

TMX

Torque motors series

Reference guide

M00065EN-00

Edition 08.2022



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1 Foreword

1.1 General safety instructions

TMX used in conformity with the present manual and the relevant PDS (Power Drive System) manuals fulfill the basic requirements of Electrical Safety as prescribed by the Directives:

Low Voltage Directive 2014/35/EU dated 20th April 2016

1.2 Machinery directive

Machinery directive 2006/42/EC dated 17th May 2006

The designed products are intended to be incorporated into machinery or assembled with other machinery to constitute products covered by the council directive.

Commissioning is forbidden until the products have been integrated in a machine that conforms with the directive 2006/42/EC.

1.3 Safety instruction symbol

Safety notices are always indicated using a signal word and sometimes also a symbol for the specific risk.

Safety instruction symbol	
Graphic	Description
	NOTE Important notes on product use.
	IMPORTANT You may find this symbol whenever a wrong operation may damage the product.
	WARNING OF MAGNETIC FIELDS! Strong magnetic fields around components pose a health risk to persons with implants (e.g. cardiac pace- makers) that are affected by magnetic fields. Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 0.3 m from components.
	ATTENTION! Anyone having active implants (pacemakers) or having any other ferromagnetic prosthesis is not qualified to work with these kinds of devices, or to approach them. Keep at a safe distance from the motor!
	WARNING Indicates possibility of injury to the user (moving parts can crush fingers, hand,...). The component (rotor) must be handled carefully and held far away from metallic parts, stators and other rotors. It indicates powerful magnetic induction, dangerous for the user.
	WARNING Signals a danger of electrical shock to the operator. Can be fatal to a person.
	PROTECTIVE GLOVES MANDATORY
	PROTECTIVE FOOTWEAR MANDATORY

1.4 General safety instruction



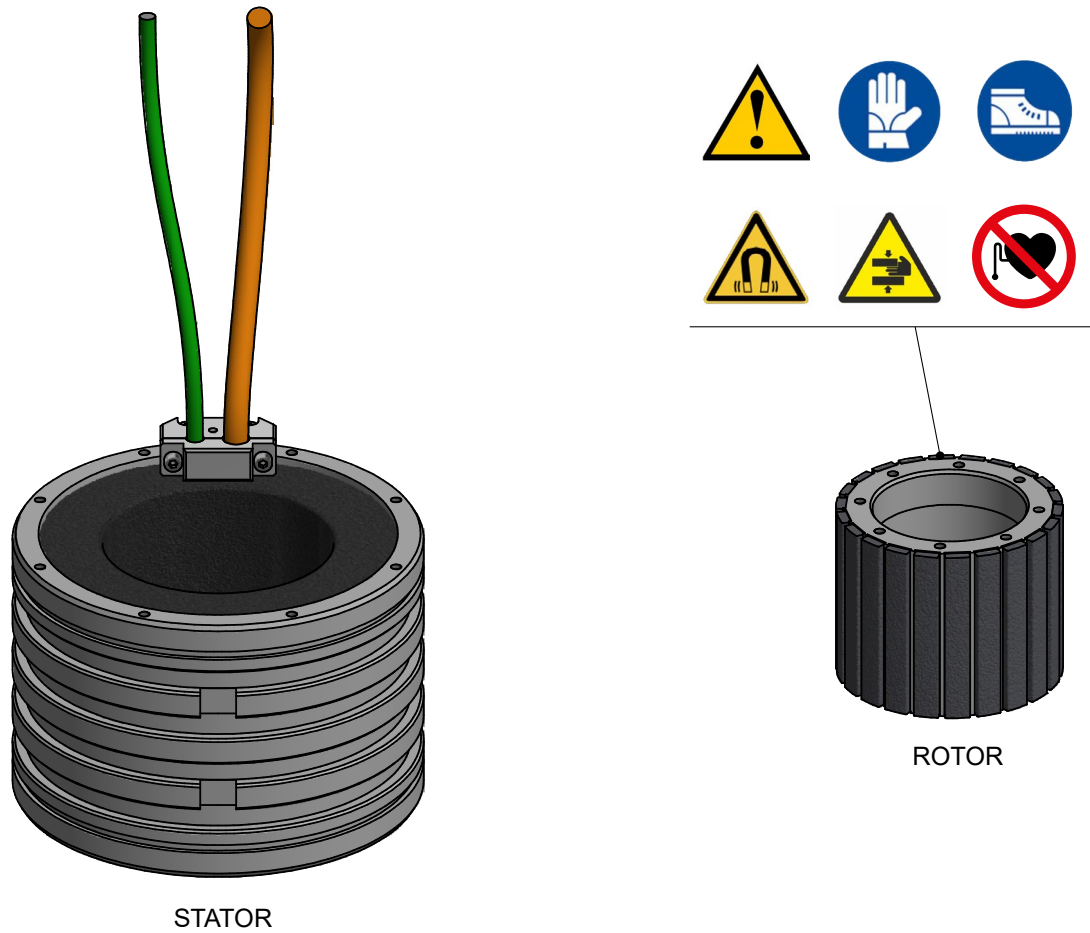
Before operating on the TMX torque motors carefully read this document.

In case something is unclear, information are missing or uncomplete please get in contact with NUM or authorized distributor.

Please read the hazards listed below and the precautions to be taken before handling a torque motor:

	1. All the international, state, regional and local standards must be complied with during the installation and during the use of this product. Assembly and operation must be carried out only by qualified and trained personnel. Always wear adequate working clothes and protective equipment (e.g. gloves, shoes, etc) when handling a motor.
	2. Strong magnetic fields around components pose a health risk to people with implants (e.g. cardiac pace- makers) that are affected by magnetic fields. People with implants that are affected by magnetic fields should maintain a safe distance of at least 1 m from rotor components.
	3. Electronic devices and measuring equipment may be affected or destroyed by strong magnetic induction. Avoid placing devices with magnetic parts close to computers, monitors and all magnetic data carriers (e.g. disks, credit cards, audio and video tapes, etc).
	4. Because of the strong attraction forces, special caution is required in the direct proximity of the rotor (i.e. under 100 mm). Heavy or wide objects made of steel or iron must never be brought close to the rotor by free hand. As magnetic forces are invisible, their effects are generally underestimated close to the rotor. The magnetic attraction forces may start abruptly and can increase up to several thousand Newtons near ferromagnetic objects (steel or iron) of medium size. 5. Never place an unpacked rotor close other ferromagnetic parts (like stator) without massive and not magnetic separator (ex. aluminium, plastic, wood, etc..., thickness>20mm): during handling of naked rotors always respect the minimum safe distance toward ferromagnetic parts. 6. In case of contact between ferromagnetic parts (like stator) and unpacked rotor during handling, in order to separate them, wedges (approx. 10°-15°) of robust not magnetic material are useful. Have them always available helps in case of accident, when wedges are necessary to free caught limbs (finger, hand, foot).
	7. If torque motors are incorrectly earthed, there is a danger of electric shock. Before connecting the electrical power supply, ensure that the torque motor is correctly earthed via the PE rail in the switch cabinet! • Ensure that the torque motor is disconnected from the power supply before the electrical connections are detached from the motors. • After disconnecting the drive amplifier from the power supply, wait at least 5 minutes before touching live parts or breaking connections. • For safety reasons, measure the voltage in the intermediate circuit and wait until it has fallen below 50 V.

1.5 View of the hazardous areas around the motors



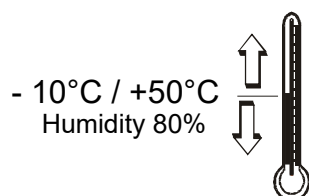
Num declines all responsibility for injury or damage to persons or objects due to incorrect use of this product.

1.6 Storage conditions

In order to avoid possible damage or malfunctioning of the torque motor it is suggested to follow the storage instructions below:

- Store the torque motor components in their transport packaging;
- storage temperature - 10°C / + 50°C;
- humidity ratio 80% maximum without condensation;
- make sure that the environment is a dry place free of dust, oils, and vibrations.

There are no magnetic fields around components in their transport packaging.
The rotor is magnetically shielded



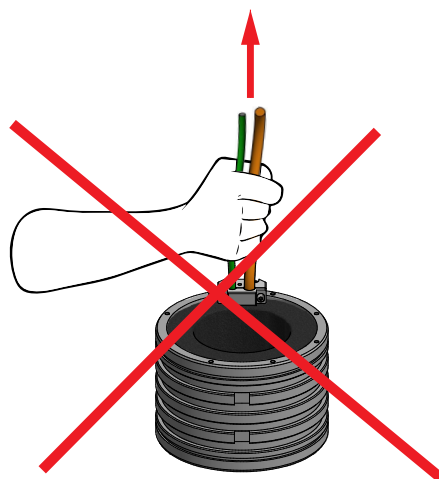
1.7 Torque motor transport

Unsuitable torque motor transport may cause damage or malfunctioning of the same. Therefore it is suggested to follow the instructions below:

- Always use suitable and safe transport.
- Pay a particular attention to avoiding impacts or shocks that could damage the packaging and the product.
- Remove the motor protections only just before the installation.
- Pay a particular attention to avoiding impacts of the products package, that could damage the stator, the cables and the rotor or even cause a geometrical deformation of the single parts.
- The are magnets magnetized onto the rotor surface: the magnetic field is shielded with a ferromagnetic protection which allow to have a very low magnetic induction density out of the rotor package. Remove the shield just before the installation



It is forbidden to lift the stator by gripping the cables, as this would compromise their integrity.



1.7.1 Packaging content

- Stator with cables
- Rotor
- o-rings (2)
- Data labels.

1.8 Document revisions

Date	Index	Reason for revision
08 - 2022	00	Document creation

1.9 NUM Agency

The list of NUM agencies is given on <http://www.num.com>.

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2 Technical characteristics

2.1 TMX torque motors highlights description



Overview

Torque motors are usually supplied as rotor and stator components ready to be installed in a built in complete motor. Stator is supplied with cooling jacket, with slots for water cooling; rotor is hollow with magnets on the external surface.

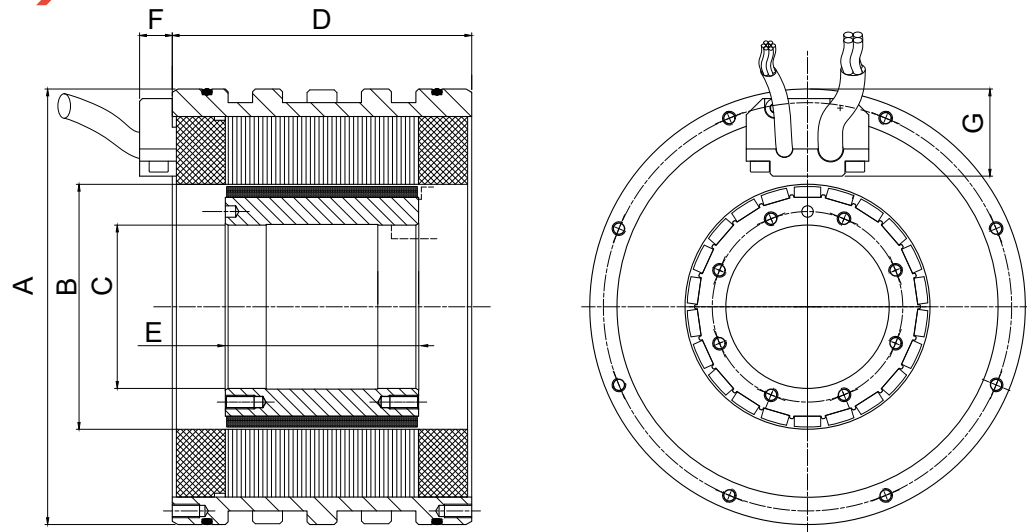
Mechanic parts, sensor and other components to get the complete assembly are provided by the Customer.

The table below summarize the main performance for continuous and peak service with water cooling conditions for the different size and length available.

TMX	Low speed continuous torque ⁽¹⁾ T _o	Low speed continuous current ⁽¹⁾	Peak torque T _{Peak}	Peak current	Maximum mechanical speed	Motor weight	
	[Nm]	[Arms]	[Nm]	[Arms]	[rpm]	Stator	Rotor
TMX140050D..	33	6.5	57	19.5	1500	6.2	1.2
TMX140070C..	50	13	81	35	1500	8	1.6
TMX210050G..	124	12.6	250	34	500	8	2.5
TMX210070I..	174	12.6	350	34	500	11	3.5
TMX291050H..	230	18.5	435	53	500	16.6	3.4
TMX291070I..	325	23.5	610	65	500	21	5
TMX291150P..	705	22.8	1307	61	200	40	10.2
⁽¹⁾ Water cooling							

General characteristics		
Type of construction	(EN 60034-7)	IM 5110
Cooling	(EN 60034-5)	Liquid cooling
Thermal motor protection	(EN 60034-11)	2 x STS1 (KTY84 like) and PTC triplet
Maximum winding temperature	(EN 60034-1)	130°C
Stator insulation class	(EN 60034-1; UL 1004; CSA 100)	H
Maximum inlet water temperature		25°C
Installation height above sea level	(EN 60034-1)	< 1000 m, then derating is needed
Supply voltage		3ph AC up to 480 Vrms
Electrical connections		cable with cable clamp (std)
Feedback system		not previewed
Mechanical architecture		Stator with steel cooling jacked + rotor sleeve with surface permanent magnets
Marking		CE UK

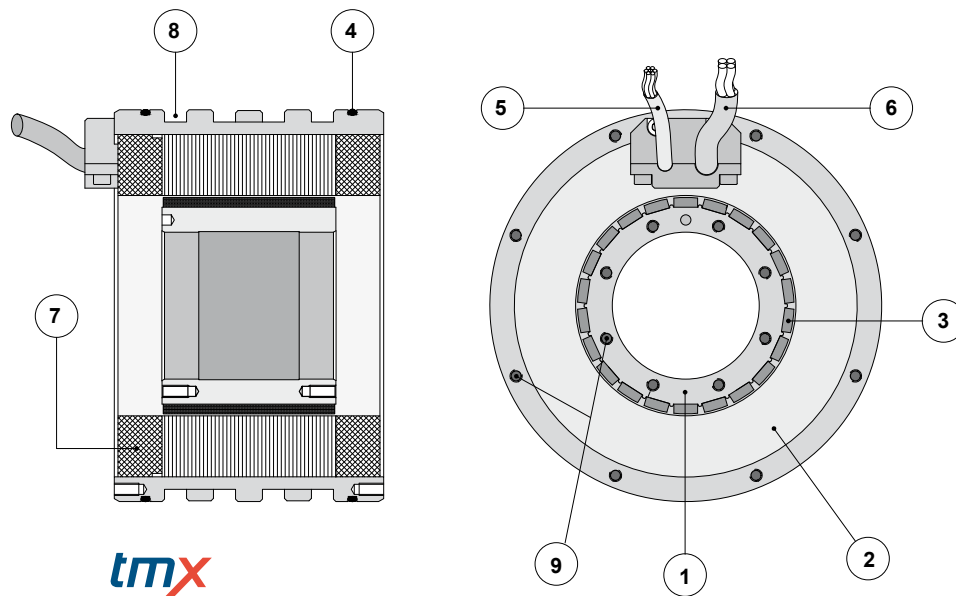
2.2 TMX Direct Drive Torque Motors Outlines



TMX140070

TMX	To	Tpeak	A	B	C	D	E	F	G
	[Nm]	[Nm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
TMX140050..	33	57	160	90	60	90	51	12	32
TMX140070..	50	81	160	90	60	110	71	12	32
TMX210050	124	250	230	170	140	90	51	12	29
TMX210070..	174	350	230	170	140	110	71	12	29
TMX291050..	230	435	310	230	200	100	51	12	36
TMX291070..	325	610	310	230	200	120	71	12	36
TMX291150..	705	1307	310	230	200	200	151	12	36

2.3 TMX torque motors description



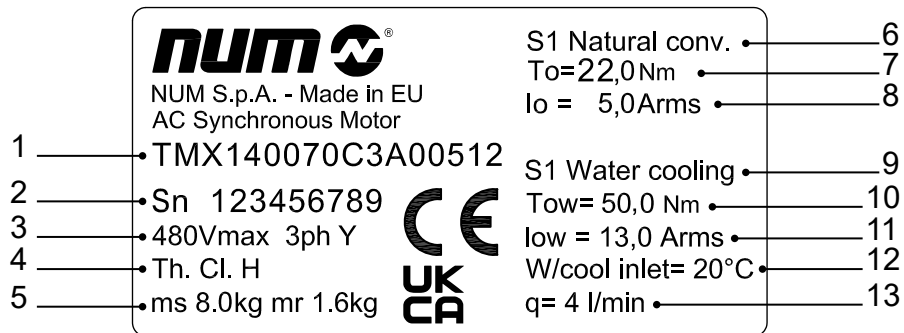
Item	Description
1	Rotor
2	Stator
3	Magnets
4	Groove for O-ring
5	Thermal sensor and PTC cable - Lenght 2 m - 7 wires - 0.25 mm ²
6	Power cable - Lenght 2 m - 4 wires - 1.5 mm ²
7	Stator windings
8	Cooling channels for water cooling
9	Threaded holes for mounting screws



Tightening torque which must be applied to M5 mountin screws of motor and stator: 5.8Nm

2.4 Type plate

The codification of the TMX torque motors is explained hereafter with an example
(See chapter § 3.5.1 - § 3.5.3 - § 3.5.4).



Item	Description
1	Motor reference
2	Serial number
3	Rated voltage
4	Motor thermal class
5	Stator and rotor mass
6	S1 natural convection cooling datas
7	Low speed continuous torque with natural convection cooling
8	Low speed continuous current with natural convection cooling
9	S1 Water cooling datas
10	Low Speed Continuous torque with water cooling
11	Low speed continuous current with water cooling
12	Water cooling inlet temperature
13	Minimum water cooling flow rate

2.5 TMX ordering code

2.5.1 TMX part number structure

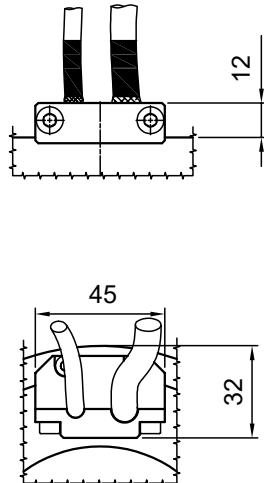
TMX	140	070	C	3	A	0	0	512
Stator diameter								
140 mm	140							
210 mm	210							
291 mm	291							
Stator stack length								
50 mm		050						
70 mm		070						
100 mm		100						
150 mm		150						
Winding type								
Ke within 2,01 and 3,00 V*sec/rad			C					
Ke within 3,01 and 4,00 V*sec/rad			D					
Ke within 7,01 and 8,00 V*sec/rad			H					
Ke within 8,01 and 9,00 V*sec/rad			I					
Ke (values to be defined)			—					
Cable type								
Cables (3ph and thermal sensors) with cable clamp				3				
Cables (3ph and thermal sensors) with 90°power cable gland ⁽¹⁾				7				
Cable length								
2 m					A			
Type of supply								
Stator and rotor						0		
Spare number								
							0	
Drawing number								
Last 3 digit of the outline drawing number								xxx

⁽¹⁾ Only available for TMX140

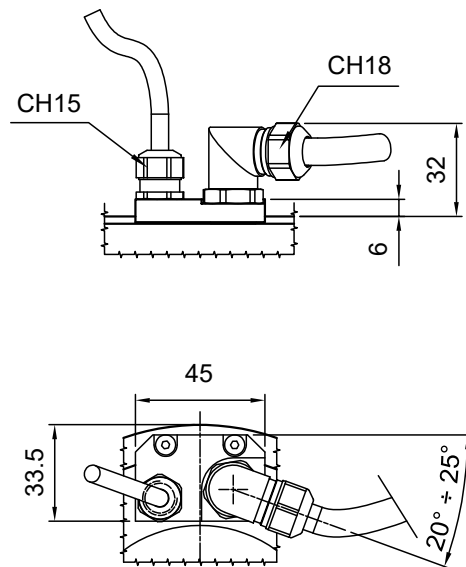
2.5.2 Wiring options

The released motors are supplied with cable and cable gland like in the drawing below (cable option "3"), for the TMX140 a 90° cable option is available (cable option "7").

Cables with cable clamp
- version "3"



Cables with 90° cable gland
(power) - version "7"



2.5.3 Stator spare parts

TMX	140	070	C	3	A	S	0	512
Stator diameter								
140 mm	140							
210 mm	210							
291 mm	291							
Stator stack length								
50 mm		050						
70 mm		070						
100 mm		100						
150 mm		150						
Winding type								
Ke within 2,01 and 3,00 V*sec/rad			C					
Ke within 3,01 and 4,00 V*sec/rad			D					
Ke within 7,01 and 8,00 V*sec/rad			H					
Ke within 8,01 and 9,00 V*sec/rad			I					
Ke (values to be defined)			—					
Cable type								
Cables with cable gland				3				
Cables with 90° cable gland ⁽¹⁾				7				
Cable length								
2 m					A			
Type of supply								
Stator						S		
Spare number							0	
Drawing number								
Last 3 digit of the outline drawing number								xxx

2.5.4 Rotor spare parts

TMX	140	070	0	0	0	R	0	512
Stator diameter								
140 mm	140							
210 mm	210							
291 mm	291							
Stator stack length								
50 mm		050						
70 mm		070						
100 mm		100						
150 mm		150						
Winding type								
Rotor			0					
Cable type								
Rotor				0				
Cable length								
Rotor					0			
Type of supply								
Rotor						R		
Spare number							0	
Drawing number								
Last 3 digit of the outline drawing number								xxx

2.6 Definitions

Description	Symbol	Definition
Low speed continuous torque	T_o	Maximum available continuous torque (S1 service) for speed between 1 rpm and 100 rpm (1)
Low speed continuous current	I_o	Equivalent rms phase current for producing the continuous low speed torque (1)
Locked rotor continuous torque	T_{cs}	Maximum available continuous torque (S1 service) for speed lower than 1 rpm (1)
Locked rotor continuous current	I_{cs}	Equivalent rms phase current for producing locked rotor continuous torque (1)
Peak torque	T_{pk}	Torque at the peak current.
Peak current	I_{pk}	Maximum rms phase current; the motor could be irreversibly damaged with higher currents (even for short time).
Maximum mechanical speed	ω_{max}	Maximum mechanical speed; the motor could be irreversibly damaged with higher speeds (even for short time).
Maximum continuous losses	P_d	Maximum continuous dissipated power in S1 service.

- (1) The continuous torques are reached when the motor is not thermally insulated and the mounting flange is bigger than 0.1 m^2

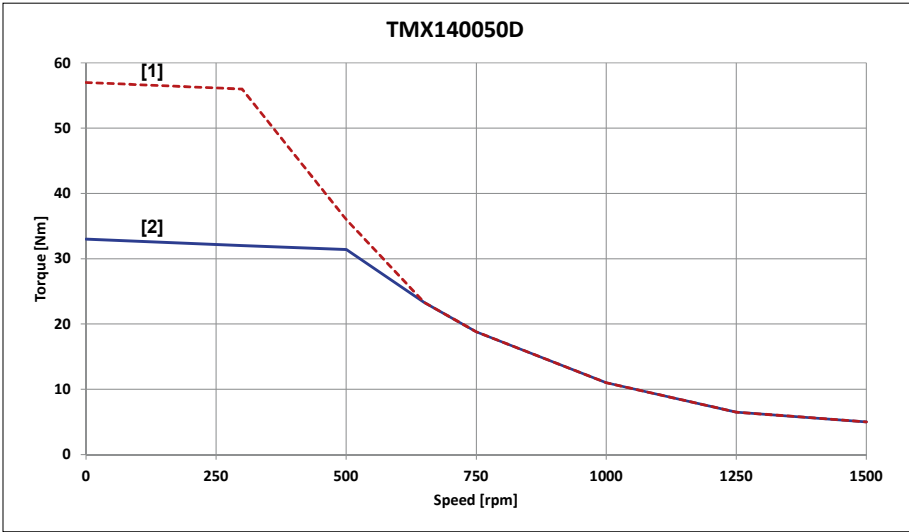
2.7 Tolerances of electromagnetic motors parameters

Motor data	Typical value	Maximum value
Torque	$\pm 5 \%$	$\pm 10 \%$
Torque constant	$\pm 3.5 \%$	$\pm 7.5 \%$
Back-e.m.f. force constant	$\pm 3.5 \%$	$\pm 7.5 \%$
Winding resistance	$\pm 5 \%$	$\pm 10 \%$
Winding inductance	$\pm 5 \%$	$\pm 10 \%$
Motor moment of inertia	$\pm 3 \%$	$\pm 10 \%$

2.8 TMX140 Detailed Technical characteristics

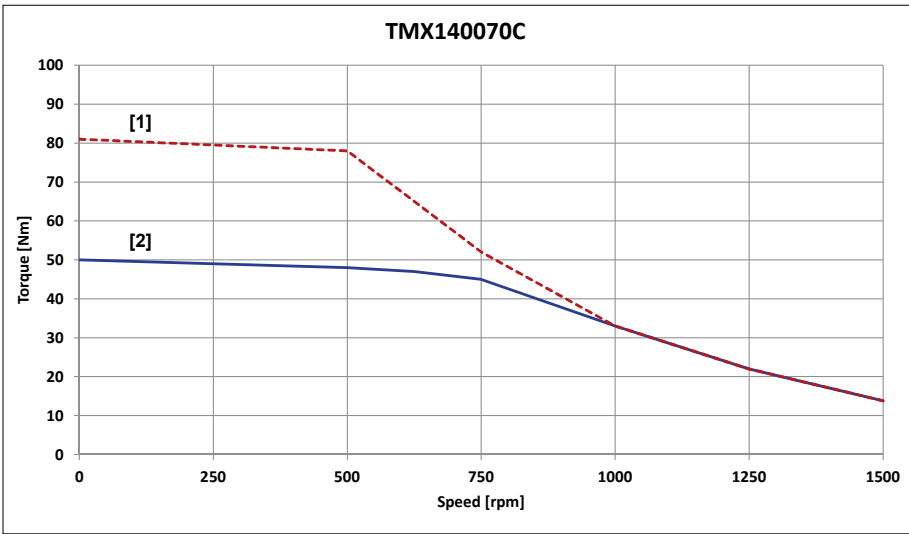
Technical characteristics	Symbol	Unit	TMX140050D	TMX140070C
Low speed continuous torque	To	Nm	33	50
Low speed continuous current	Io	Arms	6.5	13
Locked rotor continuous torque	Tcs	Nm	26	41.5
Locked rotor continuous current	Ics	Arms	4.7	9.5
Peak torque	Tpk	Nm	57	81
Peak current	Ipk	Arms	19.5	35
Maximum DC bus voltage	Vdc	Vdc	650	650
Maximum 3-phases input voltage	Vrated	Vrms	480	480
Torque constant (at rated conditions)	Kt	Nm/Arms	5.1	3.8
Back EMF constant (phase to phase) @ 25°C	Ke	Vrms/rad/s	3.58	2.7
Pole pair	pp		11	11
Maximum mechanical speed	wmax	rpm	1500	1500
Inertia	Jr	gm ²	1.6	2.3
Winding resistance (phase to phase) @ 25°C	Rw	ohm	10.2	3.3
Winding inductance (phase to phase)	Lw	mH	62	19
Electrical time constant	Tel	ms	6.1	5.8
Stator weight	Ws	kg	6.2	8
Rotor weight	Wr	kg	1.2	1.6
Minimum water flow	Q	l/min	3	4
Maximum continuous losses	Pd	W	1100	1400

2.8.1 TMX140050D speed torque curves



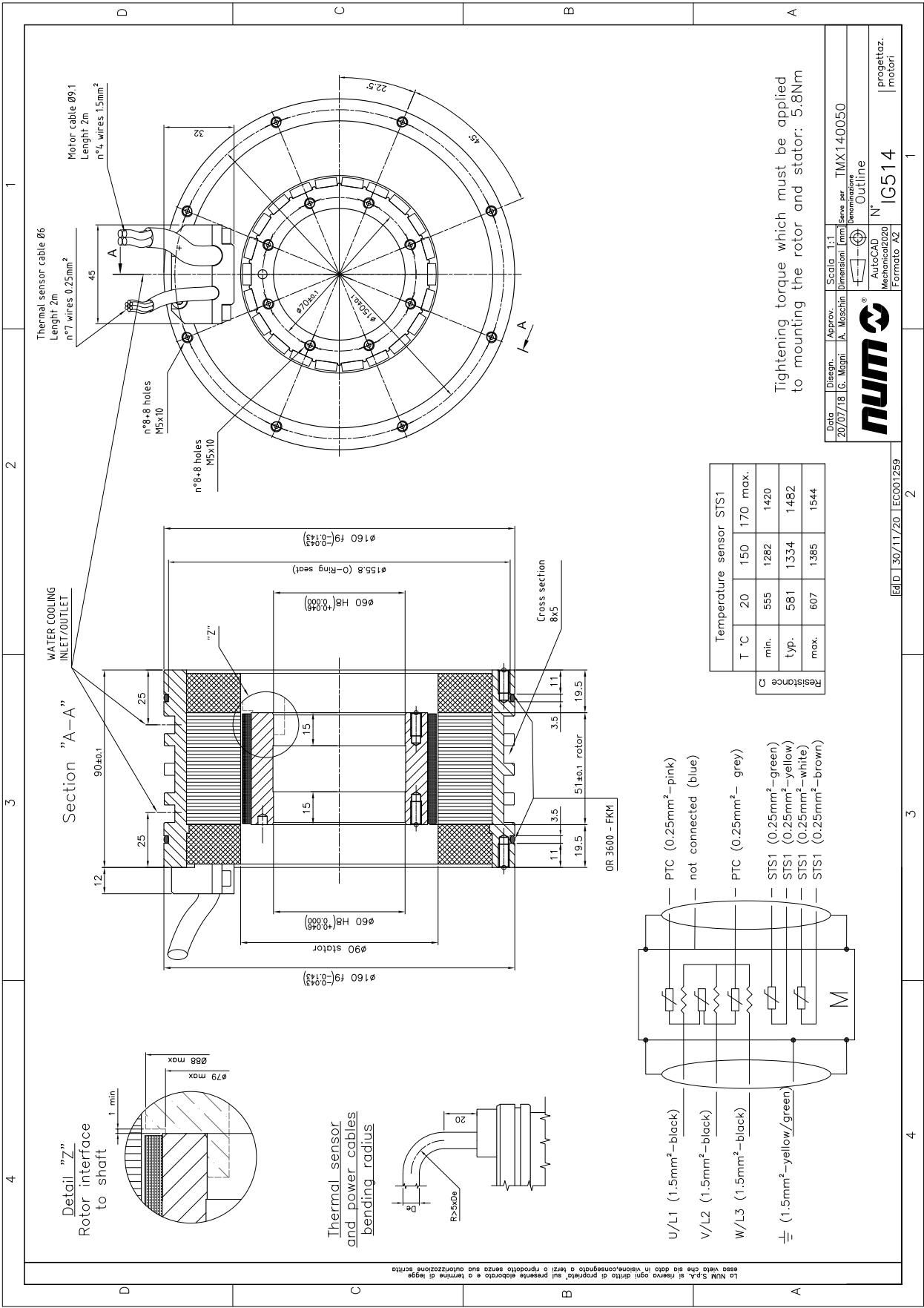
TMX140050D legend	
[1]	Peak torque 560Vdc
[2]	Continuous torque (S1) water cooled

2.8.2 TMX140070C speed torque curves

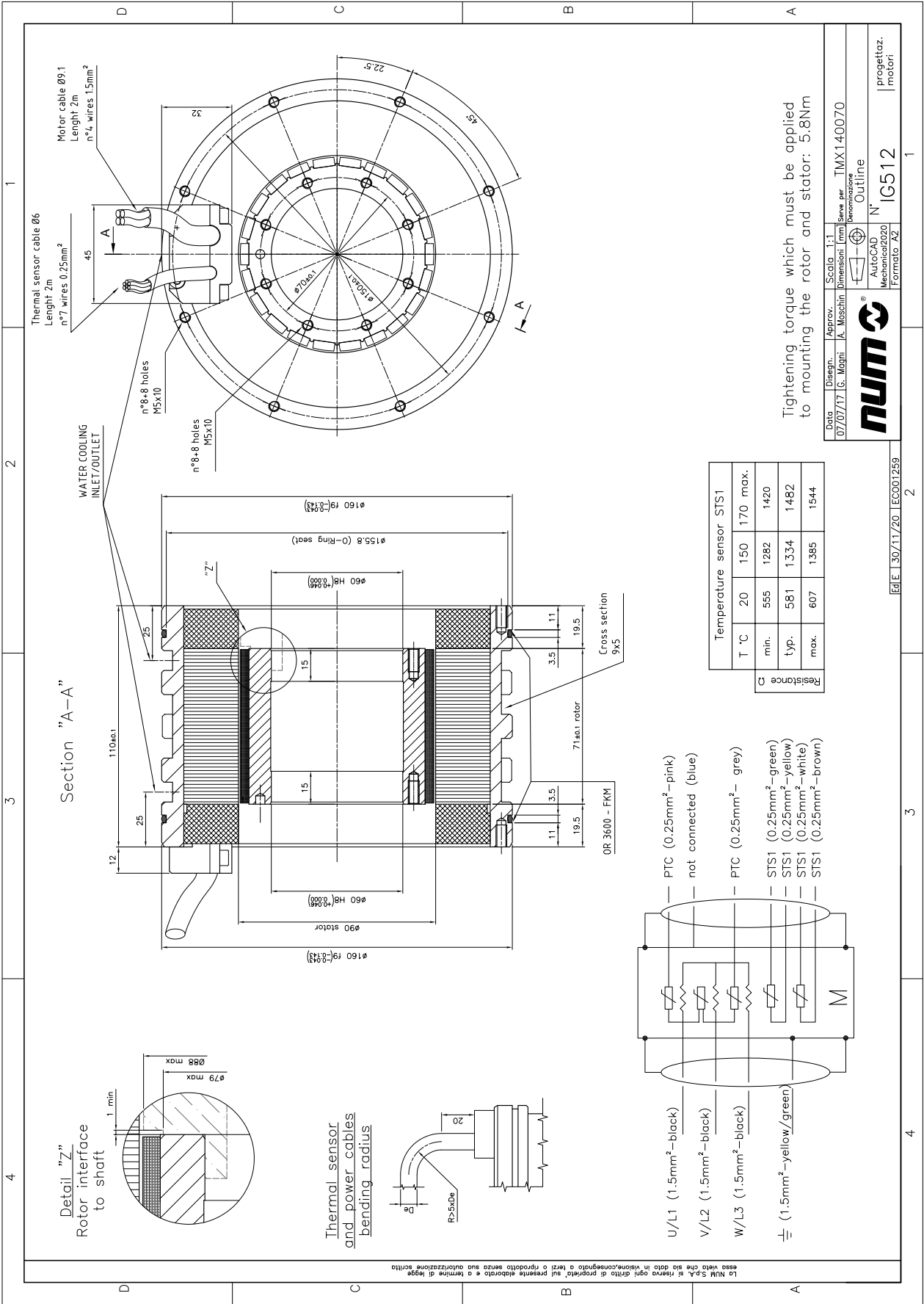


TMX140070C legend	
[1]	Peak torque 560Vdc
[2]	Continuous torque (S1) water cooled

2.8.3 TMX140050 Overall dimensions



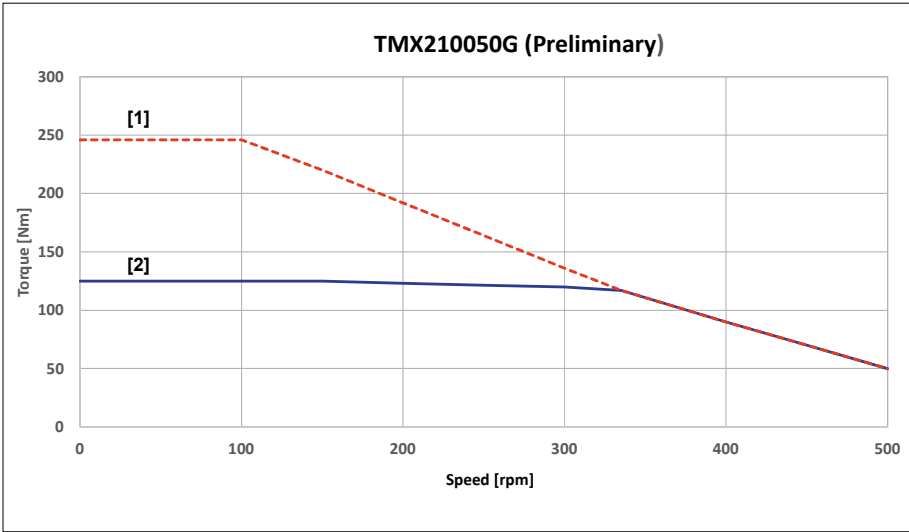
2.8.4 TMX140070 Overall dimensions



2.9 TMX210 Technical characteristics

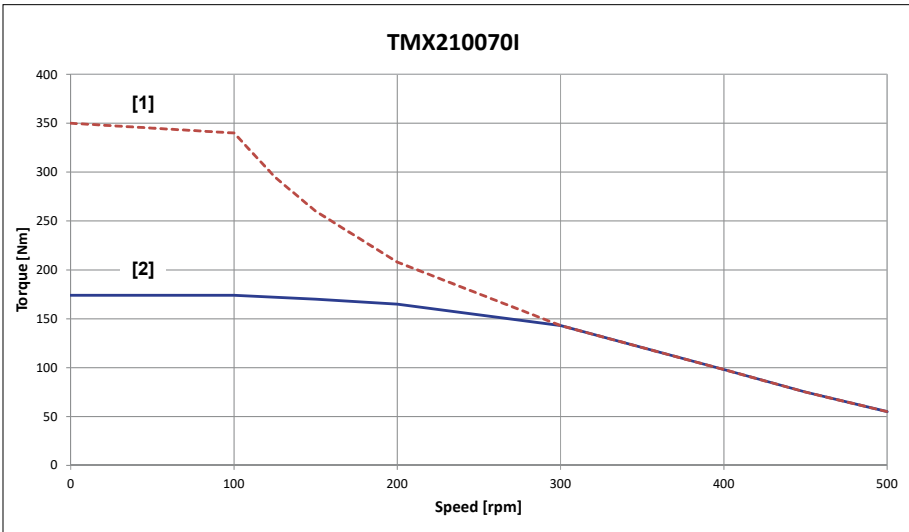
Technical characteristics	Symbol	Unit	TMX210050G *	TMX210070I *
Low speed continuous torque	To	Nm	124	174
Low speed continuous current	Io	Arms	12.6	12.6
Locked rotor continuous torque	Tcs	Nm	98	138
Locked rotor continuous current	Ics	Arms	9.5	9.5
Peak torque	Tpk	Nm	250	350
Peak current	Ipk	Arms	34	34
Maximum DC bus voltage	Vdc	Vdc	650	650
Maximum 3-phases input voltage	Vrated	Vrms	480	480
Torque constant (at rated conditions)	Kt	Nm/Arms	9.8	13.8
Back EMF constant (phase to phase) @ 25°C	Ke	Vrms/rad/s	6.06	8.5
Pole pair	pp		22	22
Maximum mechanical speed	wmax	rpm	450	450
Inertia	Jr	gm ²	14.8	20.8
Winding resistance (phase to phase) @ 25°C	Rw	ohm	5.7	7.3
Winding inductance (phase to phase)	Lw	mH	15.5	21.6
Electrical time constant	Tel	ms	1.36	2.96
Stator weight	Ws	kg	8.0	10.6
Rotor weight	Wr	kg	2.5	3.5
Minimum water flow	Q	l/min	5.5	7
Maximum continuous losses	Pd	W	2400	3050
* Preliminary data				

2.9.1 **TMX210050G speed torque curves**



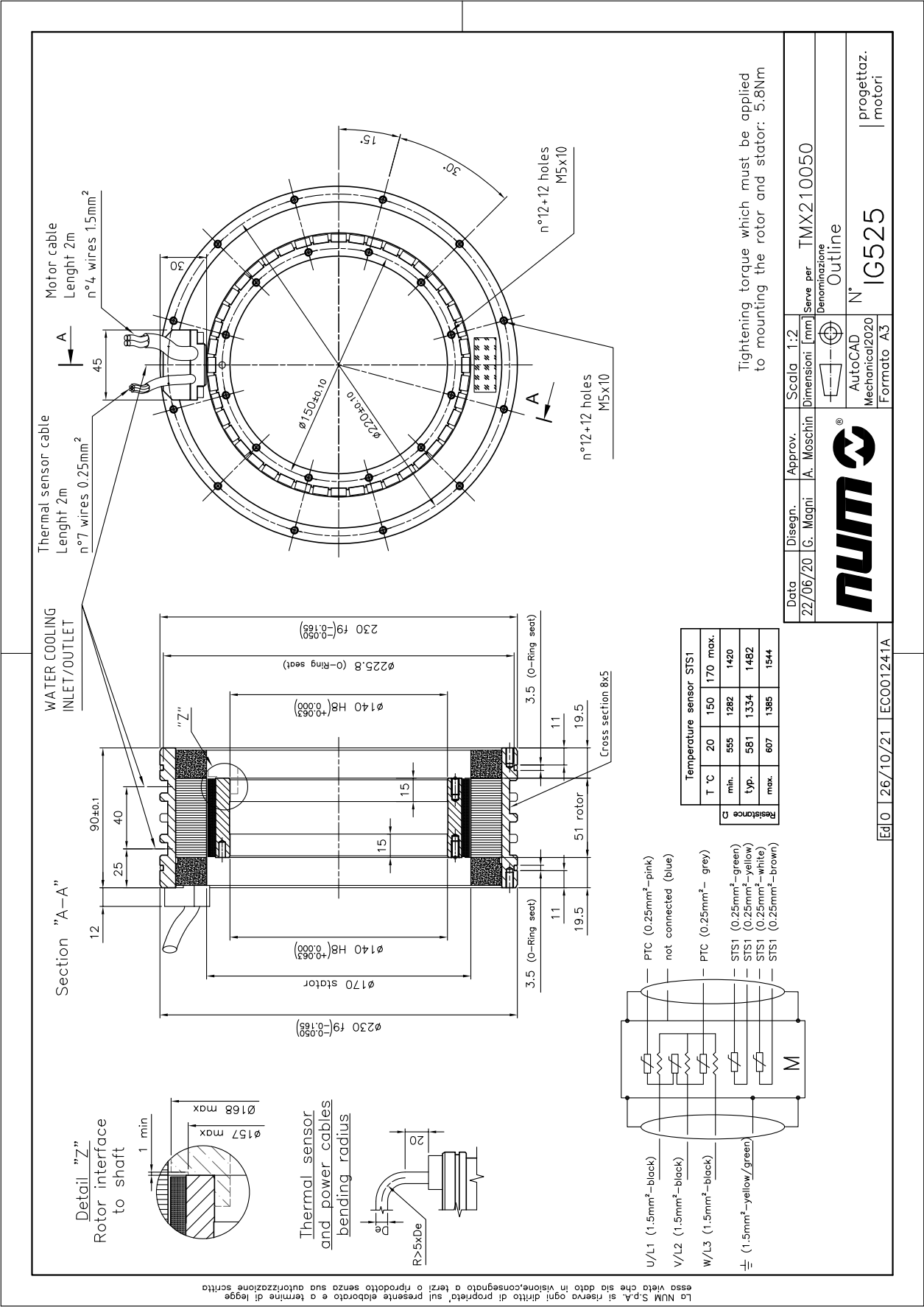
TMX210050G legend	
[1]	Peak torque 560Vdc
[2]	Continuous torque (S1) water cooled

2.9.2 **TMX210070I speed torque curves**

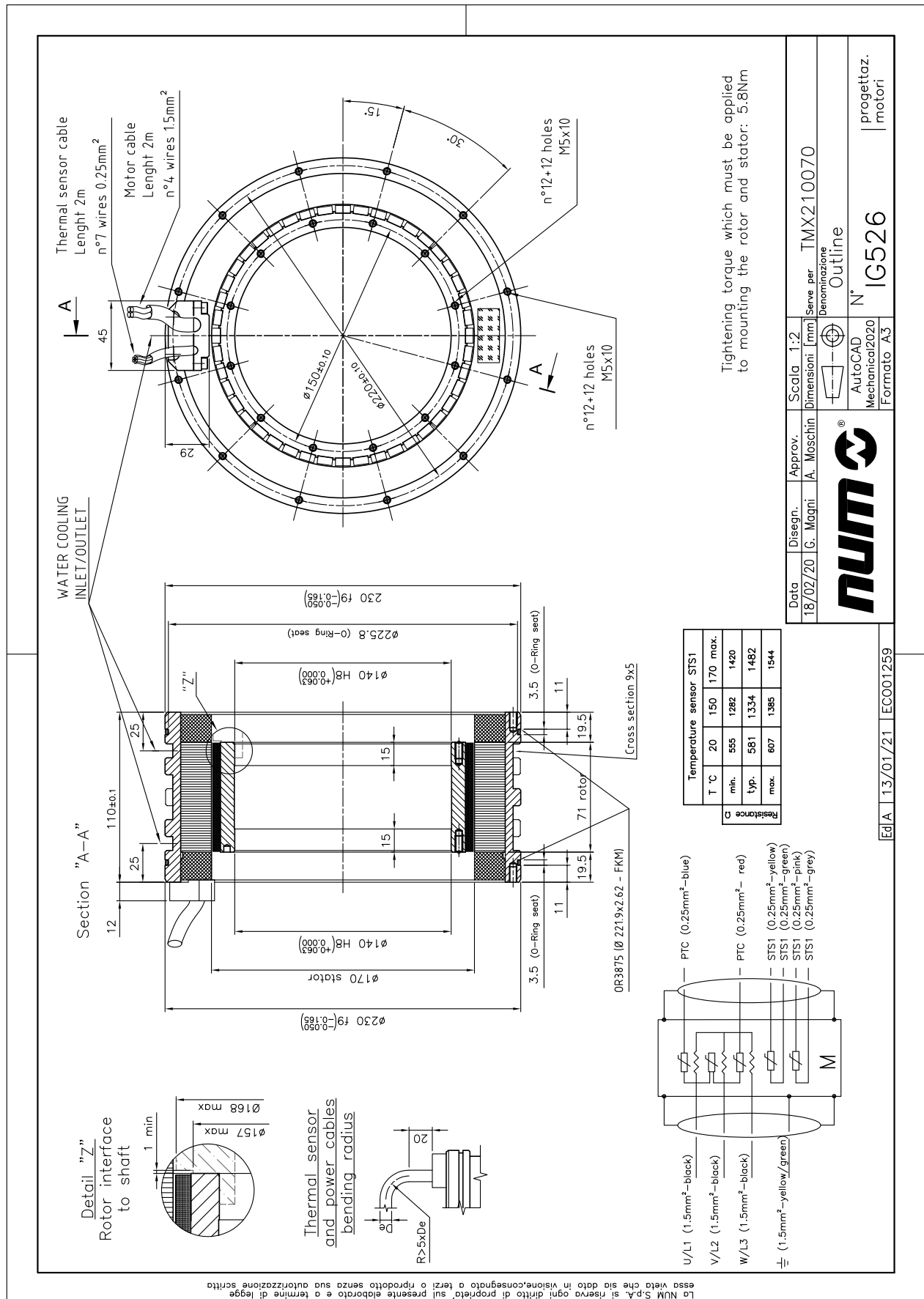


TMX210070I legend	
[1]	Peak torque 560Vdc
[2]	Continuous torque (S1) water cooled

2.9.3 TMX210050 Overall dimensions



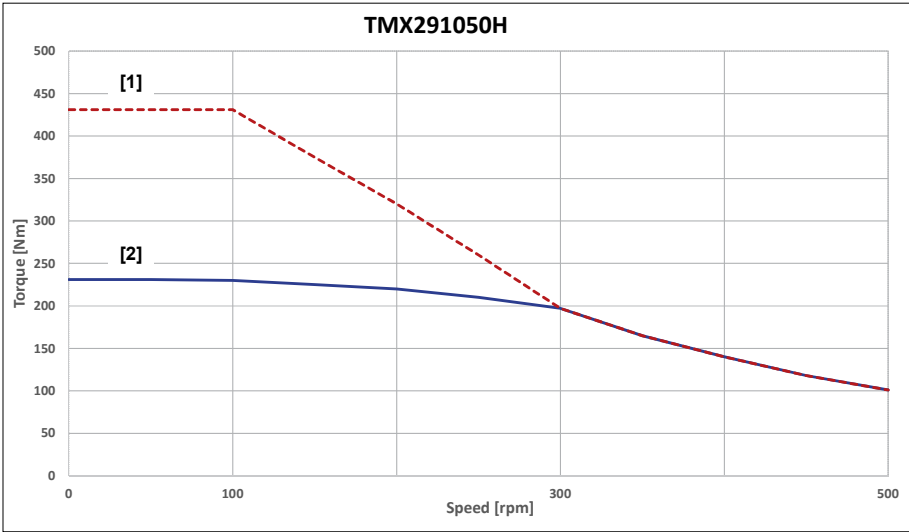
2.9.4 TMX210070 Overall dimensions



2.10 TMX291 Technical characteristics

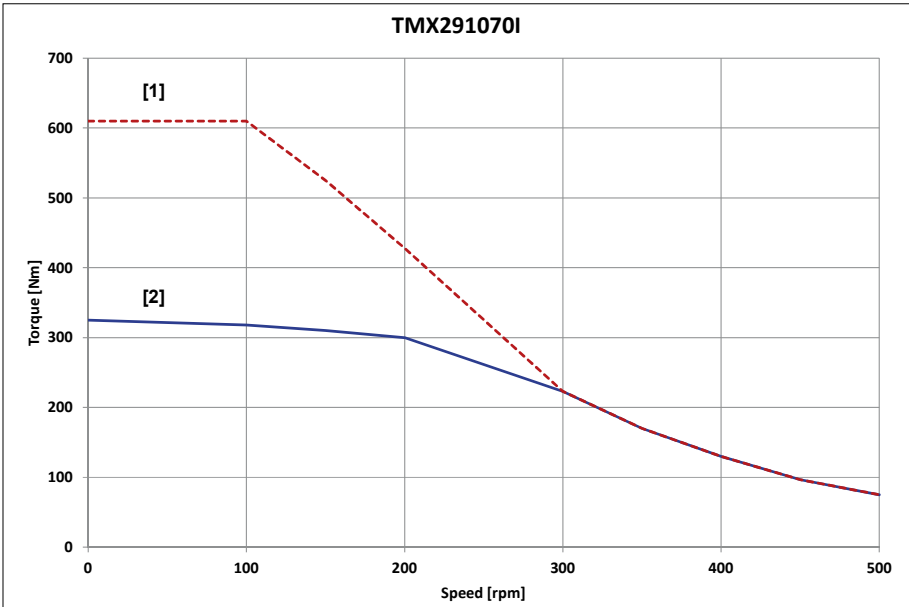
Frame sizes	Symbol	Unit	TMX291050H	TMX291070I	TMX291150P *
Low speed continuous torque	To	Nm	230	325	705
Low speed continuous current	Io	Arms	18.5	23.5	22.8
Locked rotor continuous torque	Tcs	Nm	185.0	270	585
Locked rotor continuous current	Ics	Arms	14.0	18.5	17.8
Peak torque	Tpk	Nm	435	610	1307
Peak current	Ipk	Arms	53	63	61
Maximum DC bus voltage	Vdc	Vdc	650	650	650
Maximum 3-phases input voltage	Vrated	Vrms	480	480	480
Torque constant (at rated conditions)	Kt	Nm/ Arms	12.4	13.8	30.9
Back EMF constant (phase to phase) @ 25°C	Ke	Vrms/ rad/s	7.81	8.63	19.2
Pole pair	pp		22	22	22
Maximum mechanical speed	wmax	rpm	500	500	500
Inertia	Jr	gm ²	40.3	56.2	120
Winding resistance (phase to phase) @ 25°C	Rw	ohm	3.15	2.5	4.8
Winding inductance (phase to phase)	Lw	mH	20	15.7	39.5
Electrical time constant	Tel	ms	6.35	6.3	8.2
Stator weight	Ws	kg	16.6	21	40
Rotor weight	Wr	kg	3.4	5	10.2
Minimum water flow	Q	l/min	8	10	18
Maximum continuous losses	Pd	W	2650	3300	5800
* Preliminary data					

2.10.1 **TMX291050H speed torque curves**



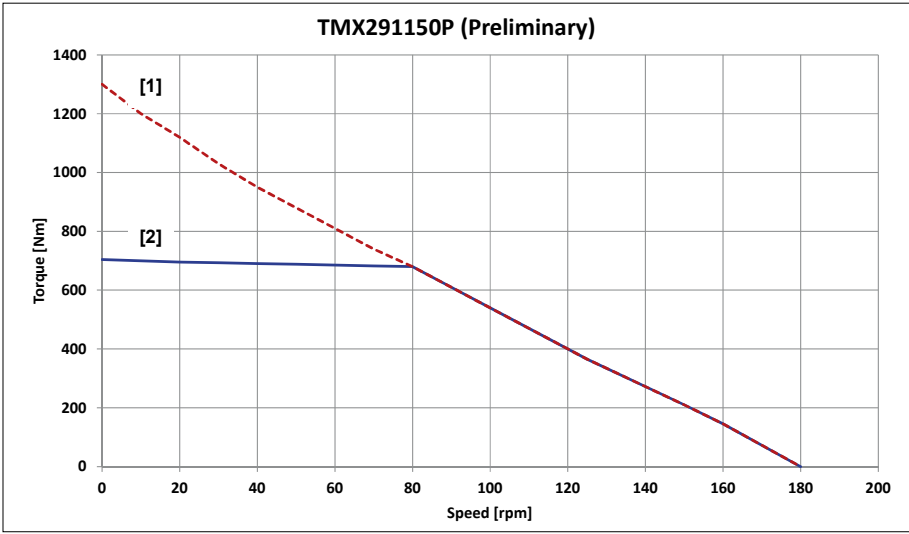
TMX291050H legend	
[1]	Peak torque 560Vdc
[2]	Continuous torque (S1) water cooled

2.10.2 **TMX291070I speed torque curves**

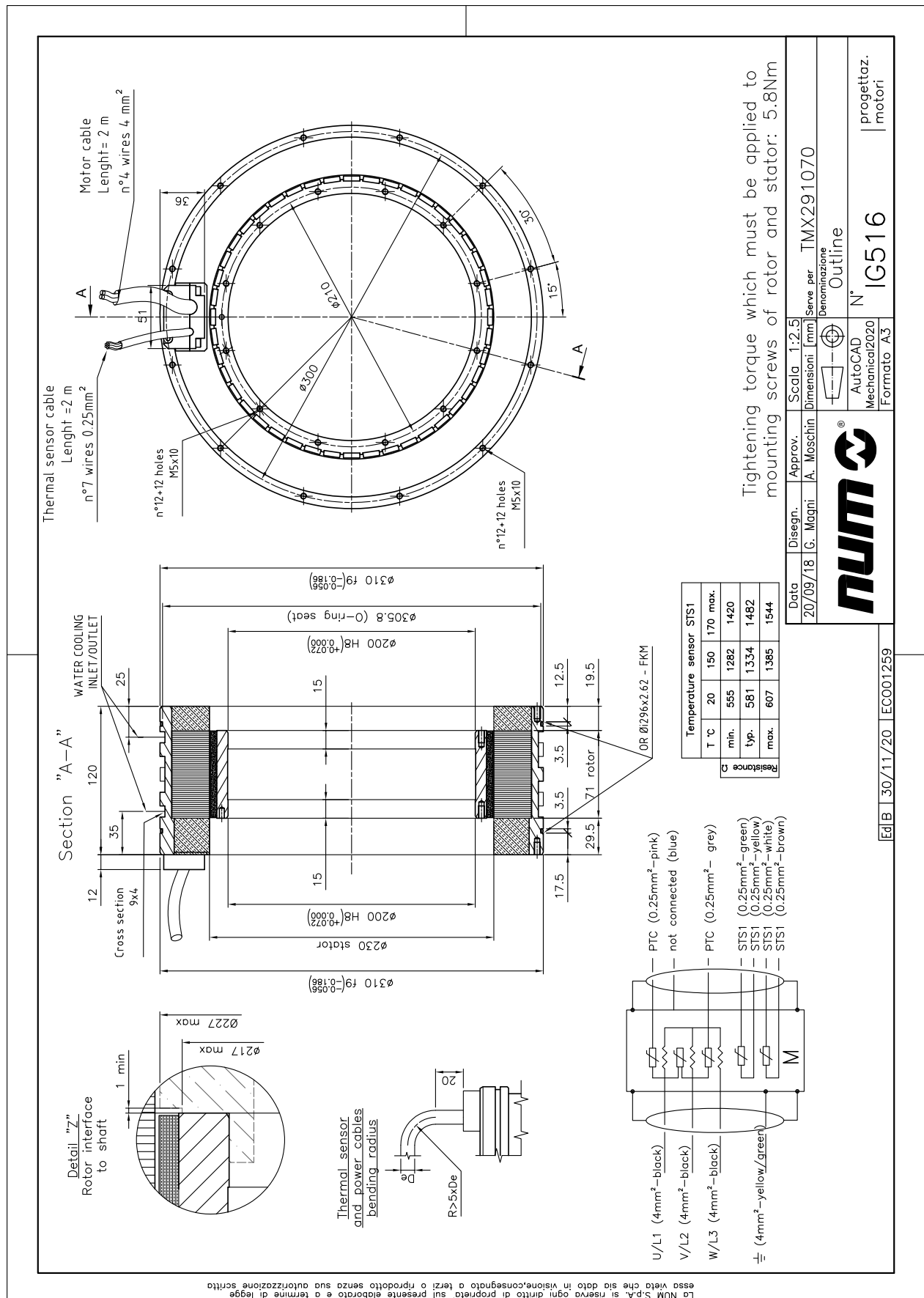


TMX291070I legend	
[1]	Peak torque 560Vdc
[2]	Continuous torque (S1) water cooled

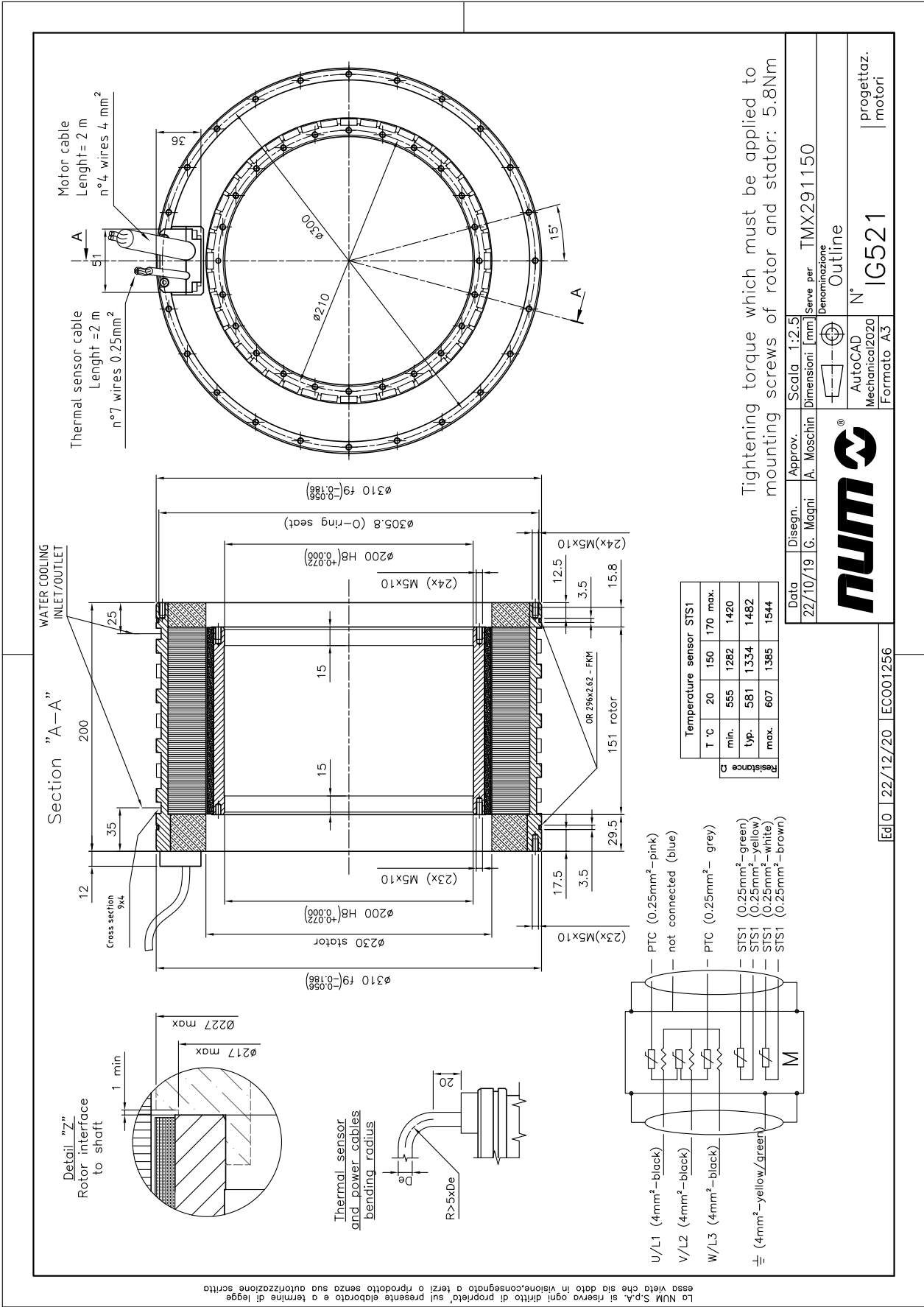
2.10.3 **TMX291150P speed torque curves**



TMX291150P legend	
[1]	Peak torque 560Vdc
[2]	Continuous torque (S1) water cooled



2.13 TMX291150 Overall dimensions



2.14 Motor / drive standard association

2.14.1 Association of TMX Motors with NUMDrive X (Switching Frequency 5 kHz)

MDLUX....		007B	007A	014B	014A	021B	021A	034A	050B	050A	075B	075A	100A	150A	200A	400A
TMX Water cooled	Low speed contin. torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque
	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]
TMX140050D	33			43	43	51	51	57	57							
TMX140070C	50							70	81	81	81					
TMX210050G	124							201	250	250	250					
TMX210070I	174							285	350	350	350					
TMX291050H	230								360	360	435	435				
TMX291070I	325								442	442	560	560	610			
TMX291150P	705								1000	1000	1250	1250	1375			

2.14.2 Association of TMX Motors with NUMDrive X (Switching Frequency 10 kHz)

MDLUX....		007B	007A	014B	014A	021B	021A	034A	050B	050A	075B	075A	100A	150A	200A	400A
TMX Water cooled	Low speed contin. torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque	Peak torque
	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]	[Nm]
TMX140050D	33						51	57	57							
TMX140070C	50								81	81	81					
TMX210050G	124								250	250	250					
TMX210070I	174								350	350	350					
TMX291050H	230								360	360	435	435				
TMX291070I	325										560	560	610			
TMX291150P	705										1250	1250	1375			

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3 TMX motors installation

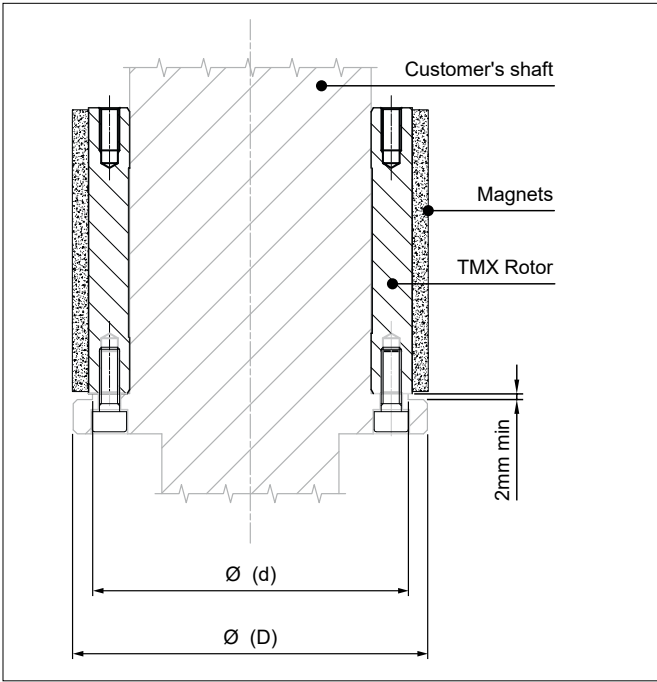
3.1 Assembly notes



Only qualified personnel can assemble torque motors and components and must necessarily read and understand the not exhaustive assembly instructions notes contained in this manual.

3.1.1 Rotor installation notes

In the following table you can find the maximum shaft coupling diameters (shaft supply by the customer) that avoid influences with the magnetic flux.



Requirements for rotor installation – TMX		
Motor type	Ø D [mm] max	Ø d [mm] max
TMX140	88	79
TMX210	168	157
TMX291	227	217

Secure the rotor to the shaft interface by tightening the screws with the torques values Indicated in the table page 47



Danger from strong magnetic fields!

Strong magnetic fields around the torque motors pose a health risk to people with implants (e.g. cardiac pacemakers) that are affected by magnetic fields.

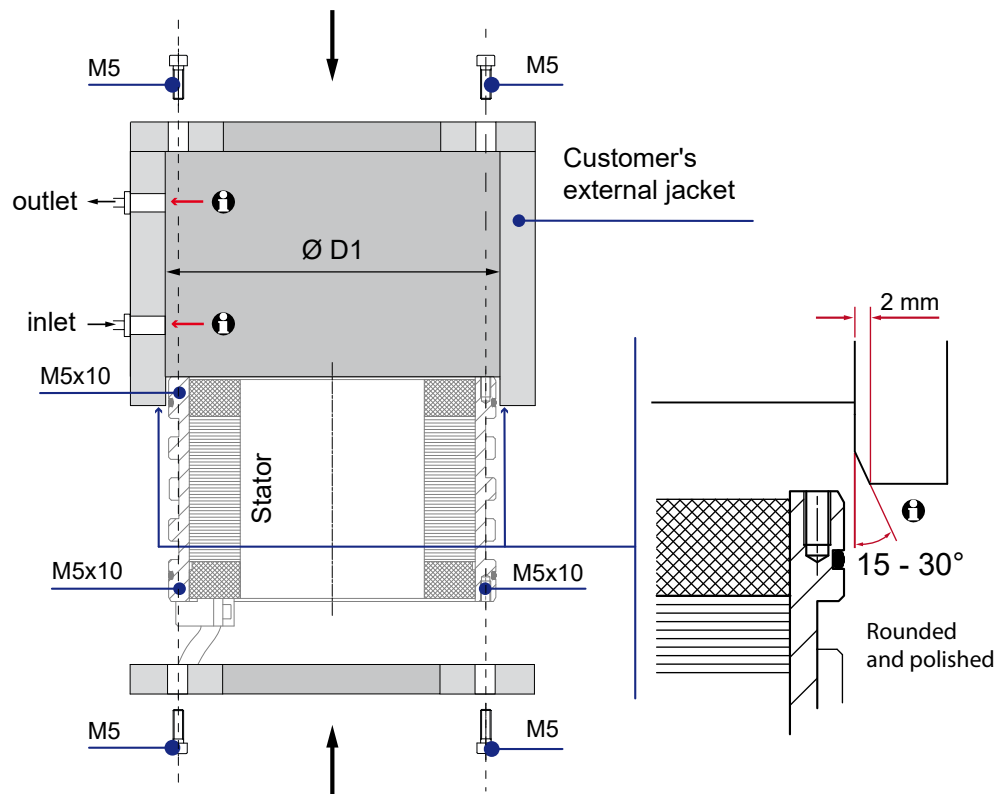


Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 1 m from components.



Danger of crushing

3.1.2 Stator installation notes



3.1.2.1 Warnings before assembly the stator

The recommended value for the tolerance of the internal diameter $\varnothing D1$ of the external jacket (and the stator mounting holes) is H7.

The suggested $\varnothing D1$ roundness is illustrated in the below table.

Requirements for stator installation – TMX	
Motor type	Roundness $\varnothing D1$ [mm] external jacket
TMX140	0,05
TMX210	0,05
TMX291	0,10

3.1.2.2 O-ring characteristics

TMX	O-ring type	Pieces	Cross section $\varnothing$ (mm)	Internal diameter (mm)	Working temperature
140	FKM 3600	2	2,62	153	-40°C to +100°C
210	FKM 3875	2	2,62	221,9	
291	FKM*	2	2,62	296,0	

(*) Custom dimension.

3.1.3 Stator assembling

- Place the two O-rings into the respective grooves provided on the stator. Take care that the O-rings do not become twisted;
- Insert the stator into the external jacket. Ensure that the coolant inlets and outlets are aligned with the motor cable outlet see paragraph 3.2.1.2. In addition, take care not to damage the O-rings, in order to prevent leaks.

During the mounting take care of the axial alignment between stator and customer external jacket.



All sharp edges have to be deburred / rounded and polished in order to avoid O-rings damaging.



It is recommended to grease the two O-rings with an ordinary lubricant to improve the tightness.



Be careful not to twist or damage the O-rings to avoid leakages.

- Secure the stator to the customer external housing. Observe the tightening torques for the mounting bolts below.

Torque motors series	Bolts	Tightening torques
TMX140	M5	5,8 Nm
TMX210		
TMX291		

3.1.4 Forces between stator and rotor



When integrating torque motor in the customer mechanics, ensure maximum concentricity between stator and rotor.
Tolerance values for concentricity error is max 0.1 mm

3.1.4.1 Radial force between stator and rotor



If the concentricity tolerance values are not observed, radial forces will arise between the stator and rotor.

Torque Motor series	Radial forces /100mm [N/mm] (fr)
TMX140	2270
TMX210	4650
TMX291	6350

The total radial force for specific active length is given by

$$\text{Force}_{\text{rad}} = f_r \cdot \frac{L_{\text{active}} [\text{mm}]}{100}$$

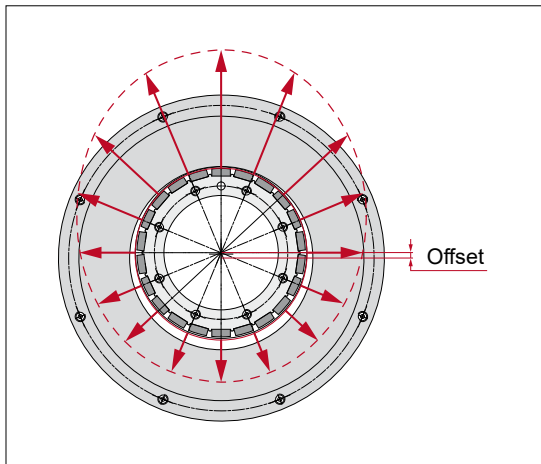
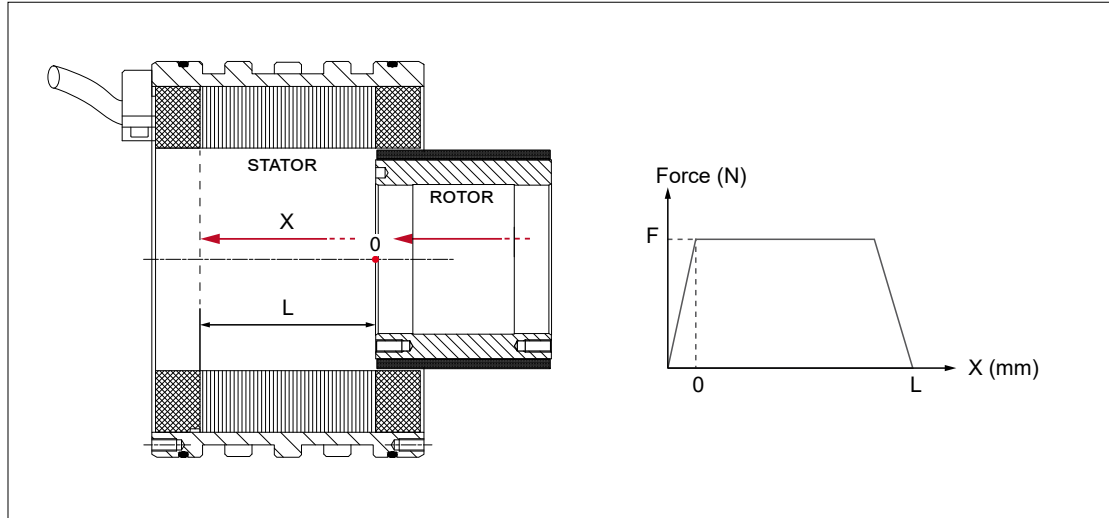


Diagram of the radial forces arising between stator and rotor.

3.1.4.2 Axial forces between the stator and the rotor

An axial force is generated when the rotor is inserted inside the stator. The axial force between the two components is $8 \div 12 \text{ N / magnet}$.

Tolerance values for alignment offset lie between $\pm 0.1 \text{ mm}$



Torque Motor series	Force during rotor insertion into the stator
TMX140	200 N
TMX210	370 N
TMX291	570 N



Possibility of injury to the user (moving parts can crush fingers, hand,...). The component (rotor) must be handled carefully and held far away from metallic parts, stators and other rotors. It indicates powerful magnetic induction, dangerous for the customer.



Warning of magnetic fields!

Strong magnetic fields around components pose a health risk to persons with implants (e.g. cardiac pace- makers) that are affected by magnetic fields.

Persons with implants that are affected by magnetic fields should maintain a safe distance of at least 0.3 m from components.



Anyone having active implants (pacemakers) or having any other ferromagnetic prosthesis is not qualified to work with these kinds of devices, or to approach them. Keep at a safe distance from the motor!

3.2 Torque motor cooling



The coolant inlet and outlet are fixed to the customer's housing.

The design of the cooling system and interface is under the customer's responsibility.

The rotor and the stator are made of not alloy steel.

3.2.1 Water cooling

Cooling channels are located in the outer jacket of the stator. O-rings limit the cooling channels at the outer edges and prevent the escape of coolant.

3.2.1.1 Temperature values of the water cooling:

- max water cooling inlet temperature 25°C;
- max water cooling outlet max temperature = inlet temp. + 5°C.



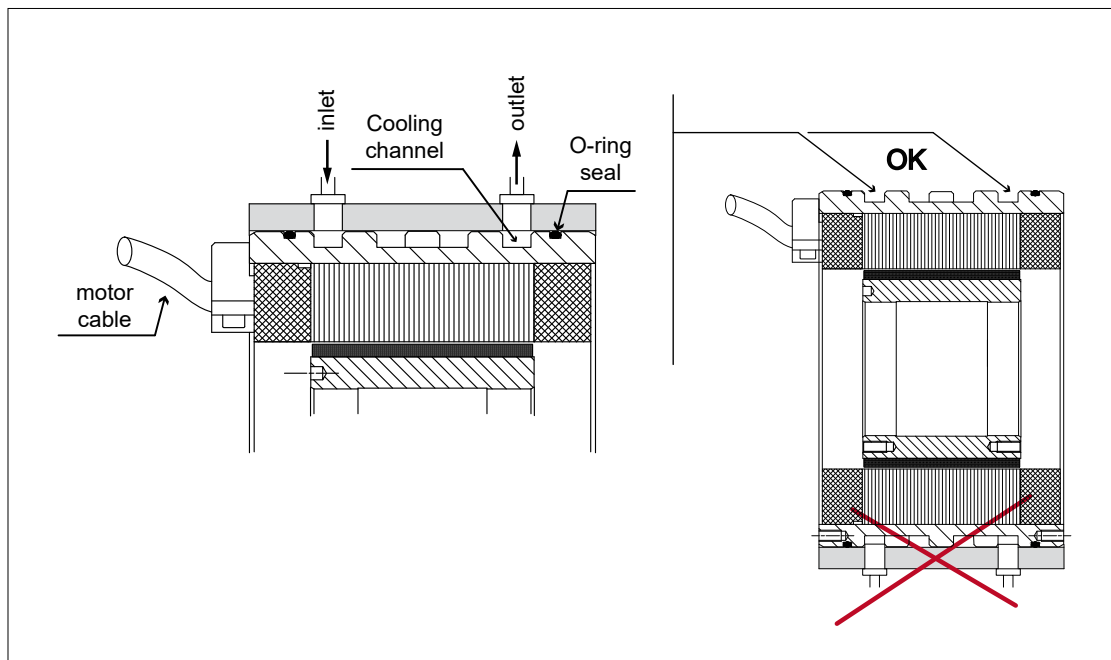
The inlet temperature have to be selected in order to avoid condensation; condensation can damage the motor. NUM suggests to use an inlet water temperature not lower than 3°C of ambient temperature.

3.2.1.2 Position of coolant inlet / outlet



Attention!

The inlet and outlet of the coolant must be aligned on the side of the motor cable as shown in the following figure.



3.2.2 Coolant characteristics

Motor performance defined in data sheets are given considering specific coolant characteristics, particularly:

- liquid cooling is water mixed with glycol additive (10 -15% indicative) with function of rustproof and antifreeze;
- coolant specific heat capacity have to be kept very close to the water value;
- closed circuit is recommended for the cooling liquid;
- tap or mixed water with any pollutant not suggested, in order to avoid (calcareous) deposits which can reduce channels flow and cooling efficiency, so demineralized water is recommended with filter for rust and waste which can occur.

Additives have to be compatible with material of stator cooling jacket (non alloy steel E355) and o-rings (as provided, FKM VITON).

Periodic maintenance of the coolant is suggested, also based on the additive producer specification.

The use of coolant with different properties leads to a reduction of motor's continuous duty characteristics.



If you are using oil as coolant, this can reduce the dissipated power and therefore it leads to a reduction of motor's continuous duty characteristics.

Please contact your local NUM office for more information.

3.3 Connections

3.3.1 Electrical connection

All the international, state, regional and local standards must be complied with during the installation and during the use of this product. Only properly qualified personnel having extensive knowledge in servomotor technology should install, commission and/or maintain the product.



Danger from electrical voltage!

If torque motors are incorrectly earthed, there is a danger of electric shock.

Before connecting the electrical power supply, ensure that the torque motor is correctly earthed via the PE rail in the switch cabinet!



Danger from electrical voltage!

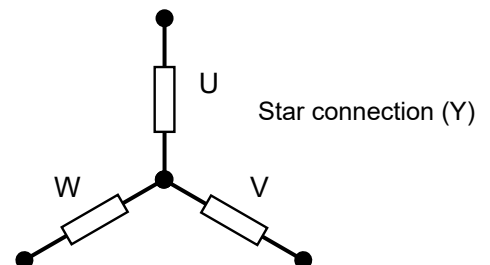
Electrical currents may flow even if the motor is not moving.

- Ensure that the torque motor is disconnected from the power supply before the electrical connections are detached from the motors.
- After disconnecting the drive amplifier from the power supply, wait at least 5 minutes before touching live parts or breaking connections.
- For safety reasons, measure the voltage in the intermediate circuit and wait until it has fallen below 50 V.

3.3.2 Power connection

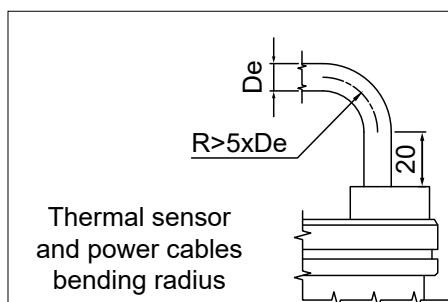
The motors are supplied with our standard PC015NH00 / PC040NH00 (1,5 or 4 mm²) orange power cable.

Drive connector pin	Motor lead wire
U	U/L1
V	V/L2
W	W/L3
Ground	Yellow/Green
Shield plate	Shield



3.3.3 Power cable and thermal sensor bending radius for TMX torque motor installation

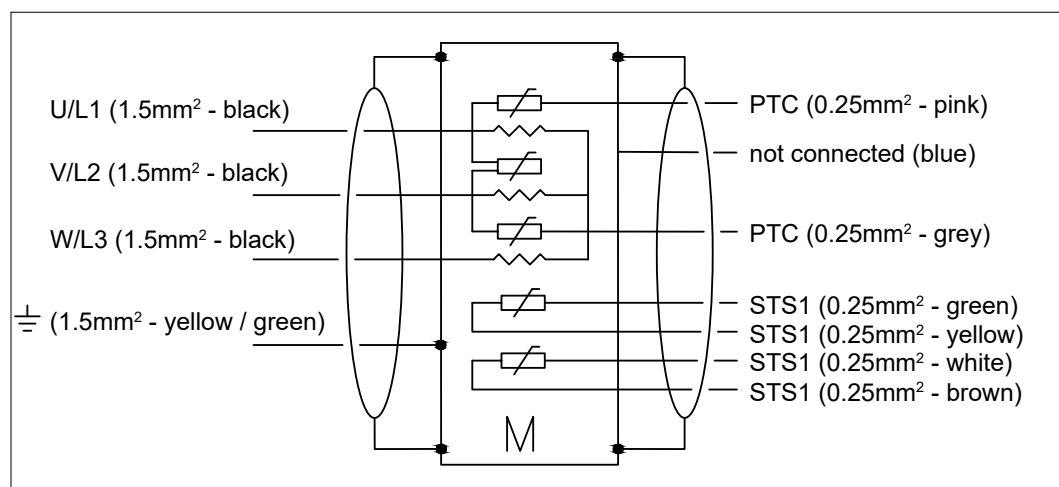
Particularly care is necessary for cables path. Refer to IG drawing of each motor for the minimum cable bending radius.



3.3.4 Thermal sensor

The released TMX motors are supplied a PTC triplet with 2 x STS1 (KTY84-130 like). All thermal sensor's wires are grouped in a PUR shielded cable.

The color code is as follows:



(*) The PTC triplet thermistor has $T_{NAT} = 130\text{ °C}$ (in accord to DIN 44082 - M180). Since heating of motor phases could be different, a PTC sensor is fitted in each phases winding.

Moreover two temperature sensors with nearly linear characteristic are provided. Some resistance temperature values (alternative to KTY84 - 130) are:

Thermal sensor STS1					
Temperature	[°C]	20	100	130	150
Resistance [Ω]	[Ω] min	555	970	1152	1282
	[Ω] typ	581	1000	1194	1334
	[Ω] max	607	1030	1235	1385

3.3.5 Electrical test

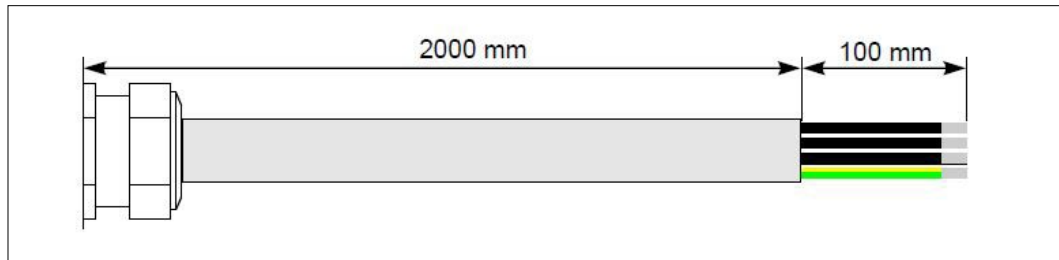
It is necessary to check electrical insulation of winding phases for all complete integrated torque motors in the customer mechanics in accord to standard regulations (e.g. EN/IEC60034-1, etc), before to connect the motor phases to the drive supply voltage.



Thermal sensors have reinforced insulation: external Customer cabling distance have to be compliance to SELV circuit regulations.

- Before apply withstand high voltage test, all temperature sensors have to be short circuited.
- Before to connect the motor to drive, always check continuity for PTC thermistor and correct thermal sensor STS1 resistance values. Motors operating without thermal protection get the risk of insulation damage.
- Check ground continuity of yellow/green wire; always connect to PE connection of the drive before the wire phases.

3.4 Motor cable and cable accessories



3.4.1 Cable description

The standard length of the temperature and power cable of torque motors is 2m (+ 100mm of bare conductors). The cables do not include connectors. Custom lengths (1max = 8m) are also available.



Please refer to NUMDrive X Installation and Maintenance manual M00030.

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Published by NUM Spa

Via F. Somma 62
20012 Cuggiono (MI) (Italy)
Tel. : +39 02 979 691
website: www.num.com

Printed August 2022