

Data Sheet

EM-PMI540-T2000

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 plain water or 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 be also 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. The design of these machines makes them 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		Rotating mass	189 kg
Nominal voltage (line to line)	500 V _{AC}	Maximum static torque range on the shaft, max. 25000 cycles, R=0 (*)	6800 Nm
Voltage stress	IEC 60034-25, Curve A: Without filters for motors up to 500 V _{AC}	Maximum dynamic torque range on the shaft, max. 1e6 cycles, R=0 (*)	4000 Nm
Nominal efficiency	96 %	Maximum allowed vibratory torque range, 1e9...1e10 cycles (*)	0.3 x Nominal torque of machine
Pole pair number	8	Maximum deceleration (fault stop)	825 rad/s ²
Power supply	Inverter fed.	Dimensions	
Nominal inverter switching frequency	8 kHz	Length (frame)	598 mm
Minimal inverter switching frequency	4 kHz (with limited speed 1.4 times nominal speed)	Diameter (frame)	648 mm
Basic information		Cooling	
Machine type	Synchronous reluctance assisted permanent magnet	Cooling liquid	Plain water with appropriate corrosive inhibitor (max. 50 % corrosive inhibitor)
Frame material	Aluminum	Cooling liquid corrosive inhibitor type	Ethylene glycol Glystantin G48 recommended
Mounting direction	Horizontal or vertical assembly, see user guide for details	Cooling method (IEC 60034-6)	IC 71 W
Mounting (IEC 60034-7)	IM 3009-B5 (Flange horizontal), IM 3019-V1 (Flange and D-end down)	Minimum cooling liquid flow	20 l/min
Standard Flange D-end (SAE J617)	SAE ½ mating transmission housing	Coolant circuit capacity	3.9 l
Standard axle spline D-end	DIN5480 W55x2x26x8a	Maximum operating pressure	2 bar
Bearing type	Standard: 6214/C3 (with LGHP2 grease) +BIN option: D-end: 6214/C3 (with LGHP2 grease), N-end: 6214/HC5C3 (with LGHP2 grease) +BIA option: 6214/HC5C3WT (with LGHP2 grease)	Pressure loss	0.4 bar with 20l/min (+25°C coolant)
Standard rotation direction	Clockwise (both directions possible)	Nominal cooling liquid temperature	+65°C (derating required if exceeded), +40°C with +CL option
Protection class	IP65 Tests: 0.3 bar under pressure held for 120 seconds. Pressure not allowed to drop under 0.1 bar	Minimum cooling liquid temperature	-20°C
Duty type (IEC 60034-1)	S1/S9	Maximum cooling liquid temperature	+70°C
Standard color	Dark grey RAL7024 powder coating	Condensation dew point	Please use anti-condensation heaters
Mechanical		Temperature rating	
Total weight	490 kg (no options)	Insulation class (IEC 60034-1)	H (180°C)
Moment of inertia	4.73 kgm ²	Temperature rise (IEC 60034-1)	85°C
Torsional stiffness of shaft drive end	5*10 ⁵ Nm/rad (from middle of the d-end spline to rotor air gap)	Maximum winding temperature	150°C
		Nominal ambient temperature	+65°C / +45°C with +CL option

Min. ambient temperature	-40°C	LV connector type	DEUTSCH HD34-24-47PE
Nominal altitude (IEC 60034-1)	1000 m	LV connector pin type	Gold plated
Vibration & Shock tolerance		LV mating connector type	DEUTSCH HD36-24-47SE or DEUTSCH HD36-24-47SE-059
Mechanical vibration	5.9 G _{RMS} ISO 16750-3 Test VII – Commercial vehicle, sprung masses – Table 12 Notes: test duration 8h per each axis (two axes tested; radial and axial) total spectral acceleration 5.91 G _{RMS} Test done with EM-PMI540-T1500 (with flange mounting)	LV mating connector pin type	DEUTSCH 0462-201-1631 DEUTSCH 0462-005-2031 Plug: DEUTSCH 0413-204-2005 (size 20) Plug: DEUTSCH 0413-003-1605 (size 16)
		LV connector pin configuration	See Table below
		Anti-condensation heater (+HEAT1 option)	130W 230 V _{AC} single phase heater resistor
Mechanical shock	50 G ISO 16750-3 4.2.2 Test for devices on rigid points on the body and on the frame Notes: –acceleration: 500 m/s ² ; –duration: 6 ms; –number of shocks: 10 per test direction. Test done with EM-PMI540-T1500 (with flange mounting)	Heater connection (+HEAT1 option)	Pflitsch blueglobe mstri212 (M12) and terminal strip inside connection box
		Heater terminal strip pin configuration	See Table below
		Bearing temp. measurement connector type	4-pin M12 A coded male
		Bearing temp. measurement mating type	4-pin M12 A coded female
Connections		Bearing temp. measurement connector pin configuration	See Table below
Coolant connection	2 x G3/4 bore		
HV cables	2 x 3 x 95 mm ² max.		
HV cable glands	Pflitsch blueglobe TRI bg 232ms tri		
HV cable	Recommended H+S Radox screened cable		(* The values are based on structural analysis and they are not applicable to any marine class rules or requirements.
HV cable lug size	35-8, 50-8, 70-8, 95-8		
Recommended cable lug	35 mm ² : Druseidt with narrow flange 03901 50 mm ² : Druseidt with narrow flange 03903 70 mm ² : Druseidt with narrow flange 03906 95 mm ² : Druseidt with narrow flange 03910		
HV connection boxes	2 x 3 phase box		
LV connector	47 pin DEUTSCH HD34-24-47PE for resolver and temperature measurement.		

PIN	Description
47	Temperature 1, PT100 (P), windings
46	Temperature 1, PT100 (N), windings
33	Temperature 2, PT100 (P), windings
32	Temperature 2, PT100 (N), windings
45	Temperature 3, PT100 (P), windings
31	Temperature 3, PT100 (N), windings
30	Temperature 4, PT100 (P), windings (+TEMP4 +TEMP5 option)
29	Temperature 4, PT100 (N), windings (+TEMP4 +TEMP5 option)
44	Temperature 5, PT100 (P), windings (+TEMP4 +TEMP5 option)
43	Temperature 5, PT100 (N), windings (+TEMP4 +TEMP5 option)
28	Temperature 6, PT100 (P), windings (+TEMP4 +TEMP5 option)
16	Temperature 6, PT100 (N), windings (+TEMP4 +TEMP5 option)
42	Temperature 7, PT100 (P), windings (+TEMP5 option)
27	Temperature 7, PT100 (N), windings (+TEMP5 option)
15	Temperature 8, PT100, (P) windings (+TEMP5 option)
14	Temperature 8, PT100 (N), windings (+TEMP5 option)
40	Temperature 9, PT100 (P), windings (+TEMP5 option)
26	Temperature 9, PT100 (N), windings (+TEMP5 option)
41	Temperature 10, PT100 (P), windings (+TEMP5 option)
13	Temperature 10, PT100 (N), windings (+TEMP5 option)
39	Temperature 11, PT100 (P), windings (+TEMP5 option)
38	Temperature 11, PT100 (N), windings (+TEMP5 option)
25	Temperature 12, PT100 (P), windings (+TEMP5 option)
12	Temperature 12, PT100 (N), windings (+TEMP5 option)
35	Resolver, RES_COS_N, in-built non-contacting
20	Resolver, RES_COS_P, in-built non-contacting
36	Resolver, RES_SIN_N, in-built non-contacting
21	Resolver, RES_SIN_P, in-built non-contacting
22	Resolver, EXCN, in-built non-contacting
10	Resolver, EXCP, in-built non-contacting
34	Resolver, SHIELD/GROUND, in-built non-contacting

Table 1 Pin configuration of LV-connector

PIN	Description
1	Heater, phase, 230 V _{AC}
2	Heater, neutral
\perp	Heater, ground / protective earth, M5 screw inside connection box
3	Reserve
4	Reserve
5	Temperature 1, PT100 (P), windings
6	Temperature 1, PT100 (N), windings
7	Temperature 2, PT100 (P), windings
8	Temperature 2, PT100 (N), windings
9	Temperature 3, PT100 (P), windings
10	Temperature 3, PT100 (N), windings
11	Temperature 4, PT100 (P), windings (+TEMP4 option)
12	Temperature 4, PT100 (N), windings (+TEMP4 option)
13	Temperature 5, PT100 (P), windings (+TEMP4 option)
14	Temperature 5, PT100 (N), windings (+TEMP4 option)
15	Temperature 6, PT100 (P), windings (+TEMP4 option)
16	Temperature 6, PT100 (N), windings (+TEMP4 option)
17	Temperature 7, PT100 (P), windings (+TEMP5 option)
18	Temperature 7, PT100 (N), windings (+TEMP5 option)
19	Temperature 8, PT100 (P), windings (+TEMP5 option)

20	Temperature 8, PT100 (N), windings (+TEMP5 option)
21	Temperature 9, PT100 (P), windings (+TEMP5 option)
22	Temperature 9, PT100 (N), windings (+TEMP5 option)
23	Temperature 10, PT100 (P), windings (+TEMP5 option)
24	Temperature 10, PT100 (N), windings (+TEMP5 option)
25	Temperature 11, PT100 (P), windings (+TEMP5 option)
26	Temperature 11, PT100 (N), windings (+TEMP5 option)
27	Temperature 12, PT100 (P), windings (+TEMP5 option)
28	Temperature 12, PT100 (N), windings (+TEMP5 option)
29	Resolver, RES_COS_P, in-built non-contacting (+RES1 option)
30	Resolver, RES_COS_N, in-built non-contacting (+RES1 option)
31	Resolver, RES_SIN_P, in-built non-contacting (+RES1 option)
32	Resolver, RES_SIN_N, in-built non-contacting (+RES1 option)
33	Resolver, EXCP, in-built non-contacting (+RES1 option)
34	Resolver, EXCN, in-built non-contacting (+RES1 option)
35	Resolver, SHIELD/GROUND, in-built non-contacting (+RES1 option)
36	Temperature, PT100 (P), bearings N-end (+BTMP1 option)
37	Temperature, PT100 (N), bearings N-end (+BTMP1 option)
38	Reserve
39	Reserve
NA	D-end bearing temperature sensor with separate connector (+BTMP1 option), see Table 4

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

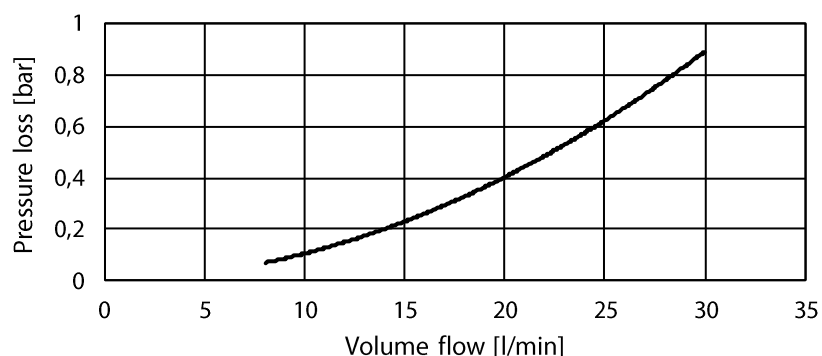
PIN	Description
1	Phase, 230 V _{AC} / Neutral
2	Phase, 230 V _{AC} / Neutral
⏏	Ground/protective earth, M5 screw connection inside connection box

Table 3 Pin configuration of heater (pin configuration does not matter)

PIN	Description
1	PT-100
2	
3	PT-100_GND
4	

Table 4 Pin configuration of bearing temperature sensor connector (one sensor)

PRESSURE LOSS VS COOLANT FLOW



Picture 1 Pressure loss vs coolant flow

MOTORS

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 SINGLE (*)	Peak torque DUAL (**)
EM-PMI540-T2000-700	2462	180	242	2716	199	267	700	1400	3400	3700
EM-PMI540-T2000-1000	2390	250	321	2570	269	344	1000	2000	2500	3650
EM-PMI540-T2000-1300	2303	313	413	2386	325	431	1300	2600	1930	3650
EM-PMI540-T2000-1700	2009	358	485	2276	405	543	1700	3400	1400	2750
EM-PMI540-T2000-2100	1919	422	569	2153	473	633	2100	4000	1150	2300

(* Peak torque achieved with one 350A inverter

(** Peak torque achieved with two 350A inverters

The maximum allowed peak torque duration at stator winding starting temperature +90°C is 6.5 minutes. The given values indicate typical duration and are not verified. In case more accurate values are required, cyclic dimensions are needed.

GENERATORS

Type	Coolant temperature +65°C				Coolant temperature +40°C				Coolant temperature +40 / +65°C		
	Apparent power [kVA]	Cont. power [kW]	Nom. Current [A]	Power factor	Apparent power [kVA]	Cont. Power [kW]	Nom. Current [A]	Power factor	Nom. speed [rpm]	Nom. Freq. [Hz]	Volt/ speed ratio [V _{AC} /rpm] (***)
EM-PMI540-T2000-700	211	201	241	0.95	233	221	266	0.95	800	107	0.714
EM-PMI540-T2000-1000	279	269	320	0.97	297	285	342	0.96	1100	147	0.492
EM-PMI540-T2000-1300	355	331	410	0.93	372	347	428	0.93	1400	186	0.363
EM-PMI540-T2000-1700	436	413	506	0.95	466	440	538	0.94	1900	253	0.272
EM-PMI540-T2000-2100	482	454	562	0.94	573	536	626	0.94	2300	307	0.227

(*** 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-PMI540-T2000-1700-DUAL	Standard 1700 rpm unit with standard options
EM-PMI540-T2000-1700-DUAL+BIN	Standard unit with insulated bearing in N-end

Table 5 Product code examples

Variant	Code	Description	Additional information
High voltage connections	-DUAL	Two galvanically isolated 3 phase systems	Two connection boxes each containing one 3 phase system with one M32 cable gland per phase
Low voltage connections	*	Low voltage connections done with connector	DEUTSCH HD34-24-47PE 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
Connection extension	*	None	Two connection boxes each containing one 3 phase system with one M32 cable gland per phase
	+CE1	Double phase connections	Extended connection boxes with two M32 cable glands per phase
N-end attachment	*	None	
	+NE4	Male shaft, no flange	DIN5480 W55x2x26x8a
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
Shaft grounding	*	None	
	+SG1	D-end shaft grounding	In-built grounding ring
Rotation sensor	*	None	No resolver
	+RES1	Resolver	In-built non contacting resolver, 8-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
	+TEMP5	Redundant temperature surveillance	12 x PT100 (two wire) in windings
Bearing temperature sensors	*	None	
	+BTMP1	PT100 in bearings	Plug-in connector
Anti-condensation heaters	*	None	
	+HEAT1	One anti-condensation heater	230 V _{AC} / 130 W
Marine classification	*	No marine classification	
	+CL1		ABS American Bureau of Shipping
	+CL2		BV Bureau Veritas
	+CL3		DNV
	+CL4		LR Lloyd's Register
	+CL5		RINA

(* 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 6 Option list

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