MPC-SVM Method for Vienna Rectifier with PMSG used in Wind Turbine Systems

Introduction:

Applications using Vienna rectifier have been expanded from grid connected systems such as the telecommunication systems to Wind Turbine Systems (WTS). Various Vienna rectifiers, which are realized from many topologies, have the same performances as three-level topologies (neutral-point clamped, T-type); nevertheless, the Vienna rectifier can reduce the topology components. This gives some advantages in terms of size and cost. However, the Vienna rectifier is boost-type unidirectional rectifier; therefore, it has some limitations in the variation of the power factor.

Existing system:

Many control methods for the Vienna rectifier have been proposed. In the Vienna rectifier, one of the main control aims is to make the input currents to have sinusoidal waveforms. The hysteresis current control method is used and it is a classic control method. The switching set is determined by the rule defined from the hysteresis current control. The classic linear controllers such as the proportional-integral controller are used and the switching set is generated by comparing the reference voltages with the carrier voltages or by the space vector modulation method. The aforementioned control methods have been widely used in other topologies such as two-level converter and three-level converter. The Direct Torque Control (DTC) method and the Model Predictive Control (MPC) method with cost
function have been proposed for the applications using a motor or generator. Research on the DTC and MPC methods at two-level converter, three-level converter, and matrix converter are being carried out consistently. Recently, DTC method for the Vienna rectifier was proposed

**Disadvantages:**

- neutral-point voltage unbalancing problem
- variation of the power factor

**Proposed system:**

This project proposes the MPC method for the Vienna rectifier used in WTS with a Permanent Magnet Synchronous Generator (PMSG). The proposed MPC method considers the feasible eight-voltage vectors of the Vienna rectifier; moreover, the additional voltage vectors, which are the center voltage vectors of two feasible adjacent voltage vectors, are taken into consideration to improve the performance of the MPC method. In the proposed MPC method, the errors in d/q-axis current are predicted based on model of the PMSG, and then, the optimized voltage vector is selected by cost function for the current ripple minimization. Additionally, from the optimized voltage vector, N-type and P-type voltage vectors, which give the different effect on the neutral-point voltage, are considered in selecting the final switching set to solve the neutral-point voltage unbalancing problem. The final switching set is generated by the Space Vector Modulation (SVM) method.
Advantages:
- Ripple minimization of PMSG currents
- No neutral-point voltage unbalancing problem

Applications:
- Telecommunication systems
- Wind turbine systems (WTS)
Block diagram:

- **AC**
- Wind supply
- Vienna rectifier
- 3-phase converter
- Gate driver circuit
- Buffer circuit
- Micro-controller circuit
- 12 V DC (gate driver circuit)
- L filter
- 5V DC (buffer circuit)
- Unbalanced Load
- Supply

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