Overview

The QX2304 is a high-efficiency, low-power, low-ripple, high-frequency PFM synchronous boost DC/DC converter.

The QX2304 requires only three external components. Boost the low input voltage to the required operating voltage.

The QX2304 can obtain the required output voltage through its internal trimming circuit (0.1V steps).

The QX2304's built-in synchronous switch enables efficiencies up to 95%. The QX2304 operates in PFM mode, which effectively reduces ripple under light load conditions.

The QX2304 has extremely low quiescent current, making it particularly suitable for handheld electronic device applications.

QX2304 adopts SOT23, SOT23-5, SOT89-3 and TO92 packages

Features

Maximum efficiency: 95%

Maximum operating frequency: 300 kHz

Low quiescent current: 15uA

ÿ**Selectable** output voltage: 2.5Vÿ3.6V

Output accuracy: ±2.5%

Wide input voltage range: 0.9Vÿ3.6V

Low ripple, low noise

Application areas

Electronic devices that **use** 1 to 2 dry cell batteries

Electronic dictionary, digital camera, LED flashlight, LED lights, blood pressure monitors, MP3 players, remote control toys, wireless headphones, wireless mice and keyboards, medical devices, anti-loss devices, car alarms, chargers, VCRs, PDAs and other handheld electronic devices

Typical application circuit diagram

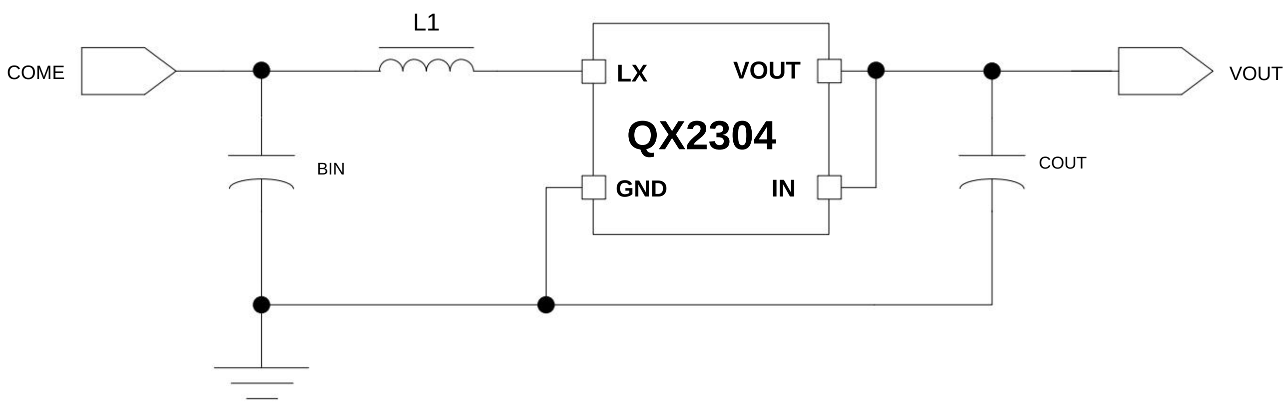


Figure 1: Typical application circuit diagram of QX2304

Ordering Information

Product Model

QX2304L XX X

Packaging

TÿSOT23

F: SOT23-5

E: SOT89-3

TOÿTO92

Output voltage

25ÿ2.5V

26: 2.6V

...

36:3.6V

silkscreen

C XX X

batch number

Output voltage

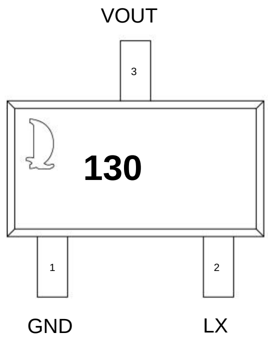
25ÿ2.5V

26: 2.6V

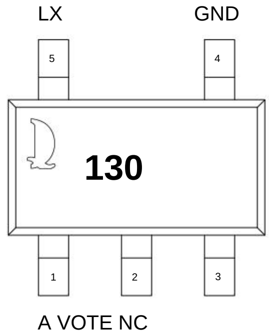
...

36:3.6V

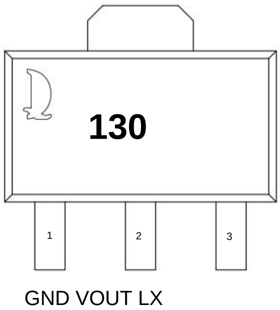
Package and pin assignment



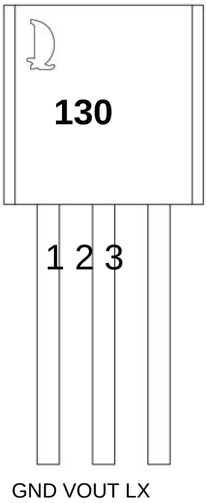
QX2304LXXT
(SOT23)



QX2304LXXF
(SOT23-5)



QX2304LXXE
(SOT89-3)



QX2304LXXTO
(TO92)

Pin Definitions

Pin number				pin name	pin type	describe
SOT23	**SOT23-5**	**SOT89-3**	**TO92**			
2	5	3	3	LX	output	power switch drain terminal
3	2	2	2	VOUT	Input/output	voltage feedback terminal
-	1	-	-	EN	input	enable pin (active high)
1	4	1	1	GND		land
-	3	-	-	NC	suspended	Suspended

Internal circuit block diagram

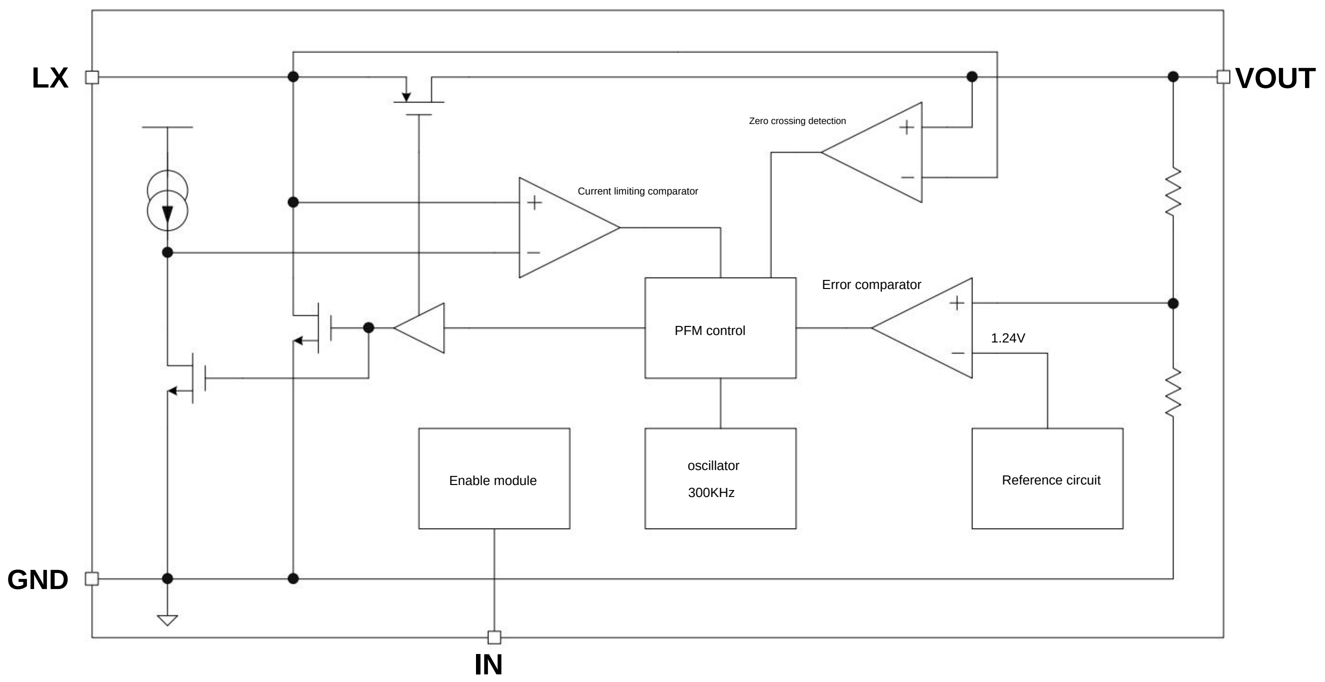


Figure 2: Internal circuit block diagram of QX2304

Limiting parameters (Note 1)

Parameter	symbol	describe	Minimum value	maximum value	unit
Voltage	VMAX	The maximum voltage values at VOUT and VLX terminals		7	In
Current	ILX_MAX	Maximum current at LX terminal		1000 mA	
Maximum power consumption	PSOT23	SOT23 package maximum power consumption		0.3	IN
	PSOT23-5	SOT23-5 package maximum power consumption		0.3	IN
	PSOT89-3	Maximum power consumption of SOT89-3 package		0.5	IN
	PTO92	Maximum power consumption of TO92 package		0.75 W	
temperature	FACING	Operating temperature range	-20	85	°C
	TSTG	Storage temperature range	-40	120	°C
	TSD1	Soldering of SOT23, SOT23-5 and SOT89-3 packages Temperature measurement (time less than 30 seconds)	230	240	°C
	Soldering temperature for TSD2 TO92 packages (for less than 5 seconds): 250°C			260	°C
ESD	VHBM	HBM		2000	In

Note 1: Exceeding the limits specified in the table above will result in permanent damage to the device. Operating under these extreme conditions may also affect the reliability of the device.

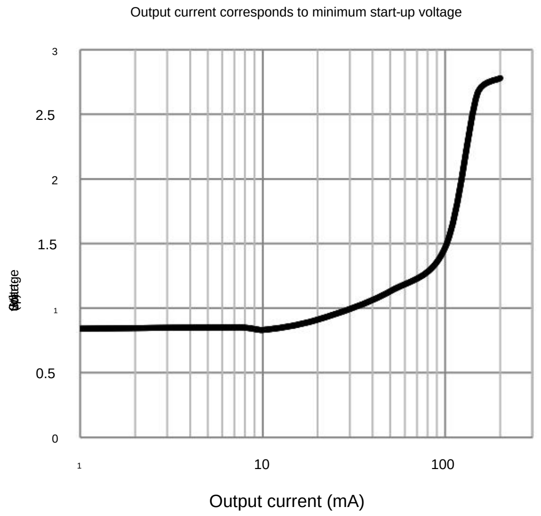
Electrical properties

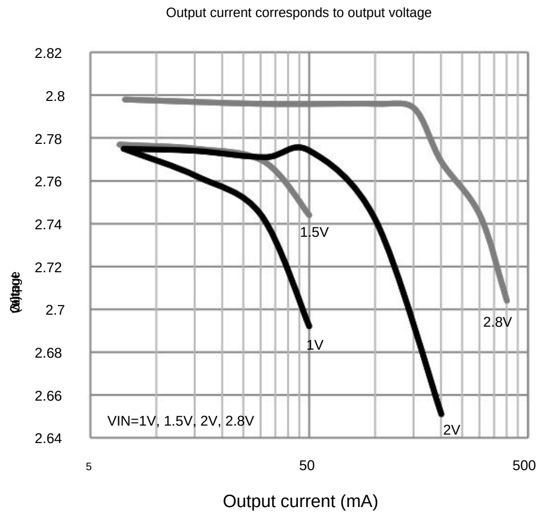
Unless otherwise specified, CIN = 100uF, COUT = 100uF, L1 = 47uH, TA = 25 °C

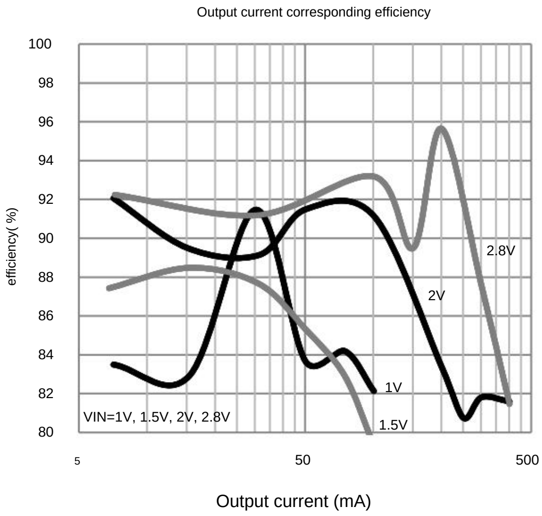
Parameter symbol, test condition, minimum value, typical value, maximum value, unit.						
power supply voltage						
Maximum input voltage	VIN_MAX				VOUT	In
Start-up voltage	VSTART	ILOAD =1mAÿ VIN rises from 0V to 2V			0.8	In
Hold voltage	VHOLD	ILOAD =1mAÿ VIN drops from 2V to 0V	0.6			In
Output voltage						
Output voltage accuracy	ÿVOUT	VIN = 2V, ILOAD = 10mA	-2.5		2.5	%
Power supply current						
Current limit value	ILIMIT		600	800	1000 mA	
No-load input current	IIN0	VIN =1.8VÿVOUT =3.3V		15		a
VOUT Input current	IOUT0	The voltage of the VOUT pin is positive. Normal VOUT voltage +0.5V		6		a
Standby input current	IINQ	is unloaded, EN is low.			1	a
efficiency						
efficiency	or			90	95	%
EN enable input						
EN terminal input high level			0.4*VOUT			In
EN input low level					0.2	In
Oscillation characteristics						
Maximum oscillation frequency	FMAX			300		KHz
Oscillating Duty Cycle	DCOSC			83		%

Typical curve

Unless otherwise specified, CIN = 47uF, COUT = 100uF, L1 = 47uH, TA = 25 °C







Application Guide

Working principle

The QX2304 is a BOOST architecture, synchronous circuit... DC-DC converter with PFM control mode.

The QX2304 requires very few external components; it only needs an inductor and input/output capacitors to provide a stable, low-noise output voltage of 2.5V to 3.6V.

The chip internally includes an output voltage feedback and correction network, a startup circuit, an oscillation circuit, and a reference voltage circuit. PFM control circuit, overcurrent protection circuit, synchronous tube control, and power tube, etc.

The PFM control circuit is the core of the QX2304. This module controls the switching of the power transistor based on the input voltage signal, load signal, and current signal transmitted from other modules, thereby achieving a constant voltage output. In the PFM control system, a stable output voltage with a fixed oscillation frequency and pulse width is achieved by adjusting the conduction time of the power transistor per unit time based on the input-output voltage ratio and load conditions through pulse clipping.

The oscillation circuit provides a reference oscillation frequency and a fixed pulse width; the reference voltage circuit provides a stable reference level; and thanks to the internal correction technology, the output voltage accuracy is guaranteed to be ±2.5%.

The power loss of a BOOST architecture DC-DC converter is mainly due to four factors: the parasitic series resistance of the inductor, the on-resistance of the synchronous transistor, the on-resistance of the power transistor, and the driving capability of the control power transistor signal. Of course, the static power consumption of the chip itself will also affect the conversion efficiency under low load conditions.

To achieve high conversion efficiency, in addition to requiring users to select appropriate inductors and capacitors, the on-resistance of the power transistors and synchronous transistors inside the chip must also be very low. The power transistors also require a highly capable drive circuit to ensure fast rise and fall edges during switching, thereby significantly reducing dynamic losses during switching.

As mentioned above, the magnitude of the parasitic series resistance of the inductor, and the on-resistance of the synchronizing transistor and the switching transistor, will affect the power output. Efficiency loss. Capacitors and inductors also affect output ripple. Choosing appropriate inductors and capacitors can achieve high conversion efficiency, low ripple, and low noise.

Before we begin, let's define the duty cycle D:

$$D = \text{ÿ } 1 \; \frac{In_{IN}}{In_{OUT}} \qquad (1)$$

Inductor selection

The following aspects need to be considered when determining the inductance value: First, it is necessary to ensure the minimum inductance value that allows the BOOST DC-DC converter to operate normally in continuous current mode.

LMIN:

$$L_{MIN} \text{ ÿ } \frac{D * (1 - D)^2 * R_{LOAD}}{2 * F_S} \qquad (2)$$

This formula is derived in continuous current mode, neglecting other factors such as parasitic resistance and diode forward voltage drop; the actual value is even larger.

Secondly, considering the ripple issue of current flowing through the inductor, and ignoring parasitic parameters in continuous current mode, a small inductor will result in excessive current ripple, leading to excessively large maximum currents through the inductor, the synchronous transistor, and the power transistor in the chip. Since the synchronous transistor and power transistor are not ideal, their power loss will increase at particularly high currents, resulting in a decrease in the overall DC-DC conversion efficiency.

Third, generally speaking, disregarding efficiency, smaller inductors have a stronger load capacity than larger inductors. However, under the same load conditions, larger inductors have relatively smaller current ripple and maximum current values, allowing the circuit to start at a lower input voltage. (These conclusions are all derived under the same parasitic resistance conditions.)

The QX2304 operates at frequencies up to 300kHz to reduce the size of external inductors. Therefore, the QX2304 only requires an inductor of 4.7uH or larger to operate normally. However, if output is required...

High current load (e.g., output current greater than 50mA).

To improve work efficiency, it is recommended to use a larger inductor.

At the same time, under heavy loads, the inductor will have a significant impact.

To influence conversion efficiency, assuming the parasitic resistance of the inductor is RL,

If the load resistance is RLOAD, then the power loss through the inductor...

Consumption can be roughly calculated using the following formula:

$$\text{ÿ ÿr} \quad \frac{R_L}{R_{LOAD} * (1-D)^2} \qquad (3)$$

For example, when the input is 1.5 V, the output is 3.0 V, negative.

With a load of 20ÿ (i.e., an output current of 150mA), RL is

At 0.5ÿ, the efficiency loss is 10%. Taking all factors into consideration, the following should be considered:

It is recommended to use 47uH with a parasitic series resistance of less than 0.5ÿ.

Inductor. If improved efficiency under heavy loads is required, then...

A larger inductance value and a smaller parasitic resistance value are required.

inductance.

Output capacitor selection

The equivalent series resistance (ESR) of the capacitor is not considered.

The output voltage ripple is:

$$r = \frac{\text{ÿ In}}{In_{OUT\ OUT}} = \frac{D}{R_{LOAD} C * _{OUT}} \qquad (4)$$

Therefore, in order to reduce the output ripple, it is necessary to compare...

A large output capacitance value. However, if the output capacitance is too large, ...

This will slow down the system's response time and increase costs.

Therefore, it is recommended to use a 22uF capacitor.

To reduce ripple, a larger capacitor is required. If

If the load is small (around 10mA), then a smaller...

Small capacitor. When considering the capacitor's ESR, the output ripple...

The wave will increase:

$$r^{ÿ} = +r \quad \frac{I_{MAX} * R_{ESR}}{In_{OUT}} \qquad (5)$$

Under heavy loads, the ripple caused by ESR

Wave will become the most important factor, and the output voltage ripple can

It could greatly exceed 100mV. At the same time, ESR will increase.

This increases efficiency losses and reduces conversion efficiency. Therefore, it is recommended to...

Use tantalum capacitors with low ESR, or connect multiple capacitors in parallel.

use.

Input capacitor

As long as the power supply is stable, even without input filter power...

Capacitive DC-DC circuits can also output low ripple and low noise.

The current and voltage of the sound. However, when the power supply is far from the DC-DC converter...

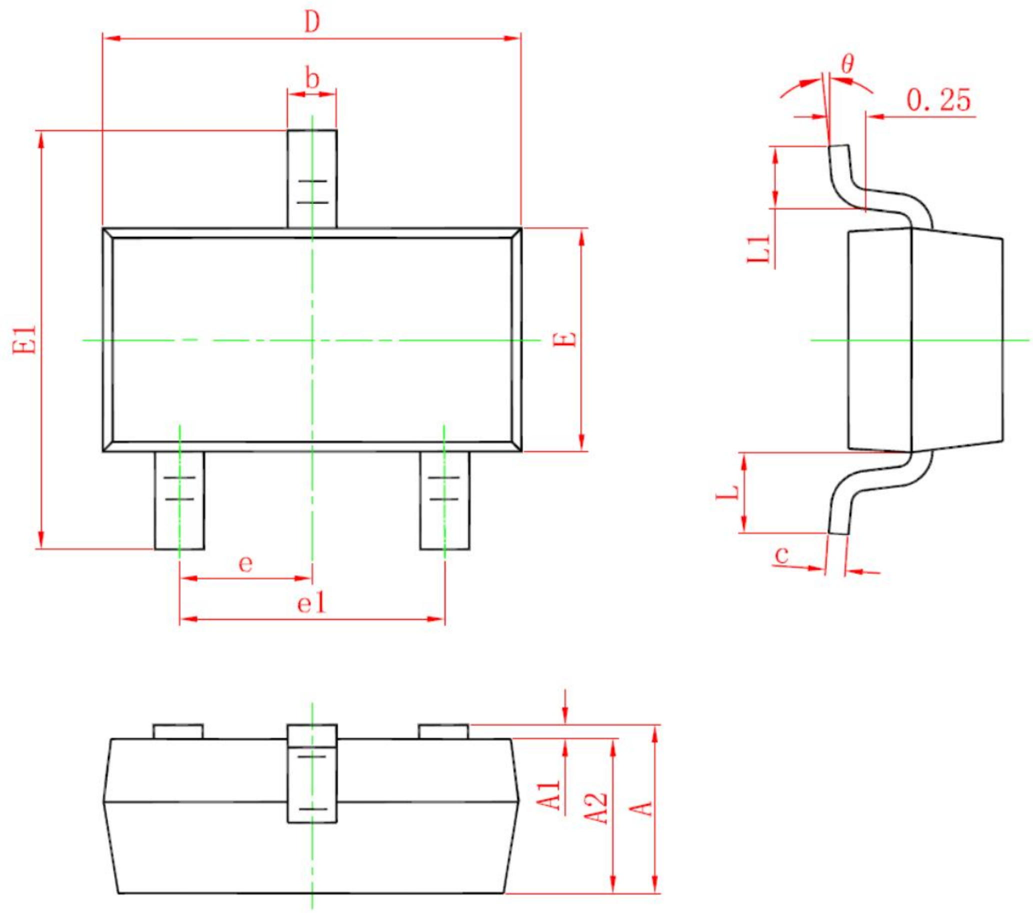
Since the route is quite long, it is recommended to add power at the nearest input terminal of the DC-DC converter.

Adding a filter capacitor of 10uF or more can reduce the output voltage.

The noise.

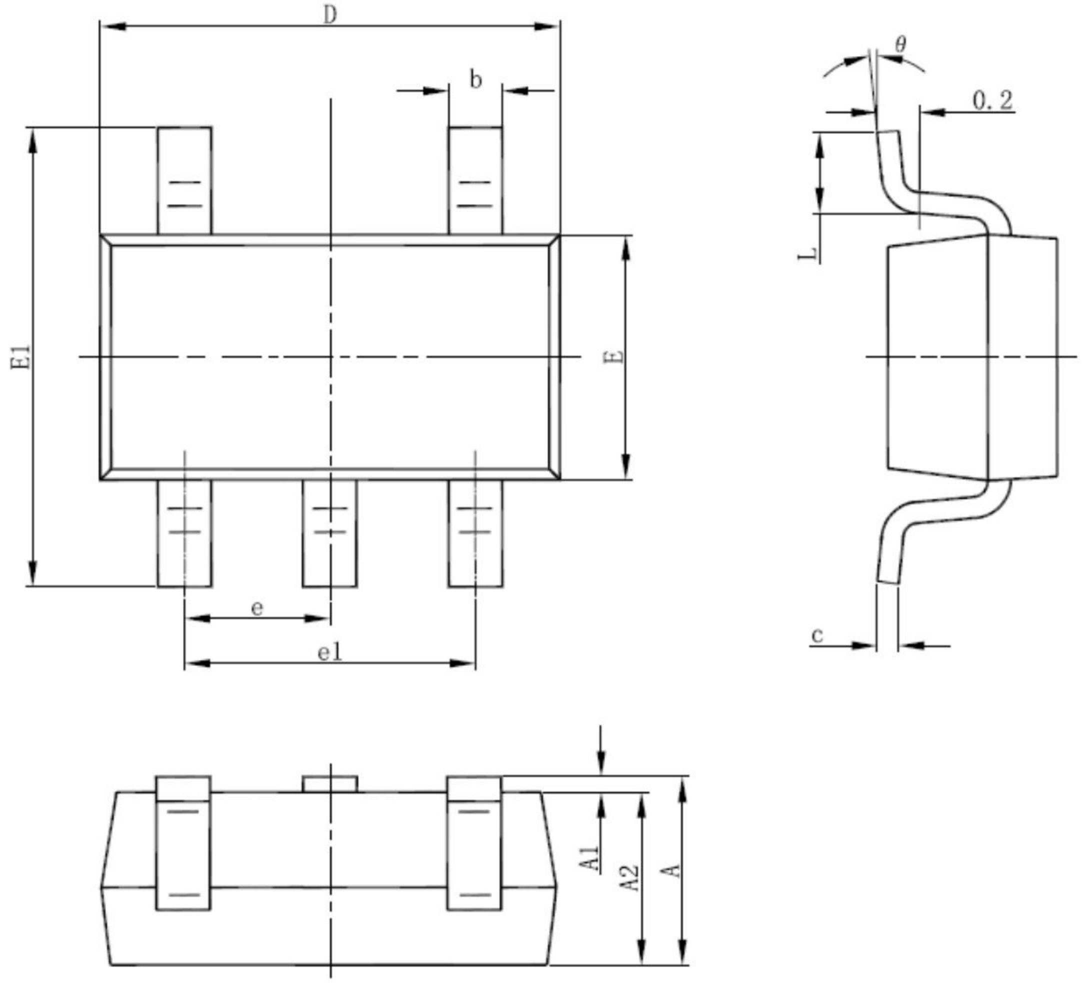
Encapsulation information

SOT23 package dimensions:



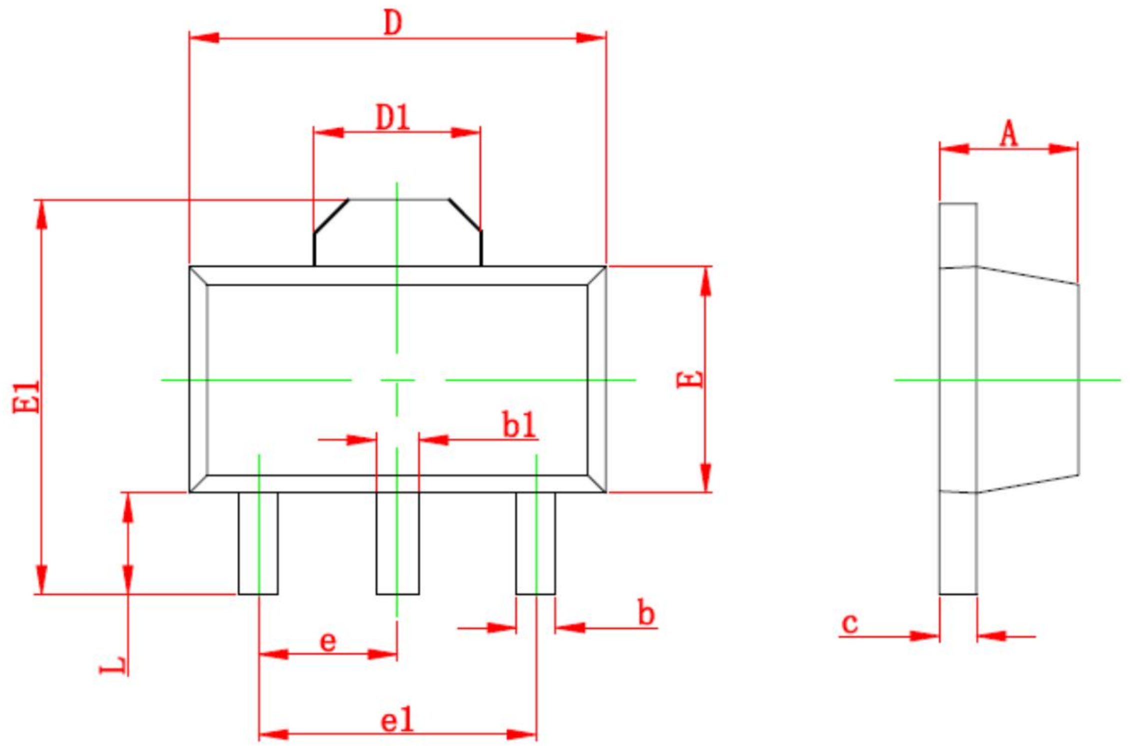
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.900	1.150	0.035	0.045
A1	0.000	0.100	0.000	0.004
A2	0.900	1.050	0.035	0.041
b	0.300	0.500	0.012	0.020
c	0.080	0.150	0.003	0.006
D	2.800	3.000	0.110	0.118
E	1.200	1.400	0.047	0.055
E1	2.250	2.550	0.089	0.100
e	0.950 TYP.		0.037 TYP.	
e1	1.800	2.000	0.071	0.079
L	0.550 REF.		0.022 REF.	
L1	0.300	0.500	0.012	0.020
θ	0°	8°	0°	8°

SOT23-5 package dimension diagram:



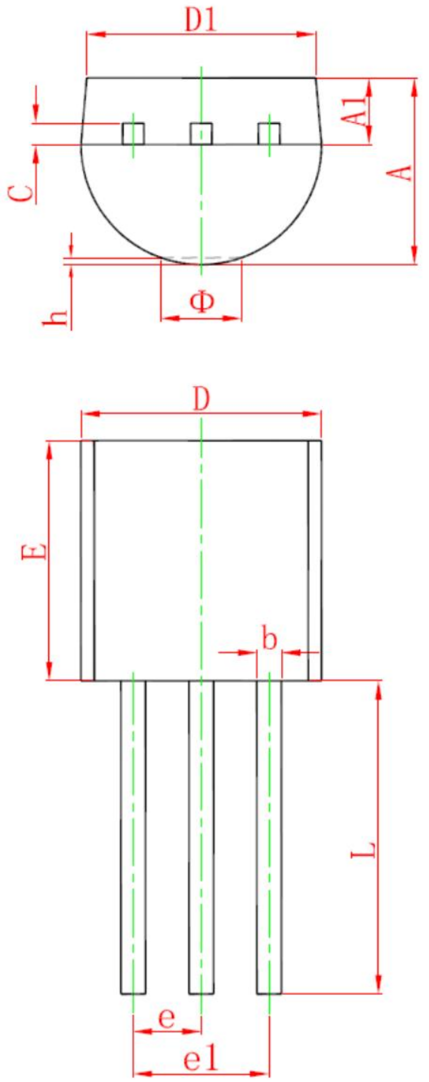
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

SOT89-3 package dimension diagram:



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.400	0.580	0.016	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF.		0.061 REF.	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP.		0.060 TYP.	
e1	3.000 TYP.		0.118 TYP.	
L	0.900	1.200	0.035	0.047

TO92 package dimension diagram:



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	3.300	3.700	0.130	0.146
A1	1.100	1.400	0.043	0.055
b	0.380	0.550	0.015	0.022
c	0.360	0.510	0.014	0.020
D	4.300	4.700	0.169	0.185
D1	3.430		0.135	
E	4.300	4.700	0.169	0.185
e	1.270 TYP.		0.050 TYP.	
e1	2.440	2.640	0.096	0.104
L	14.100	14.500	0.555	0.571
Φ		1.600		0.063
h	0.000	0.380	0.000	0.015

statement

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Customer Service Center

Quancore Electronics Technology (Shenzhen) Co., Ltd.

Address: 4th Floor, Building 22, Zhiheng Emerging Industry Park, Nantou Guankou 2nd Road, Nanshan District, Shenzhen, China

Postal code: 518052

Telephone: +86-0755-88852177

Fax: +86-0755-86350858

Website: www.qxmd.com.cn