

Electrical system of Haliade 150 by R. Piñana

The general electrical layout of Haliade 150 can be divided in

- generator,
- power converter,
- auxiliary systems,
- transformer,
- high voltage protection.

Generator

The Haliade 150 has a direct drive permanent magnet generator with an active power of 6 MW and a nominal voltage of 900V.

Power converter

The power converter is a 4 quadrant back-to-back converter in 3-level topology and pulse width modulation (PWM) with high switching frequency. Each phase of the generator is connected with one independent converter with an apparent power of 2,35 MVA and a cos phi of 0,87. Therefore, statcom operation is an option. The nominal DC voltage is 1450 V, this is limited by a DC chopper which can evacuate an energy of 36 MJ in the worst case. The operation modes are production, FRT and motorisation. Due to the modular converter concept it is fault tolerant. Therefore, the following fault tolerant operations are implemented:

- One converter trip: remaining two converters break the WT.
- Converter trips LSC: WT break normally (convert is using DC chopper to break its part).
- Ethercat communication is lost: use look-up table to stop.
- Gird loss: all three converter will use there DC breaker.

Auxiliary systems

The auxiliary systems are supplied with 400 V and located in nacelle cabinet 1 (NC1), nacelle cabinet 2 (NC2), tower cabinet and entrance cabinet.

Nacelle cabinet 1

In NC1 are the slip rings which are ready to work with 110 A. They have hybrid communication lines using copper and optical rings which are segregated from the power lines. An incremental encoder tracks the rotor position and a heating prevent condensation.

The pitch system controls the rotor speed and breaks dynamical. It consists of AC synchronous PM motor with an active power of 20 kW, a torque of 130 Nm and a nominal speed of 1500 rpm. It is designed efficiently, which makes it possible to remove up to 40% of components and wiring respect to DC conventional system. Each blade has as a backup one additional set of inverter and motor and the backup energy supply is realised with ultracaps

The yaw system consists of 7 motors which are driven by 7 ABB ACS-350 is N-1 secure. Each of them has an active power of 7,5 kW to move the ~400 tn. The motors are in master-slave configuration and a

closed loop field bus ring (ethercat) connecting each drive. This allows remote access for parametrization.

Nacelle cabinet 2

The main components located in NC2 are the generator cooling, the hydraulic systems and the I/O modules.

Tower cabinet

In the tower cabinet are amongst others the air treatment system, the arc monitor fire and the transformer converter cooling system.

Entrance cabinet

The entrance cabinet contains the lighting and services lift.

Transformer

The used transformer has a Dyn11 configuration and an apparent power of 6500 kVA. It transforms the voltage from 36 kV to 900 V and has a tab-changer with a maximum range of +-5%. The inrush current is 5 times the rated current and its impedance voltage is 6-6,5%.

High voltage protection

The high voltage protection has 36 kV nominal voltage and can withstand 70 kV for 1 minute. Its operation current is 630 A or 1250 A with a maximal short circuit current of 25/31,5 kA for 1 second.