

Spread Spectrum Technology, Built-in MOS, 10A High Efficiency Boost DC-DC Converter

General Description

CS50363E is a boost type switching regulator using CMOS technology, which mainly includes a reference voltage source, an oscillation circuit, an error amplifier, and a phase compensation circuit. The control circuit is switched through PWM/PFM. The design of the CS50363E built-in MOS requires only minimal peripheral circuitry, which can maximize the reliability of the power module and avoid the complexity of the power module design. The CS50363E can provide a constant voltage output of up to 16V; It can ensure stable load operation at a maximum average current of 8A. With a starting voltage as low as 2.5V and a wide operating voltage range of 3-15V, it can be applied to various terminal devices to the maximum extent, and the spread spectrum function can limit the external radiation of switching signals to the maximum extent. The CS50363E offers the package type of ESOP10 with a rated operating temperature range of -40 °C to 85 °C.

Features

- Working Voltage 2.5 ~ 15V
- Adjustable Voltage Output up to 16V
- Soft Start Function
- Up to 93% Efficiency
- Spread Spectrum Technology to Reduce External Radiation of Switching Signals
- Oscillation Frequency: 350KHz
- Accurate Feedback Reference Voltage: 1V (±2%)
- Built-in 17mΩ, 10A, 18V MOSFET
- Turn off current: <36μA
- Over Temperature Protection
- OVP Protection

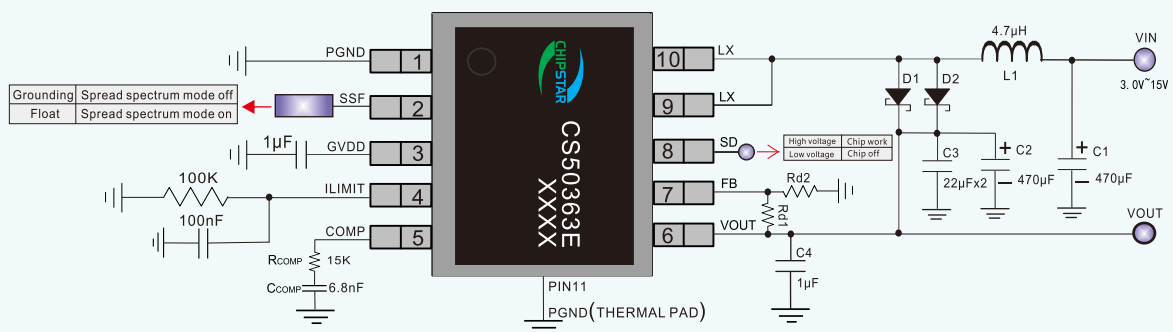
Applications

- Speaker Products
- Electric Tool
- Digital Camera
- Handheld Devices
- Mobile Terminal

Package

- ESOP10L

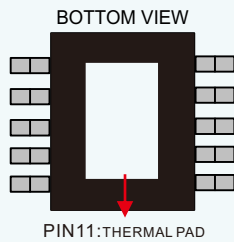
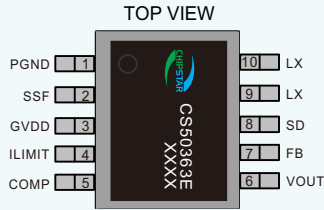
Typical Applications



Notes:

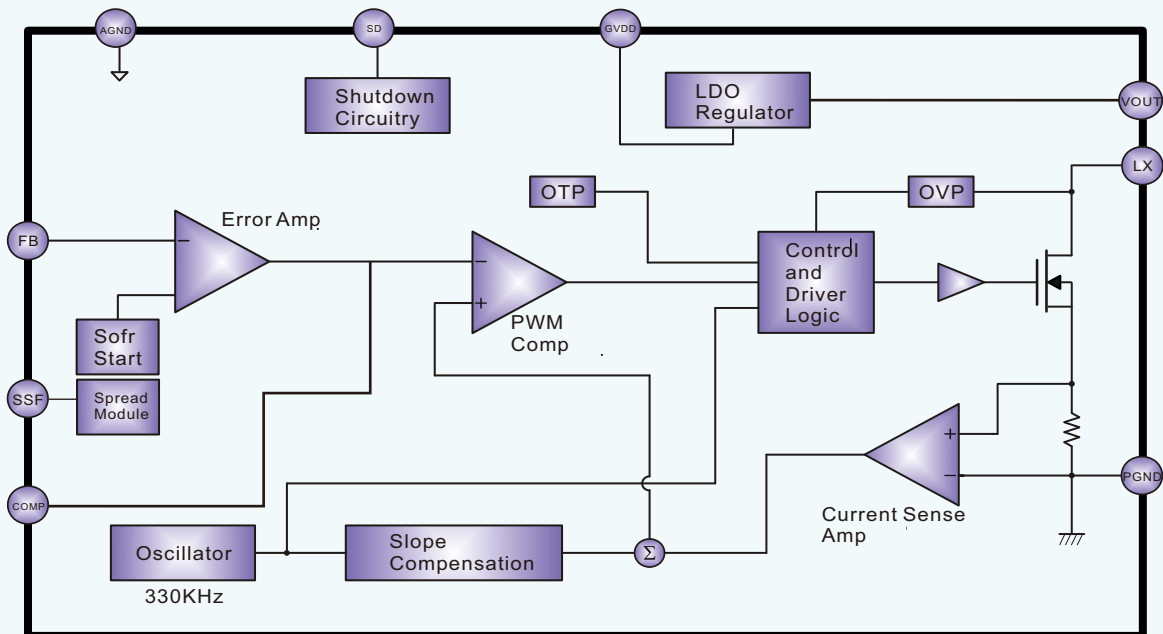
- (1) L1 uses 4.7uH power inductor with saturation current above 12A.
- (2) Schottky diode SS54 is placed at D1 and D2.

PIN Configuration and Functions



| NO. | NAME | I/O | DESCRIPTION |
|-----|-------------|-----|--|
| 1 | PGND | — | Power ground |
| 2 | SSF | I | Spread spectrum function control pin, floated spread spectrum on, grounded spread spectrum off. |
| 3 | GVDD | P | Gate driving voltage of power transistor |
| 4 | ILIM | I | Current limiting pin |
| 5 | COMP | I | External compensation pin |
| 6 | VOUT | O | Power output pin |
| 7 | FB | I | Feedback pin |
| 8 | SD | I | Enable control pin, high level operation, low level chip turn off |
| 9 | LX | I | Switch converter pin, connect external inductor |
| 10 | LX | I | Switch converter pin, connect external inductor |
| 11 | THERMAL PAD | P | It must be connected with PGND, and must be covered with large area of copper to increase heat dissipation performance |

Functional Block Diagram



Absolute Maximum Ratings ¹

| SYMBOL | PARAMETER | VALUE | UNIT |
|------------------|---------------------------------------|---------------------------|------|
| V _{IN} | Power supply without signal input | 18 | V |
| V _I | Input voltage | -0.3~V _{IN} +0.3 | V |
| T _J | Junction operating temperature range | -40~150 | °C |
| T _{STG} | Storage temperature range | -65~150 | °C |
| T _{SDR} | Lead temperature (Soldering, 10 sec.) | 260 | °C |


Recommended Operating Conditions

| SYMBOL | PARAMETER | VALUE | UNIT |
|-----------------|--------------------------------------|---------|------|
| V _{IN} | Input voltage | 2.5~16 | V |
| T _J | Junction operating temperature range | -40~125 | °C |
| T _A | Ambient temperature range | -40~85 | °C |

Thermal Information ²

| SYMBOL | PARAMETER | VALUE | UNIT |
|-----------------|---|-------|------|
| θ _{JA} | Package thermal resistance - chip to environment thermal resistance | 45 | °C/W |
| θ _{JC} | Package thermal resistance - chip to package surface thermal resistance | 10 | °C/W |

Ordering Information

| Product Name | Package Type | Device Marking | Reel Size | Tape Width | Quantity |
|--------------|--------------|---|-----------|------------|----------|
| CS50363E | ESOP10L |  | 13" | 12mm | 4000 |
| | | | Tube | | 100 |

ESD Range

HBM (Human Body Model) ----- ±2KV
 MM (Machine model) ----- ±200V

1. The above parameters are only the limit values of device operation. It is not recommended that the working conditions of the device exceed the limit values. Otherwise, the reliability and life of the device will be affected, and even permanent damage will be caused.

2. Where the PCB board is placed in CS50363E, a heat dissipation design is needed. The heat sink at the bottom of CS50363E is connected with the heat sink area of PCB board.

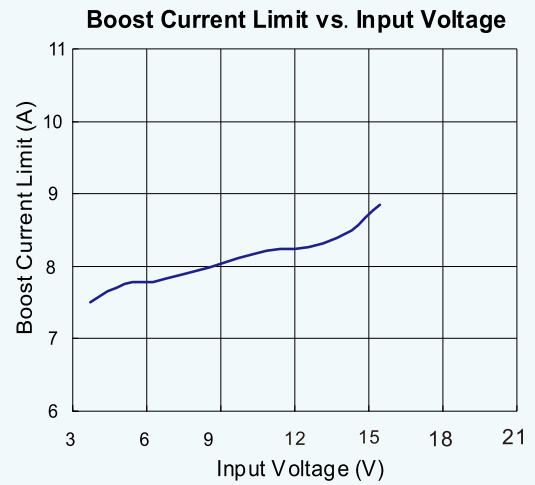
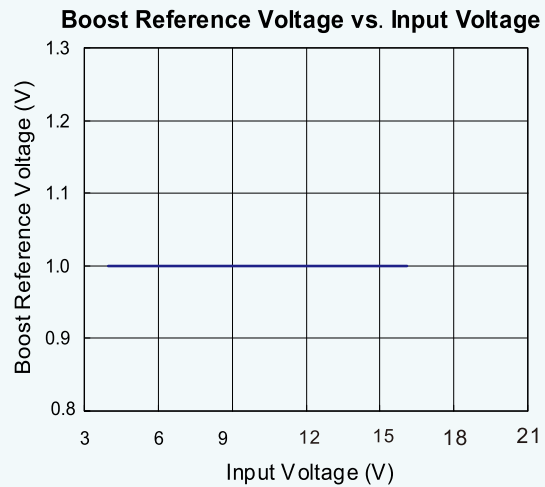
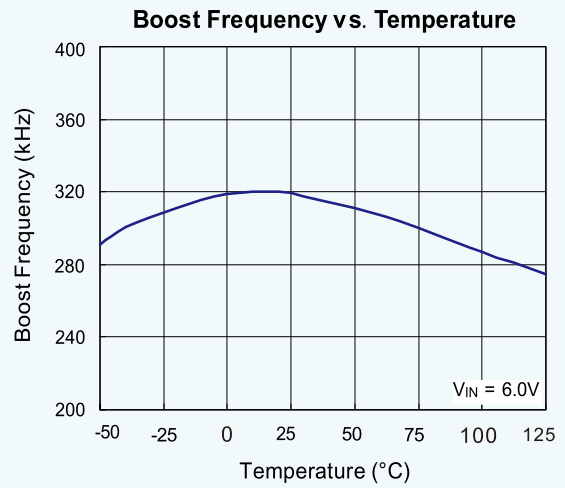
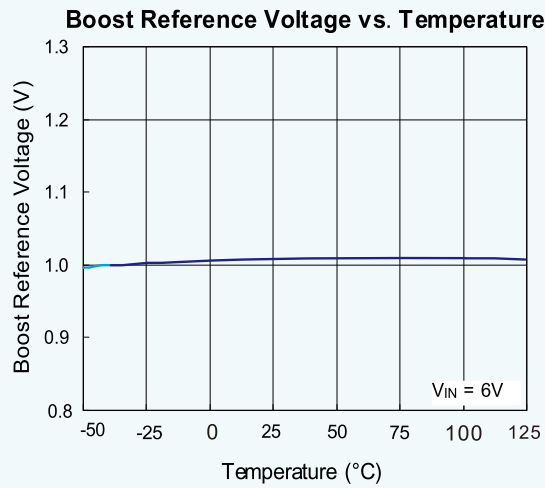
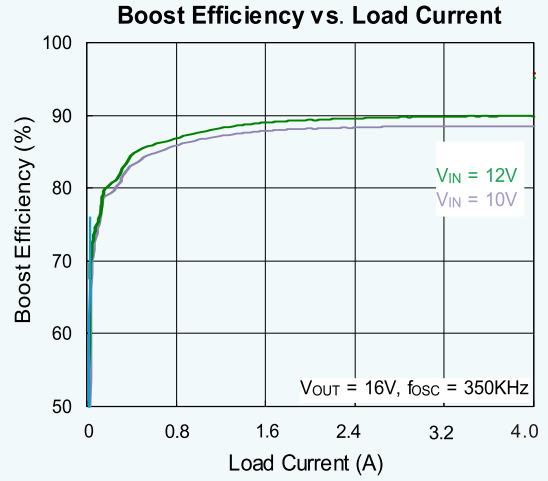
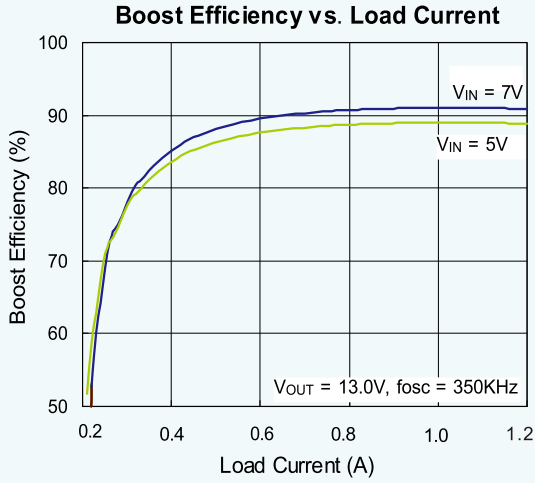
Recommended Operating Conditions

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|-----------------------------|-----------------|---------------------|------|------|------|------|
| Supply Voltage | V _{IN} | | 2.5 | | 15 | V |
| Operating Temperature Range | T _A | Ambient Temperature | -40 | | +85 | °C |

 DC Electrical Characteristics (V_{IN}=3.7V, T_A=25°C, unless otherwise specified)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|-------------------------------|----------------------|-----------------------------------|------|------|------|-------|
| System Supply Input | | | | | | |
| Input Supply Range | V _{IN} | | 2.5 | | 15 | V |
| Under Voltage Lockout | V _{UVLO} | | | 2.4 | | V |
| UVLO Hysteresis | | | | 0.1 | | V |
| Quiescent Current | I _{CC} | V _{FB} =1V, No switching | | 0.2 | | mA |
| Average Supply Current | I _{CC} | V _{FB} =1V, Switching | | 2.5 | | mA |
| Shutdown Supply Current | I _{CC} | V _{EN} =GND | | | 36 | μA |
| Oscillator | | | | | | |
| Operation Frequency | F _{OSC} | | 300 | 350 | 400 | Khz |
| Frequency Change with Voltage | Δf/ΔV | V _{IN} =3V to 12V | | 5 | | % |
| Maximum Duty Cycle | T _{DUTY} | | | 93 | | % |
| Reference Voltage | | | | | | |
| Reference Voltage | V _{REF} | | 0.98 | 1.0 | 1.02 | V |
| Line Regulation | | V _{IN} =3V ~ 12V | | 0.2 | | % / V |
| Enable Control | | | | | | |
| Enable Voltage | V _{EN} | | 1.5 | | | V |
| Shutdown Voltage | V _{EN} | | | | 0.3 | V |
| MOSFET | | | | | | |
| On Resistance of Driver | R _{DS (ON)} | I _{LX} = 4A | | 20 | | mΩ |
| Protection | | | | | | |
| OCP Current | I _{OCP} | | | 10 | | A |
| OTP Temperature | T _{OTP} | | | +150 | | °C |

Typical Characteristics



Application Points

Application information

CS50363E is a current mode PWM controlled boost power converter with built-in 18V/10A MOSFET, which can provide up to 16V output voltage.

Soft Start Function

In order to avoid the surge voltage on the power supply, CS50363E integrates the soft start function in the chip. After the chip is started, the internal soft start function is used to control the output of the error amplifier, which makes the pulse width increase slowly and reduces the input surge current.

Over Temperature Protection Function (OTP)

CS50363E has built-in over temperature shutdown to avoid chip damage caused by over temperature. Under typical conditions, the turn off temperature is set at 150°C, and the chip turns off the power transistor until the chip temperature drops to 120°C.

Over Voltage Protection Function (OVP)

When the divider resistance of FB pin is abnormal, when the PWM signal exceeds the maximum duty cycle, the boost voltage becomes higher and higher. When the output voltage exceeds the threshold voltage of OVP, the output power transistor will be turned off immediately. The threshold voltage of OVP is 18V.

Selection of Power Inductor

In the case of certain input and output voltage, the inductance determines the rise slope and fall slope of the inductor current. Inductor current ripple rate r:

$$r = \frac{\Delta i_L}{I_{L-avg}} = \frac{R_0 * (1-D) * D}{L * f}$$

Where R_0 is the equivalent impedance of output load and f is the switching frequency of CS50363E. The function $r=f(D)$ has a maximum at 1/3. If other conditions remain unchanged, the current ripple rate r is inversely proportional to the inductance L . In order to ensure that the system works in continuous mode, $r < 2$ must be met, and the minimum value of inductance is obtained :

$$L_{min} = \frac{R_0 * (1-D)^2 * D}{2 * f}$$

If the current ripple rate is too small, it will lead to large inductance and inductance volume. Therefore, a minimum ripple rate must be determined to obtain the maximum value L_{max} . On the other hand, a large ripple rate leads to a large RMS value of capacitive current, which affects the efficiency. When using a small ESR capacitor, the current ripple rate can be increased to reduce the inductance volume. In order to avoid the

saturation of the inductor, the rated current of the inductor must be greater than the over-current limit point of the chip. The typical peak current limit of CS50363E is 10A. 4.7uH power inductor with saturation current over 12A is recommended.

Selection of Input and Output Capacitors

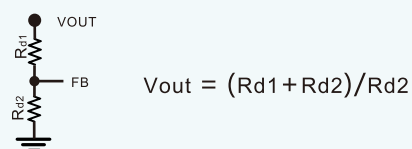
The choice of output capacitor mainly depends on the output voltage ripple. In order to reduce the output current ripple, the capacitor with low ESR must be used, and multiple capacitors can be used in parallel. At the same time, in the application, because the load will exceed the maximum output power of the system in a certain period of time, we must use a larger capacitor to avoid the drop of the output voltage.

Selection of Output Diode

The choice of output diode depends on output voltage and output current. The average current of the diode is equal to the output current of the system, the rated current of the diode used must be greater than the output current, and the loss on the diode is proportional to the forward conduction voltage drop of the diode, so the diode with small forward voltage drop should be selected. In the turn off stage, the reverse voltage of diode is the output voltage, and the diode with reverse withstand voltage greater than the output voltage should be selected. It is recommended to use SS54 or Schottky diode with higher voltage and higher current.

Output Voltage Setting

As shown in the figure below, if the output voltage is set by the divider resistance R_{d1} and R_{d2} connected to the feedback pin and the feedback pin voltage V_{FB} is 1V, the output voltage can be set as follows:



Current Limit and Soft Start Function

Setting a pull-down resistor and capacitor through the ILIMIT pin to ground can limit the peak current of boost inductor and realize the soft start function of power supply. The following table lists the effective values of soft start time and inductance current under different resistance and capacitance conditions for reference.

| Inductance | R_{lim} | Power soft start time | | | Effective value of inductance current |
|------------|-----------|-----------------------|---------|---------|---------------------------------------|
| | | 10nF C | 100nF C | 220nF C | |
| 4.7uH | 100K | 1.8ms | 18ms | 36ms | 8.0A |
| | 82K | 1.7ms | 17ms | 34ms | 6.0A |
| | 75K | 1.6ms | 16ms | 32ms | 3.6A |
| | 68K | 1.6ms | 16ms | 32ms | 2.5A |

Application Points

Spread Spectrum Function

CS50363E sets the spread spectrum mode of the chip through the SSF pin. When the SSF pin is floated, CS50363E enters into a unique spread spectrum modulation mode. In this mode, the spectrum components are expanded in a wide frequency range, which can effectively reduce EMI. The switching frequency changes randomly in the range of $\pm 25\text{KHz}$ near the center frequency of 350KHz . The modulation mode remains unchanged, but the frequency of sawtooth wave changes with the period. In this way, the energy is distributed to the whole frequency band increasing with the frequency, instead of concentrating a large amount of spectrum energy on the frequency doubling of the switching frequency. When the SSF pin is grounded, the CS50363E spread spectrum modulation mode is turned off.

Layout Considerations

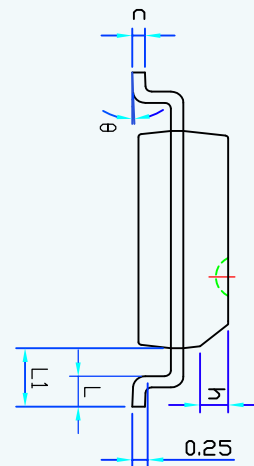
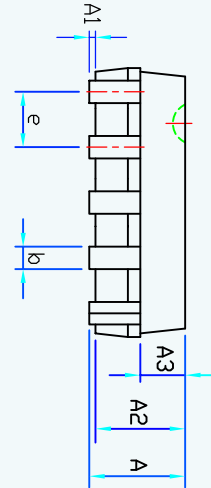
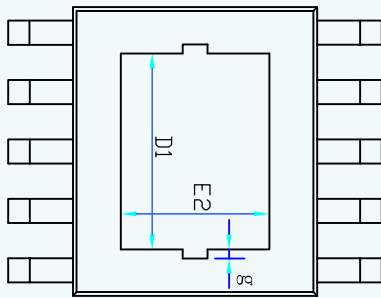
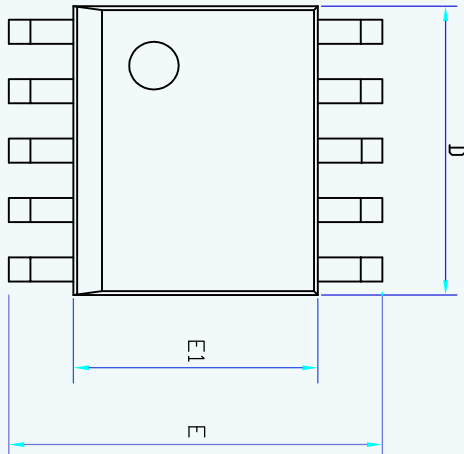
In order to provide the design reliability of the boost system, please pay special attention to the following points when designing the PCB layout of CS50363E:

- All GNDS, including the GND of each capacitor, should be well connected, which can be connected to the nearby large area copper laying, so as to reduce the resistance and inductance of the ground circuit as much as possible. The high current path of the chip is: VIN → inductor → LX → Schottky → output filter capacitor → GND. The current path should be as short and thick as possible.

- The inductor should be as close to the chip as possible to shorten the distance between LX and inductor. LX wiring should be as short and thick as possible, which is conducive to the improvement of performance, efficiency and EMI.
- Schottky and inductors are placed close to each other to shorten the routing distance as much as possible. Copper is laid on the bottom of PCB to increase the heat dissipation area and via pads are placed.
- The output filter capacitance is near Schottky, the capacitance ground is near the bottom of the chip, and the line between the sampling pin and the sampling point is as short as possible.

Package information

CS50363E ESOP10L PACKAGE OUTLINE DIMENSIONS UNITS:MM



| SYMBOL | MILLMETER | | |
|----------|-----------|------|------|
| | MIN | NOM | MAX |
| A | — | — | 1.50 |
| A1 | 0.02 | 0.05 | 0.08 |
| A2 | 1.30 | 1.40 | 1.50 |
| A3 | 0.70 | 0.75 | 0.80 |
| b | 0.35 | — | 0.45 |
| c | 0.20 | — | 0.24 |
| D | 4.80 | 4.90 | 5.00 |
| D1 | 3.10REF | | |
| e | 1.00BSC | | |
| E | 6.05 | 6.15 | 6.25 |
| E1 | 3.82 | 3.92 | 4.02 |
| E2 | 2.20REF | | |
| L | 0.50 | — | 0.70 |
| L1 | 1.15REF | | |
| h | 0.30 | 0.40 | 0.50 |
| θ | 0 | — | 8° |
| g | 0.15REF | | |