

### 描述 / Descriptions

BRCD3408 是一款恒定频率、电流脉冲宽度调制模式的降压转换器。该器件集成了一个主控开关和同步整流器替换肖特基二极管,使芯片具有更高效能。它是使用单节锂电池供电的便携式设备的理想选择,输出电压最低可调节至 0.6V。BRCD3408 在低压状态下以 100%占空比模式运行,延长便携式系统电池寿命。该器件提供 PWM (脉冲宽度调制) 和 PFM (脉冲频率调制) 两种可切换的操作模式,可以在广泛负载范围内高效运行。

The BRCD3408 is a constant frequency, current mode PWM step-down converter. The device integrates a main switch and a synchronous rectifier for high efficiency without an external Schottky diode. It is ideal for powering portable equipment that runs from a single cell Lithium-Ion (Li+) battery. The output voltage can be regulated as low as 0.6V. The BRCD3408 can also run at 100% duty cycle for low dropout operation, extending battery life in portable system. This device offers two operation modes, PWM control and PFM Mode switching control, which allows a high efficiency over the wider range of the load

### 特征 / Features

高效率高达 96%, 1.5MHz 恒频工作, 输出电流 1.2A, 输入工作电压范围: 2.5V~6.0V, 输出电压低至 0.6V, 短路保护, 过温保护, 浪涌电流限制和软启动, 关断电流: < 1 $\mu$ A。

High Efficiency: Up to 96%, 1.5MHz Constant Frequency Operation, 1.2A Output Current, 2.5V to 6.0V Input Voltage Range, Output Voltage as Low as 0.6V, Short Circuit Protection, Thermal Fault Protection, Inrush Current Limit and Soft Start, <1 $\mu$ A Shutdown Current.

### 用途 / Applications

手机和智能电话, 无线及 DSL 调制解调器, 个人数字助手 (掌上电脑) /移动互联网设备/平板电脑, 数码相机与摄像机。

Cellular and Smart Phones, Wireless and DSL Modems, PDA/MID/PAD, Digital Still and Video Cameras.

### 典型应用电路图 / Typical Application

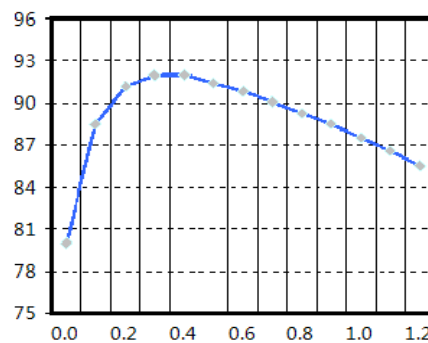
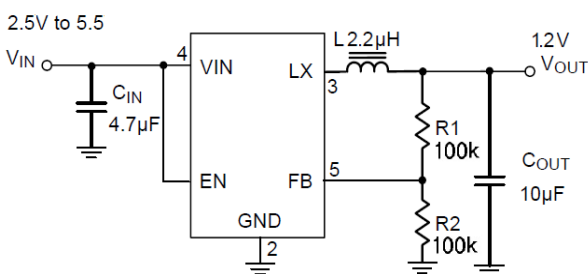
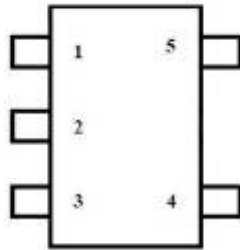


Figure 1. Basic Application Circuit

**引脚排列 / Pinning**



引脚 PIN	名称 NAME	功能 FUNCTION
1	EN/RUN	使能端，驱动电压高于1.5V时打开，低于0.3V是关断，不能悬空。 Chip Enable Pin. Drive RUN above 1.5V to turn on the part. Drive RUN below 0.3V to turn it off. Do not leave RUN floating
2	GND	接地端 Ground Pin
3	LX/SW	电源开关输出端。该引脚与器件内部P型和N型MOSFET的漏极连接，外部需要与电感连接。 Power Switch Output. It is the switch node connection to Inductor. This pin connects to the drains of the internal P-ch and N-ch MOSFET switches
4	VIN	电源输入端。靠近引脚处必须连接去耦电容，该电容可以是4.7μF或更大的陶瓷电容。 Power Supply Input. Must be closely decoupled to GND with a 4.7μF or greater ceramic capacitor
5	FB	输出电压反馈输入端。通过一个内部电阻分压器将输出电压与内部参考电压进行比较。 Output Voltage Feedback Pin. An internal resistive divider divides the output voltage down for comparison to the internal reference voltage

**印章代码 / Marking**

见印章说明。 See Marking Instructions.

**极限参数 / Absolute Maximum Ratings(Ta=25°C)**

参数 Parameter	符号 Symbol	数值 Rating	单位 Unit
Supply Input voltage(Note1)	V <sub>IN</sub>	-0.3 to +6.3	V
EN/VOUT Voltages	V <sub>EN</sub>	-0.3	V
LX Voltage	V <sub>LX</sub>	-0.3	V
Peak LX Sink and Source Current	I <sub>P</sub>	1.8	A
Power Dissipation	P <sub>D</sub>	600	mW
Junction Temperature(Note2)	T <sub>J</sub>	155	°C
Lead Temperature (Soldering,10s)	T <sub>L</sub>	300	°C
Operating Temperature	T <sub>opr</sub>	-40 to +85	°C
Storage Temperature	T <sub>stg</sub>	-65 to +150	°C

**电性能参数 / Electrical Characteristics( V<sub>IN</sub>=V<sub>RUN</sub>=3.6V, V<sub>OUT</sub>=1.8V, T<sub>A</sub> = 25°C, unless otherwise noted.)(Note3)**

参数 Parameter	测试条件 Test Conditions	最小值 Min	典型值 Typ	最大值 Max	单位 Unit
Input Voltage Range		2.5		6.0	V
OVP Threshold			6.5		V
UVLO Threshold			2.0		V
Input DC Supply Current	Vout = 90%, Iload=0mA Vout = 105%, Iload=0mA V <sub>RUN</sub> =0V, V <sub>IN</sub> =4.2V <sup>(Note4)</sup>		140	300	μA
PWM Mode			40	65	μA
PFM Mode			0.1	1.0	μA
Shutdown Mode					
Regulated Feedback Voltage	TA = 25°C	0.588	0.600	0.612	V
	TA = 0°C ≤ TA ≤ 85°C	0.586	0.600	0.613	V
	TA = -40°C ≤ TA ≤ 85°C	0.585	0.600	0.615	V
Reference Voltage Line Regulation	Vin=2.5V to 6.0V		0.04	0.40	%/V
Output Voltage Line Regulation	Vin=2.5V to 6.0V		0.04	0.4	%
Output Voltage Load Regulation			0.5		%
Oscillation Frequency	Vout=100% Vout=0V		1.5		MHz
			300		KHz
On Resistance of PMOS	ILX=100mA		0.25	0.30	Ω
ON Resistance of NMOS	ILX=-100mA		0.10	0.15	Ω
Peak Current Limit	VIN= 3V, Vout=90%		1.8		A
RUN Threshold		0.30	1.0	1.50	V

**电性能参数 / Electrical Characteristics (  $V_{IN}=V_{RUN}=3.6V$ ,  $V_{OUT}=1.8V$ ,  $T_A = 25^{\circ}C$ , unless otherwise noted.)(Note3)**

参数 Parameter	测试条件 Test Conditions	最小值 Min	典型值 Typ	最大值 Max	单位 Unit
RUN Leakage Current			±0.01	±1.0	μA
LX Leakage Current	$V_{RUN}=0V, V_{IN}=V_{LX}=5V$		±0.01	±1.0	μA
OS_EN	$I=-100\mu A$	-0.9		-0.3	V
OS_SW	$I=-100\mu A$	-0.9		-0.3	V
OS_VIN	$I=-100\mu A$	-0.9		-0.3	V
OS_FB	$I=-100\mu A$	-0.9		-0.3	V
UVLO undervoltage protection voltage	$V_{IN}=2.7V, V_{RUN}=2.5V$		2		V
Iq1 pulse width modulation mode current	$V_{IN}=V_{RUN}=3.6V, FB=0.3V$			300	uA
Iq2 pulse frequency modulation mode current	$V_{IN}=V_{RUN}=3.6V, FB=1V$			50	uA
I <sub>sd</sub> quiescent current	$V_{IN}=3.6V, V_{RUN}=0V$			1	uA
V <sub>fb</sub> feedback voltage accuracy	$V_{IN}=V_{RUN}=3.6V$	0.588		0.612	V
SV1 电压调整率	$V_{IN}=2.5V-6V, V_{RUN}=2.5V$			0.40%	
SV2 电压调整率	$V_{IN}=2.5V-6V, V_{RUN}=2.5V$			0.40%	

Notes:

1 : 超出最大绝对额定值, 可能损坏器件

Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

2 : 结温  $T_J$  是通过环境温度值  $T_A$  和功耗值  $P_D$  根据以下公式计算得出

$$T_J = T_A + (P_D) \times (250^{\circ}C / W)$$

$T_J$  is calculated from the ambient temperature  $T_A$  and power dissipation  $P_D$  according to the following formula:

$$T_J = T_A + (P_D) \times (250^{\circ}C / W)$$

3 :  $25^{\circ}C$  的参数值是经过 100%测试得出。规格书上的温度范围可以通过相关的设计和控制方法来保证 100% production test at  $+25^{\circ}C$ . Specifications over the temperature range are guaranteed by design and characterization

4 : 在栅极电荷被输送在开关频率时动态电源电流较高

Dynamic supply current is higher due to the gate charge being delivered at the switching frequency

功能框图 / Functional Block Diagram

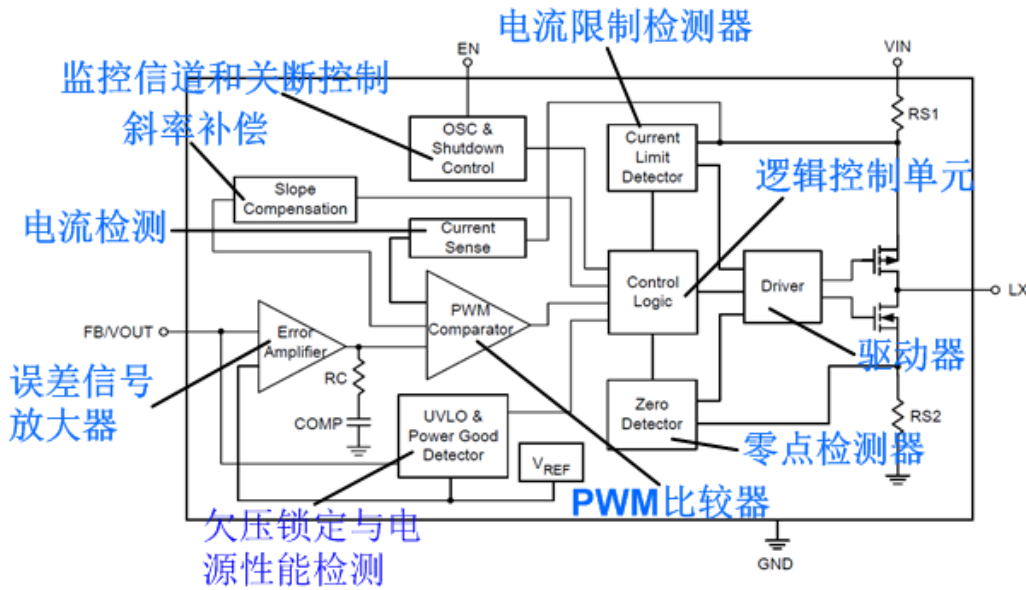


图2. BRCD3408功能框图

Figure 2. BRCD3408 Block Diagram

功能描述 / Functional Description

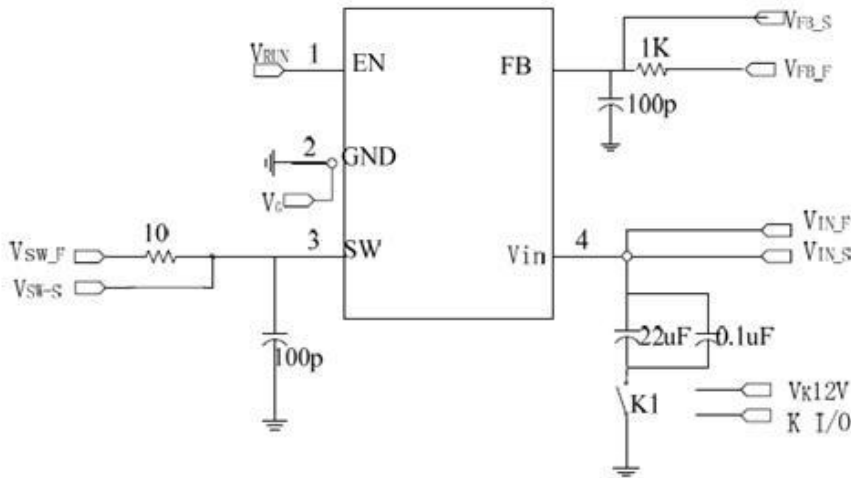
BRCD3408是一种高性能的1.2A、1.5MHz单片式的降压转换器。该BRCD3408只需要三个外部功率元件（CIN，COUT和L）。可调版本可根据外部的反馈进行编程，输出从0.6V到输入电压之间的任何电压。

The BRCD3408 is a high performance 1.2A 1.5MHz monolithic step-down converter. The BRCD3408 requires only three external power components (Cin, Cout and L). The adjustable version can be programmed with external feedback to any voltage, ranging from 0.6V to the input voltage.

在低输入电压情况下，转换器的占空比上升到100%，输出电压等于输入电压减去导通压降较高的一个MOSFET的电压。内部误差放大器和补偿器具有出色的瞬态响应特性，及时对负载电压进行线性调整。软启动功能有效防止启动过程中的输入浪涌电流和输出过冲。

At dropout, the converter duty cycle increases to 100% and the output voltage tracks the input voltage minus the  $R_{dson}$  drop of the high-side MOSFET. The internal error amplifier and compensation provides excellent transient response, load, and line regulation. Soft start function prevents input inrush current and output overshoot during start up.

**测试方法和电路 / Test Methods and Circuits**



**应用信息 / Applications information**

(1) 设置输出电压/ Setting the Output Voltage

图1示出了BRCD3408基本应用电路。该BRCD3408可以在外部编程。电阻R1和R2在图1中程序的输出来调节在电压高于0.6V以上。限制,同时保持良好的噪声抑制所需的外部反馈电阻串的偏置电流,建议的最小值为R2是59kΩ。虽然一个较大的值,将进一步减少的静态电流,它也将增加反馈节点的阻抗,因此当外部噪声和干扰更敏感。表1总结了不同的输出电压与R2设置为59kΩ的良好的噪声抑制或316kΩ以降低空载输入电流的电阻值。

Figure 1 shows the basic application circuit for the BRCD3408. The BRCD3408 can be externally programmed. Resistors R1 and R2 in Figure 1 program the output to regulate at a voltage higher than 0.6V. To limit the bias current required for the external feedback resistor string while maintaining good noise immunity, the minimum suggested value for R2 is 59kΩ. Although a larger value will further reduce quiescent current, it will also increase the impedance of the feedback node, making it more sensitive to external noise and interference. Table 1 summarizes the resistor values for various output voltages with R2 set to either 59kΩ for good noise immunity or 316kΩ for reduced no load input current.

根据下列等式的外部电阻设置输出电压：

The external resistor sets the output voltage according to the following equation:

$$V_{OUT} = 0.6 \times \left(1 + \frac{R_1}{R_2}\right) \quad R_1 = (V_{OUT} / 0.6 - 1) \times R_2$$

## 应用信息 / Applications information

### (2) 电感的选择 / Inductor Selection

在大多数设计中，BRCD3408选用的电感大小在2.2μH至10μH之间。较小值的电感体积更小，但需要使用高频开关，因此将导致一些效率损失。电感值下公式计算出：

For most designs, the BRCD3408 operates with inductors of 2.2μH to 10μH. Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

其中 $\Delta I_L$ 为电感纹波电流。较大值的电感具有较低的纹波电流，而小值电感具有的较高的纹波电流。为降低输出电压纹波并改善负载瞬态响应，应选择直流串联电阻在50mΩ至150mΩ范围的电感。

Where  $\Delta I_L$  is inductor Ripple Current. Large value inductors result in lower ripple current and small value inductors result in high ripple current. For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 50mΩ to 150mΩ range.

### (3) 输入电容的选择 / Input Capacitor Selection

输入电容能够降低设备从输入电流和开关噪声引入的浪涌电流。输入电容阻抗应小于输入源阻抗，以阻止高频电流进入芯片内部，因此需要使用低 ESR(等效串联电阻)的电容以满足最大有效值范围内的电流。建议使用具有低 ESR 和较小温度变化系数的 X5R 或 X7R 介质材料的陶瓷电容。4.7μF 的陶瓷电容能够满足大多数情况下的应用。较大值的陶瓷电容可以改善对输入电压的滤波能力。

The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency should be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. A 4.7μF ceramic capacitor for most applications is sufficient. A large value may be used for improved input voltage filtering.

### (4) 输出电容的选择 / Output Capacitor Selection

输出电容需要确保输出电压纹波小、回路波动稳定。输出电容必须具有较低的阻抗，建议使用具有低ESR、纹波电流稳定性高的X5R或X7R介质材料的陶瓷电容。输出VOUT纹波由下式决定：

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current ratings. The output ripple VOUT is determined by:

$$\Delta V_{OUT} \leq \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times f_{OSC} \times L} \times \left( ESR + \frac{1}{8 \times f_{osc} \times C3} \right) A$$

10μF陶瓷可满足大多数情况下的应用。

10μF ceramic can satisfy most applications



## 应用信息 / Applications information

### ( 5 ) PCB 布局检验清单 /PC Board Layout Checklist

铺设印刷电路板后，应做以下检查来确保 BRCD3408 能够正常运行。检查内容如下：

When laying out the printed circuit board, the following checking should be used to ensure proper operation of the BRCD3408. Check the following in your layout:

1) 由 GND、LX 和 VIN 线路构成的电源走线应尽量短、直和宽。

The power traces, consisting of the GND trace, the LX trace and the VIN trace should be kept short, direct and wide

2) 电容 CIN ( + ) 接线端与 VIN 尽可能靠近。该电容用于给内部 MOSFET 管提供交流电流。

Does the (+) plates of Cin connect to Vin as closely as possible. This capacitor provides the AC current to the internal power MOSFETs

3) 保持开关节点、LX 端口远离敏感 VOUT 节点。

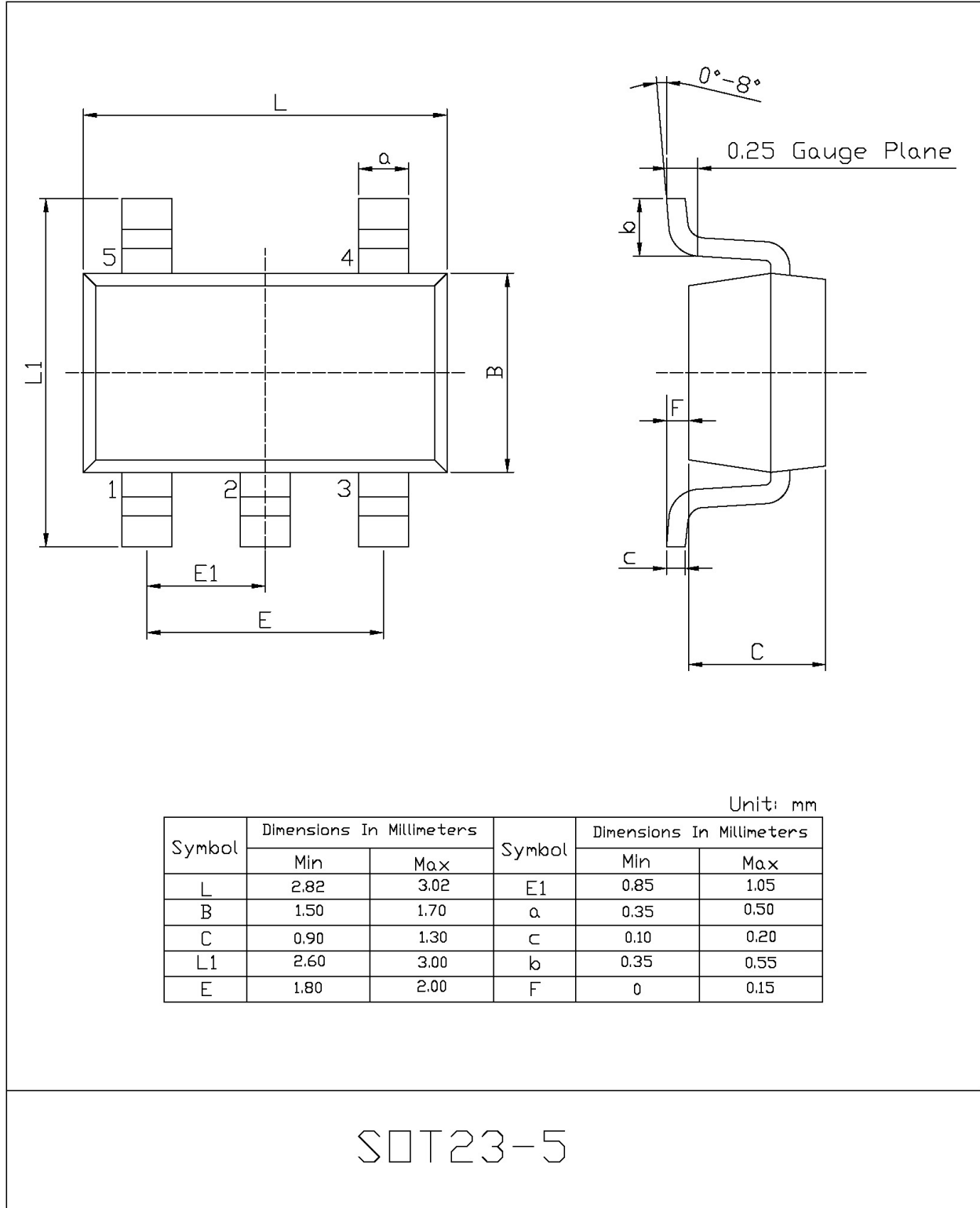
Keep the switching node, LX, away from the sensitive VOUT node

4) 保持 CIN ( - ) 接线端与 COUT 尽可能靠近。

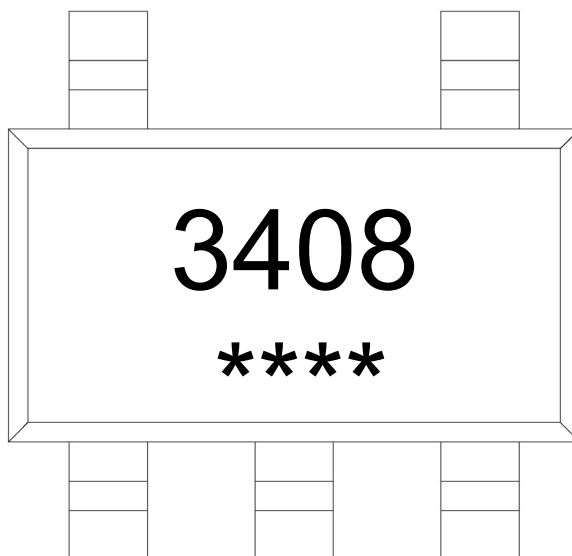
Keep the (-) plates of Cin and Cout as close as possible



**外形尺寸图 / Package Dimensions**



印章说明 / Marking Instructions



说明：

3408：为型号代码

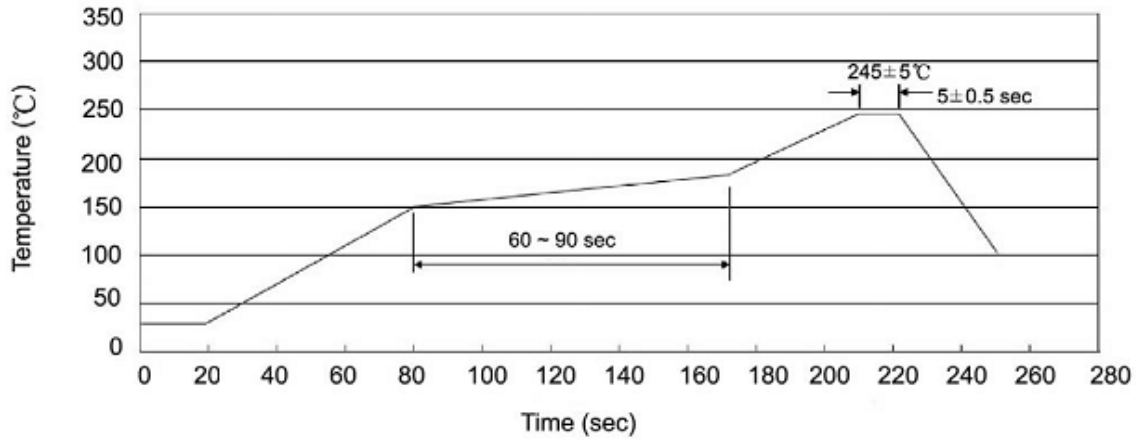
\*\*\*\*：为生产批号代码，随生产批号变化。

Note:

3408: Product Type Code.

\*\*\*\*: Lot No. Code, code change with Lot No.

**回流焊温度曲线图(无铅) / Temperature Profile for IR Reflow Soldering(Pb-Free)**



说明：

- 1、预热温度 150 ~ 180°C，时间 60 ~ 90sec;
- 2、峰值温度 245±5°C，时间持续为 5±0.5sec;
- 3、焊接制程冷却速度为 2 ~ 10°C/sec.

Note:

- 1.Preheating:150~180°C, Time:60~90sec.
- 2.Peak Temp.:245±5°C, Duration:5±0.5sec.
3. Cooling Speed: 2~10°C/sec.

**耐焊接热试验条件 / Resistance to Soldering Heat Test Conditions**

温度：260±5°C

时间：10±1 sec.

Temp.:260±5°C

Time:10±1 sec

**包装规格 / Packaging SPEC.**

卷盘包装 / REEL

Package Type 封装形式	Units 包装数量					Dimension 包装尺寸 (unit: mm <sup>3</sup> )		
	Units/Reel 只/卷盘	Reels/Inner Box 卷盘/盒	Units/Inner Box 只/盒	Inner Boxes/Outer Box 盒/箱	Units/Outer Box 只/箱	Reel	Inner Box 盒	Outer Box 箱
SOT23-5/6	3,000	10	30,000	4	120,000	7" ×8	210×205×205	435×225×420

**使用说明 / Notices**