

Wind Turbine Generator
Sound Power Level Measurement Reports - IEC 61400-11

Sound power level REpower MM82 LM Rotor Blade

Hub height 59.0m

V_{10}^1 [m/s]	3,0	4,0	5,0	6,0	7,0	8,0	9,0	10,0
L_{WA}^2 [dB(A)]	89,2	93,2	99,6	101,7	102,6	103,8	104,8	105,5

Hub height 69.0m

V_{10} [m/s]	3,0	4,0	5,0	6,0	7,0	8,0	9,0	10,0
L_{WA} [dB(A)]	89,4	93,4	99,8	101,8	102,8	103,9	104,9	105,5

Hub height 80m

V_{10} [m/s]	3,0	4,0	5,0	6,0	7,0	8,0	9,0	10,0
L_{WA} [dB(A)]	90,0	94,0	100,0	102,0	103,0	104,0	105,0	105,5

Hub height 100m

V_{10} [m/s]	3,0	4,0	5,0	6,0	7,0	8,0	9,0	10,0
L_{WA} [dB(A)]	90,6	94,6	100,2	102,2	103,1	104,1	105,1	105,5

All sound power levels 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: Wind turbine generator systems – part 11, as well as the Technical Guideline Fördergesellschaft Windenergie e.V. (FGW).

1 Wind speed at 10 meters height

2 sound power level of the turbine in hub height



Summary of results of the noise emission measurement, in accordance with IEC 61400-11, of a WTGS of the type

WINDTEST

Kaiser-Wilhelm-Koog GmbH

REpower MM82

Customer:	REpower Systems AG Hollesenstraße 15 24768 Rendsburg Germany	Site:	Reußenköge 80027
Date of Order:	2004-02-02	Contractor:	WINDTEST Kaiser-Wilhelm-Koog GmbH Sommerdeich 14b 25709 Kaiser-Wilhelm-Koog Germany
		Order No.:	6020 04 02391 06

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Wind Turbine Technical Data:

Type: REpower MM82
 Manufacturer: REpower Systems AG
 Turbine serial number: 80027
 Rated power: 2000 kW
 Power control: pitch
 Tower type: tapered conical tube

 Rotor manufacturer: A&R
 Rotor blade type: PP82-20-A
 Rotor blade serial number: 020/017/018
 Rotor diameter: 82 m
 Rotor blade pitch angle: variabel (0..91 Grad) degrees
 Number of rotor blades: 3
 Rotor speed(s) (or range): 8,5-17,1 min⁻¹

 Gearbox manufacturer: Eickhoff
 Gearbox type: CPNHZ-217
 Gearbox serial number: 20623

 Generator manufacturer: VEM
 Generator type: DASAA 5025-4 U
 Generator serial number: 2346624/2003
 Generator speed(s) (or range): 900-1800 min⁻¹
 Generator rated power: 2040 kW

These data do not replace the corresponding manufacturer's certificate.

Measurement geometry:

Hub height above ground: 59 m
 Measurement distance R_0 : 100 m
 Height of microphone h_A : -1,5 m
 Distance rotor centre to tower axis d : 3,2 m

Measurement conditions:

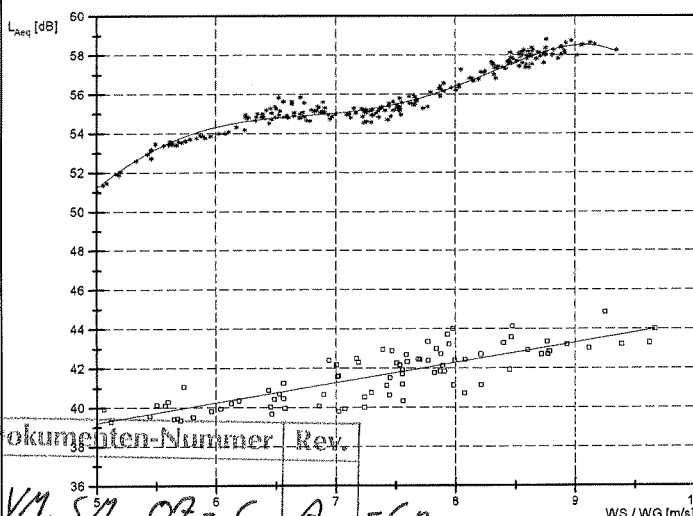
Measurement date: 2004-02-05 / 2004-03-17
 Range of wind speed at 10m height, 1-min average
 WS_{10m} : 3,1 - 9,7 m/s
 Wind direction: W / SW
 Range of power, 1-min-average $P_{W_{eff}}$: 105 - 1913 kW
 Air pressure p_{Luft} : 1010 hPa / 1020 hPa
 Air temperature T_{Luft} : 8 °C / 12 °C
 Turbulence intensity: 13,3 %

Power curve:

From report: WT 2986/03
 Testing Authority: WINDTEST Kaiser-Wilhelm-Koog GmbH
 Measurement Period: 2003-09-24 - 2003-11-20

WS (m/s)	Power (kW)	WS (m/s)	Power (kW)	WS (m/s)	Power (kW)
3,43	6,0	9,00	983,7	14,50	2048,6
3,99	47,4	9,54	1119,4	14,93	2051,5
4,46	89,3	10,01	1230,1	15,52	2050,0
5,04	148,3	10,51	1390,6	16,10	2056,6
5,50	207,8	10,99	1529,9	16,43	2057,5
6,03	286,6	11,52	1685,8	16,98	2058,1
6,46	360,9	12,00	1800,2	17,45	2057,9
7,04	496,1	12,46	1891,7	17,95	2059,5
7,50	595,3	13,02	1974,8	18,41	2060,1
8,02	738,0	13,53	2015,0	18,96	2058,6
8,50	852,1	13,99	2039,3	19,51	2060,1

Determination of the sound power level:



WS_{10m} [m/s]	6	7	8	9	9,38 ¹
$P_{W_{eff}}$ [kW]	739,0	1084,0	1456,0	1822,0	1900,0
L_{Aeq} [dB]	54,3	55,0	56,4	58,5	58,1
L_n [dB]	40,2	41,3	42,3	43,3	43,7
$L_{Aeq,c}$ [dB]	54,1	54,8	56,2	58,4	57,9
L_{WA} [dB]	100,7	101,4	102,8	104,9	104,5
U_c [dB]	0,7	0,8	0,7	0,7	0,7

¹ There were no values of κ -corrected measured wind speed above 9,38 m/s where the corresponding power output was more than 95% of rated power.

REpower Dokumenten-Nummer		Rev.
D-2.2-VM.SM.07-C		A
Freigabe	Datum	
TR	06.04.2004	



Summary of results of the noise emission measurement, in accordance with IEC 61400-11, of a WTGS of the type **REpower MM82**

Recalculation of $L_{WA,P}$ for different hub heights in dB(A) (WS at a height of 10 m) **:

Hub height [m]	$L_{WA,P}$ (6 m/s)	$L_{WA,P}$ (7 m/s)	$L_{WA,P}$ (8 m/s)	$L_{WA,P}$ (9 m/s)	$L_{WA,P}$ (9,38 m/s)
69	100,8	101,4	103,1	104,8	104,4
80	100,9	101,5	103,5	104,4	104,4
90	101,0	101,6	103,9	104,4	104,4
100	101,0	101,8	104,1	104,4	104,4

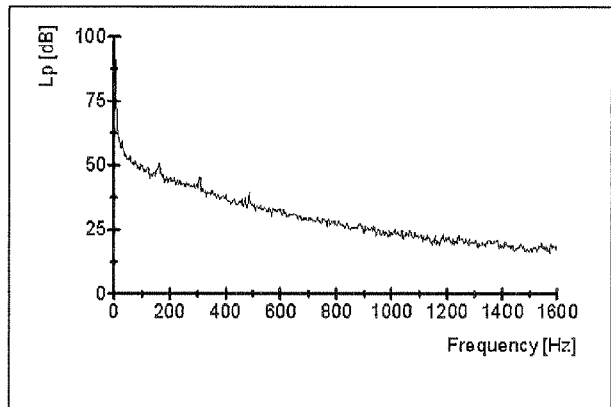
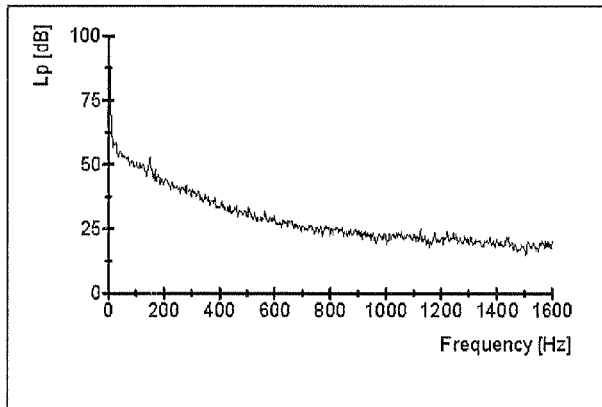
A direct recalculation of the tonality is not possible, as other acoustic effects may arise due to the changed geometry of the tower.

Third octave sound pressure spectra in dB(A) for the wind speed in 10 m height corresponding to the maximum sound power level given on page 1:

1/3 octave freq. [Hz]	50	63	80	100	125	160	200	250	315	400	500	630
L_{pA} (9 m/s)	77,5	81,7	85,8	89,4	92,3	93,8	95,9	95,8	95,3	95,2	93,4	92,4
1/3 octave freq. [Hz]	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
L_{pA} (9 m/s)	91,6	90,8	90,5	91,0	89,4	87,2	84,2	81,9	77,2	73,0	66,1	59,4

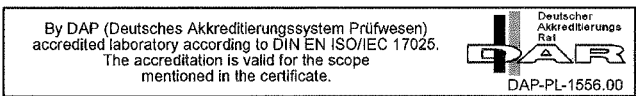
Tonality according to IEC 61400-11/Ed.2:

Representative FFT - Spectra (left 8 m/s and right 9,38 m/s at a height of 10 m):



WS in 10 m Höhe [m/s]	6,0	7,0	8,0	9,0	10,0
Freq. of tone, f [Hz]	-	-	-	-	-
Tonality, ΔL_k [dB]	-17,0	-15,4	-16,3	-17,0	-17,1
Audibility, $\Delta L_{a,k}$ [dB]	-14,4	-13,3	-14,0	-14,4	-14,4

	REpower Dokumenten-Nummer Rev. D-2.2-VM.SM.07-C A	-GB	
Engineer: Dipl.-Ing. J. Dedert	Freigabe Datum TR 06.04.2004	Checked: Dipl.-Ing. A. Trautsch	



Sound Power Levels - WTG and Estimated Standard Conditions

WTG:	S88/2100	Rated Power:	2100kW	Generator:	Single Generator
Hub Height (m):	80	Power Control:	Pitch	Blade:	AE43
Rotor Diameter (m):	88	Number of Rotor Blades:	3 (upwind)		
Air Density (kg/m³):	1.225	Tower Type:	Tubular steel		
Est. Wind Shear:	0.16	Rated RPM:	15.6		

Hub Height Wind Speed (m/s)	4.2	5.6	7.0	8.4	9.8	11.2	12.6	13.9	15.3	16.7
10m AGL Wind Speed (m/s)	3	4	5	6	7	8	9	10	11	12
A-Weighted Sound Power Level (dBA)	103.8	104.5	105.1	105.6	106.0	106.3	106.5	106.6	106.6	106.5

1/3 Octave Band Data - A-Weighted Sound Power Level (dBA)										
Freq (Hz) Bin	10m agl Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
	m/s	m/s	m/s	m/s	m/s	m/s	m/s	m/s	m/s	m/s
16	59.7	60.5	61.8	61.7	62.4	61.7	61.9	62.0	62.0	61.9
20	59.8	60.5	61.8	61.7	62.4	61.6	61.8	61.9	61.9	61.8
25	63.2	63.9	65.4	65.2	65.6	65.2	65.4	65.5	65.5	65.4
31.5	66.6	67.3	69.0	68.7	68.8	68.9	69.1	69.2	69.2	69.1
40	72.5	73.2	74.3	74.9	74.0	74.4	74.6	74.7	74.7	74.6
50	74.6	75.3	76.6	77.0	74.5	75.7	75.9	76.0	76.0	75.9
63	75.7	76.4	76.7	78.1	76.3	75.9	76.1	76.2	76.2	76.1
80	78.0	78.7	80.7	81.9	81.4	81.7	81.9	82.0	82.0	81.9
100	82.1	82.8	84.3	86.6	85.2	85.8	86.0	86.1	86.1	86.0
125	84.0	84.7	86.2	87.9	87.9	88.5	88.7	88.8	88.8	88.7
160	85.9	86.6	88.2	89.3	90.7	91.3	91.5	91.6	91.6	91.5
200	88.3	89.0	90.9	92.7	94.1	94.7	94.9	95.0	95.0	94.9
250	90.6	91.3	92.9	94.4	95.3	96.0	96.2	96.3	96.3	96.2
315	92.5	93.2	94.2	96.0	96.7	97.4	97.6	97.7	97.7	97.6
400	93.4	94.1	95.0	96.6	96.9	97.5	97.7	97.8	97.8	97.7
500	93.9	94.6	95.2	96.8	96.8	97.0	97.2	97.3	97.3	97.2
630	94.8	95.5	95.9	96.8	96.4	96.3	96.5	96.6	96.6	96.5
800	94.8	95.5	95.4	95.7	94.8	94.6	94.8	94.9	94.9	94.8
1000	95.0	95.7	95.6	96.1	94.8	94.7	94.9	95.0	95.0	94.9
1250	94.0	94.7	94.6	93.1	93.5	94.0	94.2	94.3	94.3	94.2
1600	92.1	92.8	93.4	87.7	93.5	94.1	94.3	94.4	94.4	94.3
2000	89.0	89.7	91.1	85.3	91.0	91.0	91.2	91.3	91.3	91.2
2500	84.9	85.6	87.1	84.3	87.8	88.0	88.2	88.3	88.3	88.2
3150	80.6	81.3	84.3	79.8	84.1	84.8	85.0	85.1	85.1	85.0
4000	75.1	75.8	82.2	78.1	78.4	80.2	80.4	80.5	80.5	80.4
5000	72.2	72.9	78.8	75.5	75.9	76.3	76.5	76.6	76.6	76.5
6300	67.1	67.8	74.6	70.9	72.6	72.5	72.7	72.8	72.8	72.7
8000	63.4	64.1	69.2	66.7	69.1	68.9	69.1	69.2	69.2	69.1
10000	57.4	58.1	64.2	62.2	66.9	66.0	66.2	66.3	66.3	66.2
12500	53.3	54.0	56.4	57.5	63.3	62.5	62.7	62.8	62.8	62.7
16000	50.3	51.0	52.2	53.0	55.4	54.6	54.8	54.9	54.9	54.8
20000	47.8	48.5	48.9	49.3	49.1	49.1	49.3	49.4	49.4	49.3
	103.8	104.5	105.1	105.6	106.0	106.4	106.6	106.7	106.7	106.6

1 Octave Band Data - A-Weighted Sound Power Level (dBA)										
Freq (Hz) Bin	10m agl Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
	m/s	m/s	m/s	m/s	m/s	m/s	m/s	m/s	m/s	m/s
62.5	81.9	82.6	83.5	85.0	84.0	84.2	84.4	84.5	84.5	84.4
125	89.0	89.7	91.3	92.8	93.3	93.9	94.1	94.2	94.2	94.1
250	95.6	96.3	97.6	99.3	100.3	100.9	101.1	101.2	101.2	101.1
500	98.8	99.5	100.2	101.5	101.5	101.7	101.9	102.0	102.0	101.9
1000	99.4	100.1	100.0	99.9	99.2	99.2	99.4	99.5	99.5	99.4
2000	94.4	95.1	96.0	90.8	96.1	96.5	96.7	96.8	96.8	96.7
4000	82.1	82.8	87.1	82.9	85.6	86.5	86.7	86.8	86.8	86.7
8000	69.2	69.9	76.1	72.9	75.3	75.0	75.2	75.3	75.3	75.2
	103.8	104.5	105.1	105.6	106.0	106.3	106.5	106.6	106.6	106.5

Sound Power Data: Commercial Warranty Value at 12/7/2005. Calculated from initial S88 noise measurements.

Test conditions -wind shear coeff. estimate of 0.16, standard air density, 10% site turbulence, Clean Blades, No Ice/Snow on blades, No Damage to Leading Edge, Terrain to IEC 61400-12, Inflow Angle: 0+/-2 Deg. Should site conditions vary substantially from these values the actual sound power level output may also vary.

* N.B. Manufacturer is currently undergoing extensive field testing to IEC 61400-11.