

Preliminary 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 2 |

| 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 2 x M25 cable glands (reserve 2 x plugged M16 threads available) and terminal block for LV connections. See Table 2 |
| 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 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, 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 |
| 37 | Resolver, RES_COS_N, inbuilt non-contacting (additional resolver with +RES2 option) |
| 24 | Resolver, RES_COS_P, inbuilt non-contacting (additional resolver with +RES2 option) |
| 23 | Resolver, RES_SIN_N, inbuilt non-contacting (additional resolver with +RES2 option) |
| 11 | Resolver, RES_SIN_P, inbuilt non-contacting (additional resolver with +RES2 option) |
| 9 | Resolver, EXCN, inbuilt non-contacting (additional resolver with +RES2 option) |
| 8 | Resolver, EXCP, inbuilt non-contacting (additional resolver with +RES2 option) |
| 4 | Resolver, SHIELD/GROUND, inbuilt 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, inbuilt non-contacting |
| 19 | Resolver, RES_COS_P, inbuilt non-contacting |
| 20 | Resolver, RES_SIN_N, inbuilt non-contacting |
| 21 | Resolver, RES_SIN_P, inbuilt non-contacting |
| 22 | Resolver, EXCN, inbuilt non-contacting |
| 23 | Resolver, EXCP, inbuilt 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)

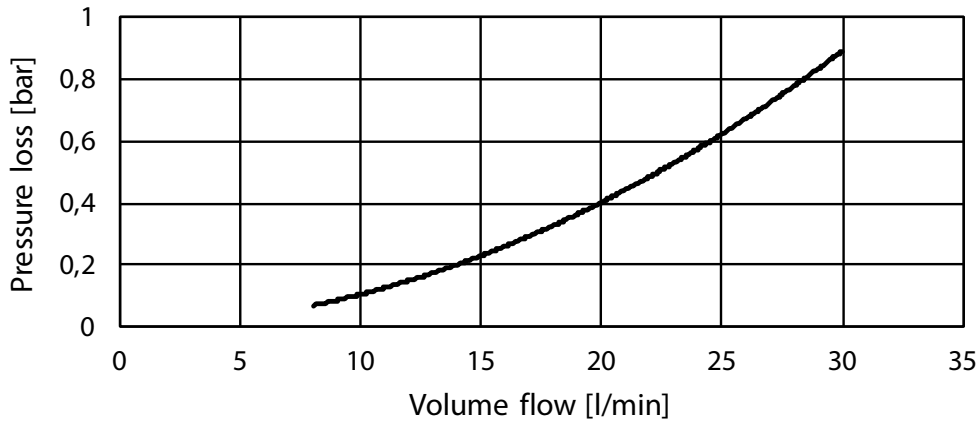
| PIN | Description |
|-----|----------------------------|
| 1 | Phase, 230 V _{AC} |
| 2 | Neutral |
| ⊥ | Ground / protective earth |
| 4 | Reserve |
| 5 | Reserve |

Table 3 Pin configuration of heater with connector

| PIN | Description |
|-----|-------------|
| 1 | PT100 |
| 2 | |
| 3 | PT100_GND |
| 4 | |

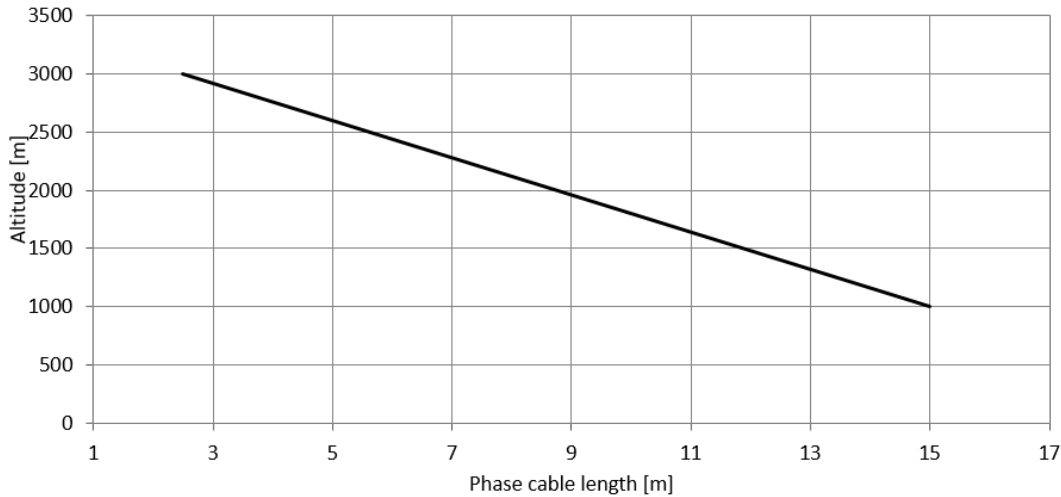
Table 4 Pin configuration of bearing temperature sensor connector (one sensor)

PRESSURE LOSS VS COOLANT FLOW



Picture 1 Pressure loss vs coolant flow

ALTITUDE DERATING



Picture 2 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 (**) | Peak torque DUAL (***) | Volt/speed ratio [VAC /rpm] (****) |
| EM-PMI375-T500-690V-1900 | 408 | 81 | 74 | 444 | 88 | 82 | 1900 | 3800 | 1330 | - | 0.403 |
| EM-PMI375-T500-690V-2700 | 374 | 105 | 100 | 419 | 118 | 113 | 2700 | 4000 (*) | 807 | 1198 | 0.280 |

(* Mechanical maximum speed

(** Peak torque achieved with one 210A inverter

(*** Peak torque achieved with two 210A inverters

(**** 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 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 |
| 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 | 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 |
| | +RES2 | Double resolver | 2 x 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 (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

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