Generators for small wind-energy installations

Synchronous 3-phase generators with permanent excitation (cast-iron housing)

Electrical supply operation

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General data and applications

These permanently excited generators have been specially developed for small wind and water energy applications, and are especially suited for feeding energy back into the electrical supply.

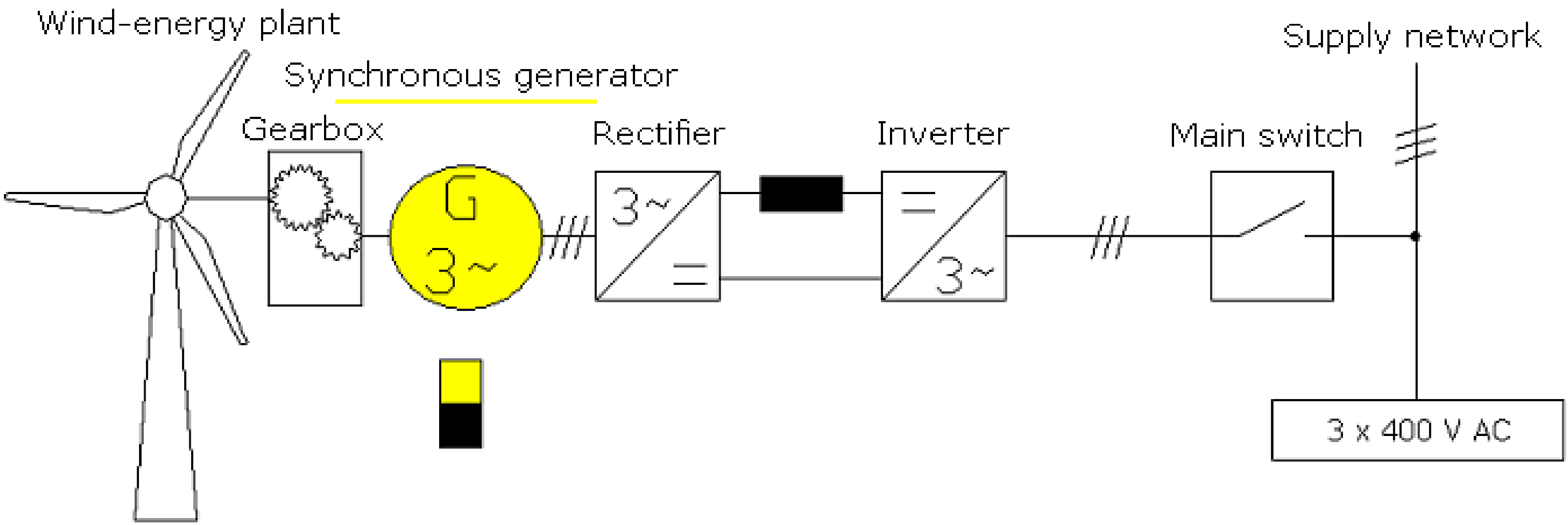
In order to achieve an optimum start-up behavior, particularly at low wind speeds, the generators have been designed to have nearing zero standstill torque, i.e. these machines will start to supply energy at very low wind speeds.

Advantages:

- very low cogging torque
- quite no standstill torque
- no wearing parts, other than ball bearings
- long life time
- (very) high efficiency, even with partial load
- Adapted for electrical braking action with resistor or with short-circuit (max. rotation speed).

Applications:

1) Energy feedback to the electrical supply:
The generators listed in the table are very well suited to energy feedback into the electrical supply, through SMA inverters, which we can also deliver, if required.
These inverters ensure energy recovery over a wide range of voltage and speed (with p.f. ≈1.0).
We can also adapt the various output voltages.



2) DC voltage output:
Via a rectifier (mounted in the terminal box). The rectifier can be provided if required.
The DC voltage can, for example, be used to feed a heater resistor. This makes it possible to warm up water in a boiler that is incorporated in the circuit of an existing heating system.

1) General Data:

Excitation:	permanent (magnets)
Voltage:	AC (DC with a rectifier)
Style:	B3/B5
Operating mode:	S1
Insulation class:	F
Cooling:	Surface (completely enclosed version)
Enclosure protection:	IP 55
Color (standard):	RAL 7030

Notes on cooling:
If the wind speed falls or the load is reduced, the rotor speed will be reduced accordingly.
The machine must be swept by the wind at low speeds (cooling).

2) Other type-dependent data and characteristics:

DSG P series

Speed	71.07-8	80.10-8	112.14-10	112.17-10	112.16-10	132.15-10	132.20-10	160.20-10	200.25-10
	Output power [W]								
200 rpm	55	120	340	420	500	850	1.092	3.200	9.000
600 rpm	380	670	1.800	2.200	2.700	4.500	5.781	11.920	32.500
1000 rpm	750	1.200	3.700	4.300	5.300	9.300	11.948	22.000	57.000
1500 rpm	1.225	2.000	5.800	7.000	8.400	15.600	20.042	35.000	87.600
2000 rpm	1.700	-	7.900	9.700	11.500	21.750	27.944	48.000	118.250
2500 rpm	-	-	-	-	-	27.850	35.781	61.000	150.000
3000 rpm	-	-	-	-	-	34.000	43.682	74.000	-

Performance details and characteristics can be found in the file:
Performance_summary.pdf (power data and characteristics).
Dimensioned drawings can be found in the file:
Dimension_table_B3-B5.pdf (dimension sheets B3/B5).
As an orientation aid and to simplify queries:
Enquiry_offer_form.doc (this file helps you to ask for an offer by fax or e-mail, without an complications).

Other type-dependent details about the individual machines can be found on the following pages.

! Caution: The nominal voltages may have been individually adjusted, and so deviate from the standard values that are presented below !

Frame size 71

Type 71.07-**8**

No. of poles: **8**
Voltage: **AC**
Excitation: **Nd. Fe. B.**
Shaft end: **19 x 40**

3-phase rotating field voltage (66.7 Hz):
Off-load voltage 3 x 84.3 V at 1000 rpm
Nominal voltage 3 x 68.13 V (6.39 A) at 1000 rpm
at nominal power 750 W

DC-voltage (on heater resistor):
Off-load voltage 113.8 V at 1000 rpm
Nominal voltage 89.9 V (6.12 A) at 1000 rpm
Converting energy into heat **750 W**

Torque applied to the shaft:
M = 8.79 Nm
at 0.75 kW / 1000 rpm

Efficiency:
Eta = 81.9 %
at 0.75 kW / 1000 rpm

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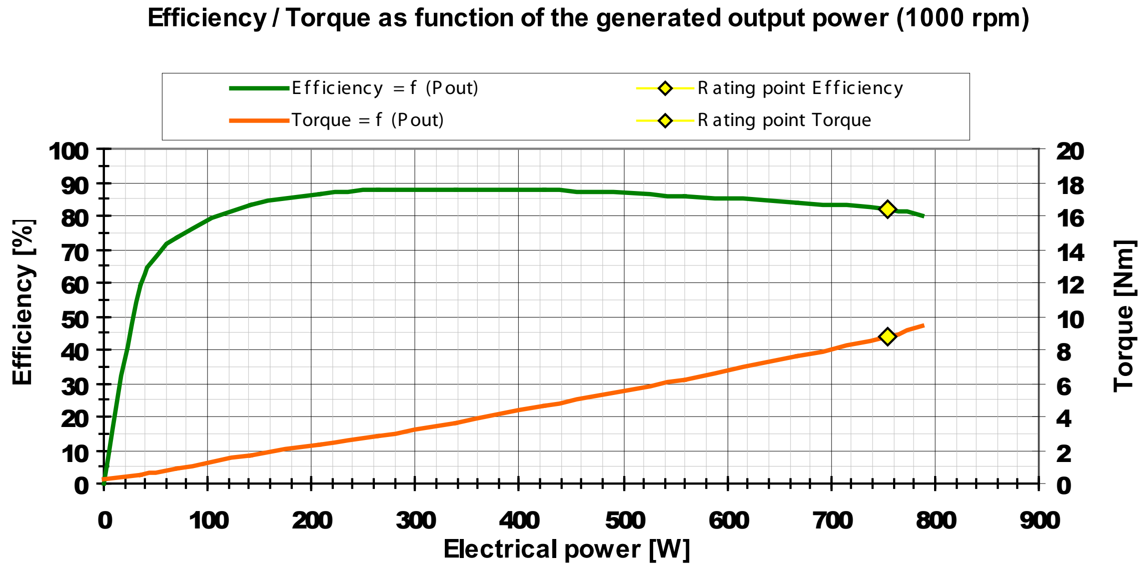
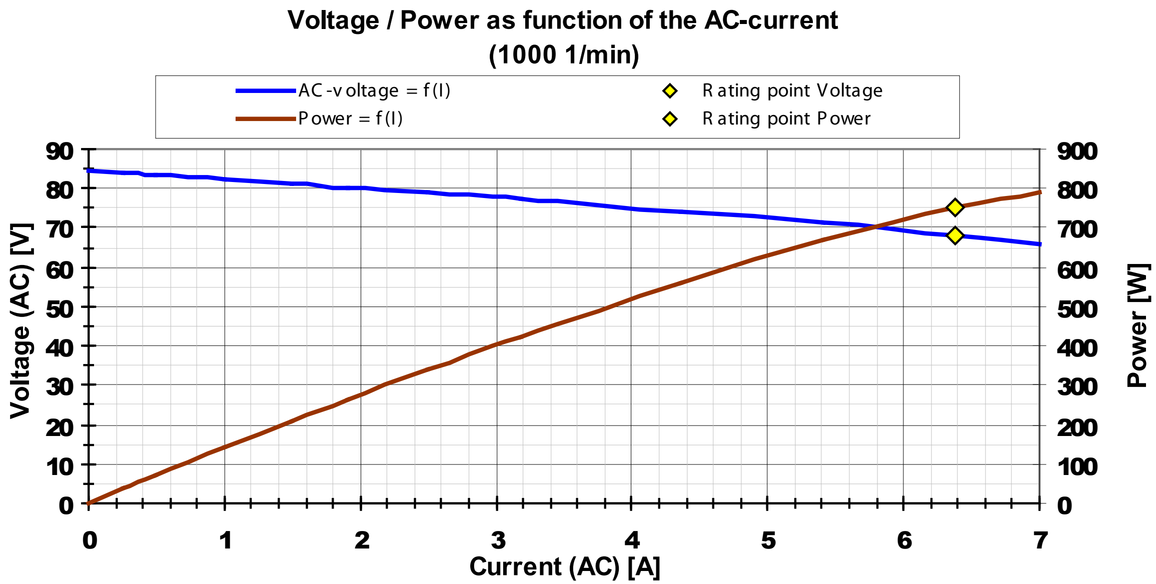




Frame size 80

Type 80.10-8

No. of poles: **8**
Voltage: **AC**
Excitation: **Nd. Fe. B.**
Shaft end: **22 x 50**

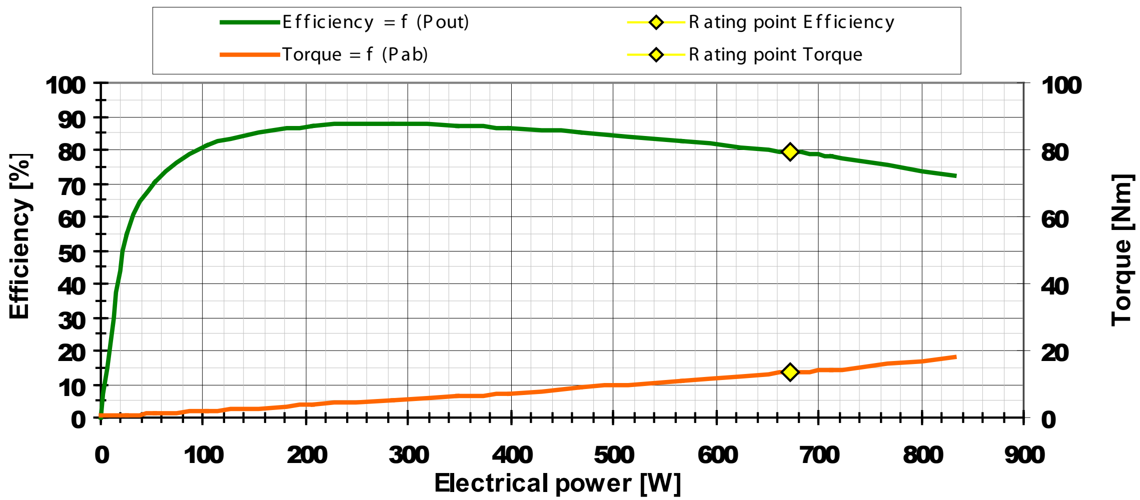
3-phase rotating field voltage (40 Hz):
Off-load voltage 3 x 51.50 V at 600 rpm
Nominal voltage 3 x 41 V (9.65 A) at 600 rpm
at nominal power 670 W

DC-voltage (on heater resistor):
Off-load voltage 69.5 V at 600 rpm
Nominal voltage 55.4 V (12.1 A) at 600 rpm
Converting energy into heat **670 W**

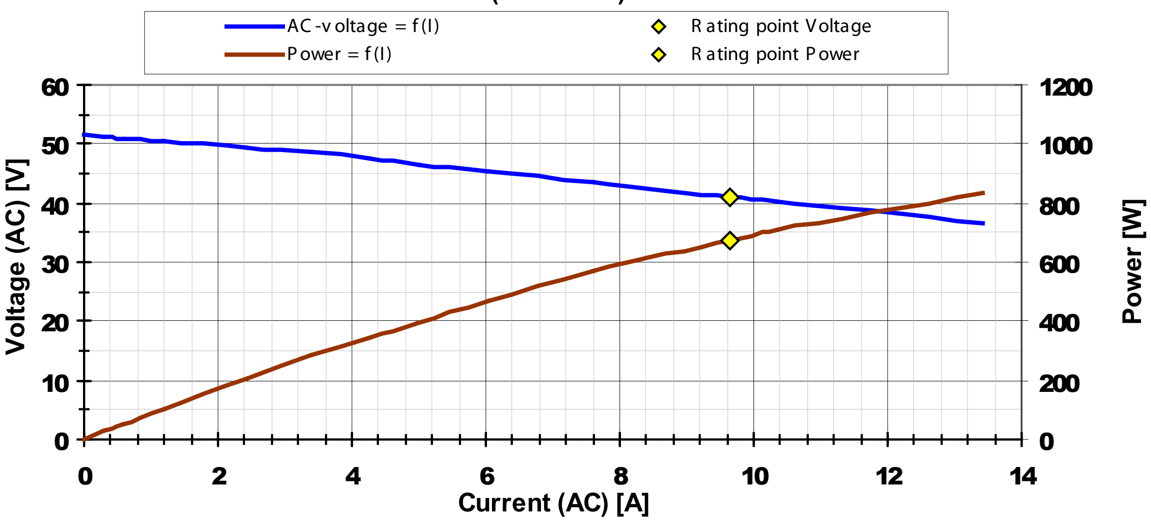
Torque applied to the shaft:
M = 13.5 Nm
at 670 W / 600 rpm

Efficiency:
Eta = 79.3 %
at 670 W / 600 rpm

Efficiency / Torque as function of the generated output power (600 rpm)



Voltage / Power as function of the AC-current (600 1/min)



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Frame size 112

Type 112.14-10

No. of poles: **10**
Voltage: **AC**
Excitation: **Nd. Fe. B.**
Shaft end: **28 x 60**

3-phase rotating field voltage (50 Hz):
Off-load voltage 3 x 188 V at 600 rpm
Nominal voltage 3 x 149 V (7.1 A) at 600 rpm
at nominal power 1800 W

DC-voltage (on heater resistor):
Off-load voltage 254 V at 600 rpm
Nominal voltage 200 V (9.0 A) at 600 rpm
Converting energy into heat **1800 W**

Torque applied to the shaft:
M = 34.2 Nm
at 1.8 kW / 600 rpm

Efficiency:
Eta = 83.4 %
at 1,8 kW / 600 rpm

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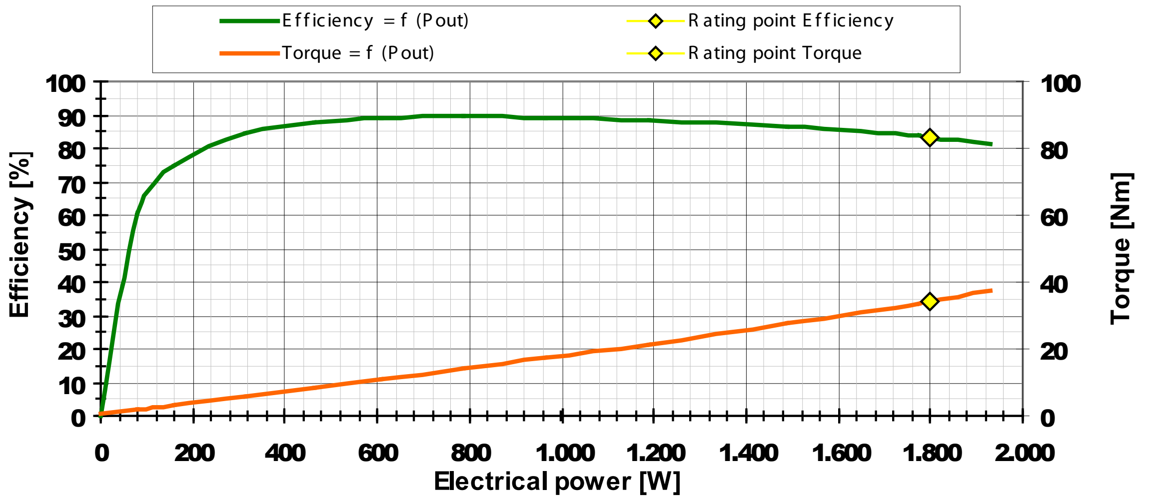
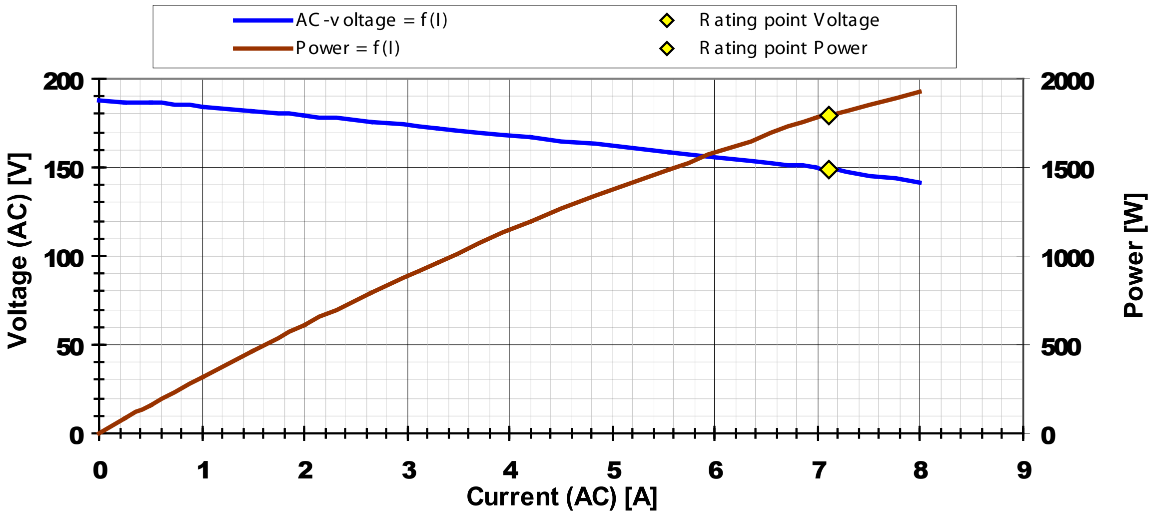
Efficiency / Torque as function of the generated output power (600 rpm)



Voltage / Power as function of the AC-current (600 1/min)



Frame size 112

Type 112.17-10

No. of poles: **10**
Voltage: **AC**
Excitation: **Nd. Fe. B.**
Shaft end: **28 x 60**

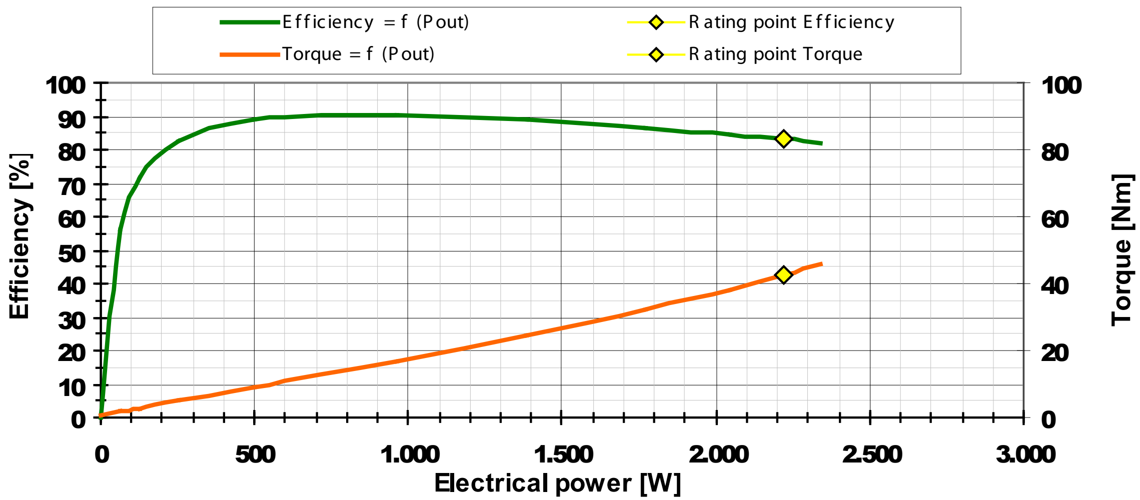
3-phase rotating field voltage (50 Hz):
Off-load voltage 3 x 306 V at 600 rpm
Nominal voltage 3 x 240 V (5.30 A) at 600 rpm
at nominal power 2200 W

DC-voltage (on heater resistor):
Off-load voltage 413 V at 600 rpm
Nominal voltage 324 V (6,79 A) at 600 rpm
Converting energy into heat **2200 W**

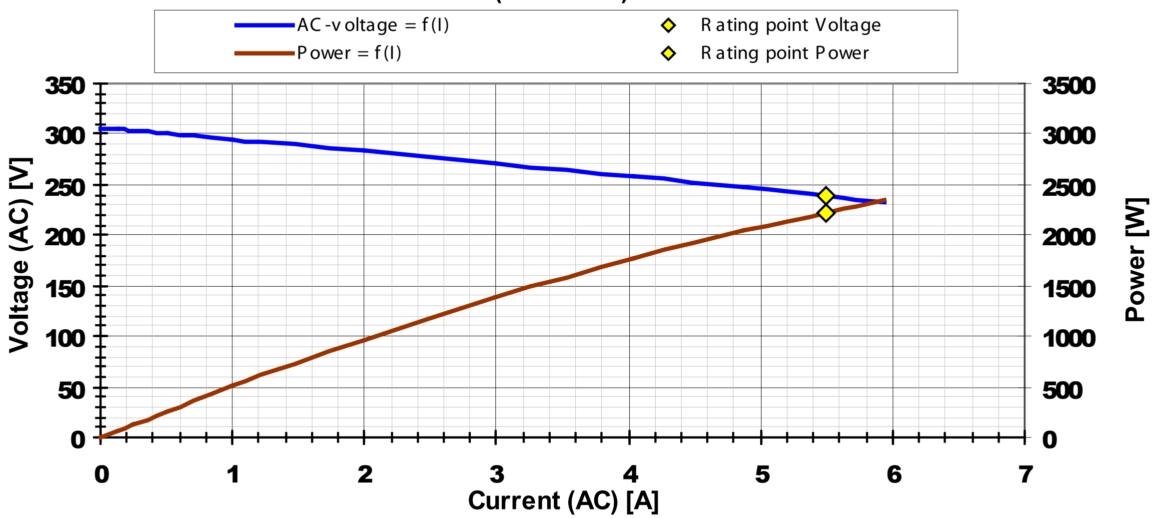
Torque applied to the shaft:
M = 42.7 Nm
at 2,2 kW / 600 rpm

Efficiency:
Eta = 83 %
at 2,2 kW / 600 rpm

Efficiency / Torque as function of the generated output power (600 rpm)



Voltage / Power as function of the AC-current (600 1/min)



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Frame size 112

Type 112.16-10

No. of poles: **10**
Voltage: **DC**
Excitation: **Nd. Fe. B.**
Shaft end: **32 x 80**

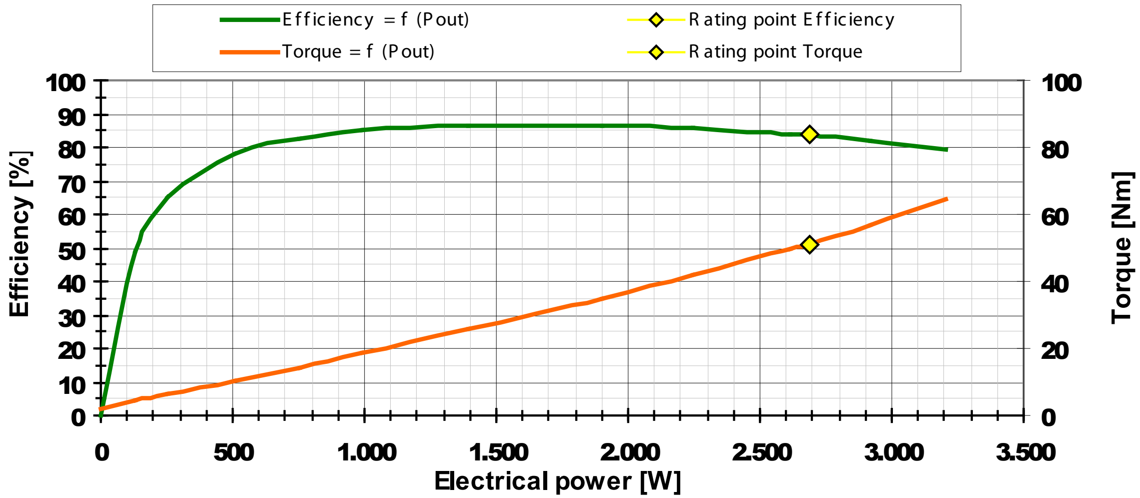
3-phase rotating field voltage (50 Hz):
Off-load voltage 3 x 308 V at 600 rpm
Nominal voltage 3 x 247.7 V (6.4 A) at 600 rpm
at nominal power 2700 W

DC-voltage (on heater resistor):
Off-load voltage 416 V at 600 rpm
Nominal voltage 334 V (8.1 A) at 600 rpm
Converting energy into heat **2700 W**

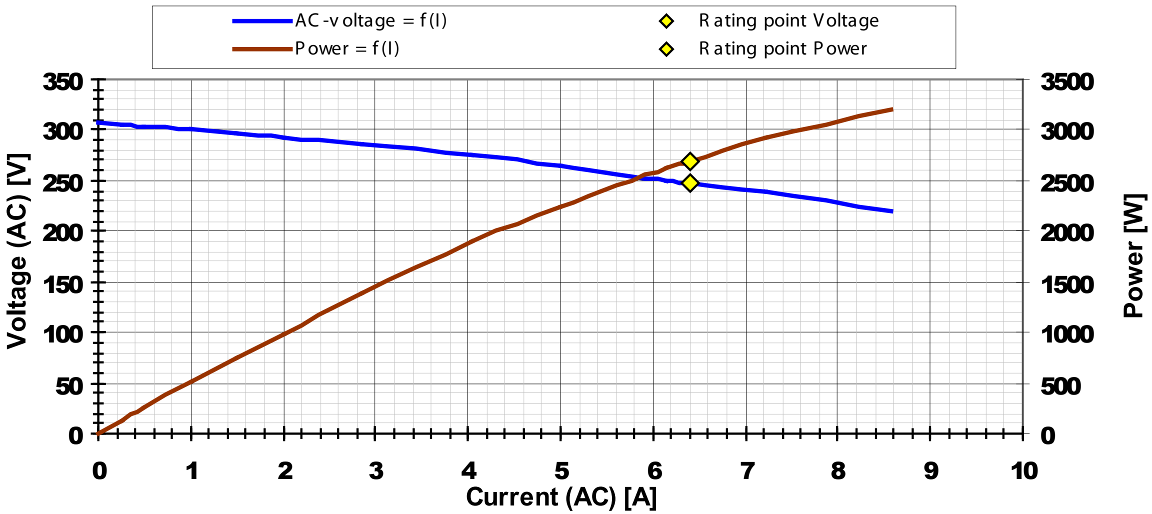
Torque applied to the shaft:
M = 51 Nm
at 2.7 kW / 600 rpm

Efficiency:
Eta = 83.6 %
at 2.7 kW / 600 rpm

Efficiency / Torque as function of the generated output power (600 rpm)



Voltage / Power as function of the AC-current (600 1/min)



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Frame size 132

Type 132.15-10

No. of poles: **10**
Voltage: **AC**
Excitation: **Nd. Fe. B.**
Shaft end: **38 x 80**

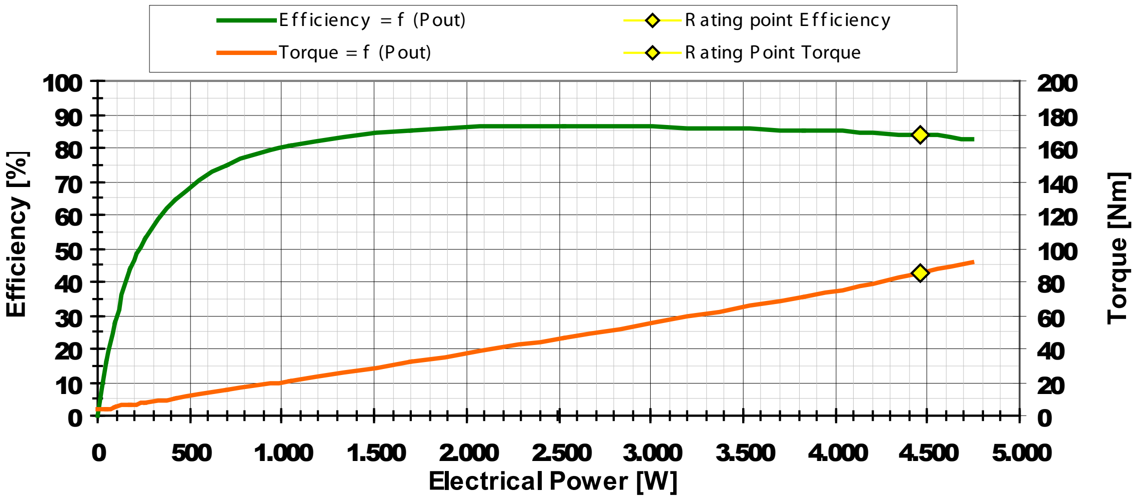
<u>3-phase rotating field voltage (50 Hz):</u>
Off-load voltage 3 x 102 V at 600 rpm
Nominal voltage 3 x 85 V (30.5 A) at 600 rpm
at nominal power 4500 W

<u>DC-voltage (on heater resistor):</u>
Off-load voltage 138 V at 600 rpm
Nominal voltage 115 V (39 A) at 600 rpm
Converting energy into heat **4500 W**

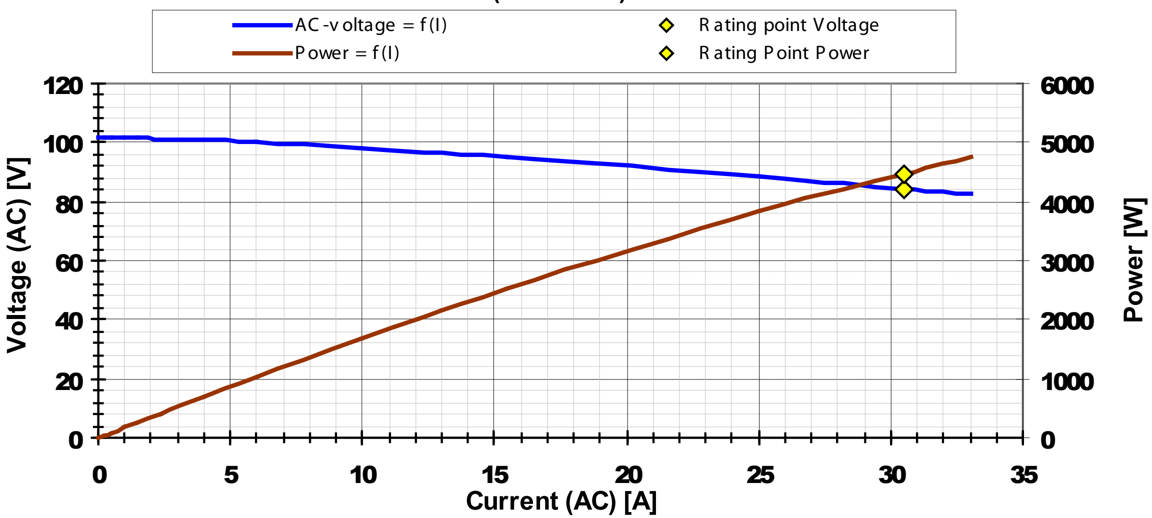
<u>Torque applied to the shaft:</u>
M = 84.9 Nm
at 4.5 kW / 600 rpm

<u>Efficiency:</u>
Eta = 83.7 %
at 4.5 kW / 600 rpm

Efficiency / Torque as function of the generated output power (600 rpm)



Voltage / Power as function of the AC-current (600 1/min)



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Frame size 132

Type 132.20-10

No. of poles:	**10**
Voltage:	**AC**
Excitation:	**Nd. Fe. B.**
Shaft end:	**38 x 80**

3-phase rotating field voltage (50 Hz):
Off-load voltage 3 x 131 V at 600 rpm
Nominal voltage 3 x 109 V (30.5 A) at 600 rpm
at nominal power 5781 W

DC-voltage (on heater resistor):
Off-load voltage 177 V at 600 rpm
Nominal voltage 144 V (40.1 A) at 600 rpm
Converting energy into heat **5781 W**

Torque applied to the shaft:
M = 109 Nm
at 5.8 kW / 600 rpm

Efficiency:
Eta = 83.9 %
at 5.8 kW / 600 rpm

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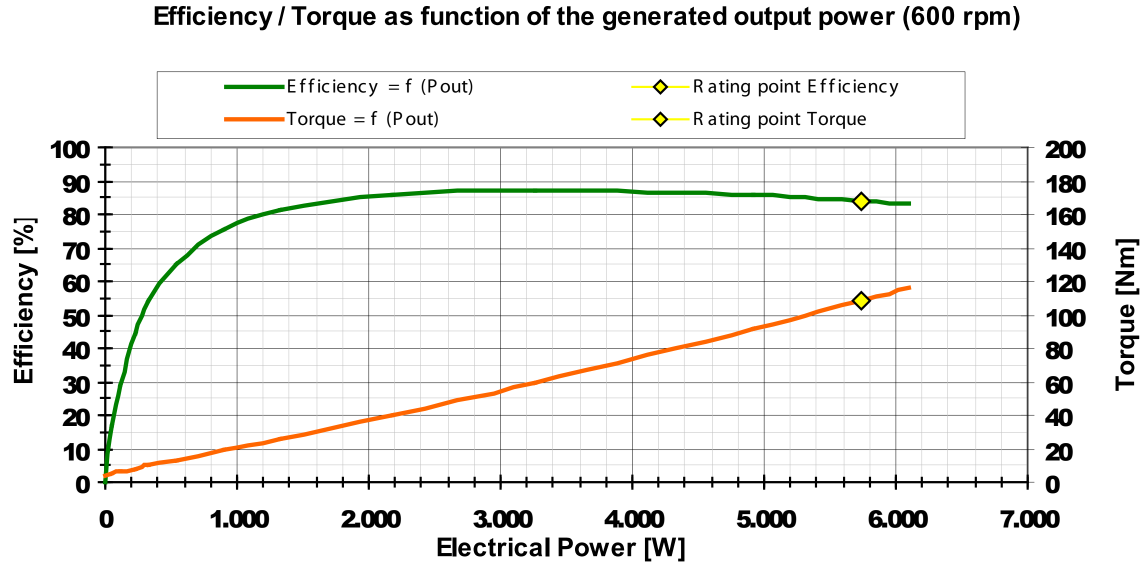
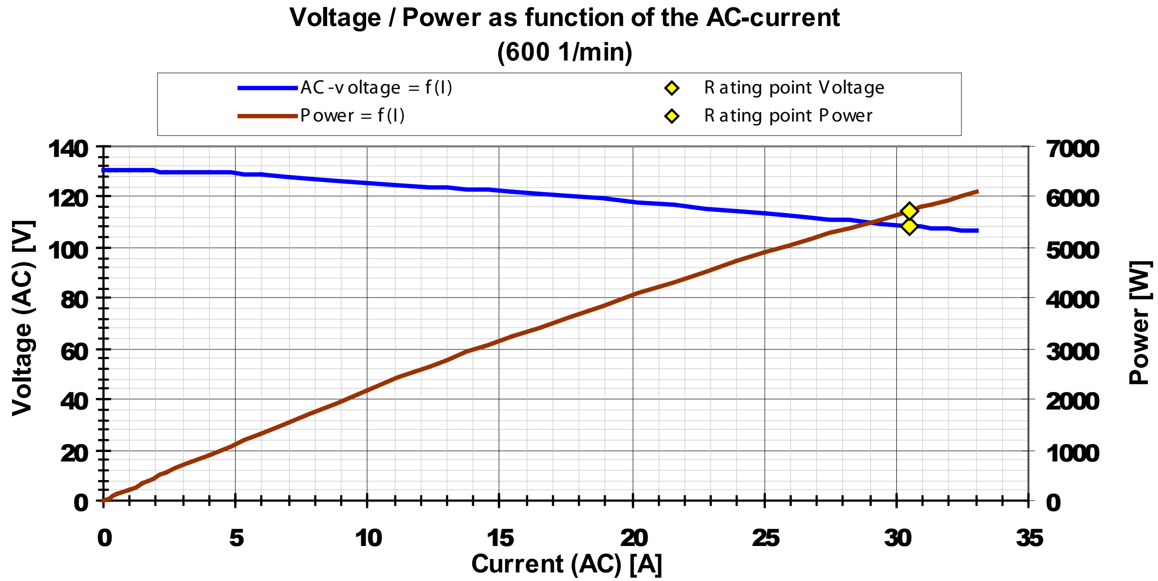




Frame size 160

Type 160.20-10

No. of poles: **10**
Voltage: **AC**
Excitation: **Nd. Fe. B.**
Shaft end: **48 x 110**

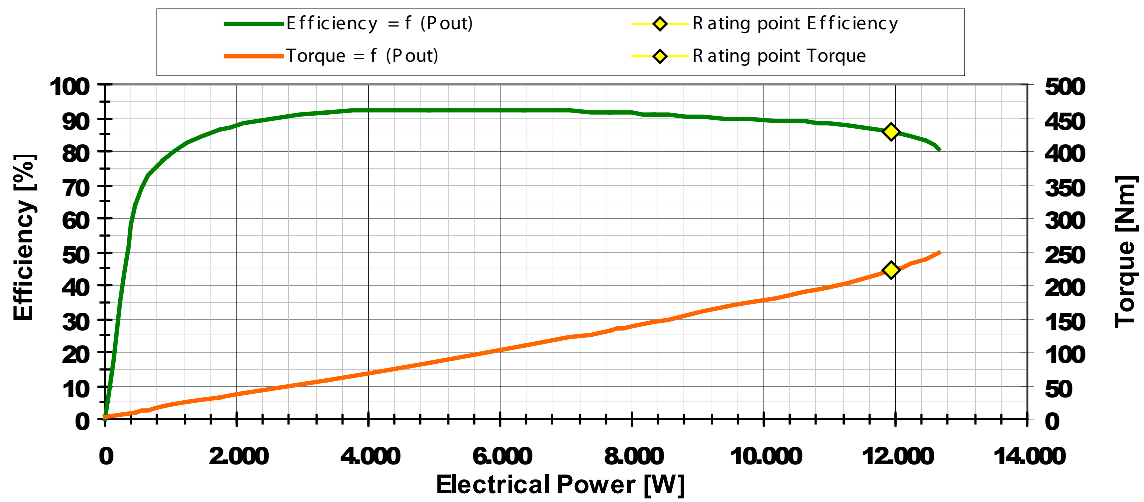
3-phase rotating field voltage (50 Hz):
Off-load voltage 3 x 517.8 V at 600 rpm
Nominal voltage 3 x 350 V (20 A) at 600 rpm
at nominal power 11900 W

DC-voltage (on heater resistor):
Off-load voltage 699 V at 600 rpm
Nominal voltage 454 V (26.12 A) at 600 rpm
Converting energy into heat **11875 W**

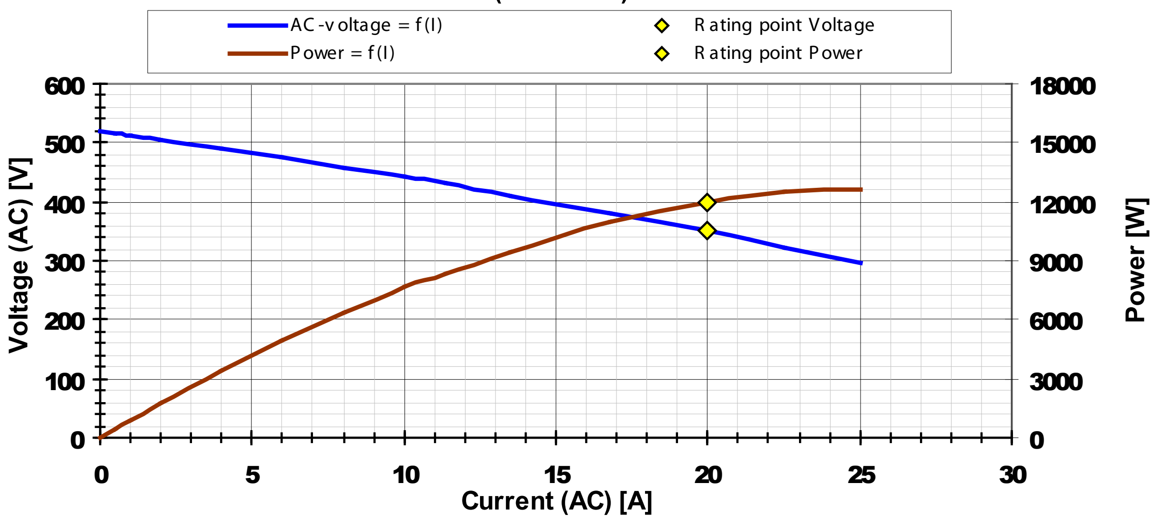
Torque applied to the shaft:
M = 222 Nm
at 11.9 kW / 600 rpm

Efficiency:
Eta = 86 %
at 11,9 kW / 600 rpm

Efficiency / Torque as function of the generated output power (600 rpm)



Voltage / Power as function of the AC-current (600 1/min)



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Frame size 200

Type 200.25-10

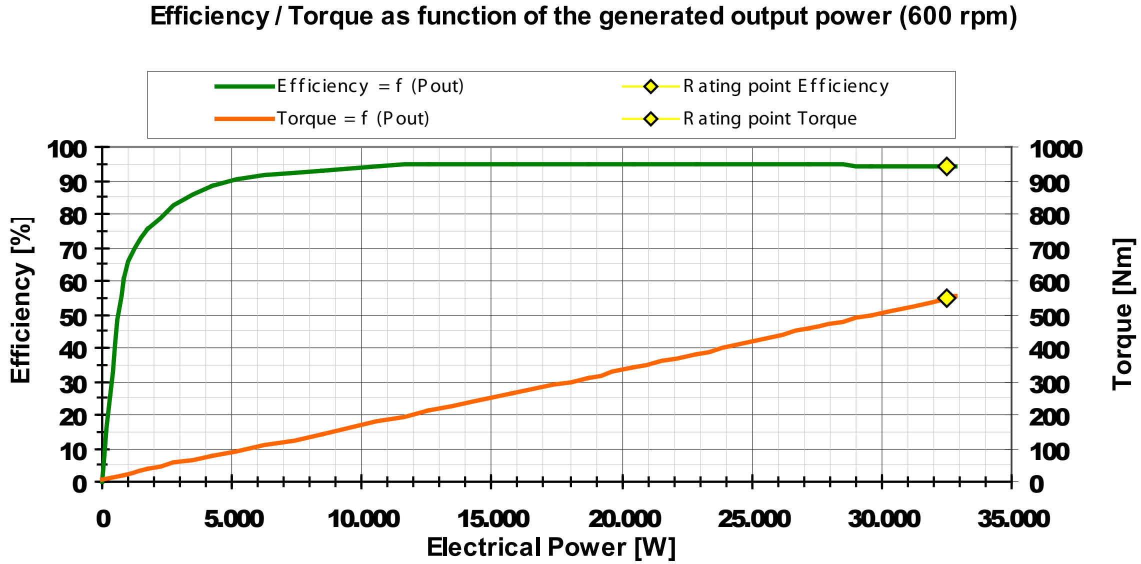
No. of poles: **10**
Voltage: **AC**
Excitation: **Nd. Fe. B.**
Shaft end: **60 x 140**

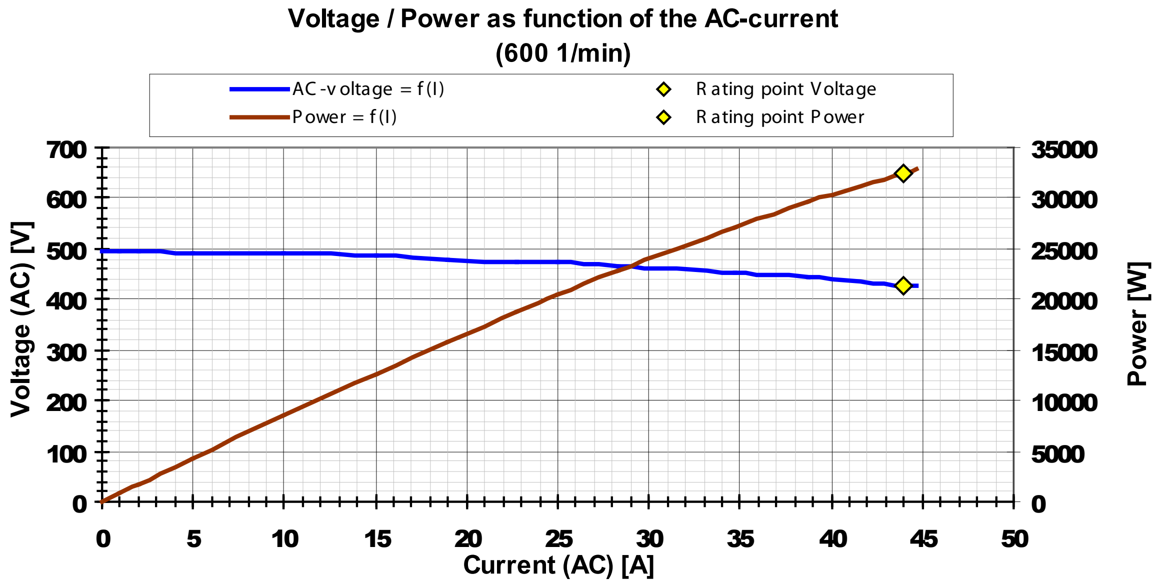
3-phase rotating field voltage (50 Hz):
Off-load voltage 3 x 495 V at 600 rpm
Nominal voltage 3 x 427 V (44 A) at 600 rpm
at nominal power 32700 W

DC-voltage (on heater resistor):
Off-load voltage 667 V at 600 rpm
Nominal voltage 564 V (57.6 A) at 600 rpm
Converting energy into heat **32500 W**

Torque applied to the shaft:
M = 550 Nm
at 32.5 kW / 600 rpm

Efficiency:
Eta = 94 %
at 32.5 kW / 600 rpm





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In a time of energy scarcity, wind generators are in demand again. Particularly when effective utilization can be achieved with acceptable expense, such as converting the wind energy into electrical energy in an environmentally friendly manner. In windy areas, this type of installation, with a generated output power in the range from 1 to about 10 kW at 1500 rpm, can operate very efficiently. In this power range, masts and rotors still have the kind of size that can often be set up by the users themselves. And such small installations are usually free from approval procedure requirements.

Energy feedback into the electrical supply or conversion into heat

To feed the wind energy back into an existing electrical supply, an inverter is required that takes the rectified voltage from the generator and feeds it back into the supply network at the correct frequency and amplitude.

If a stand-alone electrical network is to be supplied from a small wind energy installation at a constant voltage and frequency, then this can be done with an additional controller and energy storage (battery), since the wind speed is never constant for long periods.

It is less involved to convert the generated electrical energy into heat. This is independent of the rotor speed, and thus independent of the voltage and frequency. The generator can either be loaded by 3 equal heater resistors (one per phase) or can feed one heater resistor through a DC intermediate circuit. In a heater resistor, the electrical power ($P = U \cdot I$) is converted into heat, that can be stored in a hot water boiler, for instance. In practice, the user is frequently looking for a combined solution with an existing heating system (e.g. oil heating).

Application of permanently excited synchronous generators

If a permanently excited synchronous machine is used as a generator, it is able to generate a voltage with the slightest movement (no standstill torque). The generator has a 3-phase stator, familiar from the classic asynchronous machine. The rotor (magnet rotor in this case) is fitted with permanent magnet segments that provide the magnetic field. The advantage of this special construction is that it can provide a power output over a very wide speed range, and has a long working life, since the only wearing parts are the ball bearings. This design therefore has a particularly high efficiency.

Overdimensioning the wind generator can even provide protection against storms, since the increased incident torque caused by the storm can produce an equal, counteracting torque in the generator, if the latter is producing a correspondingly higher output power. Under these conditions, the wind rotor will not reach speeds that could be high enough to damage it.