Simulation of AC-DC Series Resonant Converter using Control of Supply Power Factor by PID Operation

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Abstract **–This ac-dc series resonant converter using control of supply power factor controls input power factor at unity with zero angle delay. By using PID operation strategy for switching control the system performs reliable operation in supply power factor and elimination of higher harmonic components can be achieved. By using this achieves low THD of input line current and it is found to be 2.24%. This system has fast response, ZCS (zero current switching) and natural commutation of thyristors.**

Keywords: ZCS, Resonant converters, AC-DC converter, SCR.

[I] INTRODUCTION

The basic function of ac-dc converter is to convert constant ac input voltage to an adjustable dc output voltage .Many types of ac-dc converters are used in office as well as in domestic and factory automation applications. The drawback of these converter is that the power factor depends on firing angle. When firing angle increases power factor decreases and line current contains lot of harmonics. This drawback is improved in

- A novel switch mode rectifier(SMR) with bidirectional flow and has six force commutated switches makes the controllable input power factor by PWM but this method still generates lot of harmonics.
- Next, based on idea of coordinate transformation utilized the PWM control method for the SMR. In this method the iron losses are visible due to high frequency.
- A current control strategy with fixed frequency to the PWM ac to dc converter but in this method switching losses are very big because of forced commutation switches.
- The proposed switch mode converter has the main limitation is the EMI produced due to large di/dt and dv/dt by a switch mode operation.

For realizing high switching frequency in converters and for minimizing the above mentioned drawbacks recently a high frequency series resonant dc link converter is proposed to obtain high power density, low switching losses as well as fast response.

This work proposes a method for control of supply power factor at unity with zero angle delay. In converter switching, the PID operation is used and by utilizing the PID operation, the supplied power factor can be controlled in unity and the higher harmonic components are eliminated also achieves low harmonic distortion(THD) of input line current and found to be 2.24%.

[II] INPUT POWER FACTOR CONTROL TOPOLOGY

Ac-Dc series resonant dc link converter

Through ac-dc series resonant dc link converter the output voltage across load is obtained and as shown in figure 1 the ac-dc series resonant dc link converter is composed of:

- Six thyristor bridge.
- Input low pass filter L_f and C_f.
- Resonant elements L_o and C_o
- Bias inductance L_d.
- Load R_L.
- C_L acts as smoothing capacitor.
- Switching of thyristor is performed at ZCS instant of resonant current.

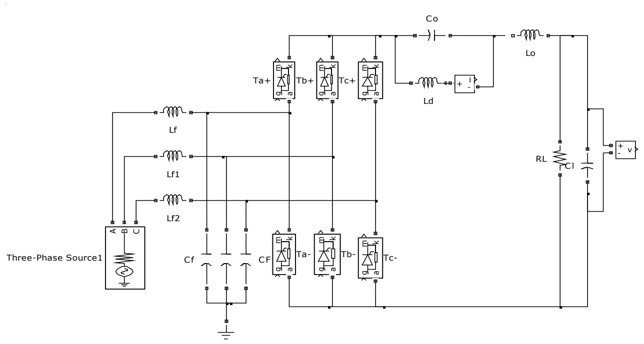


Fig 1 Ac-dc series resonant dc link converter

[III] CONTROL BLOCK DIAGRAM OF AC-DC SERIES RESONANT DC LINK CONVERTER USING PID

As shown in the figure the control block diagram of ac-dc series resonant dc link converter system is composed of 3 stages. Firstly through ac-dc series resonant dc link converter the voltage across load is obtained. Secondly the current reference generator scheme derives the current to PID controller. Next the error signals flow through the PID controller to the discrete PWM generator and then the selected signals flow to switch the thyristors. Through ac-dc series resonant dc link converter the output voltage across load is obtained. Now we have to generate the output of current refrence generator as

$$I^*in=(VL)^*(Id^*)/3Vin(COS\Phi)$$

Firstly Id* is decided by the required load voltage

and load resistance as

$$Id^*=VL/RL$$

The amplitude of I*in is defined as

$$I^*in=VL\ Id^*/3Vin(COS\Phi).$$

Where COSΦ is the power factor.

Next the difference of the current produced by the current refrence generator and the input current flows to the pid controller.

A. PID OPERATION

The output of the current refrence generator current is compared with the input current and then it is applied to PID controller.

The error current is processed in PID circuits. Further the error signals(iERPID) flow from the PID to the discrete pwm generator, then the signals flow to switch the thyristors.

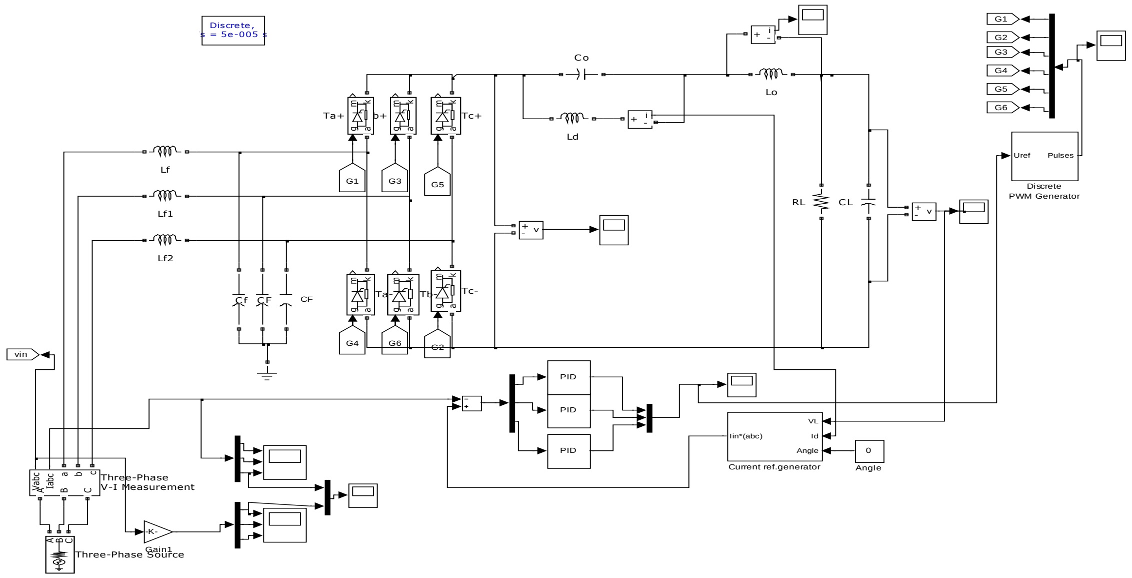
In pid circuit the balance of coefficients are important these are adjusted with load condition. The signals(iERPID)are generated with sampling frequency as high as switching frequency.

B. THYRISTOR SWITCHING

Assume that the two thyristors Ta+ and Tc- are switched to the conducting state at t=0 as shown in previous figure.

When resonant current pulse reaches zero, all the thyristors are naturally turned off also bias current through bias inductance Ld begins to charge the resonant capacitor Co, so that the forward bias reaches the value which is enough to trigger the next pair of thyristors.

As forward bias has reached a settled threshold voltage, the next set of two thyristors are triggered to obtain a new current pulse



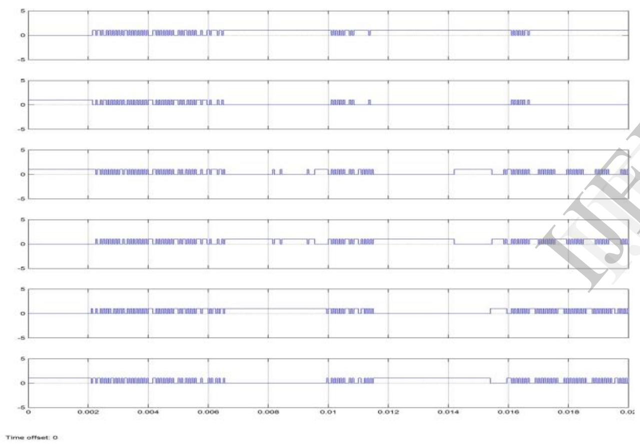


FIG-3 Thyristor Switching

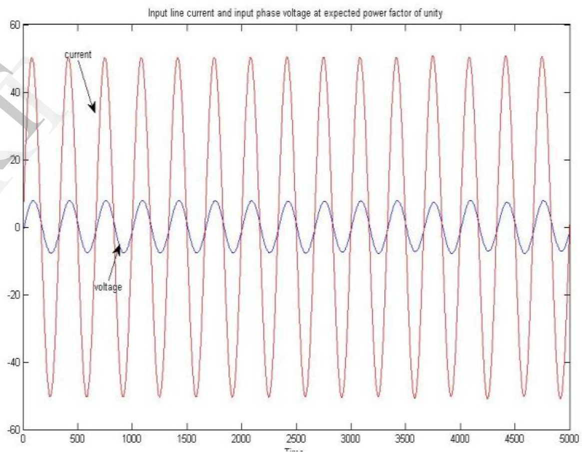


Fig-4 I/P line current and I/P phase Voltage at expected power factor of unity.

[V] SIMULATION RESULTS

Simulation parameters:

- Ac input voltage magnitude is 70V.
- Resonant element C_o is 0.9µF and L_o is 21.4µH
- Bias inductance L_d is 5mH
- Filter inductance L_f is 230mH and capacitance C_f is 30µF.
- Load R_L is 200 ohms.
- C_L is 470µF.
- Frequency is 60Hz.

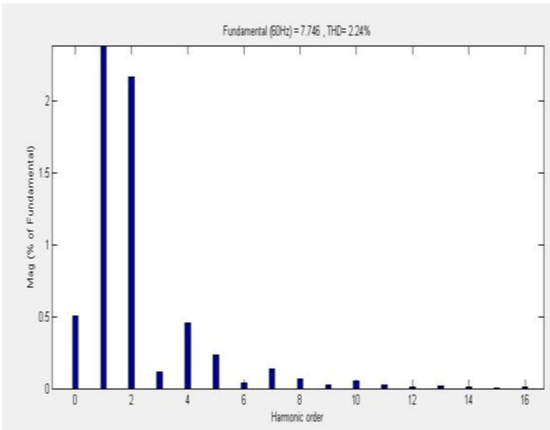


Fig-5 Harmonic components of input line current at expected power factor of unity.

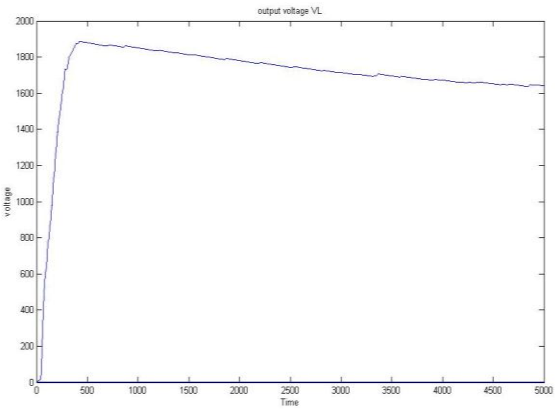


Fig-6 Output voltage VL.

CONCLUSION

In this dissertation work the "simulation of ac-dc series resonant converter using control of supply power factor by PID operation" has been simulated and analysed. I used PID operation strategy for switching and controlling purposes. the objective of dissertation work is to control input power factor and also to reduce the total harmonic distortion (THD) of input line current at unity power factor. in MATLAB/SIMULINK, input current harmonics and total harmonics distortion can be analysed through powergui/FFT toolbox. here we used PID controller for the controlling of the circuitry. after simulation, result shows that we can control the power factor to unity and also the lower THD of input line current.

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