

***Power Curve &
Sound Power Level
REpower MM92
[2050 kW]***

REpower Systems AG
Überseering 10
22297 Hamburg

Tel.: +49 - 40 - 5555090 - 0
Fax: +49 - 40 - 5555090 - 3999

www.repower.de

Copyright © 2010 REpower Systems AG

Disclaimer

All rights reserved.

Protection Notice DIN ISO 16016: The reproduction, distribution and utilization of this document as well as the communication of its contents to others without explicit authorization in writing of REpower Systems AG is prohibited. Offenders will be held liable for the payment of damages. All rights reserved in the event of the grant of a patent, utility model or design.

Please ensure to use the applicable specifications in their latest versions. Images do not necessarily reflect the exact scope of supply and are subject to technical alterations at any time. Please note that this document can not necessarily correspond with the project-specific requirements.

Possible work procedures shown in this product description comply with German and the REpower's own safety provisions and regulations. The national laws of other countries may provide for further safety specifications.

It is essential that all precautionary measures, both project- and country-specific, be strictly complied with. It is the duty of each customer to inform itself, implement and observe these measures.

The applicability and validity of the relevant legal and/or contractual provisions, the technical guidelines, DIN standards and other comparable regulations is not excluded by the contents or demonstrations contained in product description. Moreover these provisions and regulations shall continue to apply without any limitation.

All information contained in this product description are subject to change at any time without notice or approval by the customer.

REpower Systems AG assumes no liability for any errors or omissions in the content of this product description. Legal claims against REpower Systems AG based on damage caused by the use or non-use of the information offered here or the use of erroneous or incomplete information are excluded.

All brands or product names mentioned in this document are the property of their respective holders.

Table of Content

Applicable Documents	4
List of Abbreviations and Units	4
1 Introduction	5
2 Conditions for guarantee and measurement of power curve and sound power level	5
2.1 General information	5
2.2 Conditions for power curve guarantee and measurement	5
2.3 Conditions for sound power level guarantee and measurement	6
3 Guaranteed electrical power curve und guaranteed sound power level	7
3.1 Sound power level according to IEC for wind speed at hub height	7
3.2 Sound power level according to IEC for wind speed at 10 m height	8
3.3 Sound power level according to FGW Guideline at 95% of rated power	8

Applicable Documents

The documents referred to in the table below are included for information only. Reference to them in this product description does not make them part of the contract.

Title	Document no.

* If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

List of Abbreviations and Units

Abbreviation/Unit	Description
cp	Power coefficient
ct	Thrust coefficient
FGW	Fördergesellschaft Windenergie e.V.
IEC	International Electrotechnical Commission
WEC	Wind Energy Converter

1 Introduction

This document shows the guaranteed power curve and sound power level of the *REpower MM92 [2050kW]* and the corresponding guarantee and measurement conditions.

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

Rotor diameter:	92.5 m
Air density:	1.225 kg/m ³
Cut in wind speed:	approx. 3.0 m/s
Cut out wind speed:	24 m/s
Wind speed at hub height:	10 minutes mean values
Blades:	clean, no ice/snow formation

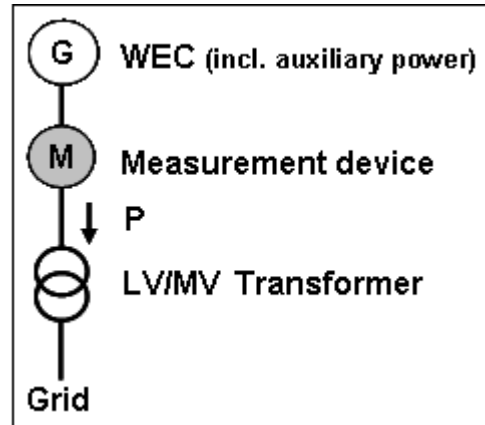
2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005¹

Turbulence intensity:	6 to 12 %
Terrain:	not complex according to IEC 61400-12-1: 2005 ¹
Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.2
air density at location (10 minutes mean value):	≥ 1.13 kg/m ³
Temperature range:	≤ 35 °C
Power factor:	cos phi ~ 1
Anemometer type:	Thies First Class
Voltage level for measurement:	690 V (50 Hz) / 575 V (60Hz)

¹ For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:

No obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the wind turbine or met mast.



Arrangement of a measuring unit for the power curve measurement of a *REpower MM92*

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006²

Roughness length (average peak):

0.05 m

² Method 1, as outlined in section 7.3 of the IEC standard 61400-11

3 Guaranteed electrical power curve und guaranteed sound power level³

The sound power level guaranteed by REpower includes a measurement uncertainty of approx. 1 dB(A). REpower warrants that there is no tonal audibility > 0 dB.

3.1 Sound power level according to IEC for wind speed at hub height

Wind speed v [m/s]	Power P [kW] ⁴	Sound Power Level L _{WA} [dB(A)] ⁵	Thrust coefficient ct [-]	Power coefficient cp [-]
3.0	20	--	0.98	0.180
4.0	94	--	0.87	0.357
5.0	205	--	0.79	0.398
6.0	391	100.4	0.79	0.440
7.0	645	101.8	0.79	0.457
8.0	979	103.3	0.79	0.465
9.0	1375	104.2	0.74	0.458
10.0	1795	104.2	0.69	0.436
11.0	2000	104.2	0.54	0.365
12.0	2040	104.2	0.39	0.287
13.0	2050	104.2	0.29	0.227
14.0	2050	104.2	0.23	0.182
15.0	2050	104.2	0.19	0.148
16.0	2050	104.2	0.15	0.122
17.0	2050	104.2	0.13	0.101
18.0	2050	104.2	0.11	0.085
19.0	2050	104.2	0.09	0.073
20.0	2050	104.2	0.08	0.062
21.0	2050	104.2	0.07	0.054
22.0	2050	104.2	0.06	0.047
23.0	2050	104.2	0.06	0.041
24.0	2050	104.2	0.05	0.036

³ Valid for unrestricted operation only. During sound reduced operation different power and sound levels are effective.

⁴ Guaranteed on 690 V (for 50 Hz) / 575 V (for 60Hz) voltage level

⁵ Sound power level at hub height

3.2 Sound power level according to IEC for wind speed at 10 m height

HH	v_{10} [m/s]	4.0	5.0	6.0	7.0	8.0	9.0	10.0
68.0 – 68.5 m	L_{WA}^5 [dB(A)]	95.7	101.2	103.1	104.2	104.2	104.2	104.2
78.0 – 80.0 m	L_{WA}^5 [dB(A)]	96.0	101.4	103.3	104.2	104.2	104.2	104.2
98.0 – 100.0 m	L_{WA}^5 [dB(A)]	96.4	101.7	103.4	104.2	104.2	104.2	104.2

All sound power levels above are based on wind speeds of v_{10} at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11: 2002 + A1: 2006.

The calculation of the wind speed in 10 m height is based on a roughness length of 0.05m.

3.3 Sound power level according to FGW Guideline at 95% of rated power

The sound power level measured according to the “Technische Richtlinie für Windenergieanlagen Teil 1: Rev. 18 der FGW” at 95 % of the rated power is independent of the hub height:

$$L_{WA, 95\%} = 104.2 \text{ dB(A)}$$

**Sound Power Level
of the
ENERCON E-82 E2
Operational Mode I
(Data Sheet)**

Imprint

Editor: ENERCON GmbH ▪ Dreekamp 5 ▪ 26605 Aurich ▪ Germany

Telephone: 04941-927-0

Fax: 04941-927-109

Copyright: Unless otherwise specified in this document, the contents of this document are protected by copyright of ENERCON GmbH. All rights reserved. No use, including any copying or publishing, of this information is permitted without the prior written consent of ENERCON GmbH.

Updates: ENERCON GmbH reserves the right to continuously update and modify this document and the items described therein at any time without prior notice.

Revision

Revision: 1.0

Department: ENERCON GmbH / Site Assessment

Glossary

WEC means an ENERCON wind energy converter.

WECs means more than one ENERCON wind energy converter.

Document information:	© Copyright ENERCON GmbH. All rights reserved.	
Author/Revisor/ date:	Sch/ 03.2010	Documentname SIAS-04-SPL E-82 E2 OM I 2,3MW Rev1_0-eng-eng.doc
Approved / date:	MK/ 04/2010	
Revision /date:	1.0/ April 2010	

Sound Power Level for the E-82 E2 with 2300 kW rated power

in relation to wind speed at 10 m height					
hub height V_s in 10 m height	78 m	85 m	98 m	108 m	138 m
5 m/s	96,3 dB(A)	96.6 dB(A)	97.2 dB(A)	97.5 dB(A)	98.2 dB(A)
6 m/s	100.7 dB(A)	101.0 dB(A)	101.6 dB(A)	101.9 dB(A)	102.6 dB(A)
7 m/s	103.3 dB(A)	103.5 dB(A)	103.6 dB(A)	103.6 dB(A)	103.8 dB(A)
8 m/s	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)
9 m/s	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)
10 m/s	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)
95% rated power	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)

Measured value at 95% rated power				103,4 dB(A) KCE 209244-03.03
--------------------------------------	--	--	--	---------------------------------

in relation to wind speed in hub height									
wind speed at hub height [m/s]	7	8	9	10	11	12	13	14	15
Sound Power Level [dB(A)]	96.6	99.9	102.6	103.5	104.0	104.0	104.0	104.0	104.0

1. The relation between the sound power level and the standardized wind speed in 10 m height as shown above is valid on the premise of a logarithmic wind profile with a roughness length of 0.05 m. The relation between the sound power level and the wind speed at hub height applies for all hub heights. During the sound measurements the wind speeds are derived from the power output and the power curve of the WEC.
2. A tonal audibility of $\Delta L_{a,k} \leq 2$ dB can be expected over the whole operational range (valid in the near vicinity of the turbine according to IEC 61 400 -11 ed. 2).
3. The sound power level values given in the table are valid for the **Operational Mode I** (defined via the rotational speed range of 6 – 18 rpm). The respective power curve is the calculated power curve E-82 E2 dated November 2009 (Rev. 3.x).
4. The values displayed in the tables above are based on official and internal measurements of the sound power level. If available the official measured values are given in this document as a

Document information:		© Copyright ENERCON GmbH. All rights reserved.	
Author/Revisor/ date:	Sch/ 03.2010	Documentname	SIAS-04-SPL E-82 E2 OM I 2,3MW Rev1_0-eng-eng.doc
Approved / date:	MK/ 04/2010		
Revision /date:	1.0/ April 2010		

reference (in italic print). The extracts of the official measurements can be made available upon request. The values given in the measurement extracts do not replace the values given in this document. All measurements have been carried out according to the recommended German and international standards and guidelines as defined in the measurement reports, respectively.

5. Due to the typical measurement uncertainties, if the sound power level is measured according to one of the accepted methods the measured values can differ from the values shown in this document in the range of +/- 1 dB.

Accepted measurement methods are:

- a) IEC 61400-11 ed. 2 („Wind turbine generator systems – Part 11: Acoustic noise measurement techniques; Second edition, 2002-12“), and
- b) the FGW-Guidelines („Technische Richtlinie für Windenergieanlagen – Teil 1: Bestimmung der Schallemissionswerte“, published by the association “Fördergesellschaft für Windenergie e.V.“, 18th revision).

If the difference between total noise and background noise during a measurement is less than 6 dB a higher uncertainty must be considered.

6. For noise-sensitive sites it is possible to operate the E-82 E2 with reduced rotational speed and reduced rated power during night time. The sound power levels resulting from such operational mode can be provided in a separate document upon request.
7. The sound power level of a wind turbine depends on several factors such as but not limited to regular maintenance and day-to-day operation in compliance with the manufacturer's operating instructions. Therefore, this data sheet can not, and is not intended to, constitute an express or implied warranty towards the customer that the E-82 E2 WEC will meet the exact sound power level values as shown in this document at any project specific site.

Document information:		© Copyright ENERCON GmbH. All rights reserved.	
Author/Revisor/ date:	Sch/ 03.2010	Documentname	SIAS-04-SPL E-82 E2 OM I 2,3MW Rev1_0-eng-eng.doc
Approved / date:	MK/ 04/2010		
Revision /date:	1.0/ April 2010		

13.3 Noise Levels**13.3.1 Noise Levels V100-2.6 MW, 50 Hz, Mode 0**

Sound Power Level at Hub Height: Noise mode 0		
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 2 2002	
	Wind shear: 0.16	
	Max. turbulence at 10 meter height: 16%	
	Inflow angle (vertical): $0 \pm 2\sigma$	
	Air density: 1.225 kg/m³	
Hub Height	80 m	100 m
LwA @ 3 m/s (10 m above ground) [dBA]	96.7	96.7
Wind speed at hh [m/sec]	4.2	4.3
LwA @ 4 m/s (10 m above ground) [dBA]	98.3	98.8
Wind speed at hh [m/sec]	5.6	5.8
LwA @ 5 m/s (10 m above ground) [dBA]	101.7	102.2
Wind speed at hh [m/sec]	7.0	7.2
LwA @ 6 m/s (10 m above ground) [dBA]	104.6	104.8
Wind speed at hh [m/sec]	8.4	8.7
LwA @ 7 m/s (10 m above ground) [dBA]	105.0	105.0
Wind speed at hh [m/sec]	9.8	10.1
LwA @ 8 m/s (10 m above ground) [dBA]	105.0	105.0
Wind speed at hh [m/sec]	11.2	11.6
LwA @ 9 m/s (10 m above ground) [dBA]	105.0	105.0
Wind speed at hh [m/sec]	12.6	13.0
LwA @ 10 m/s (10 m above ground) [dBA]	105.0	105.0
Wind speed at hh [m/sec]	13.9	14.5
LwA @ 11 m/s (10 m above ground) [dBA]	105.0	105.0
Wind speed at hh [m/sec]	15.3	15.9
LwA @ 12 m/s (10 m above ground) [dBA]	105.0	105.0
Wind speed at hh [m/sec]	16.7	17.3
LwA @ 13 m/s (10 m above ground) [dBA]	105.0	105.0
Wind speed at hh [m/sec]	18.1	18.8