GE Renewable Energy

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Technical Documentation Wind Turbine Generator Systems 2.0-2.8-116/127 - 60Hz

Technical Description and Data

Rev. 08 - Doc-0072750 - EN 2020-12-17

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Document Revision Table

Rev.	Date (YYYY/MM/DD)	Affected Pages	Change Description
07	2020=08-06	12	MODIFIED "section 3.4 from C4 to C3 for Hub internal and external corrosion protection and C4 to C5 for external corrosion".
08	2020-12-17	11	ATTACHED drawings related to Section 3 Technical Data

1 Introduction

This document summarizes the technical description and specifications of the GE Renewable Energy (GE) 2MW Platform wind turbine generator systems (applicable for systems from 2.0 MW to 2.8 MW).

2 Technical Description of the Wind Turbine and Major Components

The wind turbine is a three bladed, upwind, horizontal-axis wind turbine with a rotor diameter of 116 or 127m. The turbine rotor and nacelle are mounted on top of a tubular tower with the following hub heights:

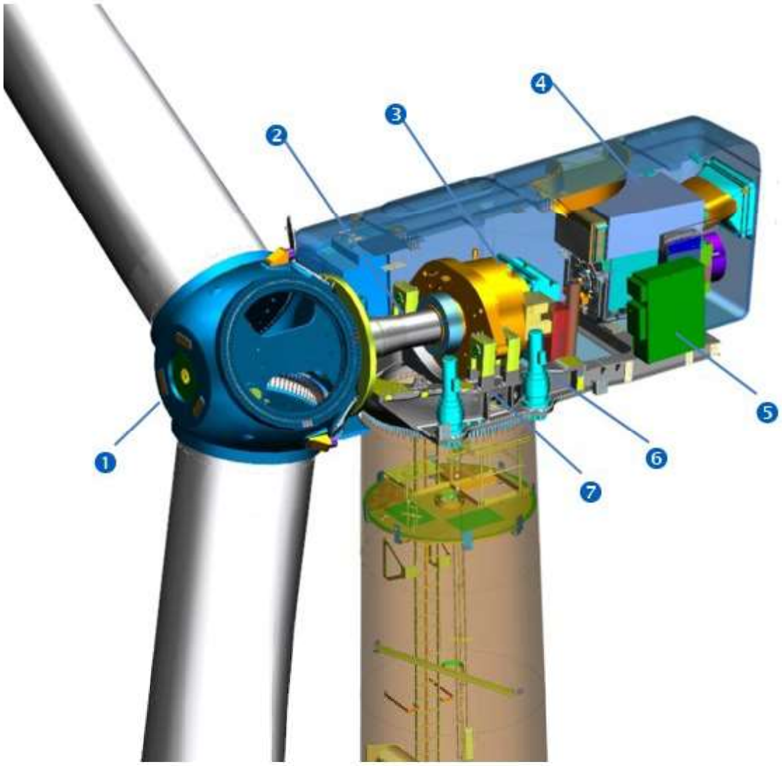
	2.0-2.4-116	2.5-116	2.7-116	2.2-2.8-127
50 Hz	80/94 m	N/A	N/A	N/A
60 Hz	80/90/94 m	80/90/94 m	90 m	89/90*/114

Table 1: 2MW Platform hub heights for 50/60Hz markets, from 2.0-2.8 MW; *

The Wind Turbine Generator (WTG) employs active yaw control (designed to steer the machine with respect to the wind direction), active blade pitch control (designed to regulate turbine rotor speed), and a generator/power electronic converter system.

The wind turbine generator features a distributed drive train design consisting of a main shaft bearing, gearbox, and generator. Figure 1 shows these, as well as other major components such as the bedplate, yaw drives and an electrical panel box.

* Brazil Only



1 – Hub

2 – Main shaft

3 - Gearbox

4 - Generator

5 – Electrical panel box

6 – Yaw drive

7 - Bedplate

Figure 1: GE Renewable Energy 2MW Platform wind turbine nacelle layout, for generator systems of 2.0-2.8 MW

2.1 Rotor

Two rotor diameter WTGs are offered: the 116m rotor and the 127m rotor WTGs. Rotor speed on the WTGs is regulated by a combination of blade pitch angle adjustment and generator/converter torque control. The rotor spins in a clock-wise direction under normal operating conditions when viewed from an upwind location.

Full blade pitch angle range is approximately 90°, with the 0° position being with the airfoil chord line flat to the prevailing wind. The blades being pitched to a full feather pitch angle of approximately 90° accomplishes aerodynamic braking of the rotor; whereby the blades "spill" the wind thus limiting rotor speed.

2.2 Blades

There are three rotor blades for each wind turbine generator. The airfoils transition along the blade span with the thicker airfoils being located in-board towards the blade root (hub) and gradually tapering to thinner cross sections out towards the blade tip.

The values below are typically needed to perform shadow casting calculations.

	Rotor Diameter	
	116m	127m
Longest chord	3.946m	3.900m
Chord at 0.9 x rotor radius	1.090m	1.000m

Low Noise Trailing Edge (LNTE) are an optional feature for sites requiring reduced noise capability.

2.3 Blade Pitch Control System

The rotor utilizes three (one for each blade) independent electric pitch motors and controllers to provide adjustment of the blade pitch angle during operation. Blade pitch angle is adjusted by an electric drive that is mounted inside the rotor hub and is coupled to a ring gear mounted to the inner race of the blade pitch bearing (see Figure 1).

GE's active-pitch controller enables the wind turbine generator rotor to regulate speed, when above rated wind speed, by allowing the blade to "spill" excess aerodynamic lift. Energy from wind gusts below rated wind speed is captured by allowing the rotor to speed up, transforming this gust energy into kinetic energy which may then be extracted from the rotor.

Three independent back-up units are provided to power each individual blade pitch system to feather the blades and shut down the machine in the event of a grid line outage or other fault. By having all three blades outfitted with independent pitch systems, redundancy of individual blade aerodynamic braking capability is provided.

2.4 Hub

The hub is used to connect the three rotor blades to the wind turbine generator main shaft. The hub also houses the three electric blade pitch systems and is mounted directly to the main shaft. Access to the inside of the hub is provided through a hatch.

2.5 Gearbox

The gearbox in the wind turbine generator is designed to transmit power between the low-rpm turbine rotor and high- rpm electric generator. The gearbox is a multi-stage planetary/helical gear design. The gearbox is mounted to the machine bedplate. The gearing is designed to transfer torsional power from the wind turbine rotor to the electric generator. A parking brake is mounted on the high-speed shaft of the gearbox.

2.6 Bearings

The blade pitch bearing is designed to allow the blade to pitch about a span-wise pitch axis. The inner race of the blade pitch bearing is outfitted with a blade drive gear that enables the blade to be driven in pitch by an electric gear-driven motor/controller.

The main shaft bearing is a roller bearing mounted in a bearing cap arrangement.

The bearings used inside the gearbox are of the cylindrical and tapered roller type. These bearings are designed to provide bearing and alignment of the internal gearing shafts and accommodate radial and axial loads.

2.7 Brake System

The electrically actuated individual blade pitch systems act as the main braking system for the wind turbine generator. Braking under normal operating conditions is accomplished by feathering the blades out of the wind. Any single feathered rotor blade is designed to slow the rotor, and each rotor blade has its own back-up to provide power to the electric drive in the event of a grid line loss.

The wind turbine generator is also equipped with a mechanical brake located at the output (high-speed) shaft of the gearbox. This brake is only applied as an auxiliary brake to the main aerodynamic brake and to prevent rotation of the machinery as required by certain service activities.

2.8 Generator

The generator is a doubly-fed induction type. The generator meets protection class requirements of the International Standard IP 34 (duct ventilated). The generator is mounted to the generator frame and the mounting is designed so as to reduce vibration and noise transfer to the bedplate.

2.9 Flexible Coupling

Designed to protect the drive train from excessive torque loads, a flexible coupling is provided between the generator and gearbox output shaft. This coupling is equipped with a torque-limiting device sized to keep the maximum allowable torque below the maximum design limit of the drive train.

2.10 Yaw System

A ball bearing attached between the nacelle and tower facilitates yaw motion. Planetary yaw drives (with brakes that engage when the drive is disabled) mesh with the outside gear of the yaw bearing and steer the machine to track the wind in yaw. The yaw brakes prevent the yaw drives from experiencing peak loads from turbulent wind.

The controller activates the yaw drives to align the nacelle to the average wind direction based on the wind vane sensor mounted on top of the nacelle.

A cable twist sensor provides a record of nacelle yaw position and cable twisting. After the sensor detects excessive rotation in one direction, the controller automatically brings the rotor to a complete stop, untwists the cable by counter yawing of the nacelle, and restarts the wind turbine.

2.11 Tower

The wind turbine is mounted on top of a tubular tower. The tubular tower is manufactured in sections from steel plate. Access to the turbine is through a lockable steel door at the base of the tower. Service platforms are provided. Access to the nacelle is provided by a ladder and a fall arresting safety system is included. Interior lights are installed at critical points from the base of the tower to the tower top.

2.12 Nacelle

The nacelle houses the main components of the wind turbine generator. Access from the tower into the nacelle is through the bottom of the nacelle. The nacelle is ventilated. It is illuminated with electric light. A hatch in the nacelle roof towards the rotor end of the nacelle provides access to the blades and hub. The rotor can be secured in place with a rotor lock.

2.13 Anemometer, Wind Vane and Lightning Rod

An anemometer, wind vane and lightning rod are mounted on top of the nacelle housing. Access to these sensors is accomplished through a hatch in the nacelle roof.

2.14 Lightning Protection

The rotor blades are equipped with lightning receptors mounted in the blade. Please refer to GE Renewables Energy Lightning Protection Facility/Lightning Protection Zone Concept document for further details.

2.15 Wind Turbine Control System

The wind turbine machine can be controlled automatically or manually from either an interface located inside the nacelle or from a control box at the bottom of the tower. Control signals can also be sent from a remote computer via a Supervisory Control and Data Acquisition System (SCADA), with local lockout capability provided at the turbine controller.

Service switches at the tower top prevent service personnel at the bottom of the tower from operating certain systems of the turbine while service personnel are in the nacelle. To override any machine operation, Emergency-stop buttons located in the tower base and in the nacelle, can be activated to stop the turbine in the event of an emergency.

2.16 Power Converter

The wind turbine uses a power converter system that consists of a converter on the rotor side, a DC intermediate circuit, and a power inverter on the grid side.

The converter system consists of a power module and the associated electrical equipment. Variable output frequency of the converter allows operation of the generator.

3 Technical Data

Dimensioned outlined drawings are embedded in this document which can be opened and referenced for permitting.

3.1 Rotor

	2.0-2.7-116	2.2-2.8-127
Maximum power output	2000 to 2700 kW	2200 to 2820 kW
Diameter	116.5 m	127.184 m
Number of blades	3	3
Swept area	10,660 m^2	12,704 m^2
Rotor speed range	7.4 to 15.7 rpm	7.4 to 15.7 rpm
Rotational direction	Clockwise looking downwind	Clockwise looking downwind
Tip speed @ rated power	81.7 m/s to 85.4 m/s	85.1 m/s to 89.1 m/s
Orientation	Upwind	Upwind
Speed regulation	Pitch control	Pitch control
Aerodynamic brakes	Full feathering	Full feathering

3.2 Pitch System

	2.0-2.7-116	2.2-2.8-127
Principle	Independent blade pitch control	
Actuation	Individual electric drive	

3.3 Yaw System

	2.0-2.7-116	2.2-2.8-127
Yaw rate	0.5 degree/s	

3.4 Corrosion Protection

Atmospheric corrosion protection (corrosion categories as defined by ISO 12944-2:1998)				
50 & 60 Hz	**Standard**		**Enhanced (Option)**	
Recommended Climate	**Inland non-industrial areas**		**Coastal or industrial areas**	
Component	**Internal**	**External**	**Internal**	**External**
Blades	C-4	C-5	C-4	C-5
Tower shell coating	C-2	C-3	C-4	C-5M
Tower internal fasteners, tower stair fasteners	C-4	C-4	C-4	C-5
Hub	C-3	C-3	C-4	C-5
MachineHead Structure (Bedplate, Generator frame)	N/A	C-3	N/A	C-5
Drivetrain (Mainshaft, Pillowblock Gearbox)	N/A	C-3	N/A	C-5
Generator	N/A	C-3	N/A	C-5
Nacelle, hub fasteners	C-4	C-4	C-4	C-5
Automatic lubrication system (option for 2MW)	C-3	C-3	C-4	C-5

3.5 Tip Height

	2.0-2.7-116	**2.2-2.8-127**
80 m hub height	138.3 m (Not available on 2.7-116)	Not available
89 m hub height	Not available	152.072 m
90 m hub height	148.25 m	153.3 m (Brazil only offering)
94 m hub height	152.0 m (Not available on 2.7-116)	Not available
114 m hub height	Not available	178.092 m

4 Operational Limit

	2.0-2.7-116		2.2-2.8-127	
Height above sea level	Maximum 3000 m. See notes in section maximum standard ambient temperature below.		Maximum 3000 m. See notes in section maximum standard ambient temperature below.	
Minimum temperature (standard) operational/survival	Standard weather (STW): -15 °C / -20 °C Cold weather (CWE) (60Hz only): -30 °C/ -40 °C		Standard weather (STW): -15 °C / -20 °C Cold weather (CWE) (60Hz only): -30 °C/ -40 °C	
Maximum standard ambient temperature (operation / survival)	+40 °C / +50 °C The turbine has a feature reducing the maximum output, resulting in minimized turbine revolutions once the component temperatures approach predefined thresholds. This feature operates best at higher altitudes, as the heat transfer properties of air diminish with decreasing density. Please note that the units are not de-rated in respect to site conditions. The units' reactions related to this feature are based solely on sensor temperatures.		+40 °C / +50 °C The turbine has a feature reducing the maximum output, resulting in minimized turbine revolutions once the component temperatures approach predefined thresholds. This feature operates best at higher altitudes, as the heat transfer properties of air diminish with decreasing density. Please note that the units are not de-rated in respect to site conditions. The units' reactions related to this feature are based solely on sensor temperatures.	
Wind conditions according to IEC 61400 **(Design life 20 years)**	2.0-116	50 / 60 Hz (IECs) Vaverage = 8.0 m/s at 80 m HH Iref = 13.5 % with Ed3	2.2-127	60 Hz (IECs) Vaverage = 7.85 m/s at 80 m HH Iref = 12.9 % with Ed3
	2.1-116	50 / 60 Hz (IECs) Vaverage = 7.0 m/s at 80 m HH Iref = 12.9 % with Ed3	2.5-127	60 Hz (IECs) Vaverage = 7.85 m/s at 80 m HH Iref = 12.9 % with Ed3
	2.2-116	50 / 60 Hz (IECs) Vaverage = 7.0 m/s at 80 m HH Iref = 12.9 % with Ed3	2.8-127	60 Hz (IECs) Vaverage = 7.85 m/s at 80 m HH Iref = 12.9 % with Ed3
	2.3-116	50 / 60 Hz (IECs) Vaverage = 7.0 m/s at 80 m HH Iref = 12.9 % with Ed3		
	2.5-116	60 Hz (IECs) Vaverage = 8.0 m/s at 80 m HH Iref = 12.9 % with Ed3		
	2.7-116	60 Hz (IECs)		

	Vaverage = 8.0 m/s at 80 m HH Iref = 12.9 % with Ed3	
Maximum extreme gust (10 min) according to IEC 61400	50 / 60 Hz: STW and CWE: 38 m/s	60 Hz: STW and CWE: 40 m/s