ENGINEERING TOMORROW

Data Sheet

EM-PMI375-T1100

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_{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 all directions, 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: 6214/C3 (with LGHP2 grease) +BGL option: 6214-2RS1/C3WT +BIN option: D-end: 6214/C3 (with LGHP2 grease), N-end: 6214/HC5C3 (with LGHP2 grease) +BIA option: 6214/HC5C3WT (with LGHP2 grease) +BGL+BIN options: D-end: 6214-2RS1/C3WT, N-end: 6214-2RS1/HC5C3WT +BGL+BIA options: 6214-2RS1/HC5C3
Standard axle spline D-end	DIN5480 W55x2x26x8a
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 0.1 bar (IP65) Pressure not allowed to drop under 0.25 bar (IP67)
Duty type (IEC 60034-1)	S1/S9
Standard color	Dark grey RAL7024 powder coating

Mechanical

Total weight	295 kg (no options)
Moment of inertia	0.99 kgm^2
Torsional stiffness of shaft drive end	7*10^5 Nm/rad (from middle of the d-end spline to rotor air gap)
Rotating mass	111 kg
Maximum static torque range on the shaft, max. 25000 cycles, R=0 (*	6800
Maximum dynamic torque range on the shaft, max. 1e6 cycles, R=0 (*	4000
Maximum allowed vibratory torque range, 1e9...1e10 cycles (*	0.3 x Nominal torque of machine
Maximum deceleration (fault stop)	2000 rad/s^2

Dimensions

Length (frame)	548 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	2.8 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)
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 G_{RMS} 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)	130 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)
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
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)
NA	D-end bearing temperature sensor with separate connector (+BTMP1 option), see Table below

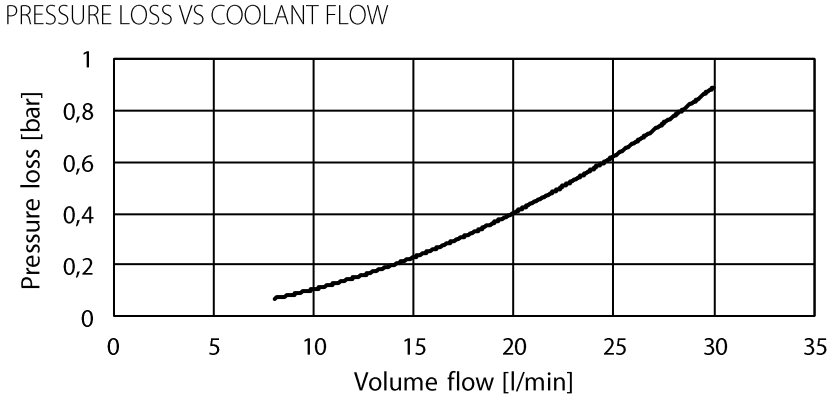
Table 2 Pin configuration of LV connections (+LVB1 option)

PIN	Description
1	Phase, 230 V_{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)



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-T1100-1200	1306	164	207	1399	176	221	1200	2400	2100	3270	4100
EM-PMI375-T1100-1500	1175	185	261	1310	206	292	1500	3000	1550	2500	3850
EM-PMI375-T1100-1800	1077	203	271	1225	231	310	1800	3600	1380	2500	2750
EM-PMI375-T1100-2100	995	219	288	1178	259	343	2100	4000	1100	2170	2400
EM-PMI375-T1100-2400	952	239	323	1060	266	358	2400	4000	1040	2000	2050
EM-PMI375-T1100-2900	896	272	367	998	303	409	2900	4000	800	1500	1750

(Peak torque achieved with one 350A inverter*
*(** Peak torque achieved with two 350A inverters*
*(*** Peak torque achieved with three 350A inverters*
*(**** 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_{AC}/rpm] (***
EM-PMI375-T1100-1200	179	175	205	0.98	193	188	219	0.97	1300	130	0.462
EM-PMI375-T1100-1500	222	205	257	0.92	251	229	288	0.92	1700	170	0.347
EM-PMI375-T1100-1800	232	214	267	0.92	266	243	305	0.92	1900	190	0.308
EM-PMI375-T1100-2100	245	230	283	0.94	293	271	338	0.93	2200	220	0.277
EM-PMI375-T1100-2400	270	248	314	0.92	302	277	351	0.92	2500	250	0.231
EM-PMI375-T1100-2900	308	281	358	0.91	344	312	401	0.91	3000	300	0.193

*(*** 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-T1100-1200	1436	135	242	900	2400	2100
EM-PMI375-T1100-1500	1346	169	301	1200	3000	1550
EM-PMI375-T1100-1800	1275	187	320	1400	3600	1380
EM-PMI375-T1100-2100	1342	225	386	1600	4000	1100
EM-PMI375-T1100-2400	1194	225	401	1800	4000	1040
EM-PMI375-T1100-2900	1143	263	460	2200	4000	800

(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 (*	Peak torque DUAL (**	Peak torque TRI (***
EM-PMI375-T1100-1200	1410	177	242	1515	190	263	1200	2400	2100	3270	4100
EM-PMI375-T1100-1500	1310	206	292	1455	228	294	1500	3000	1550	2500	3850
EM-PMI375-T1100-1800	1187	224	298	1338	252	338	1800	3600	1380	2500	2750
EM-PMI375-T1100-2100	1070	235	310	1300	286	380	2100	4000	1100	2170	2400
EM-PMI375-T1100-2400	1036	260	350	1155	290	386	2400	4000	1040	2000	2050
EM-PMI375-T1100-2900	976	296	398	1098	333	456	2900	4000	800	1500	1750

(Peak torque achieved with one 350A inverter*
*(** Peak torque achieved with two 350A inverters*
*(*** Peak torque achieved with three 350A inverters*
*(**** 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.

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_{AC}/rpm] (***
EM-PMI375-T1100-1200	211	199	239	0.94	229	213	260	0.93	1400	140	0.462
EM-PMI375-T1100-1500	251	230	288	0.92	279	253	288	0.91	1700	170	0.347
EM-PMI375-T1100-1800	252	239	292	0.95	287	269	332	0.94	2000	200	0.308
EM-PMI375-T1100-2100	264	246	305	0.93	325	306	373	0.94	2200	220	0.277
EM-PMI375-T1100-2400	293	269	343	0.92	328	300	379	0.92	2500	250	0.231
EM-PMI375-T1100-2900	332	307	385	0.93	384	349	443	0.91	3100	310	0.193

*(*** 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-T1100-1800	Standard 1800 rpm unit with standard options
EM-PMI375-T1100-1800+BIN+RES1	Standard unit 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
	-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 W55x2x26x8a + SAE 4 flywheel housing
Bearing lubrication and mounting direction	*	Grease lubricated	Deep groove ball bearing, open design. Horizontal mounting direction (see user guide for details).
	+BGL	Greased for life	Deep groove ball bearing, contact seal on both sides. Any mounting direction (see user guide for details). Maximum speed 3400 rpm.
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, only available with +BGL
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
	+TEMP5	Redundant temperature surveillance	12 x PT100 (two wire) in windings (Not available with +LVB1 option)

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
	+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