Built in MOSFET, 14A High Efficiency Boost DC to DC Converter

Features

- Input Voltage Range: 3.0V to 16V.
- Output Voltage up to 22V
- Programmable Soft-Start
- Up to 93% Efficiency
- Frequency: 350KHz
- Feedback Reference Voltage: 1V (±2%)
- Built in 17m Ω, 14A, 23V MOSFET
- Turn Off Current: <36uA
- Over temperature protection
- Overvoltage protection
- Available in ESOP-16L Packages

Applications

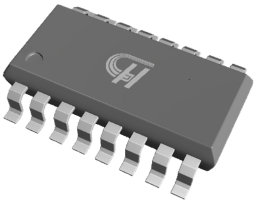
- Portable POS Terminal
- Bluetooth Speaker
- E-Cigarette
- Thunderbolt Interface
- Quick Charge Power Bank

General Description

HCR6638 is a CMOS booster switch regulator, It is mainly composed of a reference power supply, an oscillation circuit, an error amplifier and a phase compensation circuit, which are integrated by PWM and PFM switching control circuit. The design of HCR6638 built-in MOSFET requires only 12 components in the periphery. The simple peripheral circuit can guarantee the reliability of power module and avoid the complexity of power module design.

The HCR6638 can provide a constant voltage output of 22V at most, which can ensure the stabel operation of the load at 10A peak current. The minimum starting voltage is 2.5V and the wide input voltage range is from 3V to 16V, which can be applied to various terminal equipment to the maximum extent.

The HCR6638 is available in Green ESOP-16L package. It operates over an ambient temperature range of -40'C to +85'C.



ESOP-16L

Figure 1. Package Type of HCR6638

Pin Configuration

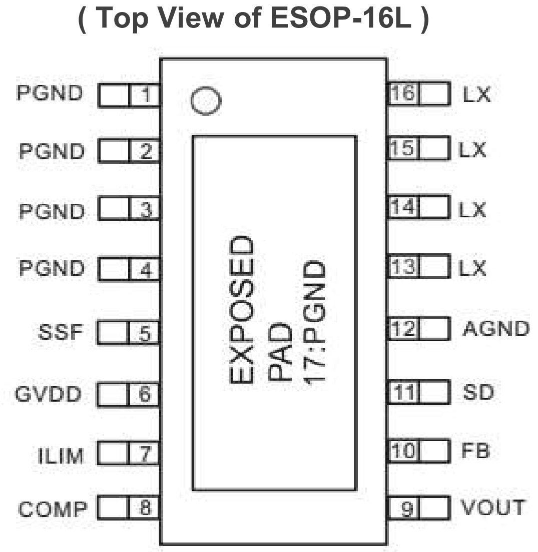


Figure 2. Pin Configuration of HCR6638 (Top View)

Pin Function Table

PIN	NAME	I/O	FUNCTION
1/2/3/4	PGND	-	Power Ground Pin
5	SSF	I	Spread spectrum function control pin, suspension spread spectrum open, ground to spread spectrum turn off
6	GVDD	P	Tope MOSFET Gate Drive Voltage.
7	ILIM	I	Adjustable Switch Peak Current Limit. An external resister should be connected between this pin and AGND pin. 100KΩ as reference.
8	COMP	I	Output of the internal Error Amplifier. The loop compensation network should be connected between this pin and the AGND pin.
9	VOUT	O	Power Output Pin.
10	FB	I	Voltage Feedback. Connect to the center tape of a resistor divider to program the output voltage.
11	SD	I	Enable Logic Input. Logic high level enables the device. Logic low level disables the device and turns it into shutdown mode.
12	AGND	P	Signal Ground of the IC
13/14/15/16	LX	I	Switch switching pins, It is connected to external inductance.
17	Exposed Pad	P	Bottom Heat Sink Pin. It must be connected to PGND in order to Heat Sink

Functional Block Diagram

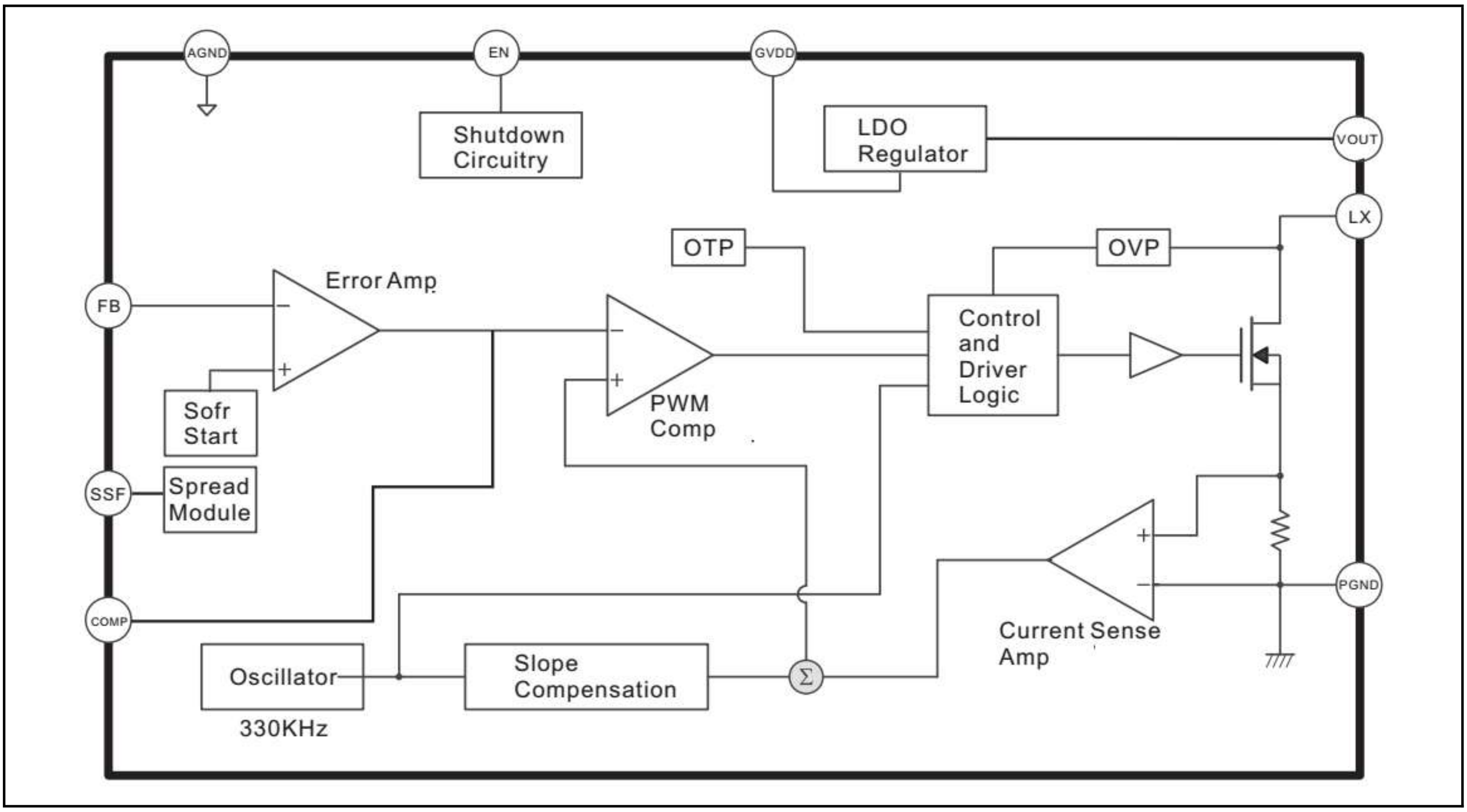
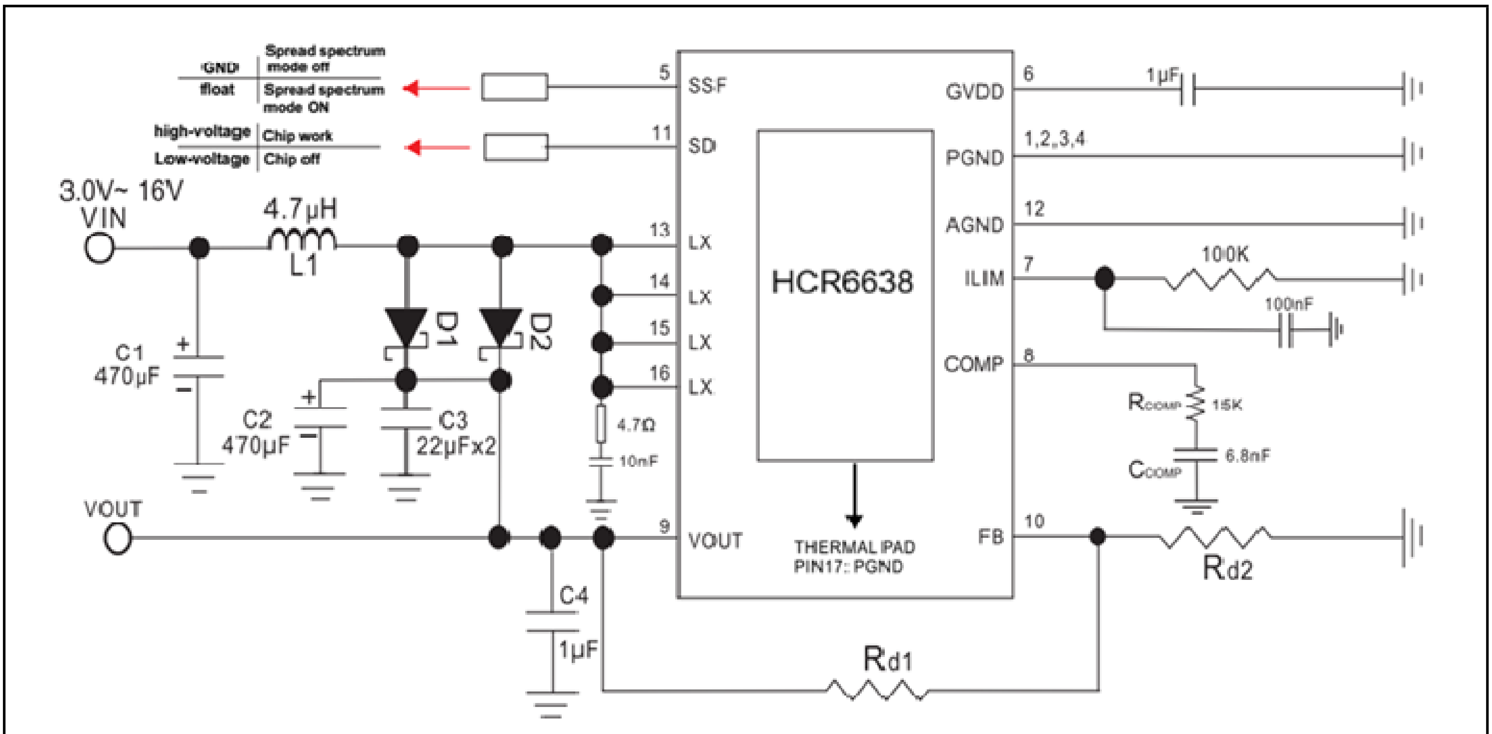


Figure 3. Functional Block Diagram of HCR6638

Typical Application Circuit

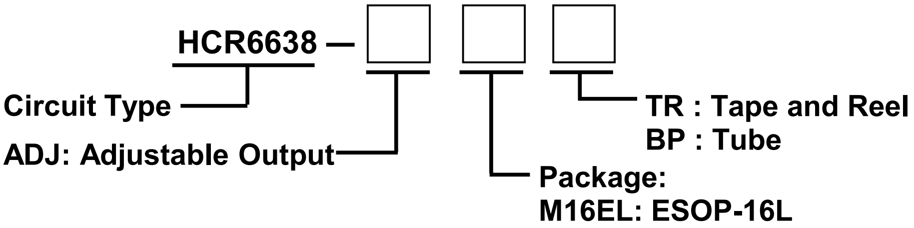


Note: a1. L1 is 4.7uH, it's saturation current is above 15A base on Power Inductor.

a2. The D1 and D2 location use the Schottky Barrier Rectifiers Diodes of SK54LS with star-wing brand

Figure 4. Typical Application Circuit of HCR6638

Ordering Information



Ordering Code

Part Number	Marking ID [2]	Temperature Range	Package	Quantity per Reel
HCR6638-ADJM16ELTR	HCR6638Exx	-40'C to +85'C	ESOP-16L	2500pcs/TR
HCR6638-ADJM16ELBP	HCR6638Exx	-40'C to +85'C	ESOP-16L	50pcs/BP

note 2. The “xx" is date code

Absolute Maximum Ratings Note 1

Parameter	Symbol	Value	Unit
Input Voltage Range of VIN	VIN	24	V
Input Voltage Range of LX	VLX	-0.3 to VIN+0.3	V
Voltage Range of SD/SSF/COMP	SD	-0.3 to +6	V
	SSF		
	COMP		
ILIM/FB Voltages	ILIM	-0.3 to +6	V
	FB		
Thermal Resistance Junction to Ambient	RθJA	45	'C/W
Thermal Resistance Junction to Case	RθJC	10	'C/W
Operating Junction Temperature Range	TJ	-40 to 150	'C
Storage Temperature Range	TSTG	-65 to 150	'C
Lead Temperature (Soldering, 10s)	TLEAD	260	'C
ESD(Machine Mode)	MM	±200	V
ESD(Human Body Made)	HMB	±2	KV

Recommend Operating Conditions note2

Parameter	Symbol	Value	Unit
Input Voltage Range	VIN	3.0 to 16	V
Output Voltage Range	VOUT	up to 22	V
Operating Ambient Temperature Range	TA	-40 to +85	'C

Note 1: Stresses beyond those listed under"Absolute maximum Ratings" may damage the device.

2: The device is not guaranteed to function outside the recommended operating conditions.

Electrical Characteristics

TA=25'C, VIN=3.7V,L=4.7uH, COUT=47uF, unless otherwise specification

Parameter	Symbol	Test Condition	Min	Type	Max	Unit
Power Supply Input						
Input Voltage Range	VIN		3.0	-	16	V
VIN Under-voltage Lockout Threshold	VIN_UVLO	VIN rising	-	2.5	-	V
		VIN falling	-	2.4	-	
VIN Under-voltage Lockout Hysteresis	VIN_HYS		-	100	-	mV
Quiescent Current	IQC	VFB=1V, No switching	-	0.2	-	mA
Average Supply Current	IASC	VFB=1V, Switching	-	2.5	-	mA
Shutdown Supply Current	ISHDN	VEN=GND	-	-	36	uA
Oscillator						
Operation Frequency	FOSC		300	350	400	KHz
Frequency Change with Voltage	Δf/ΔV	VIN=3V to 15V	-	5	-	%
Maximum Duty Cycle	TDUTY		-	93	-	%
Reference Voltage						
Reference Voltage	VREF		0.98	1.00	1.02	V
Line Regulation		VIN=3V to 15V	-	0.2	-	%/V
Enable Control						
EN High Threshold Voltage	VENH	VIN=5V	1.5	-	-	V
EN Low Threshold Voltage	VENL	VIN=5V	-	-	0.3	V
MOSFET						
On Resistance of Driver	RDS(ON)	ILX=4A	-	17	-	mΩ
OUTPUT						
Output Voltage Range	VOUT		3.5	-	22.0	V
FB Pin Leakage Current	ILKG_FB	VFB=1.0V	-	0.1	-	nA
Soft-Start Charging Current	ISS		-	5.0	-	uA
CURRENT LIMIT						
OCP Current	IOCP		-	15.0	-	A
Reference Voltage at the ILIM Pin	VILIM		-	1.00	-	V
THERMAL SHUTDOWN						
Thermal Shutdown Threshold	TSD	TA rising	-	150	-	'C
Thermal Shutdown Hysteresis	TSD_HYS	TA falling below TSD	-	140	-	'C

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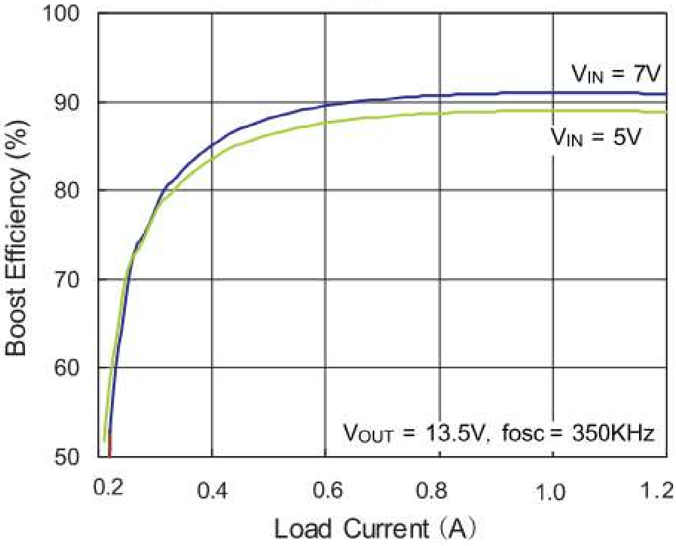
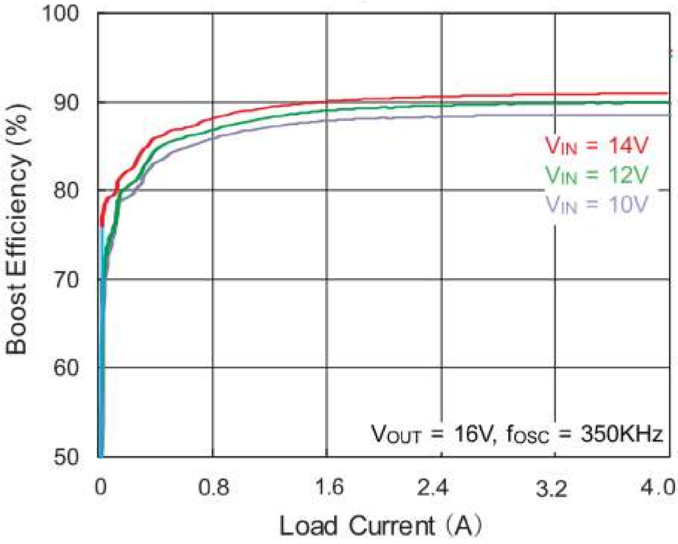
Typical Performance Characteristics

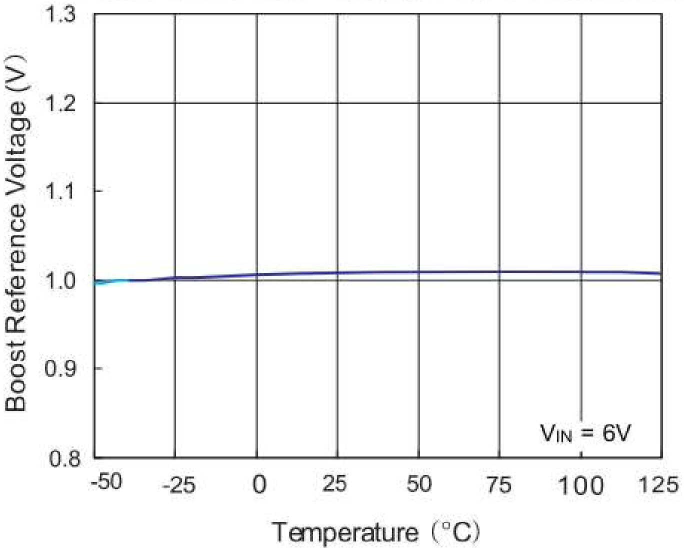
Boost Efficiency vs. Load Current



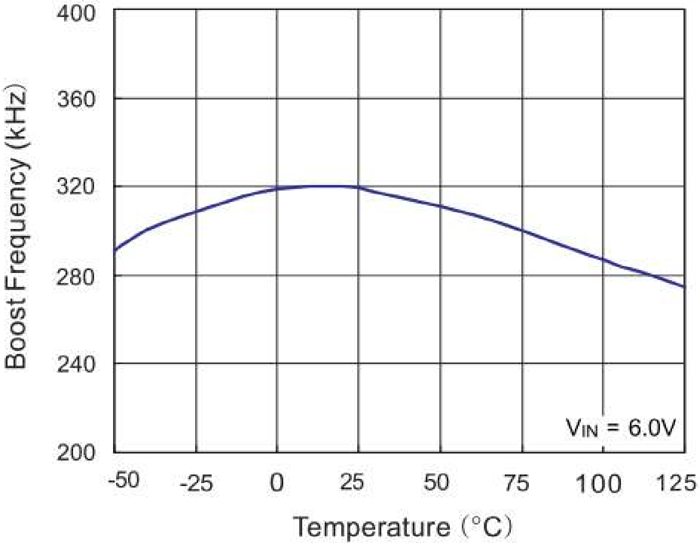
Boost Efficiency vs. Load Current



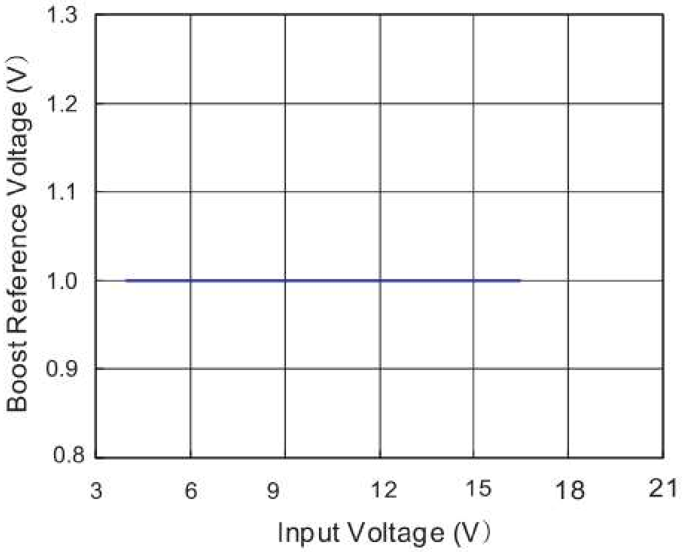
Boost Reference Voltage vs. Temperature



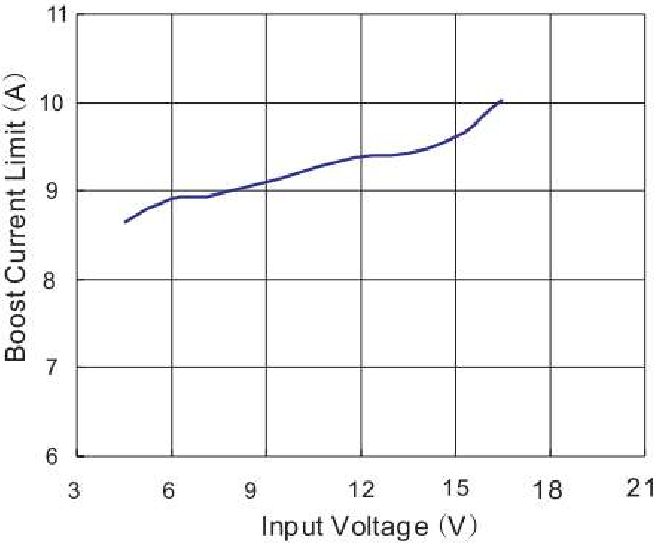
Boost Frequency vs. Temperature



Boost Reference Voltage vs. Input Voltage



Boost Current Limit vs. Input Voltage



Typical Application Circuit

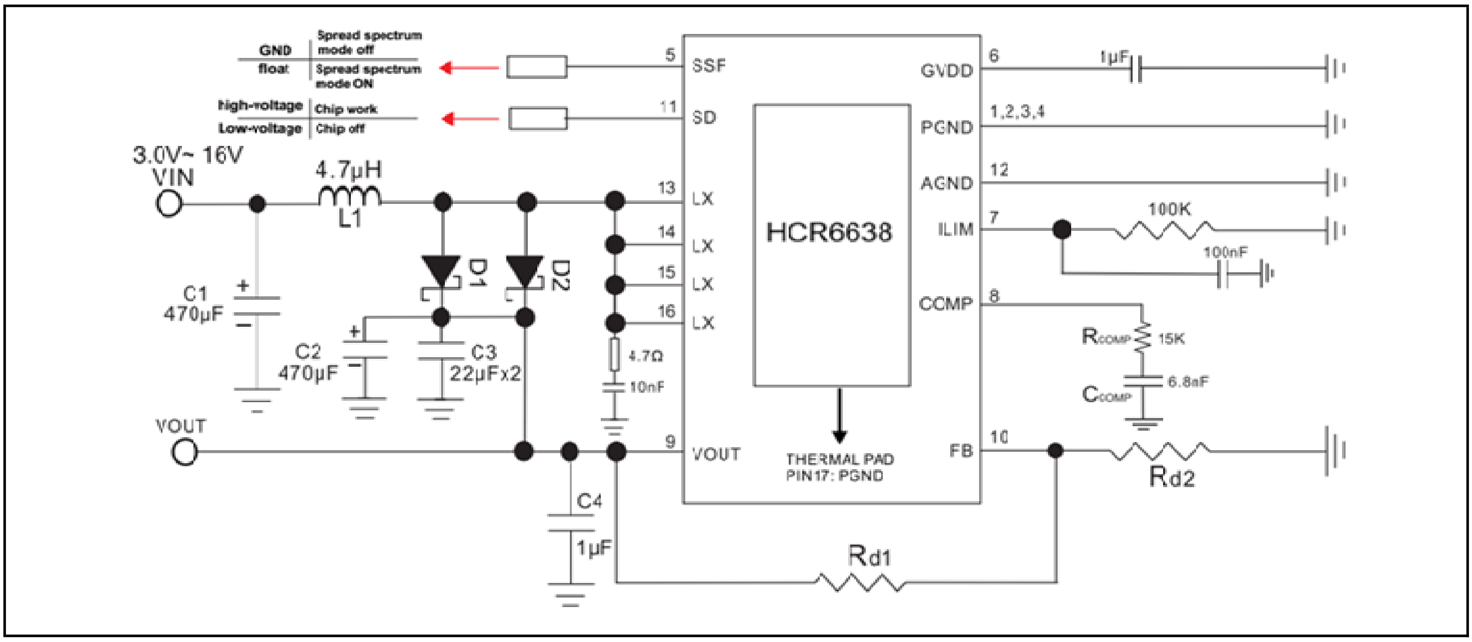


Figure 5. Typical Application Circuit of HCRG6638

Function Description

Application Message

The HCR6638 is a current mode PWM controlled boost power converter. Its built-in 24V and 14A current MOSFET can provide up to 22V output voltage.

Soft Start Function

The HCR6638 integrates soft start function in the chip to avoid surge voltage on the power supply. When the HCR6638 is started, the output of the error amplifier is controlled by the internal soft start function, which makes the pulse width grow slowly, thus reducing the input surge current.

Over Temperature Protection Function (OTP)

The SWUG6638 internal over temperature shutdown function, mainly to avoid chip damage caused by over temperature. Under typical conditions, when the shutdown temperature is set at 150'c, the chip turns off the power tube until the SWUG6638 temperature drops to 120'C, and the chip starts to work again.

Over Voltage Protection Function (OVP)

If the divider resistance of FB pin is abnormal, when its PWM signal exceeds the maximum duty cycle, the boost voltage will be higher and higher. When the output voltage exceeds OVP threshold voltage 24V, the output power will be turned off immediately.

Over Voltage Protection Function (OVP)

The threshold voltage of OVP is 24V.

Select Power Inductor

When the input and output voltage are determined, the inductance determines the up slope and down slope of the inductance current.

Ripple rate of inductance current (R):

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

Note: the"R0"is the equivalent impedance of output load and"F"is HCR6638 switch frequency, Function “r = f (d)” has a maximum value at 1 / 3. Under other conditions, the current ripple rate “ r ” is inversely proportional to the inductance " L ".

To ensure that the system works in continuous mode, The "R < 2" must be met to obtain the minimum value of inductance:

Function Description (Con.)

Select Power Inductor(con.)

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

Too small ripple rate of inductance current will lead to large inductance and inductance volume. It must determine a minimum ripple rate, from which the maximum value of inductance affects efficiency.
So a compromise is needed. When using a small ESR capacitor, the current ripple rate can be increased to reduce the volume. To avoid inductance saturation, the rated current of the inductance must be greater than the overcurrent limit of the chip.
The HCR6638 current peak limit typical value is 15A. 4.7uh power inductor with saturation current over 15A is recommended.

Input and output capacitance Selection

Output capacitor selection is mainly based on ripple of output voltage. In order to reduce the ripple of output current, a low ESR capacitor must be used. Multiple capacitors can also be connected in parallel. In practice, The load exceeds the maximum output power of the system in a certain period of time. Large capacitance can be used to avoid high output power and low voltage.

Output diode selection is mainly based on output

Output diode selection is mainly based 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 must be greater than the output current. At the same time, the loss ratio on the diode is less than the forward conduction voltage drop of the diode. Try to select the diode with small forward voltage drop. In the diode off phase, the reverse voltage of the diode is the output voltage, The reverse withstand voltage should be large.

Set Output Voltage

As shown in the figure 6 below, the output voltage is set by the partial resistance Rd1 and Rd2 connected to the feedback pin, and the constant voltage VFB of the feedback pin is 1V, then the output voltage can be according to the following formula:

Vout = (Rd1+Rd2)/Rd2

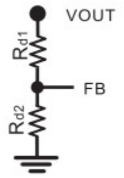


figure 6. Set Output Voltage by V_{FB}

Current limit and soft start function:

The peak current of the boost inductance can be limited and the soft start function of power supply can be realized by setting a pull-down resistor and capacitance to the ground through ilimit pin.
The following table lists the effective values of soft start time and inductance current under different resistance and capacitance conditions for reference.

L(uH)	Rlim	Power soft start			L(uH) Current
		10nF	100nF	220nF	
4.7uH	100K	1.8ms	18ms	36ms	10A
	82K	1.7ms	17ms	34ms	7.0A
	75K	1.6ms	16ms	32ms	5.0A
	68K	1.6ms	16ms	32ms	4.0A
	56K	1.6ms	16ms	32ms	2.0A

Spread spectrum function

The HCR6638 sets the spread spectrum mode of the chip through the SSF pin. When the SSF pin is suspended, the HCR6638 enters a unique spread spectrum modulation mode.
In this mode, the spectrum is spread in a wide frequency range, which can effectively reduce EMI. The switching frequency is around 350K ± 25 K. However, the frequency of sawtooth wave changes with the period, so that the energy is distributed in the whole frequency band, instead of concentrating a large amount of spectrum energy on the frequency doubling of switching frequency.
When SSF pin is grounded, the HCR6638 spread spectrum modulation mode is off.

Function Description (Con.)

Precautions for PCB design:

When designing the PCB layout of HCR6638 in order to provide the design reliability of boost system, please pay special attention to the following points:

∗All GND, 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, inductance, LX (pin13,14,15,16), 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 & 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 circuit of boost output should be as thick as possible, the output filter capacitor should be near Schottky, the capacitance ground should be as close to the bottom of the chip as possible, and the circuit between sampling pin and sampling point should be as short as possible.

∗The maximum voltage of MOS transistor in the chip is 24 v. the pulse peak height of LX pin should be considered in the design.

Circuit and PCB examples

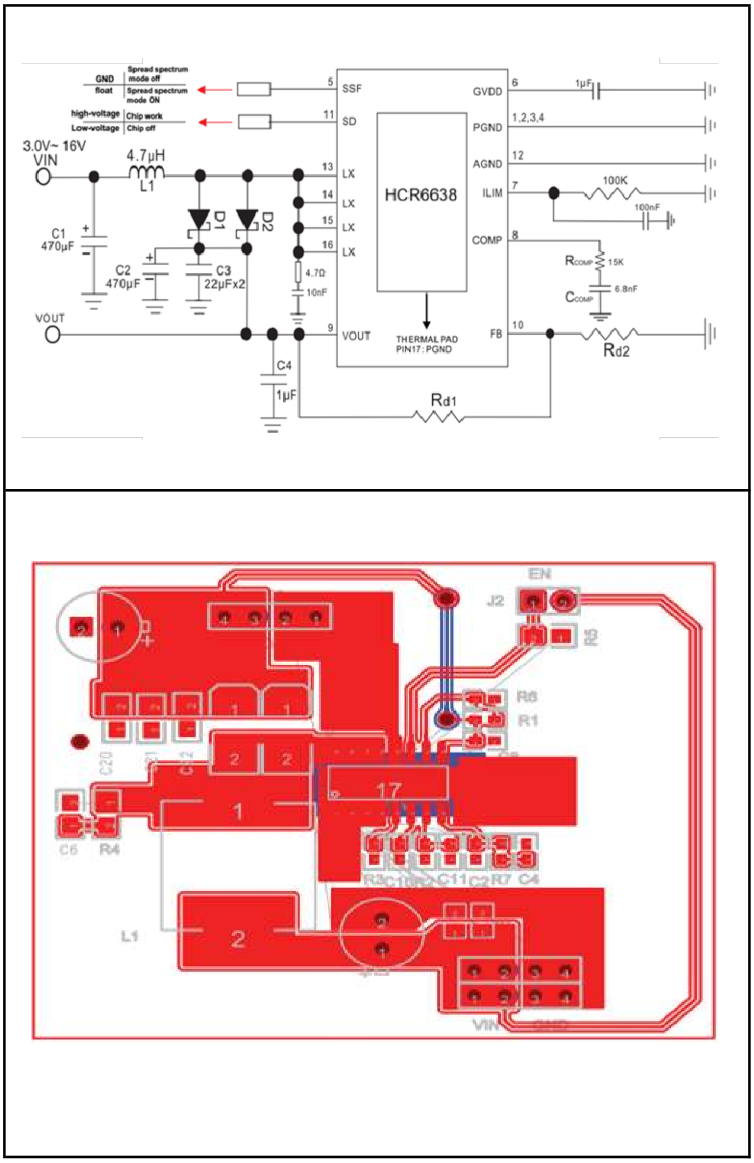
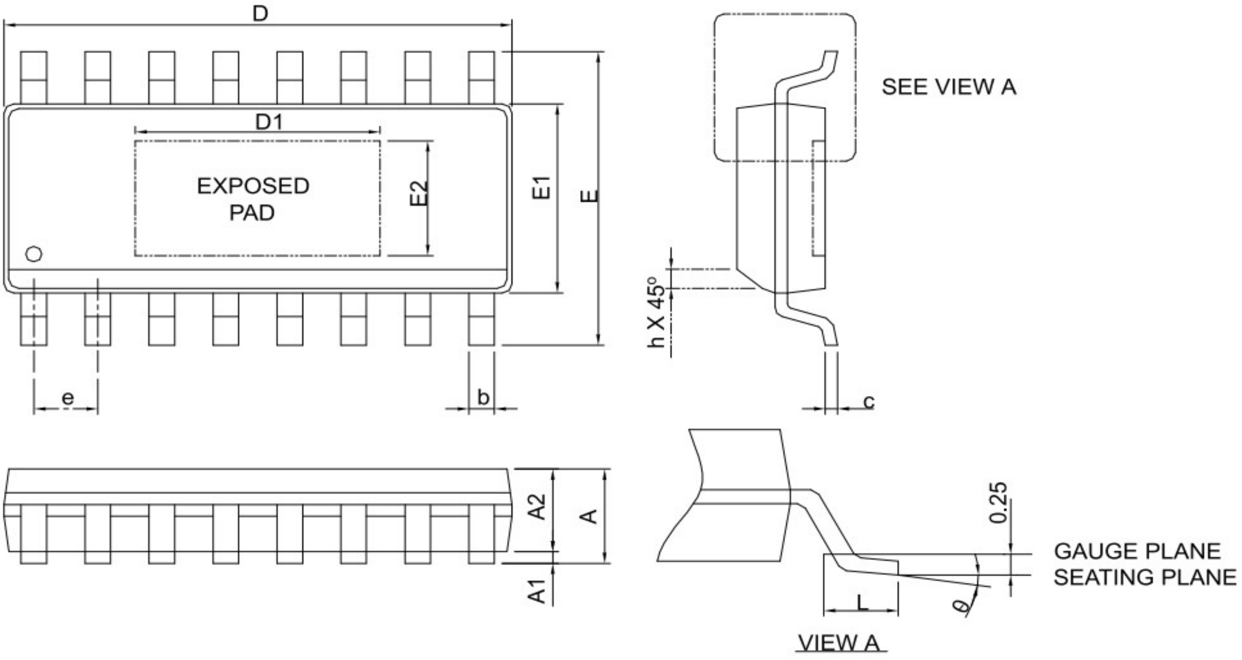


figure 7. Circuit and PCB examples

PACKAGE OUTLINE DIMENSIONS

Package: ESOP-16L

Unit: mm



SYMBOL	ESOP16L			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.75		0.069
A1	0.00	0.15	0.000	0.006
A2	1.25		0.049	
b	0.31	0.51	0.012	0.020
c	0.17	0.25	0.007	0.010
D	9.80	10.00	0.386	0.394
D1	3.50	4.50	0.138	0.177
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
E2	2.00	3.00	0.079	0.118
e	1.27 BSC		0.050 BSC	
h	0.25	0.50	0.010	0.020
L	0.40	1.27	0.016	0.050
θ	0°	8°	0°	8°

Note : 1. Follow from JEDEC MS-012 BC.

2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.

3. Dimension "E" does not include inter-lead flash or protrusions. Inter-lead flash and protrusions shall not exceed 10 mil per side.