

Data Sheet

# EM-PMI375-T500

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, IP67 available as option
- 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		Standard color	Dark grey RAL7024 powder coating
Nominal voltage (line to line)	500 V <sub>AC</sub>	Mechanical	
Voltage stress	IEC 60034-25, Curve A: Without filters for motors up to 500 V <sub>AC</sub>	Total weight	172 kg (no options)
Nominal efficiency	96 %	Moment of inertia	0.46 kgm <sup>2</sup>
Pole pair number	6	Torsional stiffness of shaft drive end	4 Nm/rad (from middle of the d-end spline to rotor air gap)
Power supply	Inverter fed.	Rotating mass	52.5 kg
Nominal inverter switching frequency	8 kHz	Maximum static torque range on the shaft, max. 25000 cycles, R=0 (*)	3400 Nm
Minimum inverter switching frequency	4 kHz (with limited speed 1.4 times nominal speed)	Maximum dynamic torque range on the shaft, max. 1e6 cycles, R=0 (*)	2500 Nm
Basic information		Maximum allowed vibratory torque range, 1e9...1e10 cycles (*)	0,3 x Nominal torque of machine
Machine type	Synchronous reluctance assisted permanent magnet	Maximum deceleration (fault stop)	6000 rad/s <sup>2</sup>
Frame material	Aluminum	Dimensions	
Mounting direction	Can be used in any direction, see user guide for details. Greased for life bearings required	Length (frame)	368 mm
Mounting (IEC 60034-7)	IM 3009-B5 (Flange horizontal), IM 3019-V1 (Flange and D-end down)	Diameter (frame)	450 mm
Standard Flange D-end (SAE J617)	SAE 3 mating transmission housing	Cooling	
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)	Cooling liquid	Plain water with appropriate corrosive inhibitor (max. 50 % corrosive inhibitor)
Standard axle spline D-end	DIN5480 W50x2x24x8f	Cooling liquid corrosive inhibitor type	Ethylene glycol Glysantin G48 recommended
Standard Flange N-end (SAE J617)	SAE 4, flywheel housing	Cooling method (IEC 60034-6)	IC 71 W
Standard rotation direction	Clockwise (both directions possible)	Minimum cooling liquid flow	20 l/min
Protection class	IP65 IP67 available as option +IP67 Tests: 0.3 bar under pressure held for 120 seconds. Pressure not allowed to drop under 0.25 bar	Maximum operating pressure	3 bar
Duty type (IEC 60034-1)	S1/S9	Coolant circuit capacity	1.4 l
		Pressure loss	0.4 bar with 20 l/min (+25°C coolant)
		Nominal cooling liquid temperature	+65°C (derating required if exceeded)
		Minimum cooling liquid temperature	-20°C
		Maximum cooling liquid temperature	+70°C
		Condensation dew point	Please use anti-condensation heaters

Temperature rating		HV connection boxes	1 x 3 phase box (SINGLE winding model) 2 x 3 phase box (DUAL winding model)
Insulation class (IEC 60034-1)	H (180°C)	LV connector	47 pin DEUTSCH HD34-24-47PE for resolver and temperature measurement.
Temperature rise (IEC 60034-1)	85°C (F) / 110°C (H)	LV connector type	DEUTSCH HD34-24-47PE
Maximum winding temperature	175°C	LV connector pin type	Gold plated
Nominal ambient temperature	65°C / +40°C with +CL option	LV mating connector type	DEUTSCH HD36-24-47SE or DEUTSCH HD36-24-47SE-059
Min. ambient temperature	-40°C	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)
Nominal altitude (IEC 60034-1)	1000 m		
Vibration & Shock tolerance			
Mechanical vibration	5.9 G <sub>RMS</sub> ISO 16750-3 Test VII – Commercial vehicle, sprung masses – Table 12 Notes: test duration 8h axis (two axes tested; radial and axial) total spectral acceleration 5,91 grms Test done with EM-PMI375-T800 (with flange mounting)	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 below
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 <sup>2</sup> ; –duration: 6 ms; –number of shocks: 10 per test direction. Test done with EM-PMI375-T800 (with flange mounting)	Anti-condensation heater (+HEAT1 option)	65 W 230 V <sub>AC</sub> single phase heater resistor
		Heater connector (+HEAT1 option)	Hummel art. no. 7651 0 51 01 D
		Heater mating connector	Hummel art. no. 7550 6 51 02 D
		Heater connector pin type	Hummel 7010 9 42 01 1
		Heater connector pin configuration	See Table below
		Bearing temp. measurement connector type	4-pin M12 A coded male
Connections			
Coolant connection	2 x G3/4 bore	Bearing temp. measurement mating type	4-pin M12 A coded female
Cable direction	Standard cable direction towards D-end	Bearing temp. measurement connector pin configuration	See Table below
HV cables	3 x 70 mm <sup>2</sup> max. (SINGLE winding model) 2 x 3 x 70 mm <sup>2</sup> max. (DUAL winding model)		
HV cable glands	Pflitsch blueglobe TRI bg 225ms tri		
HV cable	Recommended H+S Radox screened cable		
HV cable lug size	35-8, 50-8, 70-8		
Recommended cable lug	35 mm <sup>2</sup> : Druseidt with narrow flange 03901 50 mm <sup>2</sup> : Druseidt with narrow flange 03903 70 mm <sup>2</sup> : Druseidt with narrow flange 03906		

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

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 option)
29	Temperature 4, PT100 (N), windings (+TEMP4 option)
44	Temperature 5, PT100 (P), windings (+TEMP4 option)
43	Temperature 5, PT100 (N), windings (+TEMP4 option)
28	Temperature 6, PT100 (P), windings (+TEMP4 option)
16	Temperature 6, PT100 (N), windings (+TEMP4 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
37	Resolver, RES_COS_N, in-built non-contacting (additional resolver with +RES2 option)
24	Resolver, RES_COS_P, in-built non-contacting (additional resolver with +RES2 option)
23	Resolver, RES_SIN_N, in-built non-contacting (additional resolver with +RES2 option)
11	Resolver, RES_SIN_P, in-built non-contacting (additional resolver with +RES2 option)
9	Resolver, EXCN, in-built non-contacting (additional resolver with +RES2 option)
8	Resolver, EXCP, in-built non-contacting (additional resolver with +RES2 option)
4	Resolver, SHIELD/GROUND, in-built non-contacting (additional resolver with +RES2 option)

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
24	Temperature, PT100 (P), bearings N-end (+BTMP1 option)
25	Temperature, PT100 (N), bearings N-end (+BTMP1 option)

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

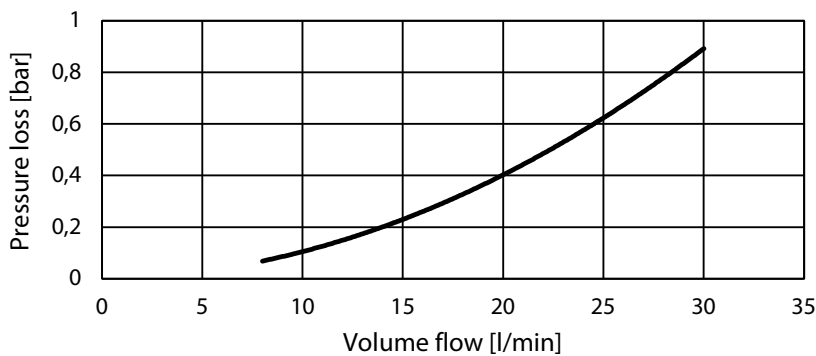
PIN	Description
1	Phase, 230 V <sub>AC</sub>
2	Neutral
⊥	Ground / protective earth
4	Reserve
5	Reserve

Table 3 Pin configuration of heater with connector

PIN	Description
1	PT100
2	
3	PT100_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 (temperature class F, maximum winding temperature 150 °C, with +CL option)

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-PMI375-T500-1100	526	61	77	573	66	86	1100	2200	1490	-
EM-PMI375-T500-1300	520	71	95	575	78	110	1300	2600	1480	-
EM-PMI375-T500-1600	515	86	111	575	96	127	1600	3200	1450	-
EM-PMI375-T500-1800	511	96	121	560	106	132	1800	3600	1400	-
EM-PMI375-T500-2000	502	105	136	550	115	149	2000	4000	1200	-
EM-PMI375-T500-2300	497	120	156	543	125	168	2300	4000	1170	1450
EM-PMI375-T500-2700	472	133	170	530	150	192	2700	4000	895	1194
EM-PMI375-T500-3200	442	148	192	484	162	208	3200	4000	736	1038

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

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

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

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/rpm] (***)
EM-PMI375-T500-1100	67	57	77	0.95	76	72	86	0.95	1200	120	0.442
EM-PMI375-T500-1300	82	77	94	0.90	95	83	109	0.87	1400	140	0.379
EM-PMI375-T500-1600	96	88	110	0.94	110	100	126	0.91	1700	170	0.316
EM-PMI375-T500-1800	104	97	120	0.97	113	110	131	0.97	1900	190	0.284
EM-PMI375-T500-2000	116	105	135	0.93	129	120	148	0.93	2100	210	0.252
EM-PMI375-T500-2300	133	120	153	0.93	144	131	165	0.91	2400	240	0.217
EM-PMI375-T500-2700	145	145	169	0.94	164	155	191	0.94	2800	280	0.190
EM-PMI375-T500-3200	164	148	190	0.94	177	166	205	0.94	3300	330	0.158

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

MOTORS (temperature class H, maximum winding temperature 175 °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 SINGLE (*)	Peak torque DUAL (**)
EM-PMI375-T500-1100	572	66	86	617	71	94	1100	2200	1490	-
EM-PMI375-T500-1300	560	76	103	607	83	114	1300	2600	1480	-
EM-PMI375-T500-1600	558	93	122	615	103	136	1600	3200	1450	-
EM-PMI375-T500-1800	552	104	131	616	116	146	1800	3600	1400	-
EM-PMI375-T500-2000	550	115	150	596	125	164	2000	4000	1200	-
EM-PMI375-T500-2300	538	130	169	578	139	184	2300	4000	1170	1450
EM-PMI375-T500-2700	524	148	190	585	165	215	2700	4000	895	1194
EM-PMI375-T500-3200	473	158	207	539	181	233	3200	4000	736	1038

(\* 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 1.5 minutes. The given values indicate typical duration and are not verified. In case more accurate values are required, cyclic dimensions are needed.

GENERATORS (temperature class H, maximum winding temperature 175 °C)

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/rpm] (***)
EM-PMI375-T500-1100	76	72	85	0.93	84	78	94	0.94	1200	120	0.442
EM-PMI375-T500-1300	90	83	102	0.93	100	90	113	0.89	1500	150	0.379
EM-PMI375-T500-1600	107	102	121	0.95	117	112	133	0.95	1800	180	0.316
EM-PMI375-T500-1800	113	110	130	0.97	126	124	145	0.98	2000	200	0.284
EM-PMI375-T500-2000	129	123	148	0.95	141	131	163	0.93	2100	210	0.252
EM-PMI375-T500-2300	144	134	166	0.93	158	146	181	0.93	2400	240	0.217
EM-PMI375-T500-2700	163	153	189	0.94	186	173	213	0.93	2800	280	0.190
EM-PMI375-T500-3200	177	166	204	0.94	199	185	230	0.93	3300	330	0.158

(\*\*\*) 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 name	Description
EM-PMI375-T500-1100	Standard 1100 rpm unit with standard options
EM-PMI375-T500-1100+BIN+RES1	Standard unit otherwise but with insulated bearing in N-end and resolver

Table 5 Product code examples

Variant	Code	Description	Additional information
High voltage connections	*	One 3 phase system	One connection box containing one 3 phase system with one M25 cable gland per phase
	-DUAL	Two galvanically isolated 3 phase systems	Two connection boxes each containing one 3 phase system with one M25 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
N-end attachment	*	Flange	SAE 4 flywheel housing
	+NE2	Male shaft + Flange	DIN5480 W50x2x24x8f + SAE 4 flywheel 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
Shaft grounding	*	None	
	+SG1	D-end shaft grounding	In-built grounding ring
Protection class	*	Standard protection class	IP65 protection class
	+IP67	IP67 protection class	IP67 protection class, not available with +BHS option
Cable direction	*	Cable direction fixed	Cable direction towards D-end
	+CNE	Cable direction towards N-end	Cable direction towards N-end
Rotation sensor	*	None	No resolver
	+RES1	Resolver	In-built non contacting resolver, 6-pole pair
	+RES2	Double resolver	2 x 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
Bearing temperature sensors	*	None	
	+BTMP1	PT100 in bearings	Plug-in connector
Anti-condensation heaters	*	None	
	+HEAT1	One anti-condensation heater	230 V <sub>AC</sub> / 65 W
Marine classification	*	No marine classification	
	+CL1		ABS American Bureau of Shipping
	+CL2		BV Bureau Veritas
	+CL3		DNV GL DNV GL AS
	+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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