

# Novel Control Algorithms for Inverter-Based Custom Power Conditioners

by

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## **Abstract**

Power electronic conditioners have been proved to be an effective way to compensate for different current and voltage disturbances in distribution systems. These Custom Power (CP) conditioners, offer flexible solutions for Power Quality (PQ) problems. The challenge in applying CP devices is the calculation of the required compensating signals. The motivation for focusing on adaptive extraction techniques is to overcome the drawbacks of the analogue LPF and HPF. Although the LPF or HPF are easy to implement with analogue circuits, they are characterized by their low detecting precision, sensitivity to change in their circuit parameters, poor adaptation, and their introduction of gain and phase errors in detecting signals. However, the computational burden of the adaptive techniques complicates their implementation requirements. In this sense, control algorithms are required that are capable of tracking and extracting the PQ disturbance, and then constructing the compensating control signal of the CP conditioner.

This thesis presents efficient control algorithms for the inverter based CP devices to compensate for various PQ problems. The proposed techniques are adaptive, feedforward, and simple in overcoming the deficiencies of the available control strategies. One proposed control strategy is based on the instantaneous tracking of the voltage envelope to compensate for the voltage disturbances such as flicker and sag. Both the adaptive linear combiner (ADALINE) algorithm and the Recursive Least Square (RLS) algorithm are utilized for the on-line tracking of the voltage envelope. The difference between the estimated envelope and the required voltage level is used to drive the Distribution STATic synchronous COMPensator (DSTATCOM) to inject the required reactive power to compensate voltage fluctuations.

Another control strategy which is based on the estimation of the symmetrical components is also designed. Novel Multi-Output (MO) structures are developed for both the ADALINE and the RLS algorithms to enable the estimation of the symmetrical components. A processing unit to estimate the harmonics and symmetrical components, as well as to resolve the fundamental positive sequence component to its active and reactive parts, is introduced. This processing unit is employed to control the Dynamic Voltage Restorer (DVR) to compensate for various PQ problems related to the voltage.

The new era of deregulation accounts for the proliferation of Distributed Generation (DG). The increasing trend to utilize DG in distribution systems motivates the development of a new CP device, which is called the Flexible DG (FDG). This proposed FDG utilizes the existing inverter link of distributed resources such as fuel cells, photovoltaics, and micro-turbines to not only control the active power flow, but also to mitigate unbalance, harmonics, flicker and sag and to manage the reactive power of the system. The FDG is similar to the FACTS, but works at the distribution level. The proposed processing unit is further employed to coordinate the different functions of this new CP device.

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*To my Parents, my wife Soha and little daughter Yara.*

# Contents

<b>1</b>	<b>Introduction and objective</b>	<b>1</b>
1.1	Preamble .....	1
1.2	Research Motivation .....	5
1.3	Thesis Objectives .....	6
1.4	Outline of the Thesis .....	7
<b>2</b>	<b>Literature Survey</b>	<b>9</b>
2.1	Introduction .....	9
2.2	Power Circuit Classification of APLCs .....	11
2.2.1	Shunt APLC .....	12
2.2.2	Series APLC .....	13
2.2.3	Hybrid Filters .....	16
2.2.4	Unified Power Quality Conditioner (UPQC) .....	17
2.2.5	Other Converter Topologies .....	19
2.3	Functionality Classification of APLCs .....	20
2.3.1	Harmonic Compensation .....	22
2.3.2	Unbalance .....	22
2.3.3	Combined Compensation for Reactive Power, Unbalance and Harmonics .....	23
2.3.4	Flicker Compensation and Voltage Regulation .....	23
2.3.5	Sag/Swell Mitigation .....	23
2.4	Control Techniques Classification of APLCs .....	24
2.4.1	Instantaneous Reactive Power Algorithm .....	25



2.4.2	Orthogonal Currents Method ( $i_p$ - $i_q$ ) .....	27
2.4.3	Synchronous Detecting Method .....	28
2.4.4	Synchronous Reference Frame (SRF) .....	28
2.4.5	Synchronous Flux Detection Algorithm .....	29
2.4.6	Voltage Detection based Notch Filter Method .....	29
2.4.7	Harmonic Resistance Method .....	30
2.4.8	Sinusoidal Peak Detector Technique .....	31
2.4.9	Power Balance Concept (PCB) .....	31
2.4.10	RMS Method .....	33
2.4.11	DVR Control Techniques .....	33
2.5	Summary of the Drawbacks of Available Control Techniques .....	34
2.6	Chapter Assessment .....	36
<b>3</b>	<b>Voltage Flicker Envelope Tracking</b> .....	<b>37</b>
3.1	Introduction .....	37
3.2	Flicker Waveform Model .....	40
3.3	Adaptive Linear Neuron (ADALINE) Algorithm .....	42
3.4	Recursive Least Square (RLS) Algorithm .....	44
3.4.1	Theory .....	44
3.4.2	Stability of the RLS Algorithm for Envelope Tracking Problem ...	46
3.5	Simulation Results .....	47
3.5.1	Dynamic Performance Evaluation .....	48
3.5.2	Parametric Sensitivity .....	50
3.5.2.1	The Learning Rate: .....	50
3.5.2.2	The Forgetting Factor: .....	52
3.5.3	The ADALINE Versus The RLS .....	52
3.5.4	Flicker Tracking of a Resistance Welder .....	54
3.6	Experimental Verification .....	56
3.6.1	Implementation of the ADALINE .....	57
3.6.2	Implementation of the RLS Algorithm .....	57

3.6.3	Experimental Results .....	58
3.6.3.1	Parametric Sensitivity .....	61
3.6.3.2	Multi-Step Operation .....	65
3.7	Chapter Assessment .....	68
<b>4</b>	<b>Symmetrical Components Estimation</b>	<b>70</b>
4.1	Introduction .....	70
4.2	Symmetrical Components Model .....	72
4.3	The Proposed MO-ADALINE Algorithm .....	74
4.4	The Proposed MO-RLS Algorithm .....	77
4.5	Reduced Order Symmetrical Components Model .....	78
4.6	A Processing Unit for Symmetrical and Harmonic Components Estimation .....	79
4.6.1	Direct Estimation of the D-Q Components of the Positive Sequence Current .....	80
4.6.2	Harmonic Components Extraction .....	81
4.6.3	The Proposed Processing Unit .....	83
4.7	Applications and Results .....	86
4.7.1	Dynamic Performance Evaluation .....	86
4.7.1.1	MO-ADALINE and the MO-RLS Versus the KF .....	91
4.7.1.2	Parametric Sensitivity .....	93
4.7.2	EMTDC Simulation of the Processing Unit .....	93
4.7.2.1	Normal Operation .....	95
4.7.2.2	Fault Conditions .....	97
4.8	Experimental Verification .....	100
4.8.1	Implementation of the MO-ADALINE .....	100
4.8.2	Experimental Results .....	101
4.9	Chapter Assessment .....	104

<b>5</b>	<b>Efficient Control Algorithms for DSTATCOM and DVR</b>	<b>106</b>
5.1	Introduction .....	106
5.2	Envelope Tracking for Flicker Mitigation .....	109
5.2.1	Envelope Tracking-Based Control Algorithm .....	109
5.2.2	System Configuration .....	111
5.2.3	Results .....	112
5.2.3.1	Case 1: Resistance Welder Flicker Mitigation .....	113
5.2.3.2	Case 2: Arc Furnace Flicker Mitigation (RLS Algorithm) .....	116
5.2.3.3	Case 3: Arc Furnace Flicker Mitigation (ADALINE) .....	117
5.3	Limitation of the Envelope Tracking Control Strategy .....	118
5.4	Symmetrical Components estimation for Sag and Flicker Mitigation ...	121
5.4.1	Structure of the DVR .....	121
5.4.2	The Proposed Control Strategy .....	123
5.4.3	Results .....	124
5.4.3.1	Case 1: Sag Mitigation .....	125
5.4.3.2	Case 2: Flicker Suppression .....	130
5.5	Chapter Assessment .....	132
<b>6</b>	<b>A New Custom Power Device: FDG</b>	<b>134</b>
6.1	Introduction .....	134
6.2	Philosophy Behind the Proposed FDG .....	135
6.3	Control Algorithm for the shunt FDG .....	137
6.3.1	Active Power Control .....	137
6.3.2	Disturbance Components Mitigation .....	139
6.3.2.1	FLC Design For Voltage Compensation .....	141
6.3.2.2	Harmonics, Unbalance, and Reactive Power Compensation .....	143
6.4	Results .....	144
6.4.1	Case 1: Harmonics, Unbalance, and Reactive Power Compensation .....	145
6.4.2	Case 2: Voltage Fluctuation Compensation .....	150

6.5	Universal FDG (UFDG) .....	153
6.5	Chapter Assessment .....	157
<b>7</b>	<b>Introduction and objective</b>	<b>159</b>
7.1	Summary .....	159
7.2	Contributions .....	163
7.3	Directions for Future Work .....	165
	<b>BIBLIOGRAPHY</b>	<b>167</b>
	<b>LIST OF PUBLICATIONS</b>	<b>182</b>
	<b>APPENDIX: Kalman Filter</b> .....	<b>184</b>

## List of Figures

Figure 2.1: Classification of APLCs. ....	11
Figure 2.2: (a) CSI topology, (b) VSI topology. ....	12
Figure 2.3: Series APLC topology. ....	16
Figure 2.4: Possible hybrid filter configuration: (a) Shunt APF with passive filter, (b) Shunt APF in series with passive filter, (c) Series APF with passive filter. ....	17
Figure 2.5: Configuration of unified power quality conditioner. ....	18
Figure 2.6: Block diagram of modular APLC. ....	20
Figure 2.7: Block diagram of the instantaneous reactive power theory. ....	25
Figure 2.8: SRF block diagram. ....	29
Figure 2.9: Block diagram of the harmonic resistance method. ....	30
Figure 2.10: Sinusoidal peak detector method. ....	31
Figure 2.11: Block diagram of calculating supply current based DC capacitor voltage regulator technique. ....	32
Figure 3.1: Block diagram of flicker tracking model. ....	42
Figure 3.2: Basic ADALINE structure. ....	43
Figure 3.3: Flicker tracking with the ADALINE. ....	48
Figure 3.4: Flicker tracking with the RLS. ....	49
Figure 3.5: Effect of learning rate on the envelope tracking. ....	51
Figure 3.6: Effect of forgetting factor on the envelope tracking. ....	53
Figure 3.7: System under study. ....	55
Figure 3.8: Tracking of the resistance welder flicker. ....	56
Figure 3.9: Experimental setup. ....	60
Figure 3.10: Sampled voltage. ....	60
Figure 3.11: ADALINE envelope tracking $\alpha = 0.25$ . ....	61

Figure 3.12: ADALINE envelope tracking $\alpha = 0.5$ .	62
Figure 3.13: ADALINE envelope tracking $\alpha = 0.1$ .	62
Figure 3.14: RLS envelope tracking $\lambda = 0.7$ .	63
Figure 3.15: RLS envelope tracking $\lambda = 0.9$ .	64
Figure 3.16: RLS envelope tracking $\lambda = 1$ .	64
Figure 3.17: ADALINE envelope tracking of multi-step voltage fluctuation.	65
Figure 3.18: Wide view from Figure 3.17.	66
Figure 3.19: RLS envelope tracking of multi-step voltage fluctuation (switching at the peak value).	67
Figure 3.20: RLS envelope tracking of multi-step voltage fluctuation (switching at zero crossing).	67
Figure 4.1: Structure of MO-ADALINE for tracking asymmetrical components.	76
Figure 4.2: Space vectors of load voltage and current in a simple network.	80
Figure 4.3: Block diagram of the proposed processing unit for three-wire systems.	84
Figure 4.4: Block diagram of the proposed processing unit for four-wire systems.	85
Figure 4.5: Three-phase unbalanced current set.	87
Figure 4.6: Estimated amplitude and phase angle of symmetrical components using the MO-ADALINE.	88
Figure 4.7: Symmetrical components estimation with the MO-ADALINE.	89
Figure 4.8: Estimated amplitude and phase angle of symmetrical components using the MO-RLS.	90
Figure 4.9: Symmetrical components estimation with the MO-RLS.	91
Figure 4.10: Symmetrical components estimation with KF, MO-ADALINE and MO-RLS.	92
Figure 4.11: Simple distribution system configuration.	94

Figure 4.12: Normal operation: estimated signals by the proposed processing unit. ....	96
Figure 4.13: Normal operation: (a) Phase $a$ voltage, active and reactive components of fundamental load current, and (b) Estimated load harmonics. ....	97
Figure 4.14: Fault condition: estimated signals by the proposed processing unit. ....	98
Figure 4.15: Fault condition: (a) Phase $a$ voltage, active and reactive components of fundamental load current, and (b) Estimated load harmonics. ....	99
Figure 4.16: Three-phase unbalanced signals. ....	102
Figure 4.17: Estimated positive sequence. ....	102
Figure 4.18: Estimated negative sequence. ....	103
Figure 4.19: Estimated zero sequence. ....	103
Figure 4.20: Simulation results. ....	104
Figure 5.1: Main components of the DSTATCOM. ....	108
Figure 5.2: Block diagram of the proposed DSTATCOM control system. ....	110
Figure 5.3: System configuration. ....	111
Figure 5.4: Flicker mitigation of the resistance welder: (a) pu voltage at PCC, (b) Phase $a$ voltage and its envelope, and (c) VSI current of phase $a$ . ....	113
Figure 5.5: Phase angle $\theta$ : (a) Estimated by the RLS algorithm and (b) PLL. ....	114
Figure 5.6: Flicker mitigation of the resistance welder: (a) quadrature current command $i_q^*$ , (b) Compensated reactive power $Q$ , and (c) DC side voltage. ....	115
Figure 5.7: Flicker mitigation of the arc furnace using the RLS algorithm. ....	116
Figure 5.8: Flicker mitigation of the arc furnace using the ADALINE. ....	118
Figure 5.9: Phasor diagram of single-phase system. ....	119
Figure 5.10: Envelope tracking control strategy for single-phase DSTATCOM. ....	120
Figure 5.11: Block diagram of the DVR system. ....	122