

GP22-60

GP22-50

Wind Turbine Generator System Specification



Shanghai Ghrepower Green Energy Co., Ltd.

Modification record

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V0.01	Initial document creation	Wang Fang	2022/12/08
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1. Wind Turbine Generator System Overview

1.1 System Characteristic

- Low-speed permanent magnet generator, direct drive gearless transmission design.
- Active pitch control technology ensures output power stability in strong wind.
- Multiple safety protection for individual pitch, mechanical, electromagnetic brakes and active yawing.
- Equipped with low-speed magnet generator with full-power converter, suitable for multinational grid -tie system.
- Direct 400V to grid and connect to the nearby load distribution system, which is self-supply, self-consumption and sufficient electricity connected to grid, for efficient energy transmission.
- SCADA remote monitoring system is the feature of real-time monitoring, report statistics, fault diagnosis and integrated operation & maintenance management.
- Suitable for industrial park, seaport, oil-field, mine, village, expressway service area, etc.

1.2 Wind Turbine Brief Introduction

1.2.1 Overall appearance of WTG



Figure 1 GP22-50 wind turbine generator system outline diagram

1.2.2 Wind rotor

The wind rotor is used to convert the kinetic energy of the air into the mechanical energy of wind rotor. The wind turbine adopts a three-blade, upwind type which is actively adjusted through pitch mechanism. The blade material uses reinforced fiber glass.

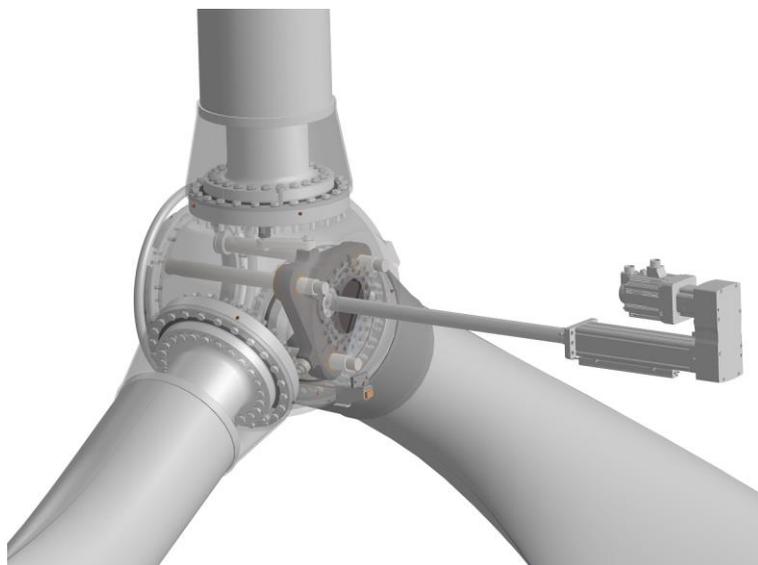
1.2.3 Nacelle

The nacelle is connected to generator and tower, which contains yawing transmission system, damper control system, wind turbine control system, sensors, wind measurement system, aviation warning system, staff passage, etc., as shown in the figure,



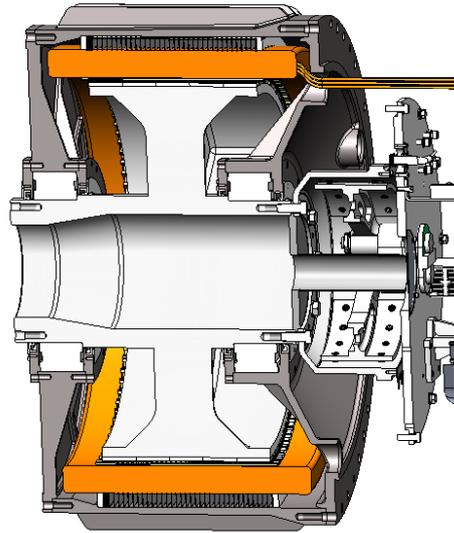
1.2.4 Three-blade synchronous pitch mechanism

Pitch of WTG adjusts the windward angle of blades, and its main functions are power adjustment and rotation speed control. It mainly includes hub, pitch reducer, drive motor, pitch controller, angle speed detection device, etc. The hub adopts a spherical structure, which has good castability and high strength, as shown in the left picture below:



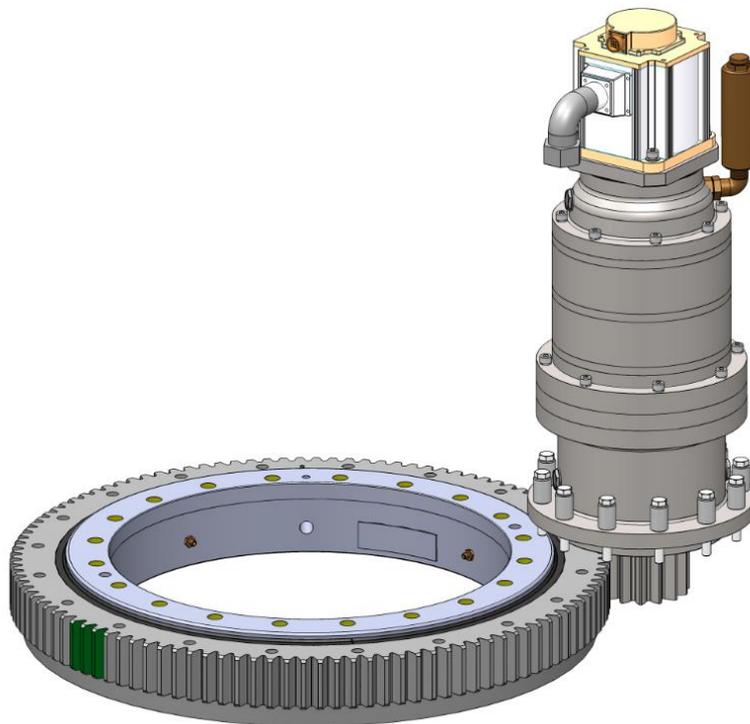
1.2.5 Generator & braking system

The generator converts the mechanical kinetic energy of wind rotor into electrical energy. It is composed of stator, rotor, brake disc, braking system and detection device. The main shaft of WTG is braked to realize blade braking, which is composed of brake disc and hydraulic braking system, as shown on the right above. As shown in the figure.



1.2.6 Yawing system

Wind turbine adopts active yawing to direct wind and consists of yaw drive devices, yaw angle detection device, twisting detection device and hydraulic brake. Yaw braking is accomplished by yaw reduction motor, which uses an electromagnetic brake.



1.2.7 Lubrication system

The lubrication system of WTG consists of automatic lubrication and manual lubrication. The yaw pivotal bearing and the front and rear main shaft lubrication of the generator are

independent automatic lubrication systems.

1.2.8 Tower

Tower mainly plays the role of supporting nacelle, generator and wind rotor. It consists of tower itself, ladder, lighting and ladder safety protection devices. Each floor of tower is equipped with a platform for installation and rest, etc.



2. System technical parameter

2.1 Wind turbine generator system parameter

Manufacturer	Shanghai Ghrepower Green Energy Co., Ltd	
Country of origin	China	
Parameter	Specs	
System model	GP22-60	GP22-50
Device model	FD22-60	FD22-50
Design standard	IEC61400-1, IEC S (reference NBT 31107-2017 D-III)	
Design class	IEC S(DIII A)	
Type	Permanent magnet direct drive, three blades, horizontal axis, upwind	
Design lifespan	20 years	
Rotor diameter	21.8m	
Hub height	≈32m	
Tower type	Tubular column	
Performance		
Power regulation	Pitch control	
Rated power	60kW	50kW
Sweep area per kilowatt	6.22 m ² /kW	7.46 m ² /kW
Rated rotation speed	66rpm	65rpm
Max rotation speed	75rpm	
Cut-in wind speed	3m/s	
Rated wind speed	9.5m/s	8.6 m/s
Cut-out wind speed	18m/s(10min), 22m/s(10s)	
Survival wind speed	52.5m/s	

2.2 Wind turbine component parameter

Weight	
Blade	3*260kg
Nacelle & generator	≈4t
Tower	10t@31.5m

Brake system	
Aerodynamic brake	Active pitch control
Mechanical brake	Mechanical main-shaft brake
Electromagnetic brake	Electronic dump load control
Yawing & untwisting	
Yawing mode	Electric
Untwisting mode	Auto untwisting
Angle of twisting	$\pm 1080^\circ$ (± 3 circles)
Control system	
Control system	Industrial PLC controller
Inverter type	Full-power inverter
Monitoring system	SCADA Cube 3.0
Generator	
Generator type	Permanent magnet
Drive mode	Direct box (gearless box)
Rated voltage	400Vac
Insulation grade	F class
Blade	
Blade material	Glass fiber (FRP)
Blade length	10.3m
Blade quantity	3
Tower	
Surface treatment	Anti-rust painting
Height	31.5m
Other	
Noise level	<58dBA (@43m)
Device position	Converter is placed into the bottom of tower. Others are placed inside of nacelle.
Lightening protection	Lightning receptors for blade tip connected to earth through loop. Anemometer and wind vane with separate lightning receptors.

2.3 Environment request

Environment temperature	
Working environment	-20°C ~ +50 °C
Storage environment	-30°C ~ +60 °C
Relative humidity	≤95 %
Elevation	≤2000m, > 2000m, derating operation
Generator protection class	IP54、ISO 12944-2 C5
Other environment request	Conform to standard of EC 60721-2-1
Ground resistance	≤ 4Ω

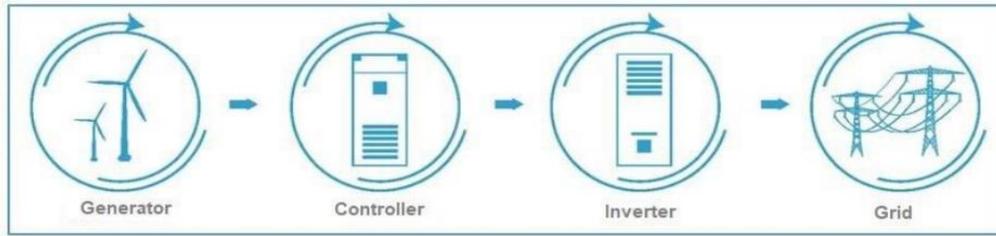
2.4 Grid connection request

Grid connection request	
Grid connection voltage range	400V±15 %
Allowable frequency range	47.5 Hz ~52.5 Hz
Allowable voltage unbalance	≤3%
Interruption duration	≤7 days
Grid connection access standards	Distribution grid connection series GB standard
Auxiliary power supply	
Normal operation	≤3kW, 3P5L
Standby power	≤0.5kW
PCS standby consumption	≤0.2kW

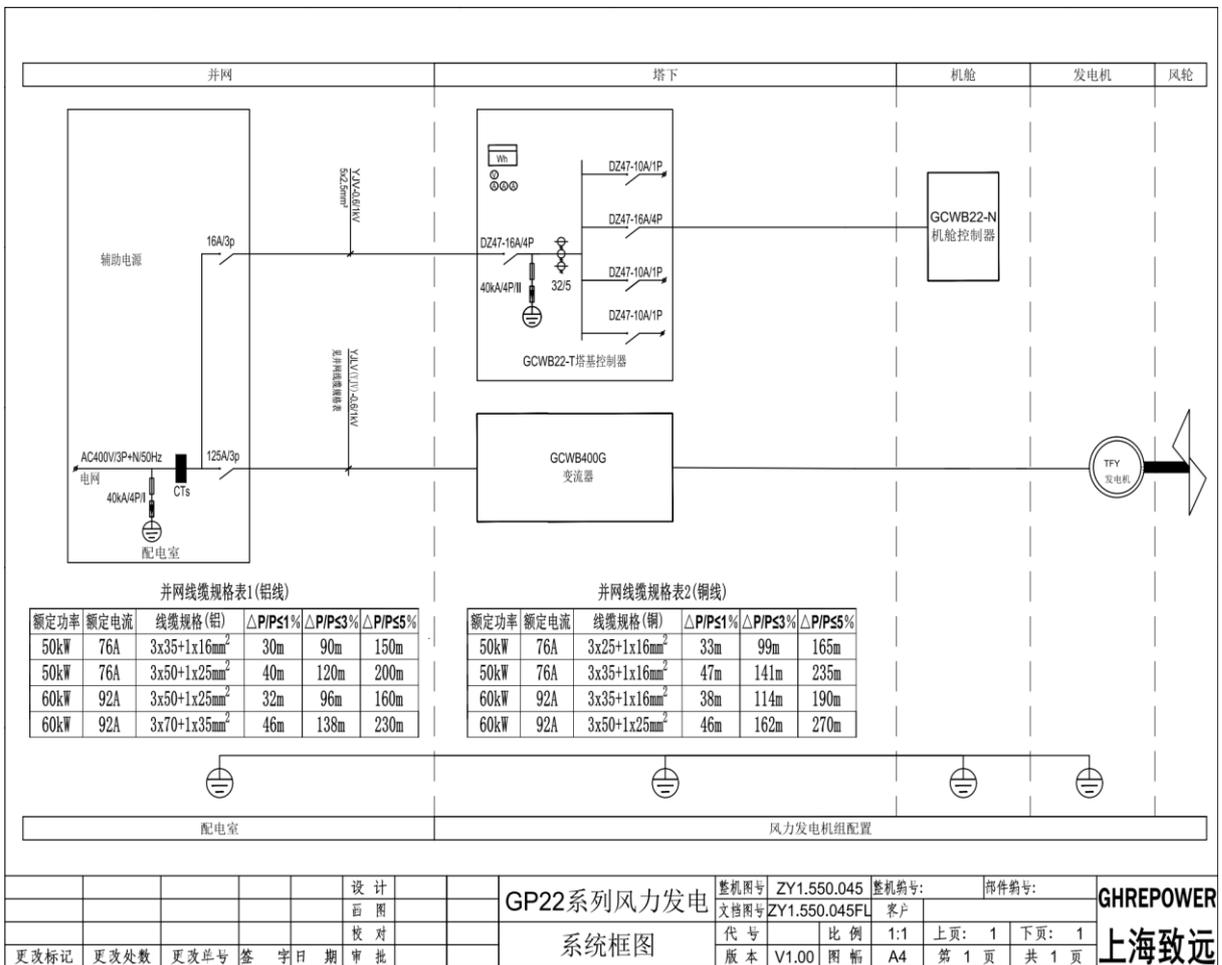
3. System composition

3.1 System connection diagram

Wind turbine generator system is composed of wind turbine generator, on-grid controller and on-grid inverter. (see the following photo)

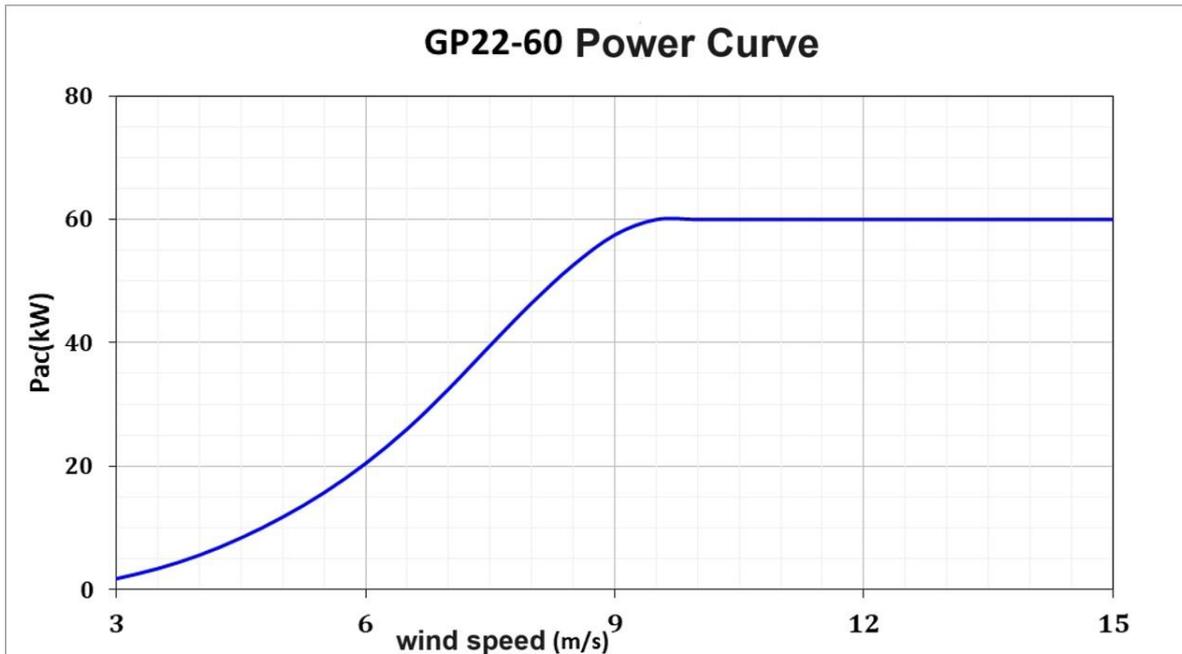


3.2 System electrical drawing



4. Performance

4.1 GP22-60 Power curve

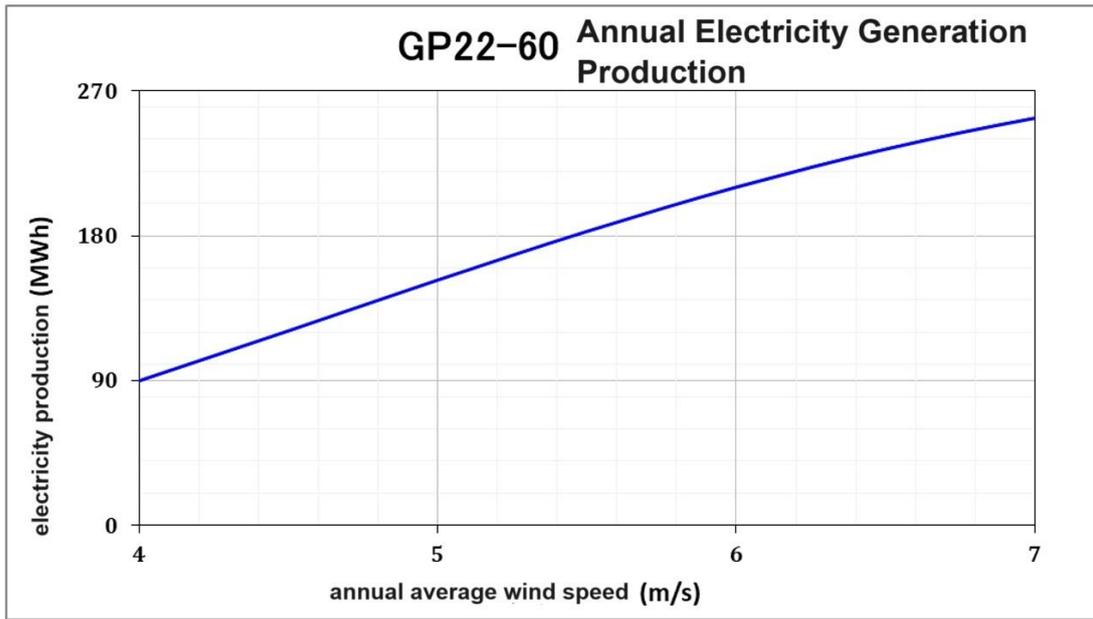


wind speed (m/s)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
power(kW)	1.8	3.4	5.6	8.4	11.8	15.7	20.5	26.0
wind speed (m/s)	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5
power(kW)	32.5	39.6	46.5	52.6	57.5	60.0	60.0	60.0
wind speed (m/s)	11.0	11.5	12.0	12.5	13.0	14.0	15.0
power(kW)	60.0	60.0	60.0	60.0	60.0	60.0	60.0

Usage instruction for power curve:

1. Data source: data source of power curve listed on the table is the result of calculation based on the theoretical aerodynamic efficiency data of blades and efficiency of each component of wind turbine generator system, which is equivalent to the data under standard air density (1.225g/L).
2. Reference standard: IEC 61400-12-1 based upon average value in each 10mins.
3. Application concern: when evaluating the site, power curve needs to be converted according to the actual air density of the site location. For related conversion methods, please refer to IEC 61400-12-1.

4.2 GP22-60 Annual electricity production

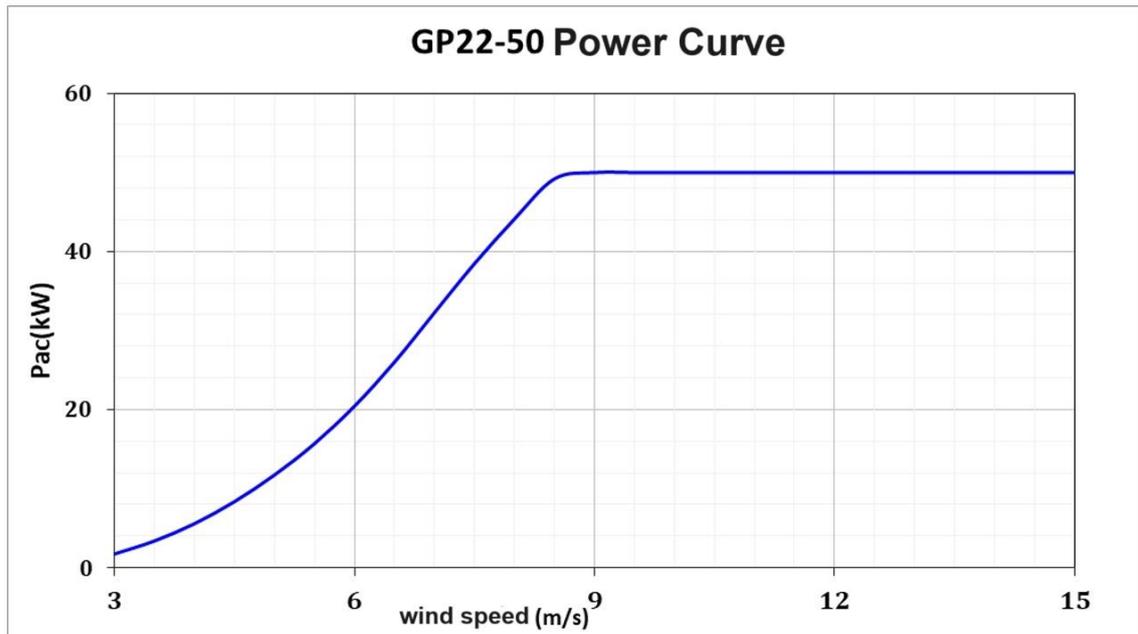


annual average wind speed (m/s)	4.0	4.5	5.0	5.5	6.0	6.5	7.0
annual electricity production (MWh)	90	121	152	183	210	234	253
annual electricity production (10MWh)	9.0	12.1	15.2	18.3	21.0	23.4	25.3
equivalent hours (h)	1494	2013	2540	3046	3504	3899	4222

Usage instructions for electricity generation:

1. Data source: the electricity generation is a theoretical value calculated according to calculation method of IEC 61400-12-1 based on the above power curve.
2. Reference standard: IEC 61400-12-1, assuming that the wind distribution is Rayleigh distribution.
3. Application concerns: actual electricity generation of WTG is related to factors such as site temperature, altitude, wind distribution, nearby obstacles, over-limit environment, and grid transmission conditions.

4.3 GP22-50 Power curve

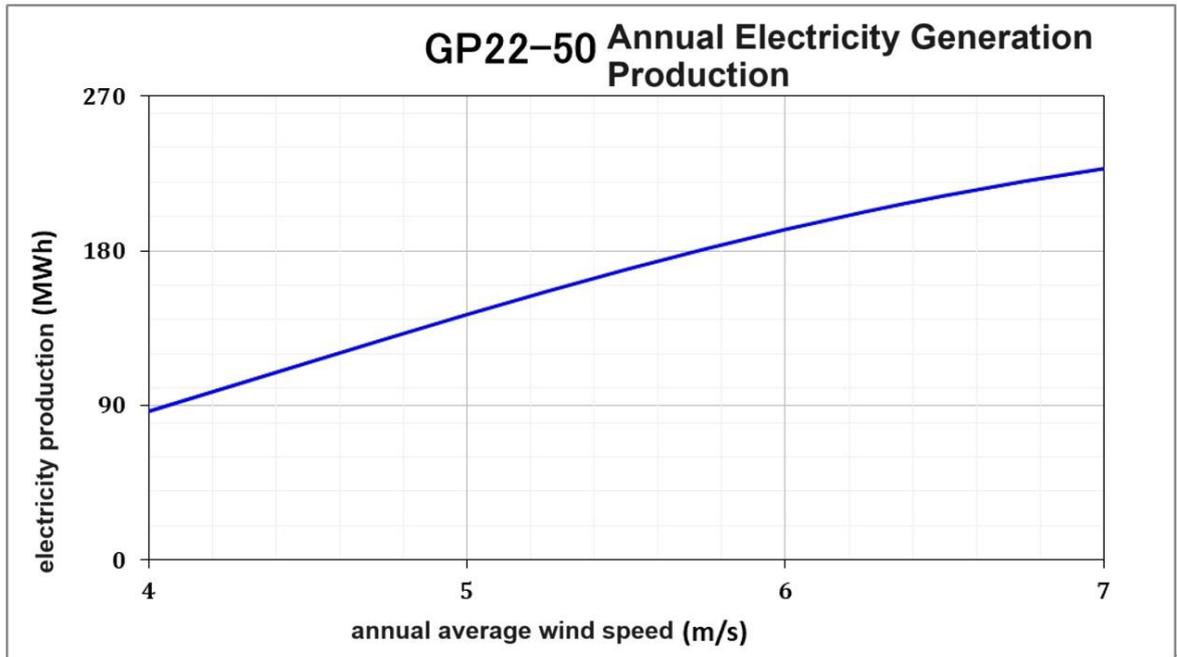


wind speed (m/s)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
power(kW)	1.8	3.4	5.6	8.4	11.8	15.7	20.5	26.0
wind speed (m/s)	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5
power(kW)	32.3	38.5	44.1	49.2	50.0	50.0	50.0	50.0
wind speed (m/s)	11.0	11.5	12.0	12.5	13.0	14.0	15.0
power(kW)	50.0	50.0	50.0	50.0	50.0	50.0	50.0

Usage instruction for power curve:

4. Data source: data source of power curve listed on the table is the result of calculation based on the theoretical aerodynamic efficiency data of blades and efficiency of each component of wind turbine generator system, which is equivalent to the data under standard air density (1.225g/L).
5. Reference standard: IEC 61400-12-1 based upon average value in each 10mins.
6. Application concern: when evaluating the site, power curve needs to be converted according to the actual air density of the site location. For related conversion methods, please refer to IEC 61400-12-1.

4.4 GP22-50 Annual electricity production

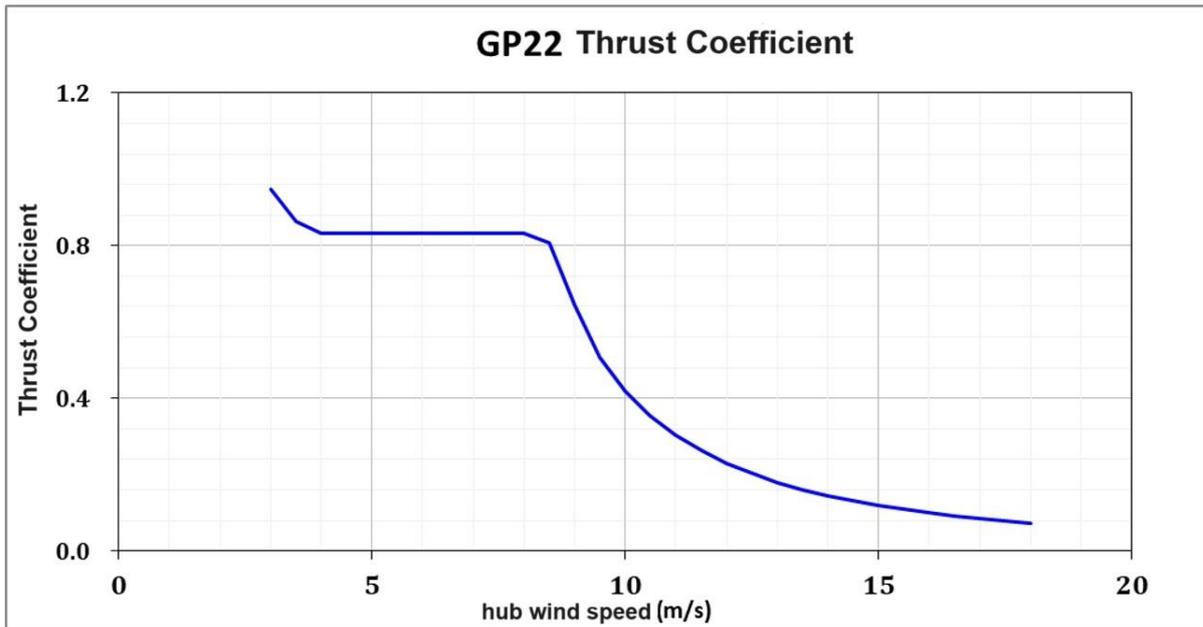


annual average wind speed (m/s)	4.0	4.5	5.0	5.5	6.0	6.5	7.0
annual electricity production (MWh)	87	115	143	169	192	212	228
annual electricity production (10MWh)	8.7	11.5	14.3	16.9	19.2	21.2	22.8
equivalent hours (h)	1735	2302	2862	3385	3850	4242	4556

Usage instructions for electricity generation:

7. Data source: the electricity generation is a theoretical value calculated according to calculation method of IEC 61400-12-1 based on the above power curve.
8. Reference standard: IEC 61400-12-1, assuming that the wind distribution is Rayleigh distribution.
9. Application concerns: actual electricity generation of WTG is related to factors such as site temperature, altitude, wind distribution, nearby obstacles, over-limit environment, and grid transmission conditions.

4.5 Thrust coefficient



Wind speed (m/s)	Thrust coefficient						
3.0	0.9489	7.0	0.8315	11.0	0.3029	15.0	0.1190
3.5	0.8638	7.5	0.8315	11.5	0.2626	15.5	0.1086
4.0	0.8314	8.0	0.8315	12.0	0.2298	16.0	0.0993
4.5	0.8315	8.5	0.8073	12.5	0.2028	16.5	0.0912
5.0	0.8314	9.0	0.6452	13.0	0.1802	17.0	0.0841
5.5	0.8314	9.5	0.5077	13.5	0.1612	17.5	0.0777
6.0	0.8315	10.0	0.4191	14.0	0.1450	18.0	0.0721
6.5	0.8315	10.5	0.3535	14.5	0.1311		

Thrust coefficient illustration:

1. Data source: thrust coefficient is a theoretical value obtained by Bladed software based on WTG data simulation.
2. Reference standard: IEC61400-1, thrust coefficient is the steady-state operating value of WTG.
3. Application concerns: actual thrust coefficient is related to factors such as instantaneous wind speed, instantaneous rotational speed, pitch angle, blade surface roughness, and environment.

5. Electronic control system

Wind turbine generator control system includes the core control unit of WTG, pitch drive control, yaw drive control, environmental monitoring, human-computer interaction, and power conversion, that realizes automatic operation control of WTG and maximizes wind energy.

Utilization and processing and recording of various events have the following characteristics,

- 1) Hardware stability & reliability: PLC-based distributed control system, using mature CANopen and EtherCAT buses for system connection.
- 2) software maturity & completeness: standard wind turbine code library and control strategy with superior performance in electricity generation efficiency improvement and load control.
- 3) Pitch control flexibility: use different control strategies under different working conditions such as light wind start-up section, rated wind speed section, strong wind control section, wind speed over-limit, etc. to maximize the wind energy utilization and safe operation of WTG.
- 4) Wind MPPT : combined with real-time air density and dynamically adjust the torque control parameters to ensure MPPT of wind energy C_p .
- 5) Intelligent yawing strategy: intelligent untwisting and wind-direction strategies balance wind-direction accuracy and action frequency to improve wind-catching ability.
- 6) Comprehensive protection: complete wind turbine protection system with multi-level protection strategies to maximize utilization.
- 7) Load optimization control: flexibility control, tower resonance zone vibration isolation, strong wind speed suppression, pitch rate flexible adjustment, etc.
- 8) Intelligent monitoring & diagnosis: complete status code, protection logic and user rights management to maximize safety of WTG.
- 9) Efficient operation & maintenance troubleshooting: abundant operation, failure, operation logs and failure recording records enable efficient operation & maintenance troubleshooting.
- 10) Abundant environmental monitoring: WTG has various monitoring functions such as wind speed, wind direction, air pressure, temperature, humidity, vibration, etc.
- 11) Convenient monitoring & debugging: real-time data monitoring and display of WTG, and LoT operation screen realizes the simultaneous uploading of operating data to the cloud.
- 12) Simple power grid connection: using a converter that meets the grid standards, which can be directly connected to the low-voltage 400V distribution network.

5.1 Controller

Control parameter	
Main controller	Beckhoff PLC
Yawing speed	0.55 °/s
Yawing accuracy	≤3.2°
Way of pitch	Synchronous pitch
Pitch speed	≥8°/s
Pitch accuracy	≤0.2°
Pitch backup power	Super capacitor
Display & Communication	
Display panel	LCD/touch screen
Communication interface	RS485, RJ45 internet access

5.2 On-grid converter

System model	GP22-60	GP22-50
Generator side parameter		
Generator side working voltage range	3 phase 200~460Vac	
DC bus working volage range	600~ 720Vdc	
Brake unit configuration	Built-in control and dump-load resistors	
Network side parameter		
Rated output power	60kW	50kW
Rated grid voltage	400V±15% 3 phase 3 lines	
Rated working frequency	50/60Hz ± 5%	
Power factor (PF)	>0.99 (0.85L~0.85C adjustable)	
Maximum inverter efficiency	≥97%	
Harmonic content (THD)	Total current harmonics <5%, each time <3% (rated power)	
Grid-tie protection function	Overvoltage, undervoltage, overfrequency, underfrequency, unbalance protection, etc.	
Other grid-tie functions	Low voltage ride through, islanding protection	

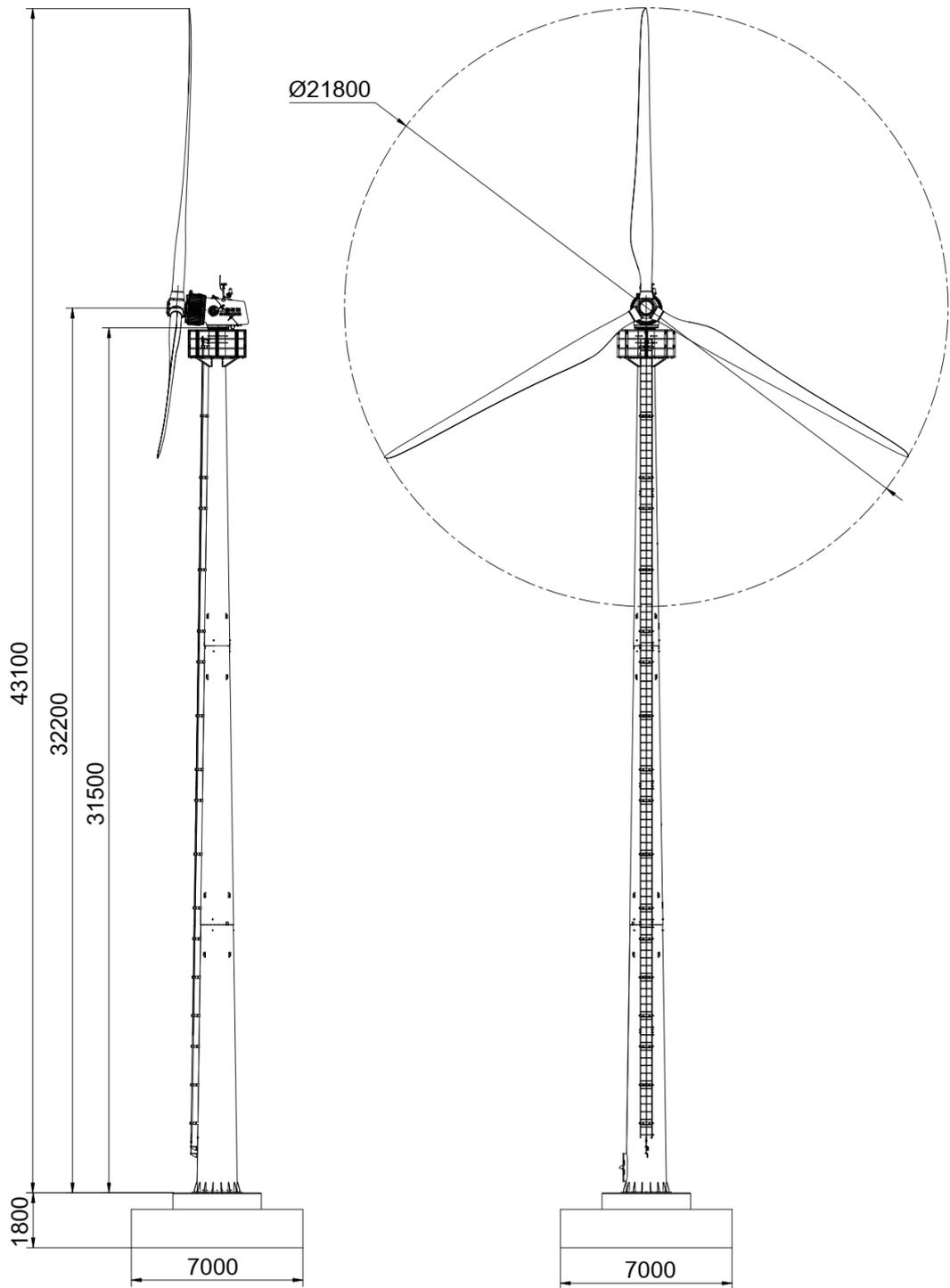
6. Tower & Foundation

Device model	FD22-60	FD22-50
Tower model	TD7-32B	
Height	31.5m	
Section	3	
Thickness	8mm	
Weight	≈10t	
Material	Q355	
Flange diameter	≈650mm(upper) / 2500mm(bottom)	
Surface treatment	Painting	
Base reference value	7m×7m×1.2m	

Foundation construction needs to go through start-up procedures, bring in machine tools and materials, excavation and leveling of the foundation pit, excavation of cable trenches and masonry manholes, pre-embedding of ground rods and cushion formwork and pouring (C25), installation of foundation sections (crane 25 tons), the production and binding of embedded parts, formwork cutting and supporting, foundation pit pouring (C35), and foundation maintenance will take at least 20 days.



6.1 Overall appearance diagram



6.2 Upper foundation load

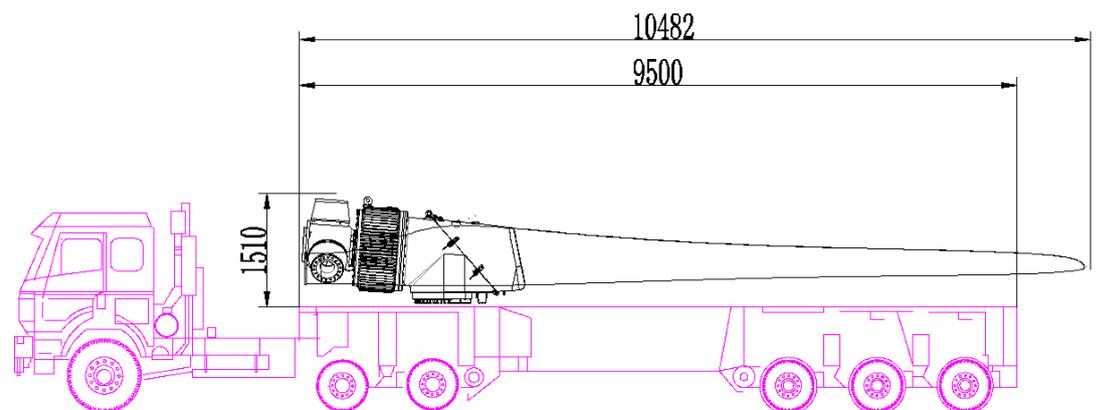
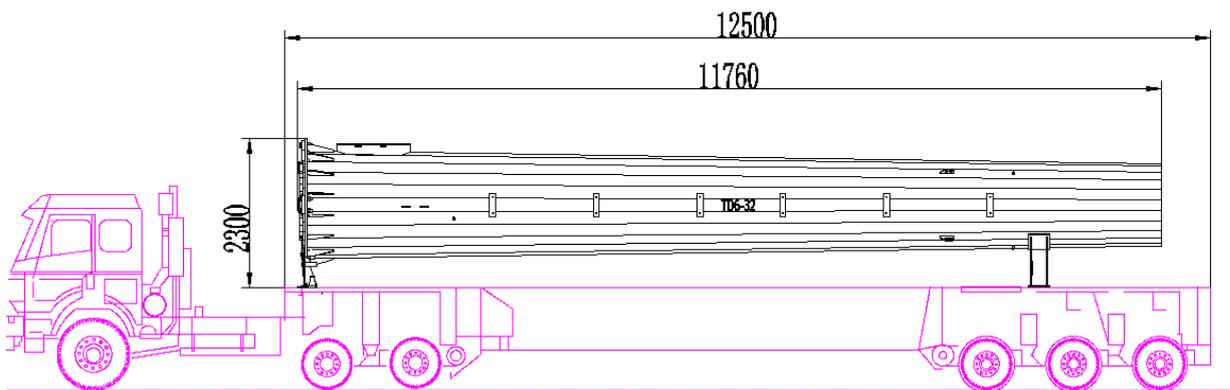
Load case	Tower Mxy [kNm]	Tower Mz [kNm]	Tower Fxy [kN]	Tower Fz [kN]	Safety factor
Normal run load case	185	20.8	8	-141	1.0
Ultimate load case	1300.5	57	53.8	-217.2	1.35

Note: The above loads all include load safety factors, please see relevant documents for detailed data.

7. Wind turbine transportation

The main components of WTGS are listed and the loading diagram as follows:

No.	Item	Weight (t)	Dimension (m)	Vehicle	Time
1	Anchor bolts, positioning plates	0.8	in bulk	Ordinary	1
2	32m tower (tube, ladder, inspection platform)	10.5	11760*2100*2300	13m truck	1
3	Nacelle	4.0	3000*1170*1790	9.6m truck	1
4	Converter	0.8	900*600*2000		
5	Tower base controller	0.05	600*350*1000		
6	Blade (one set)	1.2	10500*1150*855		



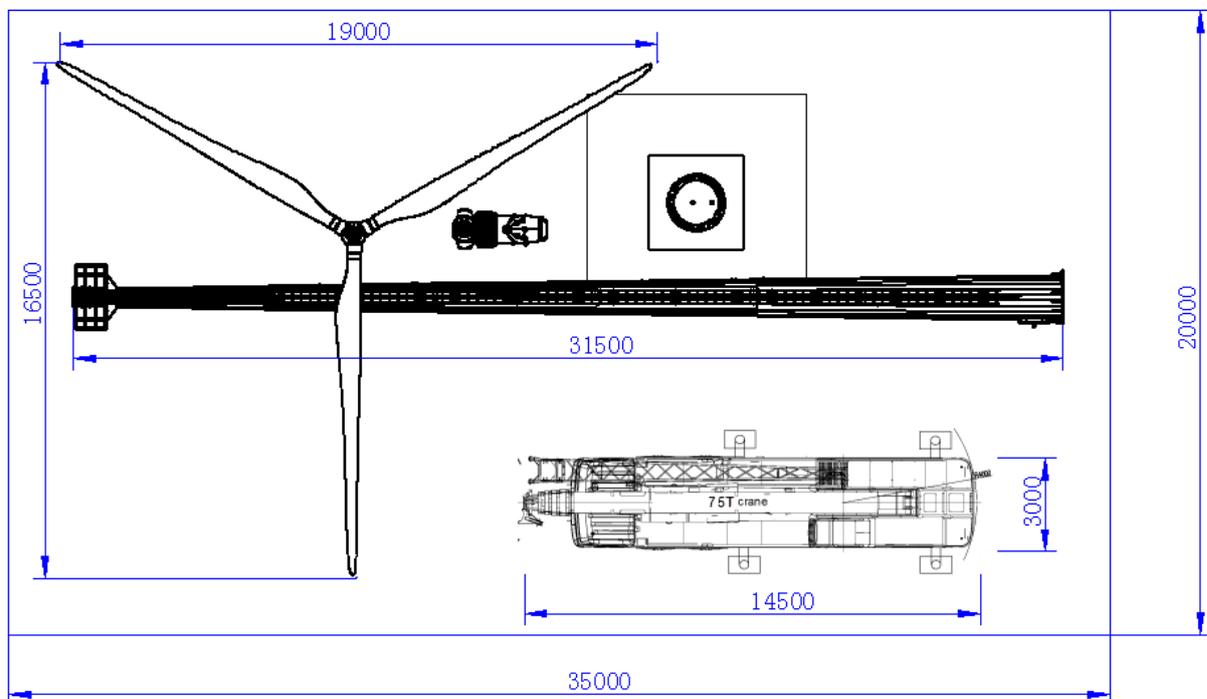
8. Hoisting request

In order to ensure the hoisting time, tower hoisting and wind rotor assembly are carried out simultaneously. The requirements for the site are very strict. It is necessary to ensure that there is space for placement and installation of components. The flat area of the site should be wider to facilitate the layout of hoisting installation. The tower needs to be placed in a flat area 20 meters long and 6 meters wide, and the blades need to be placed in a flat area 20 meters long and 18 meters wide for assembly of the wind wheel.

The road needs to ensure the passage of 13-meter flatbed vehicles. The turning radius is greater than 15m. The geology must not be soft, otherwise it needs to be paved with sand and gravel.

The list of main tool requirements for each stage of hoisting is as follows:

No.	Name	Specs	Qty	Time	Function
1	Crane	25T	1 unit	1 day	Unloading, blade assembly, tower tubes separation
2	Crane	75T	1 unit	1 day	Tower assembly, wind rotor, nacelle hoisting



9. SCADA remote monitoring

Remote monitoring system CUBE3.0 with system functions & features:

- Data transmission: data connection and interaction can be carried out through wired/wireless networks and access method is flexible and convenient.
- Real-time monitoring: log on the web page anytime & anywhere to observe and analyze real-time operation status.
- Data logging: record various operation information, meteorological, grid data, electricity generation and other types of data.
- Report analysis: statistics of each monitoring quantity and fault records can be made by day, month and year and reports can be generated.
- Failure alarm: failure information can be notified to operation and maintenance personnel in a timely manner by pre-classifying various types of failures.
- Operation & maintenance management: record each operation & maintenance information and provide operation and maintenance status reminders according to maintenance requirements.
- Safety and reliability: the server is built on a third-party cloud platform, which the network service is safe and reliable.



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