



Current Mode PWM Controller

MC7731N6

Description

MC7731N6 is highly integrated current mode PWM control IC optimized for high performance low standby power offline fly back converter applications. To meet the international power conservation requirements, optimized green mode is integrated to improve the efficiency at light or no load conditions with no audible noise. Slope compensation is integrated to ensure the stability at high load. Lead edge blanking is integrated to prevent the false trigger at the transition of the switch. Soft switching control at the gate drive can improve the EMI performance of the power supply. The Gate-drive output is clamped at 18V to protect the power MOS. MC7731N6 offers many protection functions with auto self-recovery features, including cycle-by-cycle current limiting, over-load protection (OLP) and under voltage lockout(UVLO). Excellent EMI performance is achieved with frequency jitter technique together with soft switching control at the totem pole gate driver.

Features

- Frequency jitter function to improve EMI performance of power supply
- No-audible-noise green mode Control
- External Programmable PWM Switching Frequency
- Internal Slope Compensation
- Low VDD Startup Current and Low Operating Current
- Leading Edge Blanking
- UVLO
- Gate Max Output Voltage Clamp at 18V
- Overload Protection (OLP).
- Line Compensation Over Current Protection (OCP)

Applications

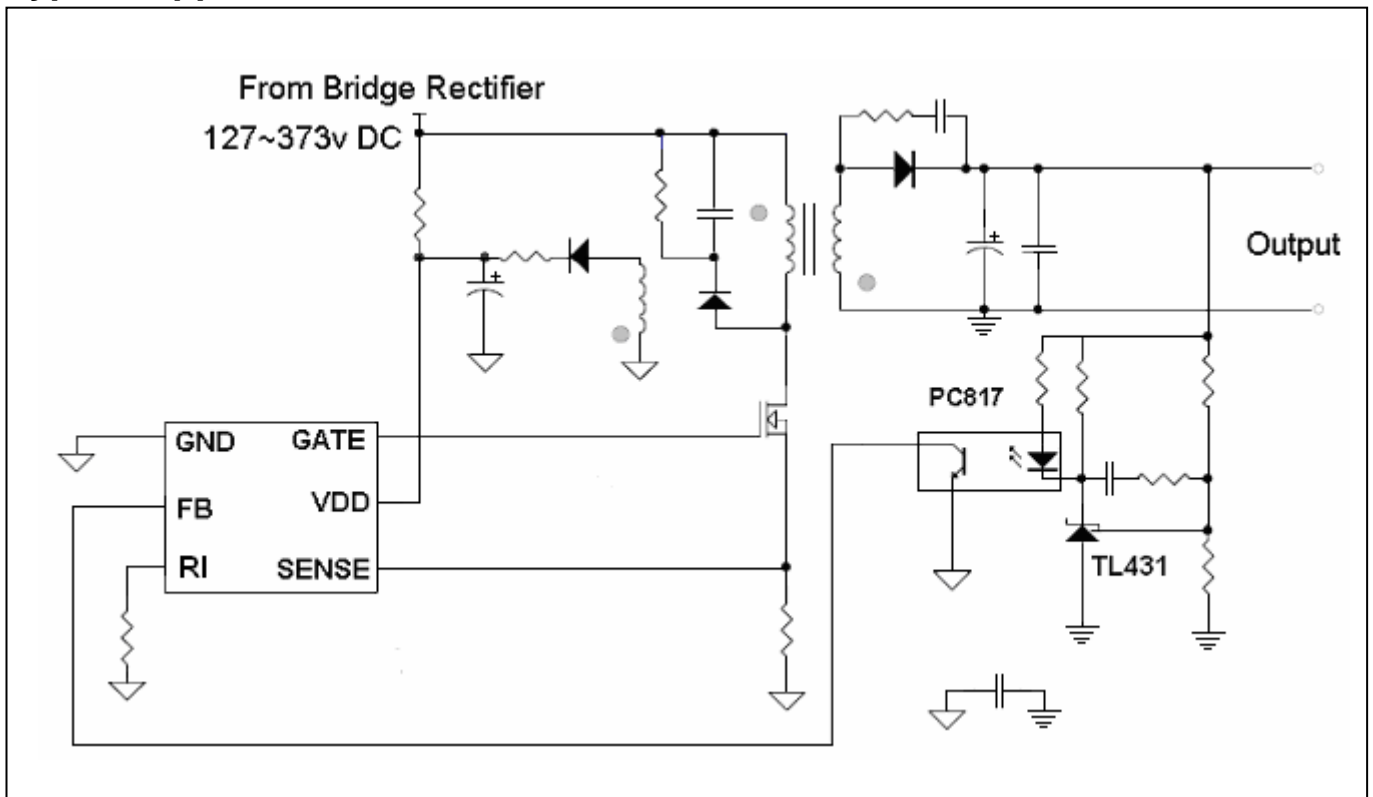
Offline AC/DC flyback converter for

- Battery Charger
- Power Adaptor
- Set-Top Box Power Supplies
- Open-frame SMPS
- PC 5V Standby Power

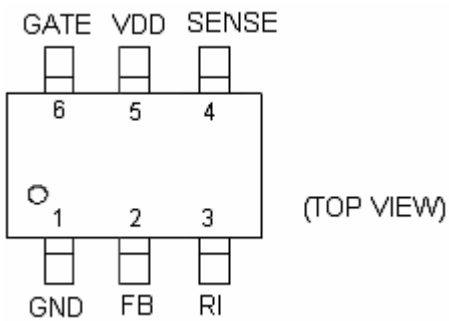
Ordering Information

Device	Package	Shipping
MC7731N6	SOT-23-6L (Pb-free lead plating)	3000 pcs / tape & reel

Typical Application Circuit



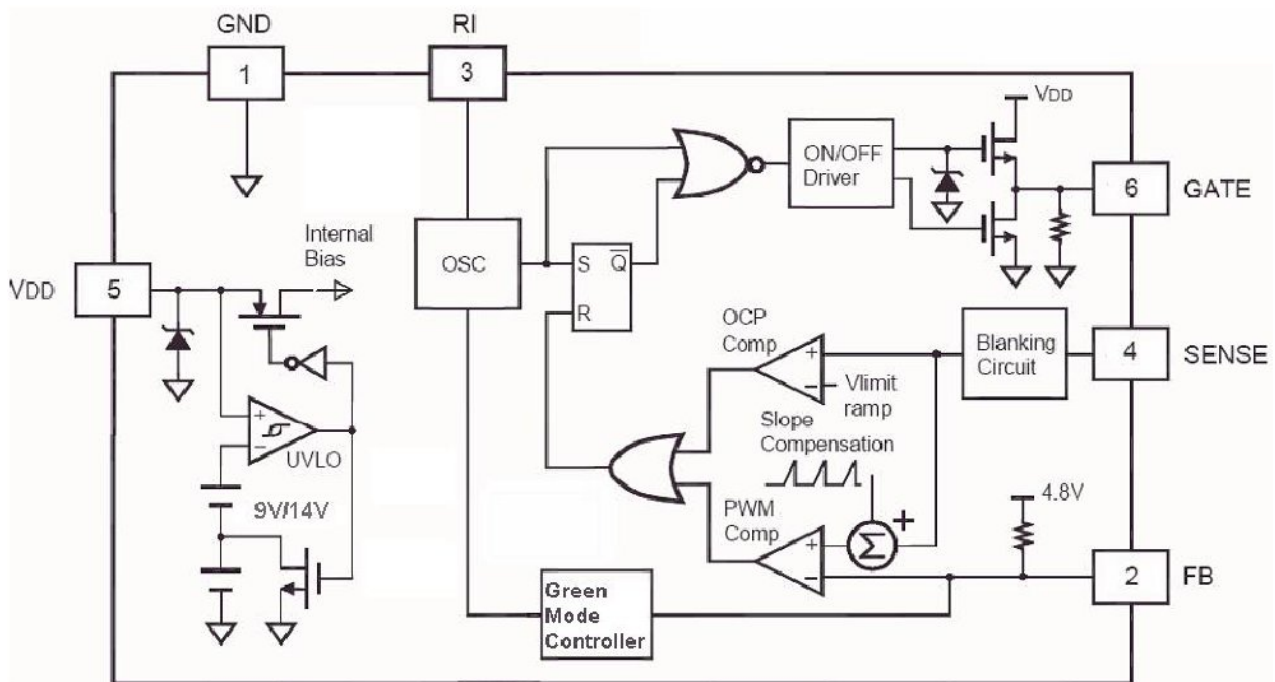
Pin Configuration



Pin Assignment

Pin Name	Pin Number	Pin Function
GND	1	Ground
FB	2	Feedback input pin. The PWM duty cycle is determined by voltage level into this pin and the current-sense signal at Pin 6.
RI	3	Internal Oscillator frequency setting pin. A resistor connected between RI and GND sets the PWM frequency.
SENSE	4	Current sense input pin. Connected to MOSFET current sensing resistor node.
VDD	5	Chip DC power supply pin.
GATE	6	Totem-pole gate drive output for the power MOSFET.

Function Block Diagram



Absolute Maximum Ratings

Parameter	Value	Unit
V _{DD} to GND	-0.3 to +30	V
V _{DD} clamped current	10	mA
V _{DD} clamped voltage	29	V
V _{FB} , V _{SENSE} and V _{RI} to GND	-0.3~+7	V
Maximum Junction Temperature (T _J MAX)	-20° to +150	°C
Storage Temperature Range	-55 ~ +150	°C

Note : Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.



Recommended Operating Conditions

- Supply Voltage, V_{DD}.....25V
- Operating Temperature Range.....-20 °C to 85 °C
- RI resistor value100 kΩ

Electrical Characteristics

(T_A = 25°C, RI=100kΩ, V_{DD}=16V if not otherwise noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
SUPPLY SECTION						
Chip start up current via VDD pin	I _{set}	V _{dd} =12V, measure current into VDD pin		5	20	uA
Operation current	I _{op}	V _{DD} =16V,V _{FB} =3V		1.4		mA
VDD Off(Turn-off threshold)	UVLO _L		8	9	10	V
VDD on(Turn-on threshold)	UVLO _H		13	14	15	V
VZ(VDD clamp voltage)	V _{DD_CLP}	I _{Z(Idd)} =10mA		34		V
FEEDBACK SECTION						
PWM input gain	A _{PWM}	ΔV _{FB} /ΔV _{CS}		2		V/V
VFB open loop voltage	V _{FB_O}			5.3		V
FB pin short circuit current	V _{FB_S}	Short FB pin to gnd and measure current		0.8		mA
Zero duty cycle FB threshold	V _{FB_th_L}			0.75		V
Power limiting FB threshold	V _{FB_th_P}			3.7		V
Power limiting delay time	T _{PL_D}			35		ms
Input impedance	R _{FB}			6		KΩ
Maxim duty cycle	D _{MAX}	V _{DD} =18V, FB=3V,CS=0		80		%
OSCILLATOR						
Normal oscillation frequency	F _{osc}		60	65	70	kHz
Frequency temperature stability	Δf _{Temp}	T _A = -20°C to +100°C		5		%
Frequency supply stability	Δf _{Sup}	V _{DD} =12-25V		5		%
Operating RI range	RI _{range}		50	100	150	KΩ
RI open load voltage	RI _{open}			2		V
Burst mode base frequency	F _{osc-BM}			22		KΩ
Frequency modulate range (jitter)	Δf _{OSC}		-3		3	%
Jitter frequency	f _{jitter}			32		Hz
CURRENT SENSE SECTION						
Leading edge blanking time	T _{blank}			300		nS
Sense pin input impedance	R _{sense}			40		kΩ
Over current threshold voltage at sense pin	V _{TH_OC}	FB=3.3V	0.7	0.75	0.8	V
Over current protect delay	T _{OC_D}	CS>V _{TH_OC} , FB=3.3V		75		nS
GATE OUTPUT						
Output low level	V _{OL}	I _o =20mA			0.8	V
Output high level	V _{OH}	I _o =20mA	10V			V

Output voltage clamped level	VO_clamp			18		V
Output rising time	Tr	Cl=1nf		220		nS
Output falling time	Tf	Cl=1nf		70		ns

OPERATION DESCRIPTION

Over-view description

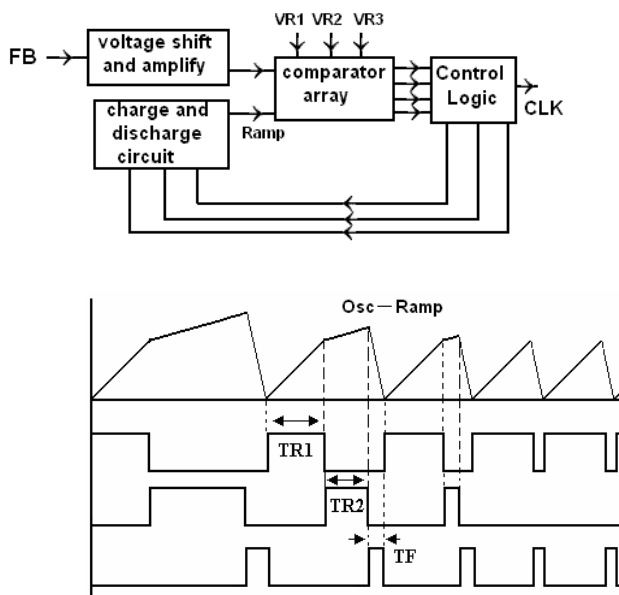
The MC7731N6 includes all necessary function to build an easy and cost effective solution for low power supplies to meet the international power conservation requirements.

Start-up current

Startup current of MC7731N6 is designed to be very low so that VDD could be charged up above UVLO (exit) threshold level and device starts up quickly. Also a large value startup resistor can be used to minimize the power loss.

Green Mode Operation (Patent)

At light load or no load condition, the switch loss become the major loss of the power supply, to reduce the power wasted in light and no load condition, based on a special designed voltage controlled oscillator, green mode operation of the power supply can be achieved by using MC7731N6. The controller will judge the load condition based on the voltage of FB pin. In light load the FB voltage will decrease, when VFB is lower than a set threshold voltage, a FB depending time (TR2) will be generated by the oscillator and decrease the operating frequency of the power supply, the minimum frequency is set about 22kHz. The function block and the working waveform can be depicted as below:





When V_{FB} decreases further, the power supply will enter into burst mode operation to decrease the power consumed at no load condition. Besides there is no audible noise in any load condition.

Oscillator Operation

A resistor from RI pin to ground will generate a constant current source for MC7731N6. This current is used to charge/discharge an internal capacitor and hence the internal clock and switching frequency are determined. Increase the resistance will decrease the current source and reduce the switching frequency. The relation between Ri and switching frequency is:

$$f_{PWM} = \frac{6500}{R_i} \text{ (KHz)}$$

Built-in Slope Compensation

The sensed voltage across the sense resistor is used for pwm control, and pulse by pulse current limit. Built-in slope compensation circuit adds a voltage ramp onto the current sense input voltage. This greatly improves the close loop stability and prevents the sub-harmonic oscillation of peak current mode pwm control scheme.

Leading Edge Blanking

Each time when the power MOSFET is switched on, a turn-on spike will inevitably occur on the sense-resistor. To avoid premature termination of the switching pulse, a 270 nsec leading-edge blanking time is built in. Conventional RC filtering can therefore be omitted. During this blanking period, the current-limit comparator is disabled and it cannot switch off the gate driver.

Gate Driver

The output stage of MC7731N6 is a fast totem pole gate driver. Cross conduction has been avoided to minimize heat dissipation, increases efficiency and enhances reliability. The output driver is clamped by an internal 18V Zener diode in order to protect power MOSFET transistors against undesirable gate over voltage. A soft driving waveform is implemented to minimize EMI.

Frequency Jitter

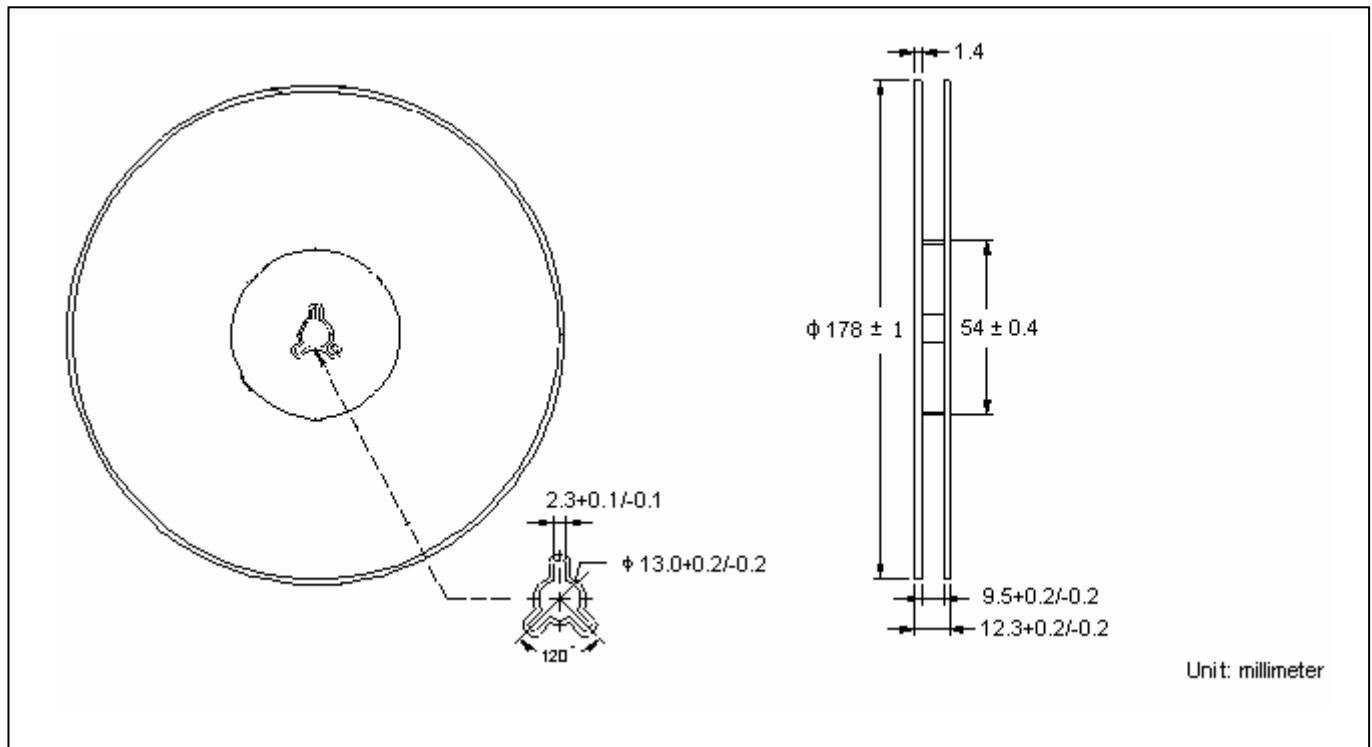
The frequency jitter function is integrated in the controller, the jitter is modulated by a periodic signal, the modulate signal frequency is much smaller than the oscillator frequency, By this way , the EMI noise has a wider spectrum with lower amplitudes.



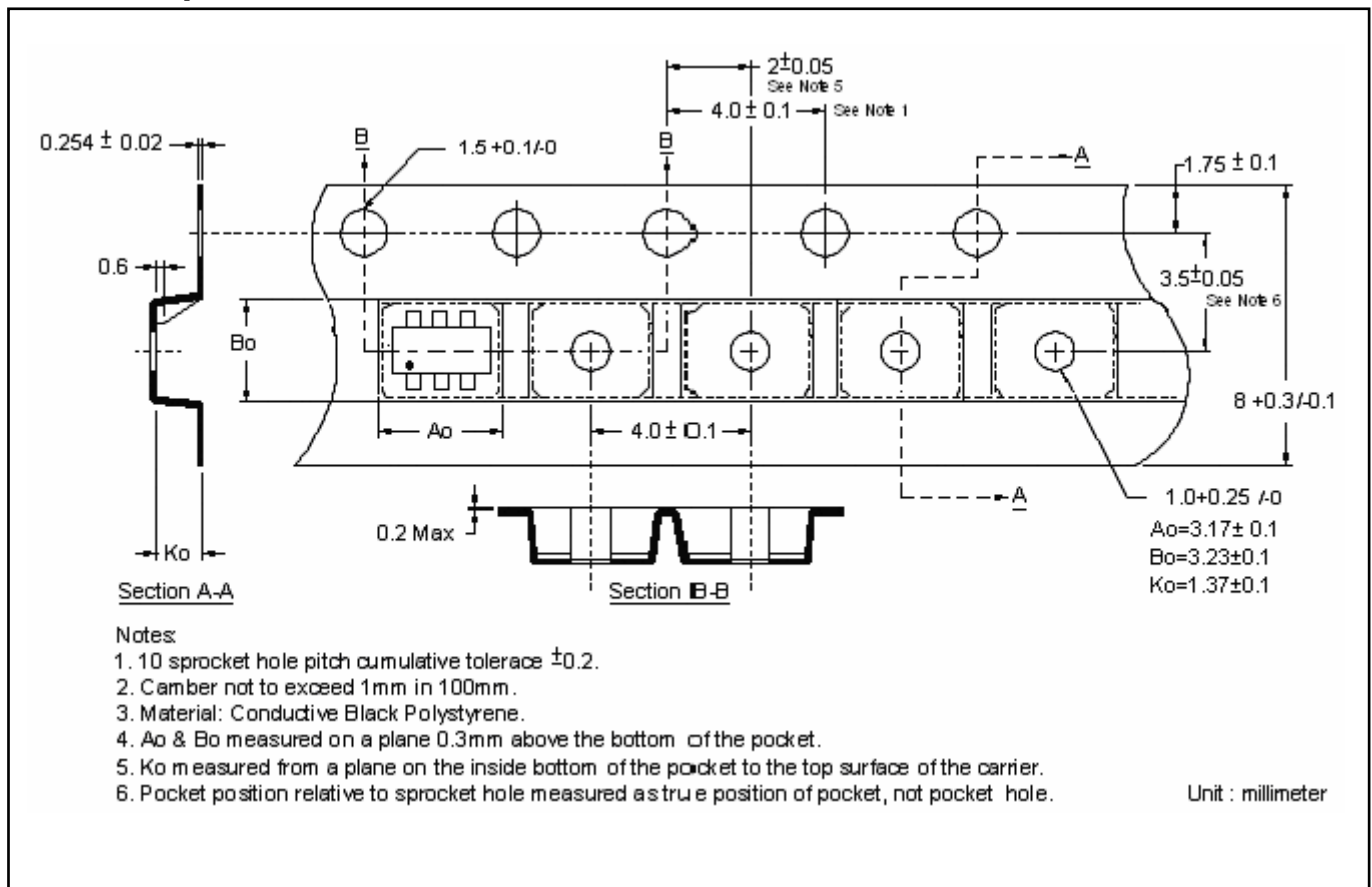
Protect Functions

To increase the reliability of power supply system, many protection functions are integrated in this controller, including Cycle-by-Cycle current limiting (OCP), Over Load Protection (OLP) and over voltage clamp, Under Voltage Lockout on VDD (UVLO). At overload condition when FB input voltage exceeds power limit threshold value for more than TD_PL (power limit debounce time), the controller reacts to shut down the output power MOSFET. Device restarts when VDD voltage drops below UVLO limit. VDD is supplied by transformer auxiliary winding output. It is clamped when VDD is higher than threshold value. The power MOSFET is shut down when VDD drops below UVLO limit and device enters power on start-up sequence thereafter.

Reel Dimension



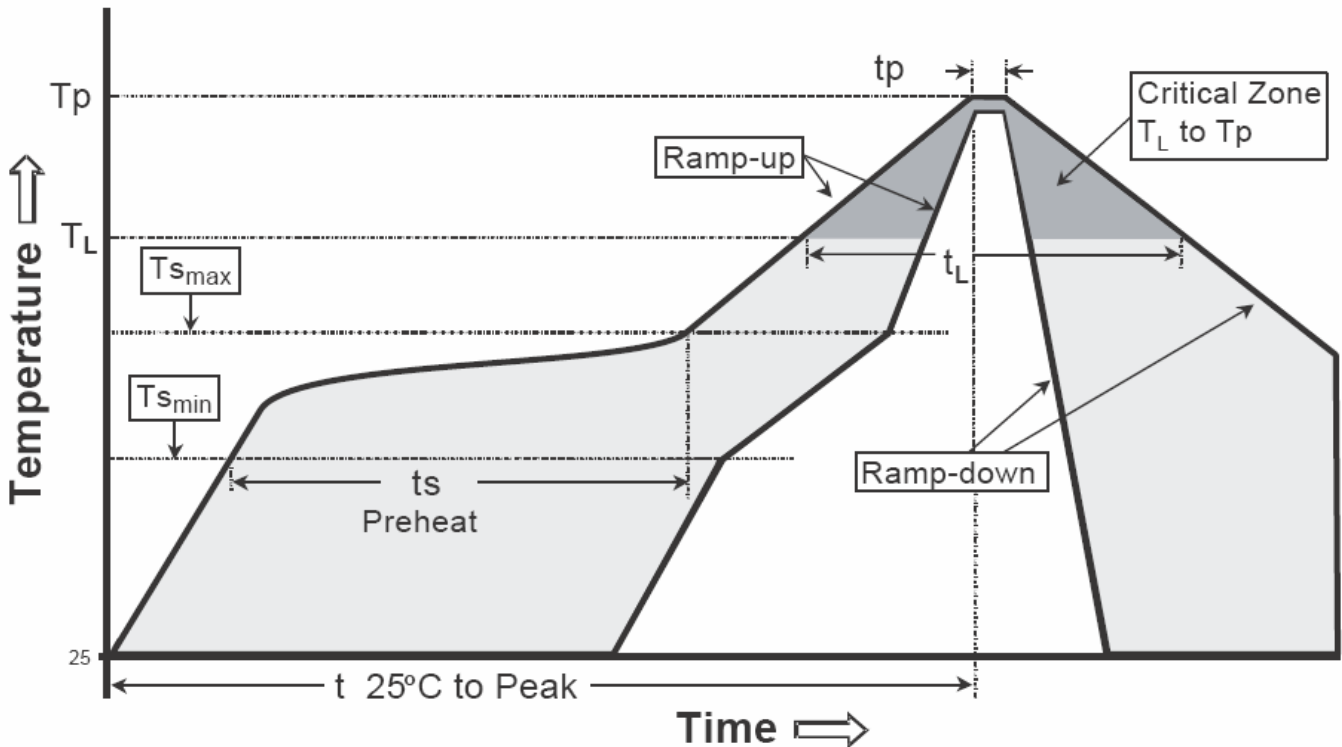
Carrier Tape Dimension



Recommended wave soldering condition

Product	Peak Temperature	Soldering Time
Pb-free devices	260 +0/-5 °C	5 +1/-1 seconds

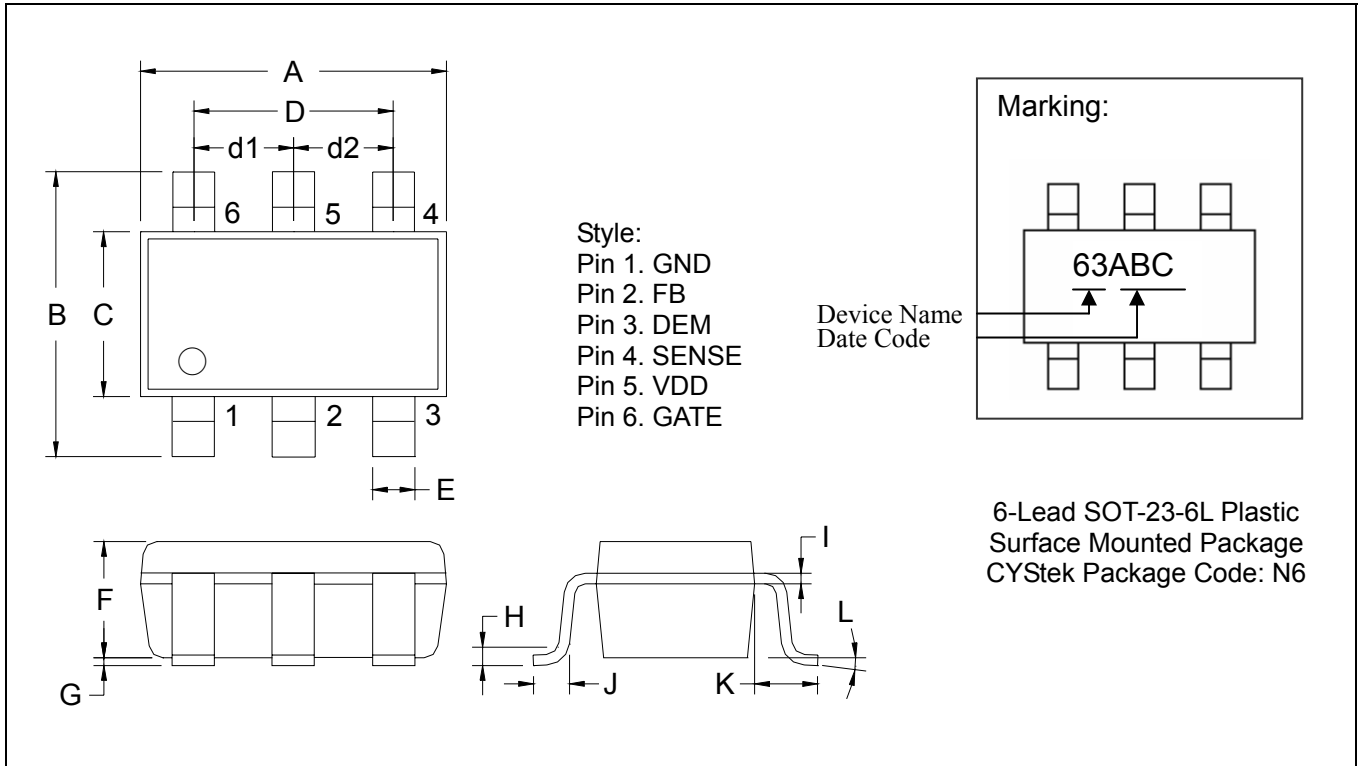
Recommended temperature profile for IR reflow



Profile feature	Sn-Pb eutectic Assembly	Pb-free Assembly
Average ramp-up rate (T _{smax} to T _p)	3°C/second max.	3°C/second max.
Preheat		
-Temperature Min(T _{s min})	100°C	150°C
-Temperature Max(T _{s max})	150°C	200°C
-Time(t _{s min} to t _{s max})	60-120 seconds	60-180 seconds
Time maintained above:		
-Temperature (T _L)	183°C	217°C
- Time (t _L)	60-150 seconds	60-150 seconds
Peak Temperature(T _P)	240 +0/-5 °C	260 +0/-5 °C
Time within 5°C of actual peak temperature(tp)	10-30 seconds	20-40 seconds
Ramp down rate	6°C/second max.	6°C/second max.
Time 25 °C to peak temperature	6 minutes max.	8 minutes max.

Note : All temperatures refer to topside of the package, measured on the package body surface.

SOT-23-6L Dimension



DIM	Inches		Millimeters		DIM	Inches		Millimeters	
	Min.	Max.	Min.	Max.		Min.	Max.	Min.	Max.
A	0.1063	0.1220	2.70	3.10	F	0.0472 REF		1.20 REF	
B	0.1024	0.1181	2.60	3.00	G	0	0.0059	0	0.15
C	0.0551	0.0709	1.40	1.80	H	-	0.0086	-	0.22
D	0.0748 REF		1.90 REF		I	0.0047 REF		0.12 REF	
d1	0.0374 REF		0.95 REF		J	0.0146 REF		0.37 REF	
d2	0.0374 REF		0.95 REF		K	0.0236 REF		0.60 REF	
E	0.0118	0.0217	0.30	0.55	L	0°	10°	0°	10°

Notes : 1.Controlling dimension : millimeters.
 2.Maximum lead thickness includes lead finish thickness, and minimum lead thickness is the minimum thickness of base material.
 3.If there is any question with packing specification or packing method, please contact your local CYStek sales office.

Material :

- Mold Compound : Epoxy resin family, flammability solid burning class:UL94V-0

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