

# A benchmarking model for harmonic distortion in a power system

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Dissertation submitted in fulfilment of the requirements for the degree

*Masters of Engineering*

at the

Potchefstroom campus of the North-West University

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November 2011

## **ACKNOWLEDGEMENTS**

- I give thanks and praise to God Almighty, through his son Jesus Christ and by the power of the Holy Spirit, for giving me the opportunity and knowledge to complete this dissertation. I am nothing without Them.
- Special thanks to Eskom, allowing me access to their database.
- I want to express my gratitude to my supervisor for his guidance, support and wisdom.
- To my wife and family, thank you for your support and encouragement.

## ABSTRACT

The present power system is loaded with sophisticated energy conversion technologies like solid state converters. With the rapid advance in semiconductor technology, power electronics have provided new devices that are highly efficient and reliable. These devices are inherently non-linear, which causes the current to deviate from sinusoidal conditions. This phenomenon is known as harmonic current distortion.

Multiple consumers are connected to the utility at the point of common coupling. Harmonic currents are then transmitted into the distribution system by various solid state users and this could lead to voltage distortion. Harmonic distortion is just one of the power quality fields and is not desirable in a power system. Distortion levels could cause multiple problems in the form of additional heating, increased power losses and even failing of sensitive equipment.

Utility companies like Eskom have power quality monitors on various points in their distribution system. Data measurements are taken at a single point of delivery during certain time intervals and stored on a database. Multiple harmonic measurements will not be able to describe distortion patterns of the whole distribution system. Analysis must be done on this information to translate it to useful managerial information.

The aim of this project is to develop a benchmarking methodology that could aid the supply industry with useful information to effectively manage harmonic distortion in a distribution system. The methodology will implement distortion indexes set forth by the Electrical Power Research Institute [3], which will describe distortion levels in a qualitative and quantitative way. Harmonic measurements of the past two years will be used to test the methodology. The information is obtained from Eskom's database and will benchmark the North-West Province distribution network [40]. This proposed methodology will aim to aid institutions like NERSA to establish a reliable power quality management system.

**Keywords:** Benchmarking indices, harmonics, voltage distortion, current distortion, power quality

## TABLE OF CONTENT

<b>ACKNOWLEDGEMENTS .....</b>	<b>II</b>
<b>ABSTRACT .....</b>	<b>III</b>
<b>LIST OF FIGURES.....</b>	<b>VII</b>
<b>LIST OF TABLES.....</b>	<b>X</b>
<b>LIST OF ABBREVIATIONS .....</b>	<b>XI</b>
<b>CHAPTER 1 – INTRODUCTION.....</b>	<b>1</b>
1.1 INTRODUCTION .....	1
1.2 ENGINEERING PROBLEM .....	3
1.3 RESEARCH METHODOLOGY .....	3
1.4 DISSERTATION LAYOUT .....	4
<b>CHAPTER 2 – LITERATURE STUDY .....</b>	<b>5</b>
2.1 INTRODUCTION .....	5
2.2 BASIC PRINCIPLES OF HARMONICS .....	6
Fourier series.....	6
Linear and non-linear loads.....	8
Harmonic penetration into a power system.....	10
2.3 HARMONIC SOURCES .....	11
Converters.....	12
Switch mode power supplies.....	12
General equations for two-way rectifiers .....	15
Six-pulse rectifiers .....	17
Twelve-pulse rectifiers.....	18
Arc Furnaces .....	20
Transformers .....	21
Fluorescent light.....	23
2.4 HARMONIC EFFECTS .....	25
Rotating Machines .....	25
Transformers .....	25
Power Cables .....	26
Power Factor Correction Capacitors .....	26
Electronic Equipment.....	27
System Protection Relays.....	27
Neutral Line Overheating.....	27
Switchgear.....	28
Residual Current Circuit Breakers .....	28
2.5 MITIGATION OF HARMONIC DISTORTION .....	29
Passive Filters .....	29
Active Filters.....	30
Amending the frequency response of the system.....	31
2.6 POWER QUALITY STANDARDS .....	32

NER Directive on Power Quality .....	32
Electromagnetic Compatibility Level .....	33
Emission Level (EL) .....	34
Immunity Level (IL) .....	35
Compatibility Level (CL).....	35
Emission Limit (E).....	35
Immunity Limit (I).....	36
Planning Level (PL).....	36
Relationship between parameters.....	37
NRS 048 Standards .....	37
NRS 048 Part 2 .....	38
NRS 048 Part 4 .....	39
2.7 HARMONIC BENCHMARKING.....	44
Segmentation.....	44
Harmonic Indices .....	45
Total Harmonic Distortion .....	45
System Average Total Harmonic Distortion .....	46
System Average Total Harmonic Distortion – CP95 % .....	47
System Average Total Harmonic Distortion – CP 99% .....	48
System Average Excessive Total Harmonic Distortion Ratio Index.....	48
Histograms and Cumulative Probability .....	49
2.8 SUMMARY .....	50
<b>CHAPTER 3 –ANALYSIS METHODOLOGY.....</b>	<b>51</b>
3.1 INTRODUCTION .....	51
3.2 NETWORK AND SEGMENT SELECTION.....	51
3.3 DATA SAMPLING.....	57
3.4 METHODOLOGY .....	58
3.5 PROGRAM 1.....	59
Data input.....	60
Data conditioning .....	60
Histogram function .....	61
Cumulative probability algorithm .....	61
Index algorithm, 1% to 4% .....	62
Average data and mean VTHD algorithm.....	62
Output parameters .....	62
3.6 PROGRAM 2.....	62
Data input and array function.....	64
Segment data .....	65
BI: SATHD, SATHD CP95%, SATHD CP99% and SATHDi .....	65
Output and Graph function.....	65
3.7 SUMMARY .....	65
<b>CHAPTER 4 – BENCHMARKING RESULTS AND CONCLUSION.....</b>	<b>66</b>
4.1 INTRODUCTION .....	66
4.2 SATHD .....	66
4.3 SATHD_CP95% .....	68
4.4 SATHD_CP99% .....	69
4.5 SATHDi .....	71
4.6 COMPARISON STUDY.....	75
4.7 METHODOLOGY EVALUATION.....	77
4.8 DATA EVALUATION .....	77

4.9 ROBUSTNESS OF PROGRAMS.....	78
4.10 CONCLUSION .....	78
4.11 FUTURE WORK.....	79
<b>REFERENCES .....</b>	<b>80</b>
<b>APPENDIX A.....</b>	<b>84</b>
<b>APPENDIX B.....</b>	<b>95</b>
<b>APPENDIX C.....</b>	<b>96</b>
<b>APPENDIX D.....</b>	<b>214</b>
<b>APPENDIX E.....</b>	<b>217</b>

<b>LIST OF FIGURES</b>
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FIGURE 2.1: DISTORTED VOLTAGE WAVEFORM.....	7
FIGURE 2.2: HARMONIC COMPONENT WAVEFORMS.....	8
FIGURE 2.3: VOLTAGE AND CURRENT WAVEFORMS FOR LINEAR LOADS.....	9
FIGURE 2.4: VOLTAGE AND CURRENT WAVEFORMS FOR NON-LINEAR LOADS.....	9
FIGURE 2.5: NETWORK EXAMPLE OF NON-LINEAR AND LINEAR LOADS CONNECTED TO A POINT OF COMMON COUPLING.....	10
FIGURE 2.6: POWER AND HARMONIC POWER FLOW.....	11
FIGURE 2.7: SINGLE-PHASE DIODE BRIDGE RECTIFIER.....	12
FIGURE 2.8: VOLTAGE AND CURRENT WAVEFORM DISTORTION FOR A SPDR.....	13
FIGURE 2.9: SWITCH MODE POWER SUPPLY CIRCUIT [2].....	13
FIGURE 2.10: HARMONIC SPECTRUM FOR A COMPUTER POWER SUPPLY [8].....	14
FIGURE 2.11: J-PHASE, TWO WAY RECTIFIER.....	16
FIGURE 2.12: SQUARE WAVE REPRESENTATION FROM EQUATION (2.15).....	17
FIGURE 2.13: CURRENT WAVEFORM DISTORTION OF A SIX-PULSE RECTIFIER.....	18
FIGURE 2.14: HARMONIC SPECTRUM FOR A SIX-PULSE RECTIFIER [8].....	18
FIGURE 2.15: TWELVE-PULSE RECTIFIER.....	19
FIGURE 2.16: HARMONIC SPECTRUM FOR A TWELVE-PULSE RECTIFIER [8].....	19
FIGURE 2.17: CURRENT WAVEFORM DISTORTION FOR A TWELVE-PULSE RECTIFIER.....	19
FIGURE 2.18: CHARACTERISTICS OF AN ARC FURNACE DURING VARIOUS OPERATING PERIODS [40].....	21
FIGURE 2.19: EXCITING PHENOMENA OF A NO LOAD TRANSFORMER [41].....	22
FIGURE 2.20: EXCITING CURRENT OF A NO LOAD TRANSFORMER [40].....	23
FIGURE 2.21: HARMONIC SPECTRUM OF INRUSH CURRENT ON A NON-LOADED TRANSFORMER [2].....	23
FIGURE 2.22: HARMONIC CURRENT COMPONENTS GENERATED BY A CFL [8].....	24
FIGURE 2.23: NETWORK EXAMPLE WITH POWER FACTOR CORRECTION [8].....	27
FIGURE 2.24: NEUTRAL CONDUCTOR HARMONIC CURRENT [8].....	28
FIGURE 2.25: PASSIVE HARMONIC FILTERS [8].....	30
FIGURE 2.26: PARALLEL ACTIVE HARMONIC CONDITIONER [24].....	30
FIGURE 2.27: TYPICAL HARMONIC SPECTRUM FOR A VSD AS MEASURED FROM THE SUPPLY SIDE [24].....	31
FIGURE 2.28: HARMONIC SPECTRUM OF A VSD WITH AHC INSTALLED [24].....	31
FIGURE 2.29: ROLES OF THE NER [15].....	33
FIGURE 2.30: GRAPHICAL DISPLAY OF EMISSIONS LEVELS [22].....	34
FIGURE 2.31: STATISTICAL DISTRIBUTION OF EMISSIONS LEVEL AND COMPATIBILITY THRESHOLD VALUE [22].....	35

FIGURE 2.32: STATISTICAL DISTRIBUTION OF EMISSIONS LEVEL AND COMPATIBILITY THRESHOLD VALUE [22].	36
FIGURE 2.33: RELATIONSHIP BETWEEN VARIOUS COMPATIBILITY PARAMETERS [43].	37
FIGURE 2.34: EXAMPLE OF NETWORK SEGMENTATION [3].	45
FIGURE 2.35: EXAMPLE OF CUMULATIVE PROBABILITY CURVE WITH A HISTOGRAM GRAPH.	50
FIGURE 3.1: DISTRIBUTION NETWORK OF THE NORTH-WEST PROVINCE, APPENDIX A PROVIDES DETAILED MAPS.	53
FIGURE 3.3: CIRCUIT SEGMENTATION OF THE NORTH-WEST PROVINCE.	55
FIGURE 3.4: NETWORK AREA USED FOR BENCHMARKING PROJECT.	55
FIGURE 3.5: FUNCTIONAL FLOW DIAGRAM OF BENCHMARKING ANALYSIS.	58
FIGURE 3.6: FUNCTIONAL FLOW DIAGRAM OF THE PROGRAMS.	59
FIGURE 3.7: HISTOGRAM OBTAINED FROM VTHD DATA, WITHOUT ZERO ENTRY ELIMINATION.	60
FIGURE 3.8: HISTOGRAM OBTAINED FROM VTHD DATA, WITH ZERO ENTRY ELIMINATION.	60
FIGURE 3.9: FUNCTIONAL FLOW DIAGRAM FOR CUMULATIVE PROBABILITY ALGORITHM.	61
FIGURE 3.10: FUNCTIONAL FLOW DIAGRAM FOR PROGRAM 2.	63
FIGURE 3.11: EXAMPLE OF DATA ARRAY FOR MTHD_ BLUE PHASE.	64
FIGURE 4.1: SATHD RESULTS.	67
FIGURE 4.2: SATHD INCREASE/DECREASE GRAPH.	67
FIGURE 4.3: GRAPHICAL REPRESENTATION OF SATHD_CP95% RESULTS.	68
FIGURE 4.4: SATHD_CP95% INCREASE/DECREASE GRAPH.	69
FIGURE 4.5: GRAPHICAL REPRESENTATION OF SATHD_CP99% RESULTS.	70
FIGURE 4.6: SATHD_CP99% INCREASE/DECREASE GRAPH.	70
FIGURE 4.7: SATHDI WITH THRESHOLD LIMIT SET AT 1%.	71
FIGURE 4.8: SATHDI WITH THRESHOLD LIMIT SET AT 2%.	72
FIGURE 4.9: SATHDI WITH THRESHOLD LIMIT SET AT 3%.	72
FIGURE 4.10: SATHDI WITH THRESHOLD LIMIT SET AT 4%.	73
FIGURE 4.11: SATHDI INCREASE/DECREASE CHART AT 1%.	73
FIGURE 4.12: SATHDI INCREASE/DECREASE CHART AT 2%.	74
FIGURE 4.13: SATHDI INCREASE/DECREASE CHART AT 3%.	74
FIGURE 4.14: SATHDI INCREASE/DECREASE CHART AT 4%.	75
FIGURE 4.15: RESULTS OBTAINED FROM THE DPQ PROJECT [13], [29].	75
FIGURE 4.16: VOLTAGE SATHD RESULTS PER MONTH AS OBTAINED FROM PROGRAM 2.	76
FIGURE 4.17: TOTAL NUMBER OF VTHD MEASUREMENTS FOR ALL SEGMENTS PER MONTH.	78
FIGUREA.1: DISTRIBUTION - TRANSMISSION MAP NORTH WEST PROVINCE.	85
FIGUREA.2: DISTRIBUTION - TRANSMISSION MAP NORTH WEST PROVINCE.	86

FIGUREA.3: DISTRIBUTION - TRANSMISSION MAP NORTH WEST PROVINCE. ....	87
FIGUREA.4: DISTRIBUTION - TRANSMISSION MAP NORTH WEST PROVINCE. ....	88
FIGUREA.5: DISTRIBUTION - TRANSMISSION MAP NORTH WEST PROVINCE. ....	89
FIGUREA.6: DISTRIBUTION - TRANSMISSION MAP NORTH WEST PROVINCE. ....	90
FIGUREA.7: DISTRIBUTION - TRANSMISSION MAP NORTH WEST PROVINCE. ....	91
FIGUREA.8: DISTRIBUTION - TRANSMISSION MAP NORTH WEST PROVINCE. ....	92
FIGUREA.9: DISTRIBUTION - TRANSMISSION MAP NORTH WEST PROVINCE. ....	93
FIGUREA.10: DISTRIBUTION - TRANSMISSION MAP NORTH WEST PROVINCE. ....	94
FIGURE D.1: TREND VIEWER – CHART CONFIGURATION.....	215
FIGURE D.2: TREND VIEWER – SUBSTATION SELECTION. ....	215
FIGURE D.3: TREND VIEWER – RESULTS. ....	216
FIGURE D.4: TREND VIEWER – RESULTS IN EXPORT FORMAT. ....	216
FIGURE E.1: CENSUS DATA 2001 – DITSOBOTLA LOCAL MUNICIPALITY. ....	218
FIGURE E.2: CENSUS DATA 2001 – VENTERDORP LOCAL MUNICIPALITY.....	218

## LIST OF TABLES

TABLE 1.1: SUMMARY OF DISSERTATION CHAPTERS. ....	4
TABLE 2.1: HARMONIC CONTENT OF ARC FURNACES FOR TWO STAGES [6].....	20
TABLE 2.2: HISTORICAL OVERVIEW OF STANDARD DEVELOPMENT [1].....	32
TABLE 2.3: QUALITY OF SUPPLY STANDARDS .....	38
TABLE 2.4: COMPATIBILITY LEVELS FOR INDIVIDUAL HARMONICS [17].....	39
TABLE 2.5: COMPATIBILITY LEVELS FOR EHV AND HV [17]. ....	39
TABLE 2.6: NRS GUIDANCE FOR PLANNING LEVELS ON HARMONIC VOLTAGES [18]. ....	40
TABLE 2.7: IEC COMPATIBILITY LEVELS FOR LV AND MV NETWORKS [18]. ....	41
TABLE 2.8: IEC PLANNING LEVELS FOR MV NETWORKS [18].....	41
TABLE 2.9: IEC PLANNING LEVELS FOR HV AND EHV NETWORKS [18].....	41
TABLE 2.10: IEEE VOLTAGE DISTORTION [18].....	42
TABLE 2.11: IEEE CURRENT DISTORTION LIMITS FOR LOW VOLTAGES (120V – 69 KV) [18].....	42
TABLE 2.12: IEEE CURRENT DISTORTION LIMITS FOR MEDIUM VOLTAGES (> 69KV – 161KV) [18]. ....	42
TABLE 2.13: IEEE CURRENT DISTORTION LIMITS FOR HIGH VOLTAGES (> 161KV) [18]. ....	43
TABLE 2.14: COMPARISON BETWEEN IEC AND IEEE STANDARDS [18]. ....	43
TABLE 2.15: CONSUMER CATEGORISING FOR EMISSION LEVEL STAGES [18]. ....	43
TABLE 3.1: SEGMENT DESCRIPTIONS. ....	52
TABLE 3.2: SUMMARY OF MUNICIPALITIES AND CONNECTED KVA [37], [38]. ....	56
TABLE 3.3: EXAMPLE OF CALCULATING CUMULATIVE PROBABILITY CURVE VALUES.....	61
TABLE 3.4: EXAMPLE OF CALCULATING CUMULATIVE PROBABILITY CURVE VALUES.....	62
TABLE 3.5: DATA ARRAYS CREATED FROM INPUT DATA. “X” REPRESENTS AN ARRAY. ....	64
TABLE 4.1: COMPARISON TABLE FOR BENCHMARKING INDICES PER YEAR. ....	76

## LIST OF ABBREVIATIONS

Abbreviation	Description
AC	Alternating Current
AHC	Active Harmonic Conditioners
BI	Benchmarking Indices
CFL	Compact Fluorescent Lights
CL	Compatibility Level
CP	Cumulative Probability
CT	Current Transformer
DC	Direct Current
DPQ	Distribution Power Quality
DSP	Digital Signal Processor
E	Emission Limit
EHV	Extra High Voltage
EL	Emission Level
EMC	Electromagnetic Compatibility
EPRI	Electrical Power Research Institute
HV	High Voltage
I	Immunity Limit
IEC	International Electrotechnical Commission
IEEE	The Institute for Electrical and Electronic Engineers
IGBT	Insulated Gate Bipolar Technology
IL	Immunity Level
ITHD	Current Total Harmonic Distortion
LV	Low Voltage
MCB	Miniature Circuit Breaker
MV	Medium Voltage
NER	National Electricity Regulator
NERSA	National Energy Regulator of South Africa
PCC	Point of Common Coupling
PFC	Power Factor Correction
PL	Planning Level
PoD	Point of Delivery
PQ	Power Quality
PQMS	Power Quality Management System
PQSE	Power Quality State Estimator
QoS	Quality of Supply
RCCB	Residual Current Circuit Breaker
RMS	Root Mean Square

<b>Abbreviation</b>	<b>Description</b>
SANS	South African National Standards
SMPS	Switch Mode Power Supply
SVC	Static VAR Compensator
TDD	Total Distortion Demand
THD	Total Harmonic Distortion
VSD	Variable Speed Drive
VT	Voltage Transformer
VTHD	Voltage Total Harmonic Distortion