

Data Sheet

# EM-PMI300-T310

Electric machine, permanent magnet internal

## FEATURES

- Synchronous Reluctance assisted Permanent Magnet (SRPM) technology
- Extremely compact and robust aluminum frame structure
- Highest efficiency throughout the operation range on the market (~96 %)
- Liquid cooled with water-glycol mixture
- Low coolant flow required
- Allowed coolant temperature up to +65°C
- IP65 enclosure class to maximize reliability
- Multiple mounting possibilities



## GENERATOR SPECIFIC FEATURES

- Standard SAE flange mounting to match the diesel engine connection
- Wide selection of speed ratings allowing the generator to be selected to customer specific applications with various voltage requirements
- Can also be used as starter motor for the ICE

## MOTOR SPECIFIC FEATURES

- Extended speed and torque capabilities compared to standard PM motors from Danfoss reluctance assisted permanent magnet motor technology
- Motor structure is designed to be able to produce high starting torque: EM-PMI motor can produce instantly full torque to a non-rotating shaft
- Optimized speed range to meet the most common gear ratios used in heavy mobile machinery

## GENERAL

The machine is developed especially for demanding applications. It is smaller, lighter and more efficient than conventional products on the market.

## TYPICAL APPLICATIONS

- Generator for diesel-electric/serial hybrid applications
- Traction/propulsion motor
- Generator/Motor for parallel hybrid applications

## SPECIFICATIONS

General electrical properties	
Nominal voltage (line-to-line)	500 V <sub>AC</sub>
Voltage stress	IEC 60034-25:2009, Curve A: Without filters for motors up to 500 V <sub>AC</sub>
Nominal efficiency	96 %
Pole pair number	6
Power supply	Inverter fed
Nominal inverter switching frequency	8 kHz
Minimal inverter switching frequency	4 kHz (with limited speed 1.4 times nominal speed)
Maximum phase-to-phase peak-to-peak voltage without du/dt	1.5 kV
Maximum voltage rise time without du/dt	8 kV/μs

Basic information	
Machine type	Synchronous reluctance assisted permanent magnet
Frame material	Aluminum
Mounting direction	Can be used in any direction, see user guide for details. Greased for life bearings required
Mounting (IEC 60034-7)	IM 3009-B5 (flange horizontal), IM 3019-V1 (flange and D-end down)
Standard flange D-end (SAE J617)	SAE 4 transmission housing
Standard axle spline D-end	DIN5480 W50x2x24x8f, shaft length 75mm
Standard rotation direction	Clockwise (both directions possible)
Bearing type	Standard: 6211-2RS1/C3WT +BHS option: 6211/C3 (with LGHP2 grease) +BIN option: D-end: 6211-2RS1/C3WT N-end: 6211-2RS1/HC5C3WT +BIA option: 6211-2RS1/HC5C3WT +BHS+BIN options: D-end: 6211/C3 (with LGHP2 grease) N-end: 6211/HC5C3WT (with LGHP2 grease) +BHS+BIA options: 6211/HC5C3 (with LGHP2 grease)
Protection class	IP65 Following best design principles
Duty type (IEC 60034-1)	S1/S9
Machine coating	Dark grey RAL7024

Mechanical	
Total weight	125 kg (no options)
Moment of inertia	0.21 kgm <sup>2</sup>
Torsional stiffness of shaft drive end	4*10 <sup>5</sup> Nm/rad (from middle of the D-end spline to rotor air gap)
Rotating mass	40 kg
Maximum static torque range on the shaft, max. 25000 cycles, R=0 (*)	3300 Nm
Maximum dynamic torque range on the shaft, max. 1e6 cycles, R=0 (*)	2200 Nm
Maximum allowed vibratory torque range, 1e9...1e10 cycles (*)	0.3 x nominal torque of machine
Maximum deceleration (fault stop)	12400 rad/s <sup>2</sup>

Dimensions	
Length (frame)	377 mm
Diameter (frame)	408 mm

Cooling	
Cooling liquid	Plain water with appropriate corrosive inhibitor (max. 50 % corrosive inhibitor)
Cooling liquid corrosive inhibitor type	Ethylene glycol (Glysantin G48 recommended)
Cooling method (IEC 60034-6)	IC 71 W
Minimum cooling liquid flow	10 l/min
Coolant circuit capacity	0.65 l
Maximum operating pressure	3 bar
Pressure loss	0.1 bar with 10 l/min (+25°C coolant)
Nominal cooling liquid temperature	+65°C (derating required if exceeded), +40°C with +CL option
Minimum cooling liquid temperature	-20°C
Maximum cooling liquid temperature	+70°C

Temperature rating	
Insulation class (IEC 60034-1)	F (+155°C)
Temperature rise (IEC 60034-1)	+85°C
Maximum winding temperature	+150°C
Nominal ambient temperature	+65°C / +45°C with +CL option
Minimum ambient temperature	-40°C
Nominal altitude (IEC 60034-1)	1000 m

Connections	
Coolant connection	2 x G3/4 bore (see dimension drawing for details)
Cable direction	Standard cable direction towards D-end
HV cables	3 x 50 mm <sup>2</sup> max.
HV cable glands	Pflitsch blueglobe TRI bg 225ms tri
HV cable recommended type	HUBER+SUHNER Radox Elastomer S, screened, single core, automotive cable (FHLR4GC13X) <a href="http://www.hubersuhner.com">www.hubersuhner.com</a>
HV cable lug size	35-8, 50-8
Recommended cable lug	35 mm <sup>2</sup> : Druseidt with narrow flange 03901 50 mm <sup>2</sup> : Druseidt with narrow flange 03903 <a href="http://www.druseidt.de">www.druseidt.de</a>
HV connection boxes	1 x 3 phase box
LV connector	12 pin TE HDSCS <a href="https://www.te.com">https://www.te.com</a>
LV connector type	TE 1-1564520-1
LV connector pin type	Gold plated
LV mating connector type	TE 1-1703639-1
LV mating connector pin type	TE 1241380-2 (gold plated)
LV connector pin configuration	See table below
LV connections (+LVB1 option)	Connection box with 2x M25 cable glands (reserve 2x plugged M16 threads available) and terminal block for LV connections. See Table 2
Anti-condensation heater (+HEAT1 option)	65 W 230 V <sub>AC</sub> single phase heater resistor (requires +LVB1 option)
Angle/Speed sensor	Type: Externally excited SIN/COS resolver Pole pair number 6 Input 7 V Frequency 10 kHz Output 2 V +/- 0.2 V Input impedance 110 Ohm +/- 10 % Output impedance 330 Ohm +/- 15 %

(\* The values are based on structural analysis and they are not applicable to any marine class rules or requirements.

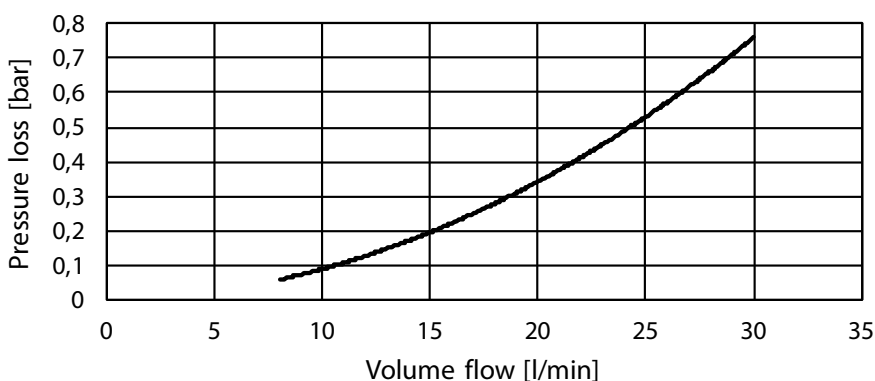
PIN	Description
1	Resolver, RES_COSN
2	Resolver, RES_SINN
3	Resolver, EXCN
4	Temperature, PT100, windings
5	Temperature, PT100, windings
6	Temperature, PT100, windings
7	Resolver, RES_COSP
8	Resolver, RES_SINP
9	Resolver, EXCP
10	Temperature, PT100, windings GND
11	Temperature, PT100, windings GND
12	Temperature, PT100, windings GND

Table 1 Pin configuration of LV-connector

PIN	Description
1	Temperature 1, PT100 (P), windings
2	Temperature 1, PT100 (N), windings
3	Temperature 2, PT100 (P), windings
4	Temperature 2, PT100 (N), windings
5	Temperature 3, PT100 (P), windings
6	Temperature 3, PT100 (N), windings
7	Temperature 4, PT100 (P), windings (+TEMP4 option)
8	Temperature 4, PT100 (N), windings (+TEMP4 option)
9	Temperature 5, PT100 (P), windings (+TEMP4 option)
10	Temperature 5, PT100 (N), windings (+TEMP4 option)
11	Temperature 6, PT100 (P), windings (+TEMP4 option)
12	Temperature 6, PT100 (N), windings (+TEMP4 option)
16	Heater, phase, 230 V <sub>AC</sub>
17	Heater, neutral
⊥	Heater, ground / protective earth, M4 screw inside connection box
⊥	General shielding, ground / protective earth, M4 screw inside connection box
18	Resolver, RES_COS_N, in-built non-contacting
19	Resolver, RES_COS_P, in-built non-contacting
20	Resolver, RES_SIN_N, in-built non-contacting
21	Resolver, RES_SIN_P, in-built non-contacting
22	Resolver, EXCN, in-built non-contacting
23	Resolver, EXCP, in-built non-contacting
NA	D-end bearing temperature sensor with separate connector

Table 2 Pin configuration of LV connections (+LVB1 option)

### PRESSURE LOSS VS COOLANT FLOW



Picture 1 Pressure loss vs coolant flow

MOTORS (temperature class F, maximum winding temperature +150°C)

Type	Coolant temperature +65°C			Coolant temperature +40°C			Coolant temperature +40 / +65°C		
	Cont. Torque [Nm]	Cont. Power [kW]	Nom. Current [A]	Cont. Torque [Nm]	Cont. Power [kW]	Nom. Current [A]	Nom. speed [rpm]	Max. speed [rpm] (**)	Peak torque (*)
EM-PMI300-T310-1100	353	41	54	399	46	64	1100	2200	700
EM-PMI300- T310-1300	353	48	63	398	54	73	1300	2600	700
EM-PMI300- T310-1600	351	59	78	389	65	90	1600	3200	700
EM-PMI300- T310-2200	345	79	105	390	90	121	2200	4000	700
EM-PMI300- T310-2800	312	91	123	369	108	148	2800	4000	700
EM-PMI300- T310-3200	279	94	125	338	113	149	3200	4000	700

(\* Peak torque achieved with one 350A inverter)

(\*\* Mechanical maximum speed)

The maximum allowed peak torque duration at stator winding starting temperature +90°C is 2 minutes. The given values indicate typical duration and are not verified. In case more accurate values are required, cyclic dimensions are needed.

MOTORS (temperature class F, maximum winding temperature +150°C, with nominal voltage 400 V<sub>AC</sub>)

Type	Coolant temperature +40°C					
	Cont. Torque [Nm]	Cont. Power [kW]	Nom. Current [A]	Nom. Speed [rpm]	Max. Speed [rpm] (*)	Peak Torque [Nm]
EM-PMI300-T310-1100	427	36	63	800	2200	700
EM-PMI300- T310-1300	412	43	74	1000	2600	700
EM-PMI300- T310-1600	404	51	92	1200	3200	700
EM-PMI300- T310-2200	418	70	125	1600	4000	700
EM-PMI300- T310-2800	389	85	156	2100	4000	700
EM-PMI300- T310-3200	364	91	159	2400	4000	700

(\* Mechanical maximum speed)

GENERATORS (temperature class F, maximum winding temperature +150°C)

Type	Coolant temperature +65°C			Coolant temperature +40°C			Coolant temperature +40 / +65°C			
	Apparent power [kVA]	Cont. power [kW]	Nom. Current [A]	Apparent power [kVA]	Cont. Power [kW]	Nom. Current [A]	Nom. speed [rpm]	Nom. Freq. [Hz]	Power factor	Volt/ speed ratio [V <sub>AC</sub> /rpm] (*)
EM-PMI300-T310-1100	49	45	53	58	51	63	1200	113	0.89	0.498
EM-PMI300- T310-1300	58	52	63	67	59	73	1400	134	0.89	0.415
EM-PMI300- T310-1600	70	63	78	80	70	89	1700	165	0.89	0.332
EM-PMI300- T310-2200	91	83	104	105	94	120	2300	227	0.90	0.249
EM-PMI300- T310-2800	104	93	122	126	110	146	2900	288	0.87	0.194
EM-PMI300- T310-3200	107	96	124	130	118	150	3300	330	0.91	0.166

(\* Back EMF for cold (+20°C) generator)

## PRODUCT CODE AND OPTIONS

Use product code including all needed options for ordering. Standard options are not given with the code as they are selected by default if a non-standard option is not selected. Standard options are indicated by a star (\*).

Product code	Description
EM-PMI300-T310-1600	Standard 1600 rpm unit with standard options
EM-PMI300-T310-1600+BHS+RES1	Standard unit with grease lubricated bearings and resolver

Table 3 Product code examples

Variant	Code	Description	Additional information
Low voltage connections	*	Low voltage connections done with connector	TYCO TE 1-1564520-1 connector for LV connections
	+LVB1	Low voltage connections done with connection box and terminal strip	Connection box with 2x M25 cable glands (reserve 2x plugged M16 threads available) and terminal block for LV connections
N-end attachment	*	None	
	+NE1	Flange	SAE 4 mating transmission housing
	+NE2	Male shaft + Flange	DIN5480 W50x2x24x8f + SAE 4 mating transmission housing
Bearing lubrication and mounting direction	*	Greased for life	Deep groove ball bearing, contact seal on both sides, any mounting direction (see user guide for details)
	+BHS	Grease lubricated	Deep groove ball bearing, open design, horizontal mounting direction (see user guide for details)
Bearing insulation	*	Non-insulated bearings	Non-insulated bearings
	+BIN	Insulated bearing in N-end	Insulated bearing in N-end
	+BIA	Insulated bearing in both ends	Insulated bearing in both ends
Rotation sensor	*	None	No resolver
	+RES1	Resolver	In-built non contacting resolver, 6-pole pair
Winding temperature sensors (**)	*	Temperature surveillance	3 x PT100 (two wire) in windings
	+TEMP4	Redundant temperature surveillance	6 x PT100 (two wire) in windings, requires +LVB1 option
Anti-condensation heaters	*	None	
	+HEAT1	One anti-condensation heater	230 V <sub>AC</sub> / 65 W, requires +LVB1 option (see user guide for more information)
Marine classification	*	No marine classification	
	+CL1		ABS American Bureau of Shipping
	+CL2		BV Bureau Veritas
	+CL3		DNV
	+CL4		LR Lloyd's Register
	+CL5		RINA
	+CL6		CCS China Classification Society

(\* Standard option

(\*\* Winding temperature sensors are for stator winding. The selection of high voltage connections does not have an influence on the quantity of PT100 elements.

Table 4 Option list

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