A Digital Controller of Hybrid Filter Based on Pseudo-Inverse Filtering Technique

Major Project Report

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF TECHNOLOGY

IN

ELECTRICAL ENGINEERING

(POWER ELECTRONICS, MACHINES & DRIVES)

By

RITESHGIR S. GOSAI

11MEEP20

Department of Electrical Engineering

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Undertaking for Originality of the Work

I, **Mr. RITESHGIR S. GOSAI**, Roll.No.**11MEEP20**, give undertaking that the Major Project entitled **"A Digital Controller of Hybrid Filter Based on Pseudo-Inverse Filtering Technique"** submitted by **Mr. RITESHGIR S. GOSAI** submitted by me, towards the partial fulfillment of the requirements for the degree of Master of Technology in **Electrical Engineering (POWER ELECTRONICS, MACHINES & DRIVES)**of Nirma University, Ahmedabad, is the original work carried out by me and I give assurance that no attempt of plagiarism has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

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Date:

Place:

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Endorsed by

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Industrial guide:

Mr. M.R.TILWALLI

Proprietor

Gururaj Engineering

Makarpura

Vadodara

Certificate

This is to certify that the Major Project Report entitled **"A Digital Controller Of Hybrid Filter Based On Pseudo-Inverse Filtering Technique"** submitted by **Mr. RITESHGIR S. GOSAI (Roll No-11MEEP20)** towards the partial fulfillment of the requirements for the award of degree in Master of Technology(Electrical Engineering) in the field of Power Electronic, machine & drives of Nirma University is the record of work carried out by him under our supervision and guidance. The results embodied in this major project work to the best of our knowledge have not been submitted to any other University or Institution for award of any degree or diploma.

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It's my pleasure in submitting the report on Prototype simulation Model Development of HVDC transmission system. I am grateful to my Project Guide Prof.Dr. P.N.Tekwani for allowing me to work on this project and his constant support and also he offered valuable advice when I needed it. I acknowledge with thanks to Prof.Dr.P.N.Tekwani and My industrial guide Dr.M.N.Tilwalli for their great encouragement. They have been very generous in extending their cooperation and help and this has enabled me to carry out this study properly. I would also like to thank the other faculty members of my group as well as the rest of the faculty for their selfless motivation. At last, I thank my friends and family for their support and encouragement.

RITESHGIR S. GOSAI

11MEEP20

Abstract

Now a days, the 12 pulse converter has vital role in the field of hvdc system. The hybrid filter in hvdc system used to minimize the ripple current. The current signal from the dc link sense by Atmega controller and develop PWM pulses. By using the passive filter to reconstruct the ripple. The proposed system is simulated with the MATLAB simulink software. The hardware prototype results compare with simulation results.

Contents

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Abbreviations

HVDC ..... High Voltage Direct Current
MOSFET ..... Metal Oxide Semiconductor Field-Effect Transistor
PWM ..... Pulse Width Modulation
ADC ..... Analog To Digital Converter

Nomenclature

I_h ..... Harmonic current
I_{pf} ..... Passive Filter Current
I_l ..... Load Current

Chapter 1

Introduction

1.1 Introduction

EHV transmission links,superposed on a lower voltage ac network,or inter-connecting two such networks,or connecting distant generating plants to an ac network,are compared as to their principal components and the arrangements thereof,according to whether the line operates on ac or dc. Three phase lines cannot be operated,except for a very short time(less than 1 sec) with one or two conductors open,because such operation causes unbalance voltages in ac system and interference in parallel telephone lines. Therefore,three pole switching is always used to clear permanent faults,although such a fault may involve only one conductor.Long circuits ac links are usually sectionalized by means of intermediate switching stations for several reasons. On long EHV ac lines,shunt reactors are required for limiting the voltage,especially at the light loads.In some case High-voltage transmission line has advantages over ac transmission line. The following type of applications for used in HVDC transmission line.

a. The cables underwater are longer than about 30 km. The high capacitance of the requiring intermediate compensation stations because of ac transmission is impractical.

b. The nominal frequency of the two system are different.Asyncrroues between two

system would not be feasible because of the system stability problem.

HVDC systems more capable to control the transmitted power. The HVDC systems is essential for the study of the stability of the power system. The proper design of the HVDC control is essential to ensure satisfactory performance of the overall ac/dc system.

1.1.1 Power Quality and Power Quality Issues

The power quality is a simple term, it describe a number of the issues that are found in any electrical power system. The issue of good and bad power depends on the different consumer. If a equipment function satisfactory,either consumer feels that the power is good or if the equipment does not function as intended, there is a feeling that the power is bad .

The deviations in five categories:-

- Harmonic distortion.
- Under or over voltage.
- Dips and surges.
- Transients.
- Blackouts.

These power quality problems has a different cause at different station.Some problems are a result of the shared construction. The benefit of relatively few customers and would be uneconomic point of view a granted quality supply would required. Whether it would be technically feasible within the current social and legal framework.In which any customer is normally entitled to excavate roadways with risk of cable damage. A high voltage direct current(HVDC) electrical power transmission system uses DC for the less power. Now a days, static systems used rectifiers,which were high maintenance and unreliable required. In HVDC systems the thyristor valves was first used.

1.1.2 Rectifying and Inverting system

At the AC ends of the HVDC system,we have a step up transformer before the rectifier and a step down transformer after the inverter.The voltage is stepped up to about 500KV for the HV system and converted to DC by rectification.The output of the three winding transformer is connected to bridge rectifier. At inverter end, the HVDC is converted to HVAC. Many substations are set up in such a way that they can work as both rectifiers and inverters. The output of the inverter is then stepped down by a three winding transformer back again.

1.2 Types of DC Links

HVDC links may be broadly classified into the following categories:

a. Monopolar links

b. Bipolar links

c. Homopolar links

1.2.1 Monopolar link

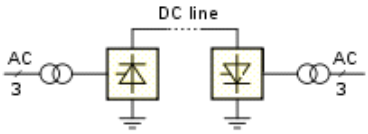

Figure 1.1: Monopolar link

It uses one conductor, usually of negative polarity.The cost consideration often to the use of such dc systems, particularly for cable transmission. This type of configuration are used in bipolar system. Instead of ground return, a metallic return

may be used in situations where the earth resistivity is too high. The conductor forming the metallic return is at low voltage.

1.2.2 Bipolar link

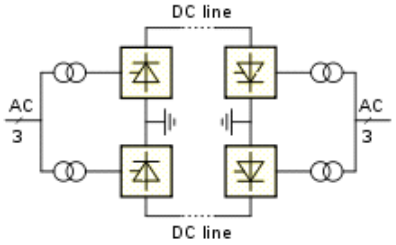

Figure 1.2: Bipoloar link

In the above fig 1.2 the two conductor one positive and the other negative. Each terminal has two converters of equal rated voltage.Normally, the currents in the two poles are equal, and there is no ground current.each pole operate independently. If one pole is isolated due to a fault on its conductor, the other pole can operate with ground.

1.2.3 Homopolar link

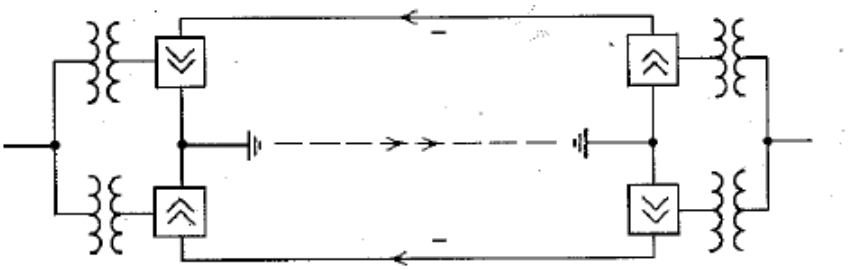

Figure 1.3: Homopolar link

It has used two conductors having the same polarity. Now usually a negative polarity is preferred because it causes corona effect. The return path for such a system is through ground level. When there is a fault on one conductor, the entire converter is feeding power at the remaining conductors which, having some overload capability, can carry more than the normal power.In contrast, for a bipolar scheme usually not feasible.

1.2.4 Literature survey

Various references have been used for theoretical understandings as well as an aid to the simulation carried out.

a. As per this paper psuedo invese technique is used for removing multiple of 12 order.Dsp controller is used to generate pwm pulses from sensing the ripple at dc link.The implementation on 30 kva hvdc laboratory system.[1]

b. As an introduction to the fundamental concepts of HVDC, Direct current transmission by Edwards Wilso Kimbark. It provides brief explanations on the rectification and inversion modes of operation and the releted problems like phase angle delay.All pertinent formula have been derived from fundamental principles. The control of the link is explained in focusing on the subtle nuances of HVDC control.[2]

c. All the major issuse pertaining to line commutated HVDC lines with thyristor conveter, Power System Stability by P.S.kundur is an in valuable book. It allows us to understand the concepts within a few days if time is limited. It also provides a basic understanding of converter action, overlap, control of the link and the introduction to topics like harmonics and modelling of HVDC lines.[3]

d. HVDC transmission Systems by K.R.Padiyar is a true textbook on the subject. It is an up-to-date book on the subject.Coverage of material is thorough and no

topic is left out. The book also serves as a reference as facts are easily accessible references are provided for further reading.[4]

e. Power Electronics by P.C.Senis a nice book for the understanding of various triggering circuits of the Phase Controlled Converters.It provides basic ideas for designing of different triggering circuits of the converters. [5]

f. Inverse-filter control and zero-crossing frequency distributions based on estimating formant frequencies of speech signals. In this method, which is called the inverse-filter control (IFC) method.According to the results, it is understandable that existence to stable formant trajectories.[6]

g. In this paper, The active DC filter controlled by a notch filter has been described and successfully applied to compensated the ripple currents on a simulated HVDC system.[7]

h. The control principle of a hybrid ADF filter installed in the lindome HVDC converter station.The drawback is long response time, low stability margin and filtering an unnecessarily many frequency of these controller. Shorter system response time and improved stability margin of these controller.[8]

i. A DSP based ADF filter for a single phase system is represented.The entire scheme required less feedback information compared to other results.[9]

j. The active DC filter works out the equation of the proposes a novel composite control strategy.Which is implemented by ac approximate inverse system control and a PI control.To obtain a high sensing performance the approximate inverse system control.[10]

Chapter 2

HVDC and Filtering Equipment

The three phase supply is giving to the three phase transformer.The transformer connection in primary side star and in secondary side star and delta.These transformer is connected to the 12 pulse rectifier.In 12 pulse rectifier two 6 pulse bridge connected in series.These are large reactor having inductance as high as 0.1H connected in series with the 12 pulse converter.They purposes of decrease the voltage and current in DC line.

Ripple current goes to the Atmega controller than this ripple pulses compared with the triangular pulses.so that ripple currents enter into passive filter.The phase shifted ripple current enter into transmission line.

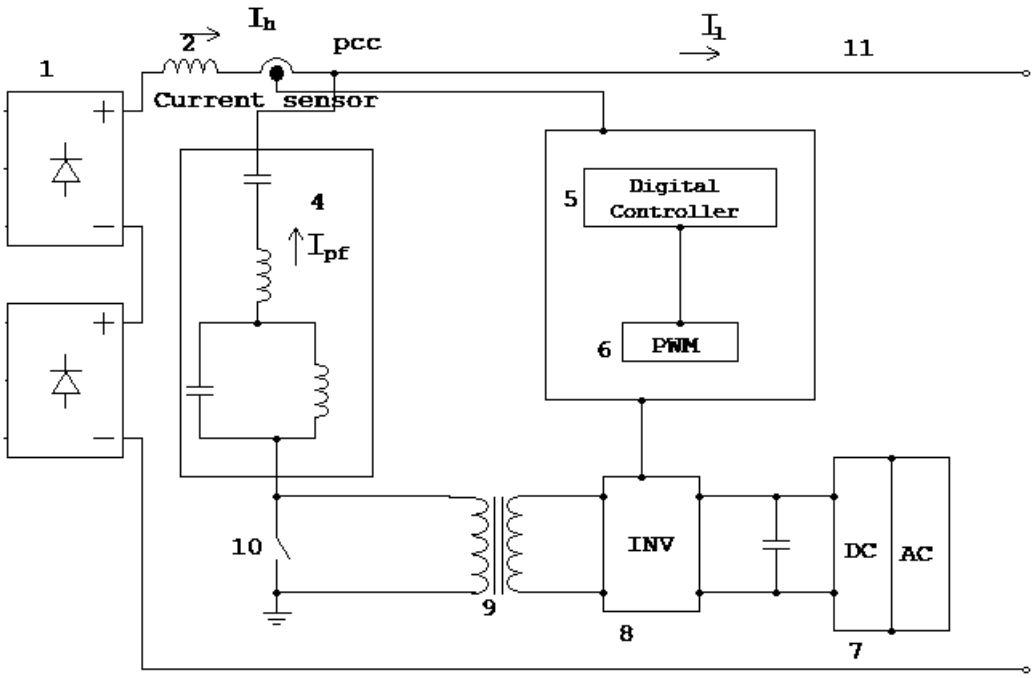

Figure 2.1: Single line diagram of HVDC system

In the above fig.2.1 the load current at point A is used as feedback signal, which act as simple closed-loop system. However,In addition to that, the ripple current component is easily sense, so it is difficult to sense ripple current from the DC line. The step is considered and solutions given below.

First method introduce of pseudo-inverse system. so the filter produce to minimize ripple current.When two current which are passive filter current and ripple current meet at point is called point of common coupling.

Chapter 3

Simulation and Results of Hysteresis band

The fig.3.1 shows the phase supply 440 V, 50 HZ. These supply is given to the 12 pulse converter. These converter connected to the resistive load. In DC line one smoothing reactor(L = 0.1H) are connected series with the load.The external resister are connected parallel with the load.

When a resister connected parallel with a load at delay of 0.1sec timer is connected. Then the current rises from 6 A to 12 A.

The load side mean current and actual current are measured. I have used 50 constant values to reduce the ac component. Which is present in output dc current.these current are compared with the rational operator. The greater than and equal to limit measured the upper limit,and less than and equal to limit measured the lower limit. The AC component are reduce to zero.

The output of hysteresis is given to the bridge of inverter.in this case,for mosfet 1,2,3,4 output is directly given.therefore inverter is given to the transformer.The output of transformer is connected with the double tuned passive filter.harmonic current by inverter is injected to the output of 12 pulse converters.

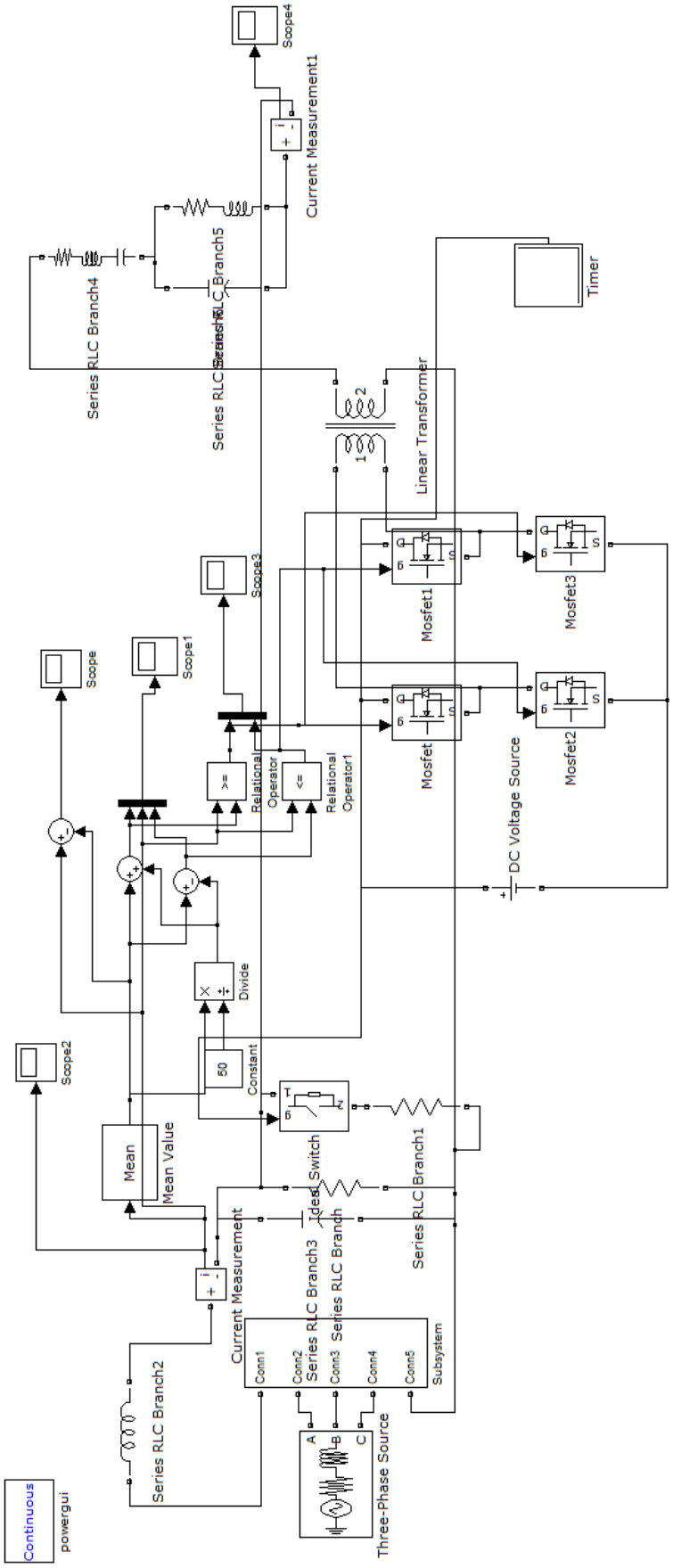

Figure 3.1: Matlab Simulation of hysteresis band circuit

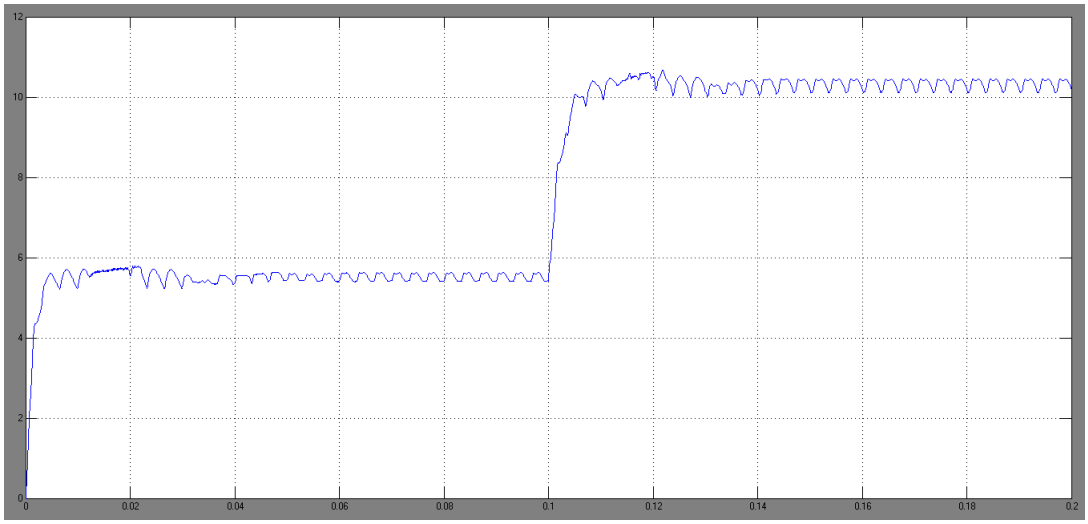

Figure 3.2: DC current output
Scale: Current: X-axis:1cm=0.02sec, Y-axis:1cm=6A

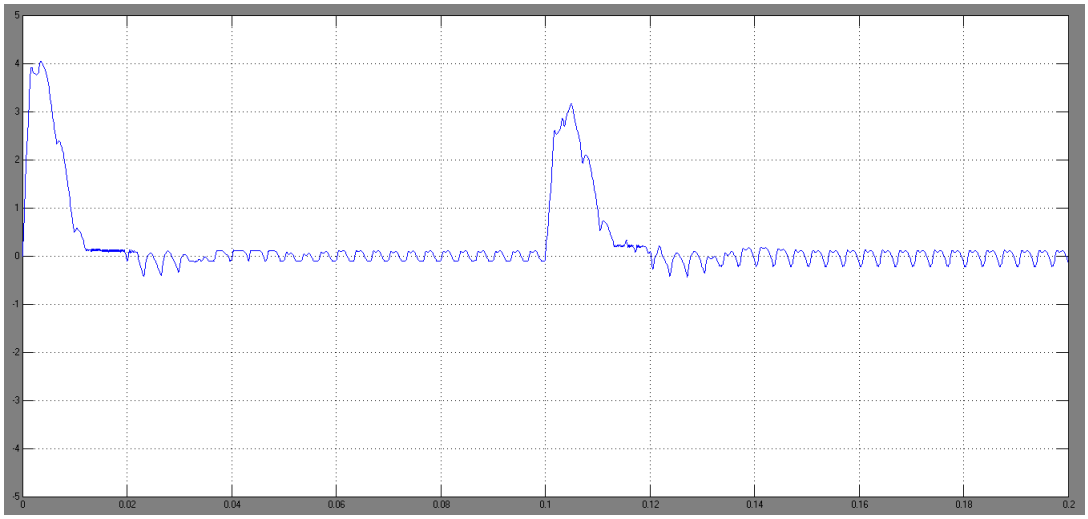

Figure 3.3: Zero DC current
Scale: Current: X-axis:1cm=0.02sec, Y-axis:1cm=4A

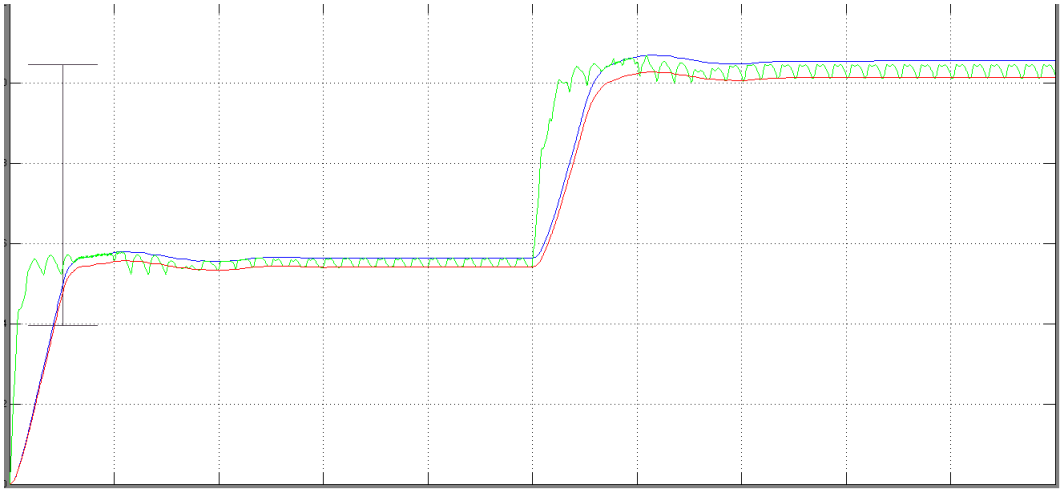

Figure 3.4: Hysteresis band

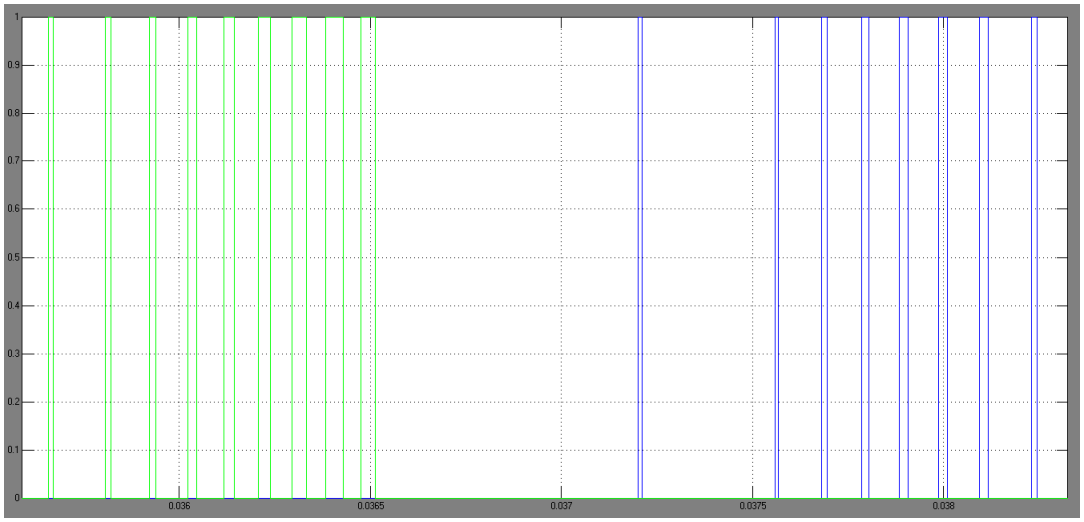

Figure 3.5: Pwm pulse

Chapter 4

Simulation and Results of HVDC System

The fig 4.1 shows three phase supply 415 V, 50 HZ is given to the two converter transformer.one of the transformer is STAR/SATR and other is STAR/DELTA.After the transformer, the uncontrolled rectifier performs ac/dc conversion. The bridge consist of high voltage valve connected in 12 pulse arrangement. The transformer provide grounded three phase voltage source of appropriate level to the converter bridge.The dc system will be able to establish its own referable to ground,usually by grounding the positive or negative end of the valve converter. These are large reactor of 1.0H inductor connected in series with the rectifier bridge. Using these smoothing reactor to minimize ripple currents in the dc line.

4.0.5 Without filter Simulation

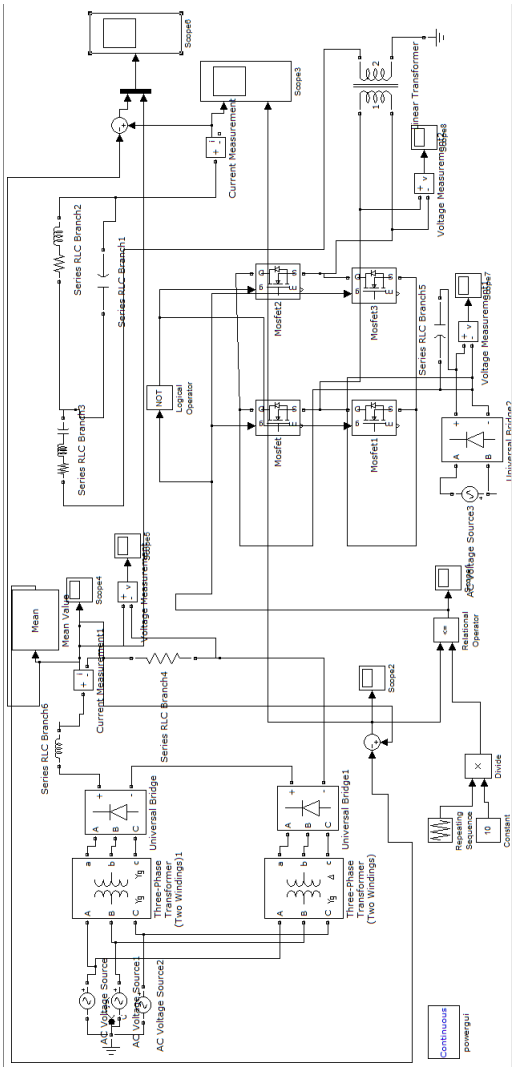

Figure 4.1: Without filter simulation

The fig 4.2 shows the simulation of results represents current before compensation.The output ripple current present in dc line.

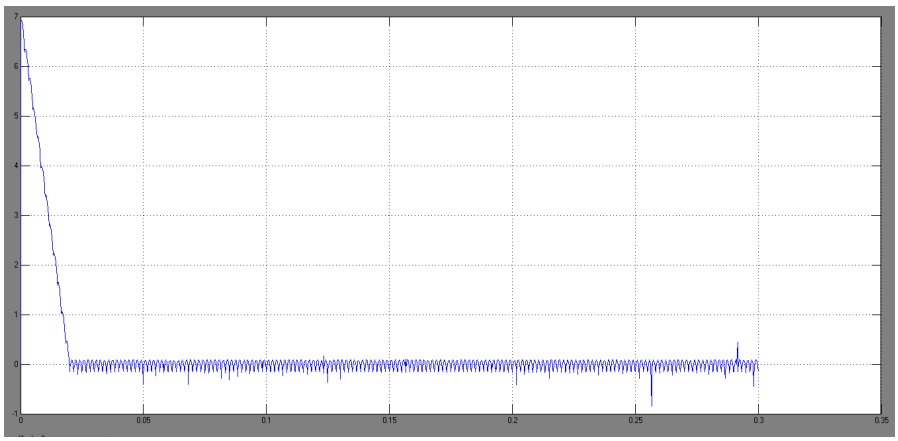

Figure 4.2: Output ripple current
Scale: Current: X-axis:1cm=0.05sec, Y-axis:1cm=1A

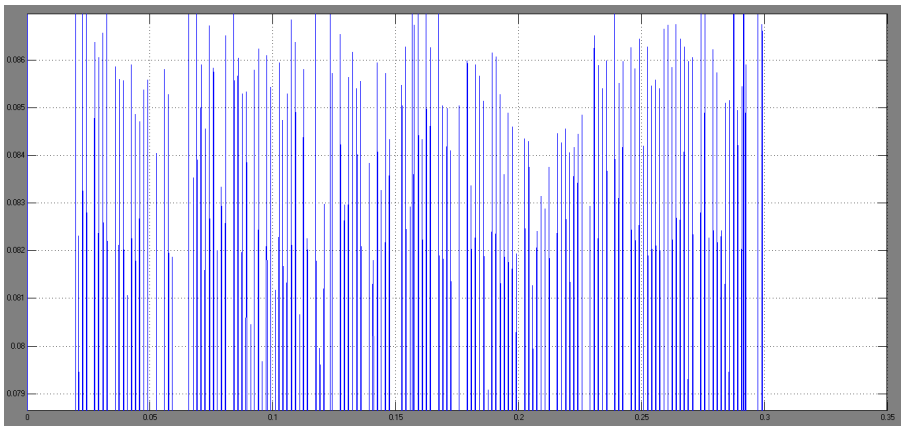

Figure 4.3: Output ripple current1
Scale: Current: X-axis:1cm=0.05sec, Y-axis:1cm=0.01A

4.0.6 With filter

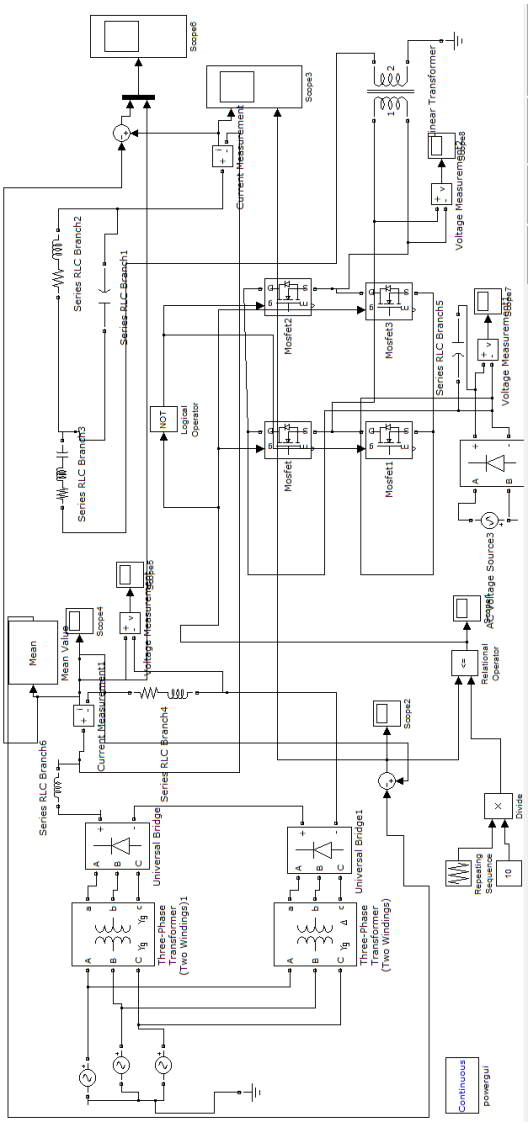

Figure 4.4: With filter simulation

The simulation of with filter the ripple current is minimize to some level. The passive filter is connected to output to compensate the ripple current. These compensated ripple current injected in DC line.

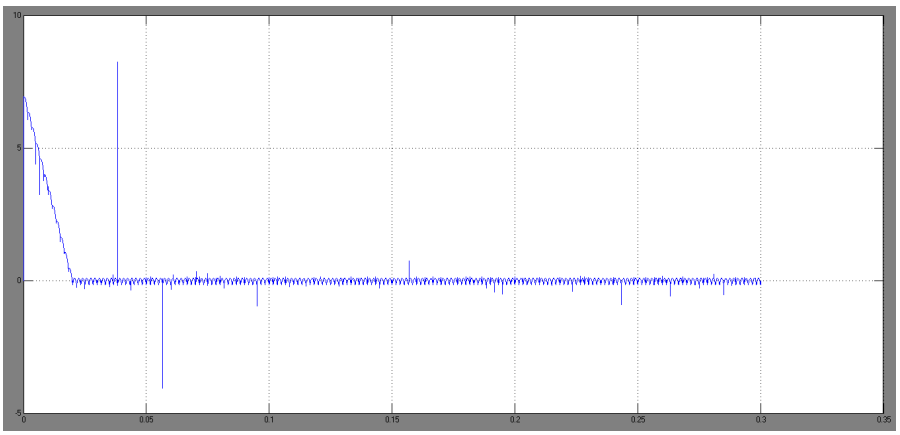

Figure 4.5: With filter output ripple current
Scale: Current: X-axis:1cm=0.05sec, Y-axis:1cm=5A

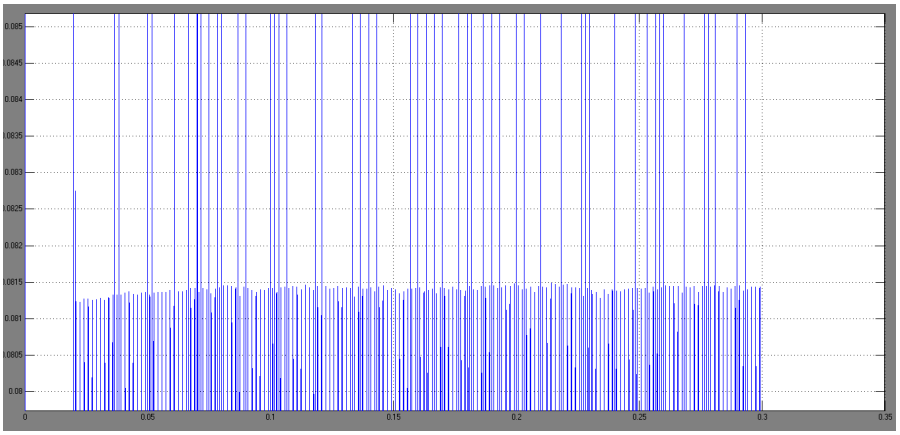

Figure 4.6: With filter output ripple current
Scale: Current: X-axis:1cm=0.05sec, Y-axis:1cm=5A

The fig 4.7 shows the ripple current are same magnitude and opposite phase difference are measured in the transmission line.

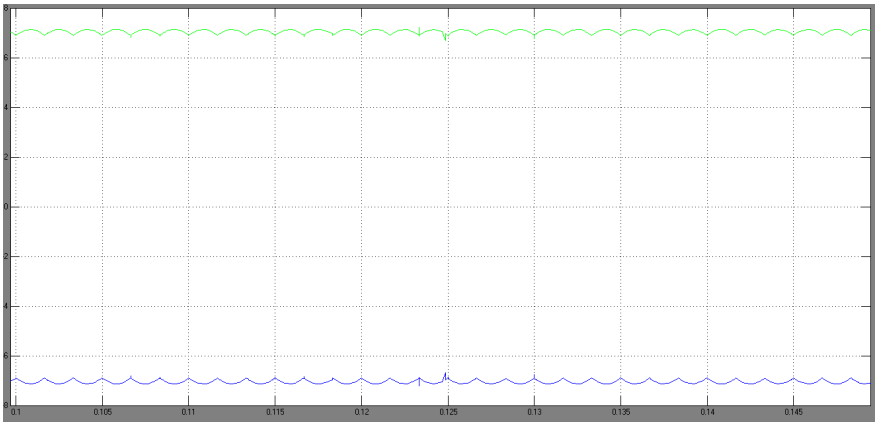

Figure 4.7: 180' phase shift output ripple current
Scale: Current: X-axis:1cm=0.02sec, Y-axis:1cm=1A

Chapter 5

Hardware Test Results

The three phase supply 415 V is applied to the rheostat.The rheostat set 230 V,50 HZ.These supply is applied to the three phase transformer(transformer is star/star and star/delata).The ratio of these transformer are (1:1: 0.73).After the transformer 12 pulse rectifier are connected. The current sensor seance the ripple current output of the rectifier. The control algorithm is implemented by a ATmega controller. The ripple current are compered with the triangular pulse. These gating pulse applied to the single phase inverter.The single phase supply 230 V is given to the rectifier.The dc link capacitor to be connected output side of the rectifier.The invert pulse generated by the controller and these pulse giving to the inventer.Undergoing,the inverter 1 and 2 switch are fired when the actual current is applied.Than 3 and 4 switch is fired when the not current is applied.The single phase inverter is connected to the coupling transformer.The ratio of coupling transformer is 230:230.The transformer is connected to the double tuned passive filter.These active filter is connected to the dc line.

The N-Channel power mosfets are used in single phase inventer, with rated value 10 A, 900 V.Detecting ripple current by current senses used to detect the ripple current. The algorithm is implemented by a ATmega controller. However, many nonlinear load situation, such as the distortion and the switching frequency limit, have been minimize the process of the simulation system.

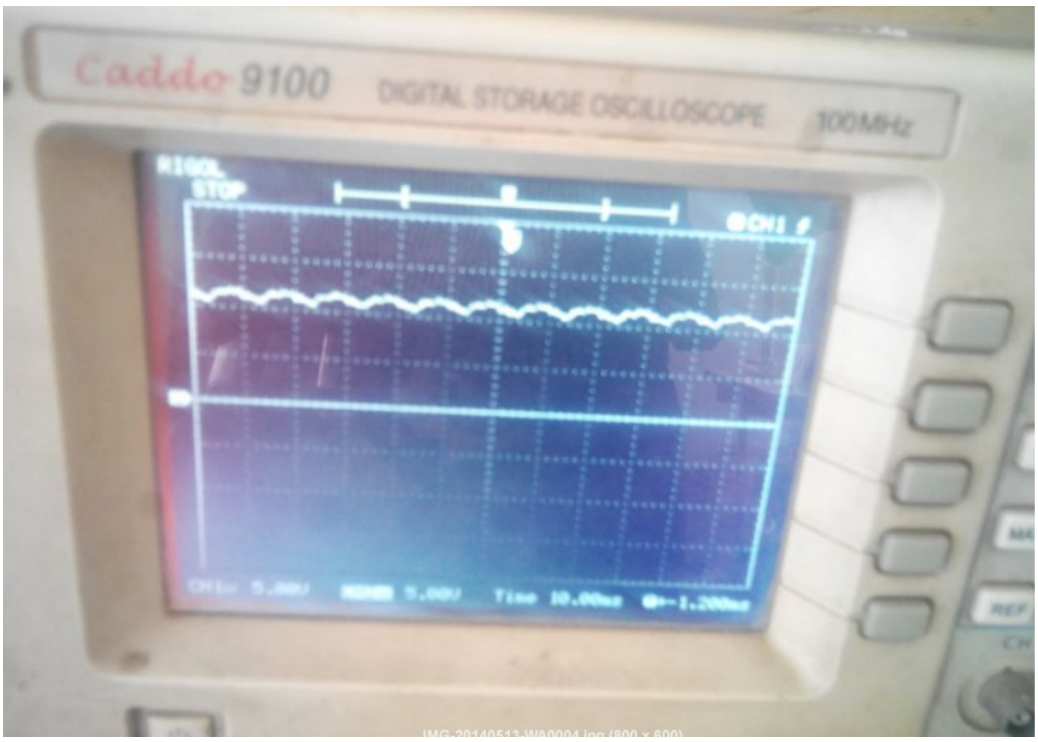

Figure 5.1: Output of 12 pulse

According to the simulation results and hardware results, it is clear that the hybrid filter made of ATmega controller can well perform in cancellation of the ripple in DC line.

The hardware set-up results are shown in the above fig.The transformer is connected to 12 pulse converter.The converter output ripple current sense by the current sense, and given to the Atmega controller.The controller generate PWM pulses.The pulses are given to the power mosfet.

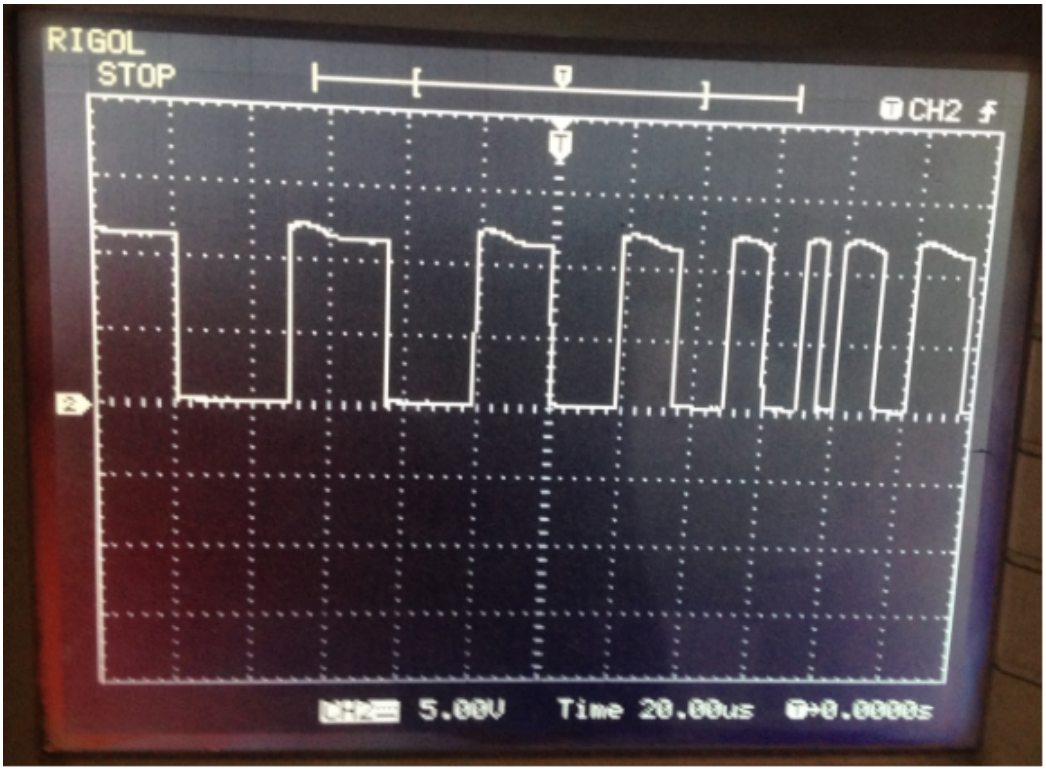

Figure 5.2: Gating pulse

Figure 5.3: Hardware

Chapter 6

Conclusion

Hence, The model of hybrid filter is simulated and variation in the ripple at the output of the 12 pulse rectifier is controlled. After completing the successful simulation work. A practical model of active filer with PWM technique had implemented. Where PWM technique is used to produce the pulses to the inverter, by comparing the triangular pulse with ripple content.

Chapter 7

Future Work

A double tuned passive filter moulding can be made.In the source side AC filter the higher order harmonicas 11th and 13th can be removed.

$regfile$"$M16DEF.DAT$"crystal = 8000000 $baud$ = 9600hwstack = 32 $swstack$ = 8framesize = 40

Do

Loop

Set P1 Reset P2 Waitus 5

Reset P1 Set P2 Waitus 5

Set P1 Reset P2 Waitus 10

Reset P1 Set P2 Waitus 10

Set P1 Reset P2 Waitus 15

Reset P1 Set P2 Waitus 15

Set P1 Reset P2 Waitus 20

Reset P1 Set P2 Waitus 20

Set P1 Reset P2 Waitus 25

Reset P1 Set P2 Waitus 25

Set P1 Reset P2 Waitus 30

Reset P1 Set P2 Waitus 30

Set P1 Reset P2 Waitus 35

Reset P1 Set P2 Waitus 35

Set P1 Reset P2 Waitus 40

Reset P1 Set P2 Waitus 40

Set P1 Reset P2 Waitus 45

Reset P1 Set P2 Waitus 45

Set P1 Reset P2 Waitus 50

Reset P1 Set P2 Waitus 50

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Reset P1 Set P2 Waitus 20

Set P1 Reset P2 Waitus 15

Reset P1 Set P2 Waitus 15

Set P1 Reset P2 Waitus 10

Reset P1 Set P2 Waitus 10

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