DESCRIPTION

PT2431 is an integrated 12V-operationable 3-phase sensorless BLDC motor driver with advanced protections which include soft-start circuit, thermal shutdown, lock protection and output current limit. PT2431 is specially designed for sensorless motor and ideal for fan motor control requiring high power efficiency. And a direct PWM-control interface is built in to smooth the fan speed from low to high. Peripheral devices are limited to few so that it is not difficult to make the PCB layout tight and small.

PT2431 uses a new multi-power BCD technology, requiring a single power supply of VDD = 5~12V, packed as TSSOP16 package and displaying excellent power efficiency, is a perfect solution for comprising a compact, low-cost sensorless BLDC motor system.

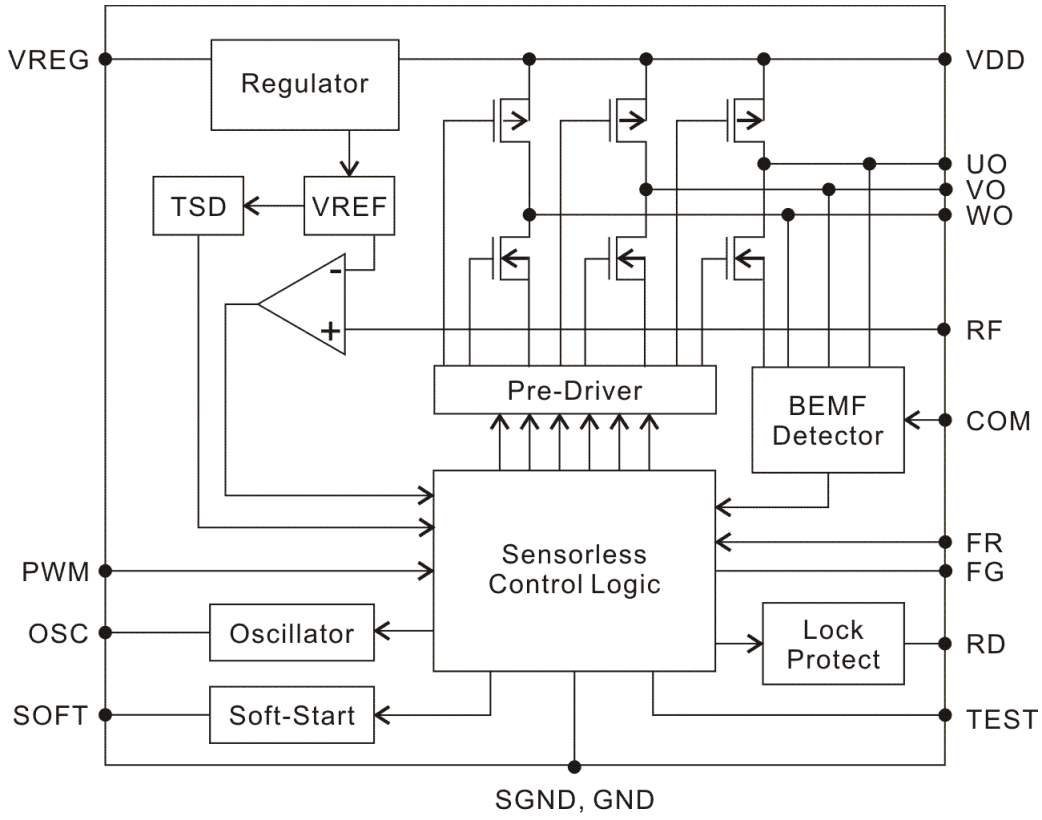
FEATURES

- Multi-power BCD technology
- Direct-PWM of 20~50 KHz for fan speed control
- Adjustable soft-start time by an external capacitor
- Adjustable Lock protection time by an external capacitor
- Thermal protection of shutdown/release at 150 °C/120°C
- Over-current limit set by an external precision resistor
- FG output is offered, which gives the pulse signal as the hall sensor system

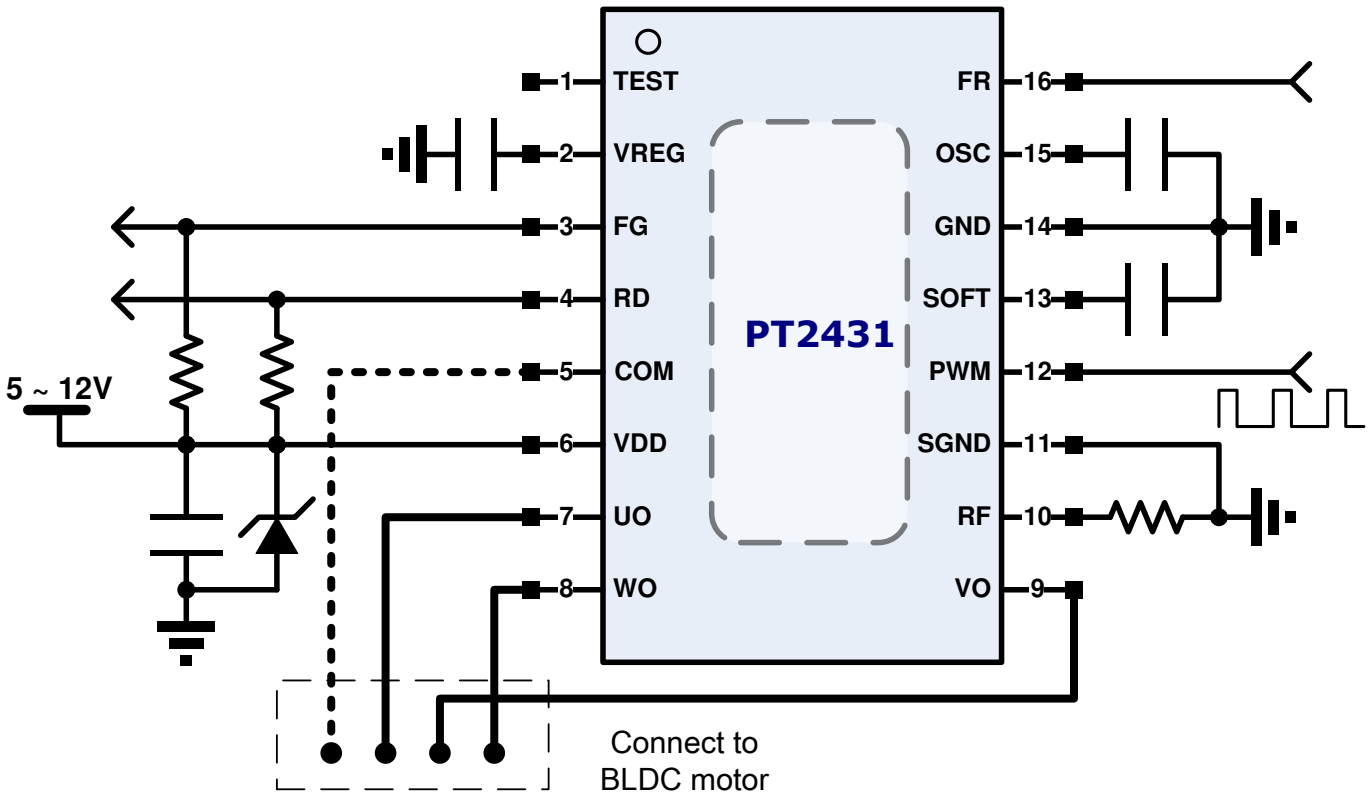
APPLICATIONS

- 3-phase sensorless BLDC fan motor driver
- Fan for CPU or graphic card
- Fan for server

BLOCK DIAGRAM



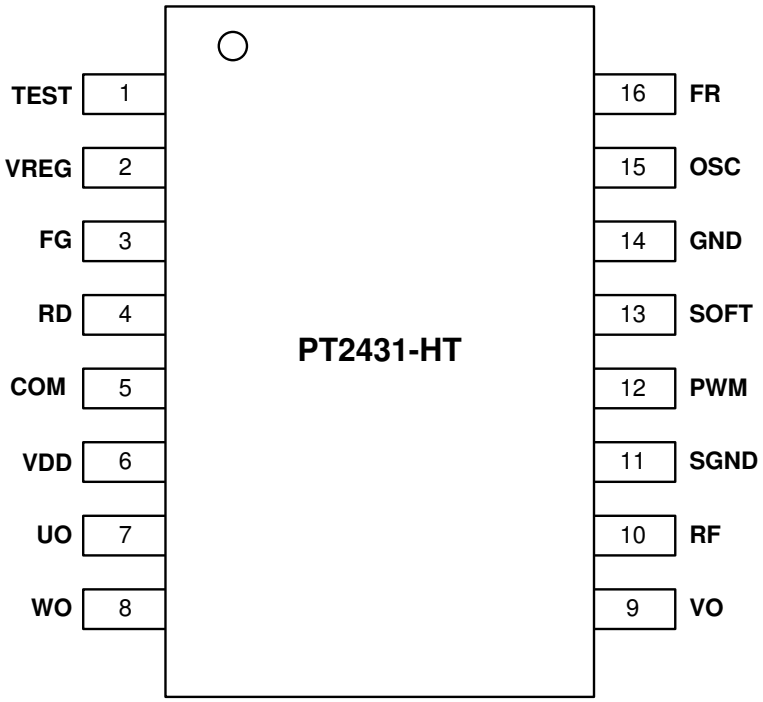
APPLICATION CIRCUIT



ORDER INFORMATION

Valid Part Number	Package Type	Top Code
PT2431	16-pin, HTSSOP, 173mil	PT2431-HT

PIN CONFIGURATION



PIN DESCRIPTION

Pin Name	I/O	Description	Pin No.
TEST	I	Test mode , keep floating or low for normal operation	1
VREG	IO	Regulator output pin. Connect a bypass capacitor of 2.2μF to ground	2
FG	O	Pulse output signal with open-drain structure	3
RD	O	Lock mode signal with open-drain structure. Hi-Z for Lock mode	4
COM	I	Motor middle point connection for BEMF detection reference It is an optional.	5
VDD	P	High voltage power supply pin	6
UO	O	Motor driving pin U. Connect to the U phase of motor coil Current flows in the order of U, W, V	7
WO	O	Motor driving pin W. Connect to the W phase of motor coil Current flows in the order of U, W, V	8
VO	O	Motor driving pin V. Connect to the V phase of motor coil Current flows in the order of U, W, V	9
RF	O	Output current sense signal Connect a 0.5Ω resistor to ground for 1A output current limit	10
SGND	P	High voltage ground signal	11
PWM	I	PWM input signal. 20~50KHz is allowed. 75KΩ pull-up to VREG	12
SOFT	IO	Soft start control pin. Connect a capacitor of 1μF to ground	13
GND	P	Low voltage ground signal	14
OSC	IO	Start-up frequency and Lock mode period setting pin Connecting a capacitor of 2200pF to ground causes 10S lock time	15
FR	I	Forward or reverse, change status when power off	16
Heatsink	P	For heat dissipation	back side

FUNCTION DESCRIPTION

POWER SUPPLY

PT2431 provides an internal voltage regulator to the analog and digital blocks, except output driver stage. The load of driver stage is motor wire, it presents inductive character and induces large current and voltage spike when motor start to rotate. It is needed to put a suitable bypass capacitor as close to VDD pin as possible to reduce these current spikes. Also, put a 15V zener diode to ward off large back-emf voltage from motor. PT2431 chip can be operated in the supply voltage range from 5.0 V to 12 V.

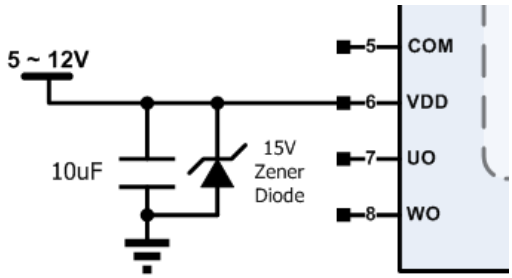


Figure 1, Zener diode and bypass capacitor for VDD supply.

SENSORLESS CONTROL

The main structure of PT2431 is based on a three-phase sensorless control algorithm. The great benefit of sensorless control is to remove three position hall sensors from motor. It is useful to reduce cost and fabrication difficulty, and enhance motor's reliability due to hall sensor's weakness of temperature characteristic.

The sensorless control method is to sense the BEMF (back electromotive force) voltage signal when the rotors of motor are commutating. The control algorithm computes and predicts the position of rotors. Hence, there are some disadvantages, such as the motor should move at minimum rate to generate sufficient BEMF to be sensed; a maximum rotation speed limitation to avoid the motor run out of idea control range, and the abrupt change of load would cause the control out of lock.

SOFT START & OVER CURRENT PROTECTION

The most difficult part of sensorless control is start-up stage. The rotors position are unknown, the disorder of BEMF signal would cause large current running through loads and MOS drivers. It is not health to MOS drivers and motor. To avoid the situation, it is better to clamp or control the current profile. PT2431 use an external capacitor at "SOFT" pin to perform a slope for clamping the current when motor is starting to rotate. It is possible to select a suitable capacitor for soft-start current profile. After the motor succeeded to start, PT2431 use an external precision resistor at "RF" pin to sense the phase current and shutdown the driver stage when the phase current exceed expected value.

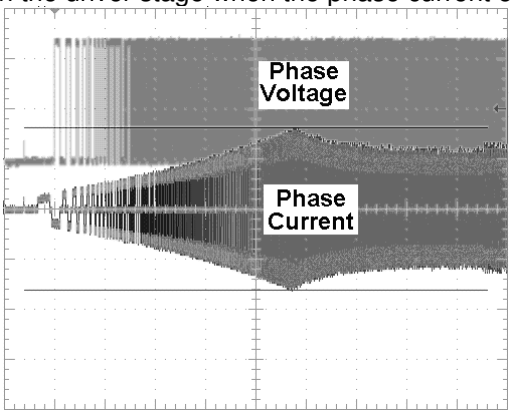


Figure 2, waveforms of phase voltage & phase current during start period.

PWM INPUT AND SOFT-SWITCHING

PT2431 can change motor rotation speed through external PWM control. The motor will run at full speed when the PWM signal is high or floating. The minimum PWM duty cycle will depend on the motor load. In general, the faster the motor can run, the minimum PWM duty cycle can reach. PT2431 allows a range from 20KHz to 50KHz PWM frequency. To lower the peak current of commutation and reduce audible noise, there is a soft-switching function cooperate with PWM signal.

LOCK PROTECTION

When the sensorless control can not determine any rotation BEMF, the control algorithm doubts the motor is locked by some reasons, and will force the motor into “lock protect” mode. After several seconds, the control algorithm will try to restart the motor. If the motor is released, it will keep running. But, if the motor is still locked, the control algorithm will back to lock mode and repeat to restart after several seconds. When control algorithm goes into “lock protection” mode, the “RD” pin will indicate a “HIGH” level.

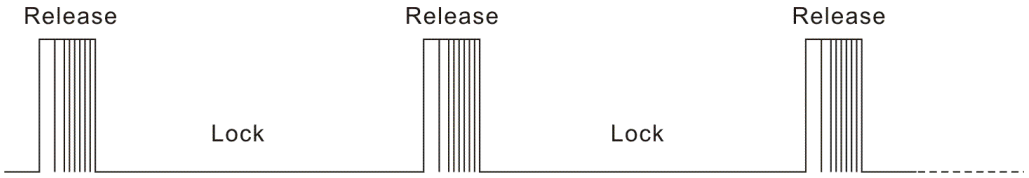


Figure 3, phase voltage of “lock protection” mode.

OVER TEMPERATURE PROTECTION

PT2431 embedded a thermal sense circuit. When chip junction temperature is heating over than 150℃. PT2431 will shutdown output driver stage; and when the chip temperature is lower than 120℃, PT2431 will let motor to work again.

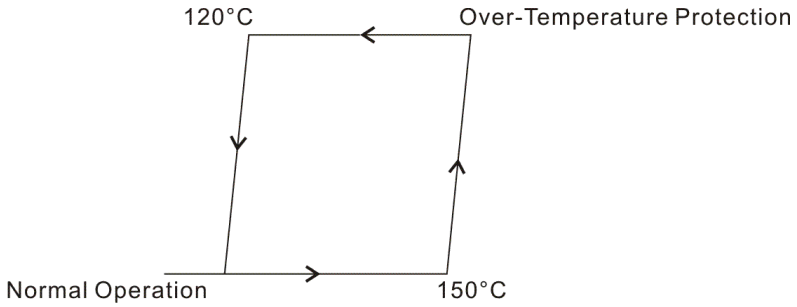


Figure 4, over temperature protection hysteresis

FG OUTPUT

To monitor the motor rotation speed, PT2431 provide an FG signal. The relation between FG frequency and RPM is:

RPM = FG x 120 / POLE, where “POLE” is the number of motor’s poles.

FORWARD AND REVERSE SETTING

PT2431 provides motor rotating direction with forward or reverse status though FR pin setting. Make sure that the IC is turned off before change status. Keep FR pin floating or connect ground, the motor would rotate with UVW direction and reverse direction when FR pin is connected to high.

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Max.	Unit
VDD supply voltage	VDD max	No break down	15.6	V
Output pin current	Iout max	UO, VO, WO pins	0.8	A
Input pin withstand voltage	Vin max	PWM, OSC, SOFT, TEST, FR	6	V
FG, RD pin withstand voltage	Vd max	FG, RD pins	15.6	V
FG, RD pin current	Id max	FG, RD pins	5	mA
Power dissipation 1	Pd max1	Independent IC	0.3	W
Power dissipation 2	Pd max 2	Mounted on evaluation board(Note)	1.2	W
Operating temperature	Topr	-	-40 ~ +85	°C
Storage temperature	Tstg	-	-40 ~ +150	°C

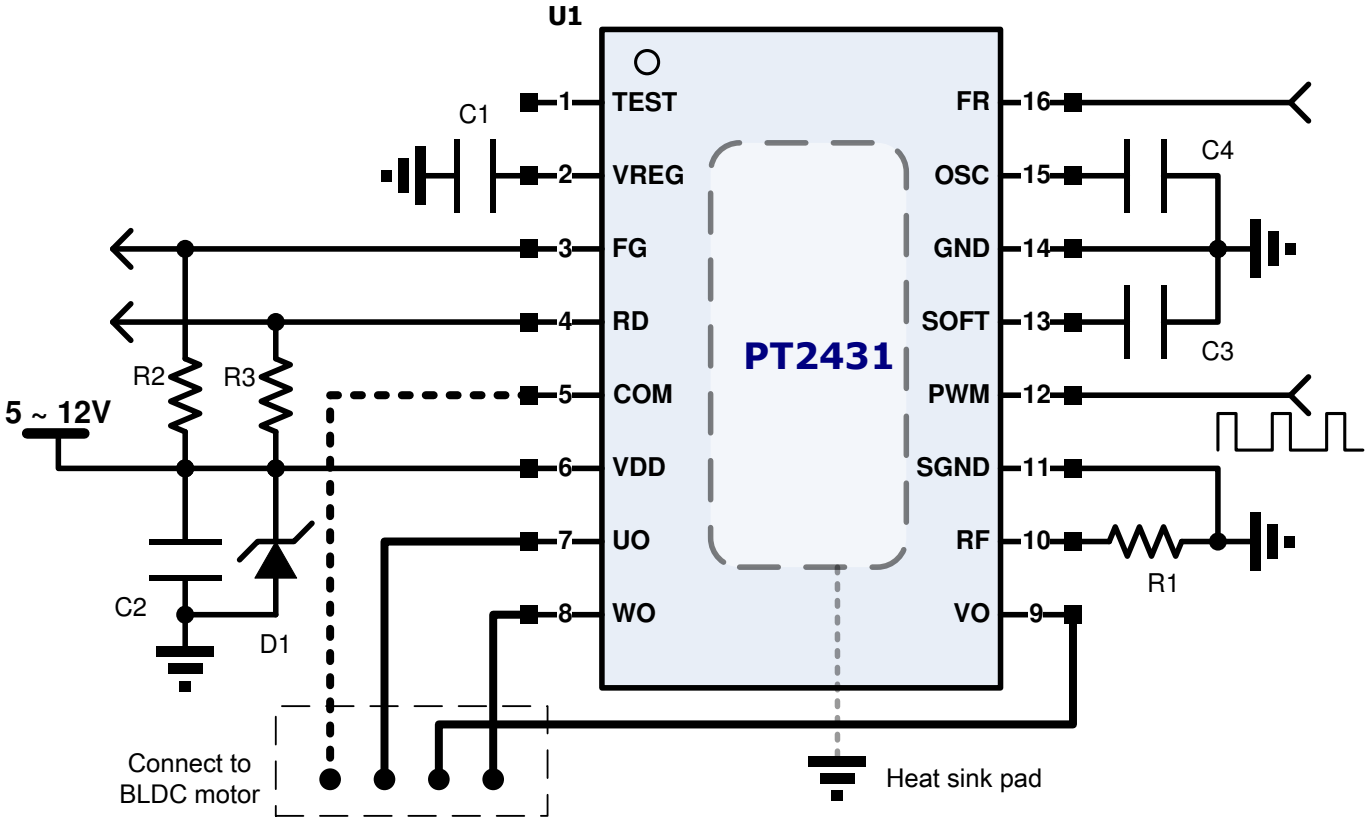
Note: Mounted on the designated board with heat-sink area.

ELECTRICAL CHARACTERISTICS

(VDD=12V, T=25°C unless otherwise specified)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
VDD supply voltage	VDD	-	5.0	-	12	V
Power supply current 1	IDD 1	PWM pin = VREG, without load	-	3.0	5.0	mA
Power PMOS Rdson	RPdson	Io = 500mA	-	0.6	1.0	Ω
Power NMOS Rdson	RNdson	Io = 500mA	-	0.6	1.0	Ω
OSC pin charge current	Iosc 1	OSC pin	-	-2.5	-	μA
OSC pin discharge current	Iosc 2	OSC pin	-	2.5	-	μA
VREG pin voltage	Vreg	No load	4.2	4.5	4.8	V
PWM high input voltage	Vpwmh	PWM voltage rising	Vreg*0.8	-	-	V
PWM low input voltage	Vpwml	PWM voltage falling	-	-	Vreg*0.2	V
PWM input frequency	Fpwm	-	20	-	50	KHz
PWM pull-up resistance	Rpwm	-	-	75	-	KΩ
FG output low voltage	Vfgl	When Io = 0.5mA	-	0.1	0.2	V
RD output low voltage	Vrdl	When Io = 0.5mA	-	0.1	0.2	V
Current limiter voltage	Vrf	RF = 0.5Ω	0.45	0.5	0.55	V
Lock re-start time	Trest	External 2200pF capacitor	-	1	-	S
Lock protection time	Tlock	External 2200pF capacitor	-	10	-	S
Thermal shutdown	Tshdn	Temperature increasing, design target	-	150	-	°C
Thermal release	Trel	Temperature decreasing, design target	-	120	-	°C

BILL OF MATERIALS FOR APPLICATION CIRCUIT



Part	Value	Unit	Description
C1	2.2μ	F	Capacitor of 4.5V regulator.
C2	1.0μ	F	Bypass capacitor of supply voltage.
C3	1.0μ	F	Soft start profile capacitor. (Note 1)
C4	2.2n	F	Capacitor of RC oscillator. (Note 2)
R1	0.5	Ω	Over current detection resister. (Note 3)
R2/R3	100K	Ω	Pull high resisters.
D1	15	V	Zener diode.
U1	PT2431	U1	Motor driver chip.

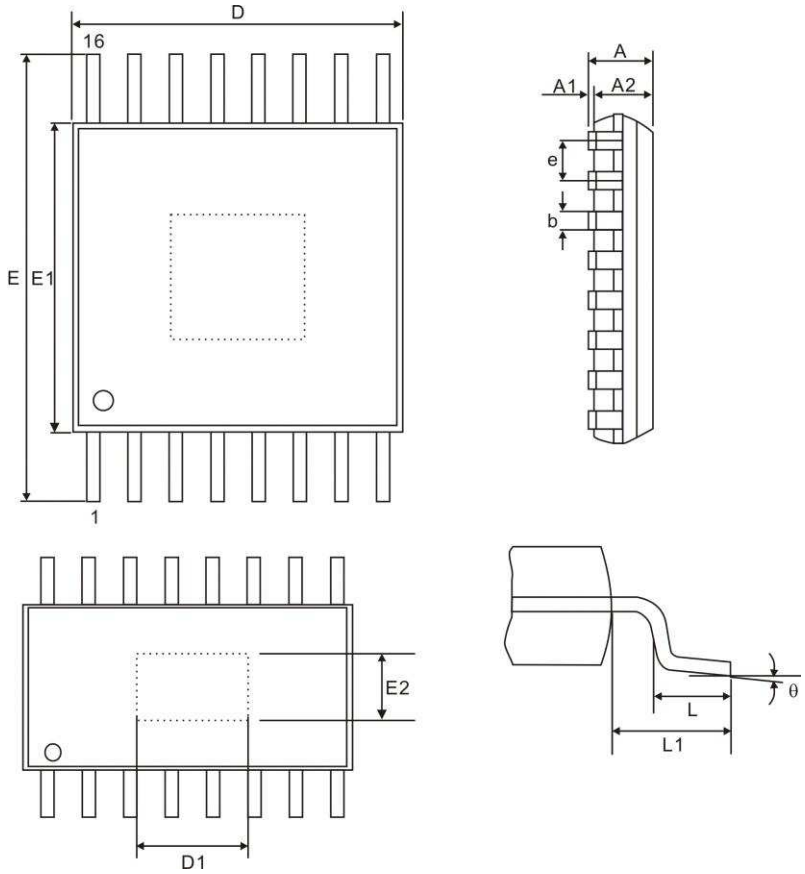
Notes:

1 & 2. The value might be adjusted for best when different motor is applied.

3. Reduce the R1 value to 0.3Ω when the operation current large than 600mA.

PACKAGE INFORMATION

16 Pins, HTSSOP (Shrink Small Outline Package with Heat Sink)



Symbol	Min.	Nom.	Max.
A	-	-	1.20
A1	0.00	-	0.15
A2	0.80	1.00	1.05
b	0.19	-	0.30
D	4.90	5.00	5.10
D1	1.70	-	-
E	6.4		
E1	4.30	4.40	4.50
E2	1.50	-	-
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00REF		
θ	0º	-	8º

Notes:

1. Refer to JEDEC MO-153 AB/ABT
2. Unit: mm

IMPORTANT NOTICE

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