A Review of Simulation and Hardware Design of a Fly back Converter for Solar Energy Powered DC Loads

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***Abstract** —This review paper provides a Simulation and Analysis Of AC-DC Fly back Converter which is operated in Discontinuous Conduction Mode (DCM) to feed supply to Vector Controlled PMSM Drive. In this operation also Improved Power Quality at supply current and voltage of PMSM Drive.*

Keywords — *Put Fly back Converter, PMSM Drive, THD, PF, DPF, DF, MOSFET, IGBT, etc.*

I. Introduction

The Permanent Magnet Synchronous Motor used to make low power rating application devices such as Refrigerator, Washing Machine, House-hold appliances, Medical Equipment, Wide speed range of servo drives and industrial robots. PMSM drives are used for its high efficiency, fast dynamic response and small size etc. For the operation of PMSM Drive first need to convert AC supply power to DC power using rectifier circuit and then DC power to variable magnitude and variable frequency AC power to feed PMSM. PMSM operates on two mode vector control and direct torque control. Here we are using vector control PMSM. Here for conversion of AC-DC we can not use simple rectifier circuit because in this circuit large value of capacitor is required which has drawn a large value of small narrow pulse current. Since we get the capacitor voltage variation is nearly constant. But due to this current we get the supply voltage poor in terms of high value of Total Harmonics Distortion (THD), low value of

Power Factor (PF), Displacement Factor (DPF), and poor Distortion Factor (DF). These large harmonic currents not only produce distortion but also produce conducted and radiated Electromagnetic Interference (EMI). This problem become more serious when all the devices are running in single phase supply [1-3]. Below Figure.1. Shows PMSM drive directly connected to power supply system.

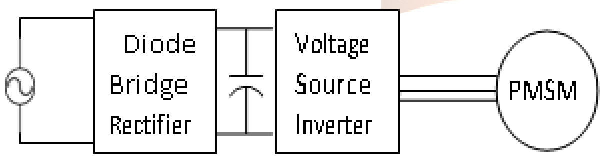


Figure.1. Basic Block Diagram of PMSM drive directly connected to Power Supply.

This problem is reduced by using AC-DC converter instead of simple rectifier circuit. Many types of AC-DC converters are available. The classification of AC-DC converter is shown in Figure 2. It classified in three ways Buck, Boost and Buck-Boost. It again classified in subtypes. Buck consists of Forward, Push-Pull, Half bridge and Full Bridge. Same way Boost consist all Buck converter and Buck-Boost consist Fly back, Cuk, Sepic and Zeta converters [8]. Here we are using high frequency isolation AC- DC fly back Buck-Boost type converter because of the following reasons:

1. Push-Pull and Half bridge converter equal switching losses compared to single switch converters e.g. Fly back, Cuk, Sepic and Zeta converters because only one switch operates at a time, however they can be used for high power applications with cost of additional switch and associated circuitry.

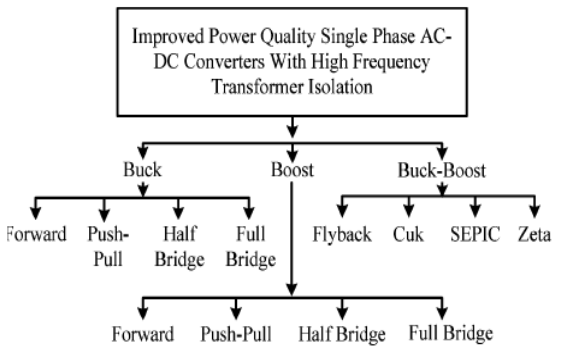
2. Fly back converter and Zeta converter provides additional protection against over current and inrush current as compared to Cuk and Sepic converter topologies.

3. Fly back converter topology requires only a capacitor as an output filter and the Cuk converter topology requires smaller core, and has lower core and copper losses [8].

So that by connecting high frequency AC-DC fly back converter with PMSM drive we get improved quality of supply power for feeding PMSM drive.

II. P SYSTEM CONFIGURATIO

The complete block diagram is shown in Figure 3 and Figure 4. In Figure 3. AC-DC converter is operating in DCM with an input current in phase with an input AC supply voltage. This converter is design for 600w vector controlled PMSM drive. The regulated output DC voltage fed to the PMSM drive system as shown in Figure 4. Output of the isolated fly back converter is fed to the Voltage Source Inverter of vector controlled PMSM drive to control appropriate currents signals to stator winding of the motor. In this drive, a current controlled pulse width modulated (CC-PWM) VSI is used to control the speed of the drive. The VSI is made up of six active bi-directional switches IGBTs with freewheeling diodes. The motor is use position sensor



for sensing the position of rotor. The rotor position in

Figure.2. Classification of improved power quality single-phase AC-DC converters with HF transformer isolation the form of two signals, which are the sine and cosine wave of rotor position angle (θr). The rotor speed (ωr) of the motor is derived from position sensor and compared with the reference speed (ωr*). The error in speed (ωe) is processed in the PI speed controller, which generates the reference torque (Tk*). This reference torque is limited using a limiter and the limited reference torque (Tref*) is used to generate torque component of reference q-axis current (iq*). The direct axis current (id*), which is flux component of stator current, is obtained as function of the rotor speed of the motor. Both torque component (iq*) and flux component of current (id*) are transformed to the stationary reference frame (ia*, ib*, ic*) using inverse Park transformation, using limiter and where these currents along with sensed currents(ia, ib, ic) are fed to CC-PWM VSI to determine the switching pulses for devices of VSI. In response to these switching signals, the VSI controls the winding currents of PMSM close their reference values, thereby controlling the speed of the motor in the desired manner.

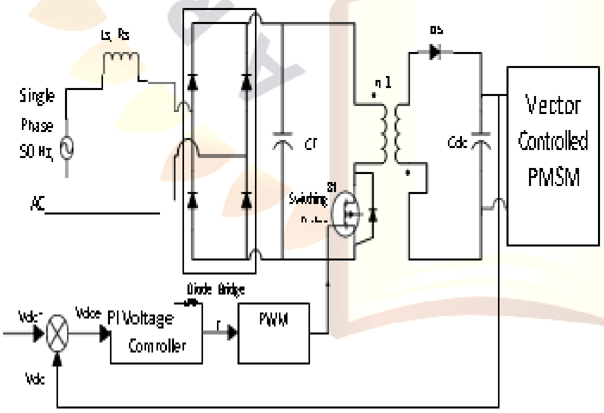


Figure.3. High frequency isolated AC-DC fly back converter feeding vector controlled PMSM drive.

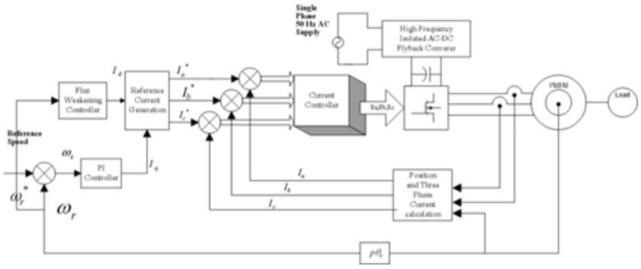


Figure.4. Vector control strategy of PMSM drive

III. OPERATION OF FLYBACK CONVERTE

An AC-DC Fly back converter operated in DCM for power factor correction of input supply. Figure.5 shows the equivalent circuit of AC-DC fly back converter.

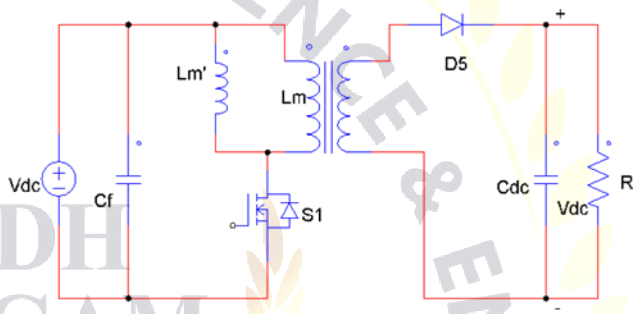


Figure.5.Equivalent circuit of high frequency isolated AC-DC fly back converter.

A. First Stage of operation

This first stage is defined by the on time ton of the witch S1 and shown in Figure 5. In the first stage of converter operation, peak input current (ipk) refer to secondary The obtained average power is equal to the power consumed by the converter at input side [10].

B. Second Stage of operation

This second stage is defined by the diode on time tdon of the diode (D5) and shown in Figure 5. It is found that the fly back converter operates as a perfect power factor preregulator (PFP) in the DCM provided that the fly back magnetizing inductance current ceases to zero before the end of switching period Ts dc out

III MODELLING OF THE DRIVE SYSTEM

The high frequency isolated AC-DC fly back converter feeding the variable speed vector controlled-PMSM drive system. This whole system is model in following ways.

Modeling of high frequency isolated AC-DC flyback converter: In this system supply is given to the diode bridge circuit and then given to flyback converter. Here for MOSFET is used for switching device which control the output voltage of fly back converter. The *output* voltage of fly back converter (Vdc) is compared with reference voltage(Vdc*). The error of this comparison gives to the PI voltage control which controls the integral and proportional gain. Then it compare with the triangular waveform by using the limiter and get Duty ratio of MOSFET. In this comparison following equation are used.

$$u_{ref}(n) = u_{ref}(n-1) + K_{pdc}\{V_{dce}(n) - V_{dce}(n-1)\} + K_{idc}V_{dce}(n)$$

Where, uref(n) is the output of the voltage controller at n^{th} sampling instant. Uref(n-1) is the output of the voltage controller at $(n-1)^{th}$ sampling instant. Vdce(n) is error in dc-link voltage at nth sampling instant. Kpdc is proportional gain of the voltage controller and Kidc is integral gain of the voltage controller..

1) Modeling of Vector Controlled PMSM Drive System

Figure.4 shows the block diagram of the vector controlled PMSM drive system. It consists of control scheme with proportional plus integral (PI) speed controller, field weakening controller, d-axis current calculation, vector controller, Pulse Width Modulated (PWM) Current Controller (CC), voltage source inverter and PMSM.

(1) PI speed controller: The input to the PI speed controller *is the speed error r(k) between reference speed ωr(k)* and the motor speed R (k)* . This error is estimated at the kth sampling instant as:

IV Conclusions

The simulation and analysis of AC-DC fly back converter in discontinuous current mode of operation with high frequency transformer isolation to feed the vector controlled PMSM drive implemented in PSIM software. The simulated result shows the low THD value at supply side with power factor improvement.

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