A New Sensorless Hybrid MPPT Algorithm Based on Fractional Short-Circuit Current Measurement and P&O MPPT

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***Abstract*—This paper presents a new maximum power point tracking (MPPT) method for photovoltaic (PV) systems. The proposed method improves the working of the conventional perturb and observe (P&O) method in changing environmental conditions by using the fractional short-circuit current (FSCC) method. It takes the initial operating point of a PV system by using the short-circuit current method and later shifts to the conventional P&O technique. The advantage of having this two-stage algorithm is rapid tracking under changing environmental conditions. In addition, this scheme offers low-power oscillations around MPP and, therefore, more power harvesting compared with the common P&O method. The proposed MPPT decides intelligently about the moment of measuring short-circuit current and is, therefore, an irradiance sensorless scheme. The proposed method is validated with computer software simulation followed by a dSPACE DS1104-based experimental setup. A buck-boost dc–dc converter is used for simulation and experimental confirmation. Furthermore, the reliability of the proposed method is also calculated. The results show that the proposed MPPT technique works satisfactorily under given environmental scenarios.**

***Index Terms*—Efficiency, hybrid MPPT, maximum power point tracking (MPPT), modeling and simulation, photovoltaic (PV).**

I. INTRODUCTION

THE electricity generation through nonconventional energy sources have seen a boost in second decade of the 21st century because of better efficiency and declined cost. Solar photovoltaic (PV) is among the most anticipated nonconventional energy sources. In a PV system, 70%–80% cost comprises PV module and inverter [1]. In the past 20 years, the decrease in production cost of solar PV systems had a significant impact on cost per unit [2], [3]. When compared with conventional energy sources like thermal and hydal power, the PV systems need less time to produce electricity. According to the European Photovoltaic Industry Association, total installed capacity of PV systems is more than 100 GW [4]. It is a good sign, as PV systems are environment friendly. Estimates suggest that the rate of PV installations in the past 15 years has been around 45% [5], which means that in the near future, PV systems will have the largest share in electricity generation among available renewable energy sources [6].

A solar PV module is a current source, i.e., it produces electric current whose amplitude depends on falling insolation on the surface of PV module. The characteristic curve (I–V and P–V) of PV module is nonlinear and it has only one maximum power point (MPP) under full exposure to sunlight. The MPP varies with the changing insolation and temperature. Therefore, an organized set of rules is required to operate the system at MPP. These sets of rules are commonly referred to as MPP tracking (MPPT) methods [7]. Because of nonlinear behavior of the PV module, MPPT is essential for an efficient PV system. Various MPPT methods have been proposed and published in relevant scientific literature, which are, in fact, diversified ways to implement the impedance matching [8]. The most discussed methods are as follows [9], [10]:

1) perturb and observe (P&O);
2) incremental conductance (InC);
3) fractional open-circuit voltage (FOCV);
4) fractional short-circuit current (FSCC).

These MPPT algorithms can be subdivided into two broader categories, i.e., online and offline methods. P&O and InC are online MPPT techniques, as they do the tracking without isolating the PV module from the system [11]. Online MPPT methods have an intricate implementation process, but they are not subjected to any power loss as a result of isolating the PV module. However, they do suffer power loss because of power oscillations around MPP. Online MPPT methods can track the true MPP. The convergence speed of the online MPPT techniques listed above depends on the size of the change in operating point (also referred to as step size). A larger step size will track MPP more rapidly, but it will also result in greater power oscillations around the MPP. A smaller step size will reduce power oscillations around MPP, but it will need more time to track the MPP. Generally, the perturbation step size is in the range of 0.05–0.1. On the other hand, offline methods disconnect the PV module from the system to measure the operating parameters [short-circuit current (I_{sc}) and open-circuit voltage (V_{oc})] [11]. FOCV and FSCC fall under the offline category. Offline techniques are simple to implement using analog or digital electronics and they have a high

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