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Modelling and Performance Evaluation of MPPT Based Solar PV System in MATLAB/Simulink Environment

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***Abstract*—Photovoltaic systems operated at maximum obtainable power under variable weather condition enhances system reliability of a solar photovoltaic (PV) system to a great extent. Maximum power point tracking (MPPT) plays a vital role in this regard as it helps in extracting the maximum yield of power. Operating point of such a system is desired to set at global maxima on the P-V curve under different weather conditions. In this study, a comparative analysis between Perturb and observe (P&O) and Incremental Conductance (INC) method are employed to assess the MPPT of a PV system under variable weather conditions. The algorithms were applied on the cascaded power electronic interface embedded in the proposed system to obtain an efficient way of energy conversion. The results showed that existence of a MPPT controller increases system reliability. It was also observed that MPPT controller embedded with Incremental Conductance logic gives a better result than its P&O counterpart.**

Keywords— PV array, MPPT, Boost converter, Perturb and Observe (P&O) method, Incremental Conductance (INC) method

I. INTRODUCTION

Presently, energy plays a significant role towards development. Per capita energy consumption and the rate of economic growth are very closely related to each other. Unfortunately, most of the resources for energy extraction comes from fossil fuels. Although such resources possess very high energy density, but they are finite by nature and causes environmental pollution to a great extent. Hence, concerns on energy extraction from renewable resources gained the attraction of the researchers since last few decades [1-2]. Though most of the renewable resources are not much reliable, however, their biggest advantage is that they are eco-friendly.

Among all other renewable alternatives solar (PV as well as solar thermal) and wind are gaining importance day by day. PV systems are more versatile by nature as it can generate electricity in both small scale as well as on large scale basis. Maintenance of PV system is very cost effective [3]. Besides, it can generate electricity either in grid connected or in islanded mode [4-5]. The major drawback of solar PV system is mainly two-folded; one is uncertainty in power generation and the other one is lower efficiency of energy conversion as solar PV system depends strongly on solar irradiance level and on the variation of temperature resulting into a non-linear current voltage or power voltage relationship [6]. There are two alternatives to carry out research work in accordance with it. The first one lies with the fabrication level of solar cell material. However, this option is not a cost-effective solution. The other option is modelling as well as simulation of power electronic interface between solar cell and load. This type of analysis provides an insight of practical as well as economic viability of the proposed system before its physical implementation. Irradiation falling on the PV system and the ambient temperature should be high enough to obtain significant power output from a PV module. However, practically it is not possible as the solar irradiance falling over the module and the surrounding temperature vary on daily basis. With change in each of these two parameters, obtainable power changes to a significant amount. In this aspect, maximum power point tracking of (MPPT) from a PV array is of a common interest of researchers since last few decades [7]. One of the efficient techniques is Perturb and Observe (P&O). It helps in implementation of an optimized system. However, the main drawback of this method is the energy loss associated with the oscillation of operating point around the maximum power point of PV system.

In this study a more efficient approach of incremental conductance has been implemented on a PV system embedded with boost converter to decrease the oscillating power loss. The model developed for this study provide a scope for simulating both photo generation system as well as the power electronic interconnection also [8-11]. By varying the operating condition of the power electronic interface, maximum power from the module can be yielded [12]. This study investigates the impact of variable weather condition on the maximum power output of the PV module based on two different MPPT algorithms (P&O and INC) in MATLAB/Simulink environment. The model includes a 2×2 PV array along with a boost converter and resistive load. For simplicity in analysis, stand-alone PV system with a DC load nature was considered for this study.

II. PHOTOVOLTAIC SYSTEM

A solar cell is basically photodiode which is responsible of emission of electrons when subjected to radiation of a particular wavelength. Electron flow causes current through an external closed circuit. In this study, one diode model [13] of solar cell is considered for analysis in MATLAB/Simulink environment as evident in figure 1 [14].

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