



Faculty of Electrical Engineering

GRID CONNECTED WITH MICRO SOLAR GENERATOR

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**Master of Electrical Engineering
(Industrial Power)**

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GRID CONNECTED WITH MICRO SOLAR GENERATOR

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**A dissertation submitted
in fulfillment of the requirements for the degree of Master of Electrical Engineering
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DECLARATION

I declare that this dissertation entitled “Grid Connected with Micro Solar Generator” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have read this dissertation/report and in my opinion this dissertation/report is sufficient in terms of scope and quality as a partial fulfilment of Master of Electrical Engineering (Industrial Power).

Signature :

Supervisor Name :

Date :

DEDICATION

To my beloved mother and late father

ABSTRACT

Nowadays, the need of renewable energy sources is on the rise because of the acute energy crisis in electricity generation due to increasing consumption demand and populations. Thus, energy from the sun is the best option for the generation of electricity as it is available everywhere, pollution-free as well as is free to harness. Therefore, objective of this dissertation is to generate simulation framework of the grid connected micro solar generator and analyse its efficiency and performance which can benefit to both educational institutions and industrial field. A framework system has been done to extract maximum obtainable solar power from the photovoltaic array and converted it into alternating current before deliver to the utility grid through controlling and synchronization mechanisms. The system includes photovoltaic array, maximum power point tracker (MPPT), DC-DC boost converter, three-phase inverter, modulation techniques, voltage source controller (VSC) controller and utility grid. Overall findings indicate the implementation of the developed framework can be useful for the further investigation and improvement of the grid connected photovoltaic (GCPV) system. In addition, result also indicate that framework system have a lower total harmonic distortion of 1.17%. The simulation studies are carried out in Simulink MATLAB environment.

ABSTRAK

Pada masa kini, keperluan sumber tenaga boleh diperbaharui adalah meningkat kerana krisis tenaga yang teruk dalam penjanaan elektrik berikutan peningkatan permintaan penggunaan dan populasi. Oleh itu, tenaga daripada matahari adalah pilihan terbaik bagi penjanaan elektrik kerana ia boleh didapati di mana-mana, bebas pencemaran serta bebas untuk dimanfaatkan. Oleh itu, objektif disertasi ini adalah untuk menghasilkan rangka kerja penjana solar mikro secara simulasi grid disambungkan dan menganalisis kecekapan dan prestasi yang boleh dimanfaatkan kepada kedua-dua institusi pendidikan dan bidang perindustrian. Satu sistem rangka kerja yang telah dilakukan untuk mengeluarkan tenaga solar maksimum yang diperolehi dari jajaran fotovoltaiik dan ditukar ke dalam arus ulang-alik sebelum disambungkan kepada grid utiliti melalui kawalan dan mekanisma penyelarasan. Sistem ini merangkumi jajaran fotovoltaiik, pengesanan titik kuasa maksimum (MPPT), penukar rangsangan DC-DC, penyongsang tiga fasa, teknik pemodulatan, pengawal sumber voltan (VSC) dan grid utiliti. Dapatan kajian ini menunjukkan pelaksanaan rangka kerja yang dibangunkan adalah berguna untuk siasatan lanjut dan peningkatan kepada sistem grid fotovoltaiik yang disambungkan (GCPV). Di samping itu, hasil kajian juga menunjukkan sistem rangka kerja yang mempunyai jumlah herotan harmonik yang rendah iaitu sebanyak 1.17%. Kajian simulasi dijalankan dalam persekitaran Simulink MATLAB.

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TABLE OF CONTENTS

	PAGE
DECLARATION	
APPROVAL	
DEDICATION	
ABSTRACT	i
ABSTRAK	ii
ACKNOWLEDGEMENTS	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF APPENDICES	xiii
LIST OF ABBREVIATIONS	xiv
LIST OF SYMBOLS	xv
CHAPTER	
1. INTRODUCTION	1
1.1 Background	1
1.2 Problem Statements	2
1.3 Objectives	3
1.4 Scope	3
1.5 Research Methodology	4
1.6 Significance of Study	5
1.7 Outline Chapters	6
2. LITERATURE REVIEW	8
2.1 Introduction	8
2.2 The Topologies of Inverter in Photovoltaic System	8
2.2.1 Single Stage Photovoltaic System	9
2.2.2 Two Stage Photovoltaic System	11
2.3 Types of Solar Cell	12
2.3.1 Crystalline Silicon (c-Si)	13
2.3.2 Amorphous Silicon (a-Si)	14
2.3.3 Hybrid Type	14
2.4 Related Works of Photovoltaic Array Modelling	14
2.5 Maximum Power Point Controller and Algorithm	21
2.5.1 Perturb and Observe (P&O)	21
2.5.2 Incremental Conductance (InCond)	26
2.6 DC- DC Converters	28
2.6.1 MPPT Circuit of DC-DC Converter Topologies	28
2.6.2 Buck MPPT Circuit	30
2.6.3 Boost MPPT Circuit	31
2.6.4 Buck-Boost MPPT Circuit	34
2.6.5 Cuk MPPT Circuit	35
2.6.6 SEPIC MPPT Circuit	37
2.7 DC-AC Converters	38
2.7.1 Classification Type of Inverters	39
2.7.2 Current Source Inverter (CSI)	40

2.7.3	Voltage Source Inverter (VSI)	43
2.8	Modulation Techniques	46
2.8.1	Sinusoidal Pulse Width Modulation	46
2.8.2	Space Vector Pulse Width Modulation	47
2.9	Standards Compliance for Grid Connected PV System	48
2.9.1	The Malaysian Grid Code	49
2.9.2	IEEE Standard 1547	49
2.9.3	IEC 61727 Standard	50
2.9.4	IEEE Standard 929-2000	50
2.10	Summary of Literature Surveys	50
3.	MODELLING FOR GRID CONNECTED WITH MICRO SOLAR GENERATOR	52
3.1	Introduction	52
3.2	General Photovoltaic System Topology	52
3.3	Modelling of Photovoltaic Array	54
3.3.1	I-V Curves Characteristic of PV Array	54
3.3.2	Photovoltaic Cells Model	56
3.3.3	Model of Photovoltaic Module	61
3.3.4	Photovoltaic Array Model	64
3.3.5	Simulink Model of Photovoltaic Array	65
3.4	DC-DC Converter	67
3.4.1	Boost Converter	68
3.4.2	Basic Operation of Boost Converter	69
3.5	Control Strategy of Boost Converter with MPPT Controller	77
3.5.1	Maximum Power Point Tracking (MPPT)	78
3.5.2	Perturbation and Observation (P&O)	80
3.5.3	Incremental Conductance (IncCond)	83
3.5.4	Simulink Model of Boost Converter with MPPT	87
3.6	DC-AC Inverter Analysis	89
3.6.1	Full Bridge Single Phase Inverter	89
3.6.2	Six Step Inverter	94
3.7	Pulse Width Modulation	97
3.7.1	Sinusoidal PWM	98
3.7.2	Simulink Model of SPWM Full Bridge Inverter	103
3.7.3	Space Vector PWM	104
3.7.4	Simulink Model of SVPWM Full Bridge Inverter	113
3.8	Recommended Strategy to Control Selected Topology of PV System	113
3.8.1	Simulation of Complete System of Grid Connected Photovoltaic Array	115
3.8.2	Simulink Model of Voltage Source Controller (VSC)	117
3.9	Summary of Modelling Chapter	118
4.	DISCUSSION OF RESULT	119
4.1	Introduction	119
4.2	Characteristic of Photovoltaic Array	119
4.2.1	The I-V and P-V Characteristic	119
4.2.2	Simulation of Photovoltaic with Varies Irradiation	123
4.3	PV System with Boost Converter and MPPT	125
4.4	Three Phase Inverter with SPWM and SVPWM Techniques	132

4.5	PV Connected to Three Phase Inverter	136
5.	CONCLUSION AND RECOMMENDATION	144
5.1	Summary of Research	144
5.2	Achievement of Research Objectives	145
5.3	Significance of Research Output	146
5.4	Problem Faced During Research	146
5.5	Recommendations	147
	REFERENCES	149
	APPENDICES	162

LIST OF TABLES

TABLE	TITLE	PAGE
3.1	PV Module JHGF 12W/12V Parameters	61
3.2	Equivalent Switches Control and Output Voltages of Each Phase of Inverter	100
3.3	Switching Vectors, Phase Voltages and Line to Line Voltages	108
3.4	Switching Time Calculation at Each Sector	112
4.1	PV Module Jiahei 12V Parameter Values at STC	120
4.2	Characteristic of 7kW Photovoltaic Array	121
4.3	DC-DC Boost Parameters	125
4.4	Total Harmonic Distortion (THD) of System Performance Involved	143

LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	Overview Flowchart of Research Methodology	4
2.1	Topologies of PV Inverter Technologies	9
2.2	Configuration of Single Stage Photovoltaic System	10
2.3	Configuration of PV String Inverter	11
2.4	Configuration of Multistring PV System	12
2.5	Three Major Categories of PV Module	13
2.6	Equivalent Circuit of Single Diode Model (Villalva, Gazoli & Filho, 2009)	15
2.7	Equivalent Circuit Dual-Exponential Cell Model (Gow & Manning, 1999)	19
2.8	Proposed Schematic of Compensation Network Prototype (Femia, Petrone, Spagnuolo, et al., 2009)	23
2.9	Two Stages Grid Connected Photovoltaic System with DC-DC Converter (Liu, Kang, Zhang, et al., 2008)	24
2.10	PV Pumping System with DC-DC Converter (Elgendy, Zahawi & Atkinson, 2008)	26
2.11	Charging Battery System using Buck Converter (Koutroulis, Kalaitzakis & Voulgaris, 2001)	30
2.12	Schematic Circuit of Boost Converter for PV Application (Hasaneen & Elbaset Mohammed, 2008)	32
2.13	Switched Inductor Multilevel Boost Converter Schematic Diagram (Mousa, Orabi, Member, et al., 2011)	33
2.14	Schematic Circuit of Typical Buck-Boost Converter (Luo & Han, 2009)	35

2.15	Cuk Converter Topology (Durán, Galán, Andújar, <i>et al.</i> , 2007)	36
2.16	Schematic Diagram of SEPIC Converter (António, Vieira & Mota, 2008)	37
2.17	Typical Circuit Diagram of Three Phase VSI and CSI Inverters (Mechouma, Azoui & Chaabane, 2012)	39
2.18	Schematic Diagram of CSI for Proposed CSI (Ertasgin, Whaley, Ertugrul, <i>et al.</i> , 2008)	41
2.19	Schematic Diagram of CSI with Series Capacitor (Photong, Klumpner & Wheeler, 2009)	42
2.20	Control Structure of Multilevel CSI Based PV System (Paramita Dash & Kazerani, 2011)	43
2.21	Proposed Hybrid Photovoltaic System Connected to Distribution Network (Tan, So, Member, <i>et al.</i> , 2010)	44
2.22	Block Diagram of Proposed Solar Generating System (Adhikari, Singh, Vyas, <i>et al.</i> , 2011)	45
2.23	The Configuration of 1kW Grid Connected PV System (Samerchur, Premrudeepreechacharn, Kumsuwun, <i>et al.</i> , 2011)	45
3.1	Single Stage Structure of Photovoltaic System	53
3.2	Dual Stage Structure of Photovoltaic System	53
3.3	Irradiance Impact on the I-V Characteristics Curve	55
3.4	Temperature Influences on the I-V Characteristic Curve	55
3.5	Maximum Power Point of I-V Curve and P-V Curve	56
3.6	Ideal Single Diode Model (ISDM)	56
3.7	Equivalent Model with Moderate Complexity	58
3.8	Solar Cell Equivalent Circuit	59
3.9	Equivalent Circuit Model of Photovoltaic Module	63
3.10	PV Array Composed of $N_{ser} \times N_{par}$ Modules	64
3.11	PV Array Model Circuit of $N_{ser} \times N_{par}$ Modules	65
3.12	Simulink Block of PV Array	66

3.13	GUI Environment of PV Array	67
3.14	Circuit Diagram of Basic Boost Converter (Hart, 2010)	68
3.15	Basic Boost Converter when the Switch is Closed (Hart, 2010)	70
3.16	Boost Converter Waveform during Switch Closed (Hart, 2010)	71
3.17	Basic Boost Converter when the Switch is Open (Hart, 2010)	72
3.18	Boost Converter Waveform during Switch Open (Hart, 2010)	73
3.19	Continuous Conduction Mode	75
3.20	Discontinuous Conduction Mode	76
3.21	Waveform Output of Boost Converter	77
3.22	Current-Voltage (I-V) Curve of PV Module (Faranda, Leva & Maugeri, 2008).	78
3.23	MPP of PV Module under Varying Insolation (Natsheh & Albarbar, 2011)	79
3.24	Plot of P-V Curve under Standard Operating Point	80
3.25	Perturb and Observe MPPT Algorithm Flowchart	81
3.26	Behaviour of Incremental Conductance Algorithm	83
3.27	Flowchart of IncCond Algorithm (Qin, Wang, Chen, et al., 2011)	86
3.28	Simulink Block of Boost Converter	88
3.29	MPPT Controller in Simulink	88
3.30	Simulink Model of MPPT with Incremental Conductance and Integral Regulator	89
3.31	Single Phase Inverter Schematic Diagram (Hart, 2010)	90
3.32	Single Phase Inverter Topology via Load or Grid Connected	90
3.33	Operation of Current Flows when S1 and S2 are Closed (Salam, 2003)	91
3.34	Operation of Current Flows when S3 and S4 are Closed (Salam, 2003)	92

3.35	Output Voltage of Single Phase Inverter (Salam, 2003)	92
3.36	Output Voltage and Current with Blanking Time (Abu-hamdeh, 2009)	93
3.37	Fundamental Component of Single Phase Inverter (Salam, 2003)	94
3.38	Six Step Three Phase Inverter	95
3.39	Three Phase Inverter Switching Waveform (Hart, 2010)	96
3.40	SPWM Control Signal Generator	98
3.41	Three Phase PWM Inverter (JUNG, 2005a)	99
3.42	Three Phase SPWM Waveforms Inverter (JUNG, 2005a)	101
3.43	Simulink Model of SPWM Implementation	103
3.44	Three Phase Voltage Source PWM Inverter (JUNG, 2005b)	104
3.45	Switching States of Three-Phase Inverter (JUNG, 2005b)	106
3.46	Relationship of abc Reference Frame and Stationary dq Reference Frame (JUNG, 2005b)	106
3.47	The Basic Switching Vectors and Sectors of SVPWM (JUNG, 2005b)	107
3.48	Space Vector Voltage and its d-q Component (JUNG, 2005b)	108
3.49	Switching Pattern and Sector Duration of SVPWM	111
3.50	Simulink Model of SVPWM Implementation	113
3.51	Block Diagram of Suggested Control Strategy for Complete Grid Connected System	114
3.52	The Block Diagram of Grid Connected with Micro Solar Generator	116
3.53	Block Diagram of Voltage Source Controller (VSC)	117
4.1	I-V Characteristic Curve of Jiahei 12V Module at STC	120
4.2	P-V Characteristic Curve of Jiahei 12V Module at STC	121
4.3	I-V Characteristic Curve of PV Array 7kW at STC	122
4.4	P-V Characteristic Curve of PV Array 7kW at STC	122

4.5	I-V Characteristic Curve of Module at Various Irradiations	123
4.6	P-V Characteristic Curve of Module at Various Irradiations	123
4.7	I-V Characteristic Curve of PV Array at Various Irradiations	124
4.8	P-V Characteristic Curve of PV Array at Various Irradiations	125
4.9	Variation of Irradiation Generator	126
4.10	Ramp Change of Photovoltaic Voltage Output	127
4.11	Photovoltaic Output Current for Varied Irradiation at $t=0s$ to $1.5s$	128
4.12	Duty Cycle of Boost Converter during Variation of Irradiation	129
4.13	Photovoltaic Output Power for Varied Irradiation at $t=0s$ to $1.5s$	130
4.14	Output Voltage of Boost Converter	131
4.15	THD for SPWM Modulation before Filtration	132
4.16	THD for SPWM Modulation after Filtration	133
4.17	THD for SVPWM Modulation before Filtration	134
4.18	THD for SVPWM Modulation after Filtration	135
4.19	Three Phase Inverter Output before Filtration	136
4.20	A Portion View of Three Phase Inverter Output before Filtration	137
4.21	Total Harmonic Distortion of System before Filtration	138
4.22	Waveform for Modulation Index of Inverter	139
4.23	Three Phase Inverter Output after Filtration	139
4.24	A Portion View of Three Phase Inverter Output after Filtration	140
4.25	Total Harmonic Distortion of System after Filtration	141
4.26	Output Power after Synchronization with Grid Power	142
4.27	Zoom Out View of Output Power after Synchronization with Grid Power	142
4.28	Portion Waveform of Voltage and Current after Grid Synchronization	143

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Matlab / Simulink Models	162
B	Simulation Model of Overall System	166
C	DC-DC Boost Converter	169

LIST OF ABBREVIATIONS

AC	-	Alternate Current
CCM	-	Continuous Conduction Mode
CSI	-	Current Source Inverter
DC	-	Direct Current
DCM	-	Discontinuous Conduction Mode
FFT	-	Fast Fourier Transform
GUI	-	Graphic User Interface
IBC	-	Interleaved Boost Converter
IGBT	-	Insulated Gate Bipolar Transistor
InCond	-	Increment Conductance
MOSFET	-	Metal Oxide Semiconductor Field Effect Transistor
MPPT	-	Maximum Power Point Tracker
PI	-	Proportional Integral
PLL	-	Phase Lock Loop
PV	-	Photovoltaic
PVA	-	Photovoltaic Array
P&O	-	Perturb and Observe
SSDM	-	Simplified Single Diode Model
SPWM	-	Sinusoidal Pulse Width Modulation
STC	-	Standard Temperature Conditions
SVPWM	-	Space Vector Pulse Width Modulation
THD	-	Total Harmonic Distortion
TNB	-	Tenaga Nasional Berhad
VSI	-	Voltage Source Inverter
VSC	-	Voltage Source Controller

LIST OF SYMBOLS

V_{mp}	-	Voltage at Maximum Power Point (V)
I_{mp}	-	Current at Maximum Power Point (A)
P_{mp}	-	Power at Maximum Power Point (W)
V_{oc}	-	Open Circuit Voltage (V)
I_{sc}	-	Short Circuit Current (A)
q	-	Electron Charge ($1.60217646 \times 10^{-19} C$)
k	-	Boltzmann Constant ($1.3806503 \times 10^{-23} J/K$)
G_a	-	Sunlight Irradiation (W/m^2)
K_i	-	Coefficient of Current Temperature.
Δ_T	-	Variation of Temperature.
M_a	-	Amplitude Modulation Index
M_f	-	Frequency Modulation Ratio

CHAPTER 1

INTRODUCTION

1.1 Background

This research project discusses about simulation framework of generating electrical energy from the renewable energy radiated from the sun. The sun's energy was cropped using solar photovoltaic (PV), and transferred it into alternating current then finally delivered into grid. The structure of energy conversion mainly consists of photovoltaic panels, maximum power point tracker, converter, inverter and other related power electronic devices. In general, process of generating electricity begins at the PV panels when it absorbs the sunlight's ray and converted it to Direct Current (DC) voltage. With presence of maximum power point tracker (MPPT), output from the PV panels can be varied with electrical operating point so that system is able to deliver maximum available power. The operation continues to DC-DC converter where output is stepped-up to range of voltage 650V. In order to be connected to the grid, an inverter plays a crucial role in converting the DC output voltage of 650V to AC voltage of 430V. At the same time, an inverter also plays an important role of control strategy to synchronization to distribution network or utility grid.

1.2 Problem Statements

In the recent years, power demand is increasing regularly and it can be fulfilled by utilization of conventional or non-conventional energy source. As greenhouse effects and environmental issues are becoming a prime concern of all over the world, which led to escalate interest in renewable energy, which is one of options in reducing pollution. Furthermore, natural resources used in the production of power are dwindling and becoming more expensive when they are increasingly dried up in a very near future especially traditional fossil energy. There are few types of renewable energies; one of them is photovoltaic (PV) system or also known as solar energy system.

Photovoltaic (PV) system has high initial investment but in recent years, its price has been slowly drop and payback period also reduces, as it becomes increasingly economical with advancement of power electronics and semiconductor technologies. The favourable incentives in a few number of countries also had profound impact on the commercial acceptance of grid-connected PV systems. With the rapid development of photovoltaic system installations and increased number of grid connected power systems, it has become imperative to develop an efficient grid interfacing instrumentation suitable for photovoltaic systems ensuring maximum power transfer. From information and arguments that have carried out during literature survey, it is clearly stated that there is no doubt of PV system has a good stand in the near future.

1.3 Objectives

Simulation framework of grid connected photovoltaic micro solar power station network systems which have following characteristics:

- a) To develop a simulation model for an optimal grid connected with micro solar generator system.
- b) To analyse an overall efficiency and utilization performance of system proposed.

1.4 Scope

The project focused on study of development modelling and designing of photovoltaic solar array, controlling maximum power point tracker (MPPT), amplification voltage by boost converter, conversion direct current to alternating current by an inverter and synchronization control strategy to be safely connected to utility grid. The output voltage from boost converter is targeted to achieve at level of 650Vdc before its being supplied for conversion to AC voltage at 430V by the usage of DC-AC inverter. In addition, it also includes the current versus voltage (I-V) characteristic and power versus voltage (P-V) characteristic of the PV module as well as the PV arrays as it is important to validate the performance of the solar module. In terms of synchronization with utility, a proper control strategy is proposed to give the best performance of the proposed photovoltaic framework study. The results illustrate the energy flow of frame system which has capability of 7kW of the power at varied irradiation level from optimum 1000 W/m^2 to lower irradiation level of 250 W/m^2 for the entire studied period of time.

1.5 Research Methodology Overview

In this dissertation, mathematical model method is implemented throughout the modelling of overall framework of grid connected with micro solar generator. The research methodology flowchart overview of grid connected with micro solar generator is shown in Figure 1.1 .

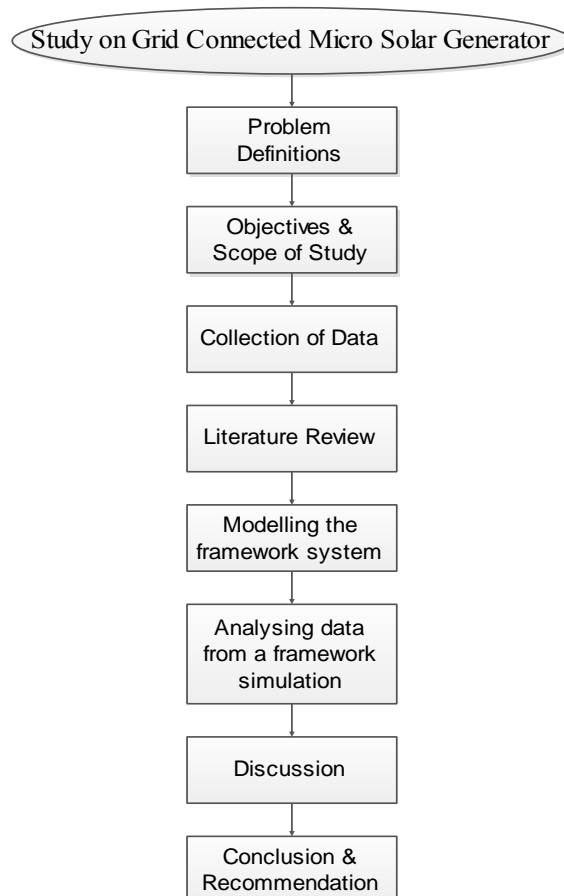


Figure 1.1: Overview Flowchart of Research Methodology

The research methodology starts with problem definitions in order to know and focus an area of the study to be concentrated and come out with a few optional idea to solve the problem. Next, an objective and scope of study is clearly explained in section 1.3 and section 1.4.