Citation: Jian-yu Bao, Wei-bing Bao, Yu-ling Li, 2014. A power conversion system for PMSG-based WECS operating with fully-controlled current-source converters. *Journal of Zhejiang University-Science C (Computers & Electronics)*, 15(3):232-240. [doi:10.1631/jzus.C1300231]

A power conversion system for PMSG-based WECS operating with fully-controlled current-source converters

基于全控电流型变流器的永磁同步风力发电功率变换系统

Key words: Grid-connected, Wind energy conversion, Current-source rectifier, Multilevel current-source inverter

关键词：风力发电；并网；MPPT；电流型多电平逆变器；多载波PWM

- Fully-controlled power converters have attractive choices and are used as power interfaces between the synchronous generator and grid for a direct-drive wind turbine (WT) based wind energy conversion system (WECS). However, for voltage source converter (VSC) based WECS, a DC-DC converter is usually added to boost DC-link voltage due to its inherent buck characteristics. Thus, the cost and complexity of the conversion system must be considered.

- The current source converter (CSC), as the dual part of VSC, has certain advantages, such as inherent boost and short-circuit protection capabilities, direct control of the output current, longer lifetime of the storage unit, and flexible power flow control. Thus, CSC based power conversion configuration is very fit for WECS. Two independent current-source rectifiers (CSRs) with space-vector pulse width modulation (SVPWM) are employed to regulate and stabilize the DC-link current. Between DC-link and the electrical grid, a direct-type three-phase five-level CSC is inserted as a buffer to regulate active and reactive power flowing to the grid.

- Based on dual theory, in this paper we propose a new configuration for PMSG based grid-connected WECS operating with fully-controlled back-to-back CSCs:

- A five-level CSC topology is obtained from the improved three-phase flying-capacitors five-level VSC through dual transformation.
- On the generator side, MPPT control is implemented based on closed-loop regulation of generator rotation speed. DC-link current is controllable according to the varying wind speed via the SVPWM current source rectifier (CSR).
- On the grid side, a PD-PWM controlled three-phase five-level CSC is inserted to achieve relatively low line current harmonics. Its harmonic spectrum is close to that of a line-line voltage of five-level VSC.
- Based on grid voltage oriented control and PLL, the leading, unity, or lagging displacement power factor can be easily implemented on the grid side by presetting *d*- and *q*-axis reference currents, respectively.

Example: Design of a power conversion system for PMSG based WECS operating with fully-controlled back-to-back CSCs

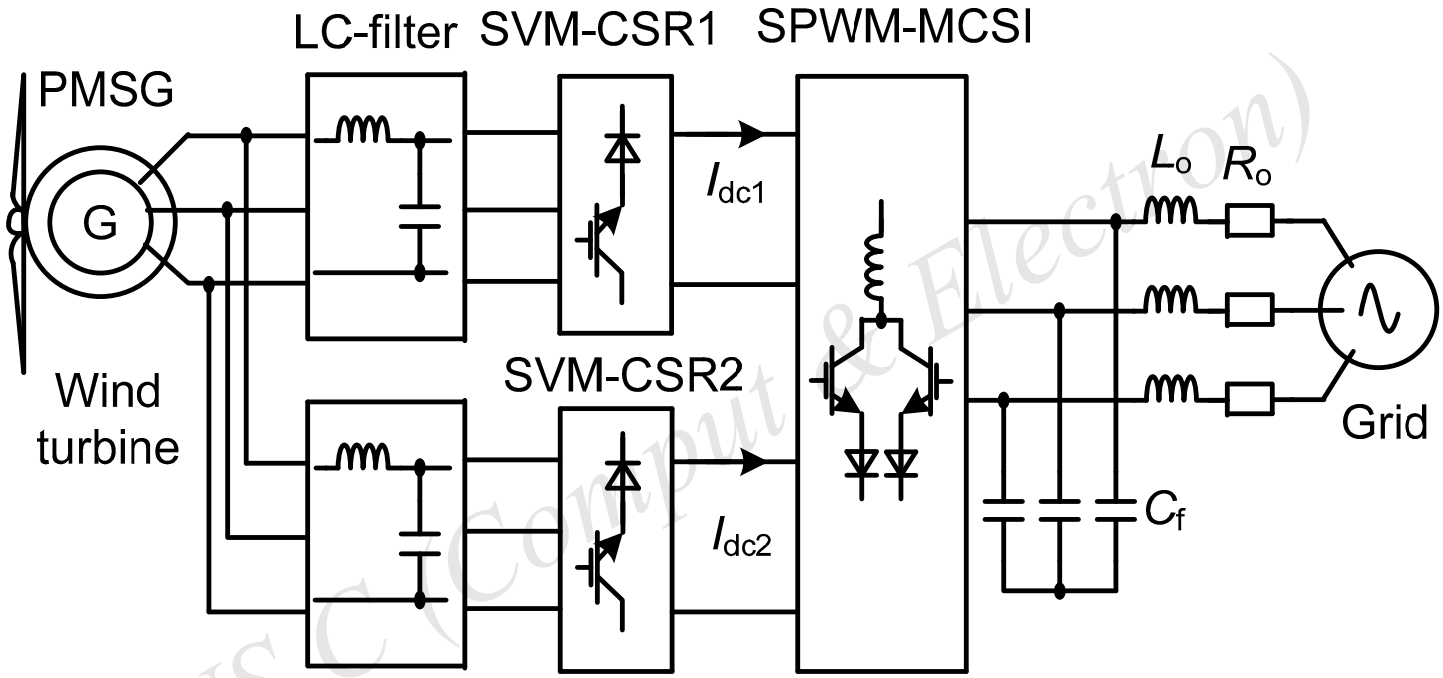

Fig. 1 Circuit configuration of CSC based WECS

The proposed power conversion system can extract maximum power from wind turbine by a current-based MPPT scheme, and achieve random power factor operation on the grid side.