General Description

BCT8320 is a high-performance current mode PWM controller with enhanced features for application which require low startup current and low power consumption at standby mode. BCT8320 enhanced with thermal shunt down feature and programmable trip point. Over temperature protection by continuously monitoring the operation temperature inside the chassis is an attractive feature to increase the long term reliability of power supply products.

The BCT8320 is current mode PWM controller which is able to sweep the switching frequency down to 1.5KHz to reduce the power consumption significantly during standby mode. An on-chip MOSFET driver will help to simplify the interface circuit to the MOSFET, together with pulse by pulse MOSFET current limit and other protection features, BCT8320 is very suitable solutions to general purpose, flyback operation in the low to medium power supplies.

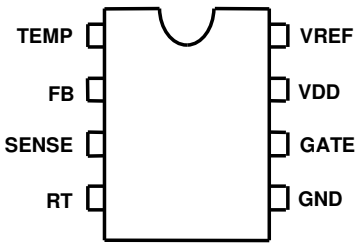
Features

- Current mode PWM controller with enhanced green mode feature
- Low green mode frequency = 1.5KHz
- Low start up and operation current
- On-chip MOSFET driver
- Pulse by pulse MOSFET current limit protection
- Programmable trip point on thermal protection
- Latched VDD over voltage protection
- Wide operation temperature: -40^{0}C to 120^{0}C
- Available in Pb-free SO8

Applications

- Battery chargers, power adapters
- Home appliances and consumer electronics
- Replace linear transformer

Pin Assignments



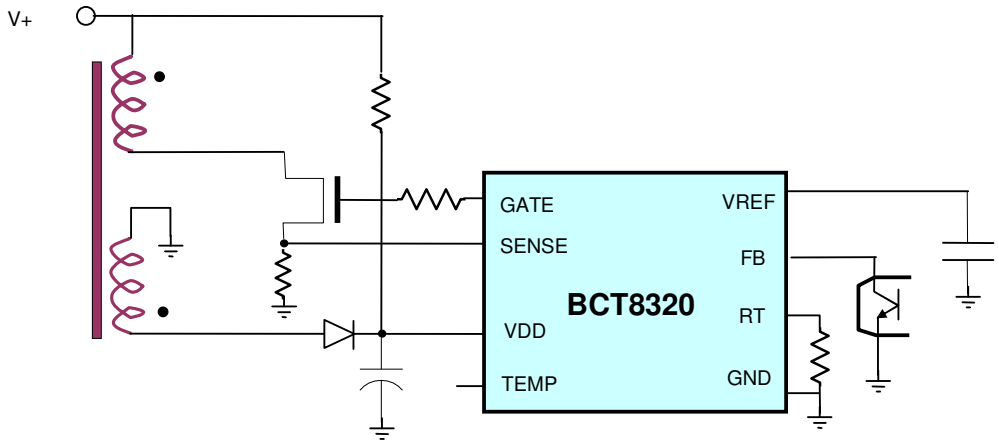
Temperature Option and Ordering Information

Suffix BCT8320-	Junction Temperature T_{OTL} (°C)	Junction Temperature T_{OTM} (°C)	Junction Temperature T_{OTH} (°C)	Tolerance
H	110	115	120	
M	95	100	105	
L	80	85	90	

Table 1: Selection of Junction Temperature

T_{OTL}: Pin TEMP connect to GND,
T_{OTM}: Connect a resistor from TEMP to GND,
T_{OTH}: Pin TEMP open

Typical Application Circuit



Functional Block Diagram

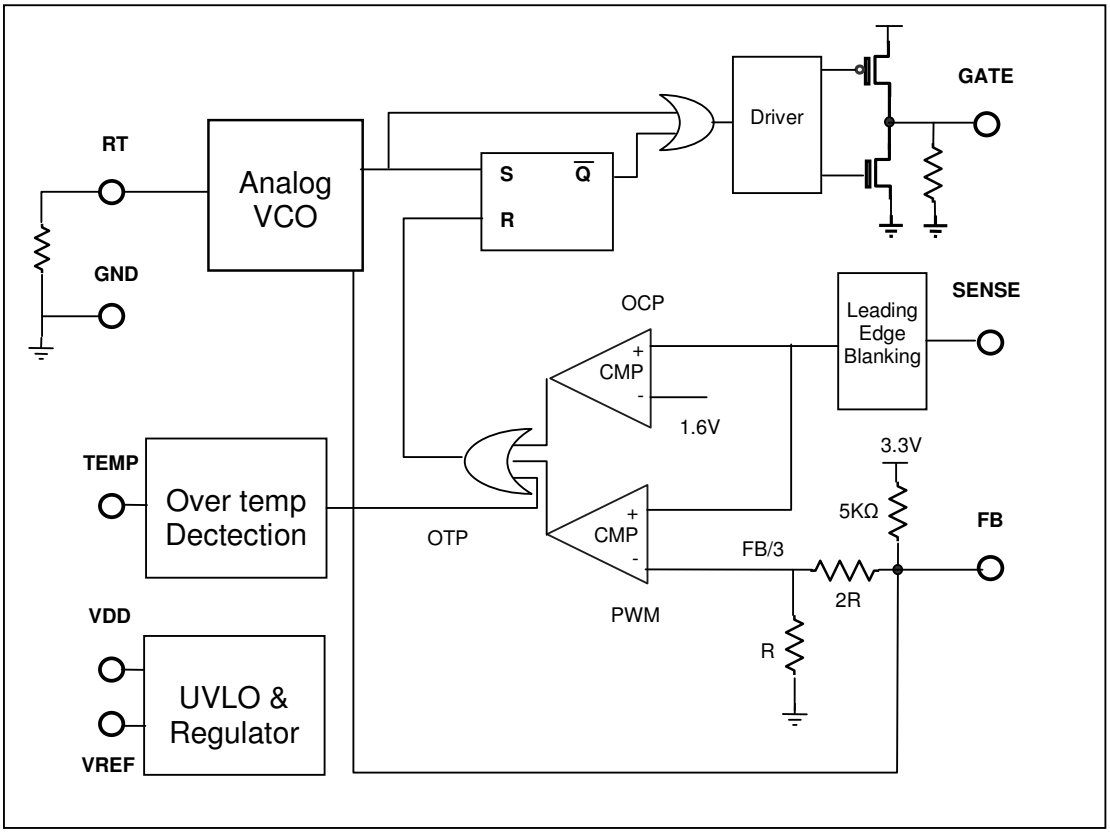


Figure 1. Functional Block Diagram of BCT8320

Pin Descriptions

Pin Number	Pin Name	I/O	Description
1	TEMP	Input	Connect either to GND, external resistor or open to set the trip point on Over Temperature Protection
2	FB	Input/ Output	Voltage feedback pin with internal 5kΩ pull up to 3.3V
3	SENSE	Input	Current sensing input for current mode control
4	RT	Input	One pin oscillator input
5	GND	Power	Ground 0V
6	GATE	Output	Power MOSFET driver output
7	VDD	Power	Input supply voltage
8	VREF	Output	3.3V voltage reference, for stability, connect an filter capacitor >1uF

Absolute Maximum Specifications

Rating	Symbol/ Conditions	Value	Unit
Supply voltage range	VDDmax	-0.3 to 18	Volts
Input voltage range	RT, FB, SENSE, TEMP	-0.3 to 3.6V -0.3 to 3.6V	Volts
Operating temperature range	T_{OPR}	-40 to 120	^{0}C
Storage temperature range	T_{STR}	-40 to 120	^{0}C

A.C. / D.C. Specifications

All specifications are measured at $T_{AMBIENT}$ at 25^{O}C. VDD = 12V unless otherwise specified.

Parameter	Description	Conditions	Min	Typ	Max	Unit
V_{DD}	VDD Voltage		8		16	V
V_{VDD-TH}	VDD Start Threshold Voltage		12.5		15.5	V
V_{UVLO}	Under Voltage Lock Out (UVLO)		8		10.5	V
V_{OVP}	VDD over voltage protection (OVP)		17			V
I_{SU}	Start up Current	VDD < V_{UVLO} ; VDD < V_{VDD-TH} (if VDD ramp from 0V)			100	µA
I_{OP}	Operation Current	F_{SW} = 75KHz		3.5		mA
V_{OTM}	Input logic voltage to select T_{OTM}	Resistor connect from TEMP to GND	1.0	1.5	2.0	Volts
F_{sw}	Switching Frequency	RT=16KΩ	70	75	80	KHz
F_{min}	Min Oscillator Frequency	RT=39KΩ		35		KHz
F_{max}	Max Oscillator Frequency	RT=13KΩ		85		KHz
D_{DC}	PWM maximum duty cycle				75	%
Tr	GATE rise time	C_L = 1nF		50		nS
Tf	GATE fall time	C_L = 1nF		25		nS
T_{LEB}	Lead Edge Blinking	Trigger PWM control		250		nS
		Trigger OCP control		150		nS
PW_{GM}	Green mode pulse width			600		nS
F_{GM}	Min Green mode Switching Frequency	FB = 0.3V F_{SW} = 75KHz	1	1.5	2	KHz

Description

BCT8320 is a Green Mode PWM controller, it is specially designed for switching power supplies which needs very low input power consumption during standby power condition. The BCT8320 can reduce the switching frequency from ~75KHz down to 1.5KHz to minimize the input power.

Over temperature protection posses with programmable trip point is an attractive feature to shunt down the switching operation when the chassis temperature is exceeds. There are total 9 different trip points can be selected by the combination of ordering and connection at TEMP pin.

Startup and Under Voltage Lockout (UVLO)

The low startup current of BCT8320 allows a big startup resistor R_S to use for bootstrapping operation to start itself from the rectified AC line V+ initially. Afterward, most of the power is taken from an auxiliary winding off the main transformer. During startup, the hold up capacitor C_H must be sufficiently large to supply current to the controller to maintain the VDD voltage greater than the lower UVLO threshold.

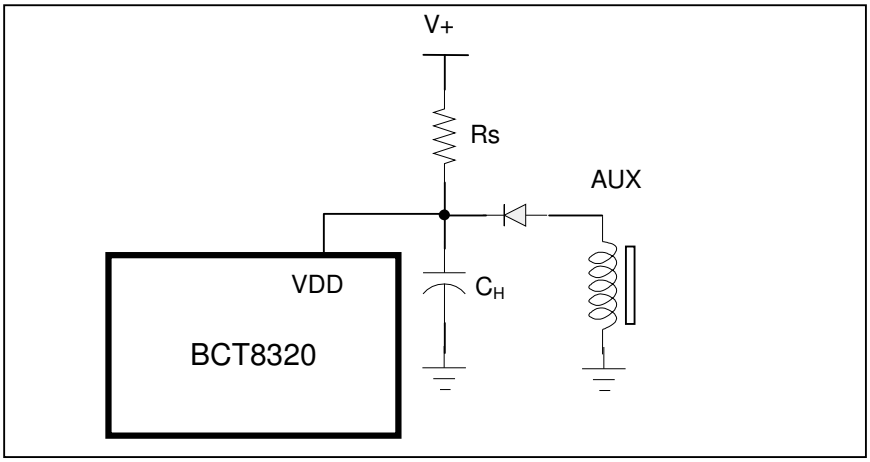


Figure 2. The Startup circuit for BCT8320

Current Mode Control

The standard current mode control is used by BCT8320, for every PWM cycle, the GATE driving output will be terminated when the MOSFET current sensing from SENSE is ramping up to a voltage level reaches one third of the voltage appears at FB, the feedback information on secondary side is collected from FB via opto-coupler.

The switching frequency of BCT8320 can be programmable from 35KHz to 85KHz by selecting a suitable resistor at pin RT, the BCT8320 has fixed maximum duty cycle at 75%.

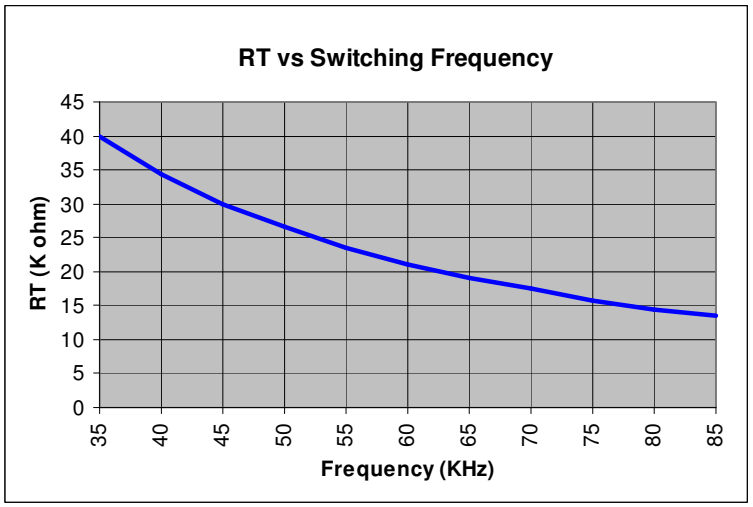


Figure 3. The switching frequency vs RT value

To order to reduce the overall current consumption during standby mode, the BCT8320 can sweep down the switching frequency linearly to a very low level. The switching frequency starts to sweep down when FB reaches 1.3V, switching frequency will meet its minimum frequency at 1.5 kHz when FB drop to 0.3V.

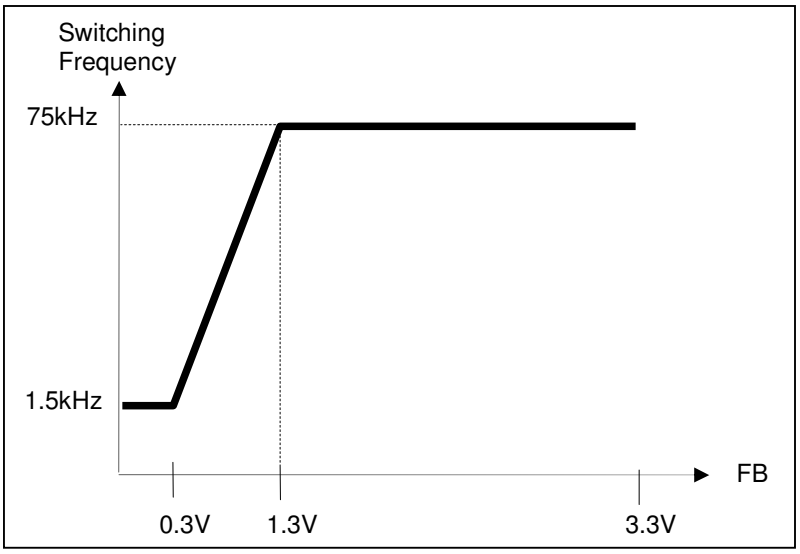


Figure 4. The switching frequency vs FB voltage

The BCT8320 has an on-chip leading Edge Blanking circuit immediately after the SENSE pin to easy the design of RC filtering which is used to avoid the pre-mature turn off the MOSFET.

Over temperature Protection

In some circumstance, it is desirable to continuously monitor the chases temperature of power supply and shut down the operation when over temperature condition is detected to increase the product reliability.

The over temperature protection circuit of BCT8320 is non-latched operation, it will pull down the GATE driving output when junction temperature exceeds a programmed over-temp threshold (T_{OT}), the GATE driving output recovers once junction temperature drop below the threshold point. Over-temp threshold programming is accomplished by setting the logic status at TEMP pin and ordering as shown in Table 1.

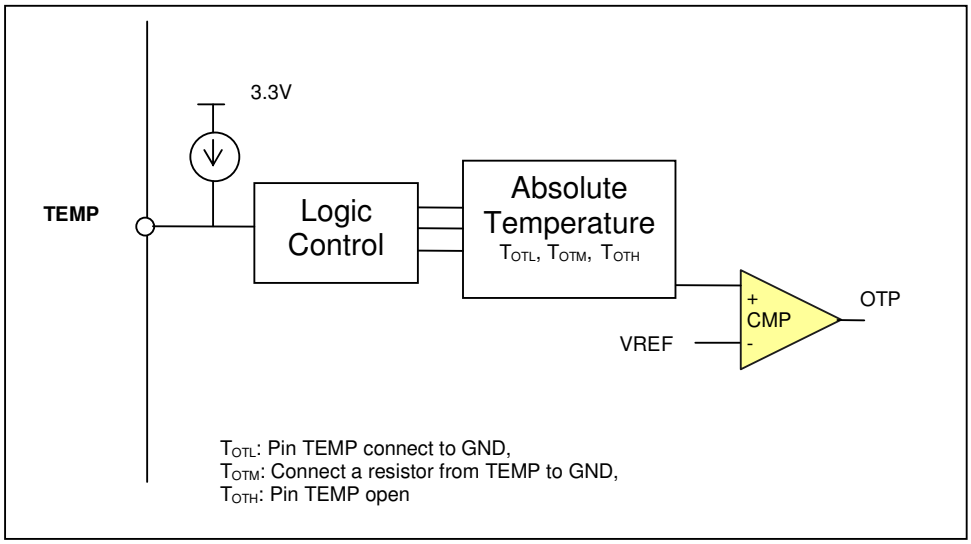


Figure 5. Control logic for TEMP pin

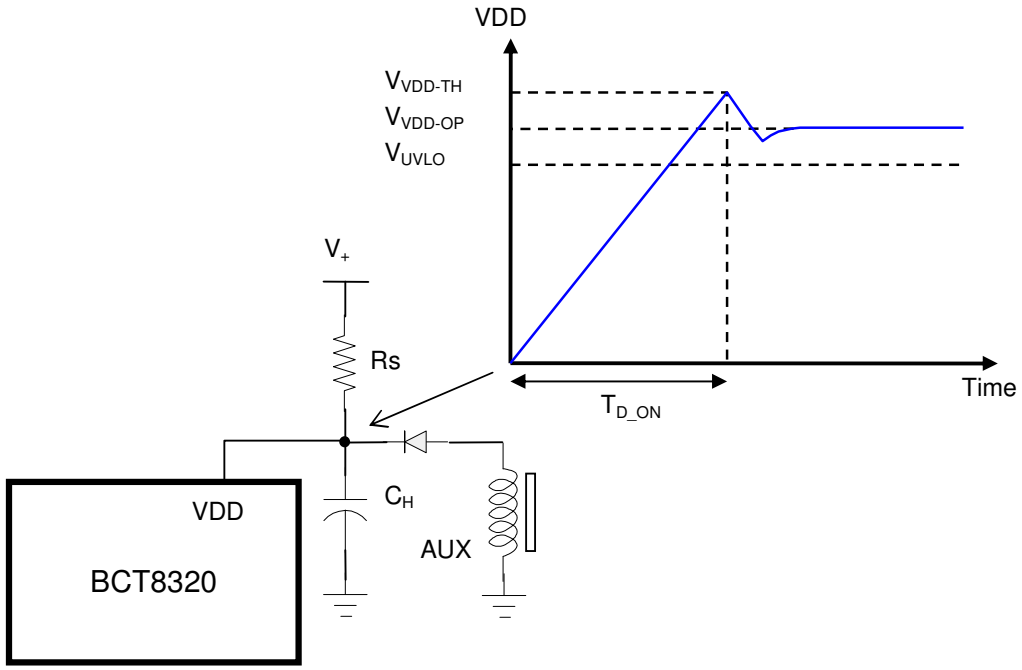
VDD Over Voltage Protection

VDD Over Voltage Protection (OVP) is a latched operation, once VDD goes above V_{OVP}, the internal over voltage detection circuit will be triggered and latched. Normally, it needs the end user to unplug the AC power to reset the VDD OVP.

Application:

1. Startup Circuit

When the switching mode power supply is plugged to the AC main line, the rectified AC line V+ charges the hold up capacitor C_H via a startup resistor R_S. Once the VDD start threshold voltage V_{VDD-TH} is reached, the PWM controller BCT8320 activates herself and turns on the GATE to wake up the entire power supply. Till being taken over by the bootstrapping operation in the steady state, most of the power is fed from an auxiliary winding of the main transformer. During the startup, C_H must be sufficiently large to supply current to the BCT8320 to maintain the VDD voltage greater than the under-voltage lockout UVLO threshold after fully charging all the output capacitors. On the contrast, C_H must be sufficiently small to realize a quick power-on process.



The power-on delay time is determined as follows,

$$T_{D\_ON} = -R_s C_H \left[\ln\left(1 - \frac{V_{VDD-TH}}{V_+ - I_{SU} R_s}\right) + \ln\left(1 + \frac{V_{VDD-TH} - V_{VDD-OP}}{V_+ - I_{OP} R_S - V_{VDD-TH}}\right) \right]$$

where

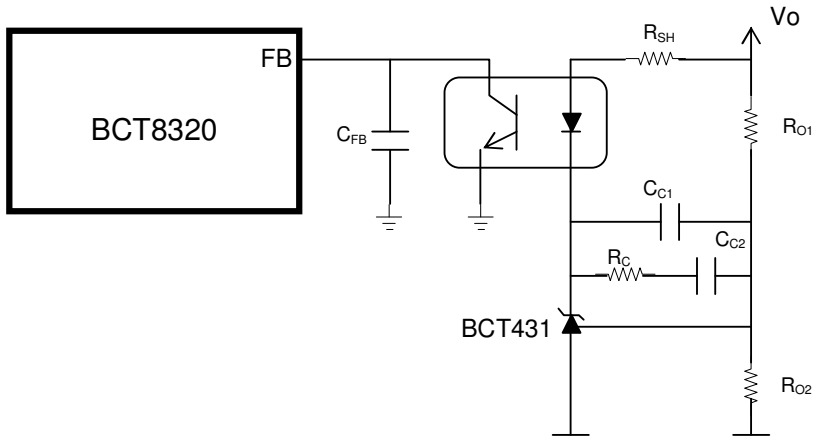
I_{SU} is the startup current;
I_{OP} is the operation current;
V_{VDD-TH} is the maximum VDD start threshold voltage;
V_{VDD-OP} is the VDD operation voltage;

T_{D_ON} is the power-on delay time of the power supply.

The low startup current of BCT8320 allows a large R_S such as 680kΩ to be used. The power dissipation on R_S is less than 0.13W at 220Vac input.

2. Feedback Control and Compensation

The FB pin is designed for the feedback control associated with the shunt regulator BCT431 on the output; it is also used to govern the green mode function. Below figure is a typical feedback circuit mainly consisting of a shunt regulator and an opto-coupler.



R_{O1} and R_{O2} form a voltage divider for the output voltage regulation. C_{C1} and R_C, $C_{C2}$are employed as the control-loop compensation elements. A small-value noise filtering capacitor (e.g. C_{FB}=1nF) placed from the FB pin to GND can increase the system stability. The maximum source current from the FB pin is (3.3V-0.3V)/5kΩ=0.6mA. The phototransistor must be capable of sinking this current to pull the FB level down at no load. Thus, the value of the biasing resistor R_{SH} is calculated as follows,

$$\frac{V_O - V_D - V_Z}{R_{SH}} K \le 0.6mA$$

Where

V_D is the voltage drop of a photodiode, about 1.2V;
V_Z is the minimum operating voltage of a shunt regulator. Typical value is 2.5V;
K is the current transfer ratio (CTR) of an optocoupler.
For an output voltage V_O=12V, with CTR=100%, the minimum value of R_B is 13.8KΩ

3. Leading Edge Blanking (LEB)

When the primary MOSFET is switching on at every cycle, a leading edge current spike is appeared at the SENSE pin due to those inevitable primary-side capacitances and leakage inductances. This spike can cause the GATE drive to switch off unintentionally. So BCT8320 has an on-chip LEB circuit immediately after the SENSE pin to ease the design of RC filtering (e.g. 100Ω + 470pF) which is used to avoid the pre-mature termination or a false-triggering of the MOSFET for both proper PWM controls.

On occasion, over current appears on the sensing resistor when a secondary side diode short or a transformer pin short occurs. As shown in Figure 1, the voltage at SENSE pin always compares with an abnormal high voltage level at 1.6V by an OCP comparator. Once this OCP comparator is trigger which is fast and provision of shorter LEB, a fast turn-off operation to MOSFET can be achieved. This fast pulse-by-pulse OCP operation can help to release the excessive stress to the MOSFET and transformer.

4. Over Temperature Protection

The over temperature protection circuit of BCT8320 is a non-latched operation. In other words, the GATE driving output is pulled down when the junction temperature exceeds a programmed over temperature threshold (T_{OT}). On the other hand, the GATE driving output recovers automatically once the junction temperature drops below the threshold point with a small hysteresis. In real application, the BCT8320 should located closer to the hottest element to protect the power supply.

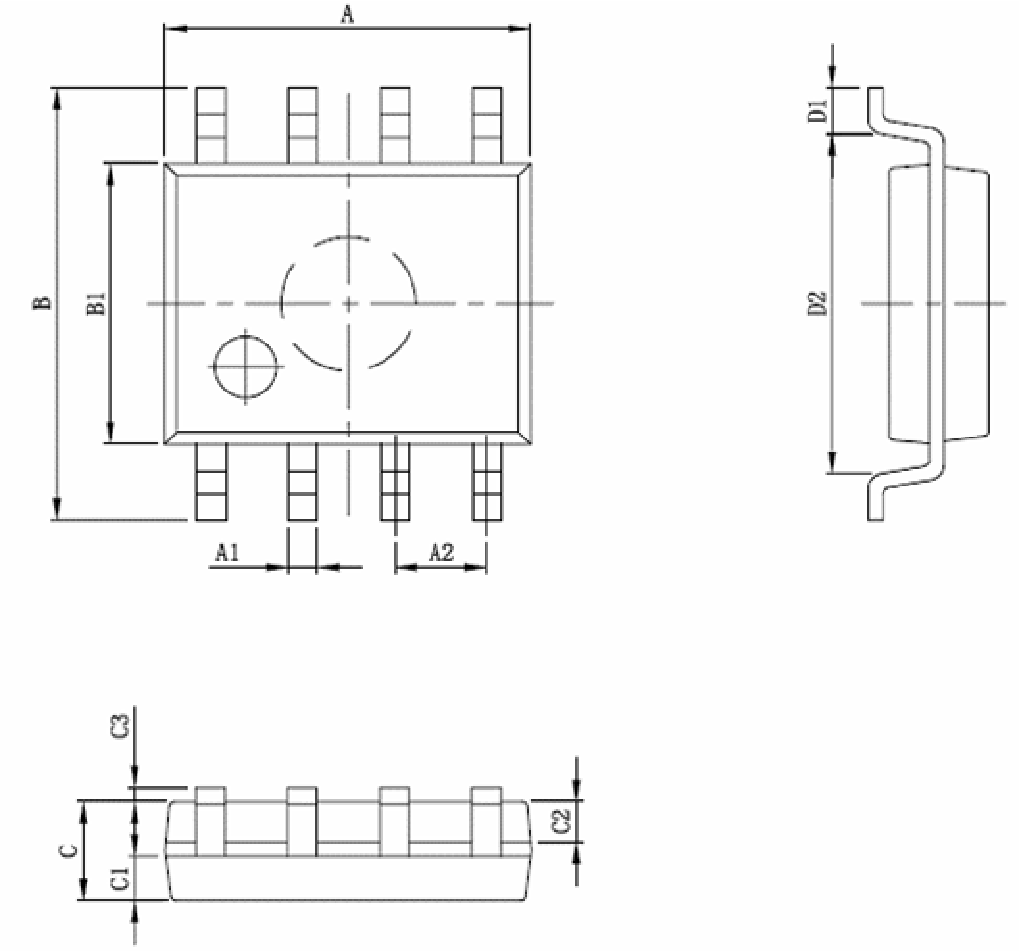
However, the overall temperature hysteresis of power supply is determined by the following factors:
1. The thermal resistance of the hottest elements to BCT8320;
2. The total heat capacity of the elements they are closer to BCT8320 (possible elements: heat sink, transformer, ….);
3. The thermal resistance of the power supply to ambient

5. Care on the negative spikes and PCB layout

It is the duty of circuit design engineer to avoid the presence of any negative spikes appears on any sensitive pins. Negative signals can cause malfunction and erratic behaviors to the controller.

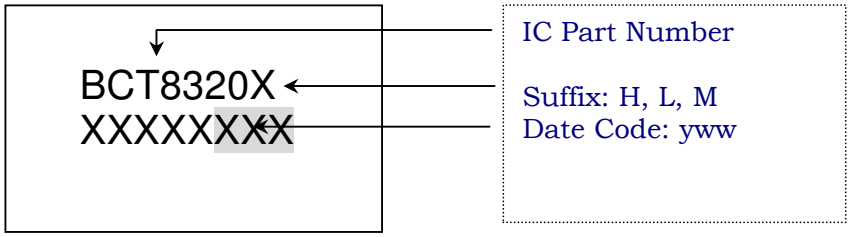
It is advised to use common point grounding techniques and separate the power ground traces from the signal ground traces. Locate the controller and circuit away from the power MOSFET and magnetic. Shorten the small signal wires to avoid coupling. VDD and VREF accompanied with own decoupling capacitors to provide a low impedance path.

Package Information: SOP8



SYMBOL	MIN (Millimeter)	MAX (Millimeter)
A	5.05	
A1	0.37	0.47
A2	1.27	
B	5.80	6.20
B1	3.85	3.95
C	1.35	1.45
C1	0.575	0.625
C2	0.575	0.625
C3	0.00	0.20
D1	0.40	0.60
D2	4.85	

Marking Notation



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