ENGINEERING TOMORROW

Data Sheet

EM-PMI375-T500-690V

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)	690 V_{AC}
Nominal efficiency	96 %
Pole pair number	6
Power supply	Inverter fed
Minimum inverter switching frequency	4 kHz
Maximum phase-to-phase peak-to-peak voltage without du/dt	2 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
Altitude	Up to 3000 m, see Picture 3

Mechanical	
Total weight	172 kg (no options)
Moment of inertia	0.46 kgm^2
Torsional stiffness of shaft drive end	4*10^5 Nm/rad (from middle of the D-end spline to rotor air gap)
Rotating mass	52.5 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^2

Dimensions

Length (frame)	368 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	1.4 l
Maximum operating pressure	3 bar
Pressure loss	0.4 bar with 20 l/min (+25°C coolant)
Nominal cooling liquid temperature	+65°C
Minimum cooling liquid temperature	-20°C
Maximum cooling liquid temperature	+65°C

Temperature rating

Insulation class (IEC 60034-1)	H (+180°C)
Temperature rise (IEC 60034-1)	+85°C (F)
Maximum winding temperature	+150°C
Nominal ambient temperature	+65°C / +40°C with +CL option
Min. ambient temperature	-40°C

Vibration & Shock tolerance

Mechanical vibration	5.9 G_{RMS} ISO 16750-3:2003 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 16750-3:2003 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 3 x M25, 1 x M20 cable glands (reserve/plugged 1 x M16) and terminal block for LV connections. See Table 4
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 %
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 (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 2
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	SeeTable 3

(* 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	Option
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
29	Temperature 4, PT100 (N), windings	+TEMP4
44	Temperature 5, PT100 (P), windings	+TEMP4
43	Temperature 5, PT100 (N), windings	+TEMP4
28	Temperature 6, PT100 (P), windings	+TEMP4
16	Temperature 6, PT100 (N), windings	+TEMP4
42	Temperature 7, PT100 (P), windings	+TEMP5
27	Temperature 7, PT100 (N), windings	+TEMP5
15	Temperature 8, PT100, (P) windings	+TEMP5
14	Temperature 8, PT100 (N), windings	+TEMP5
40	Temperature 9, PT100 (P), windings	+TEMP5
26	Temperature 9, PT100 (N), windings	+TEMP5
41	Temperature 10, PT100 (P), windings	+TEMP5
13	Temperature 10, PT100 (N), windings	+TEMP5
39	Temperature 11, PT100 (P), windings	+TEMP5
38	Temperature 11, PT100 (N), windings	+TEMP5
25	Temperature 12, PT100 (P), windings	+TEMP5
12	Temperature 12, PT100 (N), windings	+TEMP5
35	Resolver, RES_COS_N, inbuilt non-contacting	
20	Resolver, RES_COS_P, inbuilt non-contacting	
36	Resolver, RES_SIN_N, inbuilt non-contacting	
21	Resolver, RES_SIN_P, inbuilt non-contacting	
22	Resolver, EXCN, inbuilt non-contacting	
10	Resolver, EXCP, inbuilt non-contacting	
34	Resolver, SHIELD/GROUND, inbuilt non-contacting	

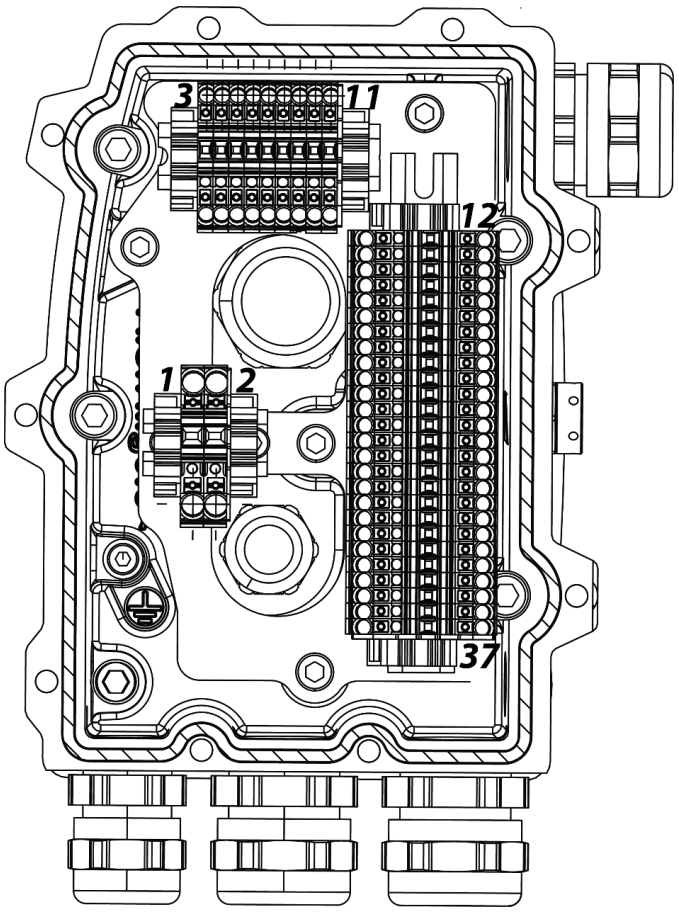
Table 1 Pin configuration of LV-connector

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

Table 2 Pin configuration of heater with connector

PIN	Description
1	PT100
2	
3	PT100_GND
4	

Table 3 Pin configuration of bearing temperature sensor connector (one sensor)



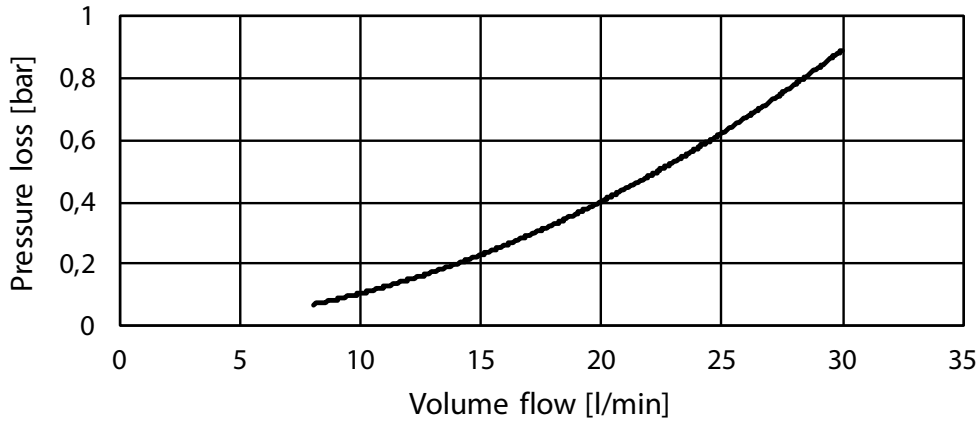
Picture 1 LVB1 terminal box

Rails	PIN	Description		Option
Rail 1	1	Heater, phase, 230 V_{AC}		+HEAT1
	2	Heater, neutral		+HEAT1
M4 screw	⏚	General shielding, ground / protective earth		
Rail 2	3	Resolver	RES_COS_N, Inbuilt non-contacting	+RES1
	4	Resolver	RES_COS_P, Inbuilt non-contacting	+RES1
	5	Resolver	RES_SIN_N, Inbuilt non-contacting	+RES1
	6	Resolver	RES_SIN_P, Inbuilt non-contacting	+RES1
	7	Resolver	EXCN, Inbuilt non-contacting	+RES1
	8	Resolver	EXCP, Inbuilt non-contacting	+RES1
	9	Not in use		
	10	Temperature	PT100 (P), bearing, N-end	+BTMP1
	11	Temperature	PT100 (N), bearing, N-end	+BTMP1
Rail 3	12	Temperature 1	PT100 (P), windings	
	13	Temperature 1	PT100 (N), windings	
	14	Temperature 2	PT100 (P), windings	
	15	Temperature 2	PT100 (N), windings	
	16	Temperature 3	PT100 (P), windings	
	17	Temperature 3	PT100 (N), windings	
	18	Temperature 4	PT100 (P), windings	+TEMP4
	19	Temperature 4	PT100 (N), windings	+TEMP4
	20	Temperature 5	PT100 (P), windings	+TEMP4
	21	Temperature 5	PT100 (N), windings	+TEMP4
	22	Temperature 6	PT100 (P), windings	+TEMP4

	23	Temperature 6	PT100 (N), windings	+TEMP4
	24	Temperature 7	PT100 (P), windings	+TEMP5
	25	Temperature 7	PT100 (N), windings	+TEMP5
	26	Temperature 8	PT100 (P), windings	+TEMP5
	27	Temperature 8	PT100 (N), windings	+TEMP5
	28	Temperature 9	PT100 (P), windings	+TEMP5
	29	Temperature 9	PT100 (N), windings	+TEMP5
	30	Temperature 10	PT100 (P), windings	+TEMP5
	31	Temperature 10	PT100 (N), windings	+TEMP5
	32	Temperature 11	PT100 (P), windings	+TEMP5
	33	Temperature 11	PT100 (N), windings	+TEMP5
	34	Temperature 12	PT100 (P), windings	+TEMP5
	35	Temperature 12	PT100 (N), windings	+TEMP5
	36	Reserve		
	37	Reserve		

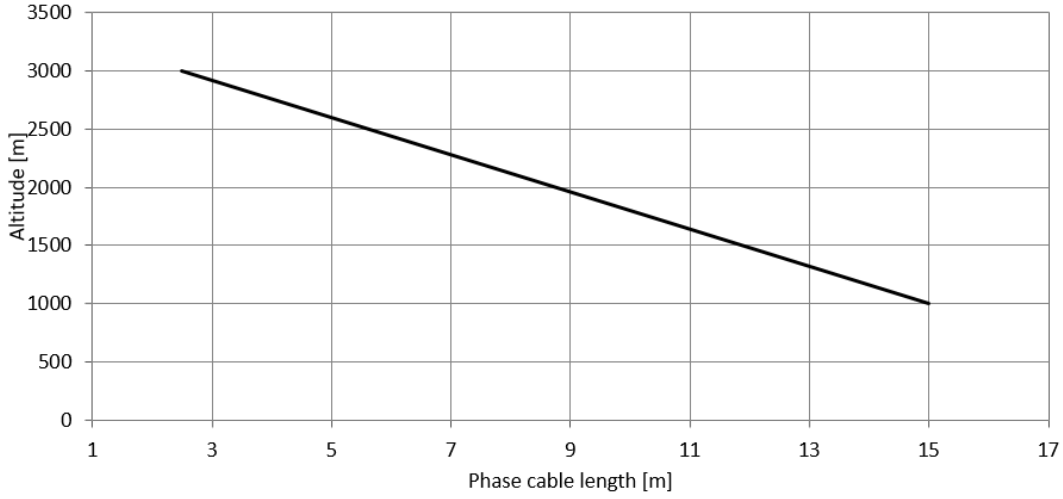
Table 4 Pin configuration of LV connections

PRESSURE LOSS VS COOLANT FLOW



Picture 2 Pressure loss vs coolant flow

ALTITUDE DERATING



Picture 3 Altitude derating

MOTORS (temperature class F, maximum winding temperature +150°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 *(a*	Peak torque DUAL *(b*	Volt/ speed ratio [VAC /rpm] *(d*
EM-PMI375-T500-690V-1900	408	81	74	444	88	82	1900	2600	1330	-	0.403
EM-PMI375-T500-690V-2700	374	105	100	419	118	113	2700	4000 *(c*	807	1198	0.280

(a Peak torque achieved with one 210A inverter
(b Peak torque achieved with two 210A inverters
(c Mechanical maximum speed
(d Back EMF for cold (+20°C)

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-T500-690V-1900	1900 rpm unit with standard options
EM-PMI375-T500-690V-1900+BIN+RES1	1900 rpm unit with insulated bearing in N-end and resolver

Table 5 Product code examples

Variant	Code	Description	Additional information
High voltage connections	*	One three-phase system	One connection box containing one three-phase system with one M25 cable gland per phase, total of 3 pcs M25 cable glands.
	-DUAL	Two galvanically isolated three-phase systems	Two connection boxes each containing one three-phase system with one M25 cable gland per phase, total of 6 pcs M25 cable glands. Available only for speed variant 3200 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 3 x M25, 1 x M20 cable glands (reserve/plugged 1 x M16) 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, non-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	Inbuilt 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	Inbuilt 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
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