PRODUCT DATA

PULSE Wind Turbine Sound Power Determination according to IEC 61400–11 Type 7914

Wind turbine noise is an increasingly important environmental issue throughout the world. International standards are constantly being developed to ensure consistency and accuracy in the measurement and analysis of noise emitted by wind turbine generator systems.

PULSE™ Wind Turbine Sound Power Determination according to IEC 61400-11 Type 7914 allows you to measure the sound power of wind turbines and their component parts according to edition 2.1 from 2006 and edition 3.0 from 2012.

Uses and Features

Uses

- Wind turbine manufacturers can define and verify/validate acoustic emission performance
- Wind turbine purchasers can check the expected acoustic emission performance of new or refurbished units
- Planners and consultants can calibrate or validate their calculated environmental noise maps for single wind turbines or extensive wind farms

Features

- Measures operational and background noise with simultaneous CPB and FFT analysis
- Determines tonality
- Flexible interface to turbine and weather data
- PULSE LabShop-based system gives access to other PULSE LabShop analysis packages (licenses permitting)

Edition 3.0

- Determines the sound power of wind turbines according to IEC 61400-11 2012 edition 3.0
- Plot of all measured data pairs containing measured total noise and background noise
- Plot of all measured total noise versus electrical power data
- Table and plot of sound power spectrum in 1/3 octaves for each bin centre wind speed
- Table showing total noise and background noise

Edition 2.1

- Determines the sound power of wind turbines according to IEC 61400-11 2006 edition 2.1 and fulfils the requirements of FGW-Richtlinie rel. 18 (Fördergesellschaft Windenergie Technischen Richtlinie für Windenergie)
- Spectra for sound power and sound pressure for each wind bin

Brüel & Kjær

Brüel & Kjær has developed a number of applications for the measurement, analysis and reporting of acoustic emission of wind turbines (Table 1). Type 7914 deals with wind turbines with a maximum power output greater than 100 kW. Both edition 2.1 and edition 3.0 of the IEC standard are supported to fulfil the requirements of different countries.

Table 1 *Current standards for acoustic measurements on wind turbines and the corresponding Brüel & Kjær PULSE applications*

	PULSE Wind Turbines Sound Power Determination Type 7914		**PULSE Small Wind Turbine Acoustic Sound Testing**		
Standard	**IEC 61400–11, edition 2.1**	**IEC 61400–11, edition 3.0**	**BWEA**	**AWEA**	**IEC Annex F**
Wind Turbine Type	Not restricted to wind turbines of a particular size or type		Applies to wind turbines with a rotor swept area of 200 m^2 or less (rotor diameter 16 m or 52 ft for horizontal axis turbines)		Applies to wind turbines with a maximum power output of less than 100 kW

A typical system incorporates a portable LAN-XI data acquisition unit (Type 3056-A-040), one Type 4189 microphone and preamplifier, a DC Signal Converter Box (to interface the turbine parameters and the weather parameters to the auxiliary channels), one LAN-XI Battery Type 2831-A and a laptop PC, see Fig. 1. With PULSE, simultaneous CPB and FFT analyses can be made in real time on the laptop PC and the portability of the system enables it to be easily transported to sites around the world.

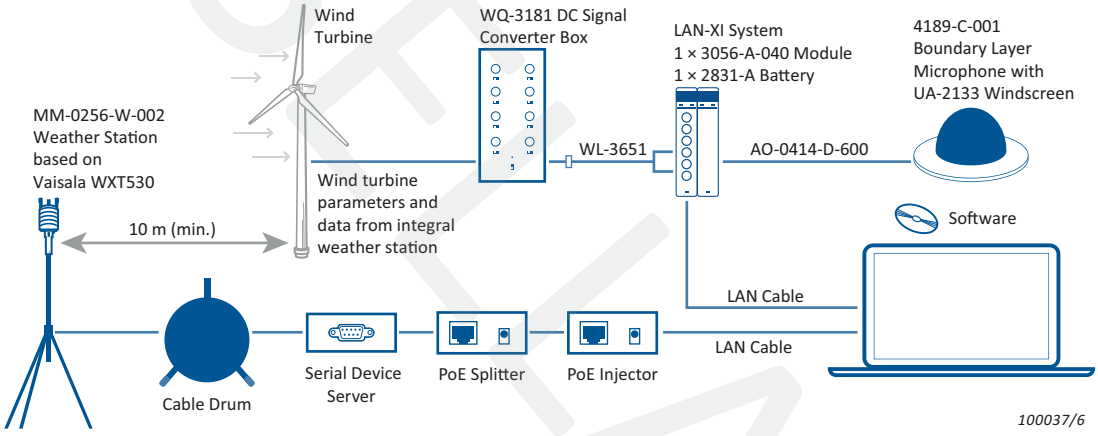


Fig. 1
Wind turbine sound power determination according to IEC 61400-11, typical system

System Setup

To determine the sound power of a wind turbine, it is necessary to place the microphone at the downwind reference position, according to the standard, and measure the main operating parameters. The position of the microphone is determined by the wind turbine height, the blade diameter and the wind direction. Other optional directions are allowed.

The data from the microphone is measured together with other parameters, such as wind direction, wind speed and turbine power output. The results are analysed in PULSE and a report produced.

During the measurements, Type 7914 permanently monitors the wind speed and direction to determine whether enough data has been acquired in the necessary wind classes, known as “bins”, to fulfil the standard. This means that you can optimize the time spent at the measurement site.

The main differences between the two editions of the standard are that in edition 2.1, the calculations are based on at least 3 × 1 minute measurements, whereas in edition 3.0, at least 10 × 10 second measurements are required. Furthermore, in edition 2.1, the width of the wind bins is 1 m/s and in edition 3.0 it is 0.5 m/s.

For further information, refer to IEC 61400-11, which specifies all the parameters and measurements relevant to the measurement of wind turbine sound power. A complete solution for this application can be supplied from the customized projects department.

Non-acoustic Measurements

According to IEC 61400-11, the wind speed measurements can be determined by one of two methods:

- **Method 1:** Determination of the wind speed from the electric output and power curve of the turbine. This is the preferred method and mandatory for certification and declaration measurements. During background noise measurements, the wind speed must be measured with an anemometer at a height of at least 10 m.
- **Method 2:** Determination of wind speed with an anemometer at a height of between 10 m and hub height.

According to IEC 61400-11 edition 3.0, the power curve must be used to determine wind speed. Anemometer measurements with the wind turbine in operation in edition 3.0, must be based on an anemometer situated on the nacelle.

DC Signal Converter Box

The electrical power and weather data from the turbine and data from the anemometer (weather station) can be in many formats. DC signals are dealt with via a converter box (customized product). For serial data (CAN) or a digital protocol, a customized solution can be supplied.

Weather Station

The weather station, based on Vaisala WXT560, is a customised product for the measurement of wind speed and wind direction. In IEC 61400-11, the following weather station specifications are given:

- **Anemometer:** The anemometer and its signal processing equipment shall have a maximum deviation from the calibration value of ±0.2 m/s in the wind speed range from 4 m/s to 12 m/s. It will be capable of measuring the average wind speed over time intervals synchronized with the acoustic measurements
- **Wind Direction Transducer:** The wind direction transducer shall be accurate to within ±6°

The Vaisala weather station can provide a wind speed accuracy of ±0.3 m/s in the wind speed range from 0 to 35 m/s and a wind direction of ±3°. It also measures temperature, atmospheric pressure and relative humidity.

Secondary Windscreen

A secondary windscreen is recommended by IEC 61400-11. The influence of Windscreen for Boundary Layer Microphone UA-2133 is included in the PULSE transducer database.

Fig. 2 *Windscreen for Boundary Layer Microphone UA-2133*

Fig. 3 *Secondary windscreen removed to reveal microphone Type 4189 fitted with the primary windscreen*

Acoustic Measurements

Type 7914 software guides you through the acoustic measurement procedure. Once you have made the measurement, you can then determine the following information about the noise emission from the wind turbine at various wind speeds:

- apparent sound power level (that is, equivalent continuous A-weighted sound pressure level)
- 1/3-octave band levels
- wind turbine noise and background noise in the form of narrow band measurements
- tonality
- impulsivity

Optional measurements may include directivity, infrasound and low-frequency noise.

Typical Measurement Interface

Fig. 4 to Fig. 7 show the typical interface when using Type 7914 during a measurement.

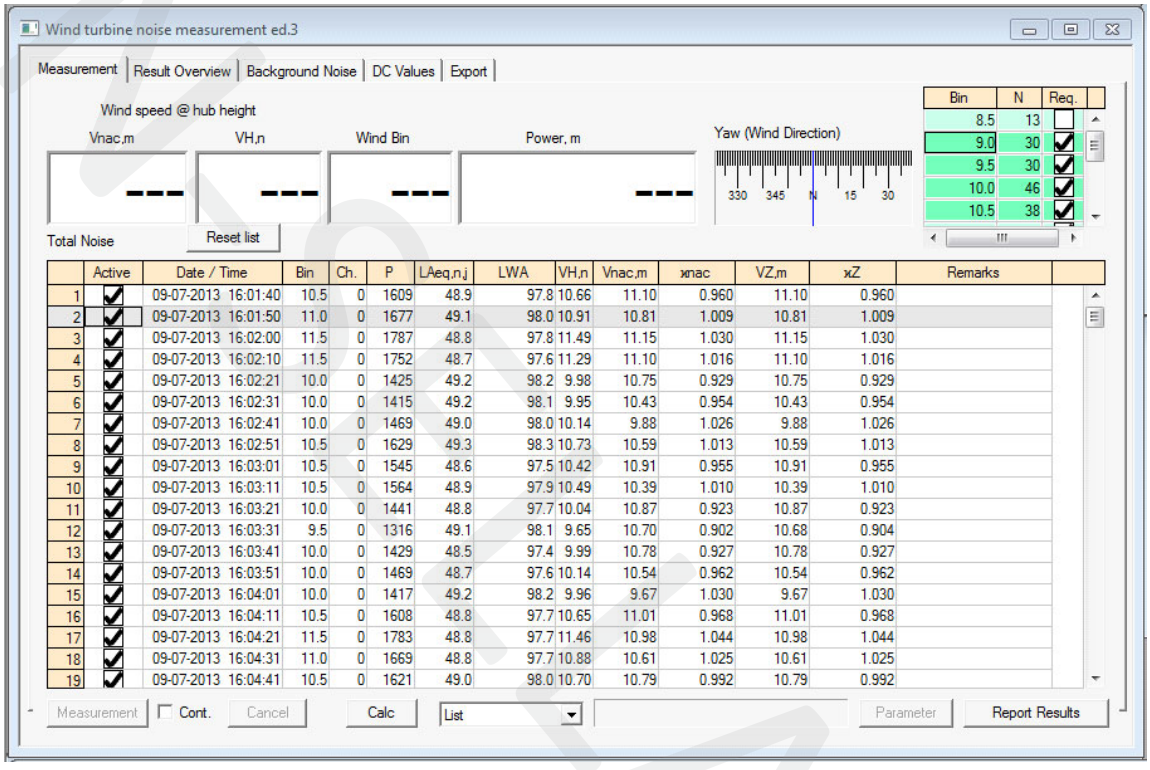


Fig. 4
Typical measurement with indication of the number of measurements per wind bin

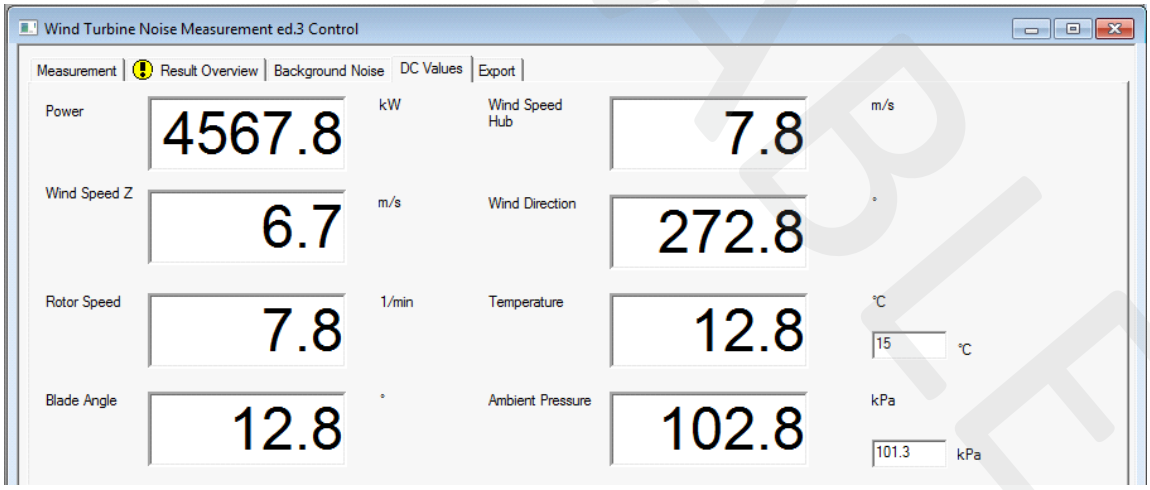


Fig. 5
Example of the DC Values tab showing typical values during a measurement

Fig. 6
Example of the Characteristics Environmental Measurements tab showing typical values during a measurement

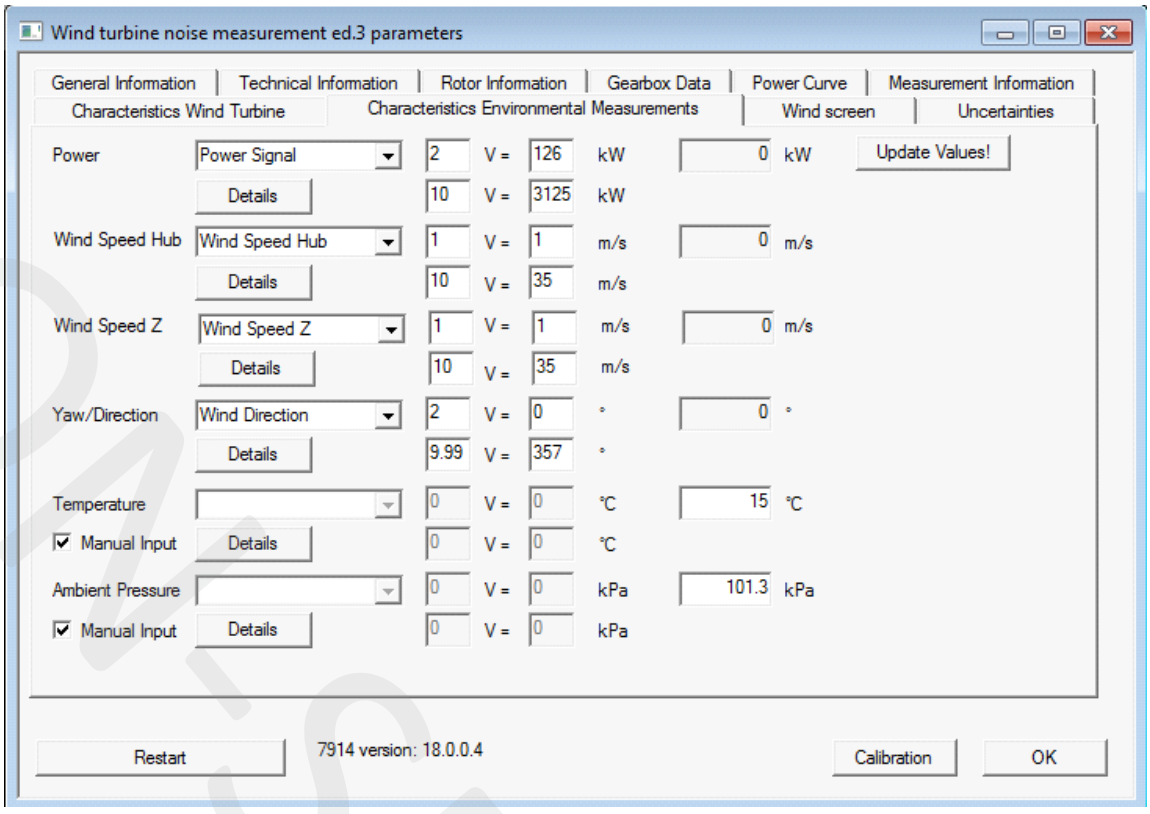
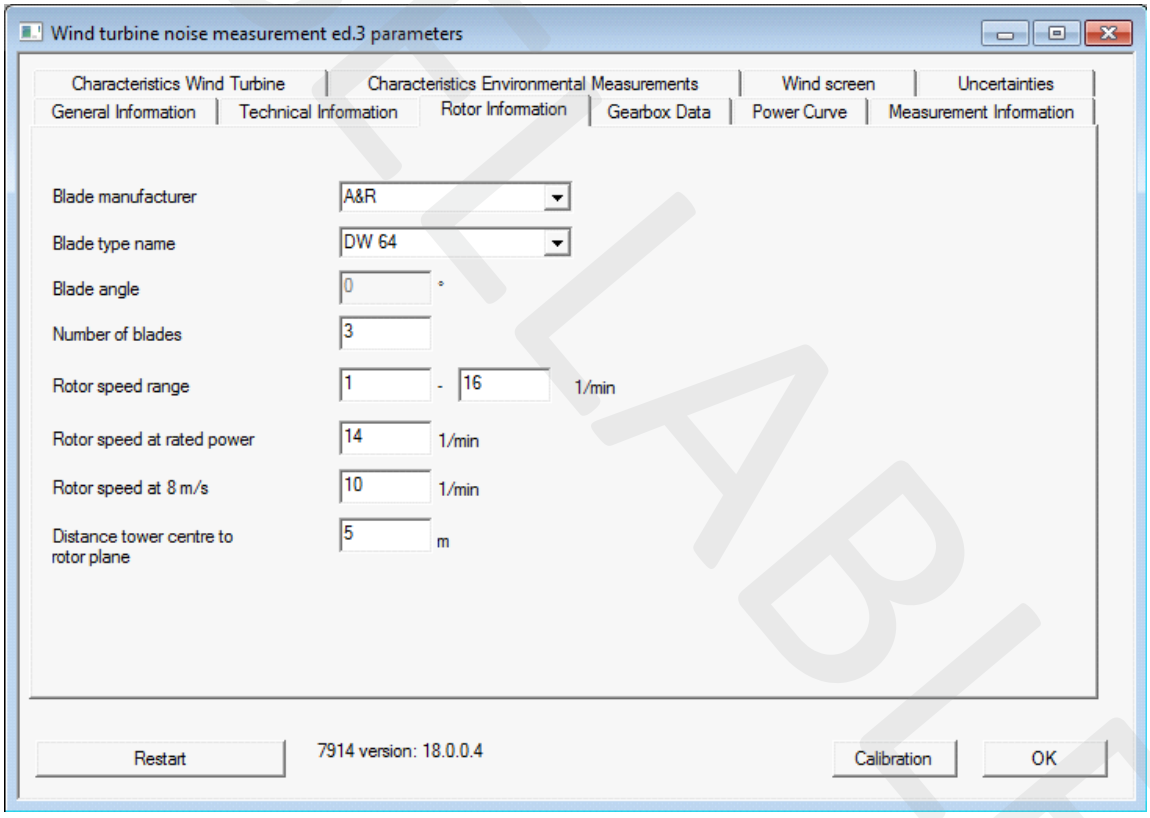


Fig. 7
Example of the Rotor Information tab showing typical values



When the measurement procedure is completed, Type 7914 allows you to produce a report according to IEC 61400-11 edition 3.0, including an overview page (see Fig. 8) with the apparent sound power levels $L_{WA,k}$ at bin centre wind speeds at hub height and at 10 m height; plots of all measured data pairs of measured total noise and background noise; table and plot of sound power spectrum in 1/3-octaves for each bin centre wind speed; tonal audibility and frequency for each identified tone.

Fig. 8
Edition 3.0; overview page from a typical report

Wind turbine noise emission test report

According to IEC 61400 Part 11: "Wind turbines - Acoustic noise measurement techniques", edition 3

Overview page

Excerpt from the test report

on sound emission from the wind turbine type Turbine Type

General information		Technical data	
Wind turbine manufacturer	**Turbine Manufacturer**	Rated power (generator):	**2500**
	Street 1	Rotor diameter:	**80**
	12345 City	Hub height above ground:	**100**
Serial number:	**1234**	Tower design:	**Tube**
Turbine location:	**N/S: 0.00 E/W: 0.00**	Power control:	**Pitch**

Additional data for rotor		Additional data for gearbox and generator	
Blade manufacturer:	**Blade Manufacturer**	Gearbox manufacturer:	**Gearbox Manufacturer**
Blade type designation:	**Blade Type**	Gearbox type designation:	**Gearbox Type**
Blade pitch:		Generator manufacturer:	**Generator Manufacturer**
Number of blades:	**3**	Generator type designation:	**Generator Type**
Rotor speed range:	**10,00 - 20,00 1/min**	Generator rated speed:	**0 - 0 1/min**

Power curve test report:

Bin	j (T)	j (B)	$L_{WA,k}$	$^{*}L_{WA,k}$	$L_{PT,k}$	$^{*}L_{PT,k}$	$L_{PB,k}$	$^{*}L_{PB,k}$	V_k	$^{S}V_k$	$^{*}V_k$	$^{*}com_{Pk}$	Remarks
7,5	5	2	95,9 dB	0,781 dB	47,1 dB	0,747 dB	33,2 dB	1,226 dB	7,54 m/s	0,060 m/s	0,283 m/s	0,289 m/s	j total noise < 10
8,0	13	2	96,2 dB	0,557 dB	47,5 dB	0,520 dB	35,5 dB	0,493 dB	7,95 m/s	0,043 m/s	0,283 m/s	0,286 m/s	
8,5	13	7	96,7 dB	0,541 dB	48,0 dB	0,506 dB	35,8 dB	0,503 dB	8,55 m/s	0,040 m/s	0,283 m/s	0,286 m/s	
9,0	30	28	96,9 dB	0,612 dB	48,3 dB	0,562 dB	37,1 dB	0,586 dB	9,02 m/s	0,027 m/s	0,283 m/s	0,284 m/s	
9,5	30	23	97,4 dB	0,623 dB	48,7 dB	0,593 dB	35,3 dB	0,407 dB	9,49 m/s	0,030 m/s	0,283 m/s	0,284 m/s	
10,0	46	16	97,9 dB	0,648 dB	49,1 dB	0,619 dB	35,6 dB	0,482 dB	9,98 m/s	0,021 m/s	0,283 m/s	0,284 m/s	
10,5	38	8	98,1 dB	0,592 dB	49,4 dB	0,558 dB	36,8 dB	0,657 dB	10,51 m/s	0,023 m/s	0,283 m/s	0,284 m/s	
11,0	19	7	98,3 dB	0,513 dB	49,6 dB	0,483 dB	36,9 dB	0,761 dB	10,97 m/s	0,027 m/s	0,322 m/s	0,323 m/s	
11,5	27	3	98,5 dB	0,579 dB	49,7 dB	0,557 dB	35,4 dB	0,616 dB	11,50 m/s	0,027 m/s	0,337 m/s	0,338 m/s	
12,0	10		98,7 dB	0,443 dB	49,8 dB	0,443 dB			11,94 m/s	0,038 m/s	0,412 m/s	0,414 m/s	No bgd. noise corr.
12,5	13		98,8 dB	0,534 dB	49,8 dB	0,534 dB			12,53 m/s	0,047 m/s	0,283 m/s	0,287 m/s	No bgd. noise corr.
13,0	13		98,6 dB	0,582 dB	49,7 dB	0,582 dB			12,99 m/s	0,031 m/s	0,283 m/s	0,285 m/s	No bgd. noise corr.
13,5	9		99,1 dB	0,736 dB	50,1 dB	0,736 dB			13,37 m/s	0,017 m/s	0,283 m/s	0,283 m/s	No bgd. noise corr.
Results related to 10 m height													
6,0	56	37	96,5 dB	0,804 dB	48,0 dB	0,714 dB	37,6 dB	1,137 dB	8,66 m/s	0,062 m/s	0,283 m/s	0,289 m/s	
7,0	114	47	97,8 dB	0,736 dB	49,1 dB	0,701 dB	35,8 dB	0,378 dB	10,03 m/s	0,039 m/s	0,283 m/s	0,286 m/s	
8,0	56	10	98,4 dB	0,681 dB	49,7 dB	0,645 dB	36,7 dB	0,718 dB	11,40 m/s	0,050 m/s	0,347 m/s	0,350 m/s	
9,0	35		98,8 dB	0,571 dB	49,8 dB	0,571 dB			12,92 m/s	0,061 m/s	0,283 m/s	0,289 m/s	No bgd. noise corr.

This excerpt from the test report is only valid in connection with the manufacturer's certificate dated xx.xx.xxxx. These information do not replace the above mentioned test report (especially not in combination with prediction regarding sound immission).

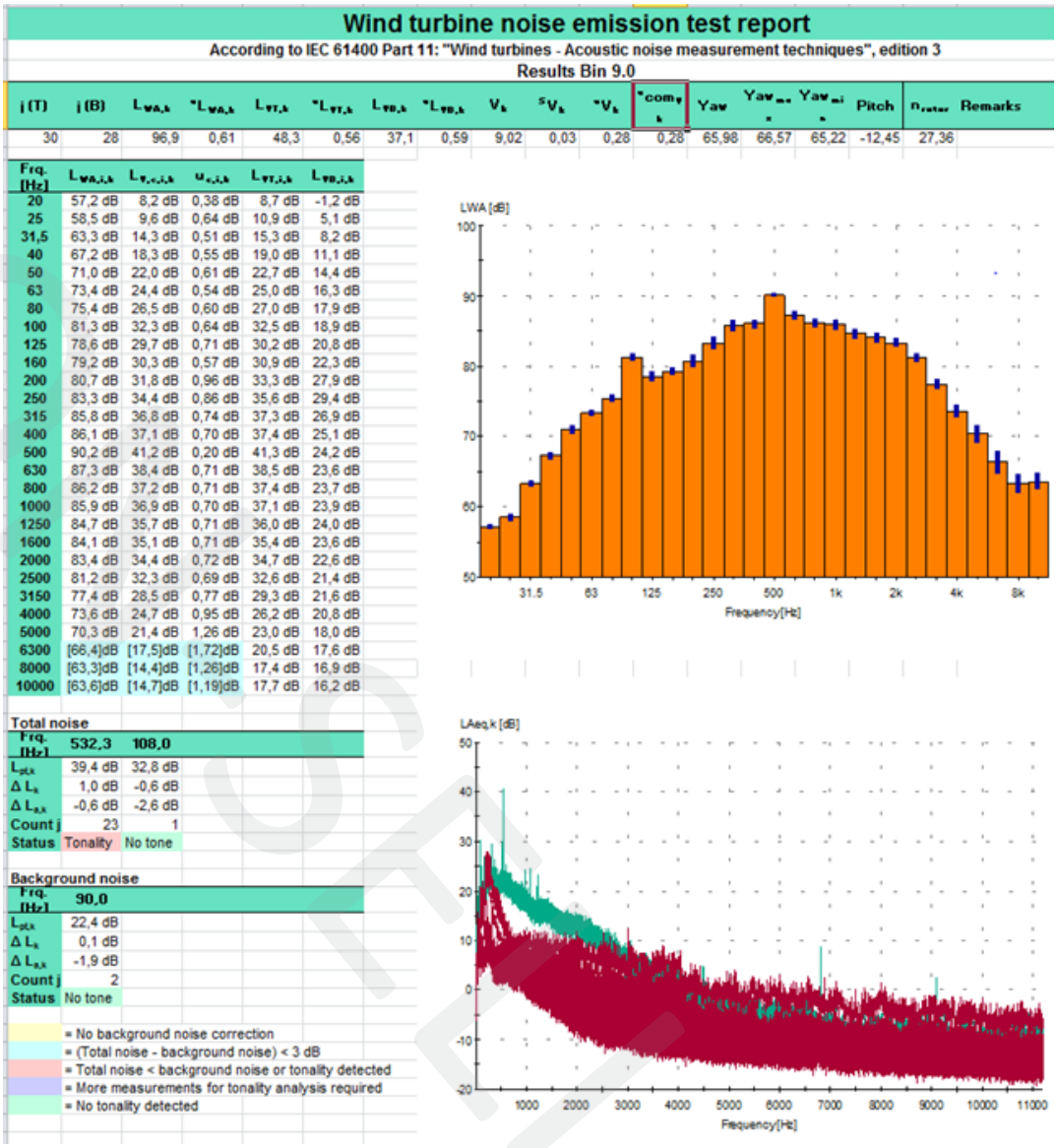
Remarks:

Measured by:

Date 29-07-2013

Fig. 9
Edition 3.0; excerpt of report showing:
Upper: *L_{Aeq} (equivalent continuous A-weighted sound pressure level) vs VH,n (wind speed at hub height H at speed n)*
Middle: *L_{Aeq} vs power generated in kW*
Lower: *Wind speed (VP,n) derived from the power curve vs wind speed at height Z, (VZ,m)*

Fig. 10
Edition 3.0; results from wind bin 9.0 m/s



Wind turbine noise emission test report

According to IEC 61400 Part 11: "Wind turbines - Acoustic noise measurement techniques", edition 3

Results Bin 9.0

j (T)	j (B)	$L_{WA,k}$	$*L_{WA,k}$	$L_{VT,k}$	$*L_{VT,k}$	$L_{TB,k}$	$*L_{TB,k}$	V_k	$*V_k$	$*V_k$	$*comp_k$	Yaw	$Yaw_{...}$	$Yaw_{...}$	Pitch	n_{rotor}	Remarks
30	28	96,9	0,61	48,3	0,56	37,1	0,59	9,02	0,03	0,28	0,28	65,98	66,57	65,22	-12,45	27,36	

Frq. [Hz]	$L_{WA,j,k}$	$L_{V,...,j,k}$	$u_{...,j,k}$	$L_{VT,j,k}$	$L_{TB,j,k}$
20	57,2 dB	8,2 dB	0,38 dB	8,7 dB	-1,2 dB
25	58,5 dB	9,6 dB	0,64 dB	10,9 dB	5,1 dB
31,5	63,3 dB	14,3 dB	0,51 dB	15,3 dB	8,2 dB
40	67,2 dB	18,3 dB	0,55 dB	19,0 dB	11,1 dB
50	71,0 dB	22,0 dB	0,61 dB	22,7 dB	14,4 dB
63	73,4 dB	24,4 dB	0,54 dB	25,0 dB	16,3 dB
80	75,4 dB	26,5 dB	0,60 dB	27,0 dB	17,9 dB
100	81,3 dB	32,3 dB	0,64 dB	32,5 dB	18,9 dB
125	78,6 dB	29,7 dB	0,71 dB	30,2 dB	20,8 dB
160	79,2 dB	30,3 dB	0,57 dB	30,9 dB	22,3 dB
200	80,7 dB	31,8 dB	0,96 dB	33,3 dB	27,9 dB
250	83,3 dB	34,4 dB	0,86 dB	35,6 dB	29,4 dB
315	85,8 dB	36,8 dB	0,74 dB	37,3 dB	26,9 dB
400	86,1 dB	37,1 dB	0,70 dB	37,4 dB	25,1 dB
500	90,2 dB	41,2 dB	0,20 dB	41,3 dB	24,2 dB
630	87,3 dB	38,4 dB	0,71 dB	38,5 dB	23,6 dB
800	86,2 dB	37,2 dB	0,71 dB	37,4 dB	23,7 dB
1000	85,9 dB	36,9 dB	0,70 dB	37,1 dB	23,9 dB
1250	84,7 dB	35,7 dB	0,71 dB	36,0 dB	24,0 dB
1600	84,1 dB	35,1 dB	0,71 dB	35,4 dB	23,6 dB
2000	83,4 dB	34,4 dB	0,72 dB	34,7 dB	22,6 dB
2500	81,2 dB	32,3 dB	0,69 dB	32,6 dB	21,4 dB
3150	77,4 dB	28,5 dB	0,77 dB	29,3 dB	21,6 dB
4000	73,6 dB	24,7 dB	0,95 dB	26,2 dB	20,8 dB
5000	70,3 dB	21,4 dB	1,26 dB	23,0 dB	18,0 dB
6300	[66,4]dB	[17,5]dB	[1,72]dB	20,5 dB	17,6 dB
8000	[63,3]dB	[14,4]dB	[1,26]dB	17,4 dB	16,9 dB
10000	[63,6]dB	[14,7]dB	[1,19]dB	17,7 dB	16,2 dB

Total noise

Frq. [Hz]	532,3	108,0
$L_{pt,k}$	39,4 dB	32,8 dB
ΔL_k	1,0 dB	-0,6 dB
$\Delta L_{a,k}$	-0,6 dB	-2,6 dB
Count j	23	1
Status	Tonality	No tone

Background noise

Frq. [Hz]	90,0
$L_{pt,k}$	22,4 dB
ΔL_k	0,1 dB
$\Delta L_{a,k}$	-1,9 dB
Count j	2
Status	No tone

= No background noise correction
= (Total noise - background noise) < 3 dB
= Total noise < background noise or tonality detected
= More measurements for tonality analysis required
= No tonality detected

Reporting for IEC 61400-11 Edition 2.1

When the measurement procedure is completed, Type 7914 allows you to produce a report according to IEC 61400-11 edition 2.1 to document your findings.

A typical report contains the configuration of the wind turbine and its operating conditions, including wind turbine details, operating details, rotor, gear and generator details (see Fig. 11). For each integer wind speed from 6 to 10 m/s (for each measurement series) the acoustic data includes the A-weighted sound power and any identified tones, plus the impulsivity.

Fig. 11
Edition 2.1; excerpt from a typical report, according to FGW (Fördergesellschaft Windenergie) Technischen Richtlinie für Windenergie, on sound emission from a wind turbine

General information		Technical data (PI)	
Wind turbine manufacturer	Windstrasse 1	Rated power (generator):	1650 kW
	50000 Köln	Rotor diameter:	90.00 m
		Hub height above ground:	100 m
Serial number:	XY123456	Tower design:	
Turbine location:	N/S: 1234180.00 E/W: 4562121.00	Power control:	Pitch
Additional data for rotor (PI)		**Additional data for gearbox and generator (PI)**	
Blade manufacturer:	GLASFIBER	Gearbox manufacturer:	POWERGEAR
Blade type designation:	ABC 12.5	Gearbox type designation:	ABCD-123
Blade pitch:		Generator manufacturer:	POWERGEN
Number of blades:	3	Generator type designation:	ABC-12345-A
Rotor speed range:	9,60 - 16,90 1/min	Generator rated speed:	744 - 1310 1/min

Power curve test report: Dok. Nr. 12345_A11_DE, Rev. 1

	Bin reference		Sound emission values		Remarks
	Standardized wind speed at 10 m height	Effective electrical power			
Sound power level $L_{WA,P}$	6 m/s	929 kW	104.0 dB(A)		Signal to noise ratio = 2.7 dB(A)!
	7 m/s	1,314 kW	104.1 dB(A)		Signal to noise ratio = 2.2 dB(A)!
	8 m/s	1,575 kW	104.1 dB(A)		Signal to noise ratio = 2.3 dB(A)!
	8.3 m/s (95%)	1,613 kW	104.1 dB(A)		
	10 m/s				
Near field tonality penalty K_{TN}	6 m/s	929 kW	1 dB	at 3236.0 Hz	
	7 m/s	1,314 kW	0 dB		
	8 m/s	1,575 kW	1 dB	at 3276.0 Hz	
	9 m/s				
	10 m/s				
Near field impulse penalty K_{IN}	6 m/s	929 kW	2 dB		
	7 m/s	1,314 kW	1 dB		
	8 m/s	1,575 kW	2 dB		
	9 m/s				
	10 m/s				

1/3 octave sound power level at v10 = 7.0 m/s

Frequency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P}$	70.9	71.0	78.3	84.6	83.6	82.1	88.1	89.3	89.7	89.6	92.4	87.8
Frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P}$	86.8	90.0	87.4	87.8	87.1	87.2	86.8	84.2	81.4	76.8	71.2	68.0

1/1 octave sound power level at v10 = 7.0 m/s

Frequency	63	125	250	500	1000	2000	4000	8000
$L_{WA,P}$	79.7	88.3	93.9	95.1	93.1	92.1	89.4	78.3

This excerpt from the test report is only valid in connection with the manufacturer's certificate dated xx.xx.xxxx. Thi information does not replace the above mentioned test report (especially not in combination with prediction regarding sound immission).

Remarks:

Measured by:

Date 03/06/2013

Signature Signature

Spectra from a Typical Report According to IEC 61400-11 Edition 2.1

Fig. 12 and Fig. 13 show spectra for the wind bin at 8 m/s from a typical report.

Fig. 12 *Sound Power L_{WA} [dB]*

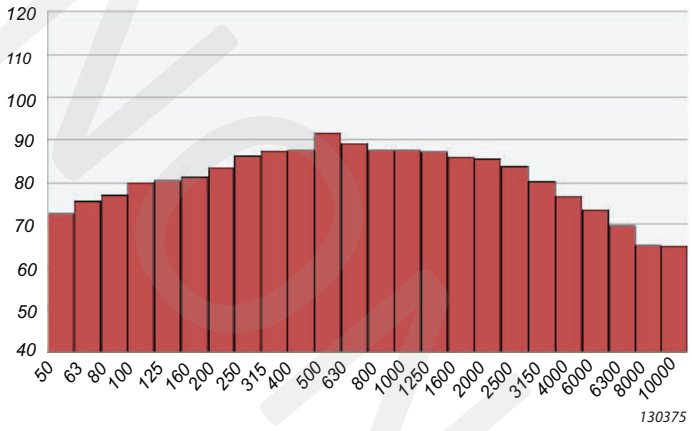
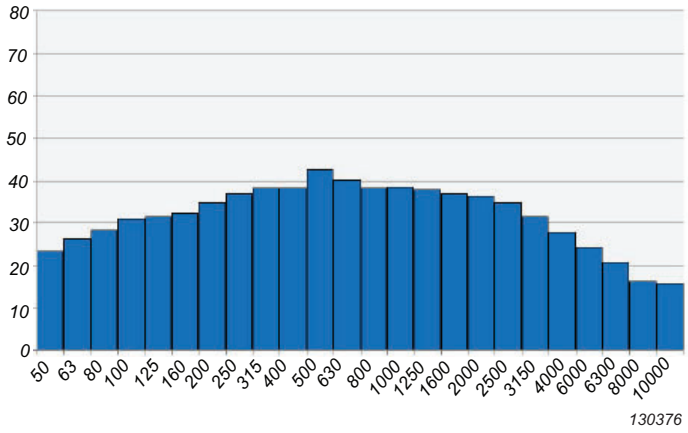


Fig. 13 *Sound Pressure $L_{Aeq,c}$ [dB]*



All levels are background noise corrected. L_{WA} is also corrected by −6 dB to account for the approximate pressure doubling that occurs for the sound level measurements on a ground board plate, while $L_{Aeq,\,c}$ is not.

Type 7914 fulfils the following requirements:

MEASUREMENTS
Measurement Positions: Records site layout, conditions (roughness)
Acoustic Measurements: Measures CPB, FFT, overall operational and background noise
Non-acoustic Measurements: Matches turbines with DC signals (aux. channels); includes an interface for the anemometer (hardware required); includes an interface for receiving output power signals from the turbine (hardware required); obtains wind speed from the power curve; includes an interface for the wind direction transducer (hardware required)
Parameters Measured: Wind speed, correction for background noise, apparent sound power levels, 1/3 octave levels, tonality, impulsivity

REPORTING
Generated in Microsoft® Excel®

Type 7914 System with LAN-XI Module Type 3056

A Windows®-based application for use with PULSE LabShop. The software is delivered via DVD or USB

SYSTEM REQUIREMENTS
- Microsoft® Windows® 10 Pro or Enterprise (x64) with either Current Branch (CB) or Current Branch for Business (CBB) servicing model
- Microsoft® Office 2016 (x32 or x64) or Office 2019 (x32 or x64)
- Microsoft® SQL Server® 2017 or SQL Server® 2019

Minimum Licence Requirements:
- BK Connect Data Viewer Type 8400
- BK Connect Hardware Setup Type 8401
- BK Connect Data Processing Type 8403

Note: Microsoft SQL Server 2017 is included in BK Connect installation

RECOMMENDED SYSTEM CONFIGURATION
- Intel® Core™ i7, 3 GHz processor or better
- 32 GB RAM
- 480 GB Solid State Drive (SSD) with 20 GB free space, or better
- 1 Gbit Ethernet network*
- Microsoft® Windows® 10 Pro or Enterprise (x64) with CB
- Microsoft® Office 2016 (x32)
- Microsoft® SQL Server® 2017
- Screen resolution of 1920 × 1080 pixels (full HD)

POWER REQUIREMENTS
Fulfils the requirements of ISO 7637-1 and 7637-2 with batteries
DC Input: 10 to 32 V DC
Power Consumption:
- **DC Input:** <15 W
- **Max.:** 26 W (while charging battery)
- **Ext. Power Connector:** LEMO coax., FFA.00.113, ground on shield

* A dedicated data acquisition network (LAN or WAN) is recommended. A network that only handles data from the front end improves the stability of the data

FRONT END
The software automatically detects the front-end hardware connected and configures the system. If IEEE 1451.4 capable transducers (with standardized TEDS) are being used, these are also detected and attached automatically to the correct channel of the input module

For information about LAN-XI data acquisition modules, see product data BP 2215

LAN-XI BATTERY TYPE 2831-A
Typical Operating Time: >7 hours with single module
Charging Time: 2 hours with included mains charger (ZG-0469)

ACOUSTIC NOISE EMISSION (AT 1 M)
Silent operation to 35 °C (95 °F) when not charging batteries. When charging batteries, fan operation may start at a lower ambient temperature

DC OUTPUT
+5 V ±0.5 V; max. 0.4 A (1 A fused)
+12 V ±1.0 V; max. 0.4 A (1 A fused)
Connector: LEMO FGG.00.302

DIMENSIONS

Type 3056-A-040:
- Height: 132.6 mm (5.22″)
- Width: 27.5 mm (1.08″)
- Depth: 248 mm (9.76″)
- Weight: 750 g (1.65 lb)

Type 2831-A:
- Height: 132.6 mm (5.22″)
- Width: 27.5 mm (1.08″)
- Depth: 248 mm (9.76″)
- Weight: 1.0 kg (2.2 lb)

MICROPHONE
½″ Prepolarized Free-field Microphone Type 4189
Nominal Open-circuit Sensitivity: 50 mV/Pa
(corresponding to −26 dB re 1 V/Pa) ±1.5 dB
Capacitance: 14 pF (at 250 Hz)

DC SIGNAL CONVERTER BOX
The converter box (customized product) is used to condition the signals from the turbine and weather station to the auxiliary channel. Switchable between voltage and current inputs of 0 to 10 V, or 4 to 20 mA†

† The 4 to 20 mA range was chosen because many wind speed and wind direction sensors output 4 to 20 mA signals, and the turbine outputs the same power signal

Type 7914-X*	**Wind Turbine Sound Power Determination according to IEC 61400-11**

SOFTWARE MAINTENANCE AND SUPPORT AGREEMENTS

M1-7914-X*	Agreement for Type 7914

REQUIRED SOFTWARE

Type 8400-X*	BK Connect Data Viewer
Type 8401-X*	BK Connect Hardware Setup
Type 8402-X*	BK Connect Time Data Recorder
Type 8403-X*	BK Connect Data Processing

Typical System

SOFTWARE

Type 7914-X*	Wind Turbine Sound Power Determination according to IEC 61400-11
M1-7914-X*	Software and Maintenance Support Agreement for Type 7914

Please note: Requires BK Connect Types 8400, 8401, 8402 and 8403

HARDWARE

WB-3635	Connection Box (Weather Station to WB-3181)
AO-0087-x-yyy†	Single screened, general purpose coaxial cable with BNC connectors (connects WB-3635 to WQ-3181)
WQ-3181	DC Signal Converter Box, excluding 12 V power supply
ZG-0432	Power Supply without Primary Plug UA-2037
UA-2037	Primary Plug, World-wide Kit
WL-3651	Cable, connects WQ-3181 to Type 3056-A-040
Type 3056-A-040	LAN-XI 4-ch. Input/HS-Tacho plus 8-ch. Aux. Module 51.2 kHz (Mic, CCLD, V), including LAN-XI Front Panel UA-2110-040
Type 2831-A	LAN-XI Battery Module, including Mains Charger ZG-0469 and Adapter ZH-0686
Type 4189-C-001	½″ Prepolarized Free-field Microphone including Preamplifier Type 2669-C and TEDS
UA-2133	Windscreen for Boundary Layer Microphone
AO-0414-x-yyy†	Special braided-shield microphone cable with 7-pin LEMO-1B connectors (connects Type 4189-C-001 to Type 3056-A-040)
Type 4231	Sound Calibrator Class 1

Weather Station‡

MM-0256-W-002	Weather Station
WQ-3413	Serial Device Server
WQ-3414	PoE Splitter and PoE Injector

* X is licence type, either X = N, where the licence is node-locked to PC host ID or dongle; or X = F, where the licence is floating, that is, shared via a licence server

† Please specify cable length when ordering: x = D (decimetres) or M (metres); yyy = length in decimetres or metres

‡ Customised product

Optional Software

Type 8400-A-X*	BK Connect Data Viewer (advanced)
Type 8404-X*	BK Connect Data Processing Specialist (instead of Type 8403)

Calibration Services

ANA-LNXI-CAI	Accredited Initial Calibration, LAN-XI Modules
CALI-S-CAI	Accredited Initial Calibration, sound level calibrators
MIC-TEDS-CAI	Accredited Initial Calibration, microphones with mounted preamplifier and TEDS programming
WQ-1256-W-CAI	Accredited Initial Calibration of Weather Station

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