

Data Sheet

EM-PMI240-T180

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/IP67 enclosure class to maximize reliability
- 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
- Hydraulic pump application
- 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	4
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 (IEC 60034-7)	IM 3009-B5 (flange horizontal), IM 3019-V1 (flange and D-end down)
Mounting direction	Horizontal or vertical assembly (V1, D-end shaft down), see user guide for details
Standard flange D-end (SAE J617)	SAE 6 transmission housing
Standard axle spline D-end	DIN5480 W40x2x18x8f
Standard flange N-end (SAE J617)	N/A
Standard rotation direction	Clockwise (both directions possible)
Bearing type	Standard: 6009/C3 Grease lubricated. Deep groove ball bearing, open design (see user guide for details)
Protection class	IP65 IP67 available as option +IP67 IP class based on design
Duty type (IEC 60034-1)	S1/S9
Machine coating	No surface treatment as a standard (shall be requested separately if needed)
Altitude	Up to 4000 m, see Picture 2

Mechanical	
Total weight	85 kg (no options)
Moment of inertia	0.057 kgm ²
Torsional stiffness of shaft drive end	1.8*10 ⁵ Nm/rad (from middle of the D-end spline to rotor air gap)
Rotating mass	23.5 kg
Maximum static torque range on the shaft, max. 25000 cycles, R=0 (*)	2000 Nm
Maximum dynamic torque range on the shaft, max. 1e6 cycles, R=0 (*)	1000 Nm
Maximum allowed vibratory torque range, 1e9...1e10 cycles (*)	0.3 x nominal torque of machine
Maximum deceleration (fault stop)	11000 rad/s ²

Dimensions	
Length (frame)	317 mm
Diameter (frame)	305 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	0.3 bar with 20 l/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

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
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}
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

Connections	
Coolant connection	2 x G3/4 bore (see dimension drawing for details)
HV cables	3 x 70 mm ² max. (range 50-70 mm ²)
HV cable recommended type	HUBER+SUHNER Radox Elastomer S, screened, single core, automotive cable (FHLR4GC13X) www.hubersuhner.com
HV cable connector	3 x AMPHENOL HVBI005R10AMHARD https://www.amphenolpcd.com
HV mating connector type	Mating connector: AMPHENOL HVBI-7-05R10-XFC-XXXX-FG/PC (straight plug) AMPHENOL HVBI-9-05R10-XFC-XXXX-FG/PC (right angle plug) (mating connector not included in standard delivery)
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
Angle/Speed sensor	Type: Externally excited SIN/COS resolver Pole pair number 4 Input 7 V Frequency 10 kHz Output 2 V +/- 0.2 V Input impedance 210 +/- 32 Ohm Output impedance 470 +/- 71 Ohm

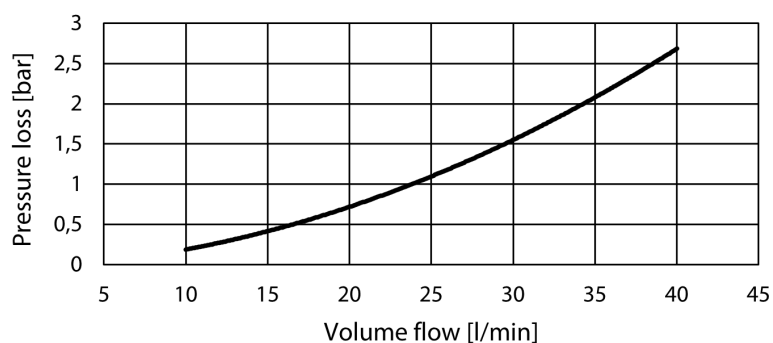
(* The values are based on structural analysis, and they are not applicable to any marine class rules or requirements.

(** 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.

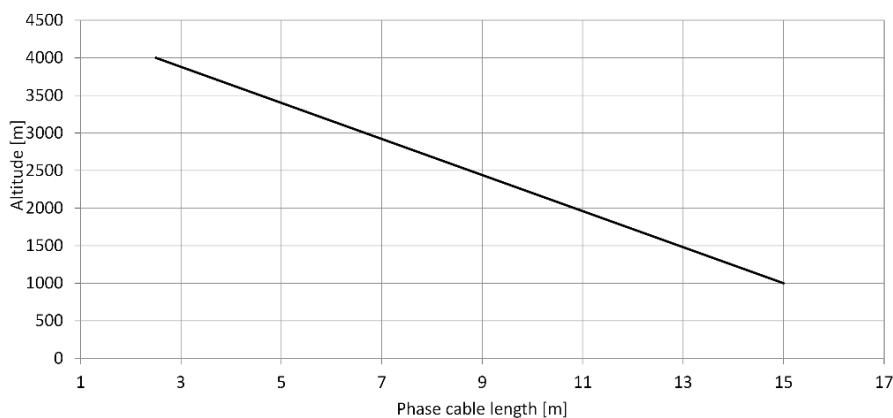
PIN	Description
47	Temperature 1, PT100 (P), windings
46	Temperature 1, PT100 (N), windings
33	Temperature 2, PT100 (P), windings
32	Temperature 2, PT100 (N), windings
45	Temperature 3, PT100 (P), windings
31	Temperature 3, PT100 (N), windings
30	Temperature 4, PT100 (P), windings option TEMP4
29	Temperature 4, PT100 (N), windings option TEMP4
44	Temperature 5, PT100 (P), windings option TEMP4
43	Temperature 5, PT100 (N), windings option TEMP4
28	Temperature 6, PT100 (P), windings option TEMP4
16	Temperature 6, PT100 (N), windings option TEMP4
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

PRESSURE LOSS VS COOLANT FLOW



Picture 1 Pressure loss vs coolant flow (+25°C coolant)



Picture 2 Allowed altitudes vs phase cable length

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)
EM-PMI240-T180-2200	192	44	59	210	48	64	2200	4400	700
EM-PMI240-T180-4400	175	80	100	184	85	106	4400	8800	500
EM-PMI240-T180-6600	130	90	110	140	97	128	6600	9200 (b)	375
EM-PMI240-T180-8800	109	100	118	117	108	126	8800	9200 (b)	340

(a) Peak torque achieved with one 350A inverter

(b) Mechanical maximum speed

GENERATORS (temperature class F, maximum winding temperature +150°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] (c)
EM-PMI240-T180-2200	46	45	53	0.98	54	52	59	0.97	2400	160	0.242
EM-PMI240-T180-4400	87	85	98	0.97	90	87	104	0.97	4500	300	0.121
EM-PMI240-T180-6600	90	89	107	0.99	103	101	122	0.98	6700	447	0.081
EM-PMI240-T180-8800	99	98	114	0.99	124	122	144	0.99	8900	593	0.060

(c) Back EMF for cold (+20°C) generator

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 (a)
EM-PMI240-T180-2200	202	46	59	220	50	65	2200	4400	700
EM-PMI240-T180-4400	185	85	106	200	92	122	4400	8800	500
EM-PMI240-T180-6600	139	96	127	145	100	135	6600	9200 (b)	375
EM-PMI240-T180-8800	114	105	122	123	114	146	8800	9200 (b)	350

(a) Peak torque achieved with one 350A inverter

(b) Mechanical maximum speed

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] (c)
EM-PMI240-T180-2200	52	50	59	0.97	58	56	65	0.96	2300	160	0.242
EM-PMI240-T180-4400	91	88	105	0.97	99	95	114	0.96	4500	300	0.121
EM-PMI240-T180-6600	108	106	123	0.98	112	110	130	0.98	6700	447	0.081
EM-PMI240-T180-8800	116	114	134	0.99	116	114	137	0.99	8900	593	0.060

(c) 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-PMI240-T180-8800	Standard 8800 rpm unit with the standard options
EM-PMI240-T180-8800+RES1	Standard unit that has resolver

Table 2 Product code examples

Variant	Code	Description	Additional information
Drive-end shaft	*	Male shaft	DIN 5480 W40x2x18x8f
	+S2	Female shaft, spline	14 tooth spline 12/24 pitch (ANSI B92.1B 1996 - Class 6e)
D-end attachment	*	Standard flange	SAE 6, transmission housing
	+DE1	Flange interface for hydraulic pump	SAE C, 4 bolt mating transmission housing
Protection class	*	Standard protection class	IP65 protection class
	+IP67	IP67 protection class	IP67 protection class
Rotation sensor	*	None	No resolver
	+RES1	Resolver	Inbuilt non-contacting resolver, 4-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

(* 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 3 Option list

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