TUGE60
Small wind turbine technical specification

This document is for potential project developers that plan to include TUGE60 small wind turbine in scope of their project. This document contains more detailed description of turbine components and functions, as well as additional information that can be useful for project planning.

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01.02.2022	1.0	Document created

Contents

1. TUGE60 general specification

TUGE60	
Rotor axis direction	Horizontal
IEC SWT Class	I (V_{ref}=50 m/s, V_{ave}=10 m/s, V_{gust}=70 m/s)
Rated power	60 kW
Rated wind speed	11 m/s
Cut-out wind speed	32 m/s
Rated rotation speed	56 rpm
Rotor diameter / area	16 m / 199 m^2
Blades	3, fixed angle, upwind, stall control and tip-brake
Ambient temperature	-25…+40°C
Generator type	asynchronous
Grid connection	Direct with reactive power compensation
Grid parameters	VDE-AR-N 4105 2011-8
Tower height / blade tip height	36 m / 44 m
Tower type	Steel, tubular tower with maintenance platform
Designed lifetime and maintenance interval	20 years / 5 years
Data connection	GPRS (OrbiScada) or Ethernet (Client SCADA)
Brakes	Stall, electro mechanic failsafe rotor brake, tip-brakes

Assumed Average Energy Production (AEP)

Yearly average wind speed m/s	Energy MWh
5	111
6	159,6
7	201,7
8	238
9	264,1
10	282,4
11	290,5

The main parts of the wind turbine are foundation, tower and nacelle with rotor, electric panels and cables necessary for energy transfer and turbine control. Electrical yaw gear is used for turbine nacelle rotation. In addition, a mechanical brake of nacelle rotation is used to avoid excessive mechanical forces to the gear. The turbine rotation speed is constant, blade tip-brakes activating and engaging the mechanical rotor brake. All these methods allow for safe operation and control of the turbine.

2. Faulty operation

During any faults two things can happen according to the specific scenario:

Hard stop – generator is disconnected from the grid simultaneously with applying shaft brake to the rotating shaft.

Tip brake over speed limitation – shaft brake is not applied to avoid fire in the nacelle and turbine brakes with blade tip brake activation. Tip brakes reset automatically once rotation speed is down to nominal.

Error list:

Error	Conditions	Stop	Reset
Wind speed instant	10 second average > 30 m/s	Hard	10 minute average below 25 m/s
Wind speed average	10 minute average > 25 m/s	Hard	10 minute average below 25 m/s
Anemometer	Faulty measurement	Hard	Manual
Yaw	Yawing too long or too slow or no signal	Hard	Manual
Untwist	Over 3 turns in either direction	Hard	Auto
No brake	30 seconds of braking	Tip	Manual
Generator temp	Generator temperature > 150 °C	Hard	Automatic
Cabinet temp	Cabinet temperature > 50 °C	Hard	Automatic
Overspeed	Rotor speed > 50 rpm	Hard	Automatic
Grid	Grid protection error	Hard	Automatic
Vibration	Vibration error	Hard	Manual
Manual stop	Manual input from emergency button	Hard	Manual

3. Safety systems

Main danger to the turbine is from overspeed events, when rotation speed is out of control. To prevent these, there are three separate systems to prevent that:

1. Special geometry of the blade that creates a stall effect and doesn't let rotor speed to grow over the limit. Special calculations were performed by blade manufacturer Olsen Wings (Denmark), and Denmark University of Technology (DDU).
2. Electromechanical rotor brake applies to rotor shaft and holds the turbine in place during danger. The brake is applied by default and is disengaged by the control system, so the rotor is always braked during grid failure event.
3. Every blade has a special tip-brake that activates at certain speed – because of excessive centrifugal force tips of each blade rotate perpendicular to the wind and slows the turbine down. This is unique and time-proven technology of blade manufacturer Olsen Wings (Denmark).

Control system monitors for all other signals in the system (temperatures, position and sensor feedback) and acts accordingly in case of failure.

4. Turbine grid connection

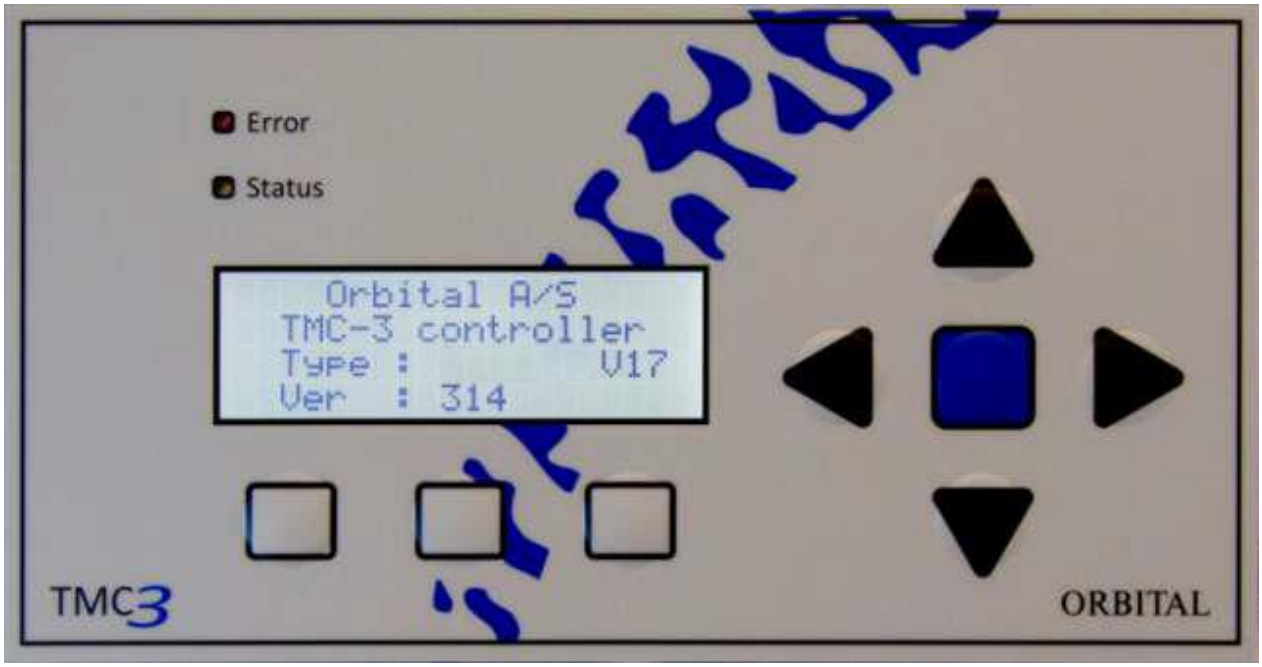
60 kW Generator is asynchronous generator from VEM (Germany.

60 kW generator is connected directly to the main shaft via gearbox.

Generated energy is fed to the grid directly via a thyristor coupling module, also system includes two-stage reactive power compensation device. System can be adapted to any grid code using transformers and grid relays.

5. Control system

TUGE60 utilizes TMC3 controller from Orbital A/S (Denmark) as its main user interface.



Monitoring submenus:

- Wind speed, power, rotor speed, mode (manual or auto), system status and operation status
- Grid feed state and control status
- Grid voltages (three phase)
- Grid currents (three phase)
- Grid power (three phase)
- Grid frequency (three phase)
- Grid protection state, uptime and software version
- Grid protection fault bit status
- Grid protection fault bit status

- Grid condition bit status
- Grid condition bit status
- Grid protection bit status
- Operation mode (manual or auto), brake state and stop type
- Brake shaft output status, input feedback status, brake time and brake time peak
- Yaw vane type, operation state, timer, yaw direction
- Yaw brake output status and input feedback status
- Counters for CW and CCW direction, yaw encoder input status and yaw direction status
- Yaw position encoder counter, position in degrees, turns and on a bar graph
- Energy counter for grid feed
- Turbine error free run hour counter, error hour counter and availability in %
- Power averages for 1, 10, 60 and 600 seconds
- Power peak averages for 1, 10, 60 and 600 seconds
- Wind speed averages for 1, 10, 60 and 600 seconds
- Wind speed peak averages for 1, 10,60 and 600 seconds
- Rotor and generator rpm speed
- Temperatures for generators and ambient
- Temperature for electrical cabinet
- Time and date
- GSM, TCP and overall connection statuses
- Connection status, IP address and service status
- APN and TCP connection counters
- Software versions for main board of the controller, display, counter and thyristor
- Information GSM modem
- Modem transmit and read data
- Controller mainboard software and firmware versions
- Digital inputs
- Digital outputs
- Vibration bands
- Vibration band error status
- Vibration sensor state, status and software version
- Vibration sensor parameter, master and sensor CRC and CAN comm. counter

Control submenus:

- Motor-start, manual stop or reset the turbine
- Toggle main or auto mode, rotate clockwise or counterclockwise

More information and logging can be accessed if the client wishes to connect the turbine to the Internet by installing a SIM card in the built-in modem.

Turbine has an optional motor start feature, when turbine can be started as a motor during low winds, which allows bringing the cut-in wind speed down. This feature is available in automatic and manual modes.

Positioning is available due to incremental encoder in the yaw system, which allows avoiding cable twist.

Yaw system is made by IMO especially for wind turbines, consists of two motors and each motor is individually braked during times between yawing.

Temperature of generator, gearbox, ambience and control cabinet are being monitored. Rotation speeds of generator and main shaft are being monitored.

Wind speed is measured by mechanical anemometer (speed is indicative, precise measurement is impossible due to interference of rotating blades) and wind direction is determined with mechanical wind vane (black/white system).

Vibration sensor signal is constantly monitored.

6. Maintenance

Yearly – visual check of general condition.

Every 5 years –gearbox oil change and filling of the grease pumps.

7. Initial cost

Full set price according to the latest price list in EUR EXW Tallinn, Estonia.

Additional costs:

1. Transport
2. Foundation
3. Installation equipment and machinery
4. Civil and grid works and permissions

Useful resource for wind data assessment:

https://globalwindatlas.info