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Adaptive Power Control of the City Bus Integrated Photovoltaic System

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Abstract : This paper presents an adaptive controller to track the maximum power point of a photovoltaic modules (PV) under fast irradiation change on the city-bus roof. Photovoltaic systems have been a prominent option as an additional energy source for vehicles. The Municipal Transport Company (MPK) in Lublin has installed photovoltaic panels on its buses roofs. The solar panels turn solar energy into electric energy and are used to load the buses electric equipment. This decreases the buses alternators load, leading to lower fuel consumption and bringing both economic and ecological profits. A DC–DC boost converter is selected as the power conditioning unit to coordinate the operating point of the system. In addition to the conversion efficiency of a photovoltaic panel, the maximum power point tracking (MPPT) method also plays a main role to harvest most energy out of the sun. The MPPT unit on a moving vehicle must keep tracking accuracy high in order to compensate rapid change of irradiation change due to dynamic motion of the vehicle. Maximum power point track controllers should be used to increase efficiency and power output of solar panels under changing environmental factors. There are several different control algorithms in the literature developed for maximum power point tracking. However, energy performances of MPPT algorithms are not clarified for vehicle applications that cause rapid changes of environmental factors. In this study, an adaptive MPPT algorithm is examined at real ambient conditions. PV modules are mounted on a moving city bus designed to test the solar systems on a moving vehicle. Some problems of a PV system associated with a moving vehicle are addressed. The proposed algorithm uses a scanning technique to determine the maximum power delivering capacity of the panel at a given operating condition and controls the PV panel. The aim of control algorithm was matching the impedance of the PV modules by controlling the duty cycle of the internal switch, regardless of changes of the parameters of the object of control and its outer environment. Presented algorithm was capable of reaching the aim of control. The structure of an adaptive controller was simplified on purpose. Since such a simple controller, armed only with an ability to learn, a more complex structure of an algorithm can only improve the result. The presented adaptive control system of the PV system is a general solution and can be used for other types of PV systems of both high and low power. Experimental results obtained from comparison of algorithms by a motion loop are presented and discussed. Experimental results are presented for fast change in irradiation and partial shading conditions. The results obtained clearly show that the proposed method is simple to implement with minimum tracking time and high tracking efficiency proving superior to the proposed method. This work has been financed by the Polish National Centre for Research and Development, PBS, under Grant Agreement No. PBS 2/A6/16/2013.
Keywords : adaptive control, photovoltaic energy, city bus electric load, DC-DC converter
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