ENGINEERING TOMORROW

Data Sheet

EM-PMI375-T800

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. 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_{AC}
Voltage stress	IEC 60034-25, Curve A: Without filters for motors up to 500 V_{AC}
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
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 axle spline D-end	DIN5480 W50x2x24x8f
Standard Flange N-end (SAE J617)	SAE 4, flywheel housing
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	210 kg (no options)
Moment of inertia	0.63 kgm^2
Torsional stiffness of shaft drive end	4 Nm/rad (from middle of the d-end spline to rotor air gap)
Rotating mass	70.2 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)	4400 rad/s^2

Dimensions

Length (frame)	428 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	1.9 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)
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)
Temperature rise (IEC 60034-1)	85°C (F) / 110°C (H)
Maximum winding temperature	175°C
Nominal ambient temperature	+65°C / +45°C with +CL option
Min. ambient temperature	-40°C
Nominal altitude (IEC 60034-1)	1000 m

Vibration & Shock tolerance

Mechanical vibration	5.9 G_{RMS} 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)
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/s²; –duration: 6 ms; –number of shocks: 10 per test direction. Test done with EM-PMI375-T800 (with flange mounting)

Connections

Coolant connection	2 x G3/4 bore
Cable direction	Standard cable direction towards D-end
HV cables	3 x 70 mm² max. (SINGLE winding model) 2 x 3 x 70 mm2 max. (DUAL winding model) 3 x 3 x 70 mm² max. (TRI 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 mm²: Druseidt with narrow flange 03901 50 mm²: Druseidt with narrow flange 03903 70 mm²: Druseidt with narrow flange 03906
HV connection boxes	- 1 x 3 phase box (SINGLE winding model) - 2 x 3 phase box (DUAL winding model) - 1x connection box with one 3 phase system and 1x connection box with two 3 phase systems (TRI winding model)
LV connector	47 pin DEUTSCH HD34-24-47PE for resolver and temperature measurement.
LV connector type	DEUTSCH HD34-24-47PE
LV connector pin type	Gold plated
LV mating connector type	DEUTSCH HD36-24-47SE or DEUTSCH HD36-24-47SE-059
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
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_{AC} 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
Bearing temp. measurement mating type	4-pin M12 A coded female
Bearing temp. measurement connector pin configuration	See Table below

(* 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_{AC}
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)

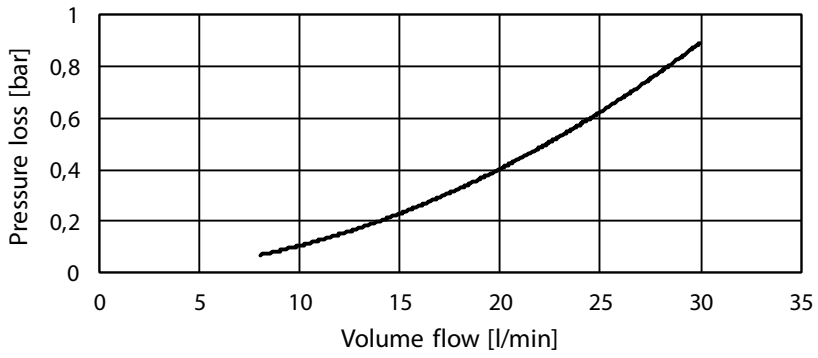
PIN	Description
1	Phase, 230 V_{AC}
2	Neutral
⏚	Ground / protective earth
4	Reserve
5	Reserve

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 (**	Peak torque TRI (***
EM-PMI375-T800-900	823	78	104	910	86	116	900	1800	2280	-	-
EM-PMI375-T800-1300	828	113	145	895	122	161	1300	2600	1900	2100	-
EM-PMI375-T800-1600	828	139	181	902	151	202	1600	3200	1550	2100	-
EM-PMI375-T800-1900	771	153	197	854	170	224	1900	3800	1300	2100	-
EM-PMI375-T800-2300	723	174	221	797	192	251	2300	4000	1050	2040	-
EM-PMI375-T800-2800	665	195	249	733	215	283	2800	4000	850	1700	1800
EM-PMI375-T800-3200	622	208	274	683	229	306	3200	4000	750	1450	1600
EM-PMI375-T800-3800 (****	570	227	288	628	250	325	3800	4000	630	1230	1450

(Peak torque achieved with one 350A inverter*
*(** Peak torque achieved with two 350A inverters*
*(*** Peak torque achieved with three 350A inverters*
*(**** Highest speed variant not applicable for +CL options*

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-T800-900	92	85	104	0.93	105	96	119	0.92	1000	100	0.509
EM-PMI375-T800-1300	128	121	145	0.95	141	131	160	0.93	1400	140	0.382
EM-PMI375-T800-1600	159	148	181	0.93	175	161	201	0.92	1700	170	0.297
EM-PMI375-T800-1900	172	160	197	0.93	193	178	222	0.92	2000	200	0.254
EM-PMI375-T800-2300	190	179	221	0.94	212	198	247	0.93	2400	240	0.212
EM-PMI375-T800-2800	215	200	249	0.93	242	223	279	0.92	2900	290	0.17
EM-PMI375-T800-3200	236	216	274	0.91	258	236	301	0.91	3300	330	0.149
EM-PMI375-T800-3800 (****	247	233	288	0.94	273	256	318	0.94	3900	390	0.127

*(*** Back EMF for cold (20°C) generator*
*(**** Highest speed variant not applicable for +CL options*

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 (**	Peak torque TRI (***
EM-PMI375-T800-900	900	85	115	1000	94	128	900	1800	2280	-	-
EM-PMI375-T800-1300	917	125	165	984	134	182	1300	2600	1900	2100	-
EM-PMI375-T800-1600	921	154	203	997	167	226	1600	3200	1550	2100	-
EM-PMI375-T800-1900	860	171	226	938	187	252	1900	3800	1300	2100	-
EM-PMI375-T800-2300	796	191	251	880	212	282	2300	4000	1050	2040	-
EM-PMI375-T800-2800	740	217	283	813	238	313	2800	4000	850	1700	1800
EM-PMI375-T800-3200	683	229	303	749	251	336	3200	4000	750	1450	1600
EM-PMI375-T800-3800 (****	630	251	323	697	277	359	3800	4000	630	1230	1450

(Peak torque achieved with one 350A inverter*
*(** Peak torque achieved with two 350A inverters*
*(***Peak torque achieved with three 350A inverters*
*(**** Highest speed variant not applicable for +CL options*

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-T800-900	101	93	115	0.92	114	106	128	0.93	1000	110	0.509
EM-PMI375-T800-1300	146	135	164	0.93	159	148	181	0.93	1400	140	0.382
EM-PMI375-T800-1600	175	164	202	0.94	197	182	224	0.92	1700	170	0.297
EM-PMI375-T800-1900	196	180	224	0.92	226	207	259	0.91	2000	200	0.254
EM-PMI375-T800-2300	217	201	248	0.93	243	223	279	0.92	2400	240	0.212
EM-PMI375-T800-2800	242	223	279	0.93	268	246	309	0.92	2900	290	0.17
EM-PMI375-T800-3200	258	236	298	0.91	284	258	331	0.91	3300	330	0.149
EM-PMI375-T800-3800 (****	271	254	315	0.95	301	281	352	0.93	3900	390	0.127

*(*** Back EMF for cold (20°C) generator*
*(**** Highest speed variant not applicable for +CL options*

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-T800-1900	Standard 1900 rpm unit with the standard options
EM-PMI375-T800-1900+BIN+RES1	Standard unit that has 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
	-TRI	Three galvanically isolated 3 phase systems	Two connection boxes one containing one 3 phase system and another one containing two 3 phase systems 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_{AC} / 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