VOLTAGE SAG MITIGATION USING DYNAMIC VOLTAGE RESTORER WITH MULTI-FEEDBACK CONTROL

by

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This thesis is submitted to the department of Electrical Engineering in partial fulfillment of the requirement for the Degree of Master of Engineering

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Abstract

Voltage sag is one of the most serious power problems that the industrial customers are facing nowadays. Voltage sag is a momentary reduction of rms voltage.

These momentary reductions are, sometimes, sufficient to cause tripping of sensitive equipment of an industrial installation. One such tripping can cause production loss worth of several hundred thousands to few millions of rupees depending on the nature of the industry (e.g. Glass industry).

Voltage sags can be remedied at 'system-level' as well as 'device-level'. The system level solutions are costly because controlling the voltage sag events of a power system involves large amount of money and effort. On the other-hand, every customer. fed by a power system is not affected by voltage sags. Only few customers have sensitive equipment such as process controllers- which need protection from sags. Therefore a device-level solution provided at the customers' doorstep is more attractive in economic terms.

Dynamic Voltage Restorer (DVR) is one of such 'device-level' mitigating devices that could be used to protect a customer from voltage sags. The basic theory behind the DVR is the series voltage compensation. In case of a sag of the incoming supply voltage to a customer installation, the DVR injects the balance of voltage in series with the incoming voltage so that the load does not see any abnormal condition.

Since a sag continues within a few fractions of a second, the DVR has to respond fast enough to compensate the sag. Therefore, the control method adopted in the DVR has a vital role in its satisfactory performance.

In this research project, three different control options, namely open-loop control system, close-loop control system and multi-feed back control system were designed,

analysed and digitally simulated. This thesis contains the details of those design, analysis and simulation.

Out of the three control options, the multi-feed back controlled DVR has shown superior performance compared with the other two options and therefore, this option is recommended for practical use in protecting an important load. From the analysis and also the digital simulations, it has been proved that the multi-feed back controlled DVR is capable of protecting any load up to 5 MVA (power factor from 0.6 to unity) against system voltage sags.

Declaration

I certify that this thesis has not been previously prepared in whole or part to any University or Institution for a higher degree.

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UOM Verified Signature

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CONTENTS

Contents		Page
Acknowledgements		vi
Abbreviations		vii
Abstract		viii
Chapter 1	INTRODUCTION	**01**
1.0	Power Quality 1	
1.1	Motivation for Research 4	
1.2	Objectives of Research 5	
Chapter 2	VOLTAGE SAGS AND SAG MITIGATION	**07**
2.0	Introduction to Voltage Sags 7	
2.1	Sources of Voltage Sags 8	
2.1.1	Power System Faults 9	
2.1.1.1	Three Phase Balanced Faults 9	
2.1.1.2	Unbalanced Faults 10	
2.1.2	Starting of Large Induction Motors 10	
2.1.3	Inrush Currents of Capacitors and Transformers 11	
2.2	Severity of Voltage Sags 11	
2.3	Voltage Divider Model for Estimation of Sag Magnitude 12	
2.4	Duration of Sags 13	
2.5	Phase Shift Associated with Voltage Sags 14	

2.6 Sag Compensation Methods 17
2.6.1 Reduction of Number of Faults 17
2.6.2 Structure Changes to the Power System 18
2.6.3 Reduction of Fault Clearing Time 18
2.6.4 Installation of Compensation Devices at the Interfacing Point 20
2.6.5 Improvement of Equipment Immunity to Voltage Sags 21

Chapter 3 VOLTAGE SAG COMPENSATION USING DYNAMIC VOLTAGE RESTORER (DVR) 22

3.0 Introduction to DVR 22
3.1 Structure of DVR 23
3.1.1 Energy Storage Device 23
3.1.2 Voltage Source Inverter 24
3.1.3 Filter 24
3.1.4 Injection Transformer 25
3.1.5 DVR By-pass Circuitry 26
3.2 Functional Description of DVR 26
3.3 Possible Methods for Compensation of Voltage Sags by DVR 27
3.3.1 Pre-sag Compensation 27
3.3.2 In-phase Compensation 27
3.3.3 Energy Optimised Compensation 28

Chapter 4 DESIGN OF CONTROL STSREM FOR DVR 30

4.0 Introduction to DVR Control System Design 30
4.1 Mathematical Model of DVR 31
4.2 Analysis of Open-Loop Controlled System for DVR 33
4.3 Close-Loop Control System of DVR with Voltage Feedback 38
4.4 Multi-Feedback Control System of DVR 45

Chapter 5 SIMULATION AND RESULTS 51

5.0 Introduction 51
5.1 Matlab/Simulink Model 51
5.1.1 Modeling of Supply Voltage Waveform with a Sag 52
5.1.2 Inverter and Pulse Circuit 52

5.1.3 DC Link Voltage 52
5.2 Digital Simulation of Open-Loop Controlled DVR 61
5.3 Digital Simulation of Close-Loop Controlled DVR 61
5.4 Digital Simulation of DVR with Multi-feedback Control System 57
5.5 Simulation of Sag Compensation Methods of DVR 61
5.5.1 Pre-Sag Compensation 62
5.5.2 In-phase Compensation 62

Chapter CONCLUSION AND RECOMMENDATIONS 64

Appendix A Computer models of Different DVR Configurations 67

Appendix B Examples for Voltage Sags in Sri Lankan Power System 71

Reference 78

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ABBREVIATIONS

AC	Alternating Current
DC	Direct Current
DVR	Dynamic Voltage Restorer
Fig.	Figure
IEC	International Electromechanical Commission
IGBT	Insulated Gate Bipolar-junction Transistor
kV	Kilo-Volt
mH	milli-Henry
ms	milli-second
MV	Medium Voltage
MVA	Mega Volt Ampere
PCC	Point of Common Coupling
p.f.	Power Factor
pu	per unit
PWM	Pulse Width Modulation
rms	Root Mean Square
sec.	second
THD	Total Harmonic Distortion
UPS	Uninterrupted Power Supply
V	Volt
VA	Volt-Ampere
VSI	Voltage Source Inverter
Ω	Ohm.