Development of a voltage regulator for solar photovoltaic cathodic protection system

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Abstract –
The voltage regulator is one of the main elements from which depends the reliability and the efficiency of the photovoltaic system. Among the large number photovoltaic applications, we are interested by the cathodic protection, it's recognized as one of the most efficacious means of the active prevention against the corrosion. Photovoltaic cathodic protection is one of the possible solutions for the structures subjected to corrosion, mainly in oil and gas industries [Tanasescu et al., 1988]. In this paper, the study about the design of a voltage regulator with variable output for solar photovoltaic cathodic protection has been carried out. Our system is based on two microcontroller controlled DC/DC converters: the first one is a buck used to match the maximum power point voltage of the solar panel to the battery charging voltage; and the second one is a buck-boost used between the batteries and the load in order to adapt the regulator at any cases of the cathodic protection stations. Usually, cathodic protection systems are working with constant current output which is the necessary condition to procure immunity voltage of the structures that strictly required preventing corrosion from occurring. The major difficulty to achieve this goal is the variations of the surrounding medium resistivity to overcome this difficulty, we propose an automatically adjustment of the output voltage of the buck-boost converter to feed the load (sacrificial anode-protected structure) thanks to the microcontroller by generating the required duty cycle by way of its PWM output. The developed system allows the solar panel to operate at its maximum power point output (MPP), when the MPP changes, the microcontroller changes the conversion ratio (duty cycle) of the buck circuit to keep the solar panel at its MPP. The buck steps higher voltage panel down to the battery charging voltage. In this paper, the study about the design of this voltage regulator with variable output for solar photovoltaic cathodic protection has been described.

Résumé - La protection cathodique par voie photovoltaïque est l'une des solutions utilisées pour les structures métalliques enterrées et exposées à la corrosion, principalement dans les industries du pétrole et du gaz. Dans ce papier, nous décrivons un dispositif de régulation et de contrôle qui permet l'ajustement automatique de la tension de sortie vers la charge (déversoir - canalisation à protéger) afin de maintenir le courant de protection constant. Ce régulateur permet aussi au champ de modules photovoltaïques 'GPV' de fonctionner à sa plus haute performance par le biais de la poursuite du point de puissance maximum et utilise comme circuit d'adaptation entre le champ photovoltaïque et le stockage électrochimique, un convertisseur CC/CC qui abaisse la tension du 'GPV' pour charger la batterie. Ce dispositif de régulation et de contrôle développé est conçu autour d'un buck et d'un buck-boost contrôlés par un μP. Nous présentons l'étude et la simulation du circuit buck-boost, ainsi que de sa commande représentant l'interface d'adaptation du système photovoltaïque aux différents cas de figures imposées par la protection cathodique.

Keywords:
Corrosion - Photovoltaic system - Cathodic protection - Regulation - Buck-boost converter.