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Fundamental Active Current Adaptive Linear Neural Networks for Photovoltaic Shunt Active Power Filters

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Abstract: This paper presents improvement of a harmonics extraction algorithm, known as the fundamental active current (FAC) adaptive linear element (ADALINE) neural network with the integration of photovoltaic (PV) to shunt active power filters (SAPFs) as active current source. Active PV injection in SAPFs should reduce dependency on grid supply current to supply the system. In addition, with a better and faster harmonics extraction algorithm, the SAPF should perform well, especially under dynamic PV and load conditions. The role of the actual injection current from SAPF after connecting PVs will be evaluated, and the better effect of using FAC ADALINE will be confirmed. The proposed SAPF was simulated and evaluated in MATLAB/Simulink first. Then, an experimental laboratory prototype was also developed to be tested with a PV simulator (CHROMA 62100H-600S), and the algorithm was implemented using a TMS320F28335 Digital Signal Processor (DSP). From simulation and experimental results, significant improvements in terms of total harmonic distortion (THD), time response and reduction of source power from grid have successfully been verified and achieved.

Keywords: shunt active power filter (SAPF); photovoltaic (PV); current harmonic; artificial neural network (ANN); total harmonic distortion (THD); digital signal processor (DSP); Simulink/MATLAB

1. Introduction

Harmonics are sinusoidal voltages or currents of frequencies that are integer multiples of the frequency at which the supply system is designed to operate. Current harmonics are more crucial than voltage harmonics because in most situations, the voltage harmonics only occur when there are current harmonics inside the power system. Current harmonics may result from nonlinear load operations produced by power electronic devices and applications which are injected into the supply network through a point of common coupling (PCC). Specifically, in smart grid systems, these problems may arise with involvement of multiple energy sources and systems which include photovoltaic (PV) grid connected systems [1–6]. Among the effects of current harmonics are capacitor blowing, equipment overheating, motor vibration and excessive neutral currents [7,8]. To compensate current harmonics, a powerful tool is the active power filter (APF), which is better as compared to a passive filter, since it can mitigate multiple harmonics instantaneously. Furthermore, for current harmonics mitigation or compensation, shunt active power filters (SAPF) or transformer-less APF topology is widely used [9–11]. However, besides SAPF, there are other topologies to compensate current harmonics, and