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AXCO AF-PM-2-D generators
Models: PMG 3.0-250-A and PMG 2.0-250-P
Technical Data Sheet

Permanent Magnet Generator for Distributed Wind Power Applications

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## Definitions

This 3-phase AC permanent magnet generator (PMG) may be used to supply passive load such as diode-bridge or heating resistors. The machine type is denoted as PMG 2.0-250-P.

The same machine may be used with an active bridge towards the generator. In this case the maximum power output of the machine is increased and the same machine is denoted as PMG 3.0-250-A.

## Standards

Generators meet the requirements of IEC 60034 with the relevant sections.

## Excitation system

The generators are equipped with a permanent magnet (PM) excitation. PM excitation provides a fixed excitation for the machine.

Employed PM material is NdFeB. Permanent magnets are surface mounted on the surface of the rotor disk. Corrosion of the magnets, due to the atmospheric gases and humidity, is eliminated via a specific coating material employed for magnets surfaces.

## Windings and electrical performance

Stator winding is a 3-phase double-layer concentrated winding. This eliminates effectively the harmonics in the voltage waveform and ensures, with the carefully designed pole profile, very low voltage waveform distortions and low torque ripple.

## Insulation and impregnation

The insulation system is class ´F´.

All wound components are varnished.

Strengthened insulation system is used in order to ensure the safe operation in inverter usage.

## Electrical performance specification – PMG 2.0-250-P – parameters under passive loading

The parameters of the generator.

| Parameter | Explanation | Value | Dimension |
|---|---|---|---|
| $P$ | Electric power | 2.0 | kW |
| $S$ | Apparent power | 2.0 | kVA |
| $T$ | Shaft torque | 76 | Nm |
| $n$ | Rotation speed | 250 | $min^{-1}$ |
| $n_{max}$ | Maximum allowed rotation speed under full loading | 300 | $min^{-1}$ |
| $n_{max}$ | Maximum allowed rotation speed under no-load condition | 500 | $min^{-1}$ |
| $2p$ | Number of pole-pairs | 5 | pcs. |
| $f$ | Line frequency on rotation speed of 250 $min^{-1}$ | 20.8 | Hz |
| $E_{pm}$ | PM excited no-load line-to-line voltage at speed 250 $min^{-1}$ | 250 | V |
| $U$ | Line-to-line voltage (full load – passive loading) | 155 [1)] | V |
| $I_{ph}$ | Line current | 7.6 | A |

1) Variation interval $0.95 \cdot U \ldots 1.05 \cdot U$ at rated point due to the variation of temperature.

Generator lumped parameters.

| Parameter | Value | Dimension |
|---|---|---|
| $X_d$ | 15.7 | Ohm |
| $X_q$ | 15.7 | Ohm |
| $L_d$ | 0.12 | H |
| $L_q$ | 0.12 | H |
| $R_{ph}$ | 1.6 | Ohm |

**REMARKS:**

- The line current of the PMG must be limited to a value of 8.0 A.
- In the case of direct heating, current limit of 8.0 A requires load of which phase resistance $R_{ph}$ is at least 15 Ohm or above.
- **It is denied to connect the generator directly to a grid!**

## Electrical performance specification – PMG 3.0-250-A – parameters under active loading

The parameters of the generator.

| Parameter | Explanation | Value | Dimension |
|---|---|---|---|
| $P$ | Electric power | 3.0 | kW |
| $S$ | Apparent power | 3.1 | kVA |
| $T$ | Shaft torque | 115 | Nm |
| $n$ | Rotation speed | 250 | $min^{-1}$ |
| $n_{max}$ | Maximum allowed rotation speed under full loading | 400 [1)] | $min^{-1}$ |
| $n_{max}$ | Maximum allowed rotation speed under no-load condition | 400 [1)] | $min^{-1}$ |
| $2p$ | Number of pole-pairs | 5 | pcs. |
| $f$ | Line frequency on rotation speed of 250 $min^{-1}$ | 20.8 | Hz |
| $E_{pm}$ | PM excited no-load line-to-line voltage at speed 250 $min^{-1}$ | 250 | V |
| $U$ | Line-to-line voltage (full load – active load) | 250 [2)] | V |
| $I_{ph}$ | Line current | 7.2 | A |

1) Converter protection due to the over voltage is required if rotation speed of 400 $min^{-1}$ is exceeded.
2) Variation interval $0.95 \cdot U \ldots 1.05 \cdot U$ at rated point due to the variation of temperature.

Generator lumped parameters.

| Parameter | Value | Dimension |
|---|---|---|
| $X_d$ | 15.7 | Ohm |
| $X_q$ | 15.7 | Ohm |
| $L_d$ | 0.12 | H |
| $L_q$ | 0.12 | H |
| $R_{ph}$ | 1.6 | Ohm |
| $X_d$ | 0.61 | p.u. |
| $X_q$ | 0.61 | p.u. |
| $R_{ph}$ | 0.07 | p.u. |

Generator may be loaded with a suitable frequency converter (active load for generator). Under this loading situation generator may produce continuous powers up to 3 kW. With the active load the shaft torque limitation is 120 Nm, up to speed of 400 $min^{-1}$. If operation speed is over 400 $min^{-1}$, the torque must be reduced by a factor $250/n$.

**REMARKS:**

- Continuous value for the line current of the PMG must be limited to a value of 8.0 A
- **It is denied to connect the generator directly to a grid!**

## Electrical performance specification – No load

No-load line voltage waveforms are illustrated in Fig 1.

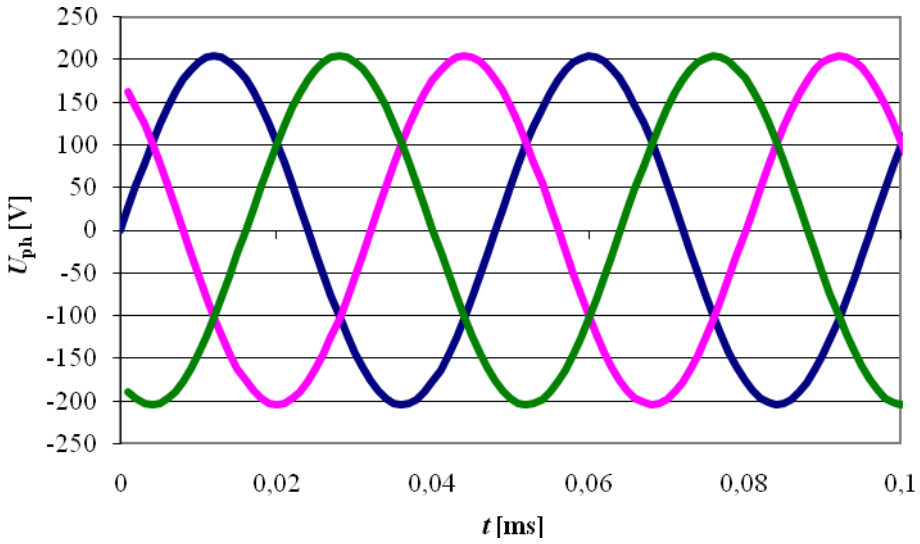


Fig 1. No-load voltage waveforms, rotation speed 250 $min^{-1}$.

## Electrical performance specification – Passive load

Efficiency as a function of resistive load is shown in Fig 2.

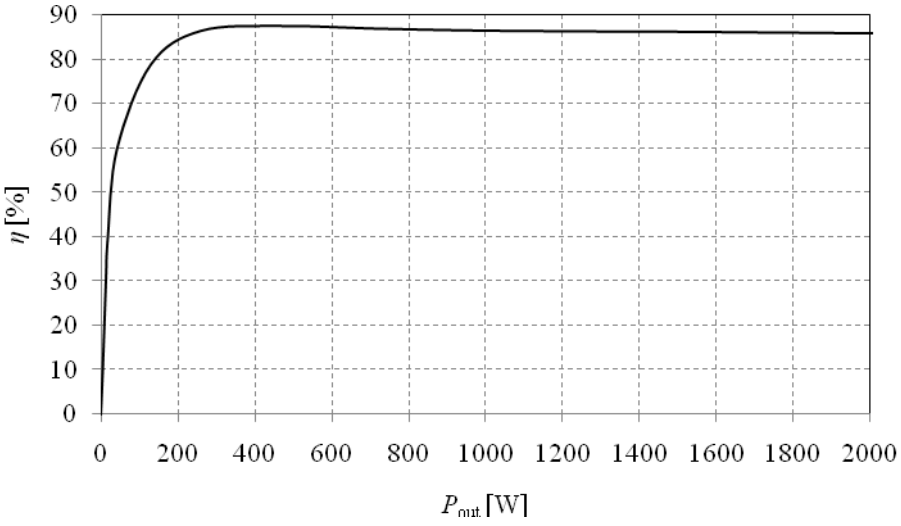


Fig 2. Efficiency of generator. Rotation speed is fixed 250 $min^{-1}$, employed load $R_{ph}$ = 20 Ohm.

Power as a function of phase voltage is presented in Fig 3.

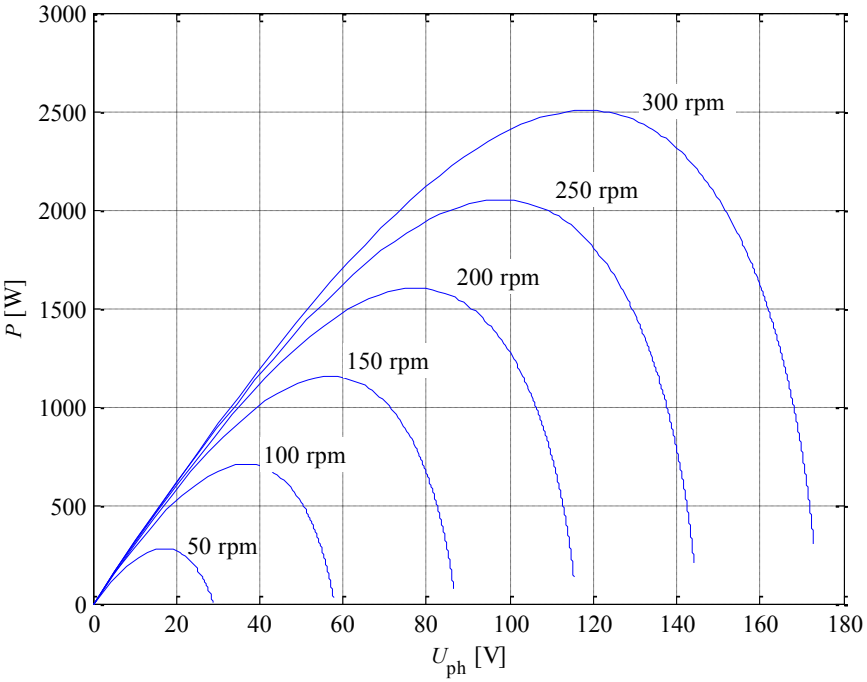


Fig 3. Power as a function of phase voltage. Characteristics curves may be used to optimize the generator loading for constructions where DC rectifier, equipped with a load control, is used against generator. (For example: By adjusting the converter DC bus voltage (converter load) to track generator and or turbine load curve optimum for different rotation speeds)

Power as a function of line resistance is presented in Fig 4.

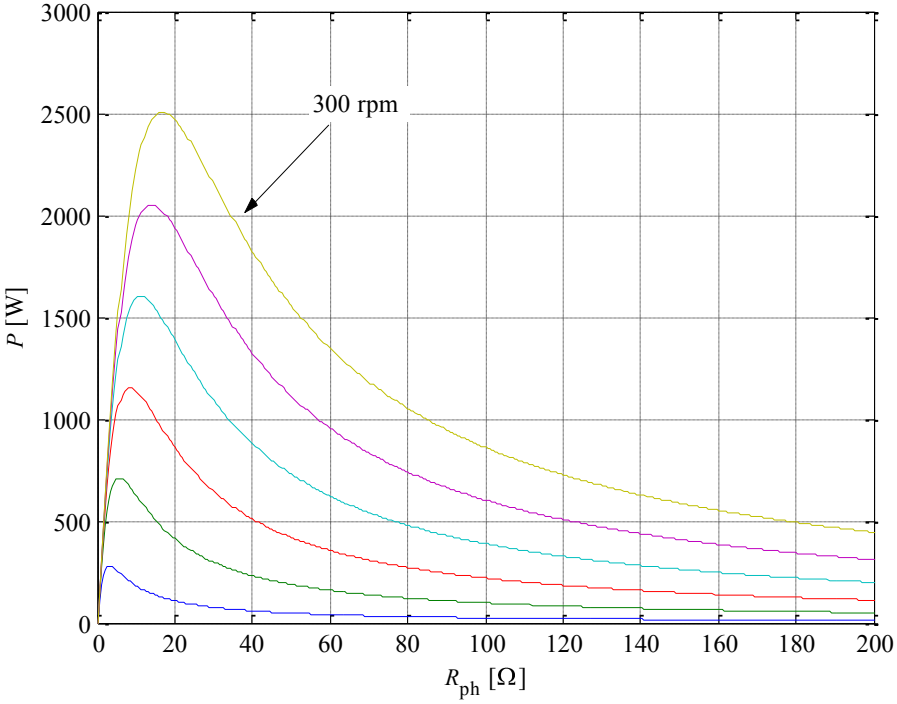


Fig 4. Power as a function of line resistance.