

DESIGN AND CONTROL OF GRID TIED BI-DIRECTIONAL AC-DC CONVERTER

BY

SHAFQAT IMRAN

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SUPERVISED BY

JEHANZEB AHMAD



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CERTIFICATE

We accept the work contained in this report as a confirmation to the required standard for the partial fulfilment of the degree of MS (EE).

Head of Department

Supervisor

Internal Examiner

External Examiner

DEDICATION

Dedicated to my loving parents and family

Shafqat Imran

DECLARATION OF AUTHORSHIP

I hereby declare that content of this thesis is my own work and that it is the result of work done during the period of registration. To the best of my knowledge, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

Shafqat Imran

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Abstract

Distributed hybrid power systems consist of AC and DC sub-systems connected to various load types, where the distributed generation (DG) resources can be either AC or DC. These resources are normally interfaced to the grid through power electronic converters. A single phase grid tied bi-directional AC-DC converter is presented in this research work. The bi-directional AC-DC converter works as the interface between the DC link and the AC grid. It meets the requirements of bidirectional power flow and to ensure high power factor and low THD as well as regulate the DC link voltage. It operates in two modes: the rectifier mode and the inverter mode. This research work is mainly focused on improvement and optimization of the converter in rectifier mode where it converts the AC line voltage into constant DC voltage which is used for energy storage systems and other DC loads.

The goals of the research work are to design and control a bi-directional AC-DC converter which has improved total harmonic distortion (THD) of the current and nearly unity power factor. The previously used AC-DC converters designed with diodes and/or thyristors have a great influence over the grid in terms of current harmonics and power factor degradation. The existing designs of bi-directional AC-DC converter use larger passive components like line inductor and output filter capacitor. The PI control and current hysteresis control (CHC) methods are used for the control of such converters. The CHC method has a great impact on converter performance in terms of switching losses and load dependency. The conventional PI control scheme has poor current tracking and non-zero steady state errors at line frequency.

A novel proportional-resonant (PR) control scheme is presented in the research work. A comparison of the conventional diode bridge AC-DC converter and the proposed bi-directional converter is made. Also, comparison is made between PI control and novel PR control for their effects on the converter in steady state and load changing conditions. The PR controller tracks reference currents with a very small steady state error and fast response to changes of grid voltage, load value and frequency which contributes to energy conversion and bidirectional flow of electricity.

The converter design and proposed control system is validated and verified in MATLAB/SIMULINK and practical prototype. The simulation and practical results proved the converter design and proportional resonant control structure for their capabilities of very low THD and power factor.

List of Figures

Figure 1.1:	Hybrid AC-DC micro grid.	2
Figure-1.2:	The Power Electronic Converter	4
Figure-1.3:	Bi-Directional Converter in DHPS	5
Figure-1.4:	Bi-Directional AC-DC Converter Power Flow.	6
Figure 2.1:	The AC-DC Conversion	13
Figure 2.2:	Sinusoidal Voltage and Current Waveforms	15
Figure 2.3:	Harmonics in the current of a non-linear load.	16
Figure 2.4:	Classification of AC-DC Converters	17
Figure 2.5:	Diode Bridge Rectifier without Filter Capacitor.	18
Figure 2.6:	A diode Bridge rectifier with Filter Capacitor.	19
Figure 2.7:	Input Current Spectrum of Diode Bridge Rectifier.	19
Figure 2.8:	Single Phase Full Bridge Controlled Rectifier.	20
Figure 2.9:	V_S and I_S of Single Phase Full Bridge Controlled Rectifier.	21
Figure 2.10:	Schematic Diagram of PFC Boost Rectifier	23
Figure 2. 11:	(a) Inductor Current (b) Q1 Gate Drive Signal.	23
Figure 2.12:	Voltage source converter. (a) Rectifier (b) Inverter	25
Figure 2.13:	Phasor diagrams for unity power factor operation.	26
Figure 2.14:	Voltage and Current Waveforms of VSC.	26
Figure 2.15:	Current Source AC-DC Converter.	27
Figure 3.1:	Ideal voltage sources.	32
Figure 3.2:	Phasor Diagram.	33
Figure 3.3:	Power Flow from V_1 to V_2 .	34
Figure 3.4:	Bi-Directional AC-DC Converter.	35
Figure 3.5:	Equivalent Circuit for AC Side	37
Figure 3.6:	Waveforms for V_S , $V_{B(1)}$ and $V_{B(H)}$.	37
Figure 3.7:	Phasor Diagram for AC/DC Converter.	38
Figure 3.8:	Phasor diagram for two different values of line side inductance.	40
Figure 3.9:	(a) PWM Generator. (b) Input and output Waveforms.	42
Figure 3.10:	Sine Pulse Width Modulation (SPWM).	43
Figure 3.11:	Over Modulated SPWM Waveform.	44
Figure 3.12:	(a) Bi-Polar PWM Generator. (b) Full Bridge PWM Converter.	45
Figure 3.13:	Bi-Polar Converter Output.	45
Figure 3.14:	Unipolar Sine PWM Generator.	46
Figure 3.15:	Unipolar PWM Converter Output.	46
Figure 3.16:	Boost DC/DC Converter.	47
Figure 3.17:	(a) Q1 is ON and D1 is OFF. (b) Q1 is OFF and D1 is ON.	47
Figure 3.18:	Waveforms for Inductor Voltage and Current.	49
Figure 3.19:	PWM Voltage (blue) and Inductor Current (red).	49
Figure 3.20:	(a) Q2 and Q4 are ON. (b) Q1 and Q4 are ON.	51
Figure 3.21:	(a) Q1 and Q3 are ON. (b) Q1 and Q4 are ON.	51
Figure 3.22:	(a) Q2 and Q4 are ON. (b) Q2 and Q3 are ON.	52
Figure 3.23:	(a) Q1 and Q3 are ON. (b) Q2 and Q3 are ON.	52
Figure 3.24:	AC-DC Boost Converter Schematic.	53
Figure 3.25:	Bi-Directional Converter with Controller Block.	55
Figure 3.26:	The Outer Voltage Loop.	56
Figure 3.27:	The PI based Current Controller.	57
Figure 3.28:	The Proposed Current Controller.	58
Figure 3.29:	Bode Plot of ' G_{PR} ' ($K_P = 1$, $K_R = 1$ and $\omega = 2\pi \times 50$).	59
Figure 3.30:	Time domain response ($K_P = 0.5$, $K_R = 1$ and $\omega = 2\pi \times 50$).	59
Figure 4.1:	Power circuit for AC-DC Converter.	62
Figure 4.2:	Block diagram of Open Loop Controller for bi-directional converter.	63
Figure 4.3:	SIMULINK Model of Diode Bridge AC-DC Converter.	64
Figure 4.4:	V_S and I_S of a Diode Bridge AC-DC Converter.	65
Figure 4.5:	FFT Analysis of AC Line Current of Diode Bridge Converter.	65
Figure 4.6:	DC Output of Diode Bridge AC-DC Converter.	65
Figure 4.7:	AC-DC Converter with Open Loop Control.	67

Figure 4.8:	PWM Generator Block.	68
Figure 4.9:	IGBT Gate Drive Signals from PWM Block.	68
Figure 4.10:	V_s and I_s with Open Loop Control at 1000Watts -Rated Load.	69
Figure 4.11:	V_s and I_s with Open Loop Control at 125% Load.	69
Figure 4.12:	V_s and I_s with Open Loop Control at 75% Load.	70
Figure 4.13:	FFT Analysis of Input Line Current at1000Watts - Rated Load.	70
Figure 4.14:	FFT Analysis of AC Line Current at 125% load.	70
Figure 4.15:	FFT Analysis of AC Line Current at 75% Load.	71
Figure 4.16:	DC Output with Open Loop Control at 1000Watts - Rated Load.	71
Figure 4.17:	DC Output with Open Loop Control and 125% Load.	71
Figure 4.18:	DC Output with Open Loop Control and 75% Load.	72
Figure 4.19:	SIMULINK Model of Bi-Directional AC-DC Converter with PR controller	74
Figure 4.20:	The conventional PI controller block for AC-DC converter.	75
Figure 4.21:	The Proposed PI and PR Controller Block.	76
Figure 4.22:	The PR Current Controller Block.	76
Figure 4.23:	The Sine PWM Block.	77
Figure 4.24:	V_s and I_s at 1000Watts – Rated Load when $L_s=15mH$.	77
Figure 4.25:	V_s and I_s with PR Controller at 125% Load.	78
Figure 4.26:	V_s and I_s with PR Controller at 75% Load.	78
Figure 4.27:	FFT Analysis of Input Line current at 1000Watts Load.	78
Figure 4.28:	FFT Analysis of Input Line current at 125% Load.	79
Figure 4.29:	FFT Analysis of Input Line current at 75% Load.	79
Figure 4.30:	DC Output with PRControllerat1000Watts - Rated Load.	80
Figure 4.31:	DC Output with PR Controller at 125% Load.	80
Figure 4.32:	DC Output with PR Controller and 75% Load.	80
Figure 4.33:	DC output voltage transient response of PI controller.	83
Figure 4.34:	DC output voltage transient response of PR controller.	83
Figure 4.35:	Line Current ' I_s ' Waveform with 5mH Inductor.	84
Figure 4.36:	Line Current ' I_s ' Waveform with 15mH Inductor.	84
Figure 4.37:	Prototype Control Board for AC-DC Converter	85
Figure 4.38:	Harmonic Filter Circuit.	86
Figure 4.39:	Input (Yellow) and Output (Green) Signals of Harmonic Filter.	86
Figure 4.40:	Phase Shifting Circuit	86
Figure 4.41:	Input (Yellow) and Output (Green) Signals of Phase Sifting Circuit	87
Figure 4.42:	Sine PWM Comparator Circuit.	87
Figure 4.43:	Sinusoidal Reference and Triangular Signals at Comparator Input.	88
Figure 4.44:	Sine PWM Comparator Output Signals	88
Figure 4.45:	Prototype Power Stage for AC-DC Converter	89
Figure 4.46:	Gate Driver Amplifier for Power IGBTs	89
Figure 4.47:	V_s and I_s and V_{DC} of Diode Bridge AC-DC Converter	90
Figure 4.48:	V_s and I_s and V_{DC} of Experimental Bi-Directional AC-DC Converter (with 2000uF Filter Capacitor).	90
Figure 4.49:	V_s and I_s and V_{DC} of Experimental Bi-Directional AC-DC Converter (with 4000uF DC Filter Capacitor).	91

List of Tables

Table 2.1:	Distortion limits for distributed generation systems.	17
Table 3.1:	Switching combinations for Bi-directional AC/DC converter.	50
Table 4.1:	Specifications of AC/DC converter used in Simulation.	61
Table 4.2:	Summary of Harmonic Magnitudes in Line Current.	66
Table 4.3:	The Controller Gains for PI Controller Block.	75
Table 4.4:	The Controller Gains for Controller Block.	75
Table 5.1:	Comparison of THD and Power Factor of Different AC-DC Converters.	94

Table of Contents

Certificate.....	ii
Dedication.....	iii
Declaration of Authorship	iv
Acknowledgements.....	v
Abstract.....	vi
List of Figures.....	viii
List of Tables	ix
1 Introduction.....	1
1.1 Evolution of Power Electronics into Power System	2
1.2 Distributed Generation of Electrical Power	3
1.3 Power Electronic Converters.....	3
1.4 Distributed Hybrid Power System	4
1.5 Bi-Directional AC-DC Converter	5
1.5.1 Operating Modes of the Bi-Directional AC-DC Converter	6
1.6 The AC-DC Converter	7
1.7 Research Motivation	7
1.8 Problem Statement	8
1.9 Research Objectives	9
1.10 Thesis Structure.....	9
2 Literature Review	11
2.1 Introduction	12
2.2 The Converter Classification.....	12
2.3 The AC-DC Conversion.....	13
2.4 Parameters for Analysis	13
2.4.1 Power and Efficiency	13
2.4.2 Ripple Factor.....	14
2.4.3 Power Factor of Linear Loads.....	14
2.4.4 Power Factor of Non-Linear Loads	15
2.4.5 Total Harmonic Distortion.....	16
2.5 Harmonic Standards for line Current	16
2.6 Classes of AC-DC Converters.....	17

2.7	Diode or Uncontrolled AC-DC Converter	18
2.7.1	Harmonic Analysis of Full Bridge Rectifier	19
2.8	Controlled Rectifiers	20
2.8.1	Thyristor Controlled AC-DC Converter	20
2.8.2	The THD and Power Factor of Controlled AC-DC Converter	21
2.9	PFC Controlled AC-DC Converter	22
2.9.1	Power Factor Correction	22
2.10	Diode Bridge with Boost Converter.....	22
2.10.1	Disadvantages of PFC Topologies.....	24
2.11	Bi-Directional PWM AC-DC Converters	24
2.11.1	Voltage Source Converter.....	25
2.11.2	Current Source Converter	26
2.11.3	Advantages of VSC over CSC	27
2.11.4	Advantages of VSC over Other Converters	27
2.12	Control Algorithms for Bi-directional PWM AC-DC Converter	28
2.12.1	PI Control.....	28
2.12.2	Voltage Oriented Control (VOC).....	29
2.12.3	Current Hysteresis Control.....	29
2.12.4	The Cascaded Control Structure	29
2.13	Review of AC-DC Converters	30
3	The AC-DC Converter Design and Control.....	31
3.1	Introduction	32
3.2	The Power Flow between two ideal AC Sources:.....	32
3.3	Unity Power Factor Operation	34
3.4	Hypothesis for Bi-Directional AC-DC Converter.....	35
3.5	Design of Bi-Directional AC/DC Converter.....	35
3.5.1	Circuit Topology of bi-directional AC/DC Converter	35
3.5.2	Principle of Operation.....	36
3.5.3	The AC Side Equivalent Circuit	36
3.5.4	Phasor Diagram for AC-DC Converter.....	37
3.6	AC/DC Converter Analysis.....	38
3.6.1	Assumptions for Analysis	38
3.6.2	AC Side Analysis.....	39
3.6.3	DC Side Analysis.....	40
3.7	Pulse Width Modulation.....	42

3.7.1	Duty Cycle and Switching Frequency	43
3.7.2	Modulation Index.....	43
3.7.3	Bi-Polar SPWM or 2-Level SPWM.....	44
3.7.4	Unipolar SPWM or 3-Level PWM	45
3.8	The Boost (Step-up) Operation of AC-DC Converter	46
3.9	Continuous and Discontinuous Conduction Modes	48
3.10	Inductor Current and Voltage in Bi-Directional AC/DC Converter	49
3.11	Possible Switching Combinations of IGBTs.....	50
3.11.1	Operation in Positive Half Cycle	50
3.11.2	Operation in Negative Half Cycle.....	51
3.11.3	Conclusions from Operational Analysis	52
3.12	The Converter Model	53
3.13	Control System for AC/DC Converter	54
3.13.1	The Control Objectives	54
3.14	The Controller Block.....	55
3.14.1	The Outer Voltage Loop	55
3.14.2	The Inner Current Loop	56
3.15	The Proposed Proportional Resonant Controller	57
4	Simulations and Experimental Results.....	60
4.1	Introduction	61
4.2	Design Specifications	61
4.3	Other Design Parameter Calculations	61
4.4	The Power Circuit of Bi-Directional Converter.....	62
4.5	The Open Loop Control System	63
4.6	Simulation of Conventional Diode Bridge AC-DC Converter	64
4.7	Simulation Results from Diode Bridge Converter	64
4.8	Result Description of the Diode Bridge AC-DC Converter.....	66
4.8.1	FFT Analysis of Line current.....	66
4.8.2	The Power Factor Analysis	66
4.8.3	Output DC Voltage Analysis	66
4.9	Bi-Directional AC-DC Converter Simulation with Open-Loop Control:.....	67
4.9.1	PWM Generator Block.....	67
4.10	Simulation Results from the Open Loop Control System.....	69
4.11	Result Description for Open loop Control System.....	72
4.11.1	FFT Analysis.....	72

4.11.2	The Power Factor Analysis	73
4.11.3	Output DC Voltage Analysis	74
4.12	Bi-Directional AC-DC Converter with Proposed Closed-Loop PR Control	74
4.12.1	Simulation Model of Conventional PI Control System	75
4.13	Simulation Model of Proposed Close Loop Control System:	75
4.13.1	The PR Controller Block.....	75
4.13.2	The Sine PWM Block in Closed Loop Control System.....	76
4.14	Results from the Closed Loop PR Control.....	77
4.15	Result Description for Proposed PR Control System	81
4.15.1	FFT Analysis.....	81
4.15.2	Power Factor Analysis	81
4.15.3	The Output DC Voltage Analysis	82
4.16	Transient Response PI and Proposed PR control Systems.....	82
4.17	The Effect of Line side Inductor Value.....	84
4.18	Experimental Set-up for Bi-Directional AC-DC Converter.....	85
4.19	Experimental Control Circuit.....	85
4.19.1	Harmonic Filter Circuit.....	85
4.19.2	Phase Shifting Circuit	86
4.19.3	Sine PWM Comparator Circuit.....	87
4.20	Experimental Power Circuit.....	88
4.21	Results from Experimental Set-up	90
4.22	Results Description for the Experimental Set-up.....	91
4.23	Implementation Difficulties	92
5	CONCLUSIONS AND FUTURE WORKS	93
5.1	Conclusions	94
5.2	Suggested Future Works	96
6	References:	97