1.0MHz, 2A Synchronous Step-Down Converter Regulator

Features

- Input voltage range from 2.5V to 6.0V
- Continuous Output Current: 2A
- 1.0MHz Constant Frequency Operation
- High Efficiency: Up to 96%(@3.3VOUT)
- 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: 40uA
- Short Circuit Protection
- Thermal Fault Protection
- Inrush Current Limit and Soft Start
- Input over voltage protection(OVP)
- <1uA Shutdown Current

Applications

- Cellular and Smart Phones
- Wireless and DSL Modems
- PDAs
- Portable Instruments
- Digital Still and Video Cameras
- PC Cards

Pacakage

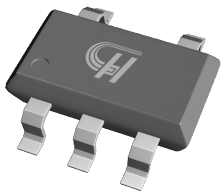
- Available in SOT23-5 package

General Description

The HCR3111A is a 1MHz constant frequency, current mode step-down converter. It is ideal for portable equipment requiring very high current up to 2A from single-cell Lithium-ion batteries while still achieving over 90% efficiency during peak load conditions. The HCR3111A 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 HCR3111A can supply up to 2A output load current from 2.5V to 6.0V input voltage and the output voltage can be regulated as low as 0.6V. The high switching frequency minimizes the size of external components while keeping switching losses low. The internal slope compensation setting allows the device to operate with smaller inductor values to optimize size and provide efficient operation. The HCR3111A is offered in a 5-pin, SOT package, and is available in an adjustable version.

The device offers two operation modes, PWM control and PFM mode switching control, which allows a high efficiency over the wider range of the load.



SOT23-5

Figure 1. Package Type of HCR3111A

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Pin Configuration

SOT-23-5 (Top View)

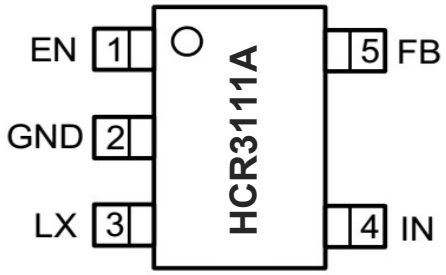
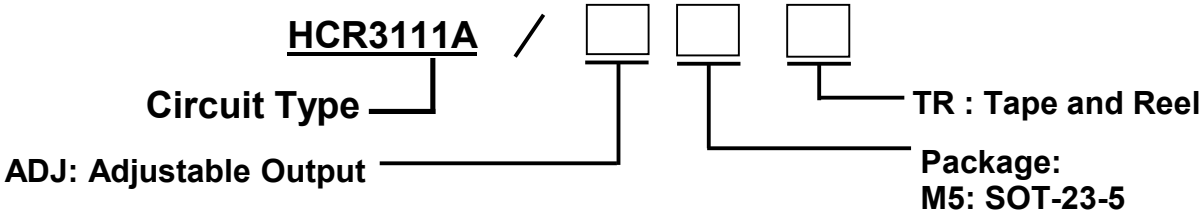


Figure 2. Pin Configuration of HCR3111A (Top View)

Pin Function Table

Pin Number	Pin Name	Function
1	EN	Chip Enable Pin. Drive EN above 1.5V to turn on the part. Drive EN below 0.3V to turn it off. Do not leave EN floating.
2	GND	Ground Pin
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	VIN	Power Supply input pin.
5	FB	Output Voltage Feedback Pin.

Ordering Information



Ordering Code

Part Number	Marking ID note2	Temperature Range	Package	Quantity per Reel
HCR3111A/ADJM5TR	S15BYXX	-40'C to +125'C	SOT-23-5	3000pcs/TR

Note 2: "S15B" is device code, "Y" is year code and "XX" is lot number code.

Absolute Maximum Ratings Note 1

Parameter	Symbol	Value	Unit
Input Supply Voltage Range	V_{IN}	-0.3 to +6.5	V
LX Voltage Range	V_{LX}	-0.3 to +6.5	V
EN Voltage Range	V_{EN}	-0.3 to +6.5	V
FB Voltage Range	V_{FB}	-0.3 to +6.5	V
Adjustable Output Voltage Range	V_{OUT}	0.6 to 5.5	V
Peak Current Limit	I_{PCT}	2.5	A
Power Dissipation	P_O	600	mW
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	168	'C/W
Thermal Resistance Junction to Case	$R_{\theta JC}$	63	'C/W
Storage Temperature Range	T_{STG}	-65 to 150	'C
Operating Junction Temperature	T_J	-40 to +125	'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}		2.5	-	6.0	V
Operating Junction Temperature Range	T_J		-40	-	125	'C

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}		2.5	-	6.0	V
Input OVP Threshold	V_{OVP}	VIN rising	-	6.2	6.5	V
UVLO Threshold	V_{UVLO}	VIN rising	-	2.3	-	V
UVLO Hysteresis	$V_{UVLO-HYS}$		-	0.3	-	V
Quiescent Current	I_Q	V_{EN}=2.0V, I_{OUT}=0 V_{FB}=V_{REF}*105%	-	40	75	uA
Shutdown Current	I_{SHDN}	VEN=0V or EN=GND	-	0.1	1.0	uA
Regulated Feedback Voltage Accuracy	VREF	T_A=25'C, PWM Operation	0.588	0.600	0.612	V
Reference Voltage Line Regulation	ΔRVLR	VIN=2.5 to 5.5V	-	0.1	-	%/V
Output Voltage Accuracy	-	VIN=2.5 to 5.5V, I_{OUT}=10mA to 2A	-3	-	+3	%
Output Voltage Load Regulation	ΔOVLR	I_{OUT}=10mA to 2A	-	0.2	-	%/A
On Resistance of PMOS	$R_{DS(ON)1}$	I_{LX}=100mA	-	150	-	mΩ
On Resistance of NMOS	$R_{DS(ON)2}$	I_{LX}=100mA	-	70	-	mΩ
Peak Current Limit	I_{PCT}	VIN=5V, V_{OUT}=90%	-	2.5	3.5	A
Oscillation Frequency	FOSC	V_{OUT}=100%	-	1.0	1.3	MHz
		V_{OUT}=0V	-	300	350	KHz
EN High Level Input Voltage	V_{EN-H}		1.5	-	-	V
EN Low Level Input Voltage	V_{EN-L}		-	-	0.5	V
EN Leakage Current	I_{EN_LC}		-	0.01	1.0	uA
LX Leakage Current	I_{LX_LC}	VEN=0V, VIN=VLX=5V	-	0.01	1.0	uA
Maximum Duty Cycle	η	VFB=0.6V	-	96	-	%
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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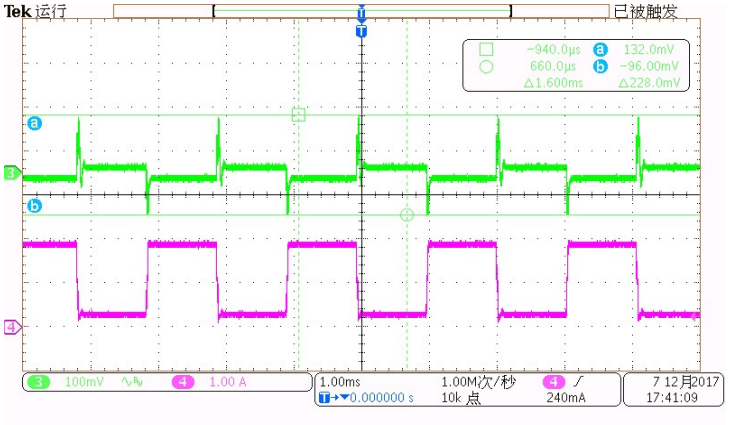
Functional Test

Test condition: Vin=5V, Vout=1.8V

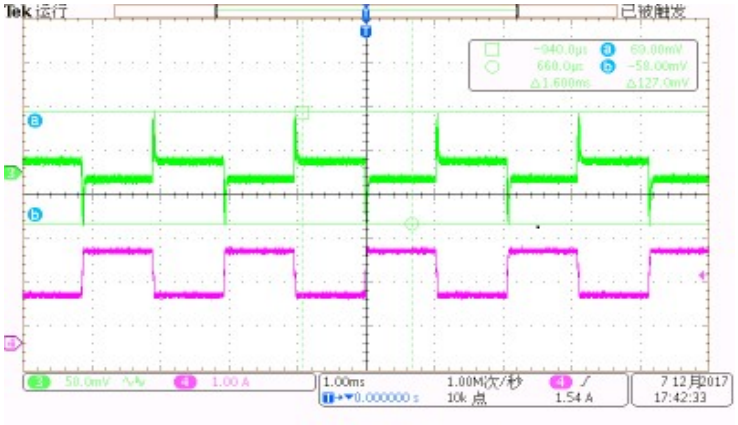
Load Dynamic Response

10% ~ 90% Load



Vin=5V, Vout=1.8V Loadtransient(0.2A-1.8A-0.2A)

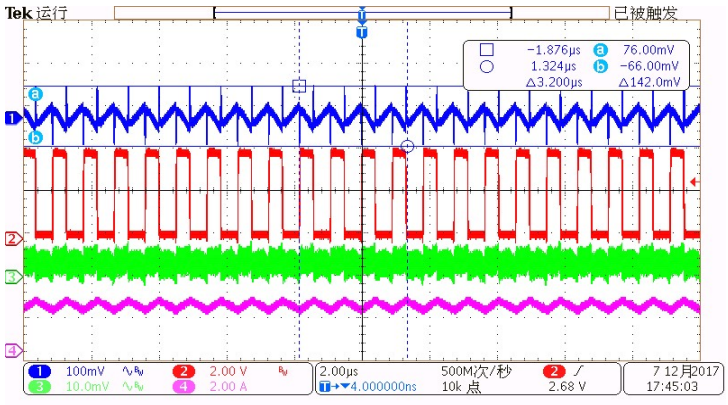
50% ~ 100% Load



Vin=5V, Vout=1.8V Loadtransient(0.2A-1.8A-0.2A)

Input/output ripple, Iout=full load

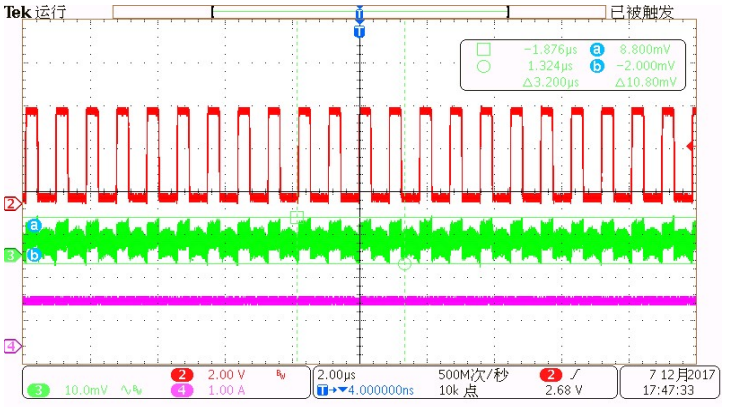
CH1: VIN(AC); CH2: SW; CH3:VOUT(AC); CH4:Isw



Vout ripple and Switching waveform

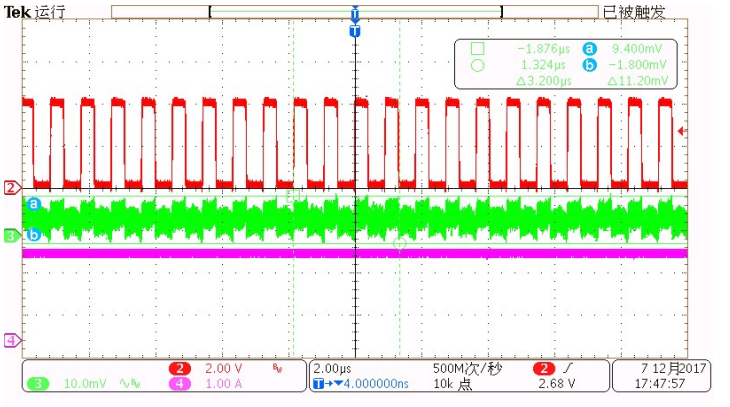
CH3:VOUT(AC); CH2:SW; CH4:Iout

Iout=50% Load



CH3:VOUT(AC); CH2:SW; CH4:Iout

Iout=100% Load

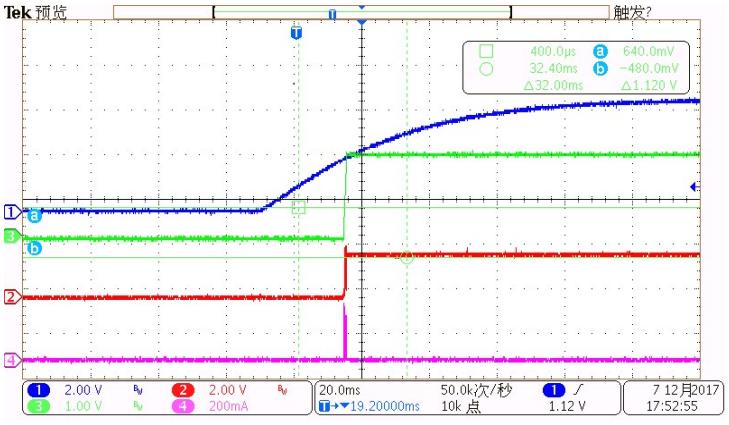


Functional Test (Con.)

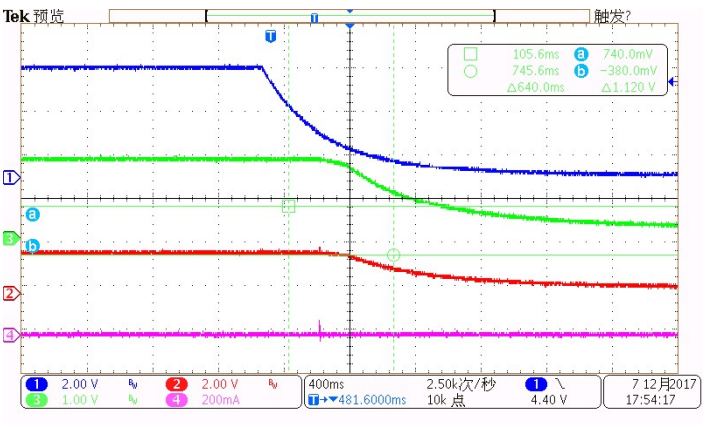
Test condition: Vin=5V, Vout=1.8V

Power on/off: CH1:VIN; CH2:SW; CH3:Vout; CH4:Isw

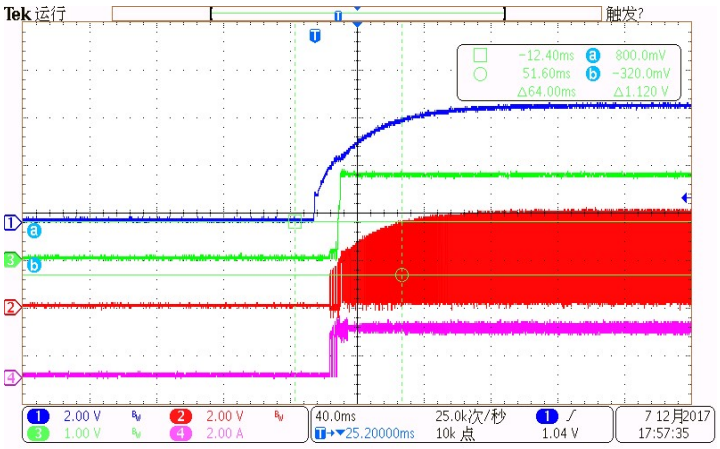
Power on, Iout=0A



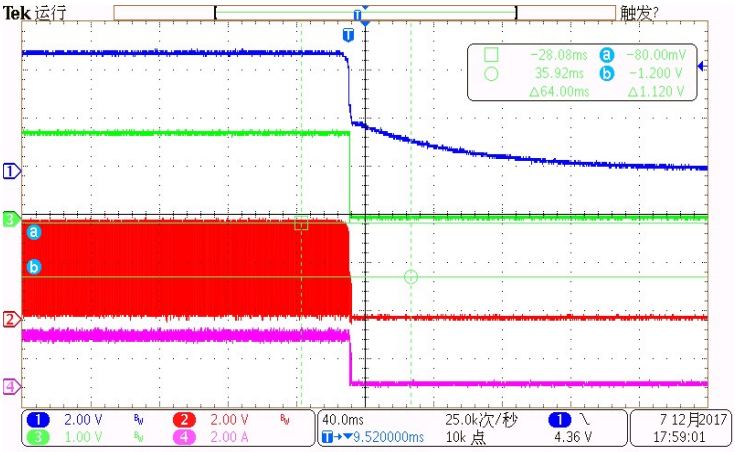
Power off, Iout=0A



Power on, Iout=2A

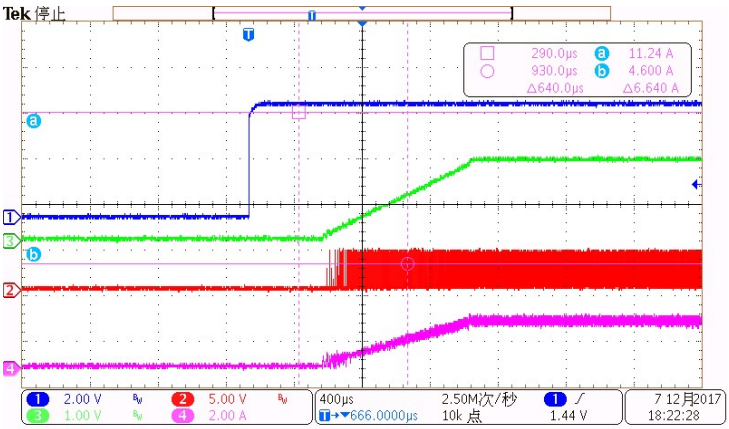


Power off, Iout=2A

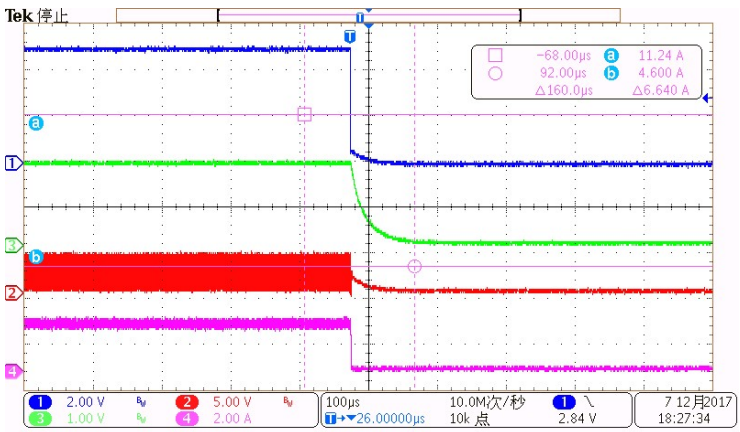


EN(5V) on/off: CH1:EN; CH2:SW; CH3:Vout; CH4:Isw

EN on, Iout=2A



EN off, Iout=2A



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Functional Block Diagram

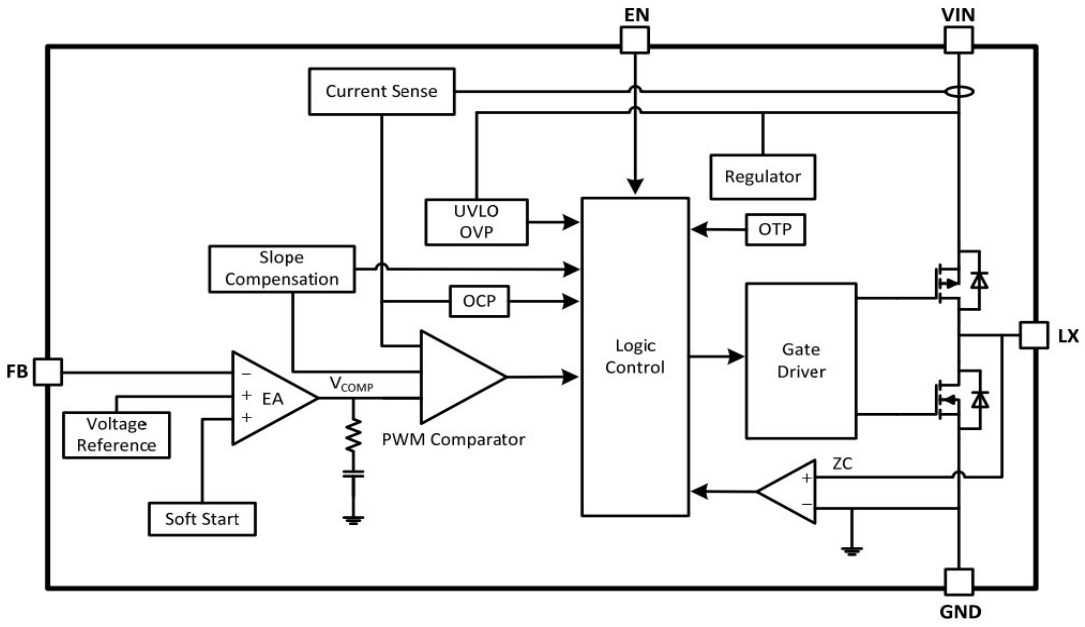

Figure 3. Functional Block Diagram of HCR3111A

Typical Application Circuit

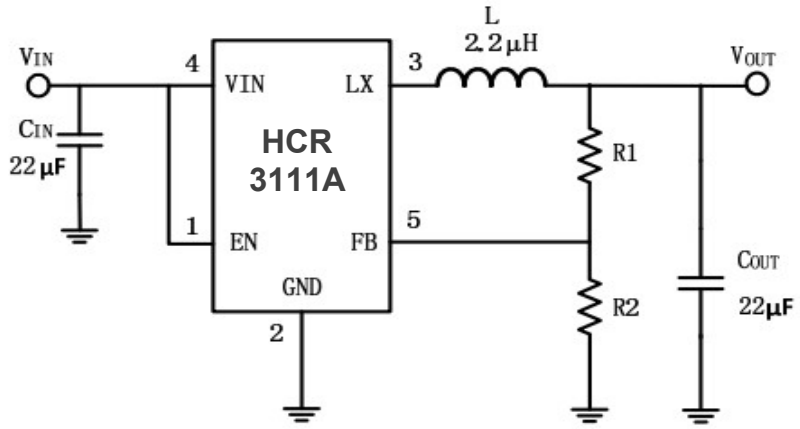

Figure 4. Typical Application Circuit of HCR3111A

Function Description

The HCR3111A is a high output current switch mode step-down DC-DC converter. The device operates 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 2A output current at VIN=5.0V and has an input voltage range from 2.5V to 6.0V. 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.

The adjustable output voltage can be programmed with 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 $R_{DS(ON)}$ drop of the P-channel high-side 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.

Application Information

Setting the Output Voltage

The HCR3111A require an input capacitor, an output capacitor and an inductor. These components are critical to the performance of the device. HCR3111A are internally compensated and don't require external components to achieve stable operation. The output voltage can be programmed by resistor divider.

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

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

Selecting the Inductor

For most designs, The inductance of 1uH to 4.7uH 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 ΔI_L 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. Choose an inductor with DC series resistance in the 50mΩ to 150mΩ range.

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.

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 cap-

-acitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current ratings.
The output ripple ΔV_{OUT} 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 HCR3111A. 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 VOUT node.

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

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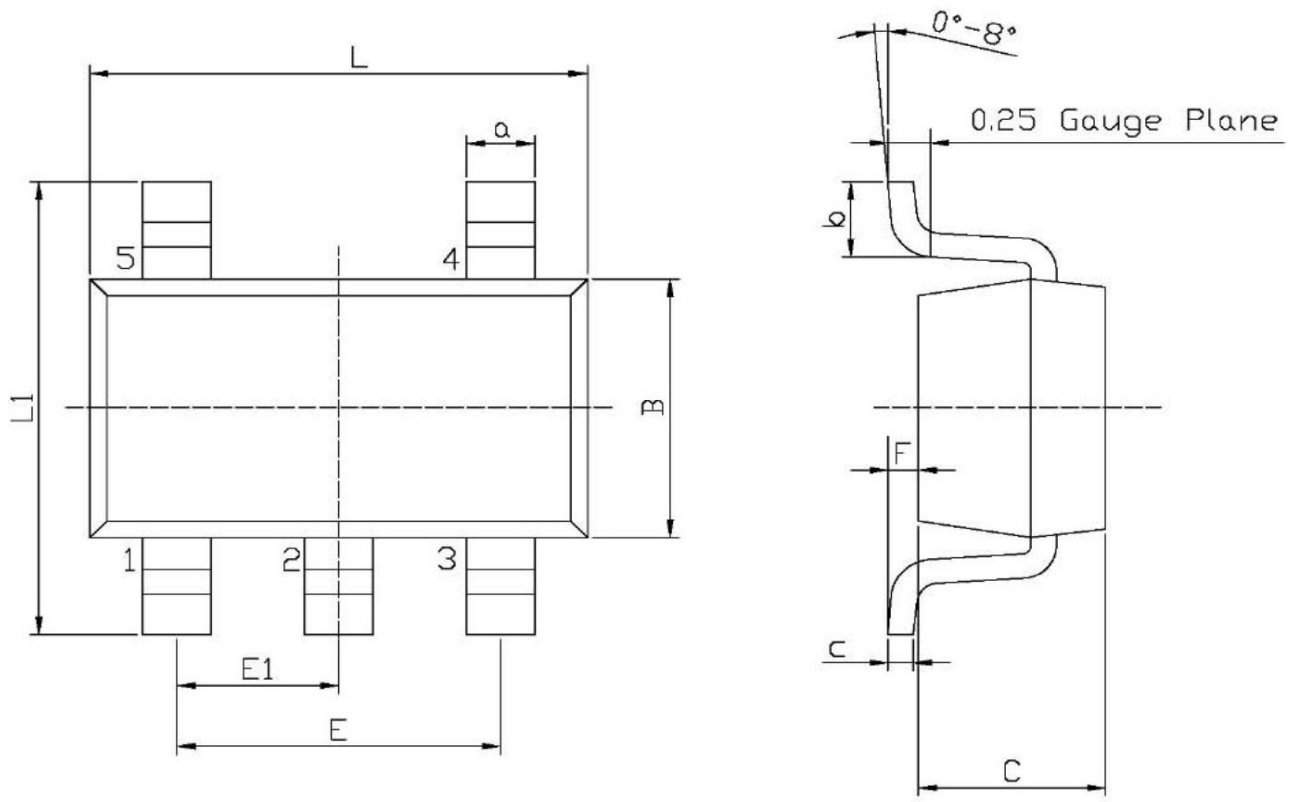
Mechanical Dimensions

M5 PKG: SOT-23-5

Unit: mm



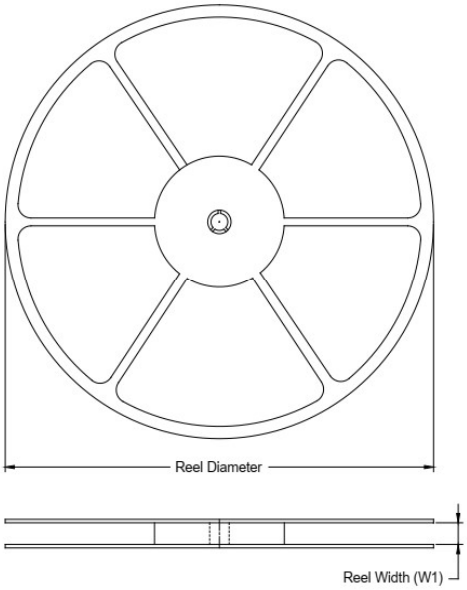
Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	Typ	Max		Min	Typ	Max
L	2.82	2.92	3.02	E1	0.85	0.95	1.05
B	1.50	1.60	1.70	a	0.35	0.425	0.50
C	0.90	1.10	1.30	c	0.10	0.15	0.20
L1	2.60	2.80	3.00	b	0.35	0.45	0.55
E	1.80	1.90	2.00	F	0	0.075	0.15

Note:

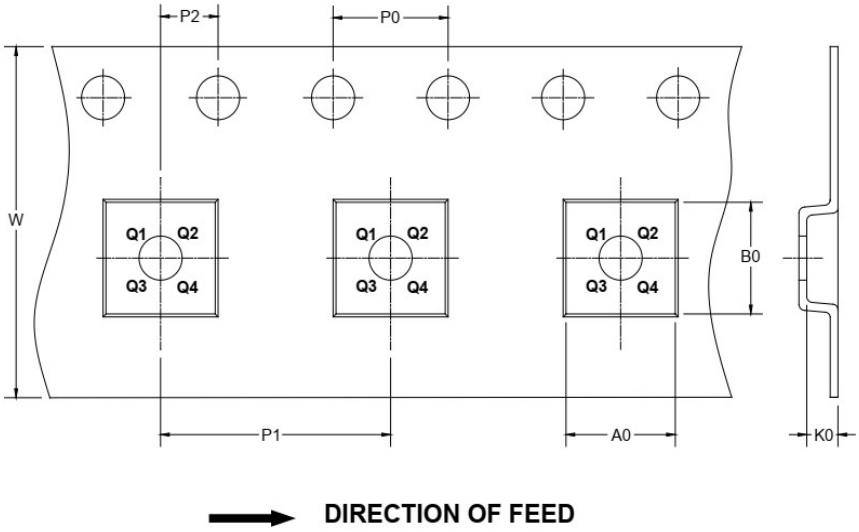
1) All dimensions are in millimeters.
2) Package length does not include mold flash, protrusion or gate burr.
3) Package width does not include inter lead flash or protrusion.
4) Lead popularity (bottom of leads after forming) shall be 0.10 millimeters max.
5) Pin 1 is lower left pin when reading top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

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS

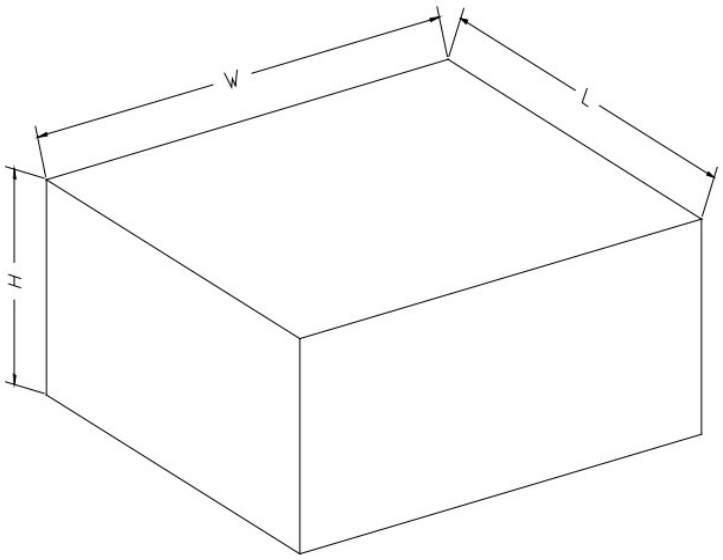


NOTE: The picture is only for reference. Please make the object as the standard.

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
SOT-23-5	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