PC112/PC113

Step Up Converter for White LED Driver

General Description

PC112/PC113 is a compact, high-efficiency step-up DC-DC converter which drives 2-6 series white LEDs with constant current from 3V to 5V. Extremely low shutdown power supply current ensures the high efficiency of battery system. The PC113 works at 500KHz, allowing the application of tiny external components. Low feedback voltage and hence minimal input current from the battery extends battery life.

Built-in N-channel power switches optimize the layout area of PCB. Since PC112/PC113 drives series LEDs, it regulates the light intensity uniformly. With a single external resistor or PWM signal, users can easily set the LED current and LED brightness.

While output loading is open, likes the case of LEDs failure, the duty cycle of the DC-DC converter will increase rapidly, causing high output voltage to damage the circuit. To avoid this situation, a Zener diode should be connected to the DC-DC converter's output to clamp the output voltage in most applications. However, PC113 has built-in the over-voltage protection circuit to protect the output circuit and thus eliminates the need of the external Zener diode.

PC112/PC113 is also characterized of the soft-start feature, which limits the inrush current. It is available in Thin-SOT type package.

Features

1. Typical 85% efficiency
2. No external power switch
3. Low shutdown supply current
4. Low feedback voltage
5. Drives 6 white LEDs 20mA from working voltage 2.0V
6. ± 4 % LED output current accuracy
7. Over voltage protection circuit build in(PC113)
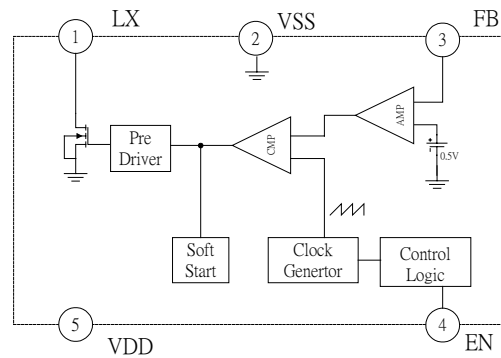8. Soft-start circuit build in
9. Thin 6-pin SOT23-6 package

Application

1. White LED Display Backlighting
2. Cellular Telephones
3. Personal Digital Assistant
4. Digital Cameras
5. Portable Machine

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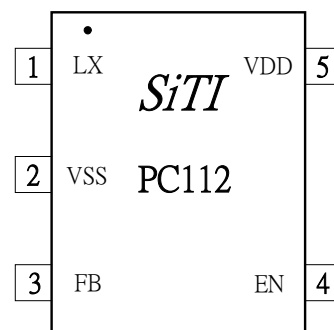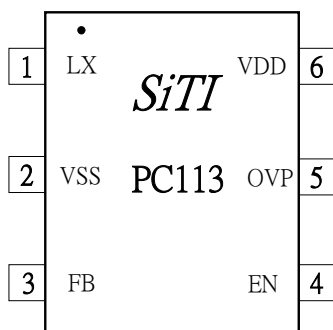*SILICON TOUCH TECHNOLOGY INC.*

Block Diagram
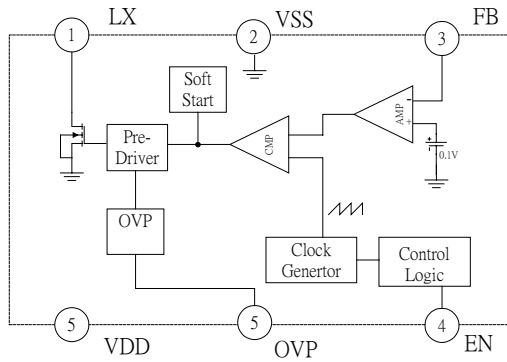
PC113

PC112

Pin Descriptions

Pin No		PIN NAME	Descriptions
PC113	PC112		
1	1	LX	Connect inductor to battery
2	2	VSS	Ground pin
3	3	FB	Feedback pin
4	4	EN	Enable pin
5		OVP	Over voltage protection
6	5	VDD	Input voltage supply pin

TopView

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Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply Voltage	VDD	5.5	V
LX Voltage	V_{LX}	24	V
EN Voltage	V_{EN}	5.5	V
Power Dissipation	P_d	2.5	mW
Storage Temperature	T_{stg}	-65~140	^{o}C
Operating Temperature	T_{opr}	-40~120	^{o}C
Junction Temperature	TJ	160	^{o}C

Electrical characteristics, VDD=3.6V, T_a = 25 ^{o}C . (unless otherwise specified)

| PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	Unit
Operating Input Voltage	VDD		2.8	3.6	5	V
FB PIN Voltage	V_{FB}		85	95	105	mV
FB Vol. Temp. Coefficient	T_{FB}	I_{LED} = 20mA		+92		μV/^{o}C
Switch-on Resistance	R_{SW}			1.5		Ω
Switch Max On-time	T_{ON}		1.4	1.5	1.6	μS
Maximum Duty Cycle	D_{MAX}				80	%
Switching Frequency	F_{SW}		450	500	550	KHz
Efficiency	η			85		%
Supply Current	I_{DD}	V_{EN}=High		1		mA
	I_{DDQ}	V_{EN}=Low		0.1		μA
Shutdown Input Current	I_{EN}	V_{EN}=High		0.2		mA
		V_{EN}=Low		10		nA
*Over voltage protection	V_P			23		V

*Note1 : Only PC113 build this function

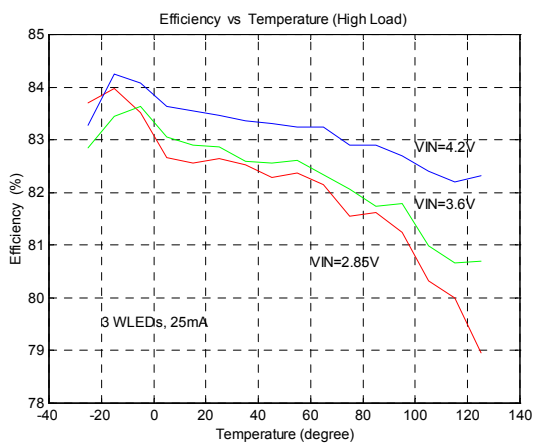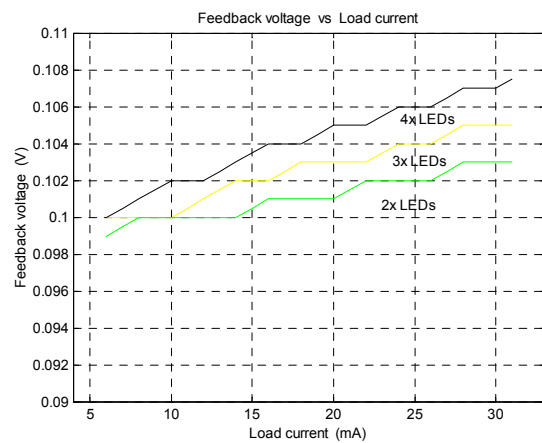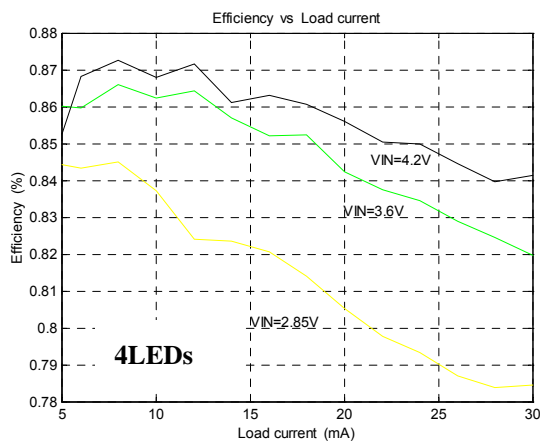## Typical application circuit
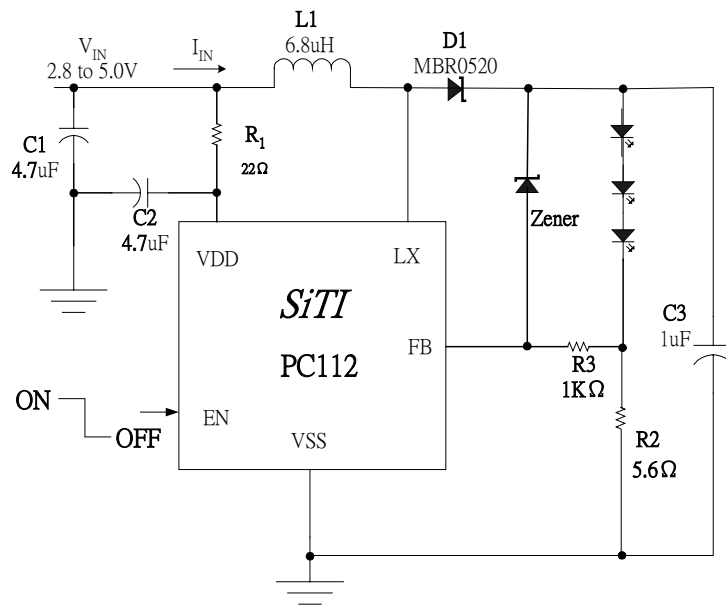
Fig. 1   Application circuit of PC112

Fig. 2   Application circuit of PC113

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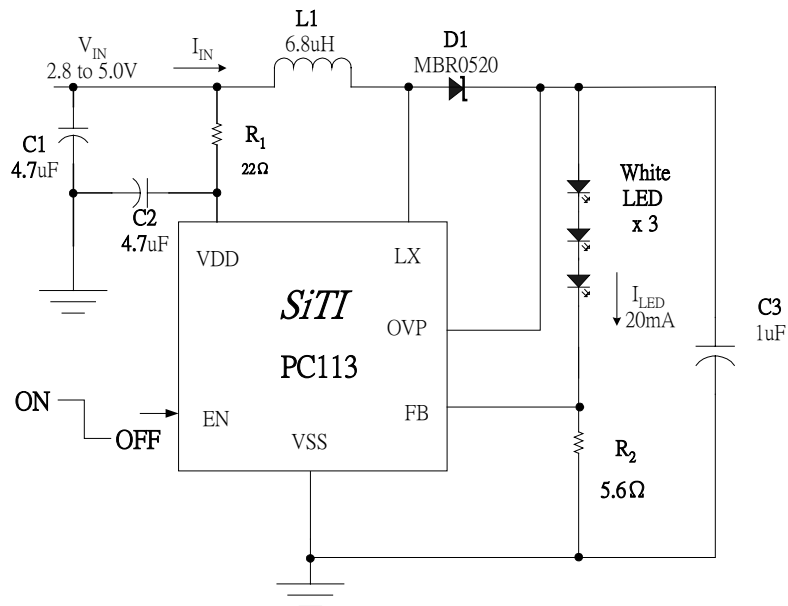
Typical performance characteristics

R₁=22Ω, L1=6.8µH, C1=4.7µF, C2=4.7µF, C3=1µF, Schottky diode VF=0.18, Tₐ = 25 °C ,

 (unless otherwise specified)
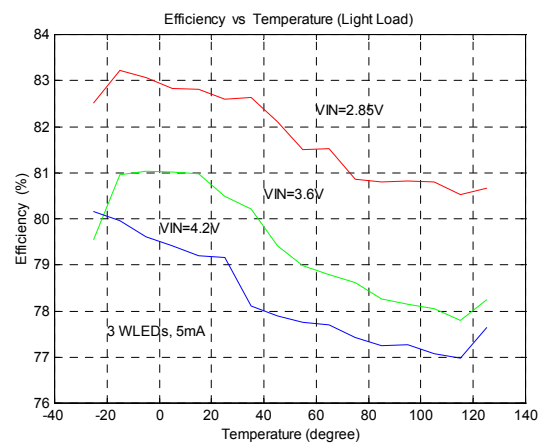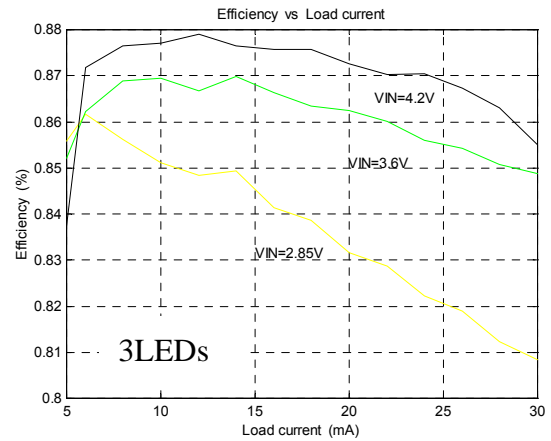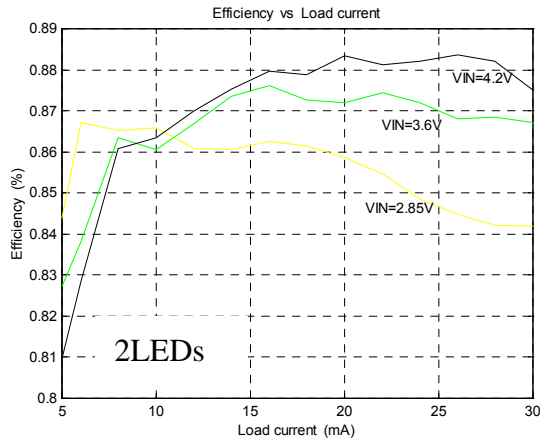
Typical performance characteristics (cond.)
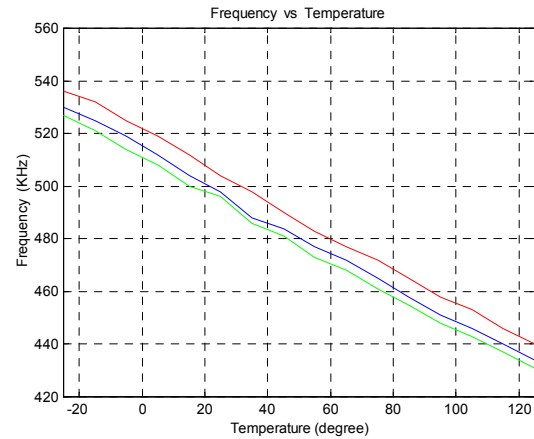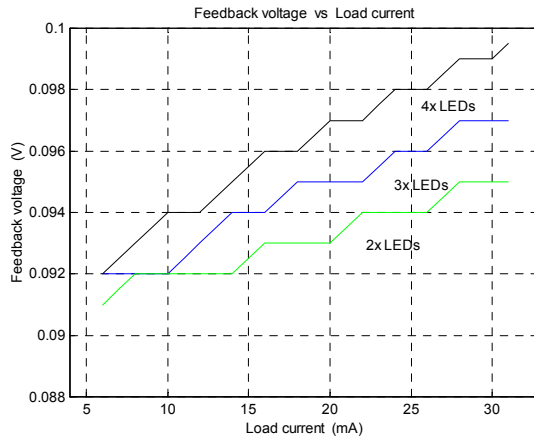
NOTE1 : The white LED forward voltage is about 3.6V, so PC112/PC113 could drive up to 6 series white LEDs.

NOTE2 : To chose D1(Schottky diode), it must has fast switch characteristics and low forward voltage. We recommend the MBR0520in this application.

NOTE3 : The ripple of input voltage could be minimized with C1. Thus, a large value of capacitor C1 is suggested. With the application of a RC-filter (R1 and C2) to VDD pin, the stability of circuit is enhanced. The ripple of output voltage also could be improved with C3. In most designs, the low ESR (equivalent series resistance) capacitors are desirable, like multi-layer capacitor. A 1uF to 2.2uF output capacitor is sufficient for most applications.

NOTE4 : $I_{LED} = \dfrac{0.095}{R2}$ (A)

Application Information

Reference Fig.1 ,condition:　Zener=15V, Ta = 25 $^{\circ}$C , unless otherwise specified
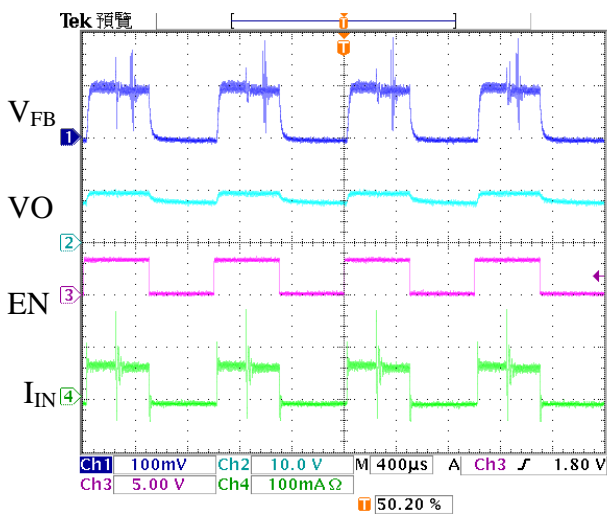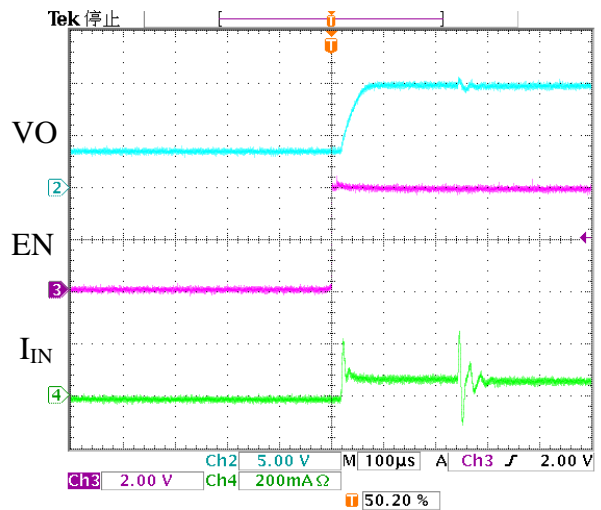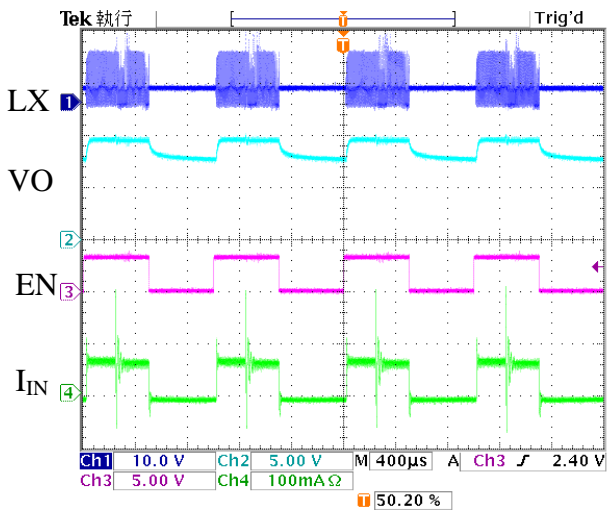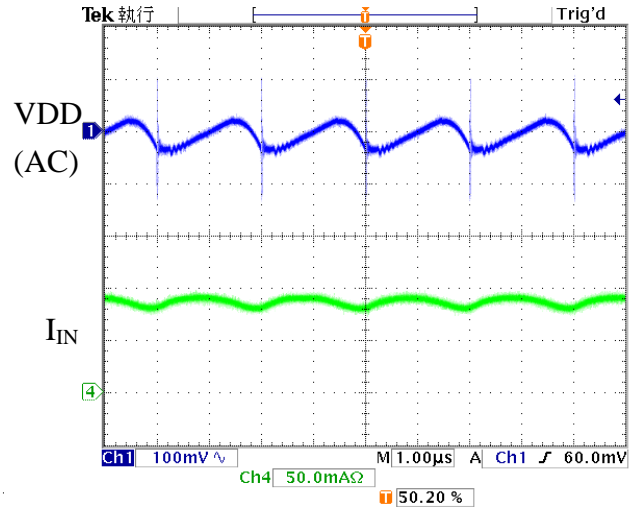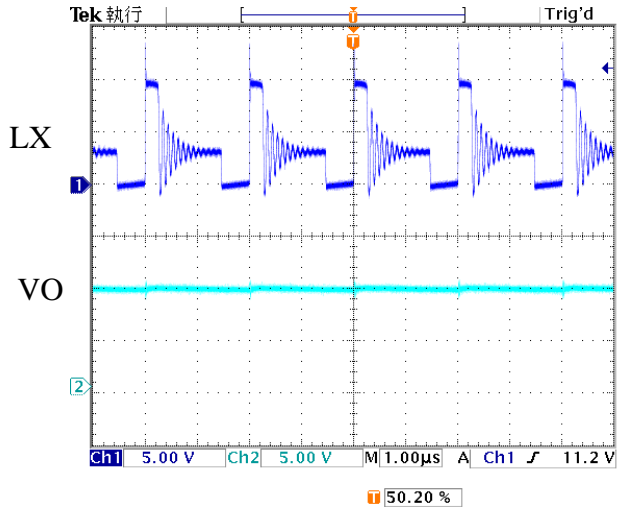
General Description

● Bias current setting

The PC112/PC113 is a DC/DC converter which provides a regulated current output from a VDD input of DC 2.8V to 5.0V. Regulating the LED current can be achieved by setting the resistor of FB pin to ground. So the value of the current setting resistor R2 could be set by:

$$R2 = \frac{0.095}{I_{LED}} \quad (\Omega)$$

● Brightness control

The brightness control can be achieved by applying a PWM control signal to EN pin or by varying the current setting resistor R2, shown as follows.
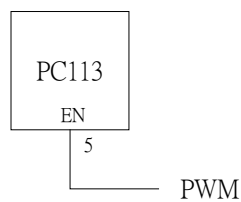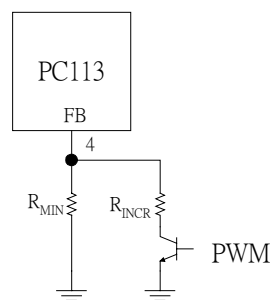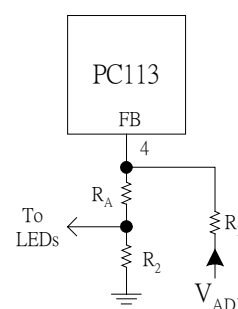
Fig. 3   **Fig. 4**   **Fig. 5**

We could apply a digital PWM signal (100Hz~3KHz) to EN pin (Fig. 3) to generate a LED current waveform identical to that of the PWM signal waveform. The average output LED current is calculated:

$$I_{LED} = \frac{0.095}{R2} \times \text{Duty of PWM} \quad (A)$$

Another control method is to vary the value of the current setting resistor (Fig. 4).

$$I_{LED} = \frac{0.095}{R2} \quad \text{which } R2 = \frac{R_{MIN} \times R_{INCR}}{R_{MIN} + R_{INCR}} \quad , \text{PWM is High} \quad (A)$$

A DAC can also be applied for brightness control, which is shown in Fig. 5. If V_{ADJ}

(output of a DAC or Ambient Light Sensor) increases, the output voltage will decrease. For example, R_A=6.2KΩ, R_B=82KΩ, V_{ADJ} = 4V, V_{FB1} will set to 0.05V, so the LED's current will be half .

- Open circuit protection (PC113 only)

    When the LEDs are disconnected from the circuit or the LEDs fail, PC113 will switch to maximum duty cycle. This situation results in a high output voltage and may cause the LX pin voltage to exceed its maximum rating of 24V and thus damages output circuit. Normally, a Zener diode is applied to clamp the high voltage; however, PC113 has built-in the over-voltage protection circuit, and thus no external component is required.

- Recommended PCB layout
    1. C2 is placed as close to PC112/113 as possible.
    2. Minimize the length and area of all traces connecting to LX pin.
    3. The power path : VDD $\rightarrow$ L1 $\rightarrow$ LX $\rightarrow$ D1 $\rightarrow$ C3 should be kept as short as possible to avoid EMI.
    4. Fig. 6 shows the exemplary test board layout. (Reference page4. typical application circuit)
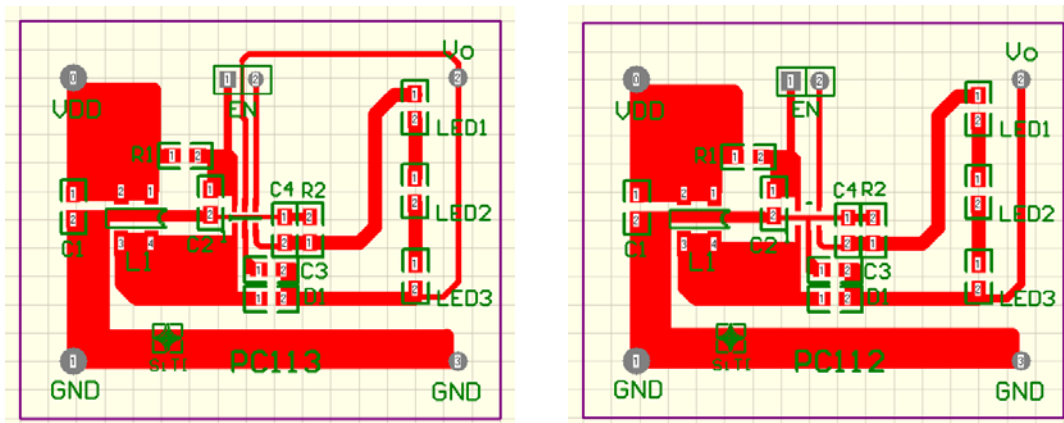

Fig. 6

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● Recommended solder pad
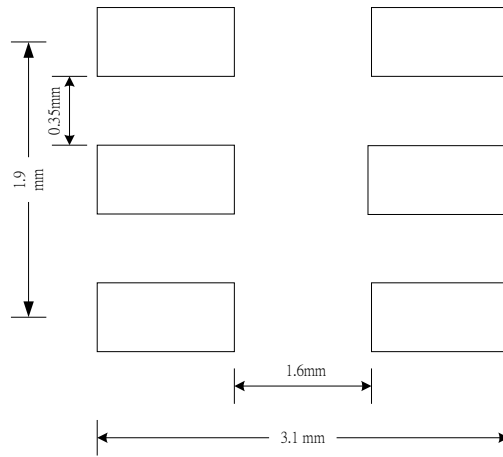
Fig. 7

Package Specification (SOT23-6)

SYMBOL	Dimensions in Millimeters		
	MIN	NOM	MAX
A	1.00	1.10	1.30
A_1	0.00	—	0.10
A_2	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.10	0.15	0.25
D	2.70	2.90	3.10
E	1.40	1.60	1.80
e	—	1.90(TYP)	—
H	2.60	2.80	3.00
L	0.37	—	—
$\theta1$	1°	5°	9°

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Package Specification (SOT23-5)

SYMBOL	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	1.00	1.10	1.30
A_1	0.00	—	0.10
A_2	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.10	0.15	0.25
D	2.70	2.90	3.10
E	1.40	1.60	1.80
e	—	1.90(TYP)	—
H	2.60	2.80	3.00
L	0.37	—	—
θ1	1°	5°	9°

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