European Pattern Recognition - Renewable Energy Impact

Work Package 7: Inertia Support

SCOPE AND REQUIREMENT DETERMINATION

CONTENTS

1 INTRODUCTION

The previous report has been revealed the literature for the inertial support mechanism for wind energy conversion system. The objective of this report is the scope and requirement determination for the WP7.

2 SCOPE

The scope of this study is evaluating the potential of the wind farm, BARES for the inertial support. In order to evaluate the capacity and the potential of the wind farm for inertial support, the wind farm should be modelled on the simulation environment. Then the real measurements from wind farm can be utilized and the frequency deviations can be investigated.

The inputs of this study will be the wind farm properties and the real measurements taken from field. These data will be utilized to reach a conclusion which includes the capacity of such inertial support and its economical results.

3 CURRENT PMSG WIND TURBINES

The main control diagram of the PMSG wind turbine is given below. In the figure, the aerodynamic model represents the wind turbine structure which captures power from the air. The mechanical model represents the generator and wind turbine connection via gearbox.

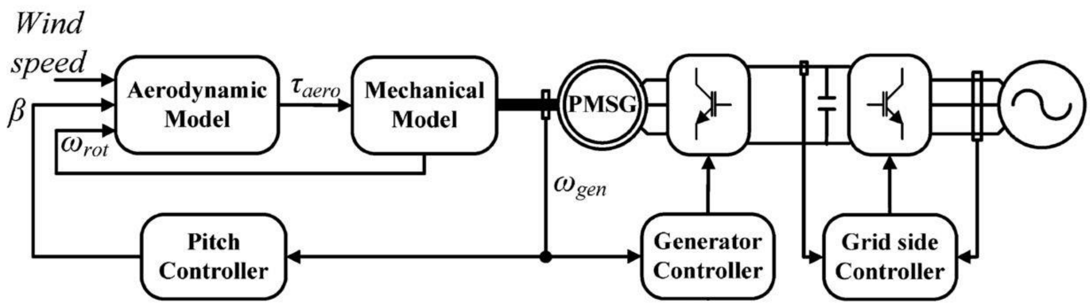

Figure 1:Main Control Diagram of the PMSG Wind Turbine

The aerodynamic power captured from wind depends on the wind speed, pitch angle and the rotational speed. The term power coefficient, C_p is the aerodynamic efficiency of the operating point of the wind turbine. Therefore, the responsibility of pitch controller and generator side controller is to maintain the maximum efficiency.

$$Pt = 0.5\ Cp(\lambda, \beta)A\rho\upsilon 3 \qquad (2)$$

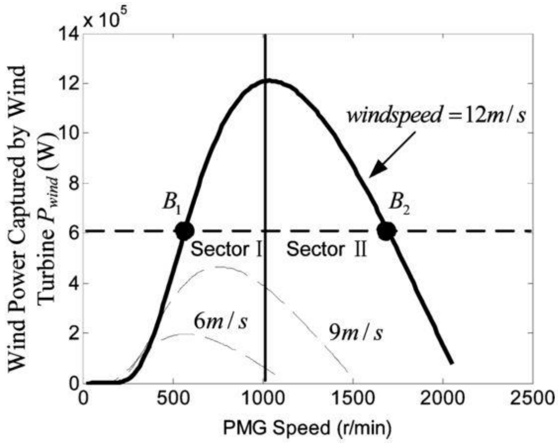

Figure 2: Wind power–speed characteristics for a 1.5-MW system[9]

Permanent magnet coupled to wind turbine shaft is connected to grid with the Back-to-Back(BTB) Converter structure. This structure gives operator freedom of control. Therefore, by making use of BTB converter, the operator can define active and reactive power set points independently. BTB converter is composed of two different structure. The first one is the generator or machine side controller (MSC) which is connected to machine side. The other one is connected to grid side and hence it is called grid side converter (GSC).

The responsibilities are shared between these converters. MSC is responsible for speed reference and the active power reference meanwhile the GSC is responsible for the reactive power reference (also the power factor) and the DC voltage reference. As seen the figure below, the generator speed is dictated by controlling the q-axis current. This generator speed should be the maximum power point which is generally taken from look up table.

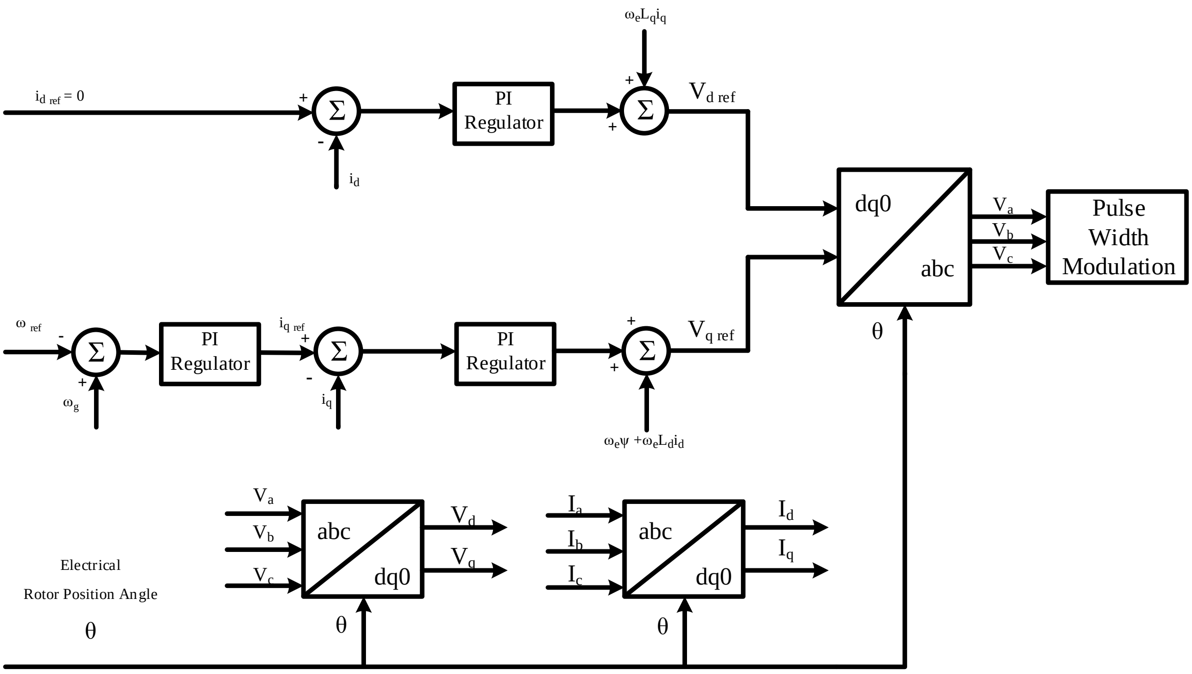

Figure 3: Machine Side Controller Diagram

Grid Side Controller is responsible for maintaining constant DC voltage and the reactive power amount. Reactive power amount can be set by controlling the q-axis current. For normal operation, wind turbines and also other renewable sources are desired to operate at unity power factor. This is achieved by setting zero current for the q-axis. Note that for the LVRT capabilities, this set point would change time to time. GSC is also responsible for maintaining the constant voltage in the DC link. The diagram for GSC is given for a wind turbine which is connected to grid with L filter.

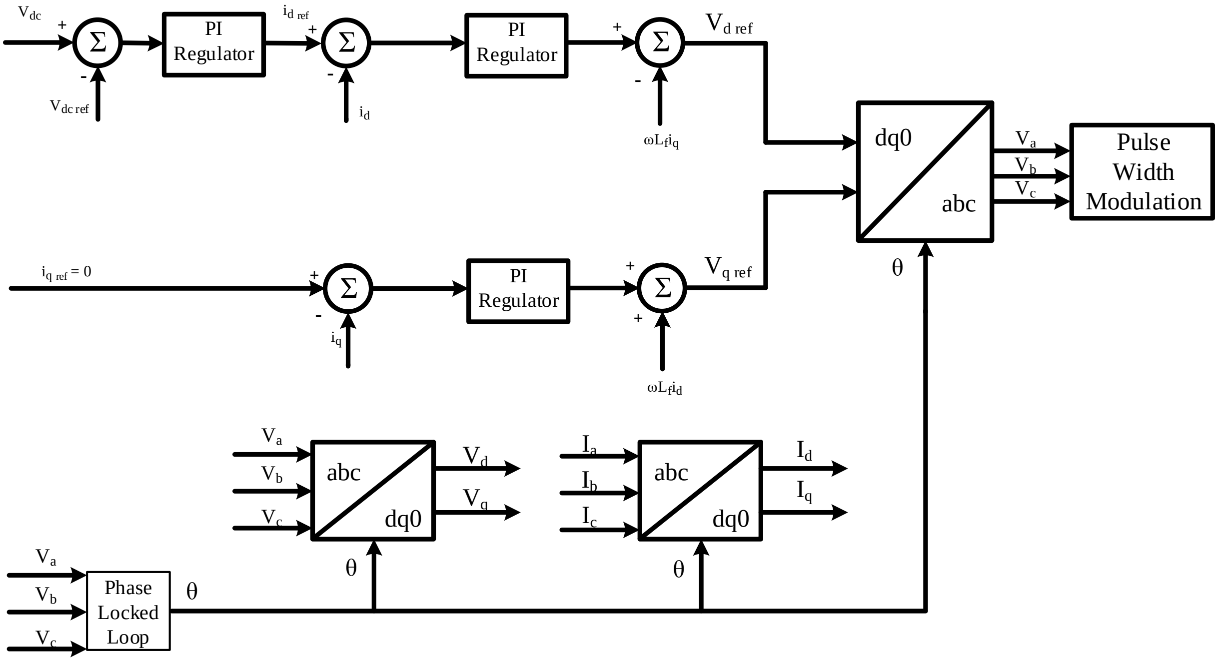

Figure 4: Grid Side Controller Diagram

4 REQUIREMENTS

4.1 REQUIREMENTS FOR AERODYNAMIC MODEL

Parameter	Unit
Wind Turbine Power	MW
Wind Turbine Blade Diameter	m
Wind Turbine Blade Inertia or Mass	$kg.m^2/kg$

4.2 REQUIREMENTS FOR MECHANICAL MODEL

Parameter	Unit
Gear Ratio	-
Gearbox Inertia	$kg.m^2/kg$

4.3 REQUIREMENTS FOR PMSG

Parameter	Unit
Generator Rating	MVA
Active Power	MW
Generator Inertia	$kg.m^2/kg$
Generator Voltage Rating	V
Generator Flux	V.s
d-q axis Leakage Inductances	H

4.4 REQUIREMENTS FOR BACK-TO-BACK CONVERTER

Parameter	Unit
Detailed Control Diagram	-
PI Compensator Constants	-
DC Link Voltage	V
DC Link Capacitance	C

4.5 REQUIREMENTS FOR FILTER

Parameter	Unit
Filter Type	L or LCL Filter
Inductance/s	H
Capacitance (if any)	C

4.6 REQUIREMENTS FOR FREQUENCY MEASUREMENTS

5 CONCLUSION

6 REFERENCES