

General Description

The BCT9230/BCT9233/BCT9236/BCT9250 are general purpose charge pump DC/DC converters which generate a range of fixed regulated output voltage from 3.0V to 5.0V. The BCT9230/ BCT9233/BCT9236 can accept wide input voltage ranging from 0.9V to 4.3V where applications using standard batteries, standard Li-ion or NiMH/NiCd rechargeable batteries are preferred.

The BCT9230/BCT9233/BCT9236/BCT9250 will step up the output voltage automatically from lower input voltage, In additional; they can also regulate the output voltage when the input voltage is greater than the output voltage. A variety of switching control will be adapted by an internal input adaptation circuitry which will generate a required output voltage with respect to the input voltage level.

A high efficiency and space saving DC/DC converter can be easily built by incorporating external SMT ceramic capacitors. No choke coil and schottky diode are required.

Features

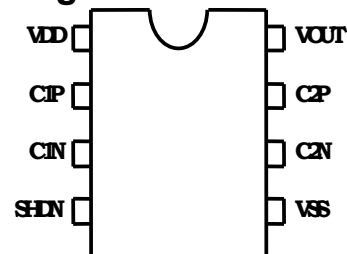
- Charge pump DC/DC converter with 500KHz switching frequency
- Wide input voltage range:
0.9V to 4.3V for BCT9230/33
1.0V to 4.3V for BCT9236
1.3V to 3.6V for BCT9250
- Fixed regulated output voltage:

BCT9230:	3.0V
BCT9233:	3.3V
BCT9236:	3.6V
BCT9250:	5.0V
- Low power consumption
- Available in Pb-free MSOP8 package, or Pb-free SOP8 package or die form

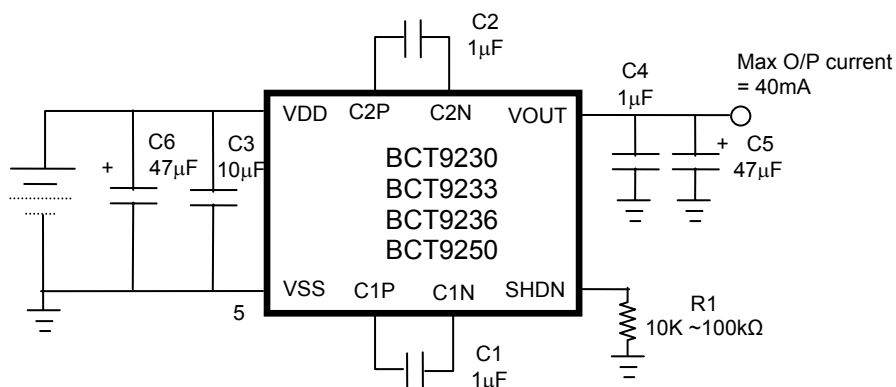
Applications

- 2 x 1.5V Batteries to ~3V regulator
- 1 x 1.5V Battery to ~3V Step-up regulator
- DC/DC converter for battery powered products (Handheld Electronics, PDAs, Toys,)

Pin Assignments

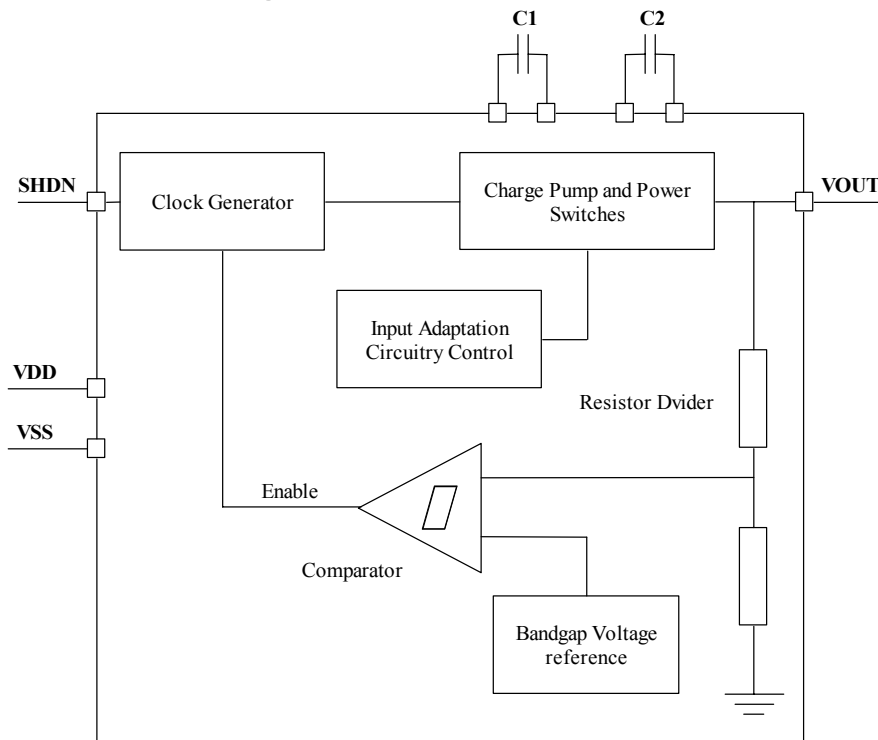


Typical Application Circuit



Feature Comparisons	BCT9230	BCT9233	BCT9236	BCT9250
Output Voltage	3.0V	3.3V	3.6V	5.0V
Max dc output Current	40mA (VDD =1.8~4.3V)	40mA (VDD =1.8~4.3V)	40mA (VDD =1.8~4.3V)	40mA (VDD =2.0~3.6V)
	5 ~ 40mA (VDD=1.1~1.8V)	5 ~ 40mA (VDD=1.1~1.8V)	2 ~ 40mA (VDD=1.0~1.8V)	12 ~ 40mA (VDD=1.4~2.0V)
Input Voltage	0.9V ~ 4.3V	0.9V ~ 4.3V	1.0V ~ 4.3V	1.4V ~ 3.6V
Shut Down (SHDN)	Yes	Yes	Yes	Yes
Package	SO8/MSO8	SO8/MSO8	SO8/MSO8	SO8/MSO8

Functional Block Diagram



Pin Descriptions

BCT9230/ BCT9233 BCT9236/ BCT9250 Pin #	Pin Name	I/O	Description
1	VDD	Power	Input Supply Voltage
5	VSS	Power	Ground 0V
2	C1P	I/O	Charge Pump Flying Capacitor 1 Pins. To connect a 0.1 μ F to 1 μ F ceramic capacitor between C1P and C1N
3	C1N		
7	C2P	I/O	Charge Pump Flying Capacitor 2 Pins. To connect a 0.1 μ F to 1 μ F ceramic capacitor between C2P and C2N
6	C2N		
8	VOUT	Output	Charge Pump Output. To connect a 10 μ F ~ 47 μ F capacitor from VOUT to VSS
4	SHDN	Input	Chip Shut Down (Active High)

Absolute Maximum Specifications

Rating	Symbol/ Conditions	Value	Unit
Supply voltage range	BCT9230 BCT9233 BCT9236 BCT9250	-0.3 to 4.3 -0.3 to 4.3 -0.3 to 4.3 -0.3 to 3.6	Volts
Input voltage range	SHDN	-0.3 to $V_{IN}+0.3$ -0.3 to $V_{IN}+0.3$	Volts
Output current Range	I_{OUT}	0 to 40	mA
Output voltage range	VOUT	-0.3 to 8	Volts
Operating temperature range	T_{OPR}	0 to 70	$^{\circ}$ C
Storage temperature range	T_{STR}	-20 to 100	$^{\circ}$ C

Electrical Specifications

All electrical specifications are specified at $T_{AMBIENT}$ from 0 °C to 70 °C, unless otherwise specified.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V _{OUT}	Output Voltage	BCT9230 BCT9233 BCT9236 BCT9250		3.0 3.3 3.6 5.0		V
V _{INS}	Minimum Starting Input Voltage	No Load BCT9230 BCT9233 BCT9236 BCT9250	1.0 1.0 1.1 1.4			V
V _{INO}	Minimum Operation Input Voltage ⁽¹⁾	BCT9230 BCT9233 BCT9236 BCT9250	0.9 0.9 1.0 1.3			V
V _{INM}	Maximum Operation Input Voltage	BCT9230 BCT9233 BCT9236 BCT9250			4.3 4.3 4.3 3.6	V
I _{dd}	Quiescent Current	No load V _{in} =1.5 V _{OUT} =3.0V		300		μA
I _{Sleep}	Sleep Mode Current ⁽²⁾			1.5		μA
V _{ripple}	Output Ripple	I _{out} =40mA		50		mV
F _{osc}	Switching Frequency			500		kHz

Note:

(1): The minimum operation voltage is measured by ramp down input voltage until the output voltage exceeds +/- 10% of its nominal value.

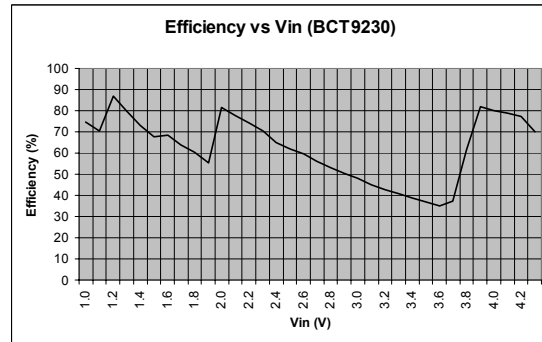
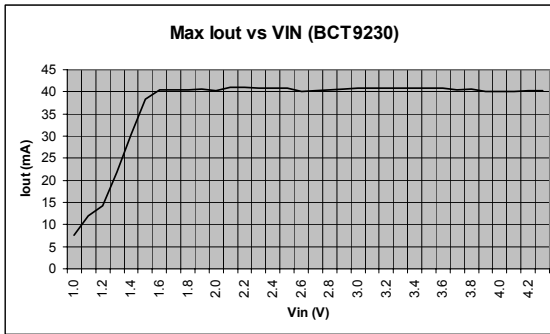
(2): V_{OUT} is not loaded, if V_{OUT} is connected to V_{SS} by a resistor, leakage current will be increased.



Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Iout30	BCT9230 Max Output Current	VDD=1.8-4.3V @ VOUT=3V		40		mA
		VDD=1.3-1.8V @ VOUT=3V		20 ~ 40		
		VDD=1.1-1.3V @ VOUT=3V		5 ~ 20		
		VDD=1.0V @ VOUT=3V		5		
Iout33	BCT9233 Max Output Current	VDD=1.8-4.3V @ VOUT=3.3V		40		mA
		VDD=1.3-1.8V @ VOUT=3.3V		20 ~ 40		
		VDD=1.1-1.3V @ VOUT=3.3V		5 ~ 20		
		VDD=1.0V @ VOUT=3.3V		5		
Iout36	BCT9236 Max Output Current	VDD=1.8-4.3V @ VOUT=3.6V		40		mA
		VDD=1.3-1.8V @ VOUT=3.6V		15 ~ 40		
		VDD=1.0-1.3V @ VOUT=3.6V		2 ~ 15		
		VDD=1.0V @ VOUT=3.6V		2		
Iout50	BCT9250 Max Output Current	VDD=2.0-3.6V @ VOUT=5.0V		40		mA
		VDD=1.4-2.0V @ VOUT=5.0V		12 ~ 40		
		VDD=1.4V @ VOUT=5.0V		12		

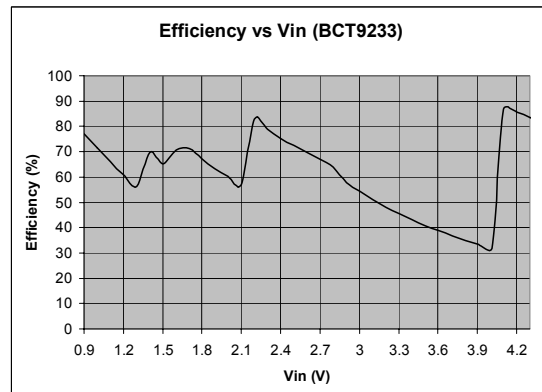
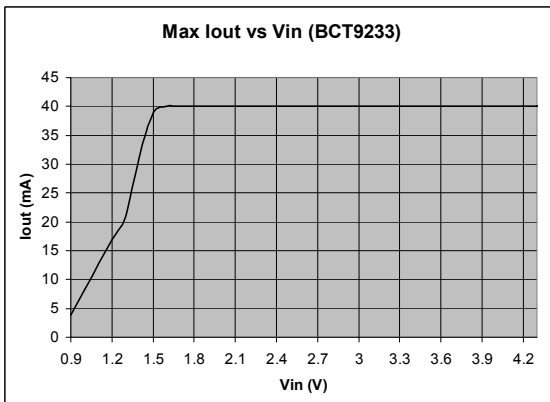
Typical Characteristic: BCT9230

Pump Cap = 1 μ F
Input Capacitor = 10 μ F (Ceramic 1206) || 47 μ F
Output Capacitor = 1 μ F || 47 μ F
VO_{UT} = \pm 10% of nominal value



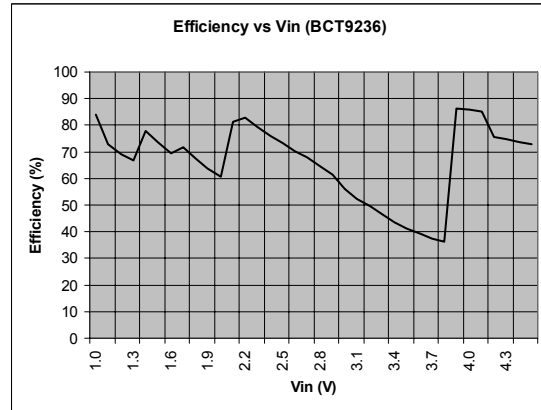
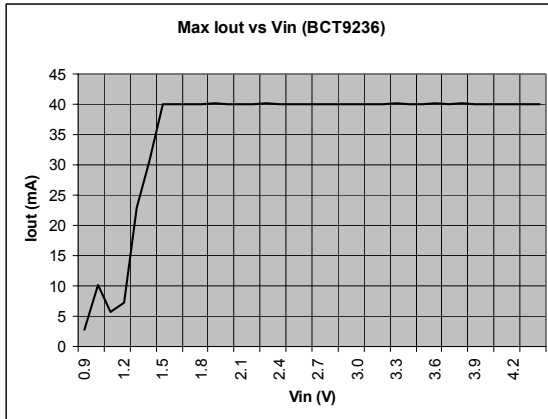
BCT9233

Pump Cap = 1 μ F
Input Capacitor = 10 μ F (Ceramic 1206) || 47 μ F
Output Capacitor = 1 μ F || 47 μ F
VO_{UT} = \pm 10% of nominal value



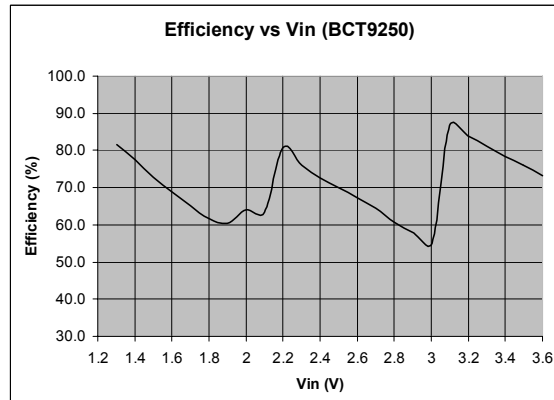
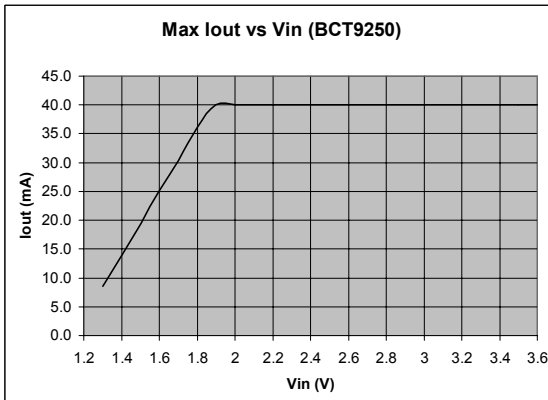
BCT9236

Pump Cap = 1 μ F
Input Capacitor = 10 μ F (Ceramic 1206) || 47 μ F
Output Capacitor = 1 μ F || 47 μ F
VO_{UT} = \pm 10% of nominal value



BCT9250

Pump Cap = 1 μ F
Input Capacitor = 10 μ F (Ceramic 1206) || 47 μ F
Output Capacitor = 1 μ F || 47 μ F
VO_{UT} = \pm 10% of nominal value



Applications

Basic Operation

BCT9230/BCT9233/BCT9236/BCT9250 are operated as step-up charge pump DC/DC converters which deliver various fixed regulated output voltages. The basic principle of charge pump is making use of capacitors to store and transfer energy to the output, Charge is transferred from one capacitor to another capacitor, then to the output under the control of input adaptation control circuit

The input adaptation control circuitry is constantly monitoring the input voltage at pin VIN; it will regulate the output voltage according to the input voltage level. Figure 1, 2, 3 and 4 shows the relationship between input and output voltage at different regulated output voltages.

In addition to the step up dc/dc conversion operation, BCT9230/BCT9233/BCT9236/BCT9250 can also regulate the output voltage when the input voltage VIN is greater than the output voltage VOUT.

The output voltage at VOUT, is fixed by an internal resistor divider, is regulated by comparing with an internal high precision band gap voltage reference.

In order to reduce the external components size, high switching frequency, 500KHz, is selected to generate non-overlapping clocks to drive the two flying capacitors: C1 and C2. The output filter capacitors are used to reduce the ripple appearing on the output.

In application of sub-system power supply, the pin SHDN can be used by external MCU to turn on or off the regulated output at VOUT.

Flying Capacitors

Low ESR, SMT ceramic capacitors are recommended for the flying capacitors. A value in the range of 0.1 μ F to 1 μ F, Y5V dielectric (X7R should be used for high operation temperature), 0805 size ceramic capacitor are recommended.

Input and Output Capacitors

One SMT ceramic capacitor in parallel with an aluminum electrolytic capacitors are the best combination to minimize the output voltage ripple, by increasing the output capacitor to 47 μ F or larger for heavy loads.

Layout Considerations

Careful PCB layout is necessary to minimize the switching noise and high transient currents. The flying capacitors C1, C2 and input capacitor should be placed as close as possible to the chip using short and wide PCB traces. A layout example is shown in Figure 6.

Efficiency

The efficiency of the charge pump DC/DC converter is affected by a lot of factors including the input voltage, the output voltage, the load current and the resistance of the internal switches.

Input Adaptation Circuitry Control:

Regulated 3.0V output (VDD is between 0.9 and 4.5V)

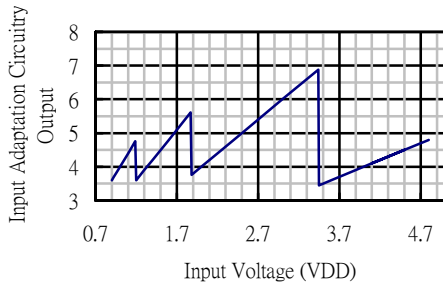


Figure 1

Regulated 3.3V output (VDD is between 0.9V and 4.5V)

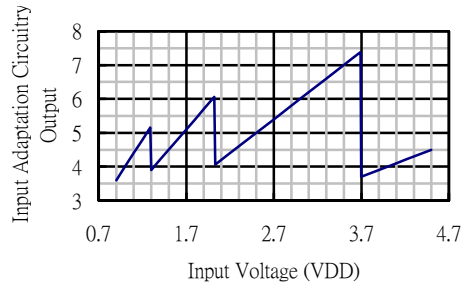


Figure 2

Regulated 3.6V output (VDD is between 0.9V and 4.5V)

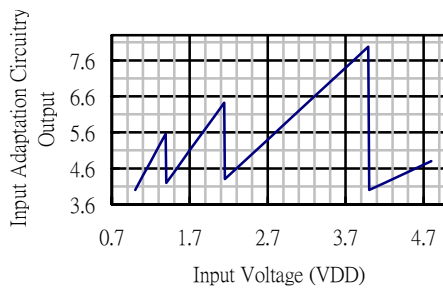


Figure 3

Regulated 5.0V output (VDD is between 1.4V and 3.6V)

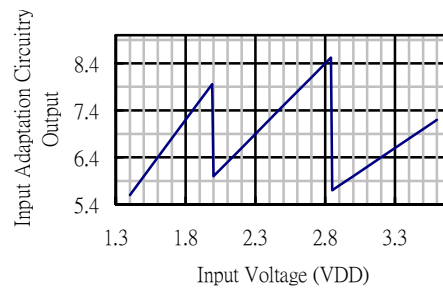


Figure 4

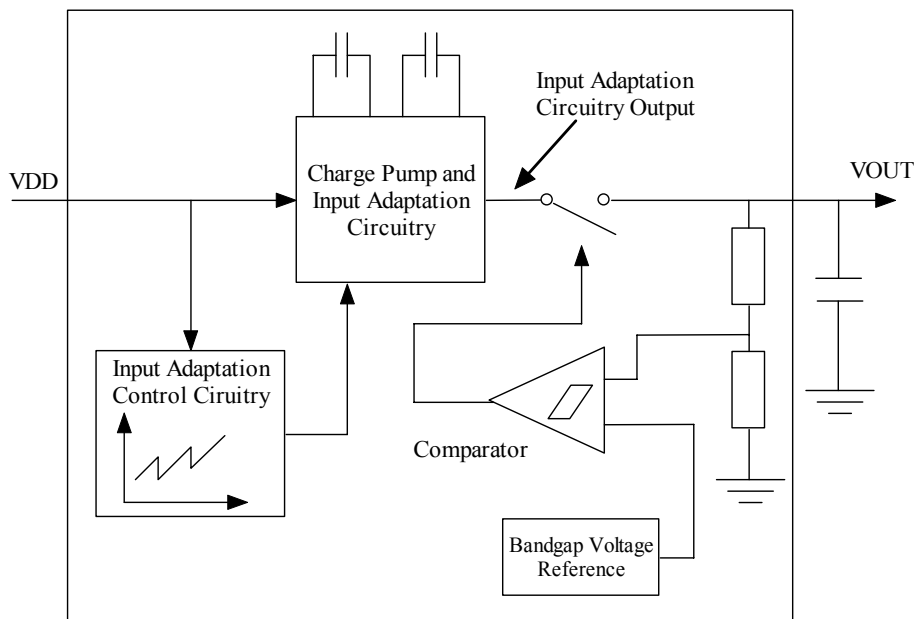
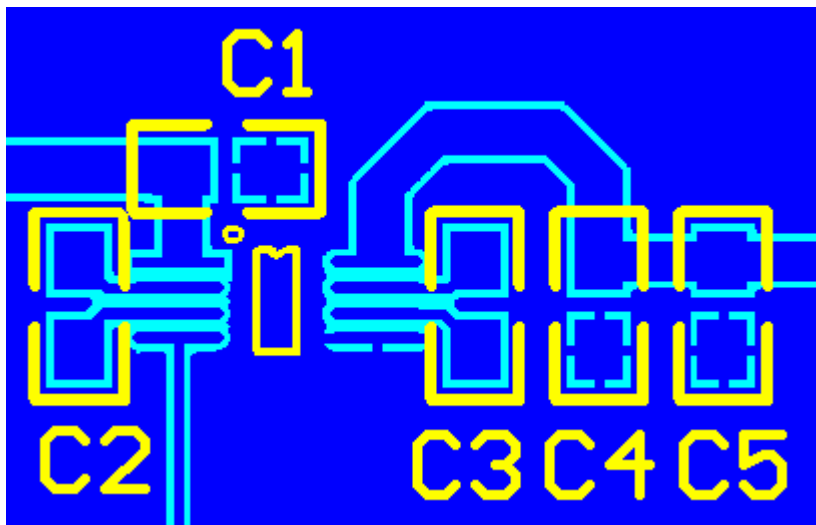


Figure 5: Input Adaptation Circuitry

Recommended Layout:



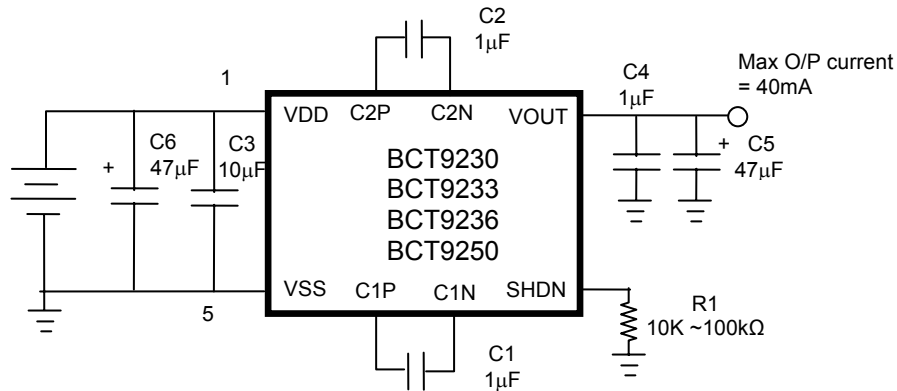
Traces - Blue
No Copper - light blue
Components Outline - Yellow

Figure 6: Recommended PCB layout

Application Example:

Fixed Regulated Charge Pump DC/DC Step-Up Converter

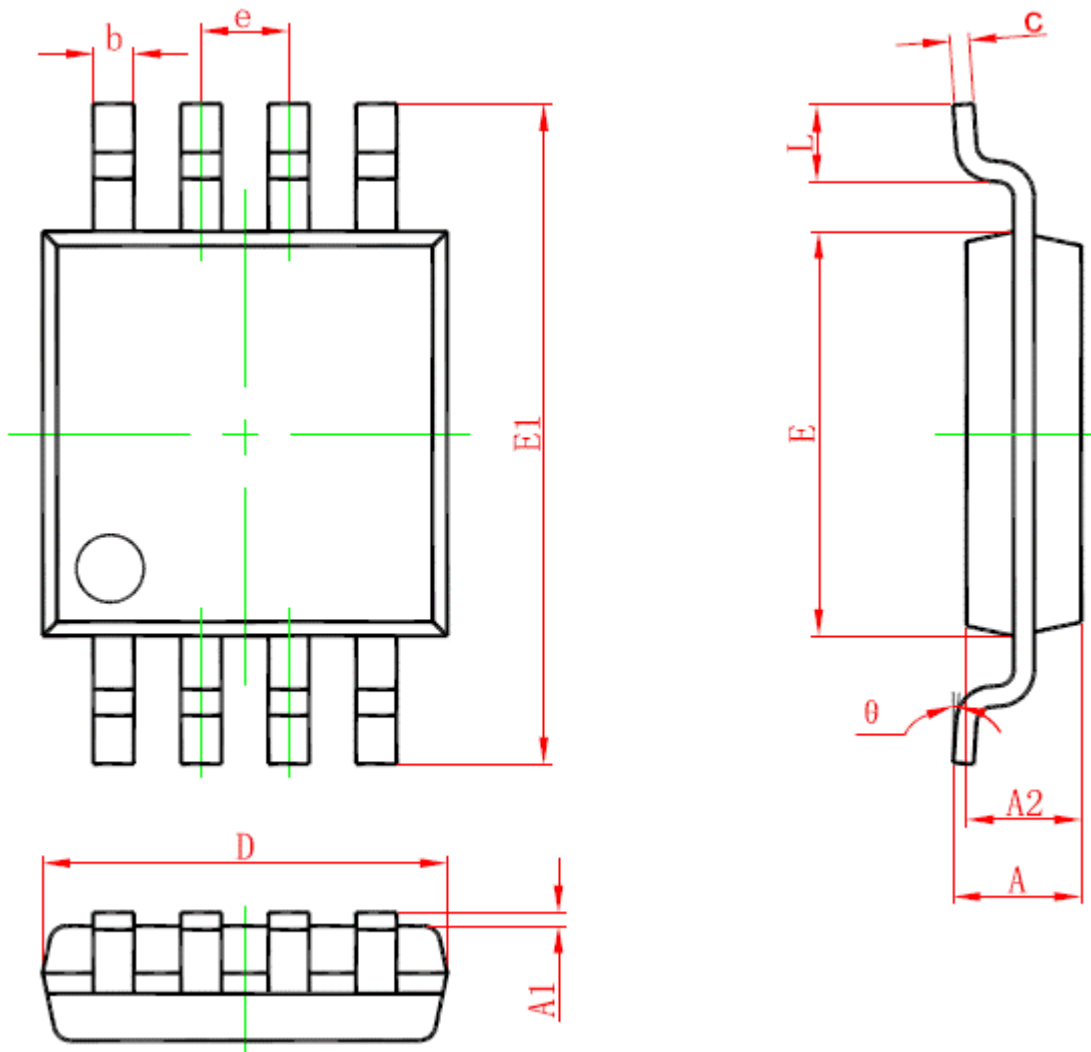
A fixed regulated charge pump DC/DC step up converter can be constructed as shown in the following figure.



BCT9230/ BCT9233/BCT9236/BCT9250			
Input power supply	2 x 1.5V batteries	2 x 1.5V batteries	
Max o/p Current	5mA	40mA	
C1 = C2	0.1µF	1µF	Ceramic 0805
Input Capacitor	1µF (0805)	10µF (1206) 47µF	Ceramic electrolytic
Output Capacitors	1µF	1µF 47µF	Ceramic electrolytic

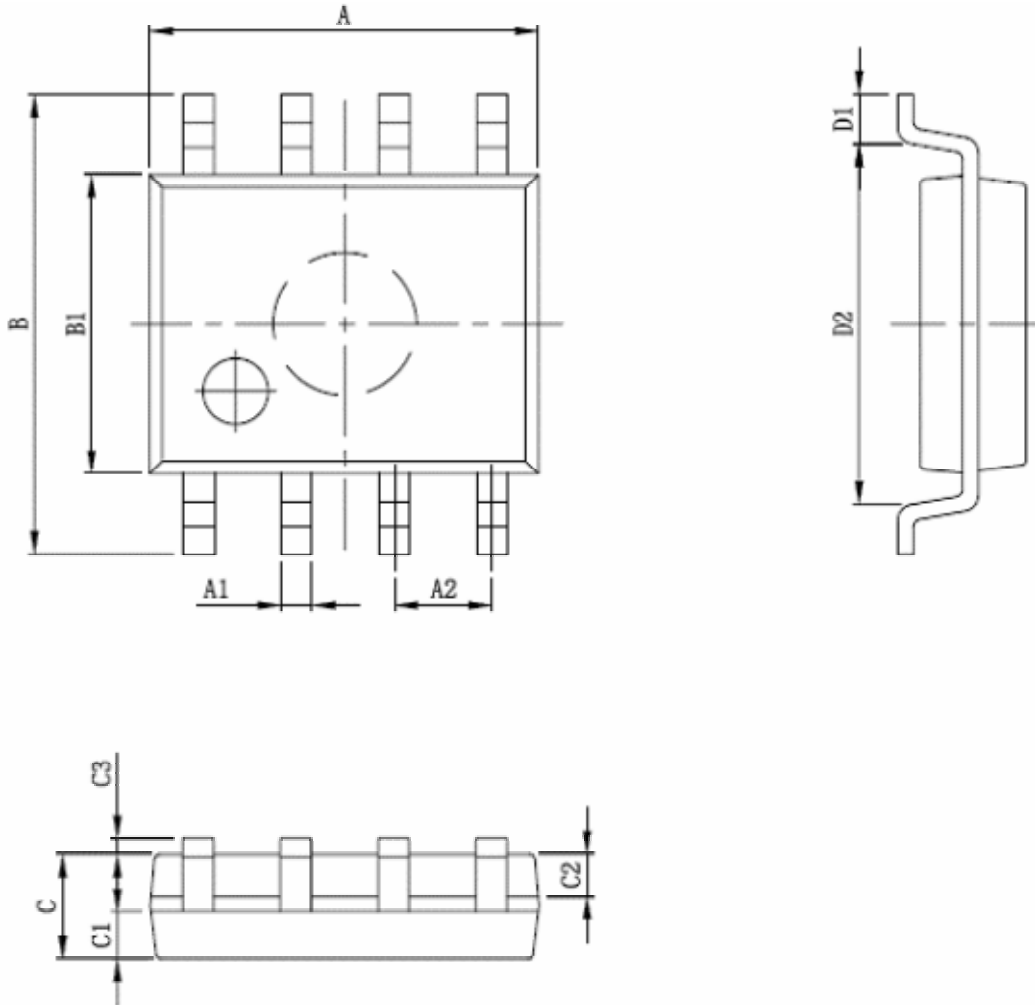
Table 1: The reference value of external components

Package Information : MSOP8



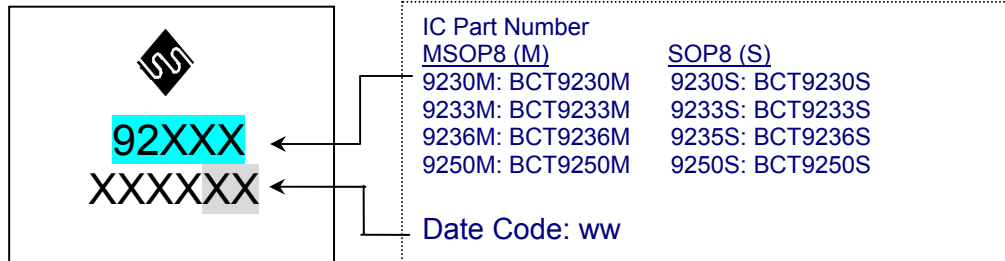
SYMBOL	MIN (Millimeter)	MAX (Millimeter)
A	0.820	1.100
A1	0.020	0.150
A2	0.750	0.950
b	0.250	0.380
c	0.090	0.230
D	2.900	3.100
e	0.650(BSC)	
E	2.900	3.100
E1	4.750	5.050
L	0.400	0.800
θ	0°	6°

Package Information: SOP8



SYMBOL	MIN (Millimeter)	MAX (Millimeter)
A	5.05	
A1	0.37	0.47
A2	1.27	
B	5.80	6.20
B1	3.85	3.95
C	1.35	1.45
C1	0.575	0.625
C2	0.575	0.625
C3	0.00	0.20
D1	0.40	0.60
D2	4.85	

Marking Notation / Ordering Information



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