

Data Sheet

# EM-PMI375-T200

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, 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. 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, 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
Minimum inverter switching frequency	4 kHz (with limited speed 1.4 times nominal speed)

### 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 3 mating transmission housing
Standard axle spline D-end	DIN5480 W50x2x24x8f
Standard Flange N-end (SAE J617)	SAE 4, flywheel housing
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)
Standard rotation direction	Clockwise (both directions possible)
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
Duty type (IEC 60034-1)	S1/S9
Standard color	Dark grey RAL7024 powder coating

### Mechanical

Total weight	98 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	26.5 kg
Maximum static torque range on the shaft, max. 25000 cycles, R=0 (*)	3400 Nm
Maximum dynamic torque range on the shaft, max. 1e6 cycles, R=0 (*)	2500 Nm
Maximum allowed vibratory torque range, 1e9...1e10 cycles (*)	0.3 x Nominal torque of machine
Maximum deceleration (fault stop)	6000 rad/s <sup>2</sup>

### Dimensions

Length (frame)	278 mm
Diameter (frame)	450 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	20 l/min
Coolant circuit capacity	0.8 l
Maximum operating pressure	3 bar
Pressure loss	0.4 bar with 20l/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
Condensation dew point	Please use anti-condensation heaters

Temperature rating

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 / +45°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 G <sub>RMS</sub> 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
		Anti-condensation heater (+HEAT1 option)	65 W 230 V <sub>AC</sub> 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 <sup>2</sup> ; –duration: 6 ms; –number of shocks: 10 per test direction. Test done with EM-PMI375-T800 (with flange mounting)	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.		
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		
HV connection boxes	1 x 3 phase box		

(\* 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)
NA	D-end bearing temperature sensor with separate connector (+BTMP1 option), see Table below

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

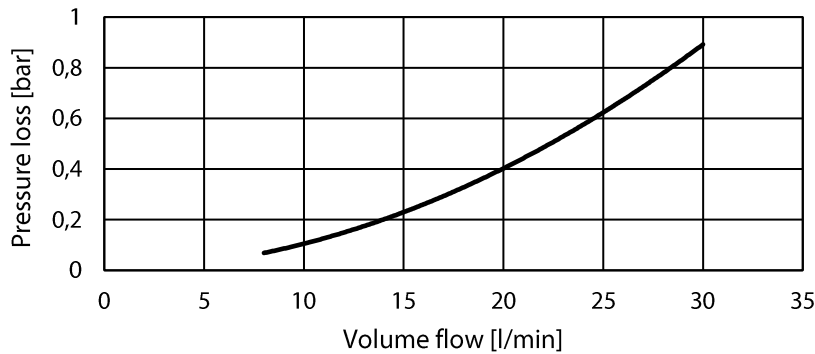
PIN	Description
1	Phase, 230 V <sub>AC</sub>
2	Neutral
⊥	Ground / protective earth
4	Reserve
5	Reserve

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 (*)
EM-PMI375-T200-600	190	12	16	210	13	18	600	1200	500
EM-PMI375-T200-1000	197	21	28	213	22	31	1000	2000	500
EM-PMI375-T200-1400	186	27	34	209	31	39	1400	2800	500
EM-PMI375-T200-1900	184	37	51	203	40	60	1900	3800	500
EM-PMI375-T200-2600	170	46	61	205	56	73	2600	4000	500
EM-PMI375-T200-3200	161	54	72	189	63	85	3200	4000	500

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

(\*\* Mechanical maximum speed

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 <sub>AC</sub> /rpm] (***)
EM-PMI375-T200-600	15	15	16	0.97	17	16	18	0.96	700	70	0.967
EM-PMI375-T200-1000	25	24	27	0.97	27	26	30	0.96	1200	120	0.524
EM-PMI375-T200-1400	31	31	33	0.98	36	35	38	0.97	1600	160	0.363
EM-PMI375-T200-1900	44	39	50	0.90	53	45	60	0.85	2200	220	0.282
EM-PMI375-T200-2600	52	49	60	0.94	63	59	72	0.93	2700	270	0.201
EM-PMI375-T200-3200	59	55	71	0.92	74	67	84	0.9	3300	330	0.161

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

MOTORS (temperature class F, maximum winding temperature +150°C, with nominal Voltage 400 Vac)

Type	Coolant temperature +40 °C					
	Cont. Torque [Nm]	Cont. Power [kW]	Nom. Current [A]	Nom. Speed [rpm]	Max. Speed [rpm] (*)	Peak Torque [Nm]
EM-PMI375-T200-600	200	10	18	500	1200	500
EM-PMI375-T200-1000	214	18	29	800	2000	500
EM-PMI375-T200-1400	224	23	40	1000	2800	500
EM-PMI375-T200-1900	204	30	56	1400	3800	500
EM-PMI375-T200-2600	200	42	69	2000	4000	500
EM-PMI375-T200-3200	201	53	89	2500	4000	500

(\* Mechanical maximum speed

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 (*)
EM-PMI375-T200-600	209	13	18	228	14	19	600	1200	500
EM-PMI375-T200-1000	213	22	31	243	25	35	1000	2000	500
EM-PMI375-T200-1400	209	31	39	231	34	43	1400	2800	500
EM-PMI375-T200-1900	208	41	62	214	43	63	1900	3800	500
EM-PMI375-T200-2600	191	52	68	212	58	76	2600	4000	500
EM-PMI375-T200-3200	189	63	86	212	71	96	3200	4000	500

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

(\*\* Mechanical maximum speed

The maximum allowed peak torque duration at stator winding starting temperature +90°C is 1 minute. 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 <sub>k</sub> /rpm] (***)
EM-PMI375-T200-600	17	16	18	0.96	19	18	19	0.95	700	70	0.967
EM-PMI375-T200-1000	27	26	31	0.96	32	30	34	0.94	1200	120	0.524
EM-PMI375-T200-1400	36	35	38	0.97	36	35	42	0.97	1600	160	0.363
EM-PMI375-T200-1900	54	46	61	0.85	53	45	62	0.85	2200	220	0.282
EM-PMI375-T200-2600	59	55	67	0.94	66	61	76	0.93	2700	270	0.201
EM-PMI375-T200-3200	74	67	84	0.90	83	74	95	0.90	3300	330	0.161

(\*\*\* 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-PMI375-T200-2600	Standard 2600 rpm unit with standard options
EM-PMI375-T200-2600+BIN+RES1	Standard unit otherwise but with insulated bearing in N-end and resolver

Table 5 Product code examples

Variant	Code	Description	Additional information
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
Side mounting	*	None	No side mounting holes available. In case side mounting holes are present, they are plugged by default.
	+SM1	Side mounting	12 x side mounting threaded holes M10x1.5. Plugged by default with M10x10, DIN 913, (ISO 4026), SET SCREW
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
	+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 6 Option list

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