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 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 also be 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 60034-25:2009, 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
Minimal inverter switching frequency	4 kHz (with limited speed 1.4 times nominal speed)
Maximum phase-to-phase peak-to-peak voltage without du/dt	1.5 kV
Maximum voltage rise time without du/dt	8 kV/µs

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 transmission housing
Standard axle spline D-end	DIN5480 W50x2x24x8f
Standard flange N-end (SAE J617)	SAE 4 flywheel housing
Standard rotation direction	Clockwise (both directions possible)
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)
Protection class	IP65 IP67 available as option +IP67
Duty type (IEC 60034-1)	S1/S9
Machine coating	Dark grey RAL7024

Mechanical	
Total weight	210 kg (no options)
Moment of inertia	0.63 kgm²
Torsional stiffness of shaft drive end	4*10^5 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/s²

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 20 l/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

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/s^2; –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 (see dimension drawing for details)
Cable direction	Standard cable direction towards D-end
HV cables	3 x 70 mm^2 max. (SINGLE winding model) 2 x 3 x 70 mm^2 max. (DUAL winding model)
HV cable glands	Pflitsch blueglobe TRI bg 225ms tri
HV cable recommended type	HUBER+SUHNER Radox Elastomer S, screened, single core, automotive cable (FHLR4GC13X) www.hubersuhner.com
HV cable lug size	35-8, 50-8, 70-8
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 www.druseidt.de
HV connection boxes	- 1 x 3 phase box (SINGLE winding model) - 2 x 3 phase box (DUAL winding model)
LV connector	47 pin DEUTSCH HD34-24-47PE for resolver and temperature measurement https://www.te.com
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 1
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 2
Anti-condensation heater (+HEAT1 option)	65 W 230 V_{AC} single phase heater resistor
Angle/Speed sensor	Type: Externally excited SIN/COS resolver Pole pair number 6 Input 7 V

	Frequency 10 kHz Output 2 V +/- 0.2 V Input impedance 110 Ohm +/- 10 % Output impedance 330 Ohm +/- 15 %
Heater connector (+HEAT1 option)	Hummel art no. 7651 0 51 01 D (combination of housing 7651 0 00 00 0, insert 7084 9 51 10 1 / 7084 9 51 12 1, crimp pins 7010 9 42 01 1) https://www.hummel.com
Heater mating connector	Hummel art no. 7550 6 51 02 D (combination of housing 7550 6 00 00 0, insert 7084 9 51 10 2 / 7084 9 51 12 2 and crimp socket 7010 9 42 00 2)
Heater connector pin type	Hummel 7010 9 42 01 1
Heater connector pin configuration	See Table 3
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 4

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

(** Connector IP-rating of IP67 is reached only when connector mating part is installed and all unused pin holes are plugged in the connector mating part with the following plugs, depending on the hole size: DEUTSCH 0413-003-1605 (size 16) or DEUTSCH 0413-204-2005 (size 20). For further information, contact the connector manufacturer TE connectivity directly.

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)

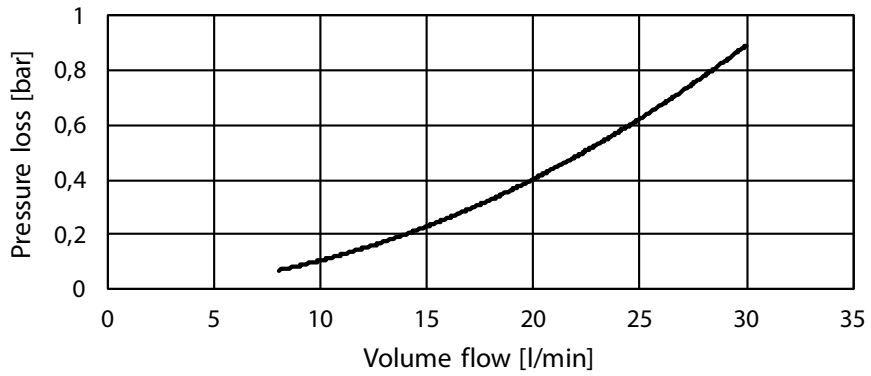
PIN	Description
1	Phase, 230 V_{AC}
2	Neutral
⏚	Ground / protective earth
4	Reserve
5	Reserve

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)

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-T800-1300	828	113	146	895	122	161	1300	2600	1900	N/A
EM-PMI375-T800-1600	828	139	182	902	151	202	1600	3200	1650	2070
EM-PMI375-T800-1900	771	153	199	854	170	224	1900	3800	1400	2070
EM-PMI375-T800-2300	723	174	224	797	192	251	2300	4000	1180	1990
EM-PMI375-T800-2800	665	195	253	733	215	283	2800	4000	925	1750
EM-PMI375-T800-3200	622	208	279	683	229	306	3200	4000	800	1430
EM-PMI375-T800-3800 (****	570	227	292	628	250	325	3800	4000	680	1230

(Peak torque achieved with one 350A inverter*
*(** Peak torque achieved with two 350A inverters*
*(*** Mechanical maximum speed*
*(**** 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_{AC}/rpm] (*
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	250	0.212
EM-PMI375-T800-2800	215	200	249	0.93	242	223	279	0.92	2900	300	0.170
EM-PMI375-T800-3200	236	216	274	0.91	258	236	301	0.91	3300	340	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 F, maximum winding temperature +150°C, with nominal voltage 400 V_{AC})

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-T800-1300	956	100	164	1000	2600	1900
EM-PMI375-T800-1600	981	123	209	1200	3200	1650
EM-PMI375-T800-1900	937	137	235	1400	3800	1400
EM-PMI375-T800-2300	829	148	250	1700	4000	1180
EM-PMI375-T800-2800	829	191	316	2200	4000	925
EM-PMI375-T800-3200	755	197	334	2500	4000	800
EM-PMI375-T800-3800	841	256	426	2900	4000	680

(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 (**
EM-PMI375-T800-1300	917	125	165	984	134	182	1300	2600	1900	N/A
EM-PMI375-T800-1600	921	154	203	997	167	226	1600	3200	1650	2070
EM-PMI375-T800-1900	860	171	226	938	187	252	1900	3800	1400	2070
EM-PMI375-T800-2300	796	191	251	880	212	282	2300	4000	1080	1990
EM-PMI375-T800-2800	740	217	283	813	238	313	2800	4000	925	1750
EM-PMI375-T800-3200	683	229	303	749	251	336	3200	4000	800	1430
EM-PMI375-T800-3800 (****	630	251	323	697	277	359	3800	4000	680	1230

(Peak torque achieved with one 350A inverter*
*(** Peak torque achieved with two 350A inverters*
*(*** Mechanical maximum speed*
*(**** 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_{AC}/rpm] (*
EM-PMI375-T800-1300	146	135	164	0.93	159	145	181	0.91	1400	140	0.382
EM-PMI375-T800-1600	175	164	202	0.94	197	178	224	0.90	1700	180	0.297
EM-PMI375-T800-1900	196	180	224	0.92	226	204	259	0.90	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	0.170
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 Available for speed variants 1600, 1900, 2300, 2800, 3200 and 3800 rpm
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
	+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} / 65 W (see user guide for more information)
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