



The Future of Analog IC Technology®

MP6536

26V, 5.5A

3-Channel Half-Bridge Driver

DESCRIPTION

The MP6536 is a 3-channel half-bridge driver IC intended to drive a 3-phase brushless DC motor.

The MP6536 features a low-current shutdown mode, standby mode, input under-voltage protection, current limit, thermal shutdown, and fault flag signal output. All channels of the drivers interface with standard logic signals.

The MP6536 is available in a 40 lead QFN 5mmx5mm package.

FEATURES

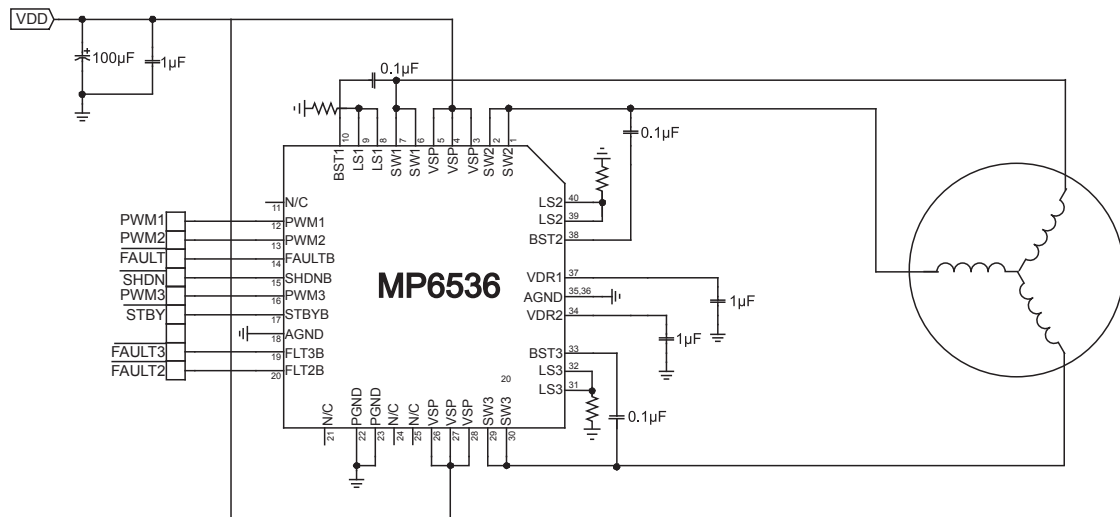
- 5V to 26V VDD
- $\pm 5.5\text{A}$ Peak Current Output
- Up to 1MHz PWM Frequency
- Protected Integrated Power 0.14Ω Switches
- 10ns Switch Dead Time
- All Switches Current Limited
- Internal Under-Voltage Protection
- Internal Thermal Protection
- Short-Circuit Protection
- Fault Output Flag

APPLICATIONS

- 3-Phase BLDC Motor Drive

All MPS parts are lead-free, halogen free, and adhere to the RoHS directive. For MPS green status, please visit MPS website under Quality Assurance. "MPS" and "The Future of Analog IC Technology" are Registered Trademarks of Monolithic Power Systems, Inc.

TYPICAL APPLICATION



ORDERING INFORMATION

Part Number*	Package	Top Marking
MP6536DU	QFN-40 (5mmx5mm)	See Below

* For Tape & Reel, add suffix -Z (e.g. MP6536DU-Z);

For RoHS, compliant packaging, add suffix -LF (e.g. MP6536DU-LF-Z).

TOP MARKING

MPSYYWW

MP6536

LLLLLLL

MPS: MPS Prefix;

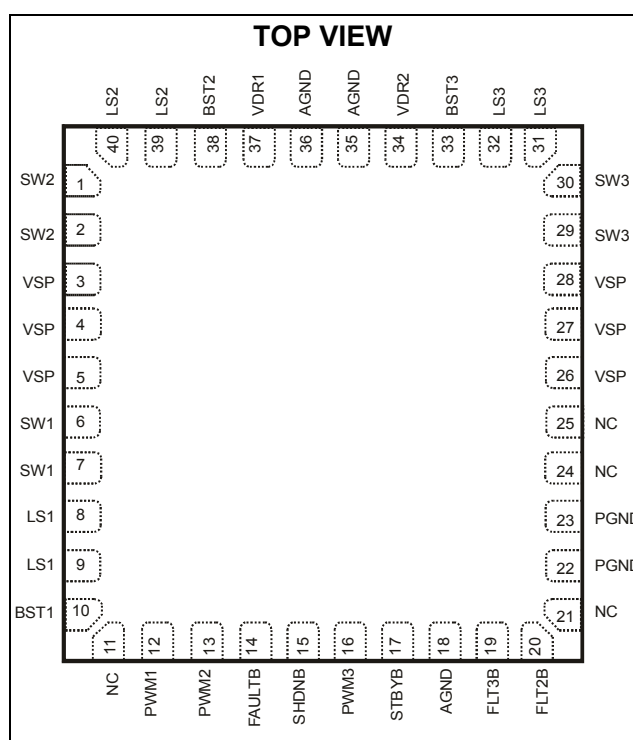
YY: Year Code;

WW: Week Code;

MP6536: Part Number;

LLLLLLL: Lot number;

PACKAGE REFERENCE



ABSOLUTE MAXIMUM RATINGS ⁽¹⁾

VSP Supply Voltage	28V
SWx Voltage	-0.3V to $V_{DD} + 0.3V$
BSTx to SWx.....	-0.3V to +6V
Voltage at All Other Pins.....	-0.3V to +6V
Continuous Power Dissipation.. ($T_A = +25^{\circ}C$) ⁽²⁾	4.2W
Storage Temperature.....	-55°C to +150°C
Junction Temperature.....	150°C
Lead Temperature	260°C

Recommended Operating Conditions ⁽³⁾

VSP Supply Voltage	5V to 26V
Operating Junction Temp. (T_J)	-40°C to +125°C

Thermal Resistance ⁽⁴⁾	θ_{JA}	θ_{JC}
QFN-40 (5mmx5mm).....	36.....	8.....°C/W

Notes:

- 1) Exceeding these ratings may damage the device.
- 2) The maximum allowable power dissipation is a function of the maximum junction temperature T_J (MAX), the junction-to-ambient thermal resistance θ_{JA} , and the ambient temperature T_A . The maximum allowable continuous power dissipation at any ambient temperature is calculated by P_D (MAX) = $(T_J$ (MAX) - T_A) / θ_{JA} . Exceeding the maximum allowable power dissipation produces an excessive die temperature, causing the regulator to go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.
- 3) The device is not guaranteed to function outside of its operating conditions.
- 4) Measured on JESD51-7, 4-layer PCB.

ELECTRICAL CHARACTERISTICS

$V_{SP} = 12V$, $V_{SHDNB} = 5V$, $T_A = +25^{\circ}C$, unless otherwise specified.

Parameters	Symbol	Condition	Min	Typ	Max	Units
VSP Operating Current		$I_{LOAD} = 0A$, $PWMx=0$		2.2	3.5	mA
VSP Shutdown Current		$V_{SHDN} = 0V$		24	30	μA
Operating VSP Threshold Low			3.7	4		V
Operating VSP Threshold High				4.4	4.8	V
STBYB Threshold Low			0.8	1.0		V
STBYB Threshold High				1.6	1.8	V
PWM Input Bias Current				0.1	1.0	μA
SHDNB Threshold Low			0.8	1.0		V
SHDNB Threshold High				1.6	1.8	V
PWMx Threshold Low			0.8	1		V
PWMx Threshold High				1.6	1.8	V
SWx On Resistance ⁽⁵⁾		$V_{SP} = 7V$, High-Side and Low-Side		0.14		Ω
SWx Current Limit ⁽⁵⁾		$V_{PWM} = 0V$, Sinking		5.5		A
		$V_{PWM} = 5V$, Sourcing		5.5		A
SWx Switching Frequency		$V_{PWM} = 0$ to 5V, 50% Duty Cycle			1	MHz
BST Voltage UVLO		Falling Value		2.2		V
BST Current		High-Side MOSFET On, $V_{BST}-V_{SW}=5.5V$		30		μA
SWx Rise/Fall Time ⁽⁵⁾		$V_{PWM} = 0V$ to 5V		5		ns
Minimum PWM Pulse Width		$V_{PWM} = 0V$ to 5V, High or Low Pulse		30		ns
Dead Time ⁽⁵⁾		$I_{OUT} = \pm 100mA$		10		ns
PWMx to SWx Delay Time Rising		$V_{PWM} = 0V$ to 5V		30		ns
PWMx to SWx Delay Time Falling		$V_{PWM} = 5V$ to 0V		30		ns
Thermal Shutdown Temperature ⁽⁵⁾		T_J Rising		160		$^{\circ}C$
Thermal Shutdown Hysteresis				35		$^{\circ}C$

Notes:

5) Not production tested.

PIN FUNCTIONS

Pin #	Name	Description
1,2	SW2	Output 2. SW2 is valid approximately 100µs after VSP goes high.
3,4,5	VSP	Power Supply Input. Connect VSP to the positive side of the input power supply. Bypass VSP to PGND as close to the IC as possible.
6,7	SW1	Output 1. SW1 is valid approximately 100µs after VSP goes high.
8,9	LS1	Low-Side Source Connection of SW1.
10	BST1	Bootstrap Supply. BST1 powers the high-side gate of the SW1 stage. Connect a capacitor (0.1µF or greater) between BST1 and SW1.
11	NC	No Connection. NC MUST be kept floating.
12	PWM1	Driver Logic Input 1. Drive PWM1 with the signal that controls SW1. Drive PWM high to turn on the high-side switch; drive PWM low to turn on the low-side switch.
13	PWM2	Driver Logic Input 2. Drive PWM2 with the signal that controls SW2. Drive PWM high to turn on the high-side switch; drive PWM low to turn on the low-side switch.
14	FAULTB	Fault Output. A low output at FAULTB indicates that the MP6536 has detected an over-temperature, over-current, or under-voltage condition. FAULTB is an open-drain output.
15	SHDNB	Shutdown Input. When SHDNB is low, the IC shuts off.
16	PWM3	Driver Logic Input 3. Drive PWM3 with the signal that controls SW3. Drive PWM high to turn on the high-side switch; drive PWM low to turn on the low-side switch.
17	STBYB	Standby Input. Default low (internal pull-down). If driven high, the output of the driver is determined by PWM1/2/3. If driven low, all outputs are high impedance.
18	AGND	Analog Ground.
19	FLT3B	Fault Monitor. For details see the “Fault Output” section. FLT3B is an open-drain output.
20	FLT2B	Fault Monitor. For details see the “Fault Output” section. FLT2B is an open-drain output.
21	NC	No Connection. NC MUST be kept floating.
22, 23	PGND	Power Ground. Connect the exposed pad on the bottom side to ground plane.
24, 25	NC	No Connection. NC MUST be kept floating.
26,27, 28	VSP	Power Supply Input. Connect VSP to the positive side of the input power supply. Bypass VSP to PGND as close to the IC as possible.
29, 30	SW3	Output 3. SW3 is valid approximately 100µs after VSP goes high.

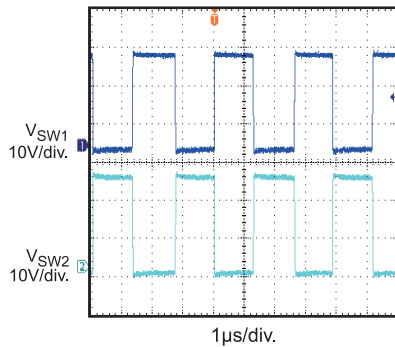
PIN FUNCTIONS *(continued)*

Pin #	Name	Description
31, 32	LS3	Low-Side Source Connection of SW3.
33	BST3	Bootstrap Supply. BST3 powers the high-side gate of the SW3 stage. Connect a capacitor (0.1μF or greater) between BST3 and SW3.
34	VDR2	Gate Drive Supply Bypass. The voltage at VDR2 is supplied from an internal regulator from VSP. VDR2 powers the internal circuitry and internal MOSFET gate drive for the SW3 output stage. Bypass VDR2 to PGND with a 0.1μF to 10μF capacitor.
35, 36	AGND	Analog Ground.
37	VDR1	Gate Drive Supply Bypass. The voltage at VDR1 is supplied from an internal regulator from VSP. VDR1 powers the internal circuitry and internal MOSFET gate drive for the SW1 and SW2 output stages. Bypass VDR1 to PGND with a 0.1μF to 10μF capacitor.
38	BST2	Bootstrap Supply. BST2 powers the high-side gate of the SW2 stage. Connect a capacitor (0.1μF or greater) between BST2 and SW2.
39,40	LS2	Low-Side Source Connection of the SW2.

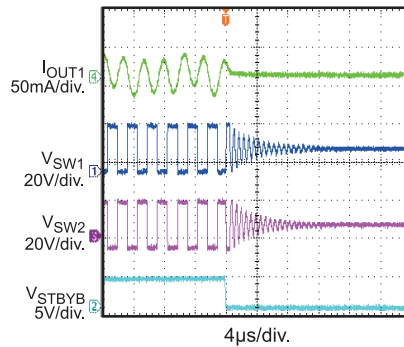
TYPICAL PERFORMANCE CHARACTERISTICS

$V_{SP} = 24V$, $V_{SHDNB} = 5V$, $R_{LOAD} = 8\Omega$, $T_A = +25^\circ C$, unless otherwise noted.

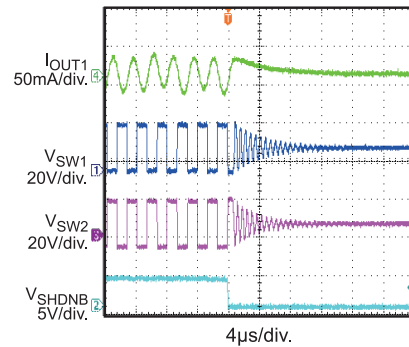
Normal Switch Waveform



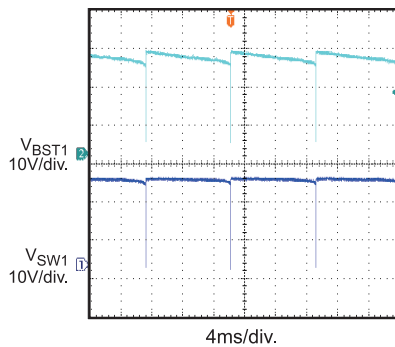
Standby



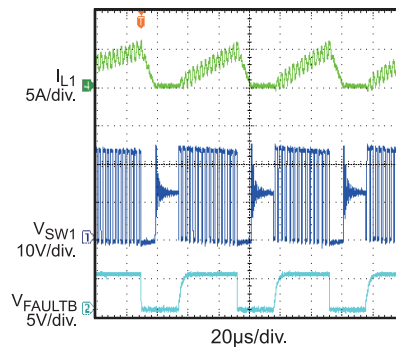
Shutdown



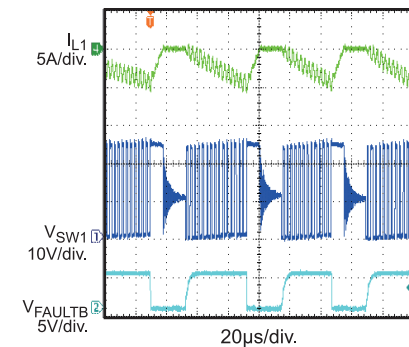
BS Re-Charge Cycling



Short-Circuit Positive Current



Short-Circuit Negative Current



BLOCK DIAGRAM

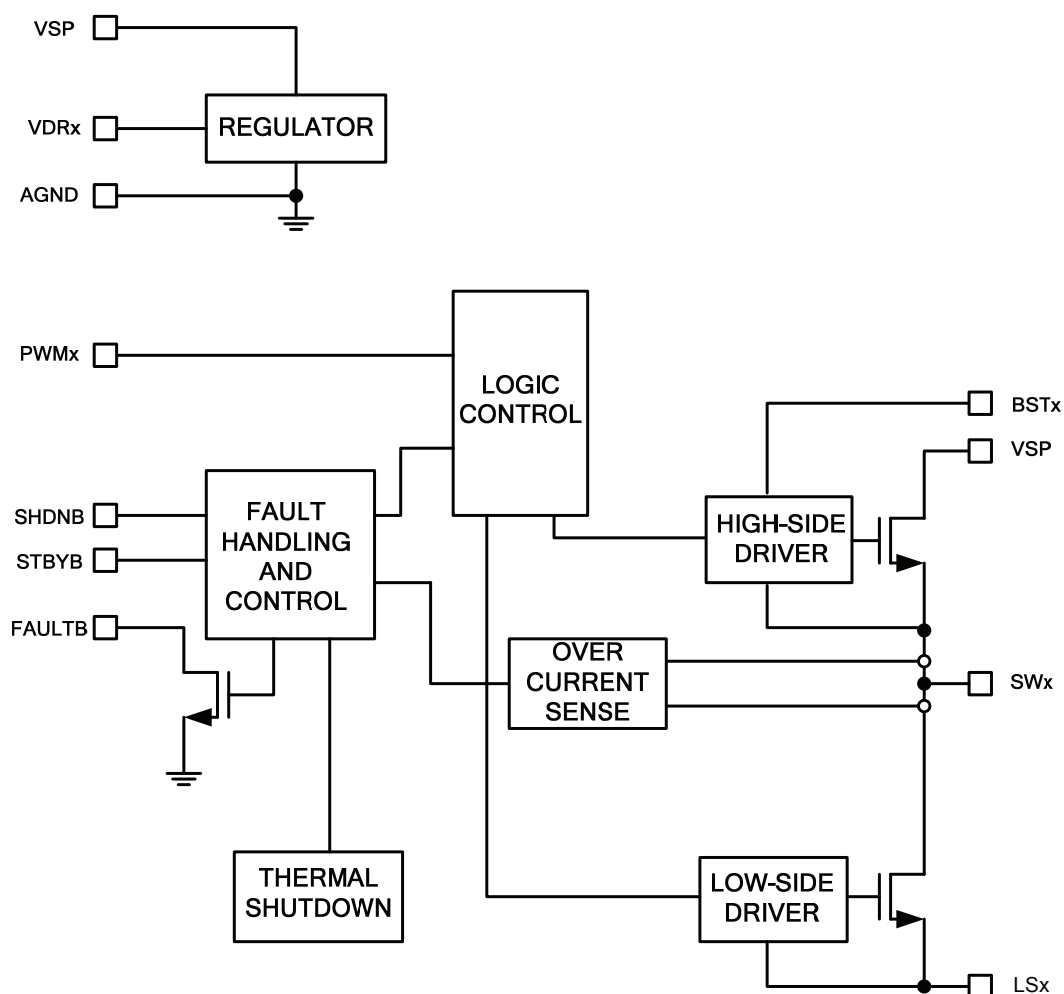


FIGURE 1. Function Block Diagram (1 Half-Bridge Channel Only)

OPERATION

The MP6536 is a 3-channel half-bridge driver intended to drive a brushless DC motor. The output is in phase with the input, and the dead time is optimized for symmetrical performance, regardless of load conditions.

When SHDN is low, all channels are off. When STBYB is pulled low, it causes the outputs of all the channels to go into high impedance. However, when the voltage across BST1/2/3 and SW1/2/3 drops low significantly, the bottom MOSFET is turned on to refresh the external bootstrap capacitor. Connecting a capacitor (0.1µF or greater) between BST and SW (as the bootstrap capacitor) is recommended.

In order to prevent erratic operation, two under-voltage lockout (UVLO) circuits are used. One ensures that the supply for the bottom gate drive circuit is sufficiently high, and the other is for the top gate driver.

Fault Protection

To protect the power MOSFETs, an internal current limit of 5.5A is set for all MOSFETs. When this limit is reached, all MOSFETs of the over-current bridge channel will go into high impedance for a fixed duration (30µs approximately) before resuming normal operation.

Thermal monitoring is integrated into the MP6536. If the die temperature rises above 160°C, all switches are turned off. The temperature must fall below 125°C before normal operation resumes.

To enhance the robustness of the device under a short-circuit condition, a capacitor can be connected to FAULTB (see Fig. 2). The time constant of the RC must be greater than 50ms for the FAULTB node to reach 2V. Under a short-circuit condition, the FAULTB node re-sets to zero, and the part is placed in standby mode until the voltage at STBYB is above 2V.

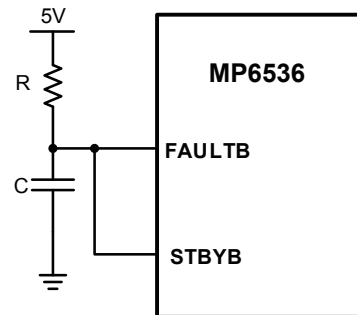


FIGURE 2. Fault Protection Enhancement Circuit

Fault Output

The MP6536 includes an open drain, active-low fault indicator output (FAULTB). A fault is indicated if one of the following conditions is detected:

1. The current limit is tripped.
2. Thermal shutdown is tripped.

A fault on any channel causes FAULTB to pull low. Once the fault is removed, the MP6536 resumes normal operation.

Do not apply more than 6V to FAULTB.

Error Reporting

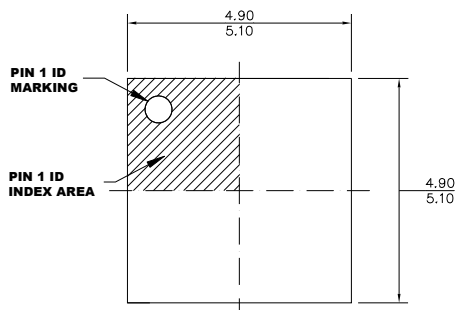
The MP6536 has two fault monitor pins (FLT3B and FLT2B), which are active low open-drain outputs. They provide protection-mode signaling to a PWM controller or another system control device (see Table 1).

TABLE 1. Fault Output Logic

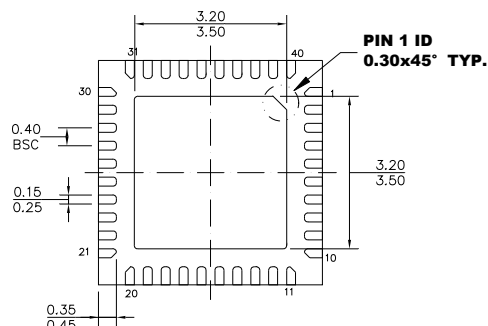
OCP	OTP	UVP	FLT2B	FLT3B
0	0	0	1	1
0	0	1	0	1
0	1	0	1	0
1	0	0	0	0

PACKAGE INFORMATION

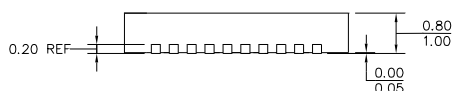
QFN-40 (5x5mm)



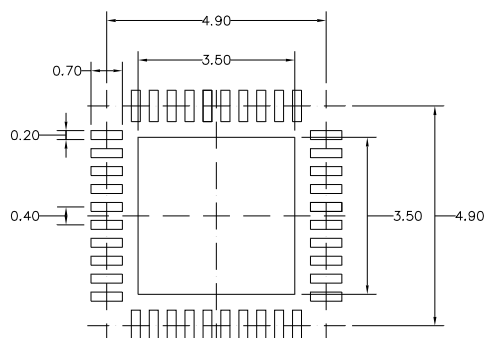
TOP VIEW



BOTTOM VIEW



SIDE VIEW



RECOMMENDED LAND PATTERN

NOTE:

- 1) ALL DIMENSIONS ARE IN MILLIMETERS.
- 2) EXPOSED PADDLE SIZE DOES NOT INCLUDE MOLD FLASH.
- 3) LEAD COPLANARITY SHALL BE 0.08 MILLIMETERS MAX.
- 4) DRAWING CONFIRMS TO JEDEC MO-220, VARIATION VHHE-1
- 5) DRAWING IS NOT TO SCALE.

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