Features

- 1 Channel H-bridge motor driver: low MOSFET on-resistance: 0.5Ω (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 < 0.1μA
- 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°C to +85°C

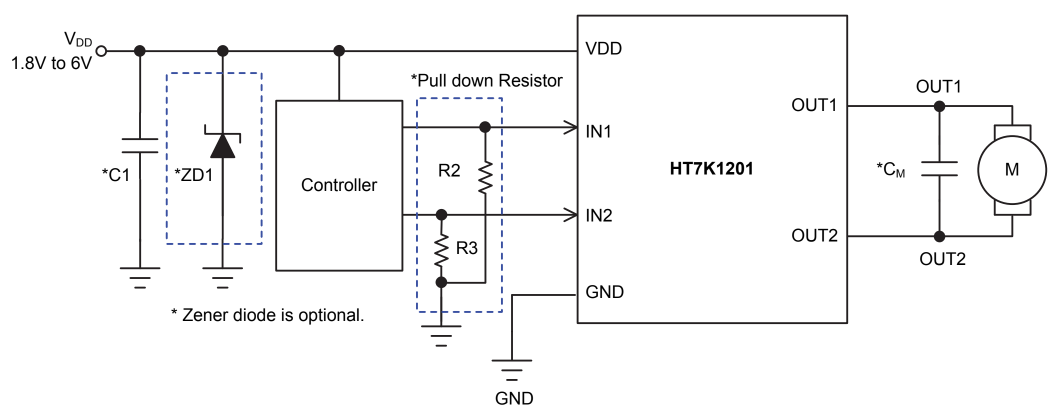
Applications

- Valve/Pump, electric locks and consumer toys

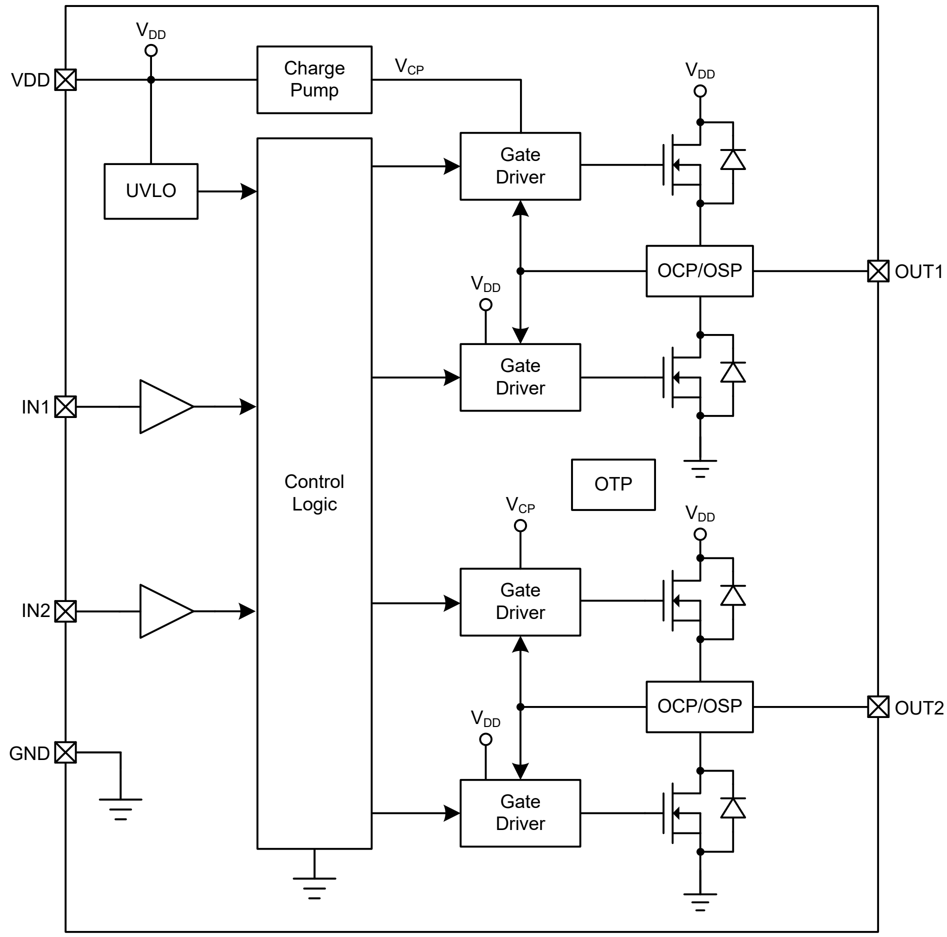
General Description

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 0.1μA sleep period current ensures long battery life.

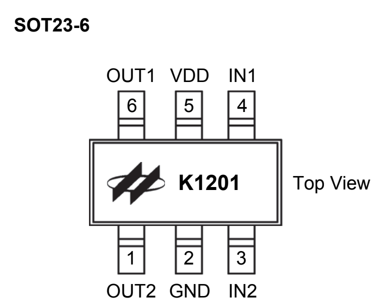
Typical Application Circuits



Functional Block Diagram



Pin Assignment



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 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 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_{DD}		-0.3 to +6.6	V
IN1, IN2		-0.3 to (V_{DD}+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_{JA}		220	°C/W

Recommended Operating Ratings

Parameter	Value	Unit
V_{DD}	1.8 to 6.0	V
$I_{OUT(RMS)}$	0.8 (Thermal Limited)	A
$I_{OUT(PEAK)}$	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 Ta=25°C, unless otherwise specified

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Power Supply						
V_{DD}	Supply Voltage	—	1.8	—	6.0	V
I_{DD}	Supply Operation Current	PWM=25kHz, no load	—	650	1000	μA
$I_{DD(STB)}$	Supply Standby Current	IN1=IN2='0', active period	—	600	800	μA
$I_{DD(SLP)}$	Supply Sleep Current	IN1=IN2='0', sleep period	—	—	0.1	μA
H-Bridge Driver						
R_{ON}	*HS+LS FET On-resistance	V_{DD}=V_M=3V, I_{OUT}=500mA	—	0.5	—	Ω
V_{CLAMP}	Clamp Diode Voltage	I=300mA (HS and LS)	—	0.8	—	V
$t_{r(OUT)}$	Output Rise Time	R_L=20Ω, 10% to 90% (Figure 1)	—	100	—	ns
$t_{f(OUT)}$	Output Fall Time	R_L=20Ω, 10% to 90% (Figure 1)	—	30	—	ns
Control Logic						
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 (Figure1)	R_L=20Ω, INx to OUTx (high-Z to high/low)	—	40	—	ns
t_{P2}		R_L=20Ω, INx to OUTx (high/low to high-Z)	—	120	—	ns
t_{P3}		R_L=20Ω, INx to OUTx	—	40	—	ns
t_{P4}		R_L=20Ω, 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
Charge Pump						
t_{CP_ON}	Charge Pump On Time	Charge pump activation time	—	11	—	ms
Protection						
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	—	μs
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	—	°C
t_{REC}	Thermal Recovery Temperature	—	—	120	—	°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.

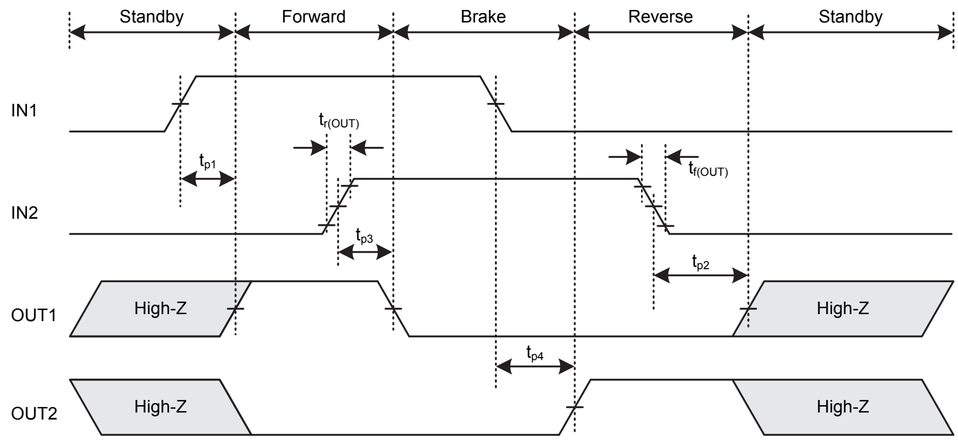


Figure 1. Operation Mode Control Logic in Active Period

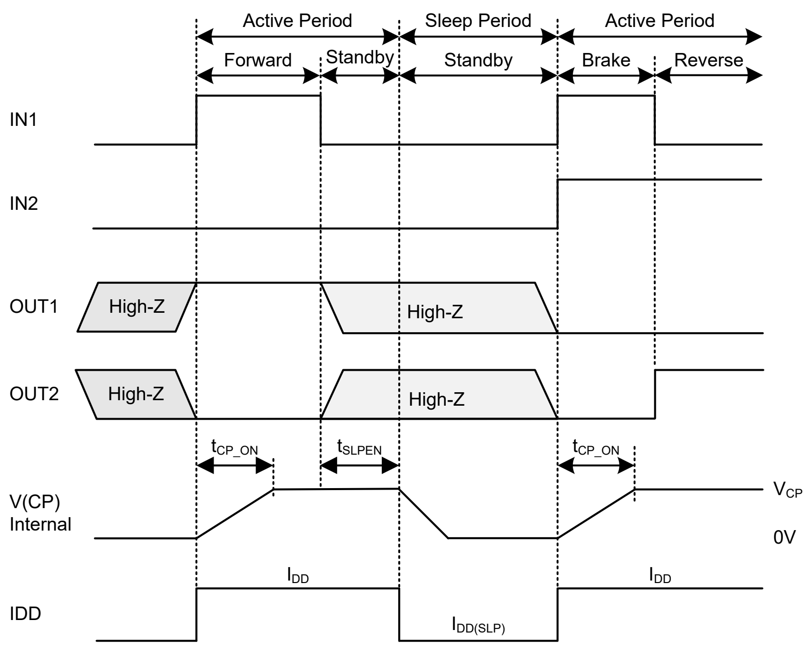


Figure 2. Operation Mode Control Timing Diagram

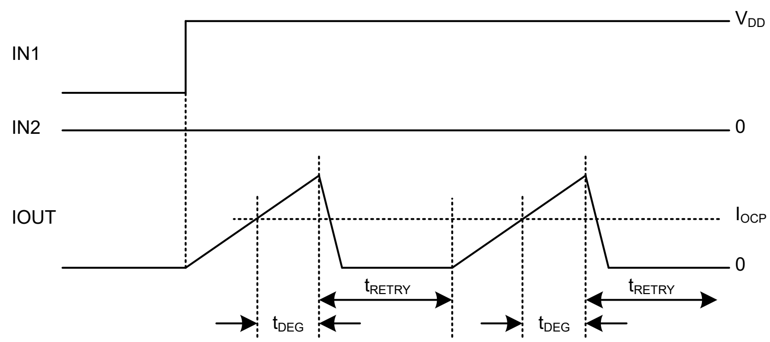


Figure 3. OCP Reaction

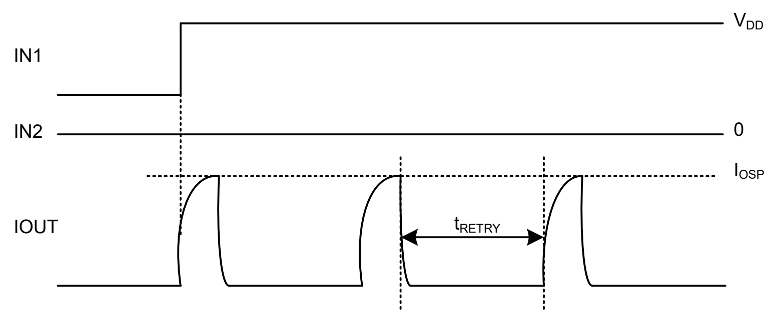


Figure 4. OSP Reaction

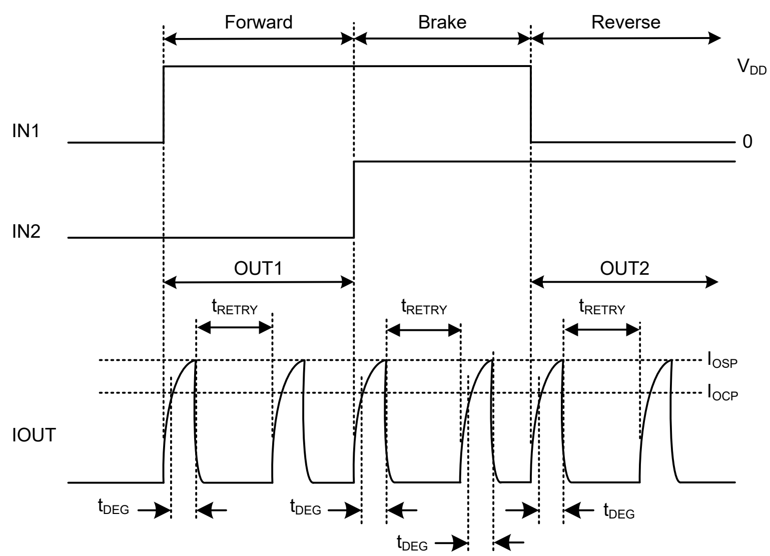
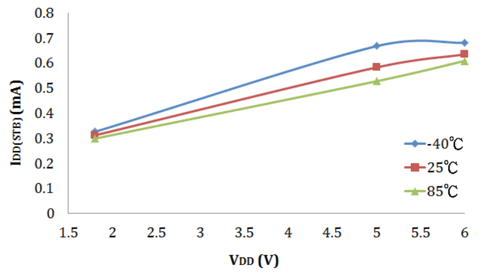


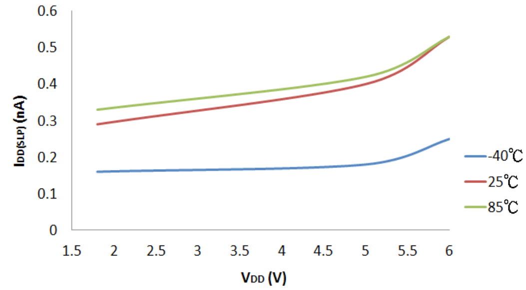
Figure 5. Retry Reaction

Typical Performance Characteristics

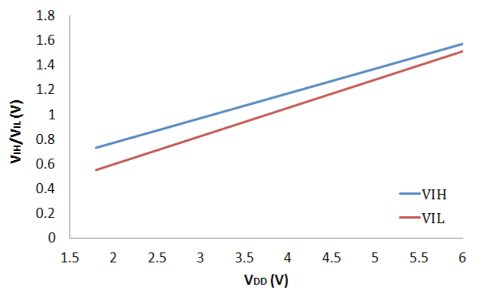
V_{DD}= 5V and T_a=+25 °C, unless otherwise specified



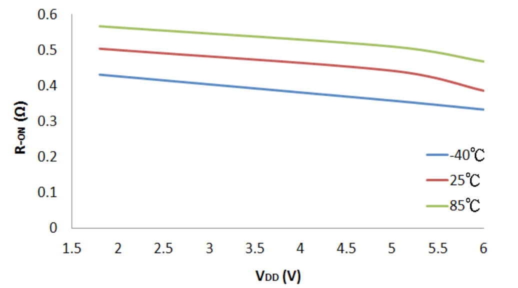
$I_{DD(STB)}$ vs. V_{DD}



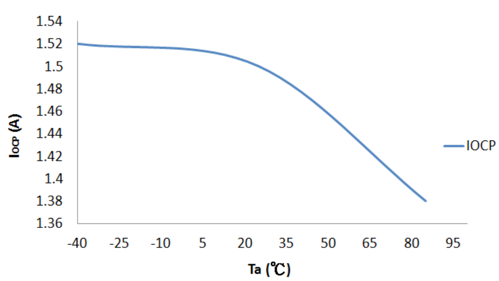
$I_{DD(SLP)}$ vs. V_{DD}



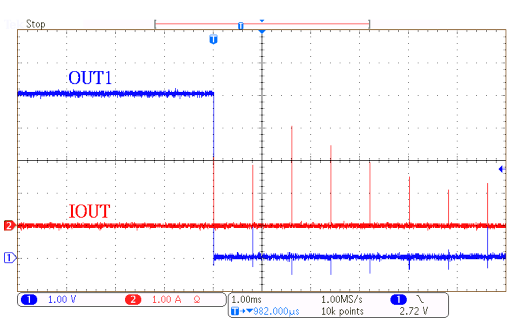
V_{IH}/V_{IL} vs. V_{DD}



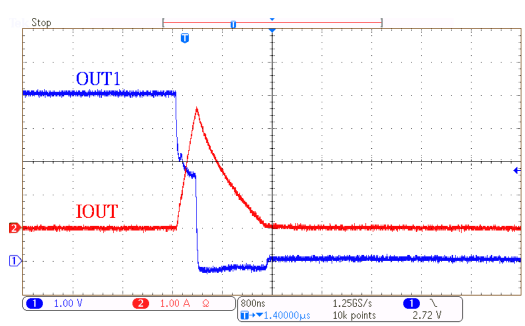
R_{ON} vs. V_{DD} (-40, 25, 85)



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_{DD} 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_{DD} is lower than V_{UVLO+}. The H-bridge outputs are only controlled by inputs when V_{DD} is higher than V_{UVLO+}. The device will be locked again when V_{DD} falls to a voltage level lower than V_{UVLO-}.

Over Current Protection – OCP

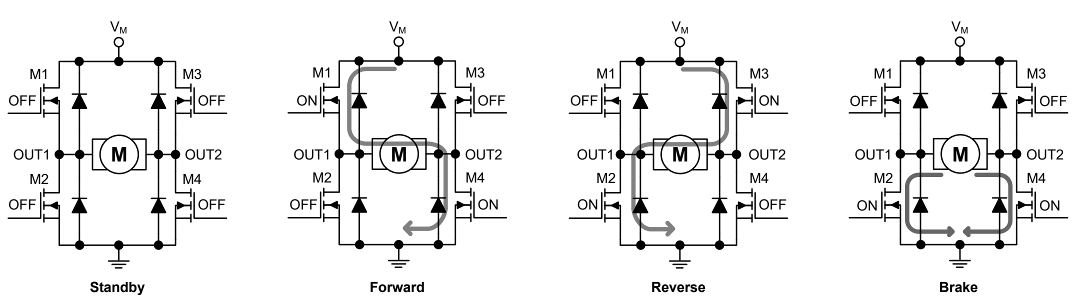
The HT7K1201 device includes a fully integrated over current protection function within each of the internal power MOSFETs. When the motor current exceeds the over current protection threshold, I_{OCP}, exceeding a de-glitch time, t_{DEG}, all power MOSFETs will be turned off immediately. After the retry 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}.

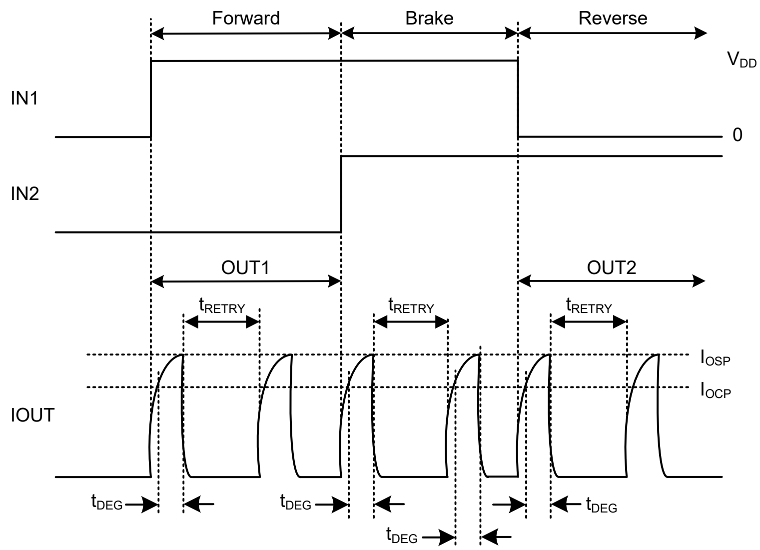


Figure 6. Retry Mechanism

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°C	O	O	O	T_J<120°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 10μF 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 0.01μF to 0.1μF. 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 47Ω to 100Ω resistor in series with the bypass capacitor.

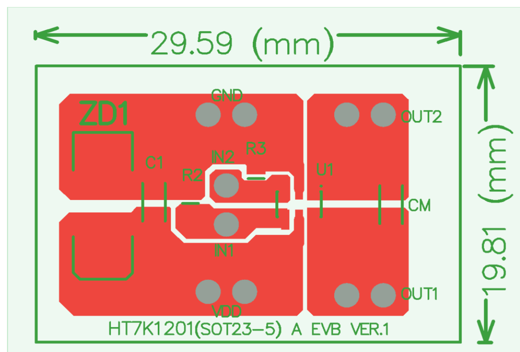
Motor Voltage Zener Diode

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:

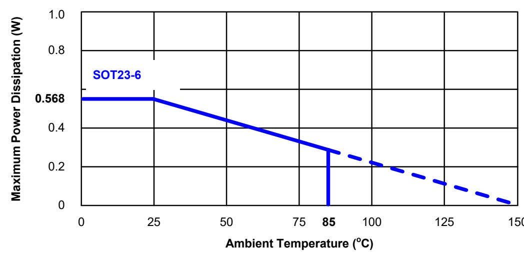
$$P_{D(MAX)} = (T_{J(MAX)} - T_a) / \theta_{JA} \quad (W)$$

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

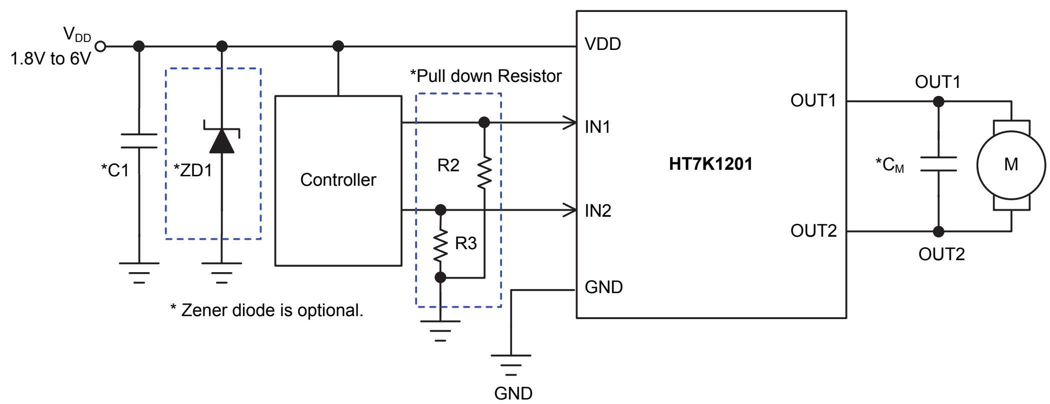
For maximum operating rating conditions, the maximum junction temperature is 150°C. However, it's recommended that the maximum junction temperature does not exceed 125°C during normal operation to maintain high reliability. The de-rating curve of the maximum power dissipation is show below:

$P_{D(MAX)} = (150°C – 25°C) / (220°C/W) = 0.568W$

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, θ_{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_M 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_{OCP}.
* ZD1 is optional – a typical value is 6.6V (VISHAY BZX85C6V8).
* R2,R3 is optional – a typical value is 100kΩ to 150kΩ.

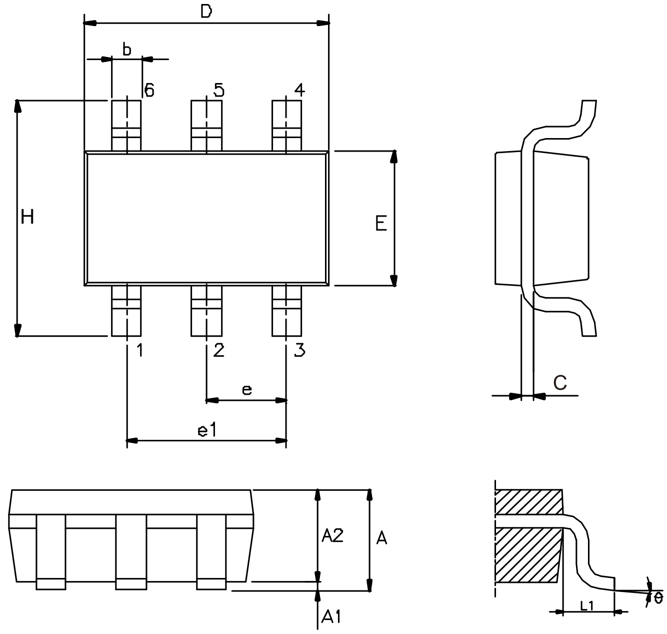
Package Information

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°