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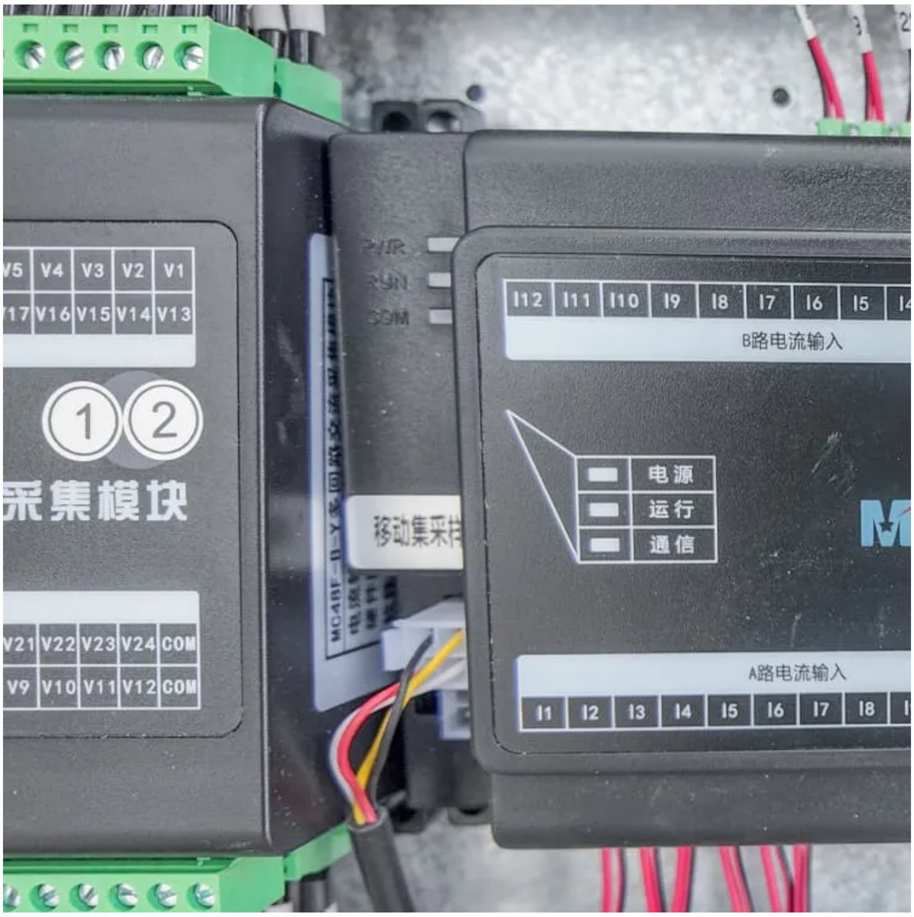
Production of wind power generation control systems



Overview

Renewable energy is being embraced globally as a viable alternative to conventional fossil fuels generators. This is in direct response to the challenge of depleting fossil fuel reserves and its impact on environmental pollution. Wind. Renewable energy is being embraced globally as a viable alternative to conventional fossil fuels generators. This is in direct response to the challenge of depleting fossil fuel reserves and its impact on environmental pollution. Wind energy has continued to play a significant role and can be regarded as the most deployed renewable energy source, however the efficiency level and cost effectiveness of a wind turbine (WT) system with regards to wind application is very much dependent on its control. This research paper reviews the various control methods associated with wind energy control. More recently there has been an attempt to review these control techniques but the authors have focused more on the maximum power point tracking (MPPT) techniques and pitch angle control of WTs however discussions around stall.

Wind turbineWind turbine controlPitch controlMPPT strategies.

The rapid development of wind energy systems is a direct response to the growing need for alternative energy sources [1]. Data obtained from the global wind energy council (GWEC) [2] reflect an increase in installed global wind capacity to about 651 GW at the end of 2019 as shown in Fig. 1. This represents a 10% increase in global wind capacity compared to 2018. It is expected that installed wind capacity would increase exponentially over the next couple of years as a result of the continuous demand for alternative energy source. WTs have evolved over the years from simple designs to complex generation units. Due to this complexity and the high dependence of wind energy systems on climatic and environmental factors, there is the need to incorporate control systems to ensure the efficient operation of WTs and effectively.

Power and speed control are two important factors which require attention in the control of WT systems. The power extracted by the WT is often expressed as(1)$P_w=0.5\rho A C_p V^3$Where Power extracted from wind is defined as Pw, ρ is the air density, the rotor area is A, the power coefficient Cp is dependent on tip speed ratio (TSR) λ and pitch angle β. V is the wind speed, λ is expressed as a relationship between V and linear velocity on the tip blade given as(2)$\lambda=\omega R V$ω is rotor speed and R is the rotor radius.Each control system has its unique control method which is dependent on the operational region and control objective of the WT. Fig. 2 illustrates the distinct regio.

WTs are typically designed to withstand extreme weather conditions but they are not designed for extreme speeds or rotational torques. At very large aerodynamic torques or rotational speeds, the force on the blades of the WT is enormous and can tear the turbine apart. To avoid this, WTs are always designed with a cut-out speed above which brakes will slow the turbine to a halt. However, there is s range of wind speeds before the cut-out speed where the WT employs various control strategies to deal with high wind speeds that would otherwise pose a threat to the turbines. All WTs are therefore designed with a kind of power control technique. This can either be stall control or pitch control. Stall control of WTs is further classified as passive and active stall control. Fig. 3 gives a description of thes.

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