1078	1078
30	1116	1117	1117
40	1155	1155	1156
50	1193	1194	1195
60	1232	1232	1233
70	1270	1271	1271
80	1308	1309	1310
90	1346	1347	1348
100	1384	1385	1386
110	1422	1423	1424
120	1460	1461	1462
130	1497	1498	1499
140	1535	1536	1537
150	1572	1573	1574
160	1609	1610	1612
170	1646	1648	1649
180	1683	1685	1686
190	1720	1722	1723
200	1757	1758	1760

3.9. Power Electrical Connections

3.9.1. Cables sizes

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

Not limiting example in France: NFC 15-100 or IEC 60364 as well in Europe.

⚠	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 cable has to support peak current for a long period. So, if the motor works at standstill, the current to select wire size is $\sqrt{2} \times 0.8\ Io \cong \mathbf{1{,}13 \times I_o}$.

Parker recommends to use the following cables Huber+Suhner Radox 155(S) with EMI screen. See datasheet below for minimum bending radius for flexing and fixed installations as well as manufacturer part number details.

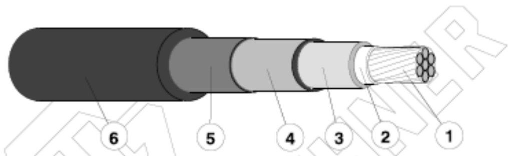
Automotive cable, single-core, screened

RADOX 155(S) / RADOX Elastomer S (FHLR91XC13X and FHLR4GC13X)

General Properties:
Excellent resistance to high and low temperature, ozone, UV and weathering resistance, resistant to pressure at high temperature, motor oil, fuels and hydrolysis, flame retardant, high abrasion resistant, solder iron resistant, easy to strip and process, according to ISO 6722-1 class D, ISO 19642-9 class D.

Complies with EU-directive 2000/53/EG on end of life vehicles. All materials are free from lead, mercury, cadmium and chrome VI.

Application:
Cable, for use in road vehicle applications.



1. Conductor: Bare copper, stranded acc. to ISO 6722-1 / ISO 19642-9, structure B
2. Coverage: Tape
3. Insulation: RADOX 155S (91X) for ≤ 6 mm^2
RADOX 155 (4G) for > 6 mm^2
4. EMC-screen: Tin plated copper braid optimised
5. Wrapping: Tape
6. Sheath: RADOX Elastomer S (13X), colour: orange

Printing on sheath: H+S XXXXXXXX - %%%%%% ↓ ATTENTION HIGH VOLTAGE MAX 1000VAC/ 1500VDC ↓
- Production lot number
- Item number

Technical Data:

Voltage rating	U_0	1000	V AC
Voltage rating.	V_0	1500	V DC
Test voltage, 50 Hz, 5 min.		10	kV AC
Temperature range (3000 h)		- 40 ... + 150	°C
Min. bending radius	fixed	4 x cable D	
	flexing	6 x cable D	

Automotive cable, single-core, screened

RADOX 155(S) / RADOX Elastomer S (FHLR91XC13X and FHLR4GC13X)

Cross-section	Conductor				Cable					
Nominal mm^2	Number of individual wires Guide value	Diameter of individual wires max. mm	Diameter max. mm	Resistance at 20 °C max. Ω/km	Diameter of Insulation nom. mm	Diameter of Screen max. mm	Overall-Diameter Nominal mm	Z_T at 30 MHz Nominal mΩ/m	Weight Nominal kg/100m	H + S Part No.
2.5	50	0.26	2.0	7.60	2.85	3.3	5.0 ± 0.2	100	4.9	12 582 675
4	56	0.31	2.5	4.71	3.55	4.0	5.8 ± 0.2	110	7.0	12 582 674
6	84	0.31	3.0	3.14	4.15	4.7	6.6 ± 0.3	70	9.8	12 582 309
8	60	0.41	3.8	2.38	5.05	5.6	7.6 ± 0.3	40	12.5	84 119 801
10	78	0.41	4.3	1.82	5.75	6.3	8.4 ± 0.3	30	15.8	84 100 295
12	92	0.41	4.7	1.52	6.10	6.7	8.9 ± 0.3	30	17.9	84 119 803
16	126	0.41	5.4	1.16	6.90	7.5	9.7 ± 0.3	40	23.0	84 116 032
20	154	0.41	6.2	0.955	7.60	8.3	10.6 ± 0.3	30	28.2	84 119 804
25	189	0.41	6.7	0.743	8.20	8.9	11.2 ± 0.3	40	32.8	84 100 604
30	224	0.41	7.4	0.647	9.10	9.8	12.1 ± 0.3	30	38.5	84 119 805
35	273	0.41	7.9	0.527	9.70	10.4	12.7 ± 0.3	60	44.7	84 100 296
40	301	0.41	8.5	0.473	10.40	11.3	13.6 ± 0.3	20	51.3	84 119 806
50	385	0.41	9.4	0.368	11.50	12.6	14.9 ± 0.3	30	64.2	84 096 257
60	294	0.51	10.6	0.315	12.60	13.5	15.9 ± 0.3	30	73.1	84 119 807
70	360	0.51	11.6	0.259	13.70	14.6	17.0 ± 0.3	30	85.8	84 100 298
95	480	0.51	13.5	0.196	16.20	17.3	19.9 ± 0.4	20	115.3	84 100 299
120	589	0.51	15.1	0.153	18.00	19.1	22.6 ± 0.4	20	145.5	84 103 410
150	741	0.51	17.0	0.122	20.00	21.3	24.9 ± 0.5	30	177.4	84 111 254

Parker

Considering the cables conditions of use, please consult the manufacturer web site.

You also have to respect the Drive commissioning manual and the cables current densities or voltage specifications

3.9.2. Conversion Awg/kcmil/mm²:

Awg	kcmil	mm²
	500	253
	400	203
	350	177
	300	152
	250	127
0000 (4/0)	212	107
000 (3/0)	168	85
00 (2/0)	133	67.4
0 (1/0)	106	53.5
1	83.7	42.4
2	66.4	33.6
3	52.6	26.7
4	41.7	21.2
5	33.1	16.8
6	26.3	13.3
7	20.8	10.5
8	16.5	8.37
9	13.1	6.63
10	10.4	5.26
11	8.23	4.17
12	6.53	3.31
14	4.10	2.08
16	2.58	1.31
18	1.62	0.82
20	1.03	0.52
22	0.63	0.32
24	0.39	0.20
26	0.26	0.13

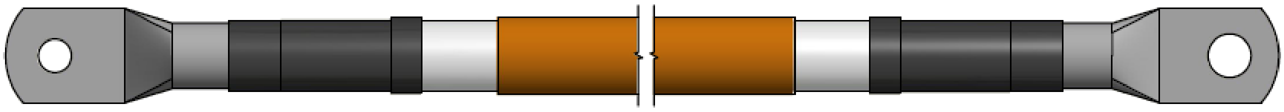
3.9.3. Motor cables

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 inverter output if the length of the cable exceeds 5 m. Consult us.

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

Parker can provide High Power cables, to be placed between the motor and the drive, with standard lengths of 1, 2, 3 or 4 meters.



Depending on the rated motor current, indicated on the motor datasheet, 2 cable cross-sections can be proposed as follows :

Terminal Mot / Drive	Motor Rated Curent up to 190A	Motor Rated Curent over 190A
M6/M6	CBM250H0-RC6-RC6-00x0-00	
M6/M8	CBM250H0-RC6-RC8-00x0-00	CBM500H0-RC6-RC8-00x0-00
M6/M6	CBM250H0-RC6-RC6-00x0-00	
M6/M8	CBM250H0-RC6-RC8-00x0-00	CBM500H0-RC6-RC8-00x0-00
M6/M10	CBM250H0-RC6-RC10-00x0-00	CBM500H0-RC6-RC10-00x0-00

Depending on the required cable length (1, 2, 3 or 4m), the "x" letter of the part number is to be replaced by 1, 2, 3 or 4

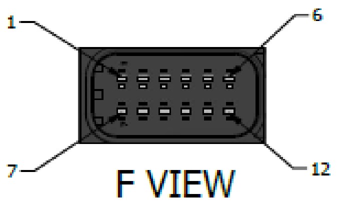
The minimum bending radius is 4 times the cable diameter, for the CBM250 = 40 mm; for the CBM500 = 60 mm.

Please note that you can use the same type of cables between the inverter and the battery (modifying the terminal on the battery side)

3.10. Feedback system

3.10.1. Sin Cos Encoder

Parker part number	220285P0002
Electrical specification	Values @ 500 Hz
Input voltage	5 Vrms ± 5%
Input current	20 mA maximum
Encoder accuracy	± 0,5° maxi
Internal serial impedance	720 Ω

Sin-Cos Encoder connector	PIN	Signal
	1	VA
	2	VB
	3	VDD
	4	GND
	5	PT1000
	6	PT1000

To connect to the encoder connector you need this parts:

The connector TE HDSCS 12 (ref 1-1703639-1)
Female crimp contact (ref 1418884-3)
This connector requires the use of plugs (ref 964972-1) to fill the used pins.
It is also necessary to ad seal on each unused pin (ref 963531-1)

In this configuration, this connector need a wire section of 0.5 to 1.5mm² and Accepts Cable Insulation Diameter of *2.4 mm*

	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 inverter body.

3.11. Motor Drive Connection Rules

General EMC rules:

- Never mix battery and motor cables
- Always ground the motor housing. Ground the motor on the vehicle frame, or on the inverter itself. Wide braid straps are recommended rather than wires. If wires, they must be as shorter as possible to avoid coil effect. Metal plate (with multiple bonds) is also good for EMC

Each Drive has its own connection rules, typically about shielding connection.

For best noise immunity, all power cables (motor / battery) should not run across the centre section of the controller.
Low current signal wires should not run parallel to the motor cables. When necessary, they should cross the motor cables at right angle to minimize noise coupling.
Following instructions are given as general rules to respect for standard architecture, all other connections like I/O, throttles … must respect rules as well. Some adjustments could be necessary.
All connections, settings, architectures are not under PARKER responsibility

Cable shielding connections:

Motor and battery cables

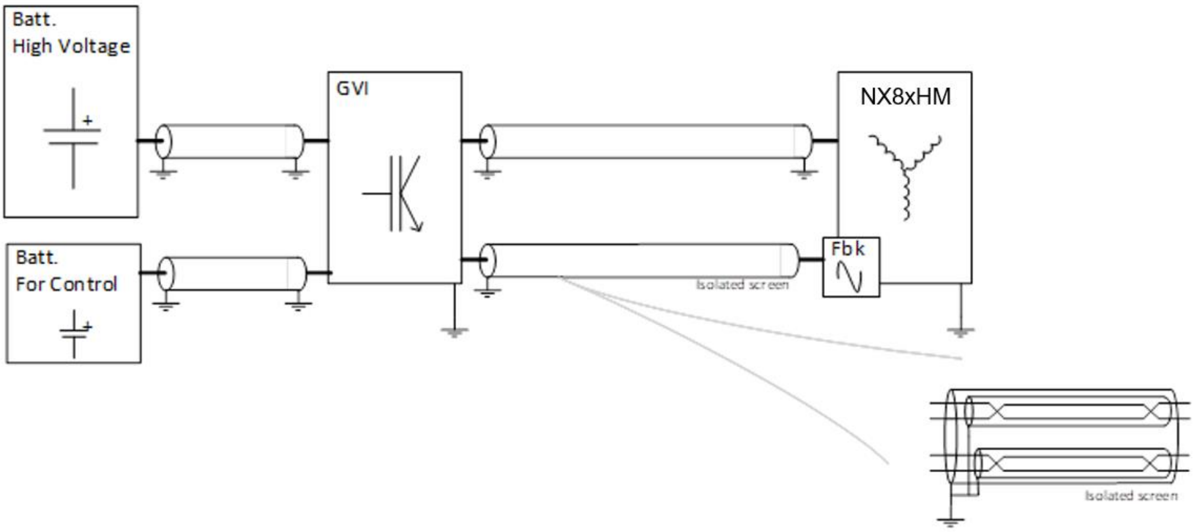
Motor and Battery cable shields must be connected on both ends to provide a continuous way to the common-mode noise current.
Battery cables (B+ and B-) must be routed in parallel to each other and close together.

Control and signal cables

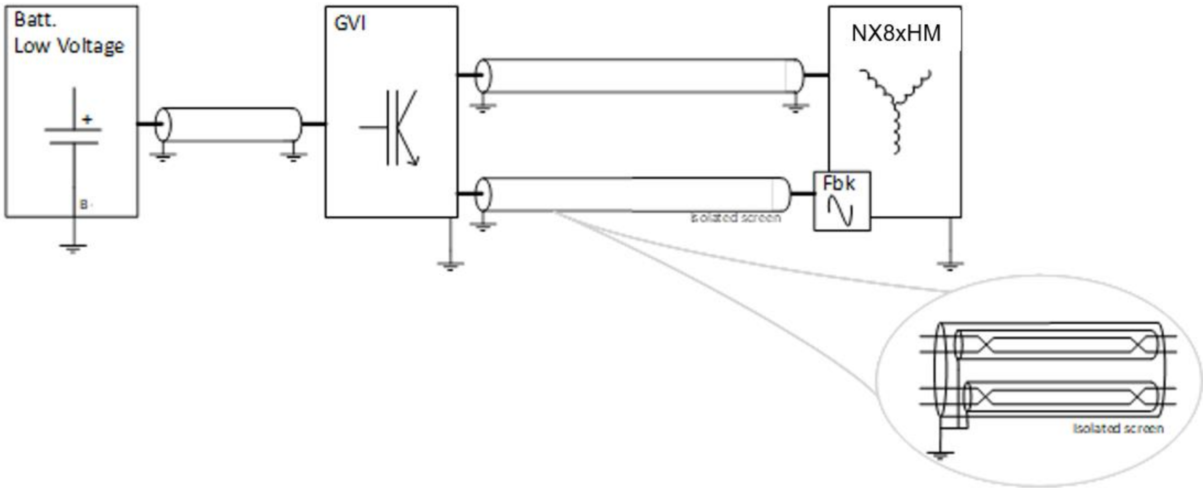
- The control cable screenings must be connected only on one end. The other end must be cut and insulated.
- The cable shielding between two electrical boxes of a vehicle must be connected to the one containing the signal source (GVI) unless specified otherwise by the external device maker.
- Never connect a shielding on the common side of a logic circuit, as this will cause noise on the circuit.

The parker feed back cable has ground connexion on motor side for simple reason, in case of issue it’s harder to add the connexion than remove it.

This is the ideal wiring:



With battery Voltage lower than 60Vdc, the B- can be “grounded”, i.e connected to the vehicle frame



4. COMMISSIONING, USE AND MAINTENANCE

4.1. Instructions for commissioning, use and maintenance

4.1.1. Equipment delivery

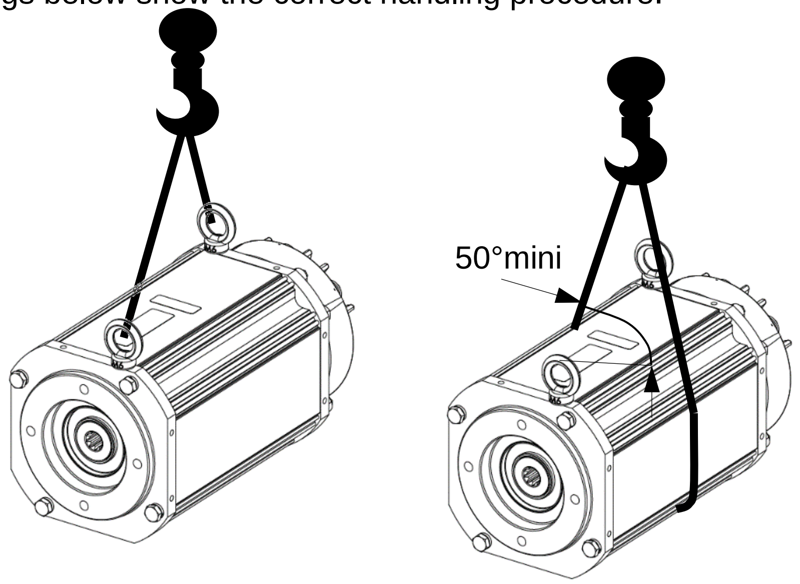
All servomotors are strictly controlled during manufacturing before shipping.
While receiving it, it is necessary to verify motor condition and if it has not been damaged in transit. Remove it carefully from its packaging. Verify that the data written on the label are the same as the ones on the acknowledgement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

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

4.1.2. Handling

Caution: Use only servomotors lifting rings, if present, or slings to handle the motor. Do not handle the motor with the help of electrical cables, connectors and water inputs/outputs, or use any other inappropriate method.

The drawings below show the correct handling procedure.



DANGER: Choose the correct slings for the motor weight. The two slings must 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 important temperature variations in order to avoid condensation.
During storage, the ambient temperature must be kept between -20 and +85°C.

If the torque motor has to be stored for a long time, verify that the shaft end, feet 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 the bearing grease spreading.
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

Foundation must be even, sufficiently rigid and shall be dimensioned in order to avoid vibrations due to resonance. Before bolting the motor, the foundation surface must be cleaned and checked in order to detect any excessive height difference between the motor locations. The surface variation shall not exceed 0,1 mm.

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 screw and nuts.

4.2.2. Preparation

Once the motor is installed, it must be possible to access the wiring, and read the manufacturer's plate. Air must be able to circulate 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 temperatures exceeding 100°C

4.2.3. Mechanical installation

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

- Prohibit any impact on the shaft and avoid press fittings which could mark the bearing tracks. If press fitting cannot be avoided, it is advisable to immobilize the shaft in motion; this solution is nevertheless dangerous as it puts the sensor at risk.
- In the event that the front bearing block is sealed by a lip seal which rubs on the rotating section, we recommended that you lubricate the seal with grease thus prolonging its operational life.

	Warning : a misalignment of the coupling device makes stress and load on the motor shaft depending the rigidity of the installation. The variations of the temperature makes stress and load due to the dilatation. These loads (axials and radiale) do not exceed the load written (§ 3.6).
	Warning : The misalignment of the coupling device makes vibration who can realize a destruction of the motor shaft.
	We cannot be held responsible for wear on the motor shaft resulting from excessive strain.

4.3. Electrical connections

	Danger: Check that the power to the inverter is off prior to making any connections.

	Caution: The wiring must comply with the inverter commissioning manual and with recommended cables.

	Danger: The motor must be earthed by connecting to an unpainted section of the motor.

	Caution: After 15 days, check all tightening torques on cable connection.

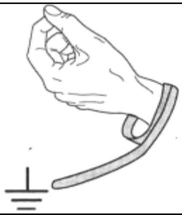
4.3.1. Cable connection

Please, read **§3.9 "Electrical connection"** to have information about cable connection
Many useful information are already available in the inverter documentations.
It is imperative to connect the shielding of the power cables to the motor frame and to the inverter frame. Else, you can have issue with the sensors.

4.3.2. Encoder cable handling

	Danger: before any intervention the inverter 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

4.4.1. Summary maintenance operations

Generality

DANGER: The installation, commission and maintenance operations 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) and local regulations.

They must be authorized to install, commission and operate in accordance with established practices and standards.

Please contact PARKER for technical assistance.

Danger: before any intervention the motor must be disconnected from the power supply.
Due to the permanent magnets, a voltage is generated at the terminals when the motor shaft is turned

Operation	Periodicity
Clean the motor	Every year
Motor inspection (vibration changes, temperature changes, tightening torques on all scews)	Every year
Bearing replacement	Every 20 000h

4.5. Troubleshooting

Some symptoms and their possible causes are listed below. This list is not comprehensive. Whenever an operating incident occurs, consult the relevant inverter installation instructions (the troubleshooting display indications will help you in your investigation).

You note that the motor does not turn by hand when the motor is not connected to the inverter.	• Check there is no mechanical blockage and that the motor terminals are not short-circuited.
You have difficulty starting the motor or making it run	• Check on the fuses, the voltage at the terminals (there could be an overload or the bearings could be jammed), also checks on the load current. • Check on any thermal protection, its connection and how it is set in the inverter. • Check on the motor insulation (if in doubt, carry out hot and cold measurements). The minimum insulation resistance value measured under a max. 50V DC is 50 MΩ: • Between the phase and the casing • Between the thermal protection and the casing • Between the encoder and the casing.
You find that the motor speed is drifting	• Reset the offset of the servoamplifier after having given a zero instruction to the speed setpoint input.
You notice that the motor is racing	• Check the speed setpoint of the inverter. • Check you are well and truly in speed regulation (and not in torque regulation). • Check the encoder setting • Check on the servomotor phase order: U, V, W
You notice vibrations	• Check the encoder connections, the earth connections (carefully) and the earthing of the earth wire, the setting of the inverter speed loop. • Check the stability of the secondary voltages. • Check the rigidity of the frame and motor support..

You think the motor is becoming unusually hot	• It may be overloaded or the rotation speed is too low : check the current and the operating cycle of the motor.
	• Check if the mounting surface is cold enough or if this surface is not a heat source – see §3.6 cooling.
	• Friction in the machine may be too high :
	    • Test the motor current with and without a load.
	    • Check the motor does not have thermal insulation.
	    • Check that there is no friction from the brake when the brake power is on.
	• Check the cooling circuit

You find that the motor is too noisy	Several possible explanations : • Unsatisfactory mechanical balancing • There is friction from the brake: mechanical jamming. • Defective coupling • Loosening of several pieces • Poor adjustment of inverter or position loop : check rotation in open loop