Technical data sheet

General design conditions

ENERCON E-160 EP5 E3 R1 / 5560 kW wind energy converter

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Applicable documents

The titles of the documents listed are the titles of the original language versions, with translations of these titles in brackets where applicable. The titles of superordinate standards and guidelines are indicated in the original language or as an English translation. Document IDs always refer to the original language versions. If the document ID does not contain a revision, the most recent revision of the document applies. This list contains documents concerning optional components if necessary.

Higher-level standards and guidelines

Document ID	Document
DIBt 2012	Guideline on wind energy converters, influences and stability analyses for tower and foundation, Deutsches Institut für Bautechnik (DIBt), Berlin, October 2012 version
DIN EN ISO 12944	Paints and varnishes – Corrosion protection of steel structures by protective paint systems
IEC 61400-1:2019	Wind energy generation systems – Part 1: Design Requirements

Associated documents

Document ID	Document
D0178786	Technische Beschreibung Sturmregelung (Technical description of storm control)

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List of abbreviations

HST	Hybrid steel tower
HT	Hybrid tower
ST	Steel tower

1 Introduction

This document lists the main design parameters based on the official applicable standards. In addition, it lays out the main requirements for potential installation sites with respect to the structural stability of the wind energy converter.

The parameters and values listed in this document do not make any statements with respect to the general or site-specific power performance and/or noise emissions of the wind energy converter. This information is available in separate documentation.

2 Technical specifications of wind energy converter

Tab. 1: Tower versions

Type	Tower version
Hybrid steel tower	E-160 EP5 E3-HST-120-FB-C-01
Hybrid tower	E-160 EP5 E3-HT-160-ES-C-01 E-160 EP5 E3-HT-166-ES-C-01
Steel tower	E-160 EP5 E3-ST-99-FB-C-01/02

Tab. 2: Data

Parameter	Value	Unit
Rotor diameter	160	m
Nominal active power	5560	kW
Cut-in wind speed	2.5	m/s
Nominal wind speed (simulated value, power-optimised operation)	13.5	m/s
Start of storm control[1] (12-second mean)	22	m/s
Cut-out wind speed[2] (10-minute mean)	28	m/s
Minimum operating speed[3]	4.4	rpm
Speed setpoint[4]	9.6	rpm
Design service life for wind class IIIA	20	Years
Design service life for wind class S[5]	25	Years

[1] Further information concerning the ENERCON storm control feature is available in the following document D0178786 ‘Technische Beschreibung Sturmregelung’ (Technical description of storm control).

[2] With activated storm control.

[3] Rotational speed at which power feed starts.

[4] Rotational speed maintained by the control system during full load operation. It is slightly greater than the nominal speed at which nominal power is first achieved. This ensures that, in the event of brief negative fluctuations of the wind speed, the rotational speed does not drop below the speed range required for achieving nominal power. With gusty winds, the rotational speed can briefly exceed the speed setpoint.

[5] Wind class S fulfils the conditions of wind class IIIA for operating and ultimate loads for a design service life of 20 years, and the conditions of wind class IIB for operating loads and wind class IIIA for ultimate loads for a design service life of 25 years.

3 Wind energy converter design

3.1 Certified/target design requirements

The wind energy converter has been/will be certified for the following design requirements laid out in DIBt 2012 and IEC 61400-1:2019 (4th edition) zertifiziert. These design requirements must be taken into consideration for the intended installation site.

Tab. 3: Certified/target design requirements, tower-specific for a design service life of 20 years

Parameter	E-160 EP5 E3-ST-99-FB-C-01/02	E-160 EP5 E3-HST-120-FB-C-01	E-160 EP5 E3-HT-160-ES-C-01	E-160 EP5 E3-HT-166-ES-C-01
IEC wind class (4th edition)	III	III	III	III
Turbulence category acc. to IEC (4th edition)	A	A	A	A
DIBt wind zone/ terrain category	WZ S GK S	WZ S GK S	WZ S GK S	WZ S GK S
50-year extreme wind speed at hub height (10-minute mean) acc. to IEC (4th edition) in m/s	37.50	37.50	37.50	37.50
Corresponds to a load equivalent of approx. (3-second gust) in m/s	52.50	52.50	52.50	52.50
50-year extreme wind speed at hub height (10-minute mean) acc. to DIBt 2012 in m/s	37.50	37.50	37.50	37.50
Annual average wind speed at hub height acc. to IEC (4th edition) in m/s	7.50	7.50	7.50	7.50
Annual average wind speed at hub height acc. to DIBt 2012 in m/s	7.50	7.50	7.50	7.50
c values of extreme turbulence model	2	2	2	2

Parameter	E-160 EP5 E3-ST-99-FB-C-01/02	E-160 EP5 E3-HST-120-FB-C-01	E-160 EP5 E3-HT-160-ES-C-01	E-160 EP5 E3-HT-166-ES-C-01
Form parameter of Weibull function k	2	2	2	2
Wind shear	0.2	0.2	0.2	0.2

Tab. 4: Certified/target design requirements, tower-specific for a design service life of 25 years

Parameter	E-160 EP5 E3-ST-99-FB-C-01/02	E-160 EP5 E3-HST-120-FB-C-01	E-160 EP5 E3 R1-HT-160-ES-C-01	E-160 EP5 E3-HT-166-ES-C-01
IEC wind class (4th edition)	S[1]	S[1]	S[1]	S[1]
Turbulence category acc. to IEC (4th edition)	S	S	S	S
DIBt wind zone/ terrain category	WZ S GK S	WZ S GK S	WZ S GK S	WZ S GK S
50-year extreme wind speed at hub height (10-minute mean) acc. to IEC (4th edition) in m/s	37.50	37.50	37.50	37.50
Corresponds to a load equivalent of approx. (3-second gust) in m/s	52.50	52.50	52.50	52.50
50-year extreme wind speed at hub height (10-minute mean) acc. to DIBt 2012 in m/s	37.50	37.50	37.50	37.50
Annual average wind speed at hub height acc. to IEC (4th edition) in m/s	8.50	8.50	8.50	8.50
Annual average wind speed at hub height acc. to DIBt 2012 in m/s	8.50	8.50	8.50	8.50
c values of extreme turbulence model	2	2	2	2
Form parameter of Weibull function k	2	2	2	2
Wind shear	0.2	0.2	0.2	0.2

[1] Wind class S fulfils the conditions of wind class IIIA for operating and ultimate loads for a design service life of 20 years, and the conditions of wind class IIB for operating loads and wind class IIIA for ultimate loads for a design service life of 25 years.

Tab. 5: General certified/target design requirements

Parameter	Value		
Turbulence intensity	Wind speed at hub height in m/s	Turbulence intensity in %	
		A	B
	2	56.80	49.70
	4	34.40	30.10
	6	26.93	23.57
	8	23.20	20.30
	10	20.96	18.34
	12	19.47	17.03
	14	18.40	16.10
	16	17.60	15.40
	18	16.98	14.86
	20	16.48	14.42
	22	16.07	14.06
	24	15.73	13.77
	26	15.45	13.52
	28	15.20	13.30
Maximum flow inclination	8°		
Normal temperature range	-10 °C to +40 °C		
Extreme temperature range	-20 °C to +50 °C		
Relative air humidity	≤ 95 %		
Maximum solar irradiance	1000 W/m^2		
Standard air density	1.225 kg/m^3		

The load calculations (operating and extreme loads) include a safety factor which corresponds to the load case group.

3.2 Other site requirements

Tab. 6: Other site requirements

Parameter	Value
Distance between wind energy converters on the wind farm[1]	≥ 5 x rotor diameter in main wind direction (turbulence category A)
	≥ 3 x rotor diameter in less frequent wind directions (turbulence category A)
Maximum elevation above sea level[2]	800 m
Survival temperature[3]	-40 °C
Site acc. to corrosion protection class	Steel tower, outside: C4 (acc. to DIN EN ISO 12944)
	All interior components not directly exposed to the weather: comparable C3 'high' (acc. to DIN EN ISO 12944)

[1] These specifications are to be considered general reference values. The influence of the wake effect must be assessed for each individual project.

[2] Sites at higher elevations are generally also feasible; however, a project-specific assessment is required.

[3] For situations with limited stress.

3.3 Application of modified design parameters

The site conditions specified in this document are general reference values. It is also possible to install and operate the wind energy converter at sites where conditions are different. However, this requires additional project-specific assessments.

The wind energy converter is equipped with an internal closed-loop control system consisting of various monitoring sensors and mechanisms (e.g. sensors for temperature, vibrations, oscillations and loads). If the wind energy converter closed-loop control system recognises that the conditions at the site are outside the acceptable range, the main control system of the wind energy converter automatically takes the appropriate protective measures (e.g. transition to a reduced-power operating mode, or stopping operation).