POWER ELECTRONIC CONTROL OF THE LOAD OF PHOTOVOLTAIC GENERATORS SYSTEM

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ABSTRACT

The paper describes a function and a technical treatment of a three-stage system of optimized power transfer from a photovoltaic (PV) generator to a low-voltage electrical distribution system.

1 INTRODUCTION

The optimization of working points of individual PV generators of the solar system is carried out in the first stage that ensures full utilization of attainable power even under varying conditions (insolation, working temperature, surface pollution). For a short time the obtained energy is stored in electrical batteries or batteries of supercondensers constituting the second stage of the system. The third stage is a controlled chopper the power of which is defined by a consumption curve or regulated according an amount of accumulated energy. The conclusions present the results of longitudinal monitoring of the behaviour of the optimizing system and its three parts which can also work individually if necessary.

2 DESCRIPTION OF FUNCTION

The solution consists in power electronic control of the load of photovoltaic generators with respect to their momentary operational conditions, especially insolation, working temperature, and surface pollution. In the same moment, these conditions can be different for individual PV generators of the same PV system working to one extraction site. The control is carried out in three stages:

In the first stage, individual generators of the system are loaded by individual DC-DC converters to supply a common accumulation component with the maximum electric current. It makes possible to keep each generator in the optimum working point of its load characteristic for given operational conditions regardless of the momentary voltage of the accumulation component depending on the stage of charge and power take-off.

The optimum load of the individual generators is reached by the control of switching of DC-DC converters using the microcontroller PIC 16F877 (see fig. 1).

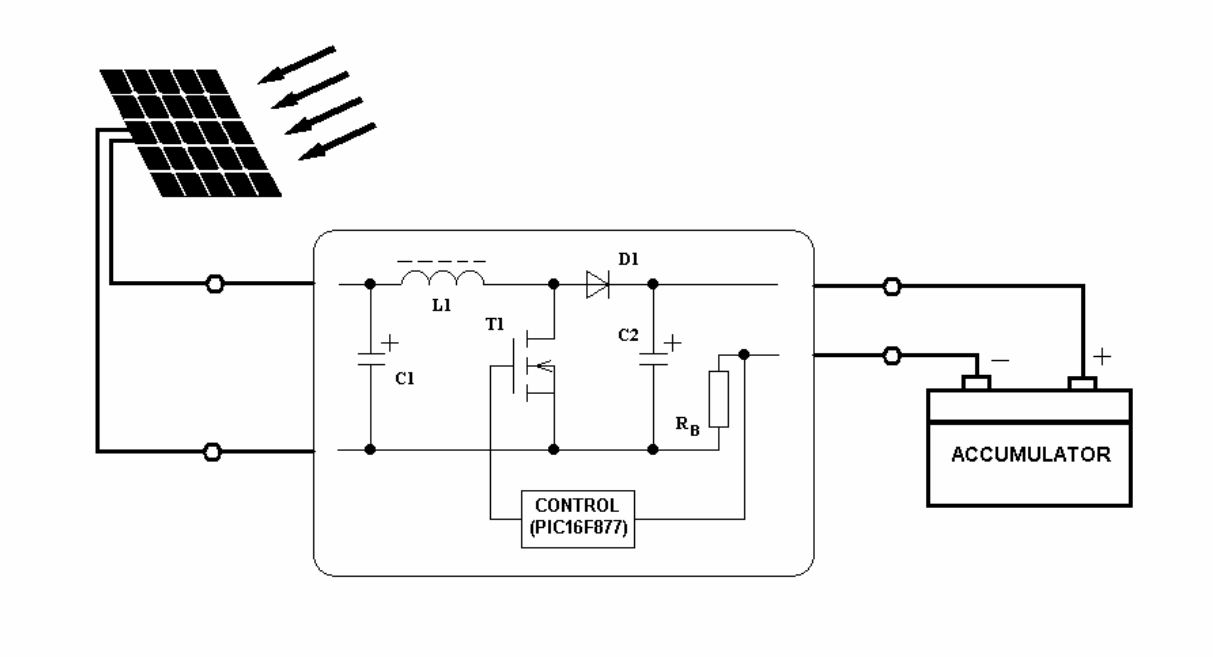

Fig. 1: *Reduced scheme of the individual optimum load of the photovoltaic converter*

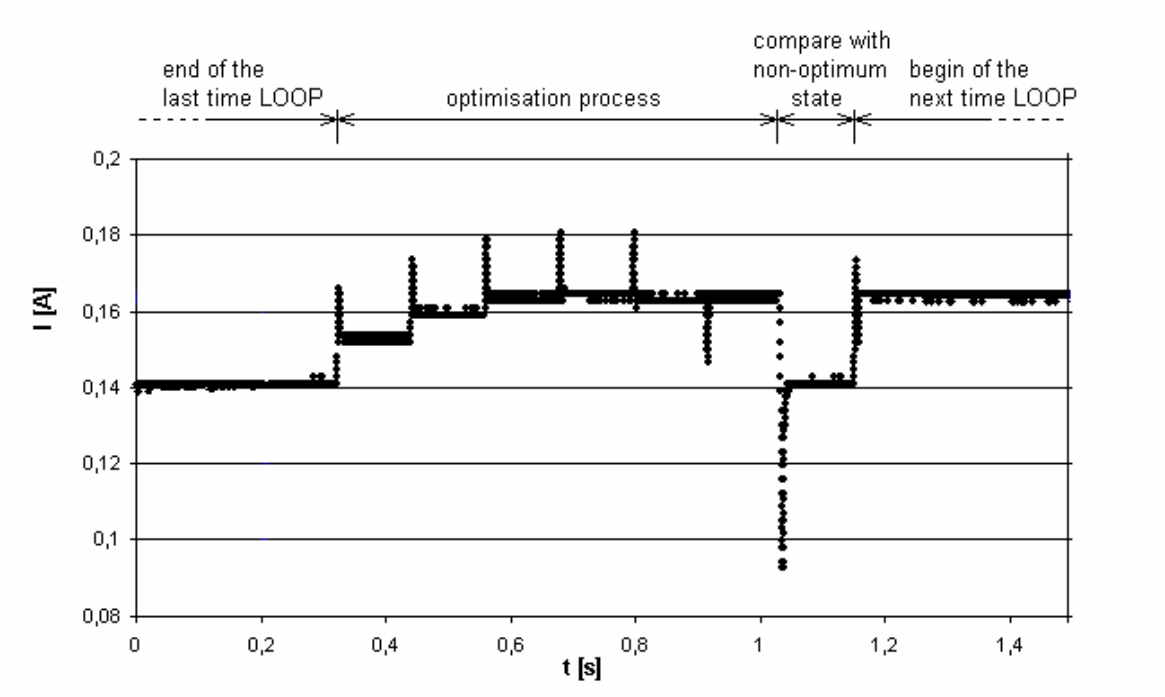

Fig. 2: *Development of the loading current in the course of optimisation process (at the small insolation)*

The principle of control is seeking for the optimum level of PWM corresponding to the maximum current supplied to the accumulation component (see fig. 3). The seeking procedure is repeated after a waiting period, thus a new optimum value of PWM is found if operational

conditions changed during this period. A typical course of the optimisation process is given in fig. 2.

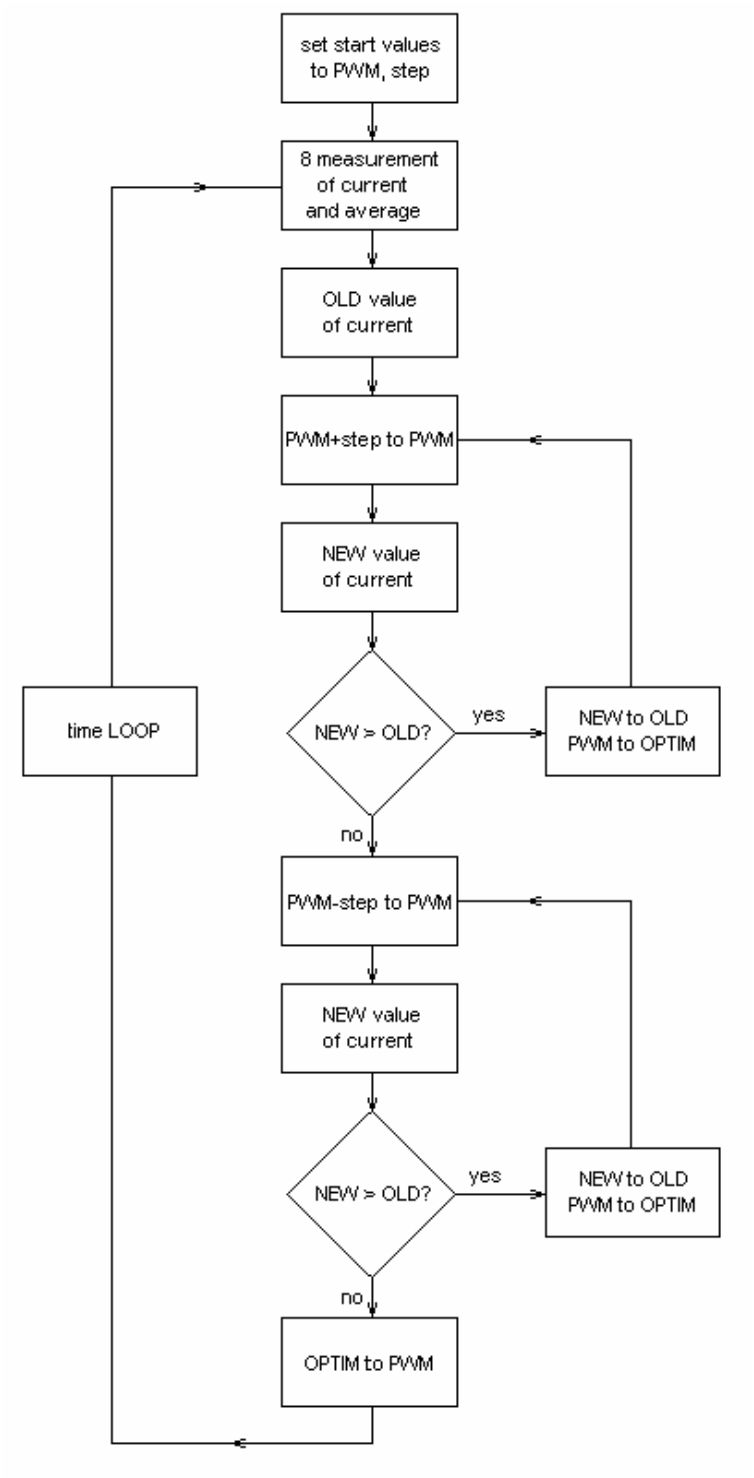

Fig. 3: *Reduced algorithm of the optimisation process*

The second stage is the accumulation component itself. It can be usual electric accumulator, or a battery of supercondensers. The capacity of the accumulator suits to the intended consumption and a period of accumulation (a day, a week etc.)

The third stage is a power chopper transforming the direct voltage of the accumulation component to the alternating voltage of the distribution network. The power of choppers can be controlled in dependence on the stage of charge of the accumulator or – if the capacitance of the battery is sufficient - according the given diagram of the supplied energy to the network.

3 CONCLUSION

The function of the designed device is tested under real operational conditions in a small solar laboratory of the Department of Electrical Power Engineering and longitudinally monitored by an automatic measuring system. Measured data are automatically saved and archived. Subsequently, the efficiency of the device is evaluated and compared with the properties of an adequate non-optimised system or different variants of technical treatment. The obtained results seem to promise the contribution of optimisation of the load about 25-30 per cent during one charging cycle of an accumulator. Presently, the power of the device is planned to be raised and a one-phase chopper of the power of hundreds of watts is prepared, together with a three-phase device.

ACKNOWLEDGEMENTS

The device is gradually developed at the Department of Electrical Power Engineering, Faculty of Electrical Engineering and Communication Technology, Brno University of Technology. Its development is financially supported by the project No. MSM 0021630516 “Sources, Accumulation and Optimisation of Use of Energy under the Conditions of Permanent Sustainable Growth” of the Ministry of Education of the Czech Republic.

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