Design of Dynamic Voltage Restorer and Active Power Filter for Wind Power Systems Subject to Unbalanced and Harmonic Distorted Grid

Introduction:

Wind power penetration in the load centres vicinity is beneficial in reducing power transmission loss and alleviating the amount of electrical power fed by fossil fuel based power plants. However, the negative impacts resulted from wind power generation including vibration and irritating acoustic noise under a distorted distribution system are still in the stage of exploration. The switch–mode voltage-sourced inverter (VSI) is capable of changing the voltage format for adapting the power sources of various types to electrical appliance, which is indispensable to many industrial applications such as electric vehicle, UPS, and renewable energy conversion. By modulating the magnitude and the phase of the VSI ac voltage, the desired VSI ac current is achievable and consequently enables bidirectional power flow control. In additional to the power flow management, the VSI can be also used to improve the power quality for the grid utility. The dynamic voltage restorer (DVR) and the active power filter (APF) are the typical applications for voltage magnitude and current harmonic compensations, respectively.

Existing system:

Two sinusoidal internal models in Laplace transform of a cosine function and a sine function were proposed as the resonant controller.
It is found that using the sine function would highly under damp the feedback control system due to 90o short in phase margin compared with the cosine function. To account for the transient and steady-state tracking performance, a pole assignment technique applied to an undammed PR controller was proposed to improve the closed loop damping. The resonant frequency of the PR controller can also be assigned at a specific frequency for compensating harmonic current caused by the nonlinear loads.

Disadvantages:

- The negative impacts resulted from wind power generation including vibration and irritating acoustic noise under a distorted distribution system are still in the stage of exploration.
- Unbalanced and harmonic distortion

Proposed system:

This project presents a combination of the DVR and APF for refining the SCIG terminal power quality. The positive sequence component at grid frequency is first extracted from the distorted SCIG terminal voltage for VSI synchronization. The unbalanced components can also be found by subtracting the positive sequence component from the distorted voltage. Once the positive and negative sequence components are determined, the defect of unbalance in voltage as well as the positive sequence component can both be compensated by the DVR. To avert the SCIG stator from specific harmonic currents distortion, an APF control design that focuses on the low-order harmonic currents was presented. The SCIG torque pulsation incurred by the distortions such as the harmonic current and
unbalanced voltage can then be alleviated with the compensation of the DVR and the APF.

**Advantages:**

- Improves the accuracy for harmonic detection
- Capable of separating harmonics from feeder current
- Harmonic current and unbalanced voltage can then be alleviated with the compensation of the DVR and the APF.

**Applications:**

Industrial applications such as electric vehicle, UPS, and renewable energy conversion
Block diagram:
Combination of DVR and APF

Wind Supply → Filter → 3-phase Converter → Gate driver circuit → 12 V DC

3-phase Converter → Filter → 3-phase Converter → Gate driver circuit

Transformer → Unbalanced Load

Buffer circuit → 5V DC Supply

Micro-controller circuit