1.0MHz, 3A Synchronous Step-Down Converter Regulator

Features

- Input voltage range from 2.7V to 5.5V
- Up to 3A Output Current
- 1.0MHz Constant Frequency Operation
- High Efficiency: Up to 95%
- No Schottky Diode Required
- Output Voltage as Low as 0.6V
- PFM Mode for High Efficiency in Light Load
- 100% Duty Cycle in Dropout Operation
- Low Quiescent Current: 50uA
- Short Circuit Protection
- Thermal Fault Protection
- Power Good Output Function(HCR3113A only)
- Inrush Current Limit and Soft Start
- Input overvoltage protection(OVP)
- <1uA Shutdown Current
- SOT23-6L package for HCR3113A
- SOT23-5 package for HCR3113B

Applications

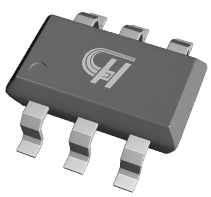
- Digital Set-top Box (STB)
- Wireless and DSL Modems
- Portable Instruments
- Digital and Video Cameras
- PC Cards

General Description

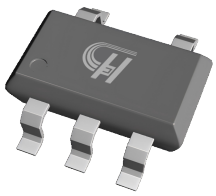
The HCR3113A and HCR3113B are a 1.0MHz constant frequency,current mode step-down converter. It is ideal for portable equipment requiring high output current up to 3A from single-cell Lithium-ion batteries. They also can run at 100% duty cycle for low dropout operation, extending battery life in portable systems while light load operation provides very low output ripple for noise sensitive applications. The high switching frequency of the HCR3113A and HCR3113B could minimize the size of external components while keeping switching losses low.The internal slope compensation setting allow the device to operate with smaller inductor values to optimize size and provide efficient operation.

The HCR3113A has power good function and it offered in 6 pin, SOT23-6L package.

The HCR3113B is offered in 5-pin,SOT23-5 pacakge with adjustable output voltage without PG pin. The devices offers two operation modes, PWM control and PFM mode switching control, which allows a high efficiency over the wider range of the load.



SOT23-6L



SOT23-5

Figure 1. Package Type of HCR3113A/HCR3113B

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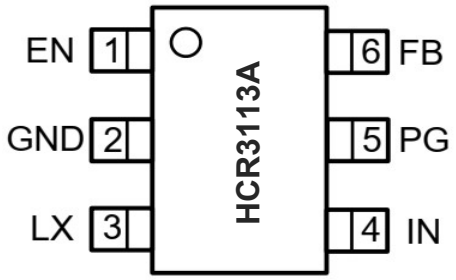
Pin Configuration

SOT23-6L (Top View)



SOT23-5 (Top View)

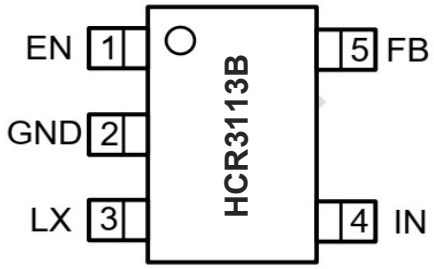
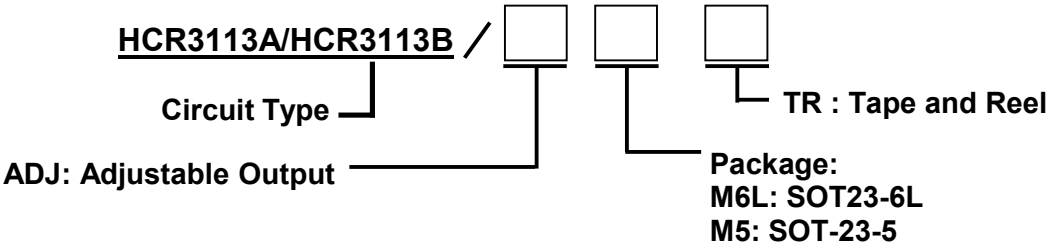


Figure 2. Pin Configuration of HCR3113A/HCR3113B (Top View)

Pin Function Table

Pins		Name	Function
HCR3113A	HCR3113B		
1	1	EN	Enable Pin. Drive EN above 1.5V to turn on the part. Drive EN below 0.4V to turn it off. Do not leave EN floating.
2	2	GND	Ground Pin
3	3	LX	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	4	VIN	Analog Supply Input Pin.
5	-	PG	Power Good Open Drain Output Pin for HCR3113A
6	5	FB	Output Voltage Feedback Pin. An internal resistive divider divides the output voltage down for comparison to the internal reference voltage.

Ordering Information



Ordering Code

Part Number	Marking ID note2	Temperature Range	Package	Quantity per Reel
HCR3113A/ADJM6LTR	TCBXXX	-40'C to +85'C	SOT23-6L	3000pcs/TR
HCR3113B/ADJM5TR	TCCXXX	-40'C to +85'C	SOT-23-5	3000pcs/TR

Note 2: "TCB&TCC" is device code, "XXX" is inside code.

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Absolute Maximum Ratings Note 1

Parameter		Symbol	Value	Unit
Input Supply Voltage Range		V_{IN}	-0.3 to +7.0	V
LX Voltage Range		V_{LX}	-0.3 to +7.0	V
EN Voltage Range		V_{EN}	-0.3 to +7.0	V
FB Voltage Range		V_{FB}	-0.3 to +7.0	V
PG Voltage Range		V_{PG}	-0.3 to +7.0	V
Adjustable Output Voltage Range		V_{OUT}	0.6 to 5.5	V
Power Dissipation	SOT23-6L	PO	600	mW
	SOT-23-5		550	
Thermal Resistance Junction to Ambient	SOT23-6L	$R_{\theta JA}$	200	'C/W
	SOT-23-5		215	
Thermal Resistance Junction to Case	SOT23-6L	$R_{\theta JC}$	105	'C/W
	SOT-23-5		110	
Storage Temperature Range		T_{STG}	-65 to 150	'C
Operating Junction Temperature		T_J	-40 to +85	'C
Lead Temperature (Soldering, 10s)		T_{LEAD}	260	'C
Human Body Model for all pins		V_{ESD_HBM}	±2000	V
Charge Device Model for all pins		V_{ESD_CDM}	±1000	V

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.

Recommended Operating Conditions

Parameter	Symbol	Test Condition	Min	Type	Max	Unit
Input Voltage Range	V_{IN}		2.7	-	5.5	V
Operating Junction Temperature Range	T_J		-40	-	125	'C

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Electrical Characteristics

(VIN=VEN=3.6V, VOUT=1.8V, TA=25'C, unless otherwise noted.)

Parameter	Symbol	Test Condition	Min	Type	Max	Unit
Input Voltage Range	V_{IN}		2.7	-	5.5	V
Input OVP Threshold	V_{OVP}	VIN rising	-	6.1	-	V
UVLO Threshold	V_{UVLO}	VIN rising	-	2.5	-	V
UVLO Hysteresis	$V_{UVLO-HYS}$		-	0.5	-	V
Quiescent Current	I_Q	V_{EN}=2.0V, I_{OUT}=0 V_{FB}=V_{REF}*105%	-	50	85	uA
Shutdown Current	I_{SHDN}	V_{EN}=0V or EN=GND	-	0.1	1.0	uA
Regulated Feedback Voltage	V_{REF}	T_A=25'C, PWM Operation	0.588	0.600	0.612	V
		T_A=25'C, PFM Operation, No Load	-	0.609	-	V
Reference Voltage Line Regulation	ΔLine	VIN=2.7V to 5.5V	-	0.1	-	%/V
Output Voltage Accuracy	ΔV_{OUT}	VIN=2.7V to 5.5V, I_{OUT}=10mA to 3000mA	-3	-	+3	%/V_{OUT}
On Resistance of PMOS	$R_{DS(ON)1}$	I_{LX}=100mA	-	95	-	mΩ
On Resistance of NMOS	$R_{DS(ON)2}$	I_{LX}=100mA	-	50	-	mΩ
Peak Current Limit	I_{PCT}	VIN=5V, V_{OUT}=90%	-	3.5	-	A
Oscillation Frequency	F_{OSC}	V_{OUT}=100%	-	1.0	-	MHz
		V_{OUT}=0V	-	300	-	KHz
EN High Level Input Voltage	V_{EN-H}		1.5	-	-	V
EN Low Level Input Voltage	V_{EN-L}		-	-	0.4	V
EN Leakage Current	I_{EN_LC}		-	0.01	1.0	uA
LX Leakage Current	I_{LX_LC}	V_{EN}=0V, V_{IN}=V_{LX}=5V	-	0.01	1.0	uA
Power Good Threshold(for HCR3113A)	η	V_{FB}=0.6V	-	91	-	%
Minimum On-Time	TON		-	60	-	nS
Minimum Off-Time	Toff		-	90	-	nS
Soft Start	Tstart		-	-	1.2	mS
Thermal Shutdown note3	TSHDN		-	155	-	'C
Thermal Hysteresis	THYTS		-	20	-	'C

Note 3. Thermal shutdown threshold and hysteresis are guaranteed by design.

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Functional Block Diagram

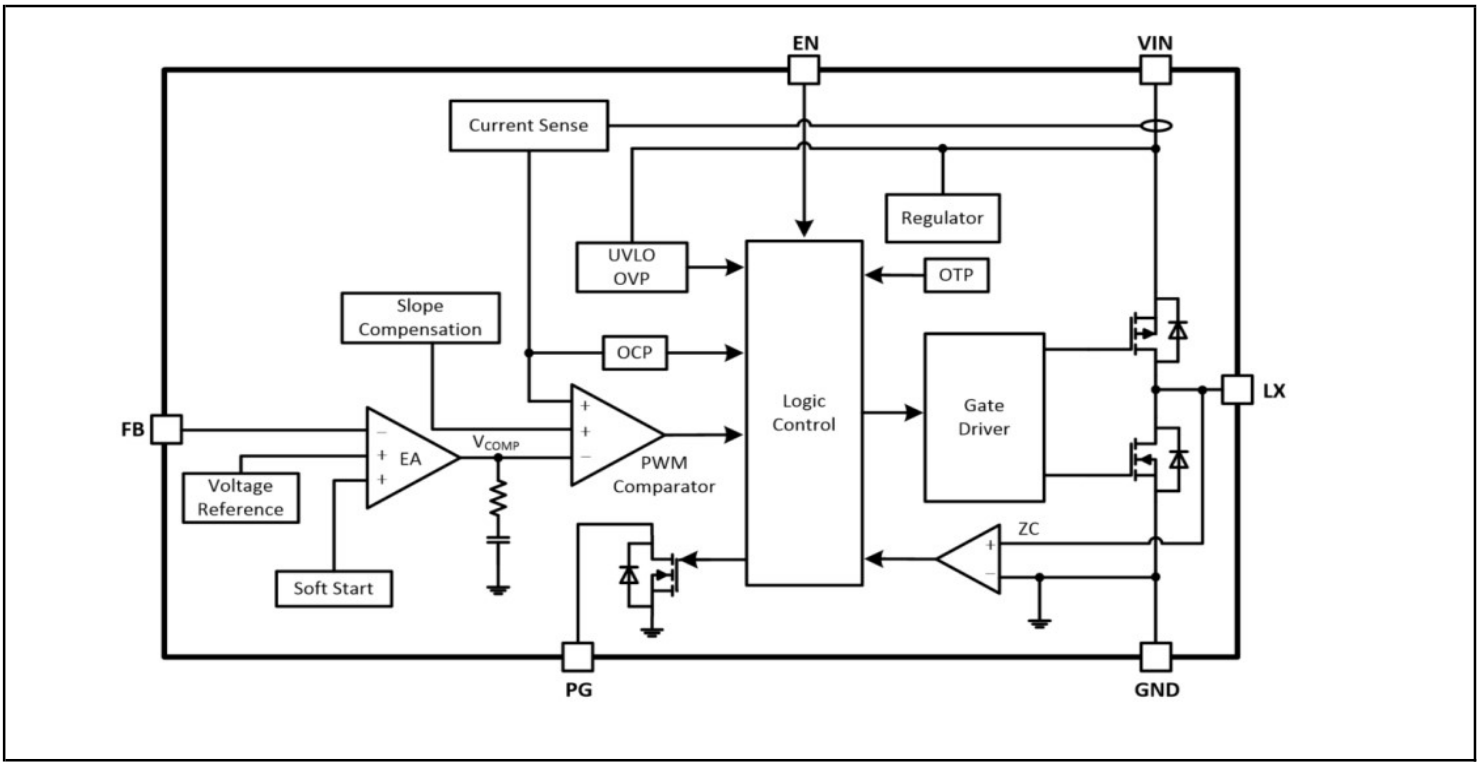

Figure 3. Functional Block Diagram of HCR3113A

Functional Block Diagram(Con.)

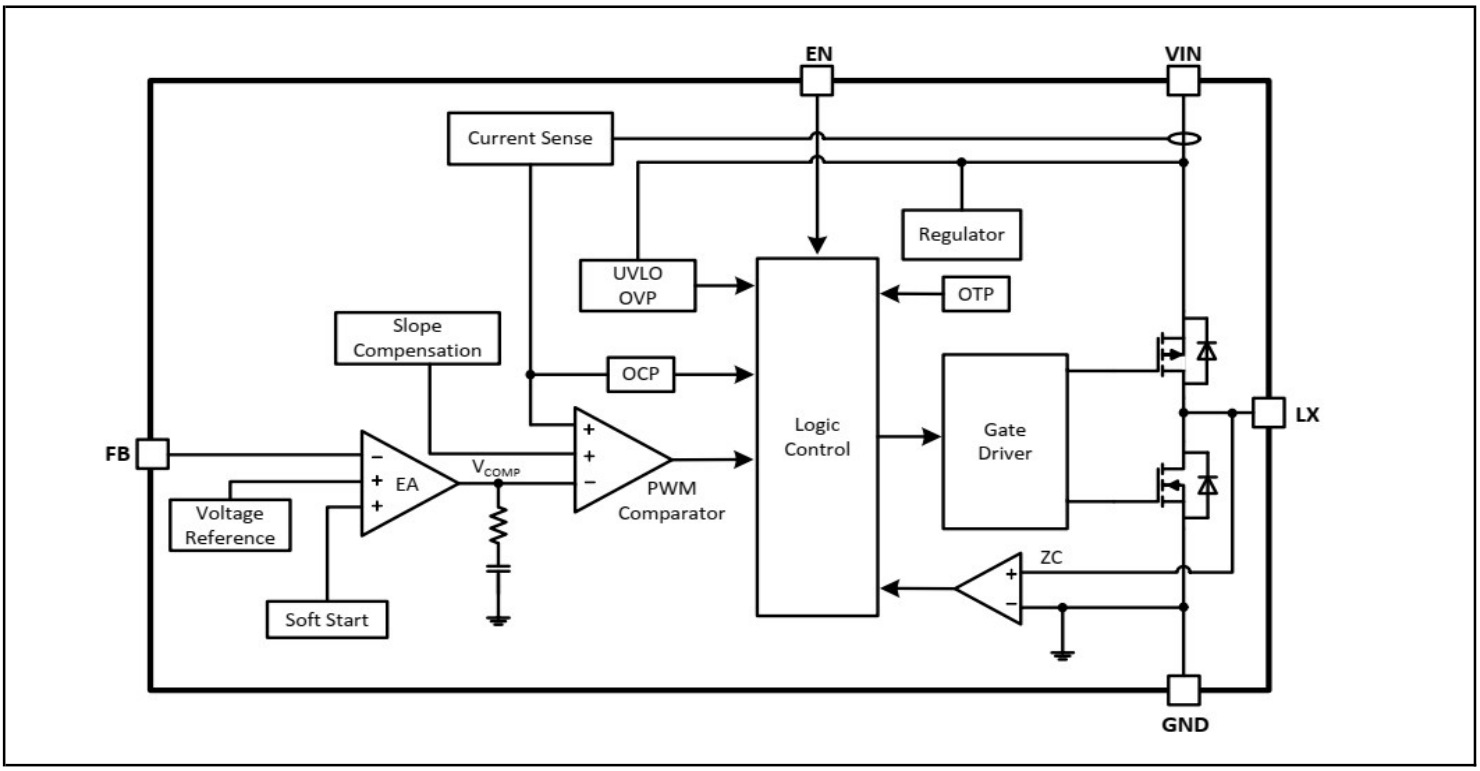

Figure 4. Functional Block Diagram of HCR3113B

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Typical Application Circuit

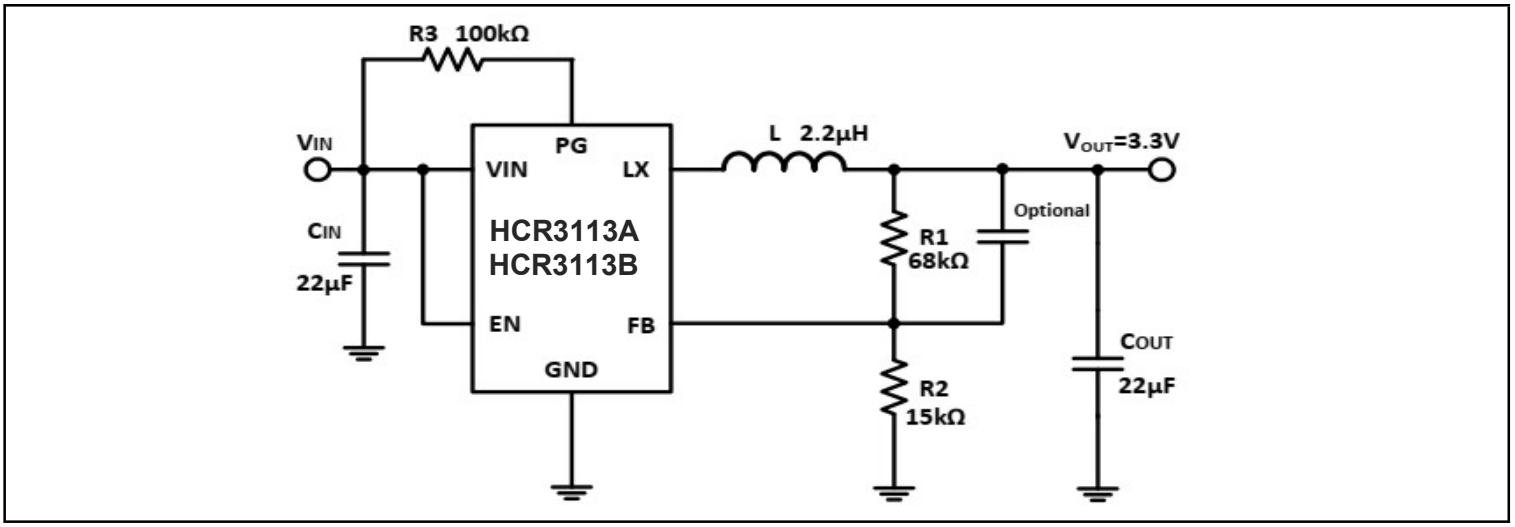

Figure 5. Typical Application Circuit of HCR3113A/HCR3113B

Function Description

HCR3113A and HCR3113B are high output current monolithic switch mode step-down DC-DC converter. The devices operate at a fixed 1.0MHz switching frequency,and uses a slope compensated current mode architecture.

This step-down DC-DC converter can supply up to 3A output current and has an input voltage range from 2.7V to 5.5V. It minimizes external component size and optimizes efficiency at the heavy load range.The slope compensation allows the device to remain stable over a wide range of inductor values so that smaller values with lower DCR can be used to achieve higher efficiency. Only a small bypass input capacitor is required at the output.

In light and no load condition, the HCR3113A and HCR3113B are operating in PFM mode for power saving. In PFM mode, the device ramps up its output voltage with several SW switching pulse, while the error amplifier output voltage VCOMP drops. The device stops switching when VCOMP voltage drops down the inner threshold, so the FB voltage in PFM mode is a little bit higher than normal 0.6V reference voltage in PWM operation. In no load condition, FB voltage is typically 1.5% higher than normal 0.6V reference voltage in PWM operation.

The adjustable output voltage can be programmed witl external feedback to any voltage, ranging from 0.6V to near the input voltage. It uses internal MOSFETs to achieve high efficiency and can generate very low output voltages by using an internal reference of 0.6V. At dropout operation, the converter duty cycle increase to 100% and the output voltage tracks the input voltage minus the low RDS(ON) drop of the P-channel high-sid MOSFET and the inductor DCR. The internal error am--plifier and compensation provides excellent transient response, load and line regulation. Internal soft start eliminates any output voltage overshoot when the enable or the input voltage is applied. the HCR3113A and HCR3113B also has power good open drain outpu to indicate output voltage status. When input voltage is higher than UVLO and EN is enabled, PG status is determined by output voltage. The PG pin goes high impedance when the output is above 91% of regulated nominal voltage and PG pin is pulled low once output voltage falls below the threshold. When the device is shutdown by EN pulled low. the PG is pulled low as well.

Application Information

Setting the Output Voltage

In the Figure 5, the typical application circuit for the HCR3113A and HCR3113B is shown. the output voltage of HCR3113A and HCR3113B can be externally programmed. Resistors R1 and R2 in typical application program the output to regulate at a voltage higher than 0.6V. The external resistor sets the output voltage according to the following equation:

$$V_{OUT} = 0.6 \times (1 + \frac{R_1}{R_2})$$

$$R_1 = (V_{OUT} / 0.6 - 1) \times R_2$$

Selecting the Inductor

For most designs, 2.2uH inductance can satisfy most application conditions. Inductance value is related to inductor ripple current value, input voltage, output voltage setting and switching frequency. The inductor value can be derived from the following equation:

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

Where ΔIL is inductor ripple current. Large value inductors result in lower ripple current and small value inductors result in high ripple current, So inductor value has effect on output voltage ripple value. DC resistance of inductor which has impact on efficiency of DC/DC converter should be taken into account when selecting the inductor.

Input Capacitor Select

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.

Input Capacitor Select(Con.)

A loe ESR input capacitor sized for maximum RMS current be used. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients A 22uF cermic capacitor for most applications is sufficient.A large value may be used for improved input voltage filtering.

Output Capacitor Selection

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 ΔVOUT is determined by:

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

A 22uF ceramic can satisfy most applications.

Layout Consideration

when laying out the printed circuit board, the following checking should be used to ensure proper operation of the HCR3113A and HCR3113B. Check the following in your layout:

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

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

1.3) Keep the switching node, Lx, away from the sensitive FB node.

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

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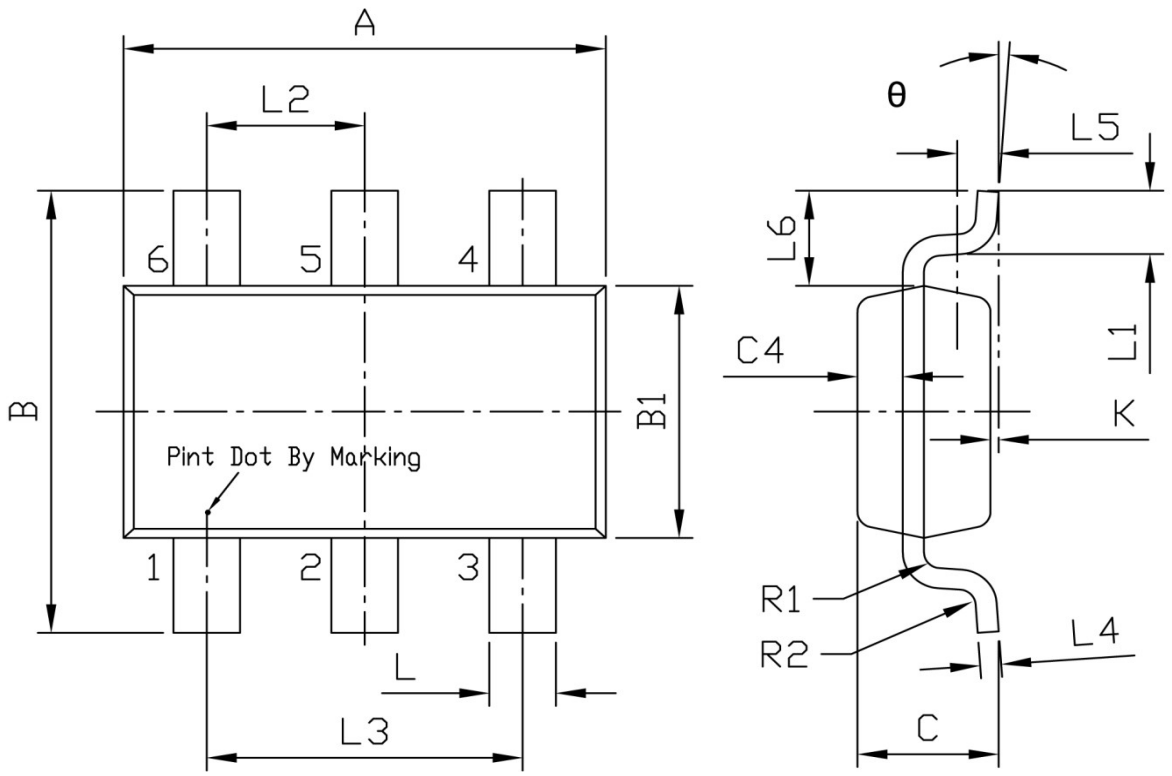
Mechanical Dimensions

M6L PKG: SOT23-6L

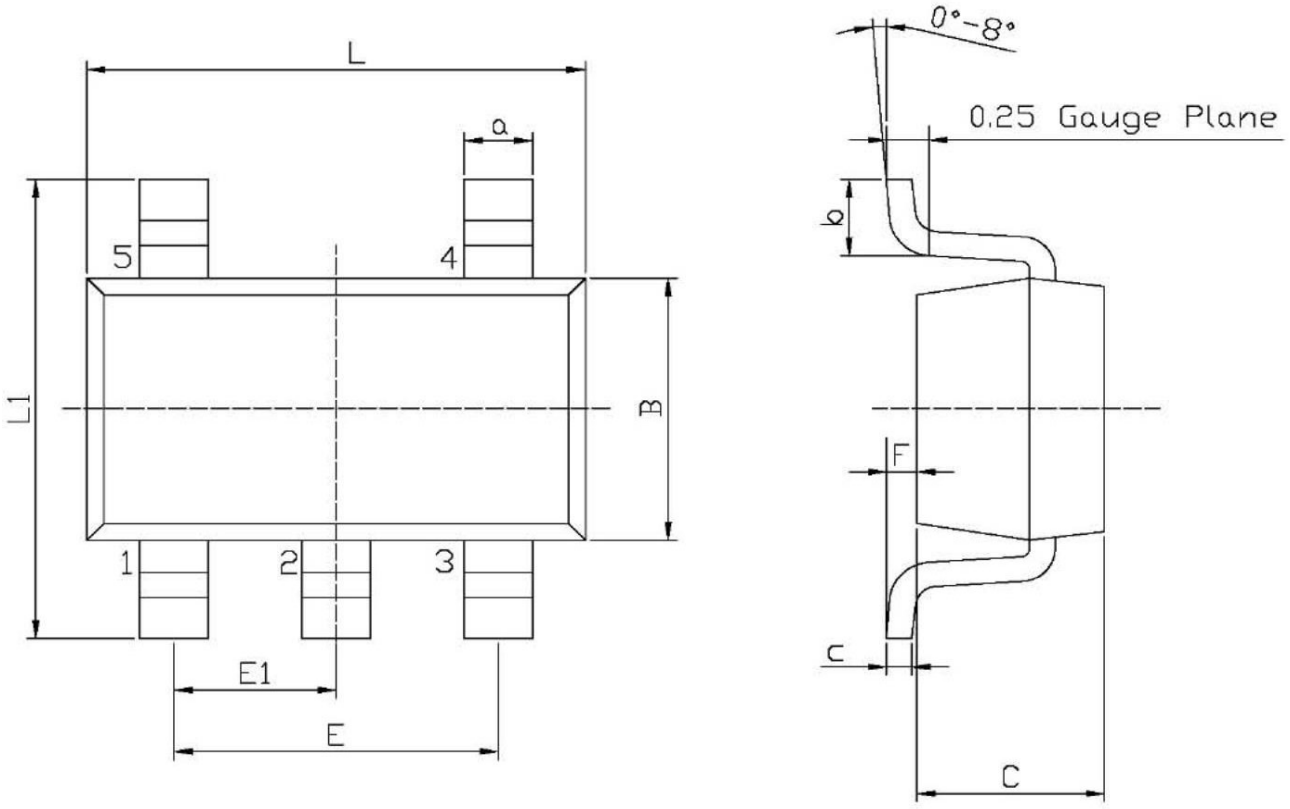


Unit: mm

Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	Typ	Max		Min	Typ	Max
A	2.80	2.90	3.00	L3	1.800	1.900	2.000
B	2.60	2.80	3.00	L4	0.077	0.127	0.177
B1	1.50	1.60	1.70	L5	-	0.250	-
C	-	-	1.05	L6	-	0.600	-
C1	0.60	0.80	1.00	θ	0°		0°
C2	0.35	0.40	0.45	θ1	10°	12°	14°
C4	0.223	0.273	0.323	θ2	10°	12°	14°
K	0.000	0.075	0.150	R	-	0.100	-
L	0.325	0.400	0.475	R1	-	0.100	-
L1	0.325	0.450	0.550	R2	-	0.100	-
L2	0.850	0.950	1.050				

Mechanical Dimensions(Con.)

M5 PKG: SOT-23-5



Unit: mm

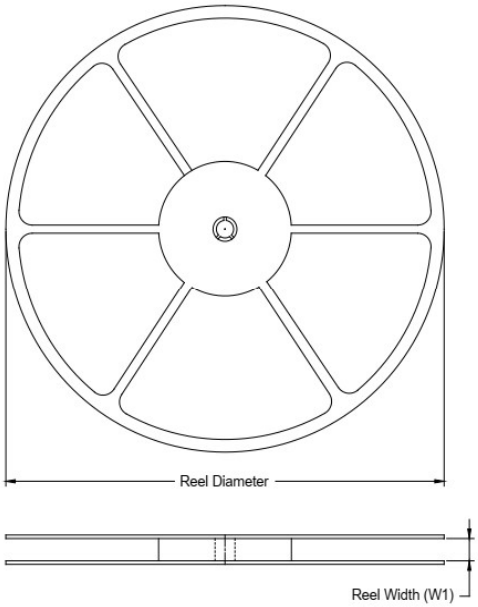
Symbol	Dimensions In Millimeters		Symbol	Dimensions In Millimeters	
	Min	Max		Min	Max
L	2.82	3.02	E1	0.85	1.05
B	1.50	1.70	a	0.35	0.50
C	0.90	1.30	c	0.10	0.20
L1	2.60	3.00	b	0.35	0.55
E	1.80	2.00	F	0	0.15

Note:

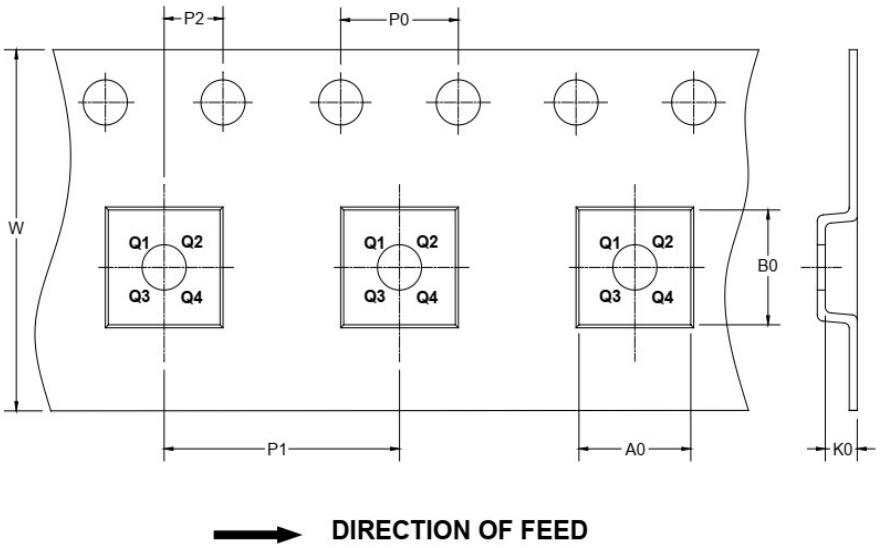
1) All dimensions are in millimeters.
2) Package length does not include mold flash, protrusion or gate burr.
3) Package width does not include interlead flash or protrusion.
4) Lead popularity (bottom of leads after forming) shall be 0.10 millimeters max.
5) Pin 1 is lower left pin when reading top mark from left to right.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS

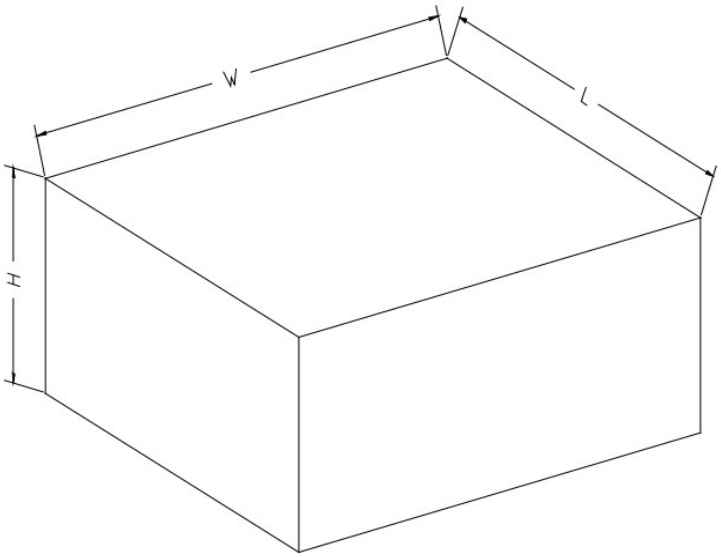


NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOT23-6	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7″	442	410	224	18