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# LB11650

Monolithic Digital IC

## PWM Input Forward/Reverse Motor Driver

### Overview

The LB11650 is a full bridge driver that supports switching between forward and reverse directions. It operates in one of four modes under application control: forward, reverse, brake, and open. It also supports direct PWM control from an external signal. The LB11650 is optimal for driving brush DC motors and bipolar stepping motors.

### Features

- Supports PWM input
- Built-in high and low side diodes
- Simultaneous on state prevention function (prevents through currents)
- Built-in thermal shutdown circuit (latching type)
- High and low side short circuit protection function (latching type overcurrent protection)
- Externally controllable modes: forward, reverse, brake, open
- Standby mode function

### Specifications

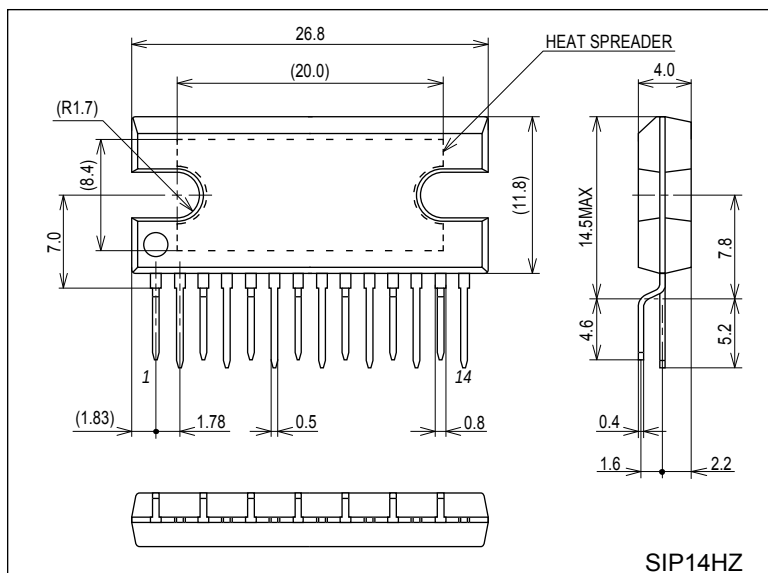
Absolute Maximum Ratings at  $T_a = 25^\circ\text{C}$ 

| Parameter                   | Symbol               | Conditions                                                                                     | Ratings     | unit             |
|-----------------------------|----------------------|------------------------------------------------------------------------------------------------|-------------|------------------|
| Motor supply voltage        | $V_M \text{ max}$    |                                                                                                | 30          | V                |
| Peak output current         | $I_O \text{ PEAK}$   | $t_W \leq 10\mu\text{s}$                                                                       | 2.0         | A                |
| Continuous output current   | $I_O \text{ max}$    | LVS pin                                                                                        | 1.5         | A                |
| Logic system supply voltage | $V_{CC} \text{ max}$ | Independent IC                                                                                 | 7.0         | V                |
| Allowable power dissipation | $P_d \text{ max}$    | When mounted on a glass epoxy circuit board<br>(reference value) : 114.3 mm × 76.1 mm × 1.6 mm | 3.5         | W                |
| Operating temperature       | $T_{opr}$            |                                                                                                | -20 to +85  | $^\circ\text{C}$ |
| Storage temperature         | $T_{stg}$            |                                                                                                | -55 to +150 | $^\circ\text{C}$ |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### Package Dimensions

unit : mm



## LB11650

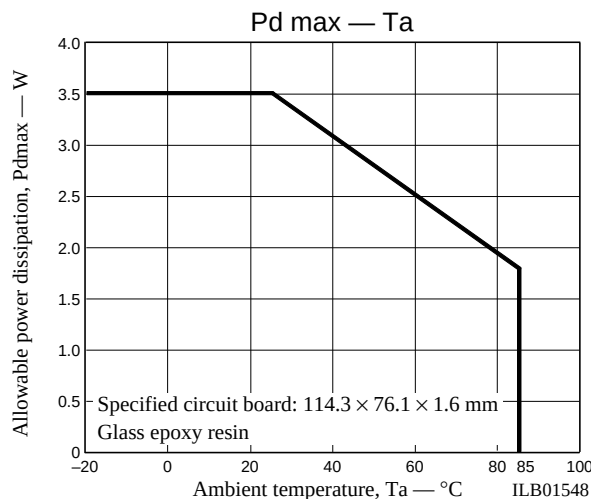
### Recommended Operating Ranges at Ta = 25°C

| Parameter                   | Symbol          | Conditions | Ratings                 | Unit |
|-----------------------------|-----------------|------------|-------------------------|------|
| Motor supply voltage        | VM              |            | 8 to 28                 | V    |
| Logic system supply voltage | V <sub>CC</sub> |            | 3.0 to 5.25             | V    |
| Logic input voltage range   | V <sub>IN</sub> |            | −0.3 to V <sub>CC</sub> | V    |

### Electrical Characteristics at Ta = 25°C, VM = 24 V, V<sub>CC</sub> = 5 V

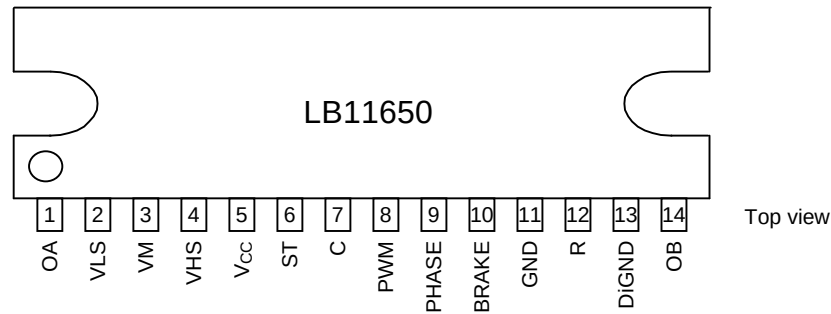
| Parameter                                   | Symbol              | Conditions                                                                                        | Ratings   |          |           | Unit |
|---------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------|-----------|----------|-----------|------|
|                                             |                     |                                                                                                   | min       | typ      | max       |      |
| [Output Block]                              |                     |                                                                                                   |           |          |           |      |
| Output stage supply current 1               | IM ON               | With no load, ST = high                                                                           | 0.84      | 1.2      | 1.56      | mA   |
| Output stage supply current 2               | IM wt               | With no load, ST = low                                                                            |           |          | 50        | μA   |
| Output saturation voltage 1                 | V <sub>O</sub> sat1 | I <sub>O</sub> = +0.5 A, sink side                                                                |           | 0.3      | 0.5       | V    |
| Output saturation voltage 2                 | V <sub>O</sub> sat2 | I <sub>O</sub> = +1.0 A, sink side                                                                |           | 0.5      | 0.7       | V    |
| Output saturation voltage 3                 | V <sub>O</sub> sat3 | I <sub>O</sub> = −0.5 A, source side                                                              |           | 1.5      | 1.8       | V    |
| Output saturation voltage 4                 | V <sub>O</sub> sat4 | I <sub>O</sub> = −1.0 A, source side                                                              |           | 1.7      | 2.0       | V    |
| Output leakage current                      | I <sub>O</sub> leak | V <sub>O</sub> = VM, sink side                                                                    |           |          | 50        | μA   |
|                                             |                     | V <sub>O</sub> = 0 V, source side                                                                 | −50       |          |           | μA   |
| [Logic Block]                               |                     |                                                                                                   |           |          |           |      |
| Logic supply current                        | I <sub>CC</sub> ON  | V <sub>CC</sub> = 5 V, with the R pin open<br>BRAKE: LOW, PWM: HI, ST: HI                         | 50        | 68       | 85        | mA   |
|                                             |                     | V <sub>CC</sub> = 3.3 V, with the R pin shorted to V <sub>CC</sub><br>BRAKE: LOW, PWM: HI, ST: HI | 55        | 75       | 95        | mA   |
|                                             | I <sub>CC</sub> BR  | BRAKE: HI, PWM: HI, ST: HI                                                                        | 3.4       | 4.7      | 6.0       | mA   |
|                                             | I <sub>CC</sub> OFF | BRAKE: LOW, PWM: LOW, ST: HI                                                                      | 4.0       | 5.2      | 6.5       | mA   |
|                                             | I <sub>CC</sub> wt  | ST: LOW                                                                                           |           |          | 50        | μA   |
| Input voltage                               | V <sub>INH</sub>    |                                                                                                   | 2.0       |          |           | V    |
|                                             | V <sub>INL</sub>    |                                                                                                   |           |          | 0.8       | V    |
| Input current                               | I <sub>INH</sub>    | V <sub>IN</sub> = 3.3 V                                                                           | 35        | 50       | 75        | μA   |
|                                             | I <sub>INL</sub>    | V <sub>IN</sub> = 0.8 V                                                                           | 5         | 10       | 13        | μA   |
| C pin charge current                        | I <sub>C</sub>      | V <sub>C</sub> = 0 V                                                                              | 35        | 50       | 65        | μA   |
| C pin output off threshold voltage          | V <sub>tc</sub>     |                                                                                                   | 1.17      | 1.3      | 1.43      | V    |
| VHS pin current detection threshold voltage | V <sub>tVHS</sub>   |                                                                                                   | VM − 0.55 | VM − 0.5 | VM − 0.45 | V    |
| VLS pin current detection threshold voltage | V <sub>tVLS</sub>   |                                                                                                   | 0.45      | 0.5      | 0.55      | V    |
| Low voltage cutoff voltage                  | V <sub>LVSD</sub>   |                                                                                                   | 2.25      | 2.5      | 2.75      | V    |
| Low voltage cutoff hysteresis               | V <sub>LVHYS</sub>  |                                                                                                   | 0.15      | 0.2      | 0.25      | V    |
| Thermal shutdown temperature                | TTSD                | Design target value*                                                                              | 150       | 175      |           | °C   |

\*: This is a design target value and is not measured.



LB11650

Pin Assignment



Truth Table

| PHASE | BRAKE | ST        | PWM | OA  | OB  | Operating mode              |
|-------|-------|-----------|-----|-----|-----|-----------------------------|
| H     | L     | H         | H   | H   | L   | Forward                     |
| L     | L     | H         | H   | L   | H   | Reverse                     |
| X     | L     | H         | L   | OFF | OFF | Output off                  |
| X     | H     | H         | X   | H   | H   | Brake                       |
| X     | X     | L or OPEN | X   | OFF | OFF | Standby mode (circuits off) |

X: H or L

Pin Functions

| Pin No. | Pin             | Pin function                                                                                                                                                    |
|---------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | OA              | Output                                                                                                                                                          |
| 14      | OB              | Output                                                                                                                                                          |
| 4       | VHS             | High side current sensing (Insert an external resistor between VM and VHS. When the voltage across this resistor reaches 0.5 V, the outputs are turned off.)    |
| 2       | VLS             | Low side current sensing (Insert an external resistor between VLS and ground. When the voltage across this resistor reaches 0.5 V, the outputs are turned off.) |
| 7       | C               | Connection for an external filter capacitor that prevents incorrect operation of the current sensing output shutdown and thermal shutdown circuits.             |
| 3       | VM              | Motor system power supply                                                                                                                                       |
| 5       | V <sub>CC</sub> | Logic system power supply                                                                                                                                       |
| 9       | PHASE           | Forward/reverse switching pin                                                                                                                                   |
| 10      | BRAKE           | Brake control input. A high input switches the IC to brake mode.                                                                                                |
| 6       | ST              | Standby mode control. The IC operates in standby mode when this pin is low or open.                                                                             |
| 8       | PWM             | PWM input. High: on<br>Low: off                                                                                                                                 |
| 12      | R               | Low side drive current switching. (Short R to V <sub>CC</sub> when V <sub>CC</sub> is 3.3 V, and leave R open when V <sub>CC</sub> = 5.0 V.)                    |
| 11      | GND             | Ground                                                                                                                                                          |
| 13      | DiGND           | Lower side regeneration diode ground connection                                                                                                                 |

### High/Low Short Protection Function

This function turns the outputs off to prevent destruction of the IC if a problem such as an output pin being shorted to VM or ground occurs and excessive current flows in the output transistors.

When an excessive current flows in an output transistor, a potential will occur across either the high side or the low side current sense resistor. If that value exceeds the current detection threshold voltage, the capacitor connected to the C pin starts to charge. Then, when the C pin voltage is charged to the output off threshold voltage, the output transistors are turned off.

To restart the IC once it has gone to the output off state, either set the ST pin to the low level, or temporarily cut the  $V_{CC}$  power supply, and then reapply power.

The overcurrent detection current setting can be set to an arbitrary level with the resistor inserted between VM and VHS for current flowing in the high side output transistor, and with the resistor inserted between VLS and ground for current flowing in the low side output transistor.

When the resistor connected to VHS or VLS pin is  $R$  ( $\Omega$ ), the detected current  $I$  (A) will be as follows.

$$I \text{ (A)} = 0.5 \text{ (V)} / R \text{ (}\Omega\text{)}$$

For example, if  $R$  is  $0.5 \Omega$ , the detected current  $I$  will be 1 A.

This function is not an output current limiter function.

The detection current described above has the meaning that the short-circuit protection circuit begins to operate when a current in excess of the detection current flows in the outputs. Therefore, if an output pin is shorted to VM or ground, the maximum possible overcurrent that the output transistors are capable of will flow until the mask time set with the filter circuit has elapsed. Designers must exert great care in designing the mask time setting.

### Filter Circuit

To prevent the overcurrent protection and thermal shutdown circuits from operating incorrectly due to noise, the LB11650 includes a circuit that sets a mask time so that when an abnormality is detected, it only turns the outputs off if that state continues for a certain length of time.

When the capacitor connected between the C pin and ground is  $C$  (pF), the mask time  $T$  ( $\mu$ s) will be as follows.

$$T \text{ (}\mu\text{s)} = 2.6 \times 10^{-2} \times C \text{ (pF)}$$

For example, if  $C$  is 50 pF, the mask time  $T$  will be 1.3  $\mu$ s.

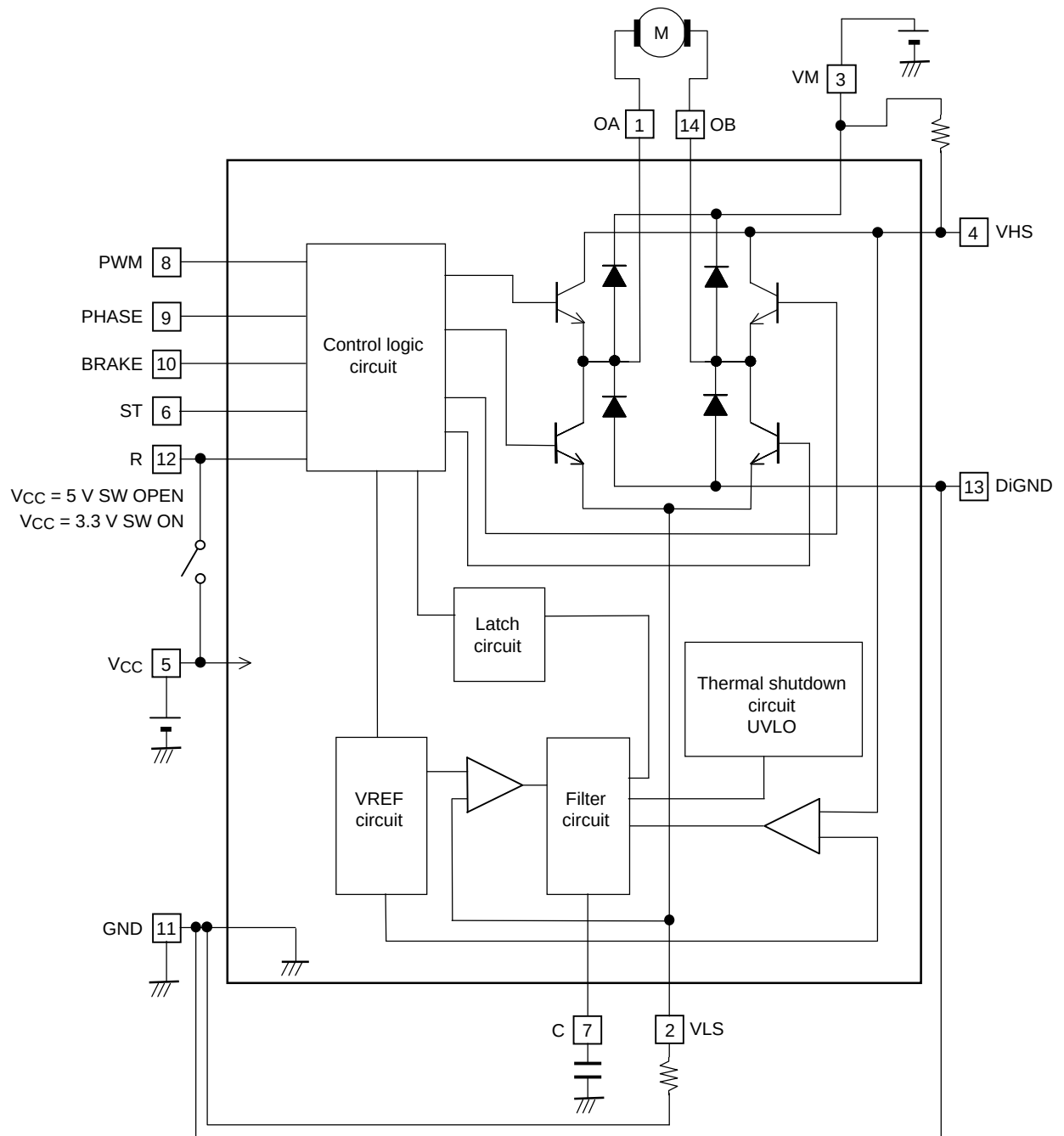
### Low Side Transistor Drive Current Switching Pin

Since the lower side output transistor drive current is created from  $V_{CC}$ , if the  $V_{CC}$  power supply level is reduced, the drive current will also be reduced. Therefore, the LB11650 is provided with a pin for switching the drive current so that the LB11650 can provide the same drive current when used with 3.3 V specifications as it does when used with 5 V specifications.

When  $V_{CC} = 5 \text{ V}$ : Leave the R pin open.

When  $V_{CC} = 3.3 \text{ V}$ : Short the R pin to  $V_{CC}$ .

## Block Diagram



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