

**INVESTIGATION ON SOME ASPECTS OF BRUSHLESS
GENERATION OF POWER USING MATRIX CONVERTER
FROM VARIABLE SPEED WIND ENERGY SOURCES**

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GENERATION OF POWER USING MATRIX CONVERTER
FROM VARIABLE SPEED WIND ENERGY SOURCES**

by

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CERTIFICATE

This is to certify that the thesis entitled, **“Investigation on Some Aspects of Brushless Generation of Power Using Matrix Converter from Variable Speed Wind Energy Sources”**, being submitted by **Mr. Shankar S.** for the award of the degree of **Doctor of Philosophy**, is a record of bona fide research work carried out by him in the Department of Electrical Engineering, Indian Institute of Technology Delhi, New Delhi.

Mr. Shankar S. worked under my guidance and supervision and has fulfilled the requirements for the submission of this thesis, which to my knowledge has reached the requisite standard. The matter embodied in this thesis have not been submitted, in part or full, to any other university or institute for award of any degree or diploma.

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ABSTRACT

Power generation technology is shifting from conventional fossil fuel based energy sources used in centralized bulk power generation to non conventional decentralized energy sources for small and medium scale power generation with wind energy being one of the most efficient renewable energy sources available. Squirrel Cage Induction Generator (SCIG) is emerging as a popular choice for small and medium scale distributed power generation to cater to the power demands of remote isolated locations due to its low cost, reliability and rugged construction. Integration of SCIG based Wind Energy Conversion System (WECS) to the grid with simple efficient means is of primary concern.

This thesis describes the work carried out on some important aspects of single stage power conversion based on Matrix Converter (MC) controlled gearless SCIG-WECS for providing a simple conversion scheme and its operation in a microgrid structure. The MC is a single stage AC-AC converter without any reactive elements in its basic structure for power conversion. Thesis mainly focuses on simple gearless operation of MC controlled SCIG-WECS using Cosinusoidal modulation and Pulse Width Modulation (PWM) techniques and reduction of total injected grid current harmonics in an environment having multiple MC-SCIG systems by paralleling individual systems using transformers having relative phase shift between them. In this way, the overall current injected into the grid contains lower harmonic content providing clean power to the grid.

A novel scheme for tracking maximum wind turbine power in a PWM controlled MC-SCIG based WECS by appropriate design of SCIG rotor resistance without having to use any complex control algorithms has been described. Maximum

Grid Power Injection (MGPI) technique for injecting maximum power into the grid rather than tracking maximum turbine power using the wind turbine parameters like optimum tip-speed ratio of wind turbine and generator slip condition has been carried out and described in detail. Operation of a PWM controlled MC-SCIG based WECS using feedforward MGPI technique in a dynamic wind velocity condition has also been presented. The overall system efficiency in this technique is better as the point of concern is the power into the grid rather than the maximum turbine power.

Operation of the PWM controlled MC-SCIG based WECS connected to a Generalized Impedance Controller (GIC) based Self Excited Induction Generator (SEIG) system forming an autonomous microgrid structure has been described, where GIC-SEIG system acts a voltage/frequency governor under all source or load perturbations. Integral feedback control for controlled active power injection into the microgrid from the MC-SCIG system has been presented. Controlled active power injection based on the feedforward MGPI technique from the MC-SCIG system into the microgrid formed by the GIC-SEIG system has been carried out. This type of controlled power injection is useful for systems having no battery backup facilities.

The comprehensive analytical and simulation work carried out on MC-SCIG system and MC-SCIG system with GIC-SEIG system has demonstrated that, this project has a very good prospect of integrating locally available renewable energy sources in autonomous microgrid applications for solving the energy crisis in remote locations thereby alleviating the social, economical and environmental aspects of the society.

CONTENTS

CERTIFICATE	i
ACKNOWLEDGEMENTS	ii
ABSTRACT	iii
CONTENTS	v
LIST OF FIGURES	xiii
LIST OF TABLES	xxix
LIST OF SYMBOLS AND ABBREVIATIONS	xxxiii
1 INTRODUCTION	1
1.1 General Introduction	1
1.2 Important Aspects of the Work	7
1.3 Structure of Thesis	8
2 LITERATURE REVIEW	15
2.1 Introduction	15
2.2 Non Conventional Energy Sources	16
2.3 Wind Energy System	18
2.3.1 Maximum Power Point Tracking	21
2.4 State-of-the-Art Generator	23
2.4.1 Permanent Magnet Synchronous Generator	24
2.4.2 Wound Rotor Induction Generator	25
2.4.2.1 Grid Connected WRIG	25
2.4.2.2 Grid Connected DOIG	26
2.4.3 Squirrel Cage Induction Generator	27
2.4.3.1 Constant Speed Generation	27
2.4.3.2 Variable Speed Generation	27
2.5 Applications of Power Electronics in Grid Connected Squirrel Cage Induction Generator Control	29
2.5.1 Back to Back Converter Application in WECS	30
2.5.2 Matrix Converter	30
2.5.2.1 Matrix Converter Modulation Methods: Current Harmonics and	

Protection Techniques	31
2.6 Matrix Converter Controlled SCIG for Wind Applications	36
2.7 Induction Generator Modeling	38
2.7.1 Loop Impedance Method	39
2.7.2 Admittance Method	40
2.8 Autonomous Microgrid or Hybrid Generation	41
2.9 Identified Research Objectives of the Present Work	45
2.10 Interim Conclusion	48
3 OPERATIONAL PERFORMANCE OF COSINUSOIDAL MODULATION BASED MATRIX CONVERTER CONTROLLED SCIG FOR GEARLESS WIND ELECTRIC GENERATION	49
3.1 Introduction	49
3.2 Wind Power Pattern	51
3.3 Matrix Converter	56
3.4 Matrix Converter Based Wind Energy Conversion System (WECS) Setup with Cosine Modulation Control	59
3.4.1 Cosinusoidal Modulation of Matrix Converter	61
3.4.1.1 Delay Calculation	63
3.4.1.2 Firing of Appropriate Switch Based on Switching Bank Selection	66
3.5 Implementation of Cosinusoidal Modulation Based MC Controlled SCIG in MATLAB/Simulink	67
3.6 Operation of Cosinusoidal Modulated MC-SCIG Based WECS	73
3.6.1 SCIG Operation with $f_o = 16.67$ Hz and $m_i = 1/3$	73
3.6.2 SCIG Operation with $f_o = 8.33$ Hz and $m_i = 1/6$	79
3.6.3 SCIG Operation with $f_o = 10$ Hz and $m_i = 1/5$	82
3.6.4 SCIG Operation with $f_o = 13.33$ Hz and $m_i = 1/3.75$	85
3.7 Performance Characteristics of SCIG With Constant Flux Operation	88
3.7.1 Effect of Speed/Slip on Generator Parameters	92
3.7.2 Effect of Slip on Grid Measurements and System Efficiency	96
3.8 Over-Fluxing and Under-Fluxing Operation of SCIG	99
3.8.1 Effect of Slip on Generator Parameters for Under-Flux, Rated Flux and Over-Flux Conditions	103
3.8.2 Effect of Slip on Grid Measurements and System Efficiency with Under-Flux, Rated Flux and Over-Flux Conditions	106
3.9 Constant Slip Operation of SCIG Under Constant Modulation Index	109

3.9.1	Effect of Generation Frequency on Generator Parameters for Constant Slip Operation With Fixed Modulation Index	110
3.9.2	Effect of Generation Frequency on Grid Parameters for Constant Slip Operation With Fixed Modulation Index	113
3.9.3	Constant Slip Operation With Constant V/f Ratio	116
3.10	Interim Conclusion	123
4	DUAL AND QUAD CONFIGURATION FOR GRID CURRENT HARMONIC REDUCTION IN COSINE MODULATION CONTROLLED MC-SCIG BASED WECS	125
4.1	Introduction	125
4.2	Harmonic Analysis	126
4.3	Parallel Operation of MC Controlled SCIG for Grid Current Harmonic Reduction	130
4.3.1	Dual Configuration	131
4.3.1.1	Dual Configuration Using Phase Shifting Transformers	131
4.3.1.2	Dual Configuration Using Star-Delta Transformers	137
4.3.1.3	6-Pulse Operation	142
4.3.1.4	Effect of Changing Modulation Index on Grid Current THD in Dual Mode	147
4.3.2	Quad Configuration	151
4.3.2.1	Quad Configuration Using Phase Shifting, Star and Delta Transformers	151
4.3.2.2	Quad Configuration Using Star-Delta Transformers	157
4.3.2.3	Effect of Changing Modulation Index on Grid Current THD in Quad Mode	163
4.4	Comparison of Different Parallel Configurations of MC Controlled SCIG in Terms of Grid Current THD	165
4.5	Quad Configuration Operation With Different Wind Speed Input to the Turbine Models for Grid Current THD Improvement	167
4.6	Interim Conclusion	171
5	PULSE WIDTH MODULATION TECHNIQUE FOR MATRIX CONVERTER CONTROLLED SCIG-WECS	173
5.1	Introduction	173
5.2	Comparison of Different MC Switching Strategies	175
5.3	Matrix Converter Based Wind Energy Conversion System (WECS) Setup with	

PWM Switching Control	178
5.3.1 Proposed Control Technique for the Modulation of Matrix Converter	179
5.3.1.1 Matrix Converter Switching Strategy	180
5.3.1.1.1 Virtual DC Bus from Grid Voltages	182
5.3.1.1.2 Generator Voltage SVM	182
5.3.1.1.3 Matrix Converter Operation	184
5.3.2 MATLAB/Simulink Implementation of PWM Controlled MC-SCIG Based WECS	187
5.3.3 Equivalent Capacitance Representation of Matrix Converter	189
5.3.3.1 Synchronous Speed Operation of MC Controlled SCIG	190
5.3.3.1.1 Circulating Currents in MC-SCIG Operating in Synchronous Speed Operation	191
5.3.3.2 Generation Operation of MC Controlled SCIG	196
5.3.3.3 Matrix Converter Equivalent Capacitance Value Validation with SEIG Model	198
5.3.3.4 Effect of m_i on Grid Reactive Power Requirement in Synchronous Speed Operation with Capacitor Bank Connected at Stator Terminals	203
5.3.3.5 Effect of Generation Operation on Grid Reactive Power Requirement with Capacitor Bank Connected at Stator Terminals	206
5.3.4 Operation of PWM Controlled MC-SCIG Coupled to Wind Turbine	208
5.3.4.1 PWM Based MC-SCIG Operation with $f_o = 16.67$ Hz and $m_i = 1/3$	208
5.3.4.2 PWM Based MC-SCIG Operation with $f_o = 13.33$ Hz and $m_i = 1/3.75$	212
5.4 Performance Characteristics of PWM Controlled MC-SCIG with Rated Flux Operation	216
5.4.1 Effect of Slip on Generator Parameters	219
5.4.2 Effect of Slip on Grid Measurements and System Efficiency	222
5.5 Over-Fluxing and Under-Fluxing Operation of SCIG	224
5.5.1 Effect of Slip on Generator Parameters for Under-Flux, Rated Flux and Over-Flux Conditions	225
5.5.2 Effect of Slip on Grid Measurements and System Efficiency with Under-Flux, Rated Flux and Over-Flux Conditions	229
5.6 Constant Slip Operation of SCIG Under Constant Modulation Index m_i	231
5.6.1 Effect of Generation Frequency on Generator Parameters for Constant Slip Operation with Fixed Modulation Index	232

5.6.2	Effect of Generation Frequency on Grid Parameters for Constant Slip Operation with Fixed Modulation Index	234
5.7	Interim Conclusion	237
6	DUAL AND QUAD CONFIGURATION FOR GRID CURRENT HARMONIC REDUCTION IN PWM CONTROLLED MC-SCIG BASED WECS	241
6.1	Introduction	241
6.2	Harmonic Analysis	243
6.3	Parallel Operation of PWM Controlled MC-SCIG for Grid Side Harmonic Reduction	248
6.3.1	Dual Configuration	249
6.3.1.1	Dual Configuration Using Phase Shifting Transformers	249
6.3.1.2	Dual Configuration Using Star-Delta Transformers	255
6.3.1.3	6-Pulse Operation	260
6.3.1.4	Effect of Changing Modulation Index on Grid Current THD in Dual Mode	265
6.3.1.5	Effect of Carrier Phase Shift on Harmonic Profile in Dual Mode Operation	267
6.3.1.6	Operation of PWM Controlled MC-SCIG in Dual Mode With LC Low Pass Filter	273
6.3.2	Quad Configuration	275
6.3.2.1	Quad Configuration Using Phase Shifting, Star and Delta Transformers	276
6.3.2.2	Quad Configuration Using Star-Delta Transformers	281
6.3.2.3	Effect of Carrier Phase Shift on Harmonic Profile in Quad-1 Configuration	286
6.3.2.4	Operation of PWM Controlled MC-SCIG in Quad Mode With LC Low Pass Filter	289
6.4	Comparison of Different Parallel Configurations of PWM Controlled MC-SCIG in Terms of Grid Current THD	290
6.5	Quad Operation of PWM Controlled MC-SCIG Operating with Different Wind Velocities	292
6.6	Interim Conclusion	296
7	OPTIMAL POWER POINT TRACKING FOR MC CONTROLLED GEARLESS WECS	301
7.1	Introduction	301

7.2	Modeling of Wind Turbine and Mechanical System	304
7.3	Optimum Power Point Tracking Technique by SCIG Rotor Resistance Design	305
7.3.1	Study on Optimum Power Point Tracking With Different SCIG Rotor Resistances	307
7.3.1.1	Simulation Results and Discussions With Different SCIG Rotor Resistances	308
7.3.2	Maximum Power Point Tracking With R_{r4} and Reduced f_o	316
7.3.2.1	Simulation Results and Discussions with R_{r4} and Reduced f_o	316
7.3.3	Effect of R_r Variation on P_g at a Particular Wind Velocity With SCIG Tracking Turbine Maximum Power Points	319
7.4	Tip Speed Ratio (TSR) Based Control for Maximum Grid Power Injection (MGPI)	321
7.4.1	System Configuration and Power Extraction Strategy	321
7.4.2	MATLAB/Simulink Implementation of TSR Based MGPI Scheme for MC Controlled SCIG-WECS	327
7.4.3	Simulation Results With Different Trigger Slip Conditions	328
7.4.4	Results Discussion and Determination of Optimum Trigger Slip	329
7.4.5	Comparison Between Maximum Turbine Power Tracking and Maximum Grid Power Tracking	340
7.5	Simulation Result for Feed-Forward MGPI Technique Under Wind Velocity Perturbation	344
7.6	Interim Conclusion	350
8	MICROGRID OPERATION OF MC BASED SCIG WECS WITH GIC BASED SEIG SYSTEM	353
8.1	Introduction	353
8.2	Autonomous Microgrid Operation: Integration of MC Controlled Gearless SCIG-WECS in Parallel with GIC-SEIG Based 3P4W SWECS	355
8.2.1	Configuration and Operation of GIC-SEIG Based Standalone WECS	356
8.2.1.1	System Configuration	356
8.2.1.2	Three-Phase Four-Wire System Modeling	358
8.2.1.2.1	Modeling of Induction Generator	359
8.2.1.2.2	Modeling of Excitation Capacitor and Load	360
8.2.1.2.3	Modeling of GIC	360
8.2.1.3	Shaft Input Adaptive Stator Current Compensation Based Amplitude and Frequency Control of SEIG Terminal Voltage	

Under Unbalanced Loads	362
8.2.1.4 Modeling of Control Scheme	365
8.2.1.4.1 GIC Synchronization Mechanism	366
8.2.1.4.2 Evaluation of Reference SEIG Stator Currents and Compensating Currents from GIC	366
8.2.1.4.3 Generation of Switching Pattern for GIC Converter Units	368
8.2.1.4.4 Modeling of Wind Turbine and Mechanical System	369
8.2.2 Integration of MGPI Strategy Based MC-SCIG GWECS With GIC-SEIG Based 3P4W SWECS for Autonomous Microgrid Operation (AMG)	370
8.2.2.1 MATLAB/Simulink Modeling of MC-SCIG Based GWECS and its Integration with SEIG-GIC Based 3P4W SWECS	372
8.2.3 Simulation Results and Discussion	379
8.2.3.1 Both Wind Turbines Having Same Wind Velocity Input	380
8.2.3.1.1 Base Operating Conditions and GIC Synchronization	380
8.2.3.1.2 Performance Under Load and Wind Velocity Perturbations	382
8.2.3.2 Both Wind Turbines Having Different Wind Velocity Input	394
8.2.3.2.1 Performance Under Load and Wind Velocity Perturbations	395
8.3 Controlled Injection of Active Power into Grid From MC Controlled SCIG Coupled to a Wind Turbine	405
8.3.1 System Configuration and Principle of Operation	405
8.3.2 Implementation of Controlled Active Power Injection from MC controlled SCIG-WECS in MATLAB/Simulink	409
8.3.2.1 Simulation Results and Discussion	411
8.3.3 Integration of Controlled Active Power Injection from MC-SCIG GWECS with GIC-SEIG System	413
8.3.3.1 Simulation Results and Discussion	413
8.4 Controlled Injection of Active Power into Grid from MC Controlled SCIG Coupled to a Wind Turbine Using Feedforward Control	418
8.4.1 Strategy to Obtain f_o and m_i for Controlled Power Injection from MC- SCIG System	419
8.4.2 Simulation Results and Discussion	424
8.5 Interim Conclusion	432

9	CONCLUSION	435
9.1	Significance of Present Work	435
9.2	Summary of the Work Carried Out	437
9.3	Suggestions for Future Work	443
	REFERENCES	445
	APPENDICES	463
A	Rating and Parameters of SCIG and 3-Phase Source	463
A.1	Rating of 3-Phase SCIG	463
A.2	Parameters of 3-Phase SCIG	463
A.3	Three-Phase Source	463
B	Parameters of Wind Turbines	464
B.1	Parameters of Wind Turbine (Used in Chapter 3 Coupled Directly to SCIG)	464
B.2	Parameters of Wind Turbine (Used in Chapter 5, 6, 7 and 8 Directly Coupled to SCIG)	464
B.3	Parameters of Wind Turbine (Used in Chapters 8 Coupled via Gearbox with SEIG)	464
C	Parameters of Transformers	465
C.1	Phase Shifting Transformer	465
C.2	Star-Star Transformer	465
C.3	Delta-Star Transformer	465
C.4	Three Phase Linear 12 Terminal Transformer	465
D	Parameters of Matrix Converter and LC filter for MC	466
D.1	Matrix Converter Parameters	466
D.2	LC Filter	466
E	Rating and Parameters of SEIG and Coupling Transformer	467
E.1	Rating of 3-Phase SEIG	467
E.2	Parameters of 3-Phase SEIG	467
E.3	Parameters of 3-Phase Coupling Transformer	467
F	Parameters of Modular GIC (Base/Converter Units)	468
F.1	DC Bus Battery Specifications	468
F.2	LC Low-Pass Filter Parameters	468
F.3	Parameters of VSC	468