Designing a Brushless DC Motor Driver with the MP6540

MPS recently released an integrated, compact motor driver IC with six power MOSFETs. This article discusses the MP6540 series, including the MP6540A, MP6540H, and the MP6540HA. The MP6540 is a 3-phase, brushless DC (BLDC) motor driver that integrates three half-bridges consisting of six N-channel power MOSFETs.

Conventional motor driver architecture combines a motor driver chip and the power MOSFETs. For 3-phase, BLDC motors, six external MOSFETs are required to form three bridge arms to drive each phase winding. However, traditional architecture requires a large circuit board, which conflicts with the current development trend for smaller circuits.

The benefits of the MP6540 and its related parts are discussed below.

High Integration

The MP6540 addresses the drawbacks of conventional motor driver architectures. The MP6540 operates from a supply voltage of up to 35V and supports 100% duty cycle operation. It offers features such as low on resistance, integrated bidirectional current-sense amplifiers, and a fault indication output. Its six integrated MOSFETs and their corresponding drivers all fit in a small QFN-26 (5mmx5mm) package.

The integrated current-sense circuit allows for bidirectional current measurement in the low-side MOSFETs of each bridge arm. This eliminates the size and cost concerns that come with an external current-sense circuit. Other features include over-temperature protection (OTP), under-voltage lockout (UVLO), and thermal shutdown. Figure 1 shows the MP6540's functional block diagram.

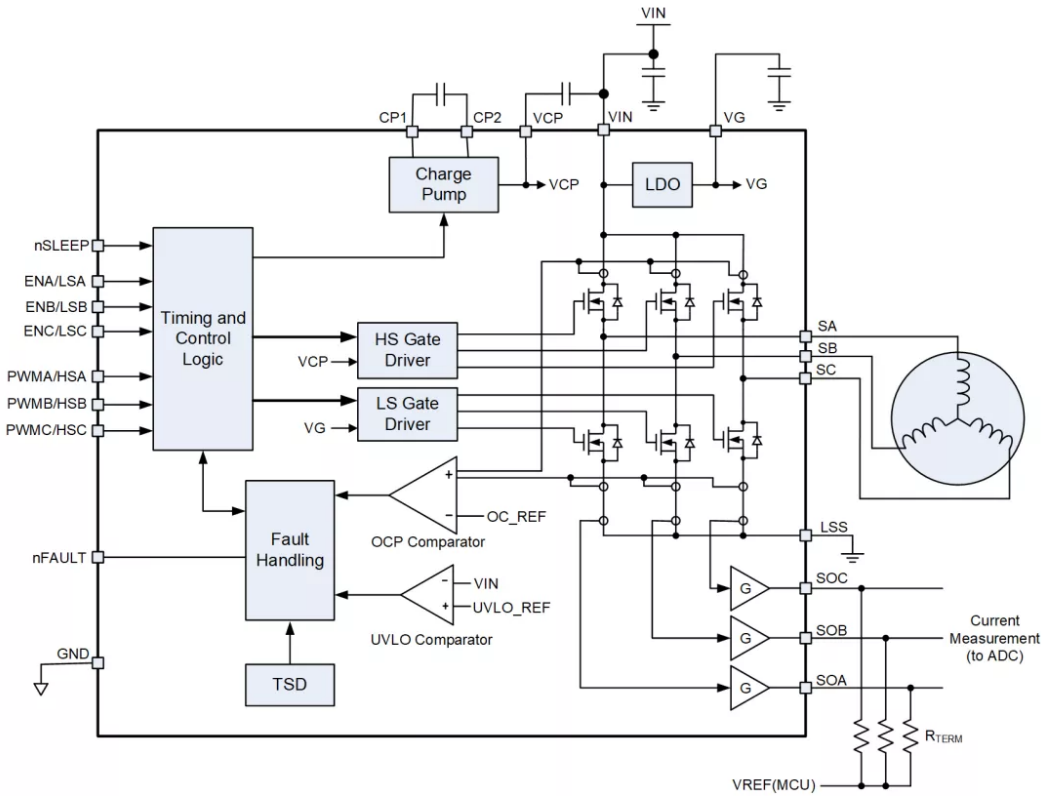

Figure 1: MP6540 Functional Block Diagram

Excellent Heat Dissipation

Figure 2 shows a 2-layer thermal test PCB for the MP6540. This PCB is 2.5cmx2.5cm, with a 1oz copper thickness and a copper area of 6.25cm^2. The board size can be adjusted to accommodate different thermal requirements.

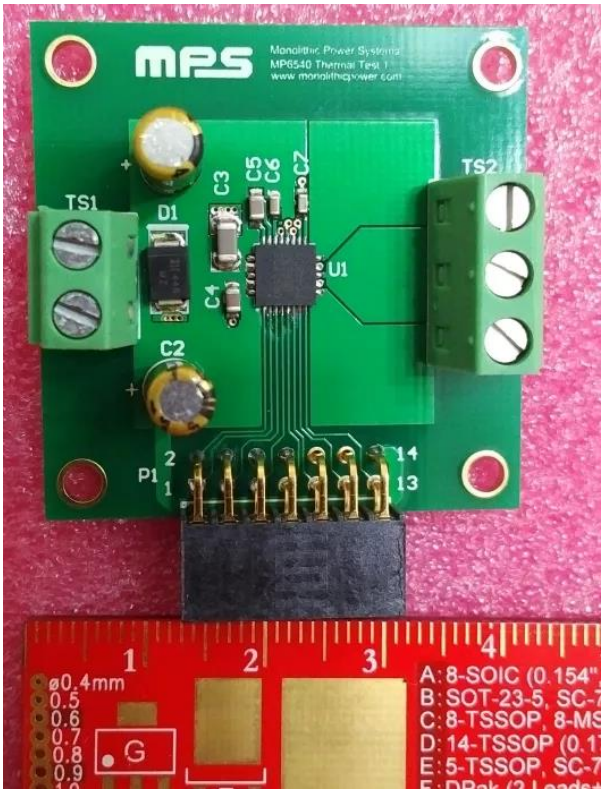

Figure 2: Thermal Test Chip

Under common conditions using 120° square wave drive control, the thermal test results shows the MP6540's excellent heat dissipation. Figure 3 shows an 8°C temperature rise at a 13V input voltage (V_{IN}) and a 1.4A output current (I_{OUT}).

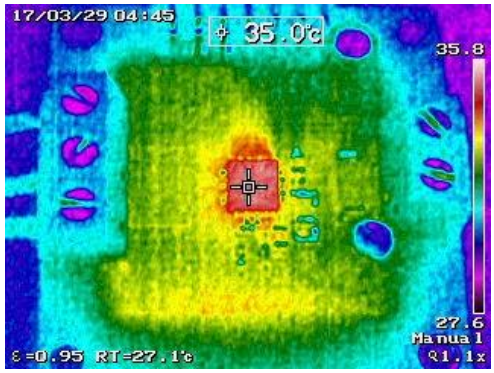

Figure 3: 8°C Temperature Rise (13V V_{IN}, 1.4A I_{OUT})

Figure 4 shows a 41°C temperature rise at a 24V V_{IN} and a 4A I_{OUT}. This shows the increase in temperature caused by V_{IN} and I_{OUT}.

Figure 4: 41°C Temperature Rise (24V V_{IN}, 4A I_{OUT})

The MP6540 Series

Excellent thermal performance allows the MP6540 and its related parts to be used in many 3-phase, BLDC driver applications.

The MP6540 and MP6540A can deliver up to 10A of peak current for 1 second, or 3A of continuous current. The MP6540H and MP6540HA can deliver 6A of peak current or 5A of continuous current. In addition, the MP6540A and MP6540HA include separate high-side (HS) and low-side (LS) inputs.

Table 1 shows a comparison of the MP6540 product series. The main differences between the products comes down to the V_{IN} range, I_{OUT}, and input logic signal.

Table 1: MP6540 Series Product Comparison

PN	Input Voltage (V)	Output Current (A)	Input Logic	MOSFET On Resistance (mΩ)	Package	AEC-Q100 Qualified
MP6540	5.5 to 35	3	EN/PWM	25	QFN-26 (5mmx5mm)	No
MP6540A	5.5 to 35	3	HS/LS	25	QFN-26 (5mmx5mm)	No
MP6540H	5.5 to 50	5	EN/PWM	25	QFN-26 (5mmx5mm)	No
MP6540HA	5.5 to 50	5	HS/LE	25	QFN-26 (5mmx5mm)	No

Fast Current Sensing

All MP6540 series products include current measurement to provide real-time and accurate current measurement, control, and motor protection.

Figure 5 shows the MP6540H's internal current detection circuit. The output can be set by the external resistor (R_{TERM}) and reference voltage (V_{REF}). Two equal-value resistors are connected to the ADC supply and ground, which terminates the outputs.

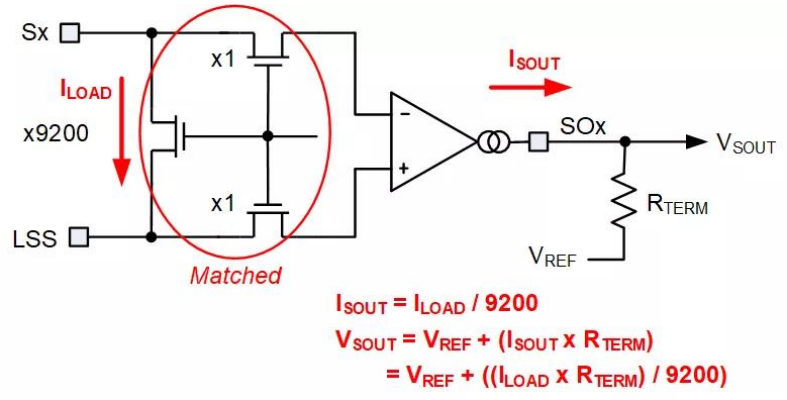

Figure 5: MP6540H Internal Current Detection Circuit

Figure 6 shows the measured waveforms where the current measurement circuit (CH3: SOB)'s output follows the actual I_{OUT} changes. This eliminates the cost and space required for an external current measurement circuit, resulting in a smaller, simpler, and more cost-effective motor driver solution.

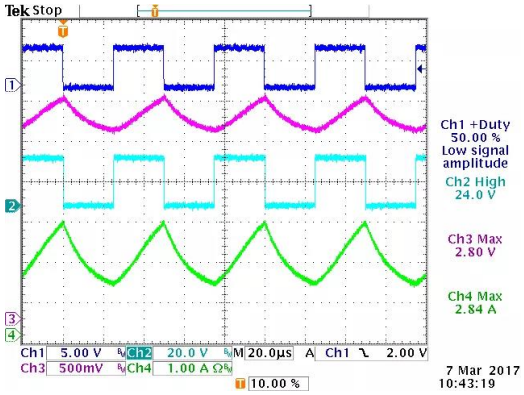

Figure 6: Current Detection Output (CH3: SOB) and Actual Current (CH4: I_{OUT})

Conclusion

In this article, we reviewed the advantages of the MP6540 series, including the MP6540A, MP6540H, and the MP6540HA. Advantages include — but are not limited to — high integration, excellent heat dissipation, adaptability, and fast current measurement.