

Introduction

The [MP5031](#) is part of the new generation of fast-charging chips, which meet the growing demand for fast-charging technology for mobile phones and devices. This USB power delivery (PD) controller is compatible with USB Type-C 2.0 and USB PD 3.0 specifications, and supports dedicated charging port (DCP) schemes. The MP5031 also supports BC1.2 charging data port (CDP) handshaking. This article discusses the features of the MP5031 and then explores solutions for various power ranges.

Overview of the MP5031

The MP5031 is available in a small QFN-20 (4mmx4mm) package (see Figure 1). Its compact package and simplified peripheral devices provide a convenient layout. In addition, the integrated physical layer, protocol layer, and policy engine support robust PD communication.

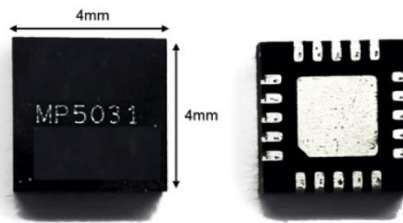


Figure 1: MP5031 Chip

As an application-specific integrated chip (ASIC), the MP5031 differs from control chips that include the microcontroller (MCU). In particular, the MP5031 does not have complex configuring requirements, which make it simple to use, highly reliable, and flexible. The MP5031 can work with a DC/DC converter to support a full power range between 15W and 100W, as well as multi-channel applications.

Configurable Power Data Objects (PDOs)

To support its wide power range, the MP5031 features five power data object (PDO) lists that can be configured according to different application specifications. The MP5031's flexible PDO combinations provide versatility for various power levels.

Figure 2 shows the MP5031's charging waveforms.

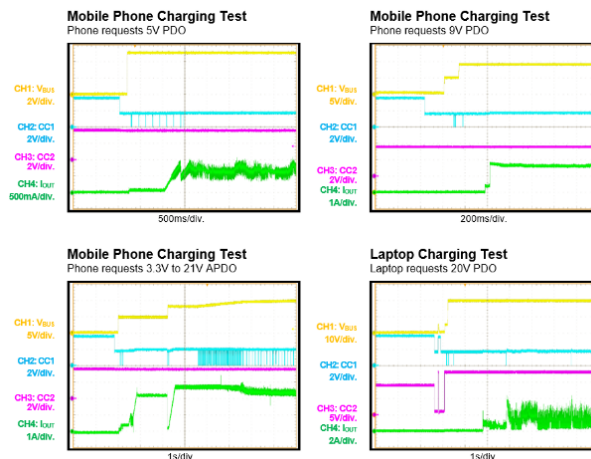


Figure 2: MP5031 Charging Waveforms

Communication Protocols

The MP5031 is compatible with various mainstream protocols such as the Quick Charge 3.0 (QC 3.0), Huawei Fast Charge Protocol (FCP), BC1.2, Apple Divider 3 mode, and 1.2V/1/2V mode without outside user interaction.

CDP Mode

In addition to the pure charging protocol, the MP5031 supports CDP mode to allow data communication between the sink and host during PD fast charging. Use the I²C interface to set CDP_EN = 1 and enable CDP mode handshaking. Figure 3 shows the CDP mode set-up.

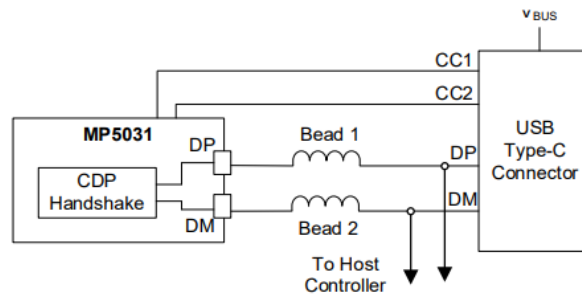


Figure 3: CDP Mode Set-Up

Protections

The MP5031 features two configurable negative temperature coefficient (NTC) pins that monitor the temperature of the USB Type-C interface and circuit board. If the temperature rises too high, these pins also support shutdown or reduce the output power to ensure safe fast charge.

The high-voltage I/O pins also support short-circuit protection (SCP) for the external DC/DC converter, including battery short protection and V_{BUS} short protection.

GPIO Pins

Multiple general-purpose I/O (GPIO) pins can be configured to monitor the input voltage (V_{IN}) and reduce the output power when the input experiences an under-voltage condition. The GPIO pins and I²C interface can provide communication with an external power converter.

Practical Application of the MP5031

The MP5031 can work with other MPS devices to achieve a complete solution.

60W to 100W Solution with the MP5031 and MP4247

The [MP4247](#) is a buck-boost converter that can provide up to 100W of peak output power at certain V_{IN} values with excellent efficiency. The device features one-time programmable (OTP) memory and is well-suited for USB PD applications.

Figure 4 shows a reference design combining the MP5031 and MP4247.

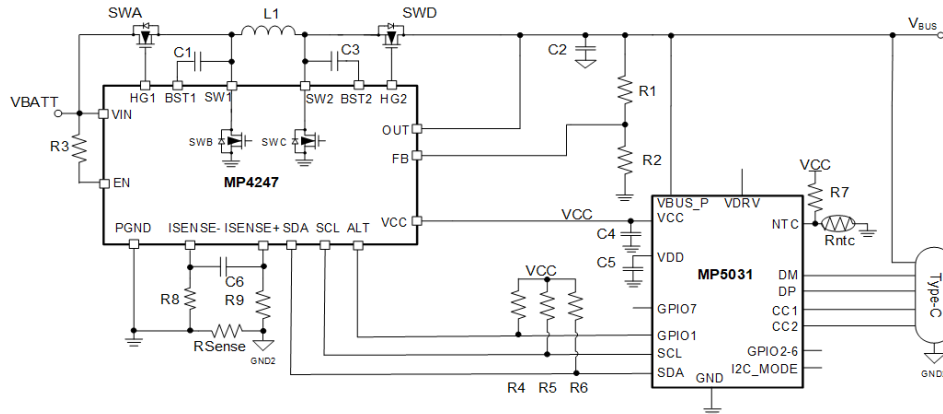


Figure 4: Reference Design Combining the MP5031 and MP4247

The advantages of this buck-boost topology solution include the following:

- Integrates two low-side MOSFET (LS-FET) transistors with low on resistance for an efficient temperature rise, smaller solution size, and reduced cost
- Supports up to a 36V V_{IN} , as well as a wide bus voltage (V_{BUS}) between 3.3V and 21V
- Supports 60W of output power by default (with a 100W maximum)
- Features three optional frequencies (250kHz, 420kHz, and 600kHz) and frequency jittering to improve EMI performance
- Supports a CC blank function and line compensation
- Demonstrates excellent efficiency and heat generation performance

At 60W of output power, efficiency can reach 98% with a 25°C temperature rise (based on a 6.4cmx6.4cm test board) (see Figure 5).

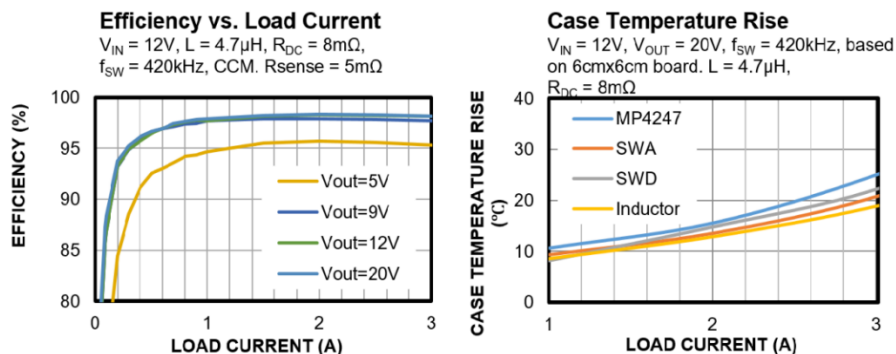


Figure 5: Efficiency and Case Temperature Rise at $V_{IN} = 12V$ and 60W Output Power

The default configurations are 5V/3A, 9V/3A, 15V/3A, 20V/3A, and 3.3V to 21V/3A augmented PDO (APDO). These configurations support CDP mode as well as DCP schemes (including USB Type-C 2.0, USB PD 3.0, QC 3.0, Huawei FCP, BC1.2, Apple Divider 3 mode, and 1.2V/1/2V mode).

Figure 6 shows how to configure the five PDOs.

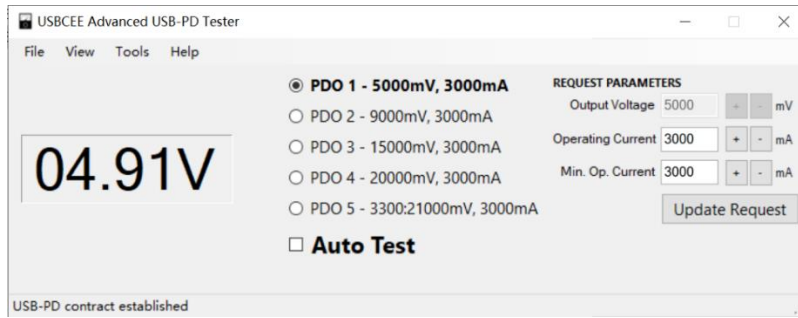


Figure 6: USB-PD Test Configuration

100W Solution with the MP5031 and MP2491C

The [MP2491C](#) is a fully integrated, high-voltage, step-down converter with V_{OUT} scaling control. The device’s constant-on-time (COT) control operation provides fast transient response, easy loop design, and tight output regulation.

Figure 7 shows a reference design combining the MP5031 and MP2491C.

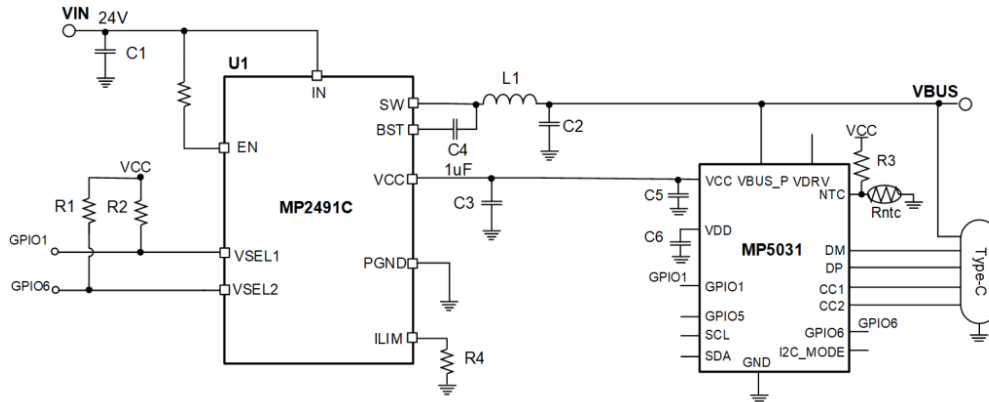


Figure 7: Reference Design Combining the MP5031 and MP2491C

The advantages of this combined solution with the MP5031 and MP2491C include the following:

- Integrates two MOSFETs with low on resistance due to the buck topology
- Supports 100W of output power by default
- Supports up to 32V V_{IN} and a wide output between 5V and 20V
- Features a fixed frequency at 490kHz
- Features an external I_{LIM} resistor to easily adjust the current limit
- Supports low-dropout (LDO) mode
- Reaches a 98% maximum duty cycle when $V_{IN} = 21V$

The MP5031 and MP2491C solution can reach up to 98.5% efficiency with a 57°C temperature rise (based on a 3.5cmx3.8cm test board) (see Figure 8).

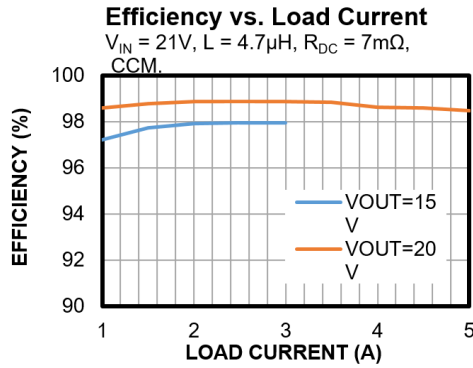


Figure 8: Efficiency Curve at $V_{IN} = 21V$

The default configurations are 5V/3A, 9V/3A, 15V/3A, 20V/5A, and 20V/5A for the fixed PDOs. These configurations support CDP mode as well as DCP schemes (including USB Type-C 2.0, USB PD 3.0, QC 3.0, Huawei FCP, BC1.2, Apple Divider 3 mode, and 1.2V/1/2V mode).

Figure 9 shows how to configure the four PDOs.

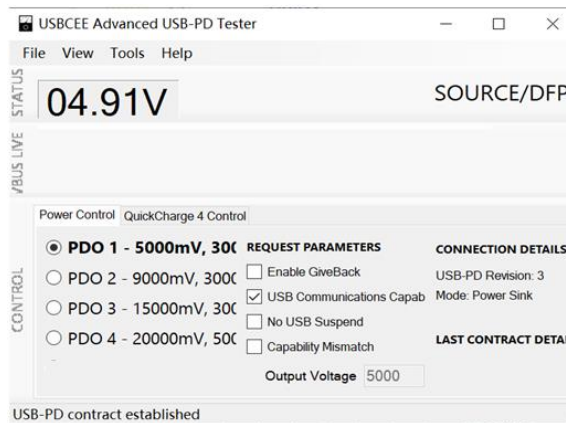


Figure 9: PDO Configurations

Conclusion

This article reviewed the [MP5031](#)'s features, and how these features improve on traditional control chips. Advantages include (but are not limited to) configurable PDOs, compatibility with various mainstream protocols, CDP mode, protections, and GPIO pins. In addition, we discussed customized solutions for the MP5031 using the [MP4247](#) and [MP2491C](#).

Explore MPS's [power management solutions](#) and broad portfolio of [buck-boost converters](#) that offer design flexibility, superior performance, and high power efficiency.