Research on the charging system of electric vehicle photovoltaic cells

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Keywords: Electric vehicle; Photovoltaic charging; maximum power point tracking; MPPT algorithm.

Abstract. Electric vehicle power battery charging can reach 100% full, which greatly affected the battery service life. A photovoltaic battery of electric vehicle charging device are studied in this paper. The device can for battery leader time trickle current charging, through part of battery energy, can make the battery as far as possible with 100%, increase the mileage, longer service life. Design of the maximum power point tracking control strategy can quickly realize the tracking of the maximum output power of photovoltaic cells, at the same time, improve the charging efficiency of the battery, small steady-state error of the system, strong practicability, and testing environment of MPPT algorithm tracking accuracy of the method provides effective reference.

1.Introduction

The energy problem has become increasingly prominent, the development and application of electric vehicles is becoming more and more popular, but there are still many problems to be solved Xu bottleneck in the development of electric vehicles, the most prominent problem is the battery management and power battery battery for them. At present, the charging of the electric vehicle power battery pack can not reach 100% full, which greatly affects the battery life and the practical life of the battery pack. Has become a major obstacle to the development of electric vehicles. The tracking control strategy of the maximum power point, the electric car charging device of a photovoltaic cell design, the device can charge the battery trickle through long time, part of the battery energy, can make the battery as much as 100% full, mileage increase, longer service life.

After testing, the device can quickly track the maximum output power of photovoltaic cells, and improve the battery charging efficiency, the system steady-state error is small, practical.

2. System hardware components

The system is mainly composed of the following parts: power battery, photovoltaic battery charging device, photovoltaic cell, vehicle mounted instrument (on board operating system), CAN bus, USB-CAN adapter, battery management system.

2.1 Charge control strategy for lithium iron phosphate battery pack

The charging method of the battery pack in the photovoltaic system is discussed. According to the number of the battery capacity and the voltage of the battery, the charging process is carried out according to the three stages of maximum power charging, constant voltage charging and floating charging. The charge control strategy that combines the constant current charging fast, timely compensation of lithium iron phosphate power battery, constant voltage charging can control the charging and keeping the advantage of 100% of battery power in the floating state.

When the maximum value of the single cell voltage is less than 3.65 V (the charge cutoff voltage is 3.65V), the maximum power tracking algorithm is used to charge the lithium iron phosphate battery pack. When the highest single battery voltage is detected, the non maximum power tracking algorithm (PI regulator) is used to charge the 3.65V. In order to avoid the system in these two modes under constant switching, lead to system oscillation, the cut-off voltage set up a hysteresis link.

In this process, the measurement signal sampling, the use of digital filtering, to ensure the accuracy of sampling. The median filter and mean filter are combined to form the average filter of the anti pulse interference, which has a good effect on the complex filter. The M ($m>3$) sampling value of the charging current signal is sorted, and the average value of the bit n value is used as the filter output of the t=kT.

The single battery voltage obtained by CAN communication network, a battery information detection system with each battery, the detected battery voltage information sent via the CAN bus to the main controller unit. Photovoltaic battery charging device through the CAN bus to the total controller to send a single battery voltage data request, and then through the CAN bus to receive a single battery voltage.

2.2 System working principle diagram

The design of the photovoltaic battery charging device, the output voltage range of 40V-60V; to track the maximum power output of photovoltaic cells, the error is less than 5%; the efficiency of the converter can reach 85%; stable output voltage and current, the fluctuation is less than 5%; capable of detecting battery charging voltage and current, the error is less than 5%; to prevent battery charging function and overcurrent protection .

3. System software design

System software includes the main function modules are: initialization module, PWM module, ADC module, the maximum power tracking module, CAN communication module, PI control module, under voltage protection module, timer module。

3.1 System main program

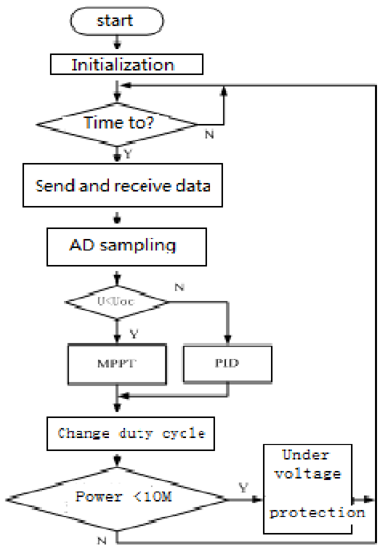


Fig. 1 flow chart of main function

The main program flow chart of the system is shown in Fig.1, which mainly includes the initialization, AD conversion, MPPT, CAN communication, PI regulation, under voltage protection and so on. The program uses the MATLAB platform based on the DSP embedded application programming model, automatic generation of program code, the design model is shown in Fig.2.

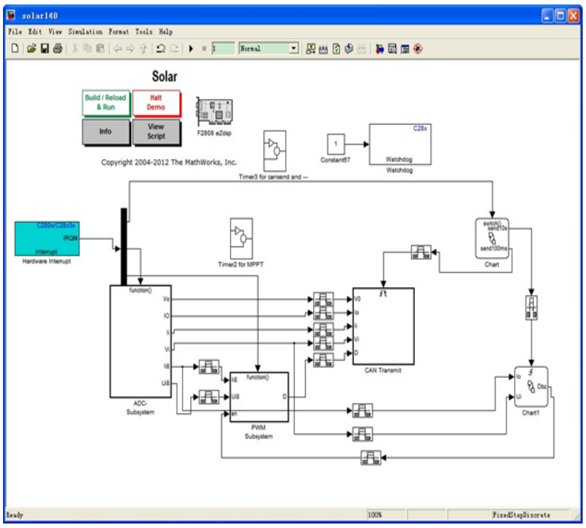


Fig. 2 DSP embedded application programming model based on MATLAB platform

3.2 Maximum power point tracking (MPPT) algorithm

Fig.3 for the maximum power tracking algorithm flow chart, that is, the control circuit used to optimize the current climbing algorithm . The flow chart in the I (n) said the current current value, I (n-1) said the current value of a moment ago; D (n) said that the current duty ratio;

D (n-1) said a moment ago the duty ratio of D; said duty ratio increment is a positive. In theprocess, the measurement of the signal sampling, each measurement of a signal to be repeated several times, the data collected by size sort, take the middle of the value, to ensure the accuracyof the sampling.

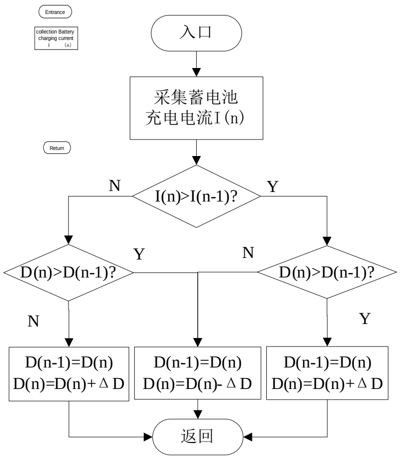


Fig. 3 flow chart of maximum power tracking

3.3 PI control module

The flow chart of PI control module is shown in Fig. 4. The PI control module adopts the incremental PI control algorithm. Ug for the set of constant voltage charging voltage, U for the battery charging voltage. The difference between the two into the incremental PI link, output and then through the limit, to draw the duty cycle. The power curve is divided into two sections in order to use the PI control algorithm in PI control, real-time tracking the maximum power, so the constant voltage method to determine the time of the maximum power point of the duty ratio, in order to determine the upper limit of the duty ratio.

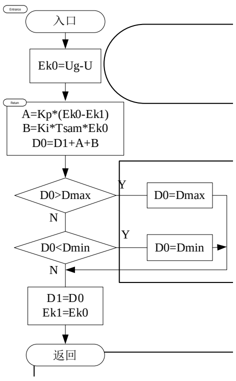
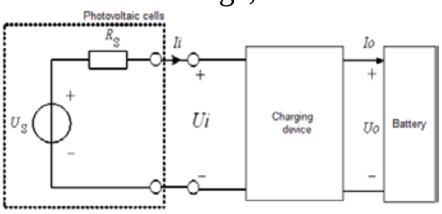


Fig. 4 flow chart of PI control module

4. Evaluation and conclusion

4.1 Maximum power point tracking test

In order to ensure the validity of the MPPT algorithm, experiments were carried out with a MPPT test circuit, the main circuit as shown in Fig.5, the 0~60 V Us series power source DC resistance Rs (3.7 Ohm) simulation of photovoltaic cells, by the Thevenin equivalent circuit of the photovoltaic maximum power point corresponding voltage should be Ui half of the Us/2 DC linear voltage stabilized source voltage, the test results are shown in Fig. 6.



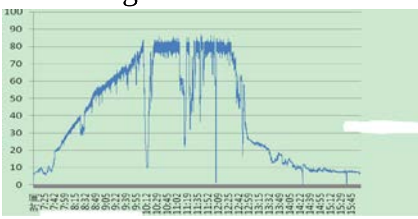


Fig. 5 maximum power point tracking test circuit Fig.6 maximum power point tracking test results

From the maximum power point tracking test results we can see that the MPPT tracking error is less than 2%, and the charging device efficiency is above 87%, which can meet the system design requirements. From the test results can be seen, when the sunlight intensity is much lower than the standard sunshine degree 1000W/m2, the output power is low, but the system efficiency is still above 88%, or at a higher level.

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