

**STEADY STATE ANALYSIS OF A GENERALIZED  
IMPEDANCE CONTROLLER (GIC) BASED BRUSHLESS  
GENERATOR**

by

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## CERTIFICATE

*This is to certify that the dissertation entitled “**STEADY STATE ANALYSIS OF A GENERALIZED IMPEDANCE CONTROLLER (GIC) BASED BRUSHLESS GENERATOR**” submitted by Dipankar Sarkar (1998REE007) in partial fulfillment for the award of the degree of Doctorate of Philosophy in Power Electronics, Electrical Machines and Drives is a bonafied record of the work carried out by him under my supervision.*

*The matter embodied in this dissertation, to the best of my knowledge, has not been submitted for the award of any degree or diploma elsewhere.*



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## ABSTRACT

Small-distributed generation (DG) systems, typically of 100 kW rating, have been gaining popularity in recent years to supply power to remote, isolated rural communities due to the cost and complexity of grid systems with heavy transmission losses and reduced reliability. DG systems have higher operating efficiency and lower emission levels compel one to seek autonomous power generation. Depletion of fossil fuels has turned the attention on DG systems to be powered by attractive renewable energy sources such as wind, small hydro and biomass etc., and can be used to share peak generation during peak load. A cluster of paralleled DG systems and loads within a certain local area can form a micro-grid. A micro-grid has larger power capacity and better-integrated control capability to fulfill power quality requirements and system reliability in addition to all the inherited advantages of a single DG system. Since they are all to be located in isolated regions the DG technology must be simple, rugged and easy to operate and maintain. Self-Excited Induction Generator (SEIG) has shown advantage for such applications. Such three-phase generators would often feed unbalanced loads due to very nature of distributed load arrangement dictated by the location of the loads.

For proper operation of the micro-grid wind and hydro turbine driven SEIG need to have suitable fast acting real time controllers to implement high performance power flow control and voltage regulation algorithm to satisfy proper power quality at the consumer end. The control algorithm should have communication link between paralleled DG systems, which can be located far apart. Under varying source and load conditions active and reactive power distribution in the micro grid have to be rapidly altered to provide voltage and frequency at the grid bus. Static compensator

(STATCOM) as GIC has been used to meet rapid demands of active and reactive power in the micro-grid.

Keeping in view of the need of a controller that can control both the voltage and the frequency of the SEIG, the Generalized Impedance Controller appears to be the most suitable for the following reasons:

- Smooth active and reactive power control capability as the controller can source and sink both active and reactive power.
- Wider control range for active power as compared to the other existing techniques.
- Simple configuration, as it needs fewer energy storage elements.
- Low cost and weight.

The past effort for voltage and frequency control has been around independent active and reactive power control. In the present work an attempt has been made to have a single unit based integrated active and reactive power control, which reduces the component cost and can also improve the reliability of the system. In the present work, an ingenious method of active and reactive power control, which is termed as “Generalized Impedance Controller” (GIC) has been dealt with.

In this work an effort has been made to show the capability of the proposed Generalized Impedance Controller to solve the problems relating to the fluctuation in voltage and frequency of an isolated ac system bus. The self-excited induction generator having its independent grid is an example of such system.

In almost all the earlier reported work, the effects of unregulated prime mover on the SEIG performance; for example, a SEIG with hydraulic turbine with constant water head has been neglected. Only recently some observation on this aspect has been made. However, no work has been reported on the behavior of an impedance

controller as an active / reactive compensator and its application as an excitation controller when connected to a stand-alone SEIG with regulated and unregulated prime mover. The following issues emerge from the above discussion:

1. The suitability of the Generalized Impedance Controller for controlling voltage of a stand-alone SEIG with regulated and unregulated mover has to be properly explored.
2. Detailed investigation on the operation of the aforesaid impedance controller has to be taken up and its power handling capability has to be estimated under steady state and transient conditions to make use of the full potential of the compensator for stand-alone SEIG operation and control.
3. As an initial study, integrated operation of the SEIG and the proposed aforesaid impedance controller under steady state condition has to be taken up to assess the voltage controlling capability of the stand-alone generating system.

## *Contents*

<u>Chapters</u>	<u>Page No.</u>
<b>Certificate</b>	<b>i</b>
<b>Acknowledgement</b>	<b>ii</b>
<b>Abstract</b>	<b>iii</b>
<b>Contents</b>	<b>vi</b>
<b>List of figure</b>	<b>xiv</b>
<b>List of symbols</b>	<b>xx</b>
<b>Chapter 1: INTRODUCTION</b>	<b>1</b>
1.1 GENERAL INTRODUCTION	1
1.2 SCOPE OF WORK	5
<b>Chapter 2: LITERATURE SURVEY</b>	<b>10</b>
2.1 INTRODUCTION	10
2.2 POWER GENERATION FROM NON-CONVENTIONAL SOURCES OF ENERGY	11
2.3 INDUCTION GENERATOR STATE-OF-THE-ART	13
2.3.1 Wound-Rotor Induction Generator	13
2.3.2 Squirrel Cage Induction Generator (SCIG)	14
2.4 PERFORMANCE OF THREE-PHASE SELF-EXCITED INDUCTION GENERATOR	16
2.4.1 Phenomena of Self-Excitation	17
2.4.2 Model	18

2.4.2.1	Loop Impedance method	18
2.4.2.2	Nodal admittance method	20
2.5	STEADY STATE AND TRANSIENT PERFORMANCE OF A STAND-ALONE THREE-PHASE SELF-EXCITED INDUCTION GENERATOR	21
2.5.1	Steady State Performance	21
2.5.2	Transient Performance	25
2.6	DIVERSE TOPICS ON THREE-PHASE SELF-EXCITED INDUCTION GENERATORS	27
2.7	APPLICATION OF POWER ELECTRONICS IN STAND-ALONE SELF- EXCITED INDUCTION GENERATION CONTROL	28
2.7.1	Voltage Control Using VAR Compensators	31
2.7.2	Capacitive or Lead VAR Compensator	31
2.7.3	Inductive or Lag VAR Compensators	32
2.7.4	Lead- Lag VAR Compensators	33
2.7.4.1	Current source type of lead-lag VAR compensator	34
2.7.4.2	Voltage source type lead-lag VAR compensator	35
2.7.5	Hybrid Voltage and Frequency Control	36
2.7.6	Controlled Rectifier Based Scheme	37
2.7.7	Voltage Source Inverter Based Induction Generation Control	39
2.7.8	Current Source Inverter Based Induction Generation Control	40
2.8	RECENT TRENDS IN APPLICATION OF MICROPROCESSOR TECHNOLOGY AND FEEDBACK CONTROL TECHNIQUES IN SEIG VOLTAGE AND FREQUENCY CONTROL	41

2.8.1 Trends in Microprocessor Technology	41
2.9 CONCLUSION	45
<b>Chapter 3: OPERATION AND PERFORMANCE EVALUATION OF GENERALIZED IMPEDANCE CONTROLLER</b>	<b>47</b>
3.1 Introduction	47
3.1.1 SYSTEM DESCRIPTION	51
3.3 PRINCIPLE OF OPERATION	54
3.4 SIMULATION RESULTS	65
3.4.1 Effects of variation of 'r'	66
3.4.2 Effects of variation of 'phi'	70
3.4.3 Effects of variation of 'r' under constant active power operation of GIC	76
3.4.4 Effects of variation of 'phi' under constant reactive power (Q) operation of GIC	81
3.5 INTERIM CONCLUSION	86
<b>Chapter 4: PRACTICAL IMPLEMENTATION OF A GENERALIZED IMPEDANCE CONTROLLER</b>	<b>87</b>
4.1 INTRODUCTION	87
4.2 RELATIONSHIP BETWEEN 'r' AND 'm'	88
4.2.1 Results	92
4.2.1.1 Plots for P	92
4.2.1.2 Plots for Q	93
4.2.1.3 Plots for $R_{eq}$	94

4.2.1.4	Plots for $X_{eq}$	95
4.3	MODELLING AND SIMULATION OF THE GENERALISED IMPEDANCE CONTROLLER	98
4.3.1	Symmetric Sampling	100
4.3.2	Modeling of the GIC	102
4.3.3	Simulation Results	105
4.3.3.1	Current and voltage waveforms	106
4.4	HARDWARE IMPLEMENTATION USING MICRO-CONTROLLER	117
4.4.1	Interrupt pulse generating Circuit	118
4.4.2	80C196KB micro-controller circuit	120
4.4.2.1	High-speed input/output (HSIO) unit	120
4.4.2.1.1	Timer1 and Timer2	120
4.4.2.1.2	High-speed input (HSI)	121
4.4.2.1.3	High-speed output (HSO)	121
4.4.2.2	Analog to Digital Converter	122
4.4.2.3	Special function registers	122
4.4.2.3.1	Control registers	122
4.4.2.3.2	HSI registers	122
4.4.2.3.3	HSO command register	122
4.4.2.3.4	Interrupt Registers	122
4.5	REAL TIME PROGRAM FOR CONVENTIONAL PWM CONTROL STRATEGY	123
4.5.1	Description of the programming technique	123

4.5.2	Driver Circuit	126
4.5.3	Power Circuit	130
4.6	TEST RESULTS	131
4.7	INTERIM CONCLUSION	134
<b>Chapter 5:</b>	<b>STEADY STATE ANALYSIS OF THE SELF-EXCITED INDUCTION GENERATOR USING GENERALIZED IMPEDANCE CONTROLLER WITH 'r' VARIATION</b>	<b>136</b>
5.1	INTRODUCTION	136
5.2	MODELLING OF SELF EXCITED INDUCTION GENERATOR	139
5.2.1	Modelling of Self Excited Induction Generator under constant speed operation	140
5.2.2	Digital Computation	143
5.2.3	Simulation Result	146
5.3	MODELLING OF SELF EXCITED INDUCTION GENERATOR WITH GENERALIZED IMPEDANCE CONTROLLER	158
5.4	STEADY STATE ANALYSIS OF THE SEIG WITH THE CONTROLLER	159
5.4.1	Simulation Result	163
5.5	CONSTANT FREQUENCY OPERATION	177
5.6	EXPERIMENTAL RESULTS	190
5.6.1	Constant speed operation of the SEIG	194
5.6.2	Constant frequency operation of the SEIG	196

5.7	INTERIM CONCLUSION	200
<b>Chapter 6: STEADY STATE ANALYSIS OF THE SELF-EXCITED INDUCTION GENERATOR USING GENERALIZED IMPEDANCE CONTROLLER WITH 'PHI' VARIATIONS</b>		
		<b>202</b>
6.1	INTRODUCTION	202
6.2	MODELLING OF SEIG WITH THE GIC UNDER COSTANT SPEED OPERATION	203
6.2.1	Steady State Analysis of The SEIG Operating With the GIC Under Constant Speed Operation	204
6.2.2	Digital Computation	205
6.2.3	Simulation Results	206
6.3	DISCUSSION ON THE EXPERIMENTAL RESULTS	234
6.3.1	Constant frequency operation of the SEIG	235
6.4	INTERIM CONCLUSION	237
<b>Chapter 7: UNREGULATED TURBINE OPERATION OF THE SEIG WITH 'r' VARIATION</b>		
		<b>238</b>
7.1	INTRODUCTION	238
7.2	MODELLING OF SELF EXCITED INDUCTION GENERATOR UNDER UNREGULATED TURBINE OPERATION	239
7.2.1	Digital Computation	244
7.2.2	Simulation results	247

7.3	MODELLING OF SELF-EXCITED INDUCTION GENERATOR DRIVEN WITH AN UNREGULATED PRIME MOVER, WITH GENERALIZED IMPEDANCE CONTROLLER	252
7.3.1	Simulation results	254
7.4	INTERIM CONCLUSION	263
<b>Chapter 8: UNREGULATED TURBINE OPERATION OF THE SEIG WITH 'phi' VARIATIONS</b>		<b>265</b>
8.1	INTRODUCTION	265
8.2	MODELLING OF SEIG WITH THE GIC DRIVEN BY AN UNREGULATED PRIME MOVER	266
8.2.1	Digital computation	267
8.2.2	Simulation results	268
8.3	COMPARISON BETWEEN REGULATED AND UNREGULATED TURBINE OPERATION	275
8.4	INTERIM CONCLUSION	282
<b>Chapter 9: CONCLUSION AND FUTURE SCOPE</b>		<b>283</b>
9.1	INTRODUCTION	283
9.2	CONCLUSION	283
9.3	SIGNIFICANCE OF THE PRESENT WORK AND FUTURE SCOPE	294
<b>REFERENCES</b>		<b>296</b>
<b>APPENDIX A</b>		<b>307</b>
<b>APPENDIX B</b>		<b>308</b>
<b>APPENDIX C</b>		<b>309</b>

<b>APPENDIX D</b>	<b>313</b>
<b>APPENDIX E</b>	<b>320</b>
<b>RESUME</b>	<b>321</b>