

### Features

- 1 Channel H-bridge motor driver: low MOSFET on-resistance:  $0.5\Omega$  (HS+LS)
- Wide  $V_{DD}$  input voltage range of 1.8V to 6.0V
- Maximum 1.3A motor peak current
- Four operation modes: Forward, Reverse, Brake and Standby
- Low sleep current  $< 0.1\mu A$
- Sleep period activation mechanism
  - Automatically entering sleep period by resetting both IN1 and IN2 pins for over 10ms
- Up to 200kHz PWM input control operation
- Protection features
  - $V_{DD}$  under voltage lock-out
  - Over current protection
  - Thermal shutdown protection
  - Output short circuit protection
- Package type: 6-pin SOT23
- Operation temperature range:  $-40^{\circ}C$  to  $+85^{\circ}C$

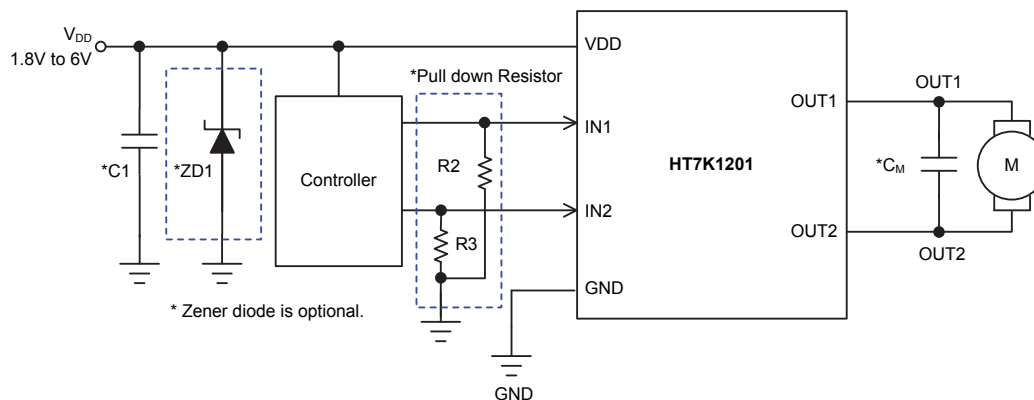
### Applications

- Valve/Pump, electric locks and consumer toys

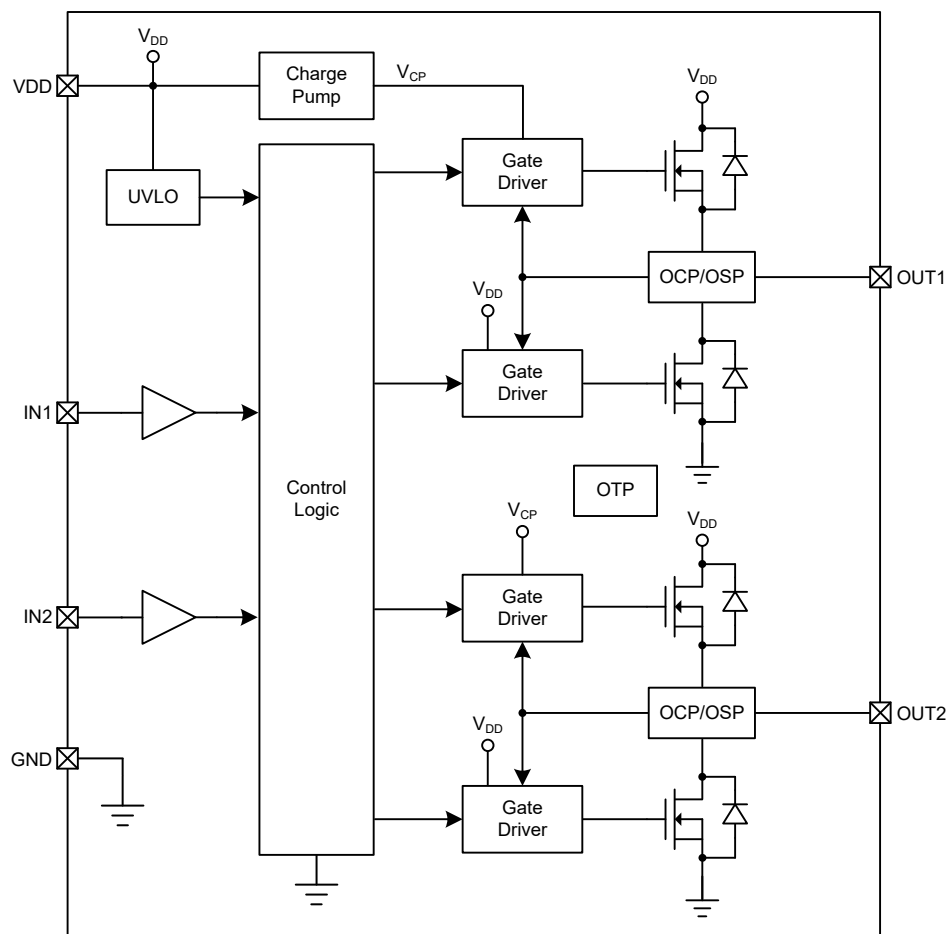
### General Description

The HT7K1201 is a 1-channel H-bridge driver with a maximum motor peak current of 1.3A. Its outstanding low on-resistance characteristic results in excellent output efficiency which is a major advantage in battery powered systems. A simple two input control pin structure is used to provide four control modes: Forward, Reverse, Brake and Standby modes. With a PWM input control frequency of up to 200kHz, accurate speed control can be implemented for a wide variety of applications. A full range of protection functions are integrated including OCP, OSP and OTP to prevent device damage even if the motor stalls or experiences a short circuit in critical operating environments. As the automatic sleep period activation mechanism uses the same mode control pins, an additional extra shutdown signal is not required. In addition, an ultra-low  $0.1\mu A$  sleep period current ensures long battery life.

### Typical Application Circuits

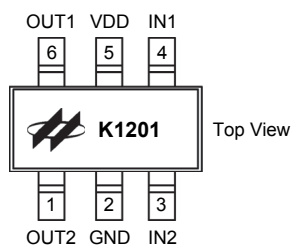


## Functional Block Diagram



## Pin Assignment

**SOT23-6**



## Pin Description

| Pin No. | Pin Name | Type | Description                                                                                                               |
|---------|----------|------|---------------------------------------------------------------------------------------------------------------------------|
| 1       | OUT2     | O    | H-Bridge Output 2                                                                                                         |
| 2       | GND      | G    | Ground                                                                                                                    |
| 3       | IN2      | I    | Control Input 2<br>Pin must not be allowed to float. Should be connected to external 100kΩ pull up or pull down resistor. |
| 4       | IN1      | I    | Control Input 1<br>Pin must not be allowed to float. Should be connected to external 100kΩ pull up or pull down resistor. |
| 5       | VDD      | P    | Power supply                                                                                                              |
| 6       | OUT1     | O    | H-Bridge Output 1                                                                                                         |

Note: I: Input  
O: Output  
P: Power  
G: Ground

## Absolute Maximum Ratings

| Parameter                                               |                  | Value                          | Unit |
|---------------------------------------------------------|------------------|--------------------------------|------|
| V <sub>DD</sub>                                         |                  | -0.3 to +6.6                   | V    |
| IN1, IN2                                                |                  | -0.3 to (V <sub>DD</sub> +0.3) | V    |
| Operating Temperature Range                             |                  | -40 to +85                     | °C   |
| Maximum Junction Temperature                            |                  | +150                           | °C   |
| Storage Temperature Range                               |                  | -65 to +160                    | °C   |
| Lead Temperature (Soldering 10 sec.)                    |                  | +260                           | °C   |
| ESD Susceptibility                                      | Human Body Model | ±5000                          | V    |
|                                                         | Machine Model    | ±400                           | V    |
| Junction-to-Ambient Thermal Resistance, θ <sub>JA</sub> |                  | 220                            | °C/W |

## Recommended Operating Ratings

| Parameter              | Value                 | Unit |
|------------------------|-----------------------|------|
| V <sub>DD</sub>        | 1.8 to 6.0            | V    |
| I <sub>OUT(RMS)</sub>  | 0.8 (Thermal Limited) | A    |
| I <sub>OUT(PEAK)</sub> | 1.3                   | A    |

Note that the Absolute Maximum Ratings indicate limitations beyond which damage to the device may occur. Recommended Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specified performance limits.

## Electrical Characteristics

$V_{DD}=V_M=5V$  and  $T_a=25^{\circ}C$ , unless otherwise specified

| Symbol                 | Parameter                                | Test Condition                                        | Min. | Typ. | Max. | Unit        |
|------------------------|------------------------------------------|-------------------------------------------------------|------|------|------|-------------|
| <b>Power Supply</b>    |                                          |                                                       |      |      |      |             |
| $V_{DD}$               | Supply Voltage                           | —                                                     | 1.8  | —    | 6.0  | V           |
| $I_{DD}$               | Supply Operation Current                 | PWM=25kHz, no load                                    | —    | 650  | 1000 | $\mu A$     |
| $I_{DD(STB)}$          | Supply Standby Current                   | IN1=IN2='0', active period                            | —    | 600  | 800  | $\mu A$     |
| $I_{DD(SLP)}$          | Supply Sleep Current                     | IN1=IN2='0', sleep period                             | —    | —    | 0.1  | $\mu A$     |
| <b>H-Bridge Driver</b> |                                          |                                                       |      |      |      |             |
| $R_{ON}$               | *HS+LS FET On-resistance                 | $V_{DD}=V_M=3V$ , $I_{OUT}=500mA$                     | —    | 0.5  | —    | $\Omega$    |
| $V_{CLAMP}$            | Clamp Diode Voltage                      | $I=300mA$ (HS and LS)                                 | —    | 0.8  | —    | V           |
| $t_{r(OUT)}$           | Output Rise Time                         | $R_L=20\Omega$ , 10% to 90% (Figure 1)                | —    | 100  | —    | ns          |
| $t_{f(OUT)}$           | Output Fall Time                         | $R_L=20\Omega$ , 10% to 90% (Figure 1)                | —    | 30   | —    | ns          |
| <b>Control Logic</b>   |                                          |                                                       |      |      |      |             |
| $V_{IL}$               | Input Logic Low Voltage                  | $V_{DD}=5V$                                           | —    | —    | 0.8  | V           |
| $V_{IH}$               | Input Logic High Voltage                 | $V_{DD}=5V$                                           | 2    | —    | —    | V           |
| $V_{HYS}$              | Input Logic Hysteresis                   | —                                                     | —    | 0.1  | —    | V           |
| $t_{P1}$               | IN-to-OUT Propagation Delay<br>(Figure1) | $R_L=20\Omega$ , INx to OUTx (high-Z to high/low)     | —    | 40   | —    | ns          |
| $t_{P2}$               |                                          | $R_L=20\Omega$ , INx to OUTx (high/low to high-Z)     | —    | 120  | —    | ns          |
| $t_{P3}$               |                                          | $R_L=20\Omega$ , INx to OUTx                          | —    | 40   | —    | ns          |
| $t_{P4}$               |                                          | $R_L=20\Omega$ , INx to OUTx                          | —    | 120  | —    | ns          |
| $t_{SLPEN}$            | Sleep Period Entry Time                  | IN1=IN2='0' until charge pump switches off (Figure 2) | —    | 10   | —    | ms          |
| $f_{PWM}$              | Input PWM Frequency                      | Internal charge pump activates                        | —    | —    | 200  | kHz         |
| <b>Charge Pump</b>     |                                          |                                                       |      |      |      |             |
| $t_{CP\_ON}$           | Charge Pump On Time                      | Charge pump activation time                           | —    | 11   | —    | ms          |
| <b>Protection</b>      |                                          |                                                       |      |      |      |             |
| $V_{UVLO+}$            | $V_{DD}$ Turn On Level                   | $V_{DD}$ rises                                        | —    | —    | 1.8  | V           |
| $V_{UVLO-}$            | $V_{DD}$ Turn Off Level                  | $V_{DD}$ falls                                        | 1.5  | —    | —    | V           |
| $I_{OCP}$              | Over Current Threshold                   | With deglitch time, $t_{DEG}$ (Figure 5)              | 0.9  | 1.3  | —    | A           |
| $t_{DEG}$              | Over Current Deglitch Time               | (Figure 3, 5)                                         | —    | 1    | —    | $\mu s$     |
| $t_{RETRY}$            | Over Current Retry Time                  | (Figure 4, 5)                                         | —    | 1    | —    | ms          |
| $I_{OSP}^{**}$         | Short Circuit Protection Threshold       | Without deglitch time (Figure 4, 5)                   | —    | 1.9  | —    | A           |
| $t_{SHD}$              | Thermal Shutdown Threshold               | —                                                     | —    | 150  | —    | $^{\circ}C$ |
| $t_{REC}$              | Thermal Recovery Temperature             | —                                                     | —    | 120  | —    | $^{\circ}C$ |

Note: \* The "HS" means High Side while the "LS" means Low Side.

\*\* The HT7K1201 device provides full short circuit protection for the OUTx-to-ground, OUTx-to-power or OUT1-to-OUT2 path.

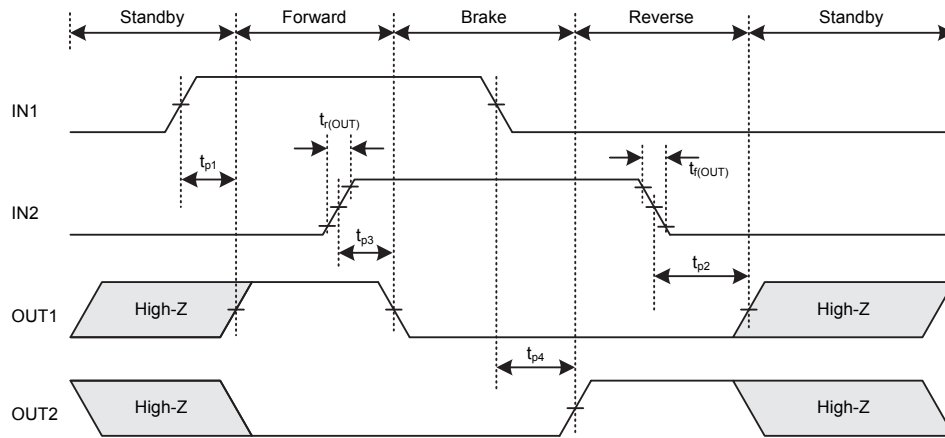


**Figure 1. Operation Mode Control Logic in Active Period**

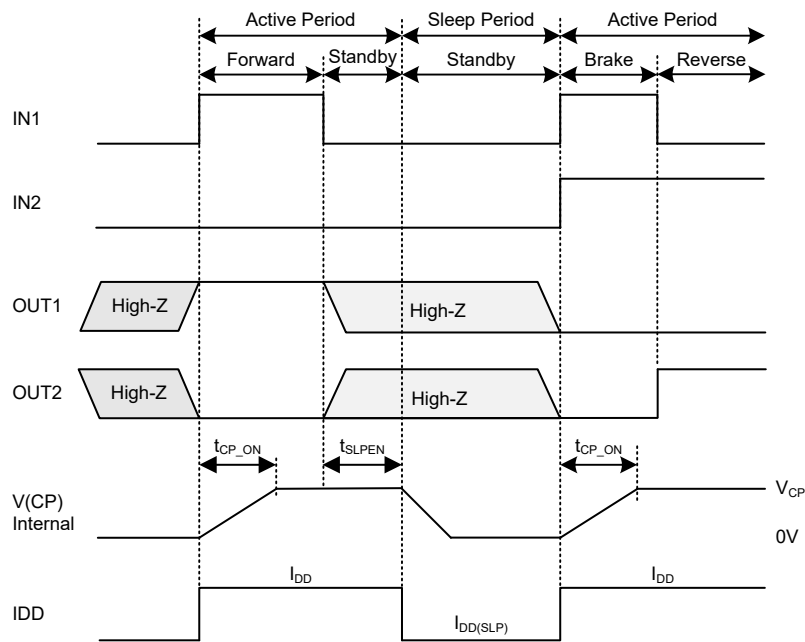


**Figure 2. Operation Mode Control Timing Diagram**

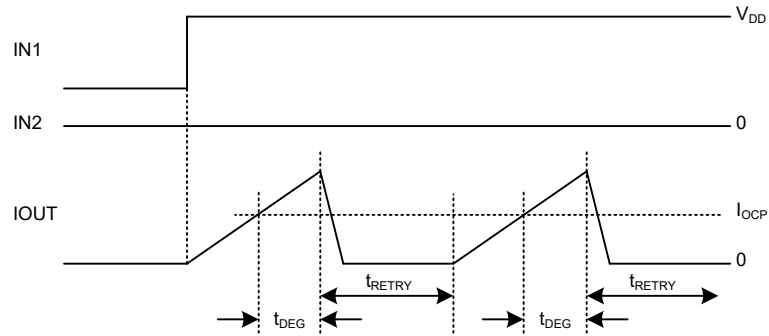


**Figure 3. OCP Reaction**

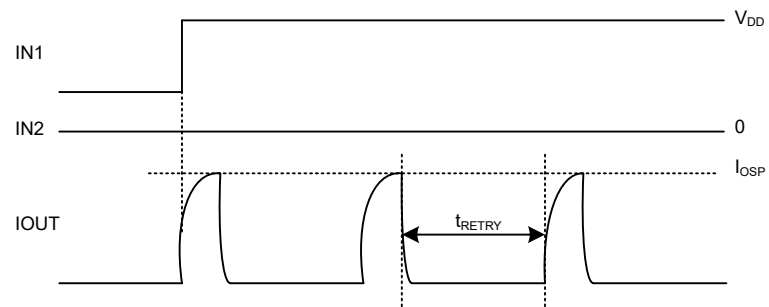


**Figure 4. OSP Reaction**

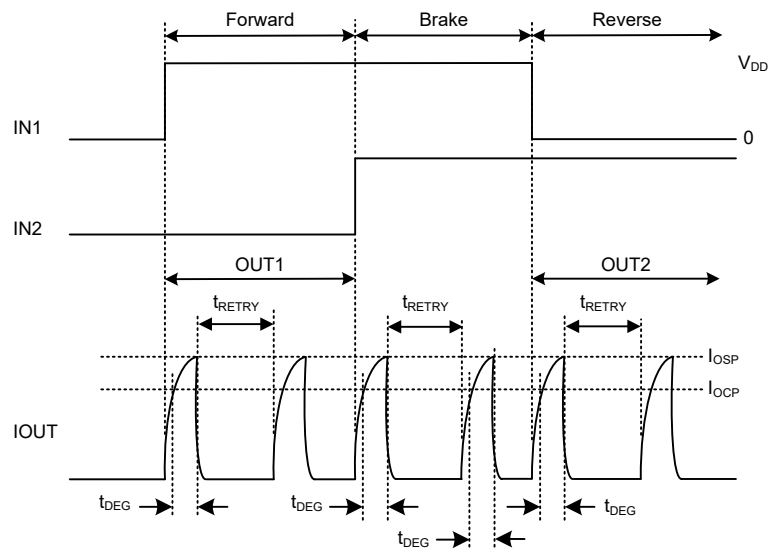
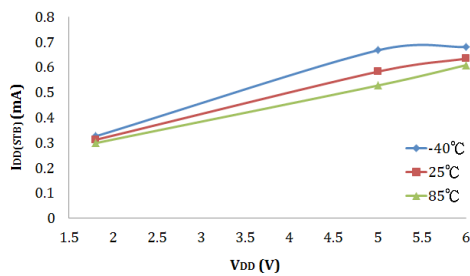


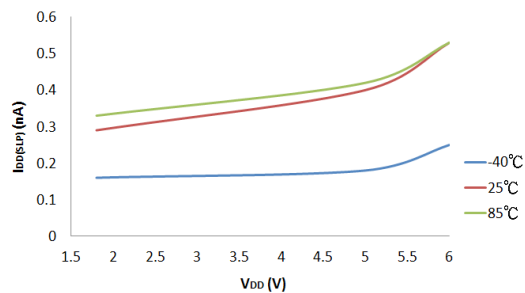
**Figure 5. Retry Reaction**

## Typical Performance Characteristics

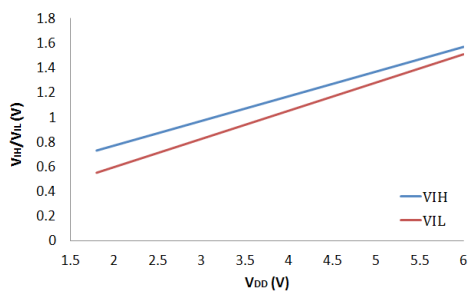
$V_{DD} = 5V$  and  $T_a = +25^\circ C$ , unless otherwise specified



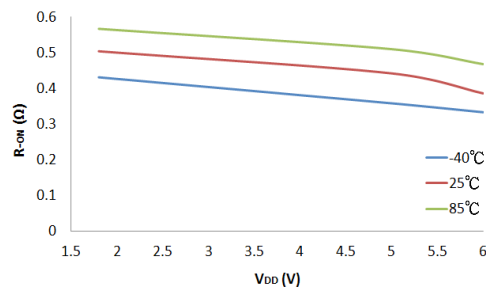
$I_{DD}(STB)$  vs.  $V_{DD}$



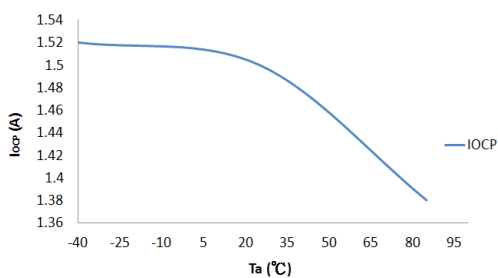
$I_{DD}(SLP)$  vs.  $V_{DD}$



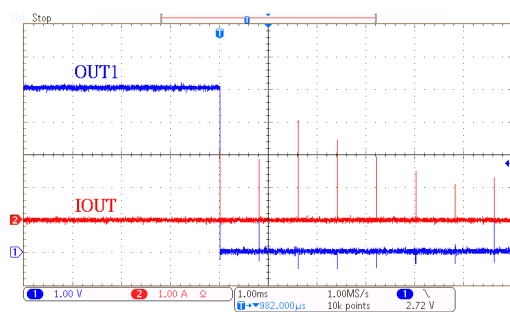
$V_{IH}/V_{IL}$  vs.  $V_{DD}$



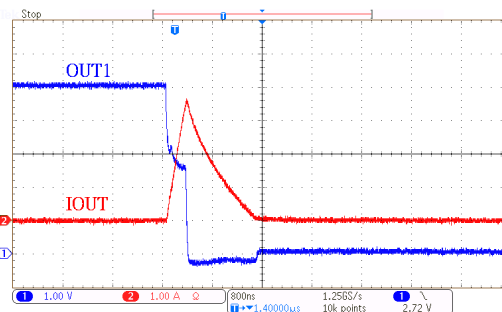
$R_{ON}$  vs.  $V_{DD}$  (-40, 25, 85)



$I_{OCP}$  vs. TEMP



Short Protection Reaction



Short Protection Reaction (Zoom-in)

## Functional Description

### Overview

The HT7K1201 is a 1-ch H-bridge driver that can drive DC brush motors or solenoids. Due to the 4 internal very low on-resistance power MOSFETs which have parallel spark killer diodes in the 6-pin SOT23 package, the HT7K1201 motor driver has a high efficiency motor driving capability, reduced external components. The device also includes a full range of protection functions including over-current and over-temperature to prevent the possibility of burn-out occurring even if the motor stalls or if the output pins are shorted to each other.

### H-Bridge Control

According to the IN1 and IN2 pin states the device will generate four H-bridge output states: Standby, Forward, Reverse and Brake. The input/output operation truth table in Active Period is shown in Table1. Note that the IN1 and IN2 control input pins are not allowed to float and must be connected to an external 100kΩ pull-up or pull-down resistor.

### Active Period and Sleep Period

When the Standby mode continuously exceeds over 10ms, the HT7K1201 will enter the Sleep Period. At this time, the Standby mode still works in the Sleep Period as shown in Table 2. Changing the operation mode to Forward or Reverse will go back to the Active Period.

In the Sleep Period, all functional blocks are turned off to reduce the current consumption to an ultra-low value of less than 0.1μA (max). The driver remains in the Sleep Period (Figure 2). Since all functional blocks are turned off, the Standby mode outputs are not protected. When an IN1 or IN2 pin is set to “High”, the device will exit from the Sleep Period.

### V<sub>DD</sub> Under Voltage Lock-out

In order to avoid an H-bridge metastable output condition when powered-on or with a low battery voltage, an under voltage lockout function is integrated within the device. During the power-on period, the H-bridge outputs will remain in high impedance states and the control inputs are ignored when V<sub>DD</sub> is lower than V<sub>UVLO+</sub>. The H-bridge outputs are only controlled by inputs when V<sub>DD</sub> is higher than V<sub>UVLO+</sub>. The device will be locked again when V<sub>DD</sub> falls to a voltage level lower than V<sub>UVLO-</sub>.

### Over Current Protection – OCP

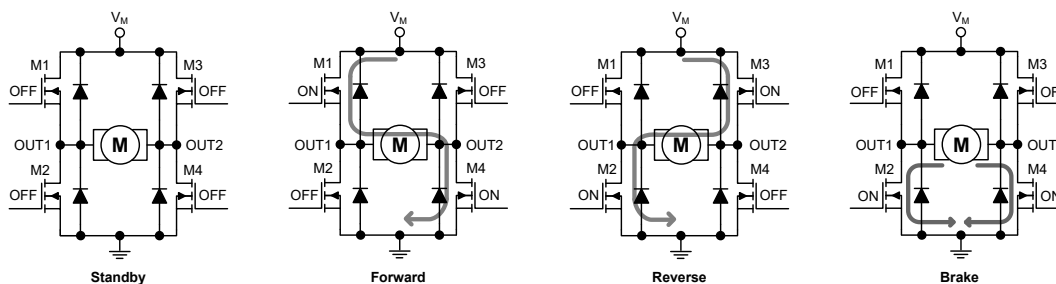
The HT7K1201 device includes a fully integrated over current protection function within each of the internal power MOSFETs. When the motor current exceeds the over current protection threshold, I<sub>OCP</sub>, exceeding a de-glitch time, t<sub>DEG</sub>, all power MOSFETs will be turned off immediately. After the retry time times out, the device will release the protection activation and allow normal operation to resume.

| IN1 | IN2 | OUT1 | OUT2 | Operation Mode | H-Bridge Status |     |     |     |
|-----|-----|------|------|----------------|-----------------|-----|-----|-----|
|     |     |      |      |                | M1              | M2  | M3  | M4  |
| 0   | 0   | Z    | Z    | Standby        | OFF             | OFF | OFF | OFF |
| 0   | 1   | L    | H    | Reverse        | OFF             | ON  | ON  | OFF |
| 1   | 0   | H    | L    | Forward        | ON              | OFF | OFF | ON  |
| 1   | 1   | L    | L    | Brake          | OFF             | ON  | OFF | ON  |

Table 1. Operation Truth Table in Active Period

| IN1 | IN2 | OUT1 | OUT2 | Operation Mode | H-Bridge Status |     |     |     |
|-----|-----|------|------|----------------|-----------------|-----|-----|-----|
|     |     |      |      |                | M1              | M2  | M3  | M4  |
| 0   | 0   | Z    | Z    | Standby        | OFF             | OFF | OFF | OFF |

Table 2. Operation Truth Table in Sleep Period



H-Bridge Operation Modes

## Output Short-Circuit Protection – OSP

The device provides full output protection for conditions such as an output pin short to ground, to the motor supply or to each other. The device detects the current through each power MOSFETs and compares it with the output short circuit protection threshold,  $I_{OSP}$ , without a de-glitch time. The current threshold  $I_{OSP}$  is internally set to 1.5 times the  $I_{OCP}$ . When an OSP condition occurs, the device will turn off all power

MOSFETs and keep checking the output status every retry time,  $t_{RETRY}$ , until the fault is removed.

## Over Temperature Protection – OTP

If the die temperature exceeds the internal limit threshold,  $T_{SHD}$ , the device will turn off all power MOSFETs until the temperature decreases to a specific level less than the recovery temperature,  $T_{REC}$ .

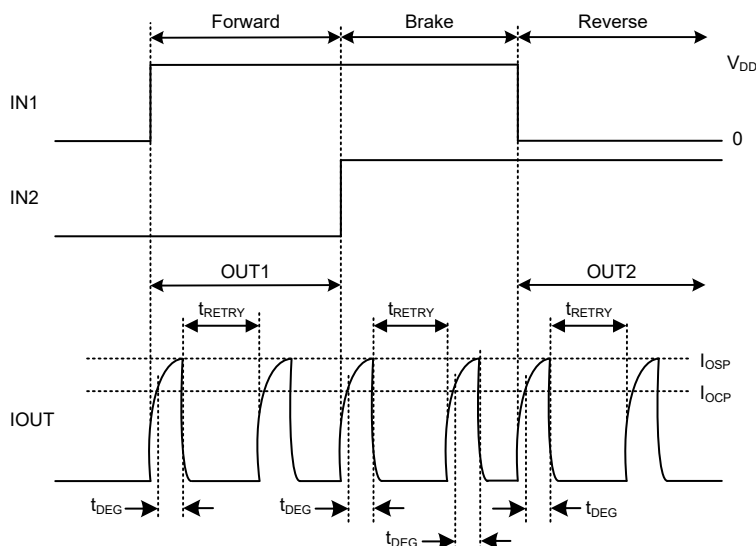


**Figure 6. Retry Mechanism**

The retry mechanism entry and release conditions are shown as follows.

| Protection Type | Retry Entry Condition                              | Functional Mode |       |         | Retry Release Condition        |
|-----------------|----------------------------------------------------|-----------------|-------|---------|--------------------------------|
|                 |                                                    | Forward/Reverse | Brake | Standby |                                |
| OCP             | $I_{OCP} > 1.3A$                                   | O               | O     | —       | $I_{OCP} < 1.3A$               |
| OSP             | OUTx-to-ground, OUTx-to-power or OUT1-to-OUT2 path | O               | O     | —       | Short circuit fault is removed |

**Table 3. Retry Mechanism Conditions**

The protection function entry and release conditions are shown as follows.

| Protection Type | Protection Entry Condition                         | Functional Mode |       |         | Protection Release Condition   |
|-----------------|----------------------------------------------------|-----------------|-------|---------|--------------------------------|
|                 |                                                    | Forward/Reverse | Brake | Standby |                                |
| UVLO            | $V_{IN} < 1.5V$                                    | O               | O     | —       | $V_{IN} > 1.8V$                |
| OCP             | $I_{OCP} > 1.3A$                                   | O               | O     | —       | $I_{OCP} < 1.3A$               |
| OSP             | OUTx-to-ground, OUTx-to-power or OUT1-to-OUT2 path | O               | O     | —       | Short circuit fault is removed |
| OTP             | $T_J > 150^{\circ}C$                               | O               | O     | O       | $T_J < 120^{\circ}C$           |

**Table 4. Protection Function Conditions**

## Power Dissipation

The main power dissipation in the HT7K1201 device is determined by the on-resistance of internal power MOSFETs. The average power dissipation can be estimated using the following equation:

$$P_{AVG} = R_{ON} \times (I_{OUT(RMS)})^2$$

Where  $P_{AVG}$  is the average power dissipation of the device,  $R_{ON}$  is the total on-resistance of HS and LS MOSFETs and  $I_{OUT(RMS)}$  is the RMS or DC output current through the load. Note that the  $R_{ON}$  value will vary with the die temperature. The higher the die temperature is, the higher will be the  $R_{ON}$  value. When the ambient temperature increases or as the device heats up, the power dissipation of the device will also increase.

## Component/Motor Selection Guide

### Motor Consideration

The appropriate motor voltage depends upon the desired RPM and power supply source. Higher motor voltages also increase the motor current rate. Note that the motor stall current must be less than the internal limit output current,  $I_{OCP}$ , to avoid failures when the motor starts up.

### Supply Capacitor

It is suggested to use at least a 10 $\mu$ F value capacitor for C1. There are two main functions for this capacitor. Firstly, it absorbs the energy released by the motor to reduce any overshoot voltage damage. Secondly, it provides a transient power source to the motor to compensate for the battery response time or for long connecting wire effects when the motor starts up or for fast control switching between forward and reverse modes.

### Motor Bypass Capacitor

The bypass capacitor,  $C_M$ , provides the fast flywheel path to release the inductive energy of the motor. In most applications, the capacitance value is set to a value of 0.01 $\mu$ F to 0.1 $\mu$ F. Usually this capacitor is internally contained within the motor and not required externally. In some applications, especially in low speed motors, the large internal motor resistor connected with the bypass capacitor in parallel may result in an instantaneous large current when the motor starts up. It may however trigger a faulty OCP/OSP reaction which will fail to start up the motor. There are two ways to solve this phenomenon: decrease the bypass capacitor value or add a 47 $\Omega$  to 100 $\Omega$  resistor in series with the bypass capacitor.

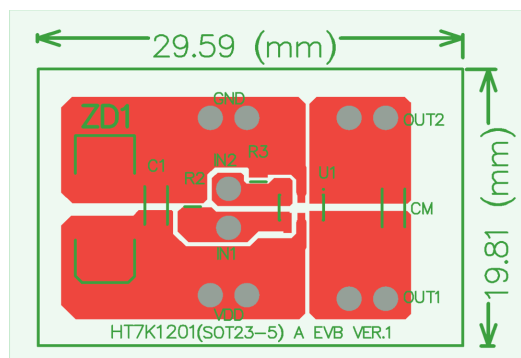
## Motor Voltage Zener Diode

The Zener Diode (ZD1) is optional, located at the input of the IC VM pin to prevent the motor's back EMF voltage from flowing to the VM. This back EMF voltage may exceed the IC's rated voltage and cause damage. ZD1 is set to a value of 6.6V.

## Layout Consideration Guide

To reduce the problems with conducted noise, there are some important points to notes on the PCB layout.

1. The input capacitor C1 must be placed close to the VDD pin.
2. The bypass capacitor  $C_M$  is optional and should be placed close to the motor side.
3. Ensure that the power routing path such as VDD, OUT1, OUT2 and PGND is as wide as possible.



## Thermal Consideration

The maximum power dissipation depends upon the thermal resistance of the IC package, PCB layout, rate of surrounding airflow and difference between the junction and ambient temperature. The maximum power dissipation can be calculated by the following formula:

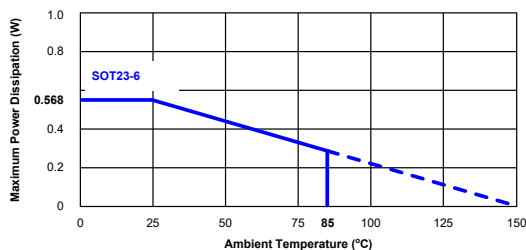
$$P_{D(MAX)} = (T_{J(MAX)} - T_a) / \theta_{JA} \quad (W)$$

where  $T_{J(MAX)}$  is the maximum junction temperature,  $T_a$  is the ambient temperature and  $\theta_{JA}$  is the junction-to-ambient thermal resistance of IC package.

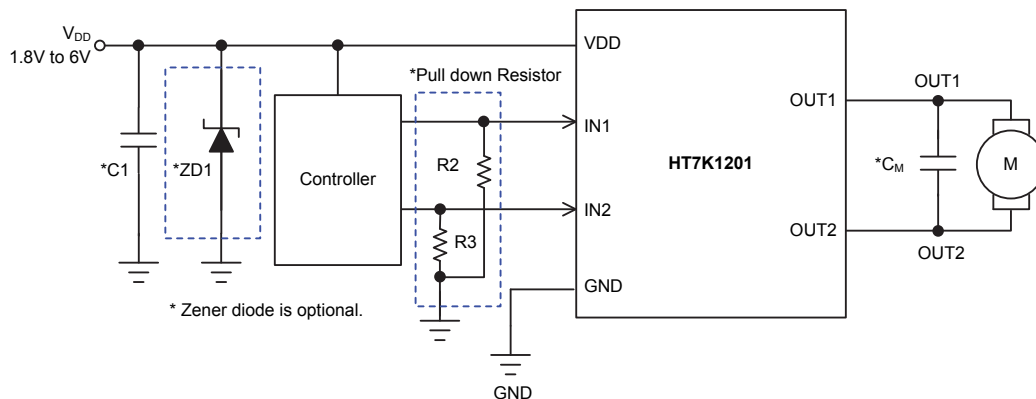
For maximum operating rating conditions, the maximum junction temperature is 150°C. However, it's recommended that the maximum junction temperature does not exceed 125°C during normal operation to maintain high reliability. The de-rating curve of the maximum power dissipation is show below:

$$P_{D(MAX)} = (150^{\circ}\text{C} - 25^{\circ}\text{C}) / (220^{\circ}\text{C}/\text{W}) = 0.568\text{W}$$

For a fixed  $T_{J(MAX)}$  of 150°C, the maximum power dissipation depends upon the operating ambient temperature and the package's thermal resistance,  $\theta_{JA}$ . The de-rating curve below shows the effect of rising ambient temperature on the maximum recommended power dissipation.



## Application Circuits



Note: \* The capacitance value of C1 is determined by application – a minimum recommended value is greater than 10μF.

\* C<sub>M</sub> is optional – a typical value is 0.01μF to 0.1μF.

\* The motor stall current should be less than the over current protection threshold, I<sub>OCP</sub>.

\* ZD1 is optional – a typical value is 6.6V (VISHAY BZX85C6V8).

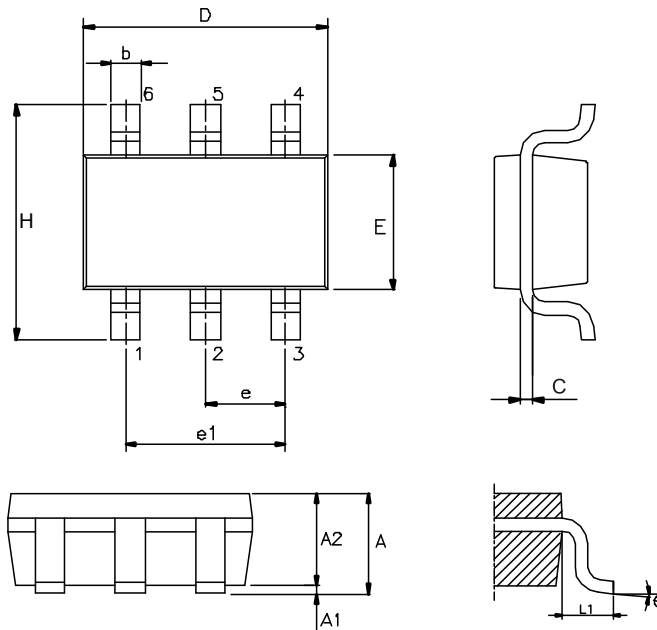
\* R2,R3 is optional – a typical value is 100kΩ to 150kΩ.

## Package Information

Note that the package information provided here is for consultation purposes only. As this information may be updated at regular intervals users are reminded to consult the [Holtek website](#) for the latest version of the [Package/ Carton Information](#).

Additional supplementary information with regard to packaging is listed below. Click on the relevant section to be transferred to the relevant website page.

- [Package Information \(include Outline Dimensions, Product Tape and Reel Specifications\)](#)
- [The Operation Instruction of Packing Materials](#)
- [Carton information](#)

**6-pin SOT23 Outline Dimensions**


| Symbol | Dimensions in inch |           |       |
|--------|--------------------|-----------|-------|
|        | Min.               | Nom.      | Max.  |
| A      | —                  | —         | 0.057 |
| A1     | —                  | —         | 0.006 |
| A2     | 0.035              | 0.045     | 0.051 |
| b      | 0.012              | —         | 0.020 |
| C      | 0.003              | —         | 0.009 |
| D      | —                  | 0.114 BSC | —     |
| E      | —                  | 0.063 BSC | —     |
| e      | —                  | 0.037 BSC | —     |
| e1     | —                  | 0.075 BSC | —     |
| H      | —                  | 0.110 BSC | —     |
| L1     | —                  | 0.024 BSC | —     |
| θ      | 0°                 | —         | 8°    |

| Symbol | Dimensions in mm |          |      |
|--------|------------------|----------|------|
|        | Min.             | Nom.     | Max. |
| A      | —                | —        | 1.45 |
| A1     | —                | —        | 0.15 |
| A2     | 0.90             | 1.15     | 1.30 |
| b      | 0.30             | —        | 0.50 |
| C      | 0.08             | —        | 0.22 |
| D      | —                | 2.90 BSC | —    |
| E      | —                | 1.60 BSC | —    |
| e      | —                | 0.95 BSC | —    |
| e1     | —                | 1.90 BSC | —    |
| H      | —                | 2.80 BSC | —    |
| L1     | —                | 0.60 BSC | —    |
| θ      | 0°               | —        | 8°   |

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