



# LC2315

REV1.0-Revised MAY 2008

## Wide Input Voltage Range, 2A, PWM/PFM Step-down DC-DC Converter

### DESCRIPTION

The LC2315 is a CMOS-based PWM step-down DC-DC Converter. The device offers the following advantages: lower supply current and wider operating input-voltage range.

The LC2315 consists of a P-channel MOSFET, an oscillator, a PWM control circuit, a reference voltage unit, an error amplifier, a soft-start circuit, a protection circuit, a PWM/PFM alternative circuit, a Chip Enable circuit, and under voltage lockout circuit. A low ripple, high efficiency step-down DC-DC converter can be easily composed of this IC with only several external components, or an inductor, a diode and capacitors. Output Voltage can be adjusted with external resistors.

The LC2315 uses voltage type PWM/PFM mixed operation mode. When the load current is small, the operation will switch into the PFM mode from PWM mode. Therefore the efficiency at small load is improved, then the chip works on PWM mode.

The LC2315 embeds reset type protection circuit. If the term of maximum duty cycle keeps on a certain time, the protection circuit restarts the operation with soft-start and repeat this operation until maximum duty cycle condition is released. When the cause of large load current is removed, the chip returns to normal condition.

### FEATURES

- ◆ Range of input Voltage: 3V~16V
- ◆ 2A Output Current
- ◆ Output Voltage Adjustable from 1.22V to 15V
- ◆ Built-in 90mΩ P-Channel MOSFET
- ◆ Built-in Soft-start Function and Protection Function (Reset type protection)
- ◆ <1μA Shutdown Current and 80μA Quiescent Current
- ◆ Oscillation Frequency: 500KHz
- ◆ High efficiency: 95%
- ◆ High Accuracy Output Voltage: ± 2.0%
- ◆ Low Temperature-Drift Coefficient of Output Voltage: Typ: ± 100ppm/°C
- ◆ Operating Temperature Range: -25°C ~85°C
- ◆ Demo Board Available

### APPLICATIONS

- ◆ Power source for hand-held communication equipment, cameras, video instruments such as VCRs, camcorders.
- ◆ Power source for battery-powered equipment.
- ◆ Power source for household electrical appliance

### ORDERING INFORMATION

LC2315 [1](#) [2](#) [3](#) [4](#)

Code	Description
<a href="#">1</a>	Temperature & Rohs: C: -40~85°C, Pb Free Rohs Std.
<a href="#">2</a>	Package Type: D8: SOP-8
<a href="#">3</a>	Packing Type: TR: Tape & Reel (Standard)
<a href="#">4</a>	Output Voltage: e .g. AD=Output voltage adjustable

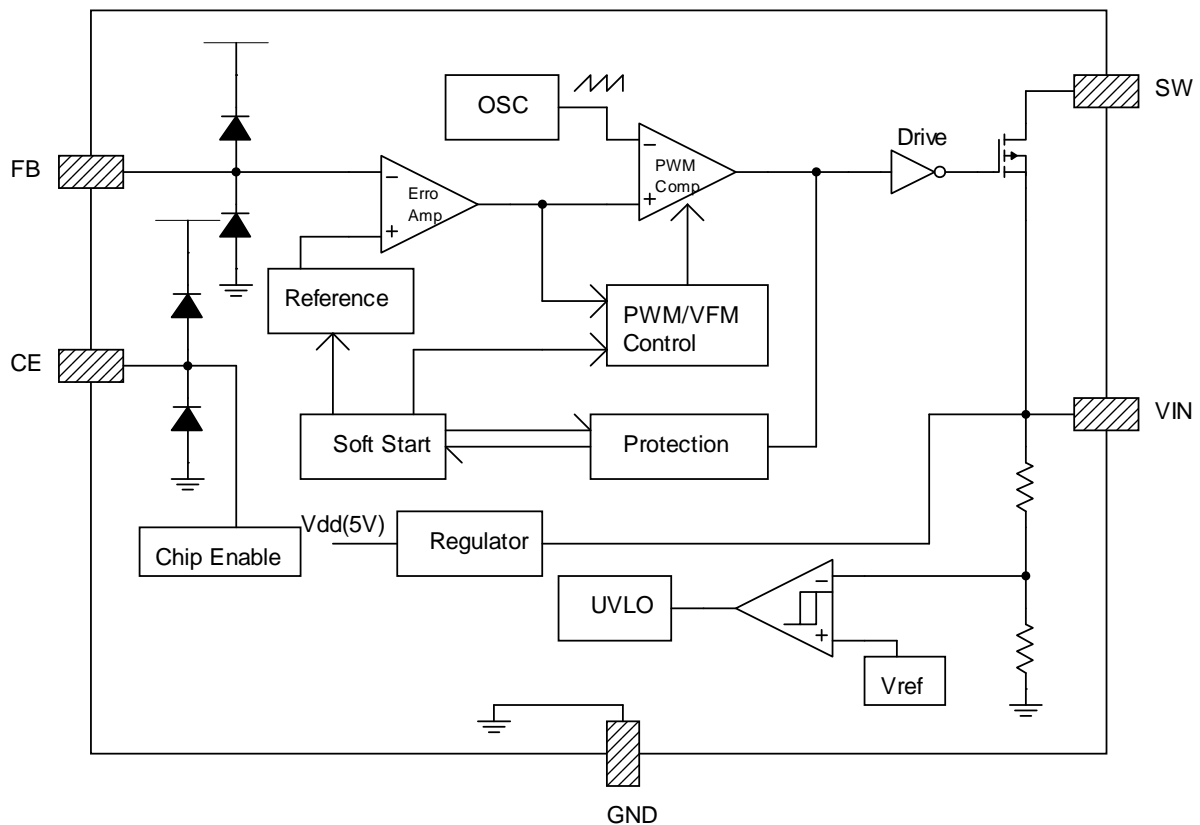
### PIN CONFIGURATION

Product Classification		LC2315CD8TR
Marking		
HE AD YYBZZ	HE: Product Code	
	AD: Output Voltage Adjustable	
	YY: LOT NO.	
	B: FAB Code	
	ZZ: Data Code	

## PIN DESCRIPTION

Pin No.	Symbol	Description
1	NC	Not Connected
2	VIN	Power Supply Pin
3	SW	Switching Node: PWM output connection to inductor.
4	GND	Ground Pin
5	FB	Pin for Feedback Voltage
6	NC	Not Connected
7	CE	Chip Enable Pin (Active with "H")
8	NC	Not Connected

## BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATING

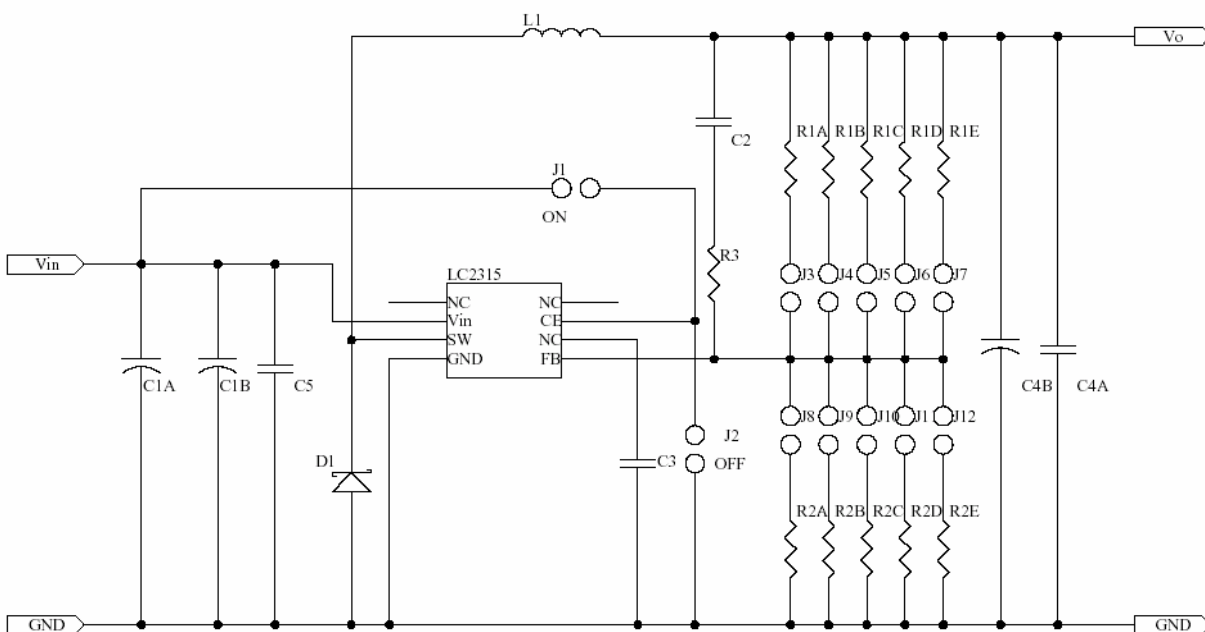
Supply Voltage	-0.3V to 18V
Switch Node	-0.3V to Vin + 0.3V
Chip Enable	-0.3V to Vin+0.3V
Feedback Pin Input Voltage	-0.3V to 6V
Operating Ambient Temperature Range	-25°C to 85°C
Storage Temperature Range	-40°C to 150°C
Lead Temperature (Soldering, 10 sec)	260°C
Thermal resistance: $\Theta_{JA}$	105°C/W

## ELECTRICAL CHARACTERISTICS

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
VIN	Operating Input Voltage		3		16	V
Rds_on	Static P-Channel MOSFET On State Resistance			90*		mΩ
VFB	Feedback Voltage	VIN=VCE=12V, Iout=-100mA	1.203	1.220	1.241	V
ΔVFB/ΔT	Feedback Voltage Temperature Coefficient	-25°C ≤ Topt ≤ 85°C		±100		ppm/°C
fosc	Oscillator Frequency	VIN=VCE=12V, Iout=-100mA	400	500	600	KHz
ΔfOSC/ΔT	Oscillator Frequency Temperature Coefficient	-25°C ≤ Topt ≤ 85°C		±0.2		%/°C
IDD1	Supply Current 1	VIN = VCE =12V VFB =1.4V		80		μ A
Istb	Standby Current	VIN=12V, VCE =0V		0	1	μ A
ICEH	CE "H" Input Current	VIN = VCE =12V		0	0.5	μ A
ICEL	CE "L" Input Current	VIN =12V, VCE = 0V	-0.5	0		μ A
VCEH	CE "H" Input Voltage	VIN = 12V	1.0			V
VCEL	CE "L" Input Voltage	VIN = 12V			0.3	V
VUVLO1	UVLO Threshold Voltage	VIN=VCE=5 to 0V	1.5	1.9	2.3	V
VUVLO2	UVLO Release Voltage	VIN=VCE=0 to 5V	1.6	2.0	2.4	V
Maxdty	Oscillator Maximum Duty Cycle		100			%
Tstart	Delay Time by Soft-start function	VIN = 12V, VCE = 0→>8V	2	5	10	ms
Tprot	Delay Time for protection circuit	VIN = VCE = 12V VFB = 2.5V→>0V	150	200	250	μ s

\*Ensured by design. Not 100% production tested.

## TYPICAL APPLICATION



## DEMO BOARD BOM

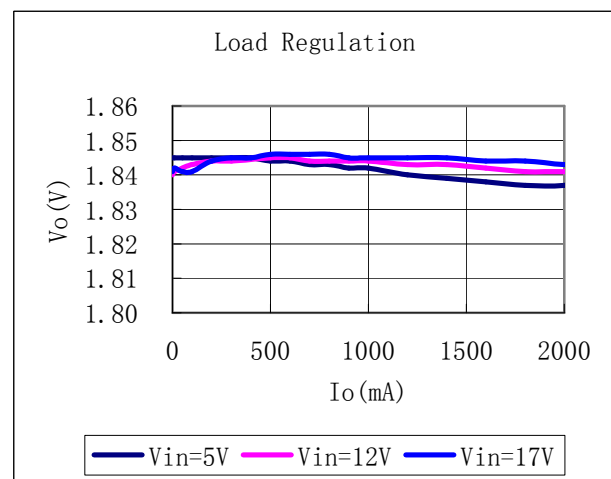
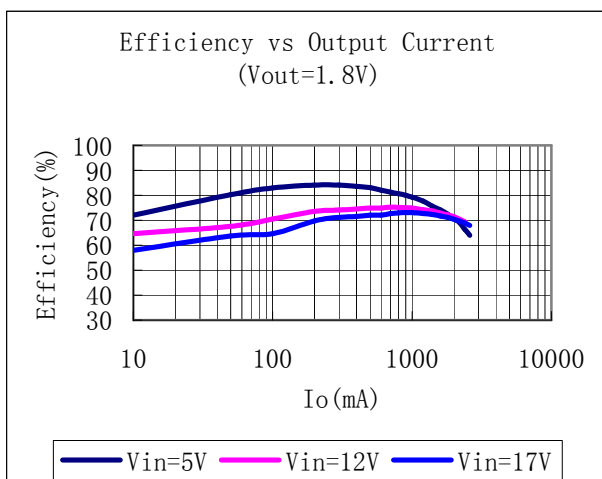
### ➤ Table 1 Bill of Materials

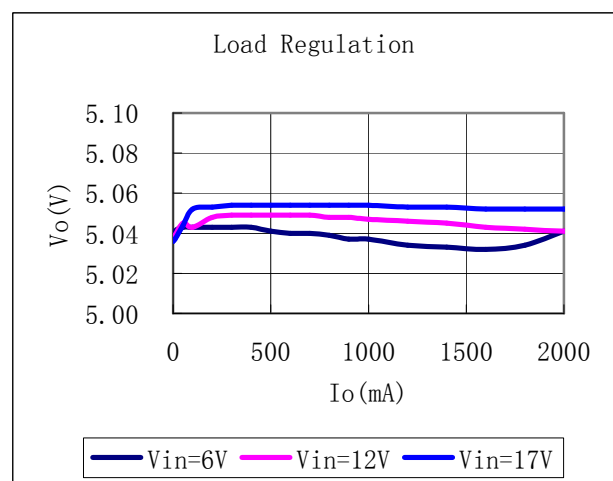
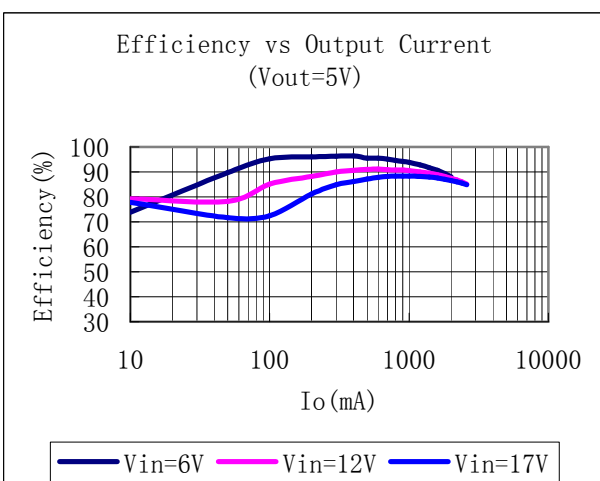
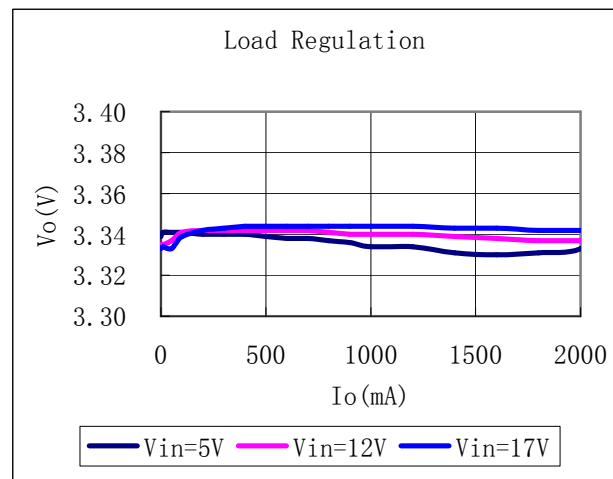
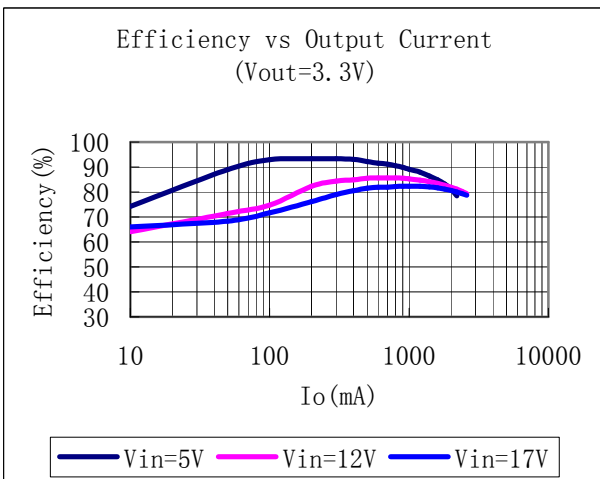
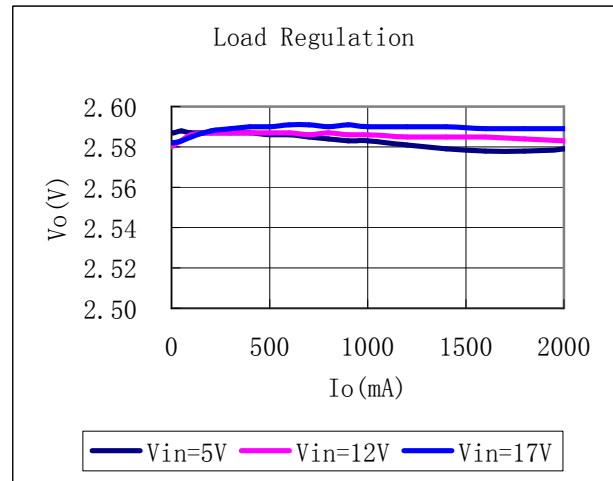
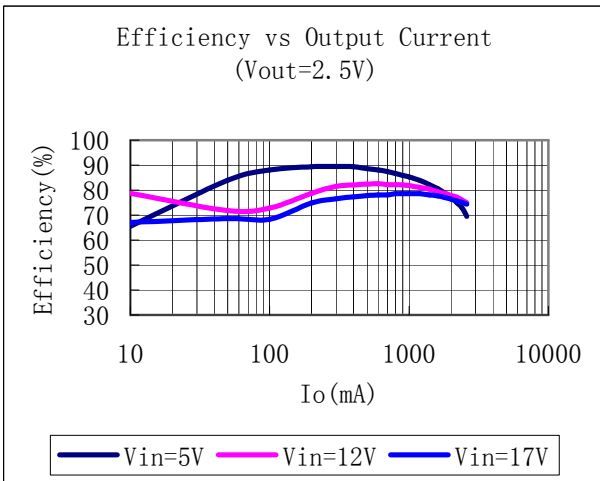
No.	Reference	Type	Specification	Note
1	C1A	Capacitor	Tantalum Capacitor; 25V/47uF; SMD	
2	C1B	Capacitor	Open	
3	C2	Capacitor	MLCC 6.8nF; SMD 0805	
4	C3	Capacitor	Open	
5	C4A	Capacitor	MLCC 0.1uF; SMD 0805	
6	C4B	Capacitor	Tantalum Capacitor; 25V/100uF; SMD	
7	C5	Capacitor	MLCC 1nF; SMD 0805	
8	D1	Diode	SS34; 40V, 3A; SMD	
9	L1	Inductor	22uH; 3A; SMD, Shielding	
10	IC1	IC	LC2315; SMD SOIC 8	
11	R1A~R1E	Resistor	SMD 0805; 1%	Refer to Table 2
12	R2A~R2E	Resistor	SMD 0805; 1%	Refer to Table 2
13	R3	Resistor	5.6 KΩ; SMD 0805; 1%	

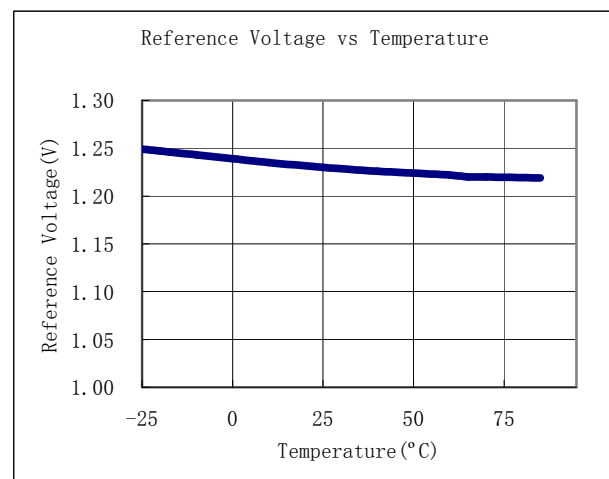
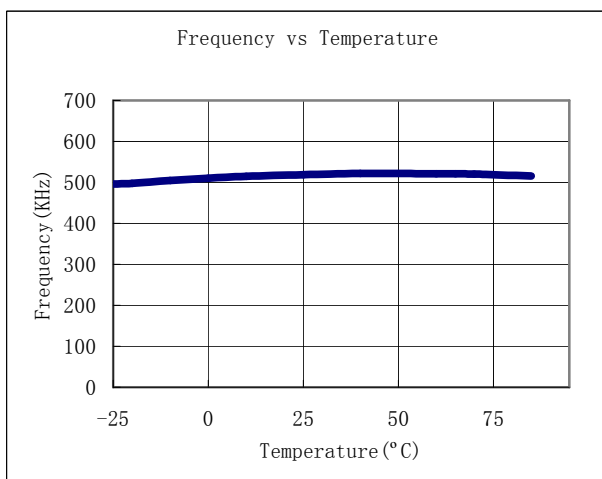
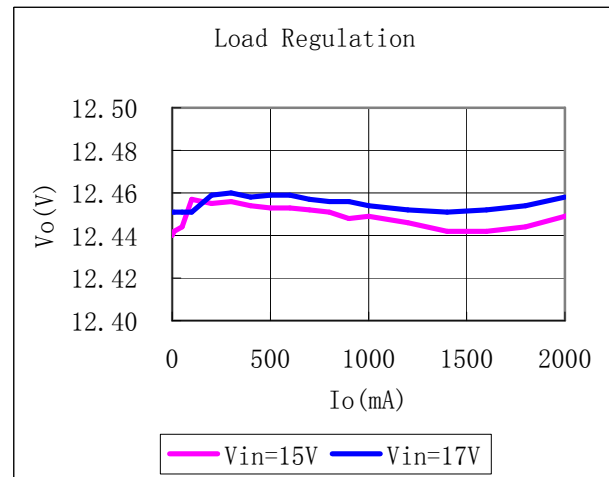
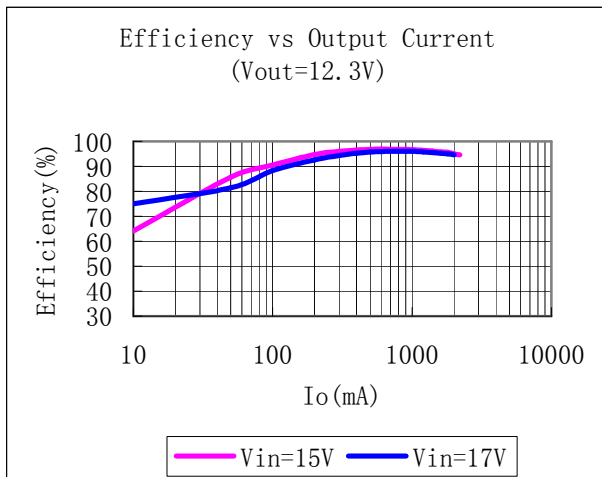
### ➤ Table 2 Feedback Resistors Selection

Vout	R1A	R1B	R1C	R1D	R1E	R2A	R2B	R2C	R2D	R2E
1.8V	30K					62K				
2.5V		51K					47K			
3.3V			27K					16K		
5.0V				56K					18K	
12.3V					39K					4.3K

## DEMO BOARD MEASUREMENT







## DETAILED DESCRIPTION

The LC2315 consists of a P-channel MOSFET, an oscillator, a PWM control circuit, a voltage reference unit, an error amplifier, a soft-start circuit, a fault protection circuit, a PWM/PFM alternative circuit, a chip enable circuit, and an input voltage detecting circuit.

## PWM OPERATION

In normal operation, adjusting the width of pulses regulates the system output voltage. It is implemented by regulating the FB voltage at 1.220V. The LC2315's high-gain differential error amplifier and low temperature-drift coefficient reference guarantee the accuracy of output voltage with different input voltage and load conditions. In order to reduce the ripple voltage and improve the loop stability, a high bandwidth error amplifier is designed with a built-in zero. This zero, plus the ESR zero on the output electrolytic capacitor, balances the double poles of the output LC filter. Thus the step-down system is stable and external compensation network is not required. In practice, a low cost ceramic capacitor paralleling with the upper resistor on feedback resistors divider implements additional phase lead compensation function. This improves the dynamic response performance. In order to improve the efficiency, The LC2315 integrates a low on-resistance P-channel MOSFET and well designed driver circuits inside a SOP-8 package, the power loss is reduced at very low level.

## PFM OPERATION

At light load, the error amplifier's output voltage becomes very low and the duty cycle becomes very small. The system switching losses dominate and conduction losses become less important. The LC2315 limits its minimum duty cycle. If the output current is low enough, the output voltage exceeds the desired value and the error amplifier output voltage decreases down to a preset threshold, then the output pulses are disabled and the system output voltage decreases until the error amplifier output ramps up above the preset threshold. Thus the switching node waveform looks like a pulse-skipping mode. The number of pulses and switching losses are significantly reduced.

## OSCILLATOR

The oscillator circuit provides a clock to set the converter operating frequency.

## PROTECTION CIRCUIT

If the duration of maximum duty cycle is long enough, the embedded protection circuit shuts down internal power switch. Then the IC starts a soft start cycle. This procedure

repeats until the cause of the protection condition is removed.

## SOFT-START

A small current charges the soft-start capacitor and raises the internal soft start voltage. The reference voltage follows the soft-start voltage, and limits the speed of voltage rising on the error amplifier output, and hence reduces the speed of rising of output voltage during startup.

## UVLO

If the input voltage is equal or less than UVLO threshold, the IC goes to standby mode. If the input voltage increases above the UVLO threshold with a hysteresis voltage, the IC starts another soft-start cycle and normal operation.

## ENABLE (CE)

Logic low on CE puts the LC2315 in shutdown state. In shutdown mode, the output power switch, voltage reference, and other functions are shut off, the supply current is reduced to 1 $\mu$ A or less.

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## NOTIFICATION

Be aware of the following issues while using the LC2315:

Set external components as close as possible to the IC and minimize the connection between the components and the IC. In particular, the power rails and SW connection should be short. Make sufficient grounding and reinforce supplying.

If the difference between input and output voltage is too small and load is very high,

maximum duty cycle may last long enough to trigger the maximum duty-cycle protection.

If the duty cycle in PWM mode needs to be less than the minimum duty cycle to go to PFM mode, the IC switches to PFM mode to reduce switching frequency and operating current. However, if the ratio of output voltage vs. input voltage is low enough (for example,  $V_{in}=15V$  and  $V_{out}=1.8V$ ), even if the load current is large, the IC keeps in PFM mode, and the ripple of output voltage may increase.

## PACKAGE LINE

Package	SOP-8	Devices per reel	2500Pcs	Unit	mm
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Package specification:

SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.77
A1	0.08	0.18	0.28
A2	1.20	1.40	1.60
A3	0.55	0.65	0.75
b	0.39	—	0.48
b1	0.38	0.41	0.43
c	0.21	—	0.26
c1	0.19	0.20	0.21
D	4.70	4.90	5.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
L	0.50	0.65	0.80
L1	1.05BSC		
$\theta$	0	—	8°

SECTION B-B