Photovoltaic Charging Solution with the MP2731

Introduction

For the 2022 Beijing Winter Olympics, all Olympic venues used green electricity to promote the goal for carbon neutrality. Green electricity mainly comes from solar photovoltaic and wind power generation. Utilizing more renewable photovoltaic energy is an effective approach to reach the greenhouse gas pollution target by 2030.

Photovoltaic System Charging

Photovoltaic cells have many subdivisions of applications, including common outdoor cameras, outdoor lighting, and electric bicycles. These applications require a backup battery and small photovoltaic panel. Photovoltaic panels convert solar energy into electrical energy to simultaneously supply power to the system and charge the backup battery. In the case of insufficient light (or during the night), the backup battery releases its stored energy to supply power to the system, which ensures uninterrupted system operation.

The photovoltaic panel's output current (I_{OUT}) and voltage (i.e. its output power) vary with the light intensity and photovoltaic panel temperature. When there is more light, I_{OUT} and voltage increase. When the photovoltaic panel's temperature increases, I_{OUT} and the voltage decrease.

To obtain maximum power for photovoltaic panels, the maximum energy is stored in the backup battery and supplies power to the system. In the case of insufficient light, it is vital for the photovoltaic charging system to switch seamlessly between using the system's power supply and the backup battery.

Figure 1 shows the I-IV and P-V curves for the photovoltaic panels.

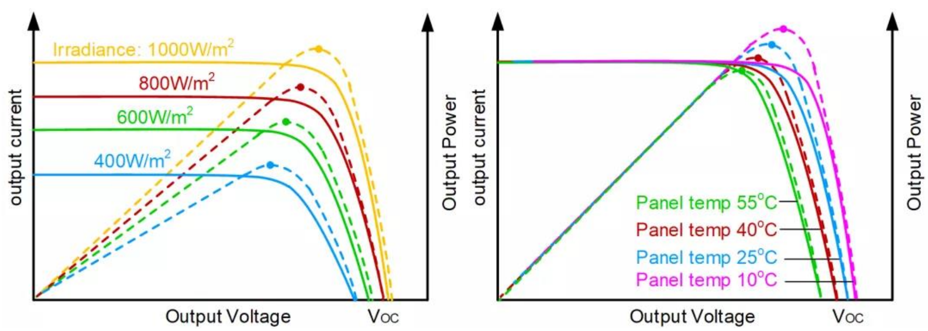

Figure 1: I-V and P-V Curves of Photovoltaic Panels

Battery Charging Solution with the MP2731

The MP2731 is a battery charge management device that integrates voltage and current sampling. By implementing a photovoltaic charging scheme as the core power management, the device directly addresses the fundamental problems in photovoltaic applications.

The MP2731 integrates a charge and discharge power architecture, voltage and current sampling, and loop control, simplifying the whole photovoltaic charging scheme. Other features of the MP2731 include the following:

- Highly integrated
- Wide 3.7V to 16V input voltage (V_{IN}) range
- Integrated analog-to-digital converter (ADC) for monitoring V_{IN}, current, and various charging parameters
- Configurable charging parameters
- V_{IN} and current loop
- Narrow voltage DC (NVDC) architecture

In small photovoltaic applications, the panel's output voltage (V_{OUT}) is typically between 5V and 12V, and the maximum power is between 5W and 7W. The MP2731's wide V_{IN} range covers the output range for photovoltaic panels in application.

Figure 2 shows the MP2731 block diagram.

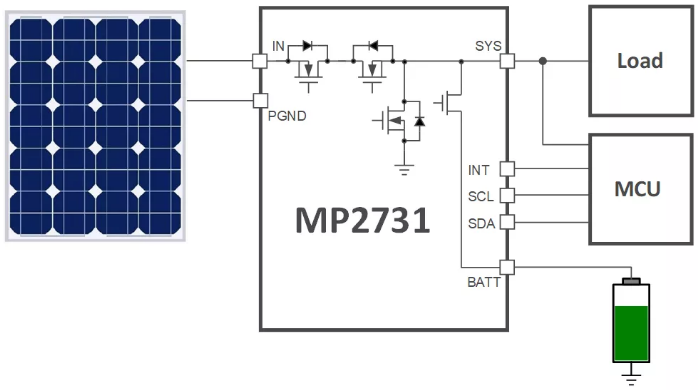

Figure 2: MP2731 Block Diagram

Monitoring a Photovoltaic Cell's Maximum Power

According to the P-V characteristic curve, a photovoltaic panel's output power can be adjusted if its V_{OUT} is changed (see Figure 3).

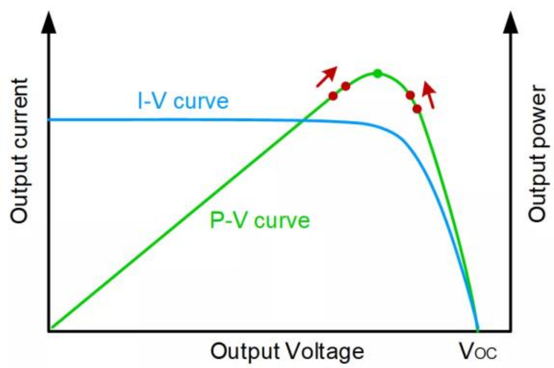

Figure 3: Obtaining the Maximum Output Power

As the voltage changes, the output power can be tracked, as well as the direction of the power change. This allows the photovoltaic panel's maximum power level to be determined.

The MP2731 integrates a configurable V_{IN} loop to track the photovoltaic panel's V_{OUT} by adjusting V_{IN}. The MP2731 integrates an ADC to monitor V_{IN} and the current, which then converts the data into digital information that can be stored in the registers. The microcontroller (MCU) can read the ADC results and calculate the photovoltaic panel's output power. The MCU records the output power by dynamically adjusting the configuration of the V_{IN} loop.

In addition, the MP2731 adopts an NVDC architecture. When there is sufficient light, the system power supply takes priority. In this scenario, the MP2731 supplies power to the system load and charges the backup battery simultaneously. When there is insufficient light, the MP2731 automatically reduces the charging current to reduce the system's power consumption.

Figure 4 shows how the photovoltaic cells power the system and charge the battery.

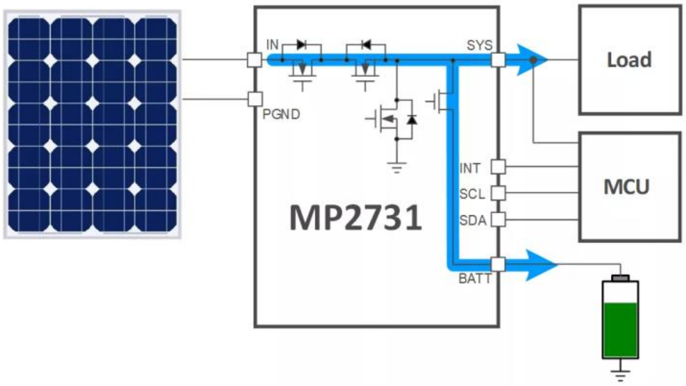

Figure 4: Photovoltaic Charging Scheme of the MP2731

The MP2731's photovoltaic charging solution efficiently tracks the maximum output power of the photovoltaic panel, and the measured tracking accuracy can reach up to 96.8% (see Figure 5).

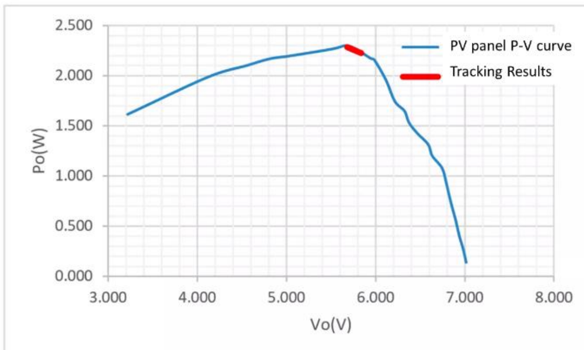

Figure 5: Tracking Results of P-V Curve

In the absence of light, the photovoltaic panel has no V_{OUT}. The MP2731 automatically switches and uses the battery to supply power to the system, which ensures smooth system operation (see Figure 6).

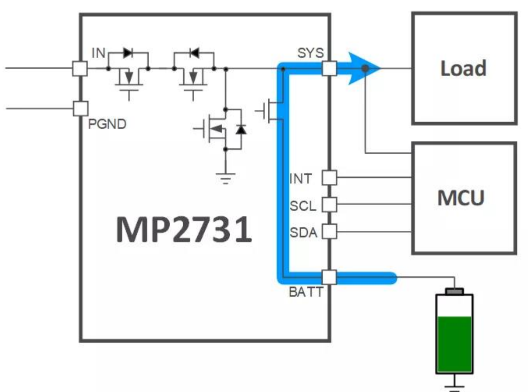

Figure 6: Backup Battery Powers the System

Conclusion

To advance green electricity and other renewable energy initiatives, MPS provides a variety of solutions to maintain uninterrupted system operation under various lighting conditions. In this article, we introduced the MP2731 as a photovoltaic charging solution that overcomes the limitations of common applications. Explore MPS's other battery management solutions that offer fast charging, accuracy, safety, and easy customization.