Features

- Primary-Side Voltage Regulation without Secondary-Side Feedback Circuitry
- Power Factor Higher than 0.9
- Constant Voltage Regulation Less than ±5%
- Full Protection Functions for Enhanced Safety
  - Output Over Voltage Protection
  - Output Over Load Protection
  - VCC Over Voltage Protection
  - VCC Under Voltage Lockout
  - External/Internal Over Temperature Protection
- Package Type: 8-pin SOP

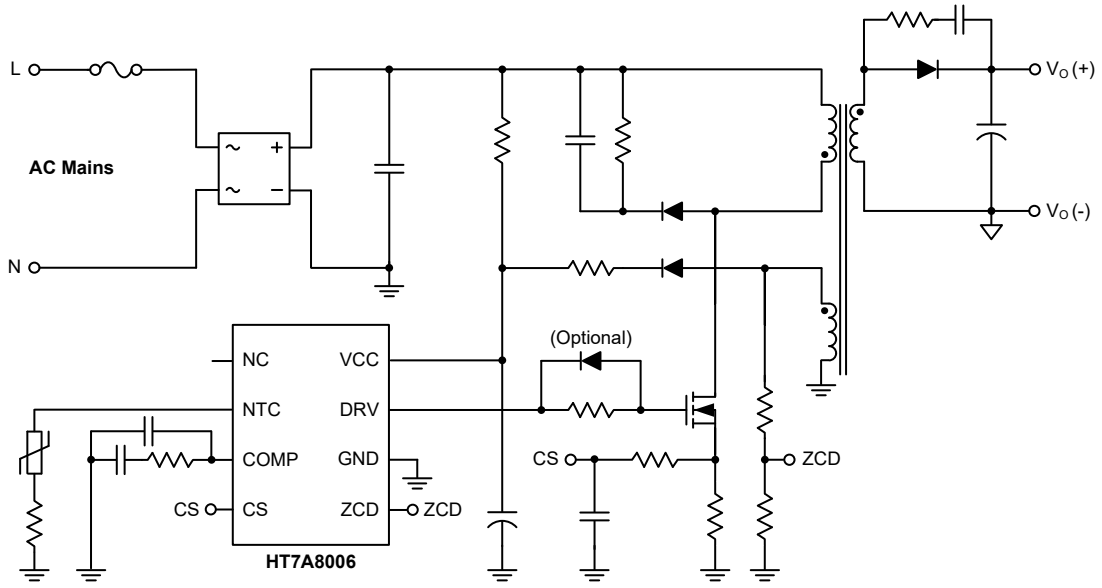
Applications

- BLDC Fan Power Supply
- LED Lighting Applications

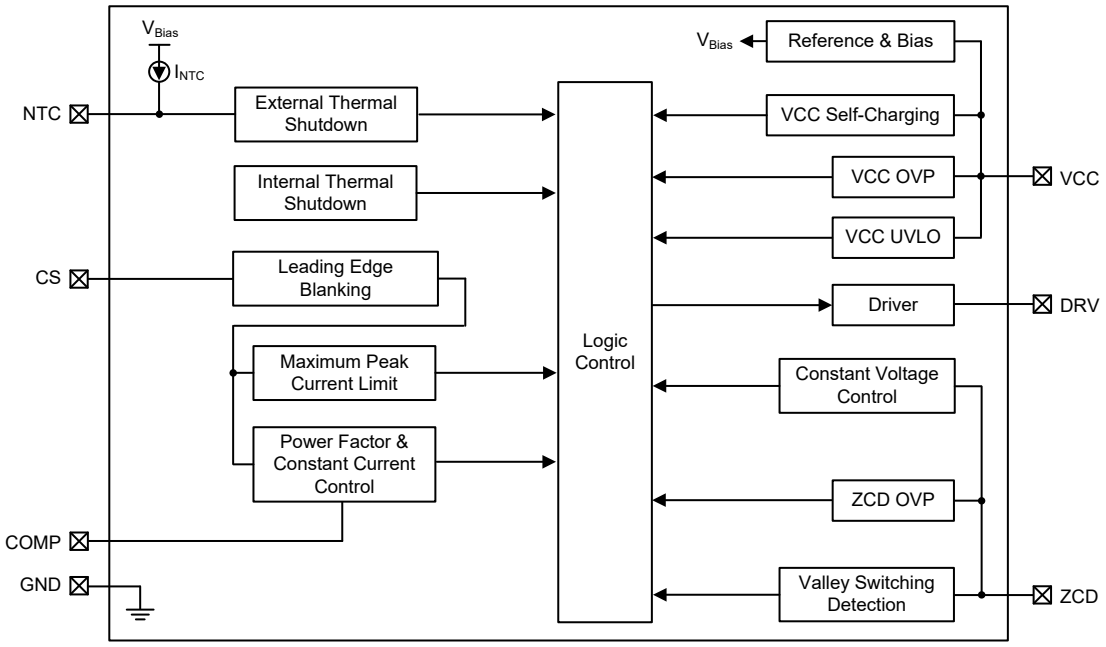
General Description

The HT7A8006 is a controller for implementing constant voltage LED driver with power factor correction (PFC). By using primary-side regulation, it controls the output voltage accurately without the need of secondary side feedback components. The HT7A8006 operates in the quasi-resonant mode to achieve higher efficiency. The HT7A8006 integrates robust protection functions, including output over voltage protection, over load protection (OLP), VCC over voltage protection, VCC under voltage lockout and over temperature protection (OTP).

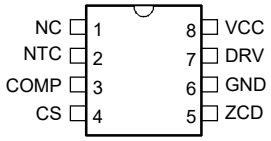
Typical Application Circuit



Block Diagram



Pin Assignment



HT7A8006
8 SOP-A

Pin Description

Pin No.	Pin Name	Type	Description
1	NC	—	No connection
2	NTC	I	Connect an NTC resistor to this pin for programmable thermal protection
3	COMP	I	Loop compensation pin. A capacitor should be placed between COMP and GND
4	CS	I	Current sense pin. A resistor is connected to sense the MOSFET's current
5	ZCD	I	Connected to a resistor divider from the auxiliary winding to sense the valley and the output voltage
6	GND	G	Ground pin
7	DRV	O	Gate drive output for driving the external power MOSFET
8	VCC	P	Power supply input

Legend: I: Input, O: Output, P: Power, G: Ground.

Absolute Maximum Ratings

Parameter		Value	Unit
VCC Supply Voltage, VCC to GND		-0.3 to 48	V
DRV to GND		-0.3 to 20	V
COMP, NTC, ZCD, CS to GND		-0.3 to 6	V
Maximum Junction Temperature		150	°C
Lead Temperature (Soldering 10sec)		260	°C
Storage Temperature Range		-60 to 150	°C
ESD Susceptibility	Human Body Model	±2000	V
	Machine Model	±200	V

Recommended Operating Range

Parameter	Value	Unit
VCC Supply Voltage	10 ~ 40	V
Ambient Temperature	-40 ~ 105	°C

Electrical Characteristics

V_{CC}=15V, Ta=25°C

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Supply Voltage (VCC)						
V_{CC_OVP}	VCC Over Voltage Protection	—	—	44	—	V
V_{CC_ON}	VCC Turn-On Threshold Voltage	—	—	18	—	V
V_{CC_OFF}	VCC Turn-Off Threshold Voltage	—	—	7.5	—	V
V_{CC_ET}	Entry VCC Self-Charging Threshold Voltage	V_{CC} Falling	—	8.5	—	V
V_{CC_EX}	Exit VCC Self-Charging Threshold Voltage	V_{CC} Rising	—	9	—	V
I_{CC_ST}	Start-up Current	V_{CC}=V_{CC_ON}-1V	—	10	—	μA
I_{CC_QU}	Quiescent Current	ZCD Pin and DRV Pin Open Circuit	—	1.2	—	mA
Current Sense (CS)						
V_{CS_MAX}	Maximum Current Sense Limit Voltage for Over Load Protection	—	—	1.55	—	V
V_{CS_MIN}	Minimum Current Sense Limit Voltage for Output Under Voltage Protection	$V_{ZCD} \le V_{ZCD\_UVP}$	—	0.4	—	V
t_{LEB}	Leading Edge Blanking Time	—	—	400	—	ns
t_{D_OCP}	Over Current Protection Debounce Time	$V_{COMP} \ge 4.8V$	—	100	—	ms
Zero Current and Output Voltage Detector (ZCD)						
V_{ZCD_OVP}	ZCD Pin Over Voltage Protection Threshold Voltage	—	—	3.6	—	V
V_{ZCD_CV}	Constant Voltage Threshold Voltage	—	—	2.5	—	V
V_{ZCD_UVP}	ZCD Pin Under Voltage Protection Threshold Voltage	—	—	0.6	—	V
t_{D_ZCDUVP}	ZCD Pin Under Voltage Protection Debounce Time	—	—	16	—	ms

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
t_{BK_ZCD}	ZCD Pin Blanking Time	V_{CS_PK}≥150mV	—	1.12	—	μs
		V_{CS_PK}<150mV	—	0.77	—	μs
Timing Control						
t_{OFF_MIN}	Minimum Off Time	—	—	2.2	—	μs
t_{OFF_MAX}	Maximum Off Time	—	—	150	—	μs
t_{OFF_GM}	Fixed Off Time for Green Mode	—	—	40	—	μs
t_{OFF_ST}	Start Timer Period	—	—	150	—	μs
t_{ON_MAX}	Maximum On Time	—	—	22	—	μs
Gate Driver (DRV)						
I_{DRV_SOURCE}	DRV Pin Source Current	—	—	400	—	mA
I_{DRV_SINK}	DRV Pin Sink Current	—	—	500	—	mA
V_{DRV_CLAMP}	DRV Pin Clamp Voltage	—	—	12	—	V
External Over Temperature Protection						
V_{NTC_OP}	NTC Pin Open Voltage	—	—	3.7	—	V
I_{NTC}	NTC Pin Current Source	—	—	85	—	μA
V_{NTC_SD}	External Thermal Shutdown Voltage	—	—	0.5	—	V
V_{NTC_RESET}	External Thermal Shutdown Reset Voltage	—	—	1.0	—	V
t_{D_NTCSD}	NTC Pin Thermal Shutdown Debounce Time	—	—	16	—	ms
Internal Over Temperature Protection						
T_{OTP_SD}	Internal Thermal Shutdown Protection	—	—	150	—	°C
T_{OTP_SDHYS}	Internal Thermal Shutdown Protection Hysteresis	—	—	25	—	°C

Functional Description

The HT7A8006 is a constant voltage driver designed for isolated LED lighting applications. The controller can achieve high power factor values and low total harmonic distortion (THD) values without additional circuits.

Constant Voltage Control

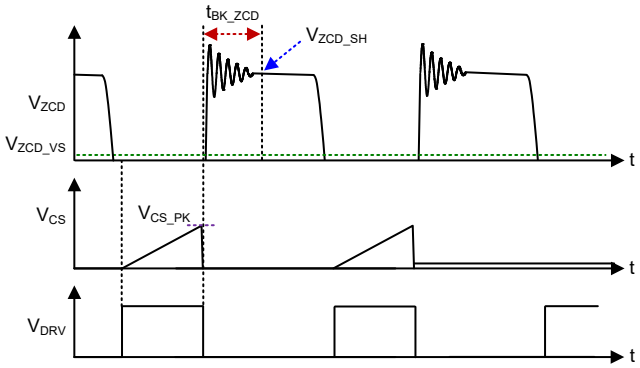
The HT7A8006 regulates the output voltage by sensing the ZCD voltage (V_{ZCD_SH}). The Figure below "ZCD Pin Voltage Sampling Method" shows the ZCD pin samples the V_{ZCD_SH} after the blanking time (t_{BK_ZCD}) when the MOSFET is turned off. The t_{BK_ZCD} is adjusted by the peak current voltage of CS pin (V_{CS_PK}), and the output voltage can be adjusted by R_{ZCD1} and R_{ZCD2} as shown in the Figure below "ZCD Pin Voltage Divider Resistor Schematic". The upper resistor (R_{ZCD1}) of voltage divider is determined by the following equation:

$$R_{ZCD1} = 335 \times \frac{N_A}{N_P} \times 10^3 \quad \Omega$$

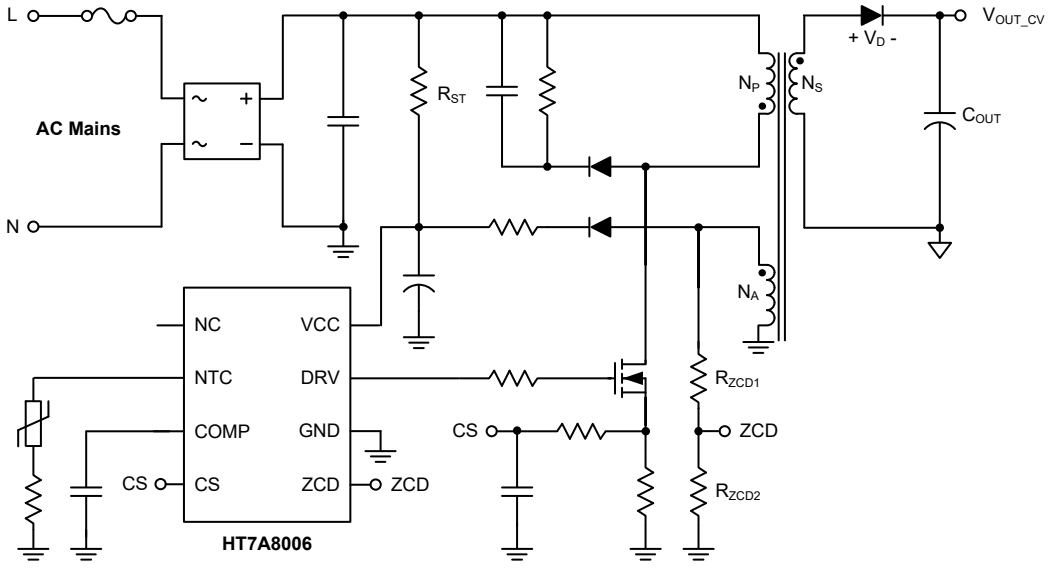
Where N_P and N_A are the turns of the primary winding and auxiliary winding respectively. Therefore, the output constant voltage (V_{OUT_CV}) can be designed by the following equation:

$$V_{OUT\_CV} = V_{ZCD\_CV} \times (1 + \frac{R_{ZCD1}}{R_{ZCD2}}) \times \frac{N_S}{N_A} - V_D$$

where V_{ZCD_CV} is the turns of the constant voltage threshold voltage, N_S is the secondary winding and V_D is the forward voltage of the secondary side rectifier diode.



ZCD Pin Voltage Sampling Method



ZCD Pin Voltage Divider Resistor Schematic

Boundary Conduction Mode (BCM)

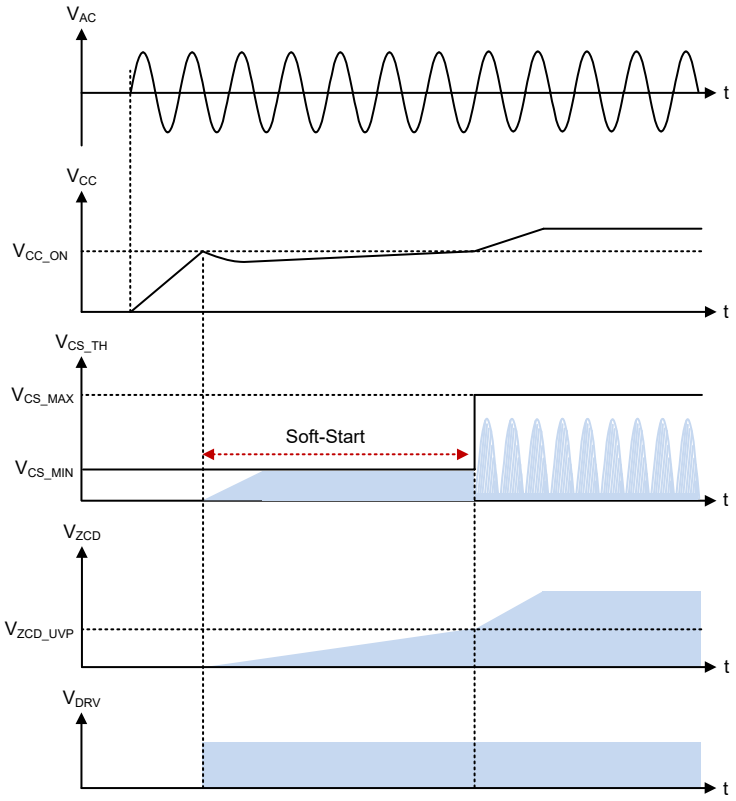
The power MOSFET is turned on by inductor current zero-crossing detection. When the inductor current is falling to the zero-crossing point, the voltage on the ZCD pin will detect the zero voltage and turn on the MOSFET. The BCM control provides low turn-on switching losses and high conversion efficiency.

VCC Self-charging Mode

When VCC pin voltage reaches the self-charging threshold voltage (V_{CC_ET}), the HT7A8006 will enter VCC self-charging mode to charge VCC to avoid triggering VCC UVLO during start-up or light load. It is highly recommended to design the VCC operating voltage higher than V_{CC_ET} to avoid the output voltage out of regulation.

Soft-Start

When the VCC pin reaches the turn-on threshold voltage (V_{CC_ON}) after power-on, the MOSFET will be turned on and the CS pin will be set to the minimum current sense threshold voltage (V_{CS_MIN}) to limit the power so as to reduce the voltage spike on the MOSFET. In the soft-start period, the on-time of DRV is determined by V_{CS_MIN} and the maximum off-time of quasi-resonant operation is limited by t_{OFF_MAX}. When the V_{ZCD} is higher than V_{ZCD_UVP}, the controller will set the maximum current sense threshold voltage (V_{CS_MAX}) and operate in normal operation, as shown in the following figure.

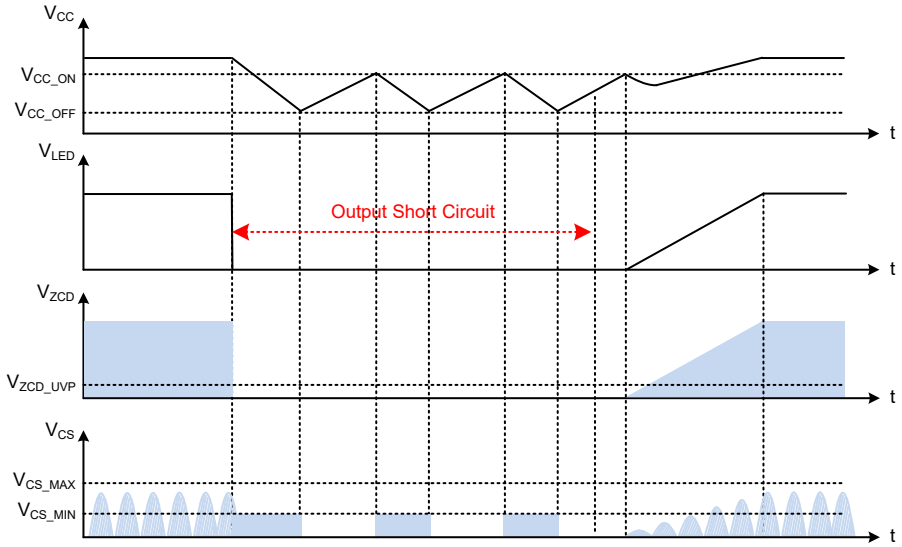


Over Current Protection (OCP)

The HT7A8006 includes an over current protection function on the CS pin. An internal circuit detects the current level and when the current is larger than the over current protection threshold level (V_{CS_MAX}), the MOSFET will be turned off.

Output Short Circuit Protection (SCP)

The HT7A8006 determines whether the output is short-circuited by detecting V_{ZCD}. When the output is short-circuited and the V_{ZCD} is lower than V_{ZCD_UVP}, the controller will set the current sense limit voltage to V_{CS_MIN} to limit a lower output power to protect the power components, as shown in the following figure.



VCC Over Voltage Protection (VCC OVP)

In order to prevent PWM controller damage, the HT7A8006 integrates a VCC OVP function. When the VCC voltage is higher than the OVP threshold voltage (V_{CC_OVP}), the PWM controller will stop operating immediately. If the VCC voltage decreases below the UVLO threshold voltage (V_{CC_OFF}), the controller will reset.

VCC Under Voltage Lockout (VCC UVLO)

The HT7A8006 has an integrated UVLO function which includes a hysteresis of 10.5V (Typ.). The PWM controller will switch on when the VCC voltage exceeds V_{CC_ON}. It will switch off when the VCC voltage is less than V_{CC_OFF}. The wide hysteresis characteristics will ensure that the device can be powered by an input capacitor during start-up. When the output voltage increases to a certain value after start-up, the VCC will be charged through auxiliary winding.

External and Internal Over Temperature Protection

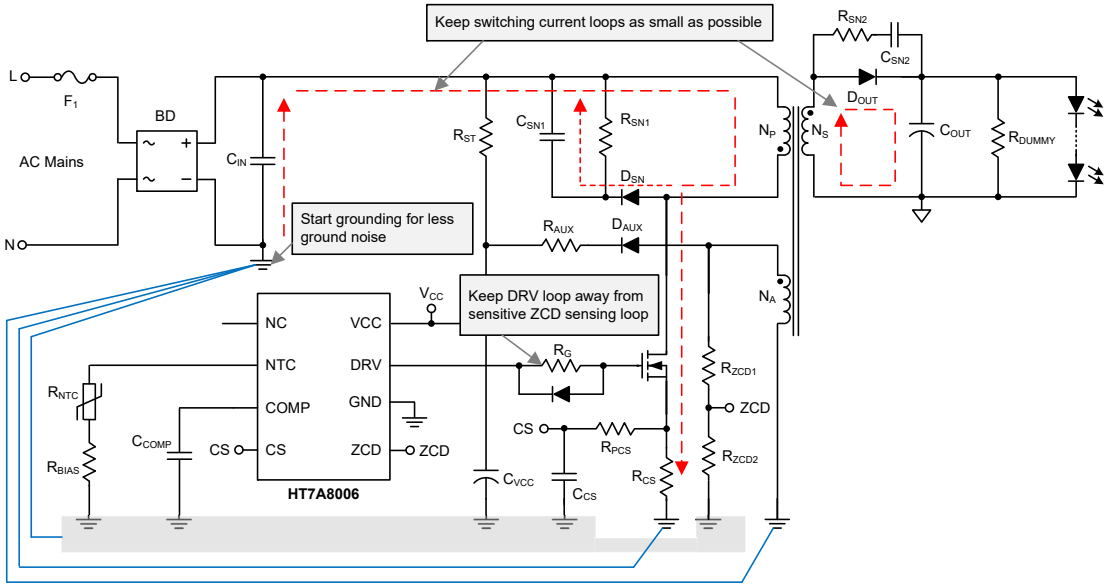
The HT7A8006 provides a programmable external over temperature protection (Ex-OTP) to protect the device from excessive heat damage. Ex-OTP is detected by connecting an NTC resistor between NTC pin and ground. When the NTC pin voltage is lower than the thermal shutdown threshold voltage (V_{NTC_SD}) for a time period of t_{D_NTCSD}, the system will stop operating, and then the controller will enter the auto-recovery mode until V_{NTC} is higher than the reset voltage (V_{NTC_RESET}), the protection will be released. It is highly reminded that the NTC resistor can only be used to detect primary side components for safety requirements.

The HT7A8006 also has an internal over temperature protection (In-OTP). When the junction temperature exceeds T_{OTP_SD}, the controller will immediately turn off the DRV terminal. When the VCC voltage decreases below the V_{CC_OFF}, the controller will reset.

Layout Guide

When designing the switching power supply, good layout can improve the system performance and reliability. The following layout practices are recommended.

- Keep the switching current loops as small and straight as possible to decrease noise coupling.
- RCD snubber loop is a high frequency switching loop. Keep it as small as possible.
- The DRV pin trace is also a high frequency loop. Keep it away from the sensitive ZCD feedback loop.
- The resistor divider connected to ZCD is recommended to be placed beside the IC.
- Separate signal ground and power ground. Connect grounds close to C_{IN}.



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.

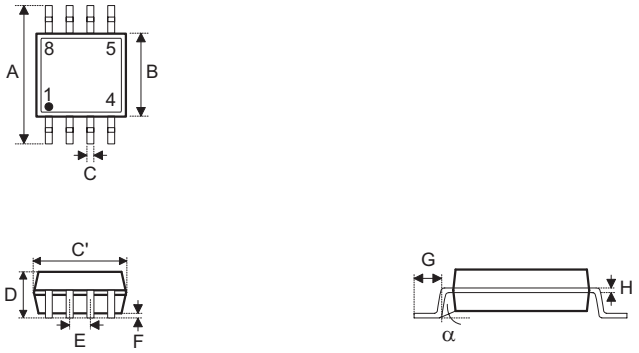
Additional supplementary information with regard to packaging is listed below. Click on the relevant section to be transferred to the relevant website page.

• Package Information (include Outline Dimensions, Product Tape and Reel Specifications)

• Packing Meterials Information

• Carton information

8-pin SOP (150mil) Outline Dimensions



Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A		0.236 BSC	
B		0.154 BSC	
C	0.012	—	0.020
C′		0.193 BSC	
D	—	—	0.069
E		0.050 BSC	
F	0.004	—	0.010
G	0.016	—	0.050
H	0.004	—	0.010
α	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A		6.00 BSC	
B		3.90 BSC	
C	0.31	—	0.51
C′		4.90 BSC	
D	—	—	1.75
E		1.27 BSC	
F	0.10	—	0.25
G	0.40	—	1.27
H	0.10	—	0.25
α	0°	—	8°