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Voltage Control and Load Sharing In DC Distribution Systems with Three Phase AC Machines

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Abstract— In this paper describes the excellent control strategy of voltage droop characteristics based on load sharing concept for multiple DC sources. The input is given to the two dc sources are 800V, 800V and by using DC-DC converters. The voltage values are stepped down to 364V by using PID controller the voltage is constant at the load side. The two converters of the bus voltages are shared by the ratio of -1/50 and -1/100. By using inverter DC voltages are converted into AC voltages that inverter voltage is given to the Induction motor and a Permanent Magnet Synchronous motor.

This paper describes the control strategy of voltage droop characteristics as a potential source of load sharing control problem for two DC converters and also observes the DC bus converter powers and extend to design and simulation. The DC bus voltage is fed to the 3-phase induction motor and permanent magnet synchronous motor. Induction motor and permanent magnet synchronous motor characteristics are also shown in Matlab Simulink.

Index Terms— Buck converter, Induction motor, Load sharing, Micro grid topology, and PMSM.

1 Introduction

A micro grid is illustrated to be a promising technology to obtain effective and efficient energy in a power system with distributed formation including renewable energy sources such as wind, solar power etc. A dc micro grid has a number of attached sources operating in parallel,/provides the ability to the dc bus and loads. Renewable energy sources are associated with dc bus by means of DC-DC converter like as a Buck converter. Here in this document using a DC-DC converter for the purpose of decreasing the voltage. The decreasing voltage is given to the DC bus and the voltage is shared by the two converters at the load side. Sagging is taking place so that the voltage is not continuous at load side, we notice sagging features of bus voltage and power converters to address this problem a PID controller is connected to the load side and observe the sagging features of the bus voltages and power converters.

DC to DC converters can be given as a technique to generate multiple voltage sources from a specific dc supply voltage to feed the different sub circuits in the solution. This strategy is useful for to generating several voltage sources from a single battery power source can decrease the device area considerably. In DC-DC converters we are using buck converters.

The Buck converter is used to decrease the input voltage from higher voltage values to a lower voltage value. The input and output power values are same. In buck converter circuit the PID controller is used to improve the performance and measurement by choosing suitable changing frequency. The circuit usually consists of an inductor to store the energy and modify to managing the power flow.

Sagging occurs when the linear operating range of a compensator with given the highest possible capacitive and inductive rating. The Regulation drop means that the terminal voltage is allowed to be less than the no-load voltage at full load capacitive compensation and its permitted to be greater than the nominal voltage at full load inductive compensation.

PID controllers are discovered in a wide range of applications for industrial purposes. PID looks for Proportional- Integral- Derivative control. These three controllers are combined in such a way that it produces a control signal. As a feedback controller, PID provides the output at the desired value due to the overall flexibility and stability of the controllers.

In this paper, the DC bus voltage is converted into ac bus voltage by using an inverter, which converts fixed DC voltage to variable AC voltage. This variable AC voltage is used to run the induction motor and PMSM. This paper describes modelling and simulation of voltage drooping characteristics for with and without PID controller and which are connected at the load side and also simulated the motor characteristics.

An induction motor is a variety of asynchronous AC motor and the principle of an induction motor is based on electromagnetic induction. An induction motor the type of rotor is based on the rotor design. Basically induction motor is a self-starting device because the power is supplied to the armature directly from a dc source. In sometimes induction motor is also called as rotating transformer. Induction motors are frequently used in domestic and industrial applications.

PMSM (Permanent Permanent magnetic Synchronous Motor) is much used in commercial programs, equipment for the home and software system due to the best quality, great twisting and great management performance. In order to get an excellent twisting management performance, many techniques are examined. Among the various management techniques, SVPWM (Space Vector Beat Size Modulation) with PI current operator is commonly used for twisting management over PMSM due to a great management performance. A PMSM uses permanent heat included in metal blades to create a continuing magnetic area. The stator provides windings linked with an ac supply to generate a Rotating Magnetic Field(RMF)

A permanent magnetic synchronous engine (PMSM) is an engine that uses long-lasting heat to generate the air gap permanent magnetic area rather than using electromagnets. These engines have significant benefits, gaining the interest of scientists and industry for use in many programs. Two options of permanent magnetic synchronous engine pushes are usually considered based upon on the back-EMF waveform: sinusoidal kind and trapezoidal kind. Then different management techniques (and management hardware) are applied. In this paper, a manager for the sinusoidal PMS engine is described.

2 Actual Concept

The actual concept of a 48V DC bus voltage having two DC-DC converters working in similar is regarded. The output of DC-DC converter voltages can be monitored by controlling the duty cycle of PWM converters, therefore, to be included drop features in a DC-DC converter, an obvious decrease in duty cycle is created with improvements in power. Slopes of decreasing characteristics of converter1 & converter2 are fixed to be -1/50 & -1/100 respectively to achieve the load sharing is ratio is 1:2. Further the recommendations to the continuous voltage control system as 48V. The control system and converters are simulated in Matlab/ Simulink. Hence the reaction of the control system to load fluctuations is studied. PID controller benefits are updated to improve the response of the system..

2.1 Buck Converter Design

Basically buck converter consists of a Mosfet, an inductor, diode, and a capacitor to filter out the output values. The buck converter is always operating with the arranged frequency mode. The converter is created to improve the size and efficiency by selecting the suitable switching frequency. The inductor value is measured so as to operate it always an ongoing method. Even for small load is present and to reduce the present swell content in the outcome.

Following equations are used to find the values of an inductor and a capacitor.

$L\ mean = ((Vin(min) - V\ out) * D\ max) / (\Delta IL * f)$

$C\ mean = 1/(8 * f * \Delta V\ out / \Delta IL - R\ c)$ Where,

$V\ in(min)$=minimum input voltage

V out=output voltage

ΔIL=inductor ripple current

D max=maximum duty cycle

$R\ c$=Equivalent series resistance of capacitor

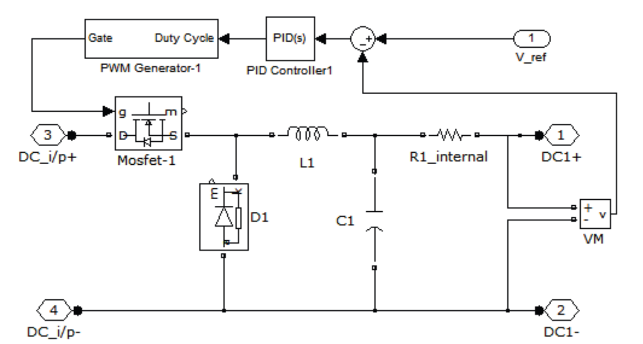

Fig. a: DC-DC converter (as simulated in MATLAB Simulink).

3 Results

Load sharing and voltage drooping for without PID controller:

The two converters are talks about the load sharing between the ratios of 1:2. The dc bus explains the short-term fluctuations in power from converter due to the unexpected changes in the load. Therefore the load sharing ratio is same even after the load is changed. In this situation, the dc bus voltage is not continuous so that voltage values are decreasing as the voltage value is absent. The results in dc bus voltage are displaying a drop of 0.5V from 48V to 47.5V.

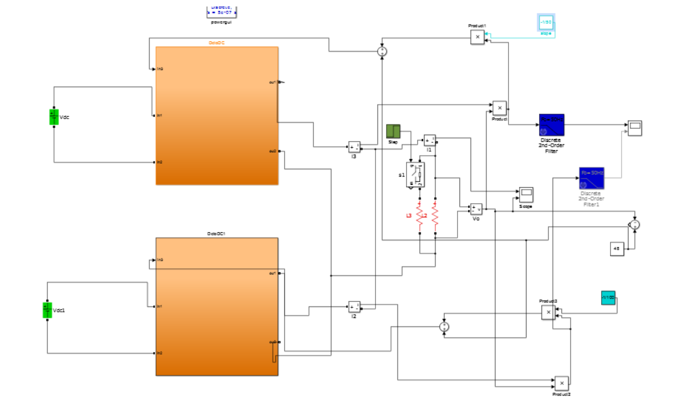

Fig1. Simulink diagram for without PID controller

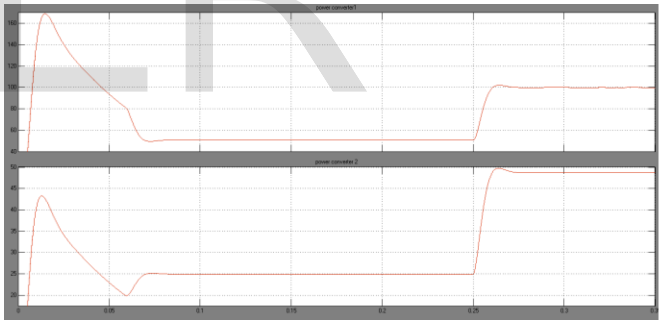

Fig2. Converter power for without PID or load sharing between the converters without PID

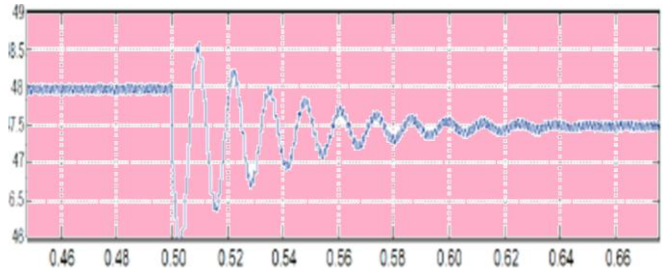

Fig3. Dc bus voltages for without PID

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4 Load Sharing And Voltage Drooping For With PID Controllers

In this case, the decreasing voltage is controlled by using a PID controller at the load side. The PID controller is used to reduce the drooping and maintaining the constant voltage at 48V on dc bus even the load changes but the load sharing ratio is always the same.

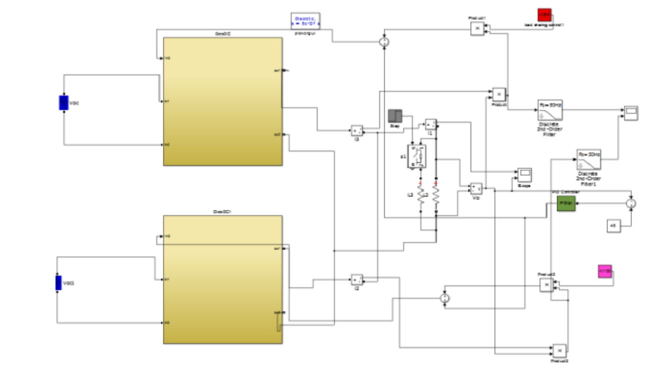

Fig4. Simulink diagram for with PID controller

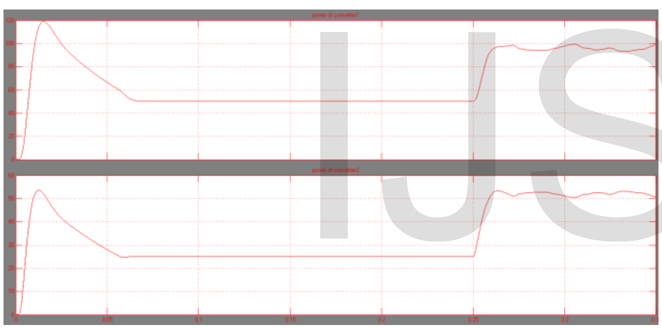

Fig5. Converter power for with PID or load sharing between the converters with PID

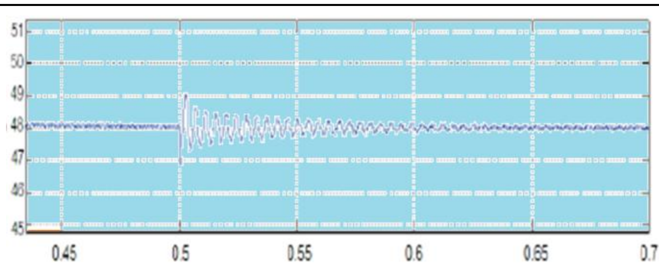

Fig6. Dc bus voltages for with PID

5 Proposed Strategy

In this paper, a 364V dc bus voltage having two DC-DC converters working in parallel is considered and by using PWM converter the output voltage is controlled. Therefore to be including sag features in DC-DC converter an obvious reduction in duty cycle is made with the increase in power. The slopes of the converter 1& converter 2 are fixed to be -1/50 & -1/100 respectively to achieve the load sharing ratio in 1:2 and further the constant voltage control system is set to be 364V. Therefore the dc bus voltage is converted ac voltage and that ac voltage is given to the induction motor and PMSM and motor characteristics and drooping characteristics are also observed.

6 Results

6.1 Load sharing and drooping for without PID controller and with an induction motor:

The ratio of load sharing between the two converters is 1:2 and the drooping has occurred in the voltage. The results in the drooping voltage show decreasing of 184V from 364V to 180V and also the motor characteristics are observed.

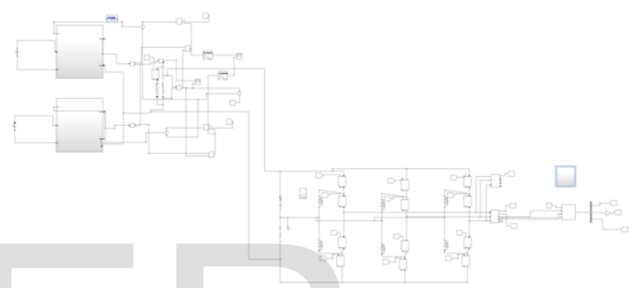

Fig7. Simulink diagram for voltage drooping characteristics for without PID

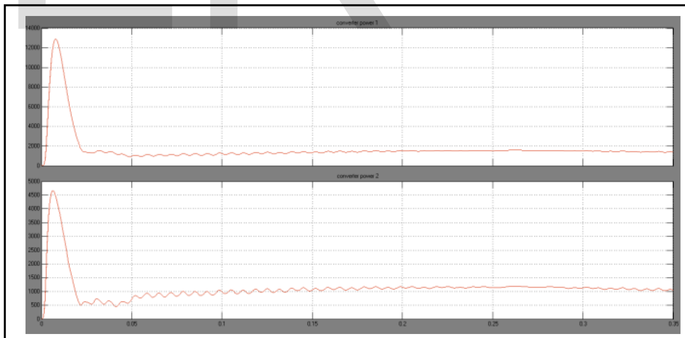

Fig8. Converter powers for without PID

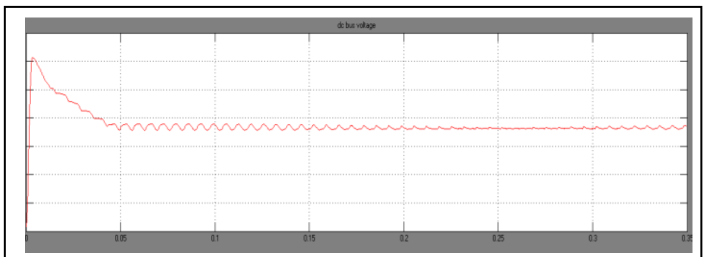

Fig9. Dc bus voltage for without PID

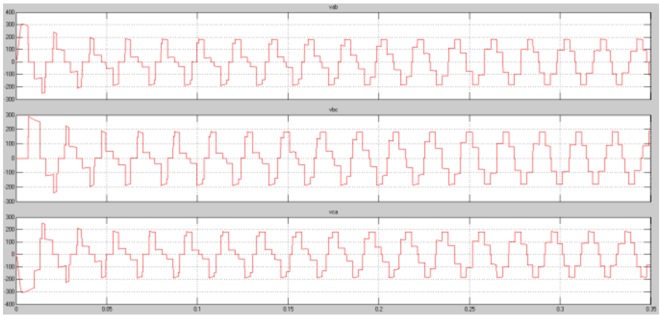

Fig10. 3-phase line voltages without PID

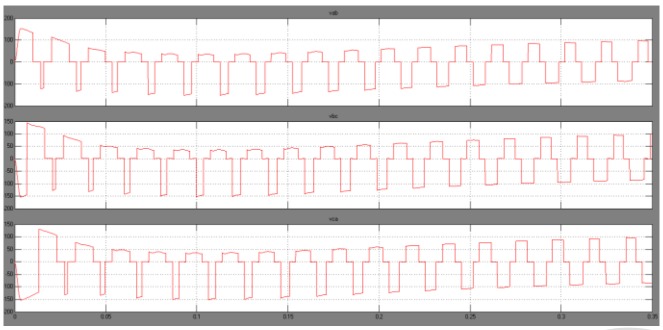

Fig11. 3-phase phase voltages without PID

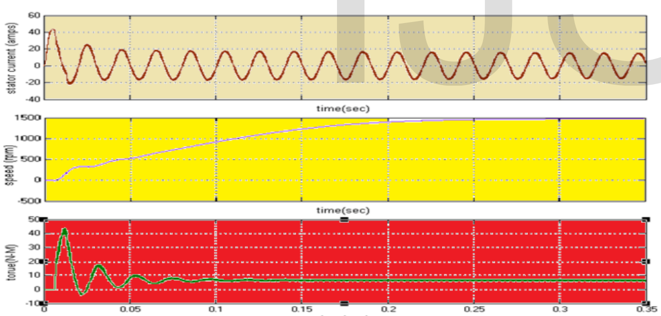

Fig12. Induction motor characteristics for without PID

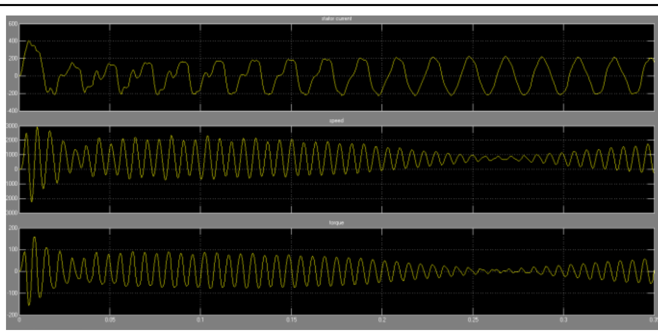

Fig13. PMSM characteristics for without PID

6.2 Load sharing and drooping for with PID controller and with an induction motor

In this case, the voltage is controlled by a PID controller. This controller is used to reduce the voltage and maintain a constant voltage at 364V. Load sharing ratio is the same.

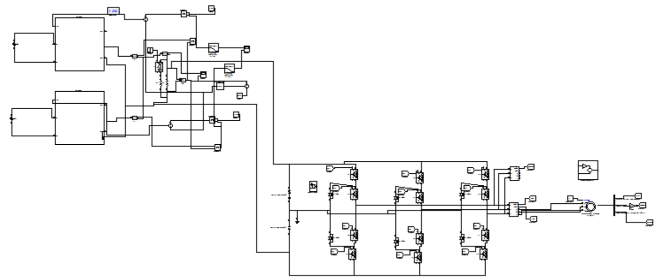

Fig14. Simulink diagram for voltage drooping characteristics for with PID

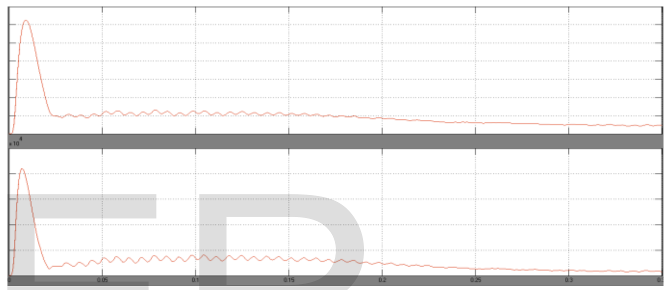

Fig15. Converter powers for with PID

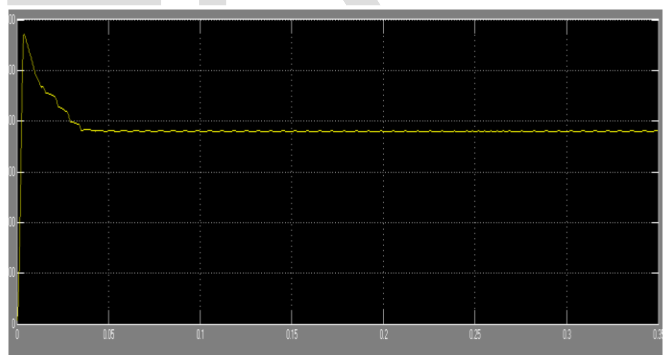

Fig16. Dc bus voltage for with PID

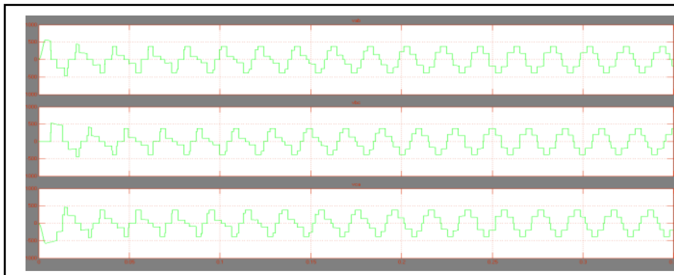

Fig17. 3-phase line voltages with PID

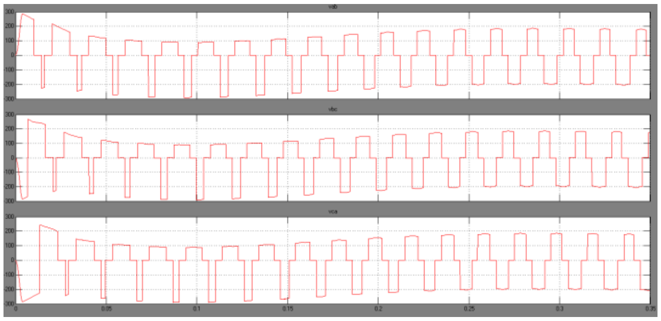

Fig18. 3-phase phase voltages with PID

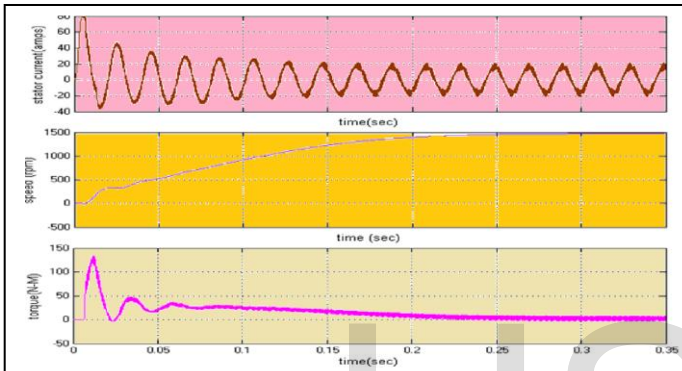

Fig19. Induction motor characteristics for with PID

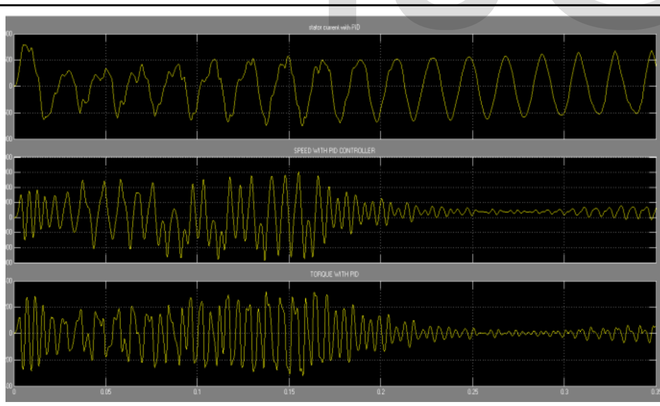

Fig20. PMSM characteristics for with PID

7 Conclusion

This paper presents a Voltage Control and Load Sharing in DC Distribution Systems with Three Phase Ac Machines. By controlling the voltage axis intercept of droop characteristics, constant DC Bus voltage can be maintained under any loading conditions. Transient response of control system can be improved by tuning gains of PID compensator or by replacing it with better modern control technique.

Future Scope

This system is designed to maintain a power quality improve the power-sharing issues. This can be extended to the other types of motors for various renewable energy sources and also extended to a fuzzy logic controller.

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