

## General Description

The family of BCT9010S/BCT9020AS/BCT9035AS are general purpose charge pump DC/DC converters with programmable regulated voltage. The BCT9010S/ BCT9020AS/BCT9035AS has wide input voltage ranging from 1.8V to 3.6V which is designed for use in low cost application where standard batteries or NimH/NiCd rechargeable batteries are preferred. This family provides maximum dc output current ranging from 100mA to 350mA. A high efficiency and space saving 3V to 5V DC/DC converter can be easily built by incorporating external SMT capacitors and resistors. No expensive choke coil and schottky diode are needed

## Features

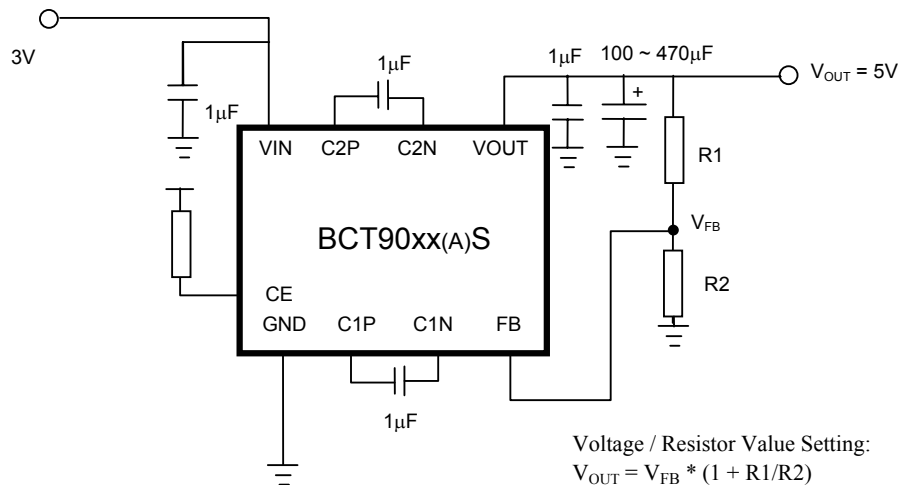
- Charge pump DC/DC converter with 1MHz switching frequency
- Wide input voltage range: 1.8V to 3.6V
- Maximum dc output current:
 

BCT9010S:	100mA
BCT9020AS:	200mA
BCT9035AS:	350mA
- Programmable output voltage by external resistor divider
- Low power consumption
- Wide operation temperature: -20°C to 70°C
- Pb-free package

## Applications

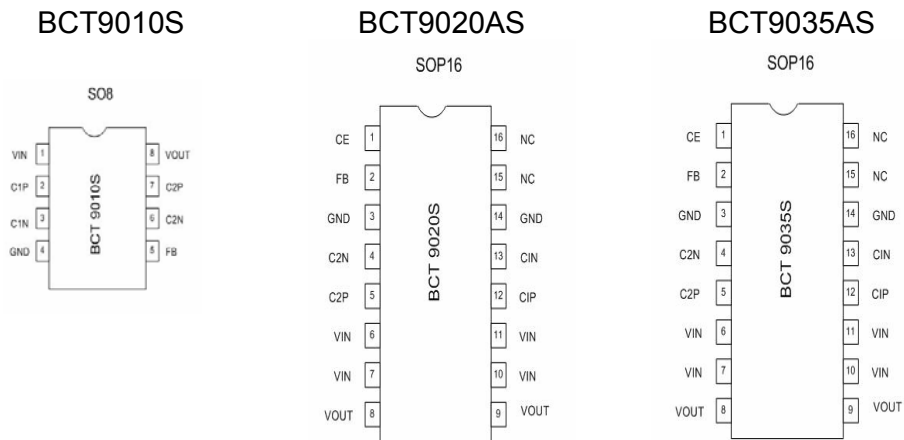
- 3V to 5V DC/DC converter for battery powered products
- Toys, Handheld Electronics, Cellular Phones, PDAs
- Mobile phone Battery charger

## Typical Application Circuit

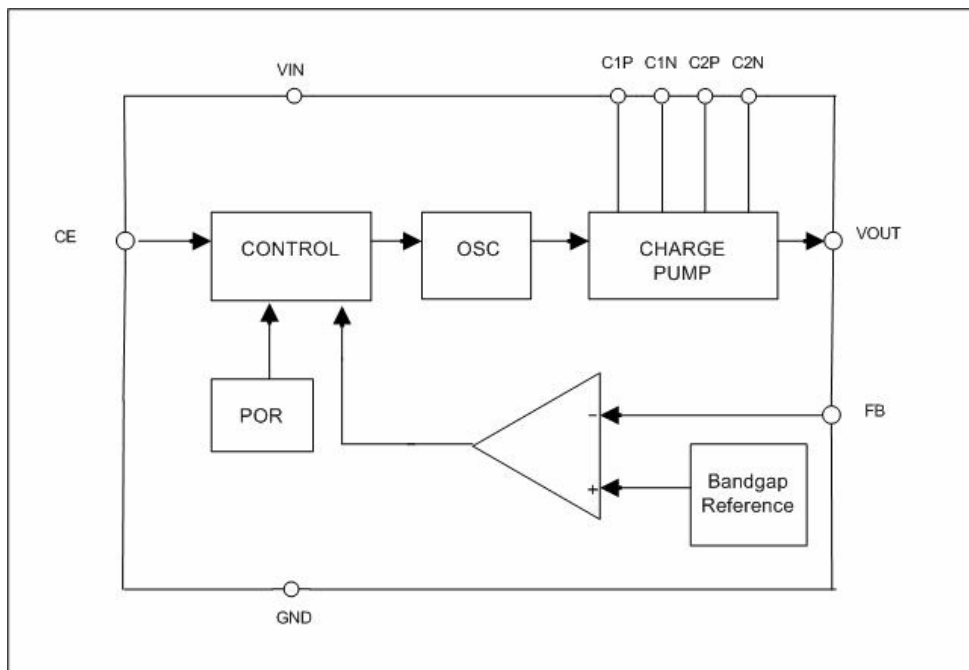


Feature Comparisons	BCT9010S	BCT9020AS	BCT9035AS
Max dc Output Current	100mA	200mA	350mA
Input Voltage	1.8V ~ 3.6V	1.8V ~ 3.6V	1.8V ~ 3.6V
Chip Enable (CE)	No	Yes	Yes
Thermal Protection	No	Yes	Yes
Package	SO8	SO16	SO16

## Pin Assignments



## Block Diagram



## Pin Descriptions

BCT9010S (SO8) Pin #	BCT9020AS (SO16L) Pin #	BCT9035AS (SO16L) Pin #	Pin Name	I/O	Description
1	6,7,10,11	6,7,10,11	VIN	Power	Input Supply 1.8V – 3.6V
4	3,14	3,14	GND	Power	Ground 0V
2	12	12	C1P	I/O	Charge Pump Flying Capacitor 1 Pins. To connect a 1 $\mu$ F ceramic capacitor between C1P and C1N
3	13	13	C1N		
7	5	5	C2P	I/O	Charge Pump Flying Capacitor 2 Pins. To connect a 1 $\mu$ F ceramic capacitor between C2P and C2N
6	4	4	C2N		
8	8,9	8,9	VOUT	Output	Charge Pump Output. To connect a 100 $\mu$ F ~ 470 $\mu$ F capacitor from VOUT to GND
--	1	1	CE	Input	Chip Enable (Active High), connect external pull-up resistor (1 k $\Omega$ to 10 k $\Omega$ )
5	2	2	FB	Input	Connect to the resistor divider. Regulated VOUT is proportional to the feedback voltage which is comparing with an internal bandgap reference

## Absolute Maximum Specifications

Rating	Symbol/ Conditions	Value	Unit
Supply voltage range	$V_{IN}$	-0.3 to 4.3	Volts
Input voltage range	CE, BCT9020AS CE, BCT9035AS	-0.3 to $V_{IN}+0.3$ -0.3 to $V_{IN}+0.3$	Volts
Output current Range	$I_{OUT}$ , BCT9010S $I_{OUT}$ , BCT9020AS $I_{OUT}$ , BCT9035AS	0 to 100 0 to 200 0 to 350	mA
Output voltage range	$V_{OUT}$	-0.3 to 8	Volts
Operating temperature range	$T_{OPR}$	-20 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  $-20^{\circ}C$  to  $70^{\circ}C$ ,  $V_{IN}$  from 1.8V to 3.6V, unless otherwise specified.

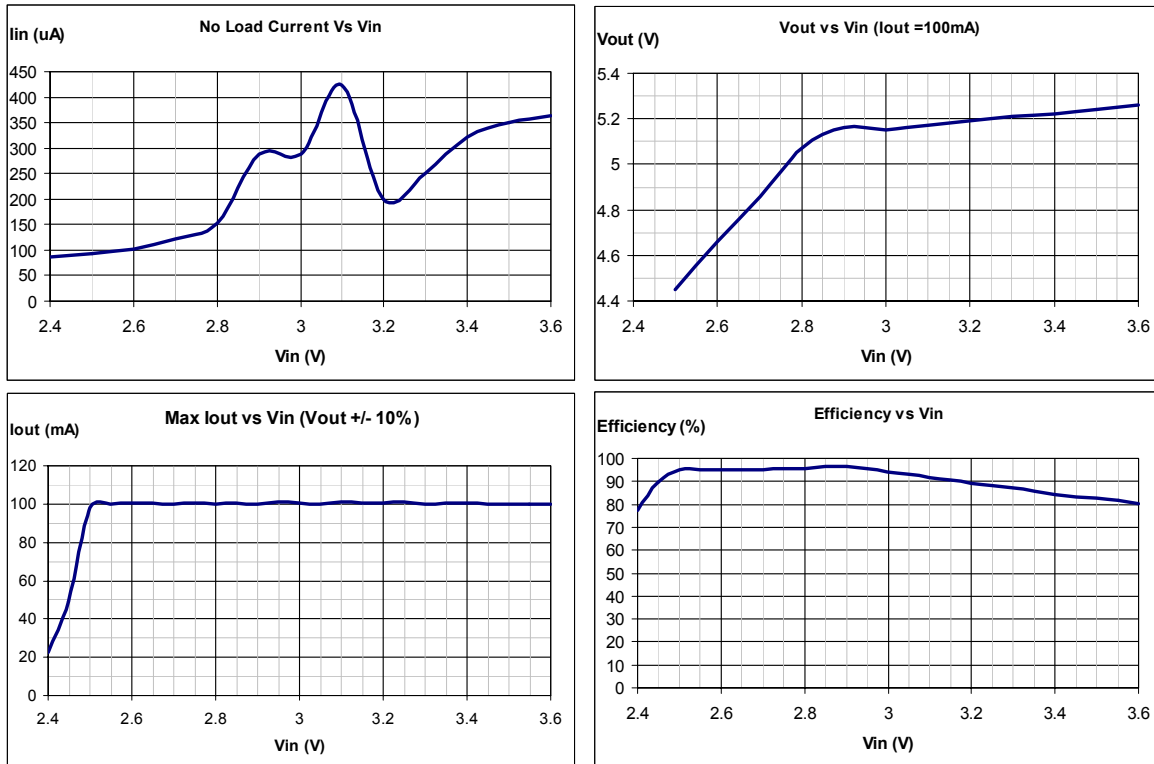
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{IN}$	Input Power Supply		1.8	2.4	3.6	V
$I_{CC}$	Operating Current	$I_{OUT} = 0mA$ $V_{OUT} = 3.6Volts$		1.1		mA
$I_{SHDN}$	Shutdown Current	CE = Low, $V_{OUT} = 0V$ BCT9020AS BCT9035AS		5 5		$\mu A$
$V_{FB}$	Feedback Voltage at FB	BCT9010S BCT9020AS BCT9035AS		110 100 100		mV
$F_{OSC}$	Internal Oscillator Frequency			1.0		MHz
$V_{IL}$	Input Voltage Low for CE	BCT9020AS BCT9035AS	0		0.3	V
$V_{IH}$	Input Voltage High for CE	BCT9020AS BCT9035AS	$V_{IN}-0.3$		$V_{IN}$	V
$T_j$	Junction Temperature	BCT9020AS BCT9035AS		110 110		$^{\circ}C$

## Typical Performance:

The typical performance is measured by employed circuit in typical application with 25 deg C ambient Temperature unless otherwise specified:

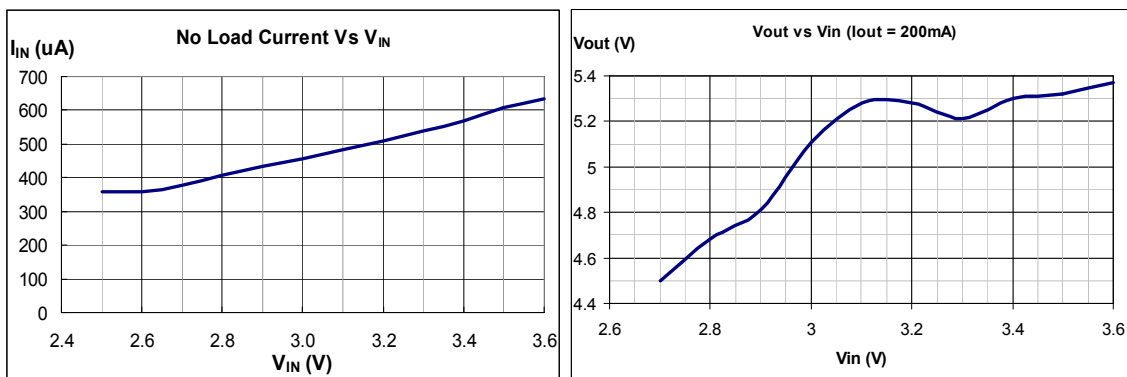
### BCT9010S

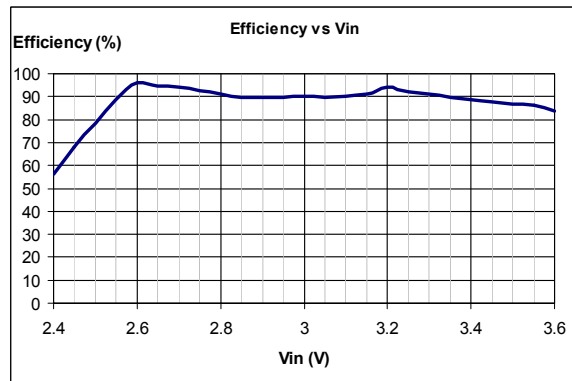
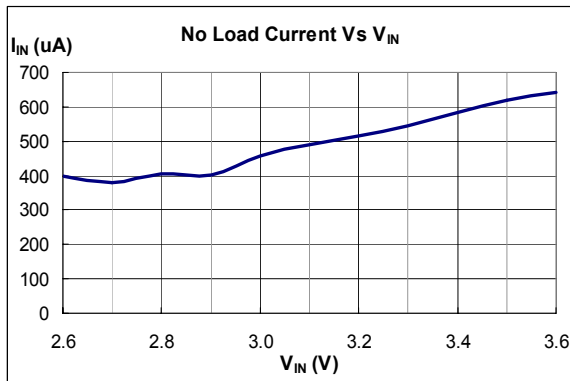
$C1 = C2 = 1\mu\text{F}$ ,  $R1 = 440\text{K}\Omega$ ,  $R2 = 10\text{K}\Omega$ ,  $C(\text{VIN}) = 1\mu\text{F}$ ,  $C(\text{VOUT}) = 1\mu\text{F} || 100\mu\text{F}$



### BCT9020AS

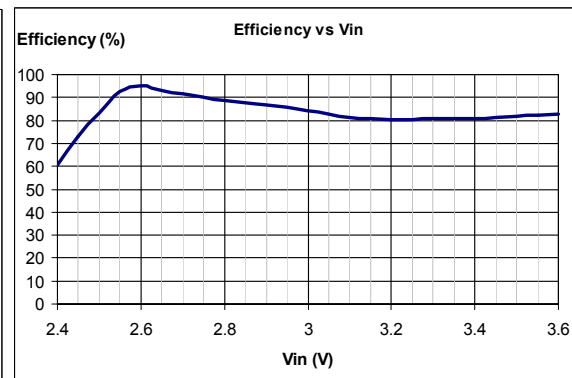
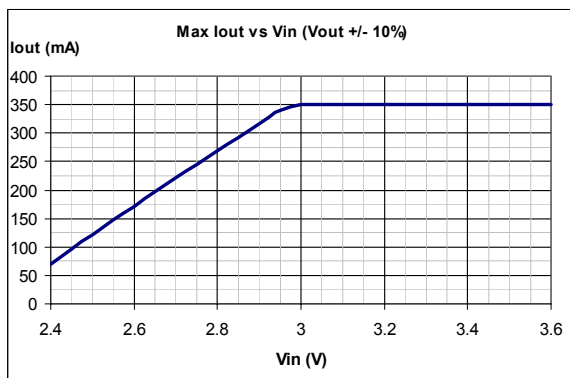
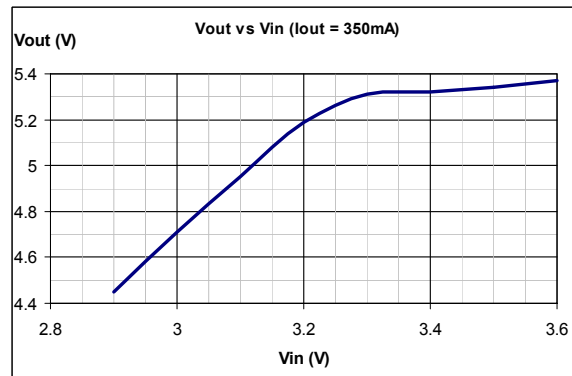
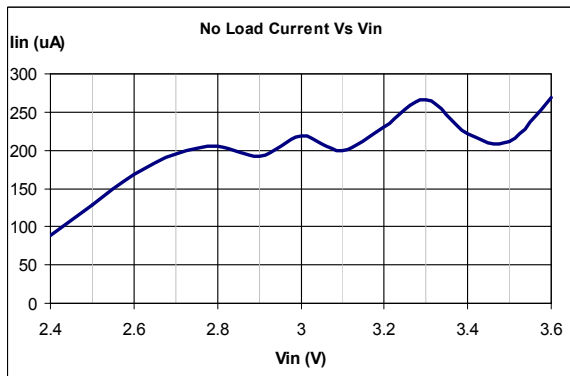
$C1 = C2 = 1\mu\text{F}$ ,  $R1 = 490\text{K}\Omega$ ,  $R2 = 10\text{K}\Omega$ ,  $C(\text{VIN}) = 1\mu\text{F} || 1\mu\text{F}$ ,  
 $C(\text{VOUT}) = 1\mu\text{F} || 1\mu\text{F} || 220\mu\text{F}$





### BCT9035AS

$C1 = C2 = 1\mu F$ ,  $R1 = 475.6K\Omega$ ,  $R2 = 10K\Omega$ ,  $C(V_{IN}) = 1\mu F || 1\mu F$ ,  
 $C(V_{OUT}) = 1\mu F || 1\mu F || 470\mu F$



## Applications

### Basic Operation

BCT9010S/BCT9020AS/BCT9035AS are operated as a charge pump DC/DC converter which double the input voltage and transfer the charge stored in the flying capacitors to the load. The output voltage, is determined proportionally by the 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, 1MHz, 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 appear on the output. The BCT9020AS/BCT9035AS are protected against over-temperature conditions by reducing the output current in half when the chip temperature over 110 deg C.

### Regulated Output Voltage

The output voltage is determined by using the following equations

$$V_{OUT} = V_{FB} \left(1 + \frac{R1}{R2}\right)$$

When  $V_{OUT} \leq 2 V_{IN}$

For example, the  $V_{IN}$  voltage range and the resistor is setting for 3V to 5V conversion by using BCT9020AS

$V_{OUT} = 5V$

$V_{IN} = \sim 2.6V$  to  $3.6V$

$R1 = 10 K\Omega$

$R2 = 490 K\Omega$

### Flying Capacitors

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

### 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 470 $\mu F$  or larger for heavy loads. Some reference values are shown in Table 1.

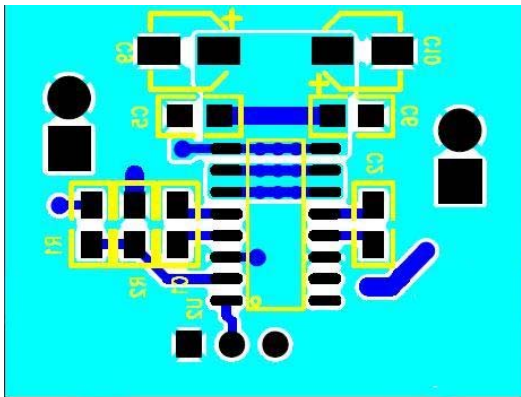
### Layout Considerations

Careful PCB layout is necessary to minimize the switching noise and high transient currents. Place the flying capacitors C1 and C2 as close as possible to the chip using short, direct PCB traces. A layout example is shown as following figure.

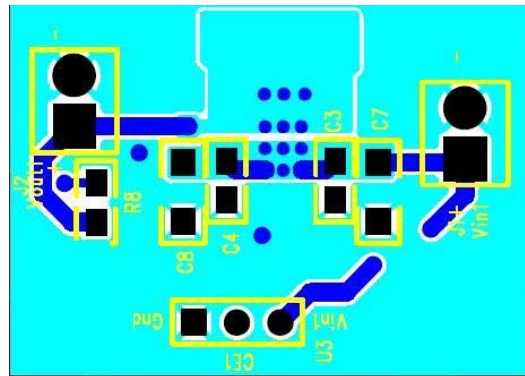
### Efficiencies

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.

Layout Examples:



Top view



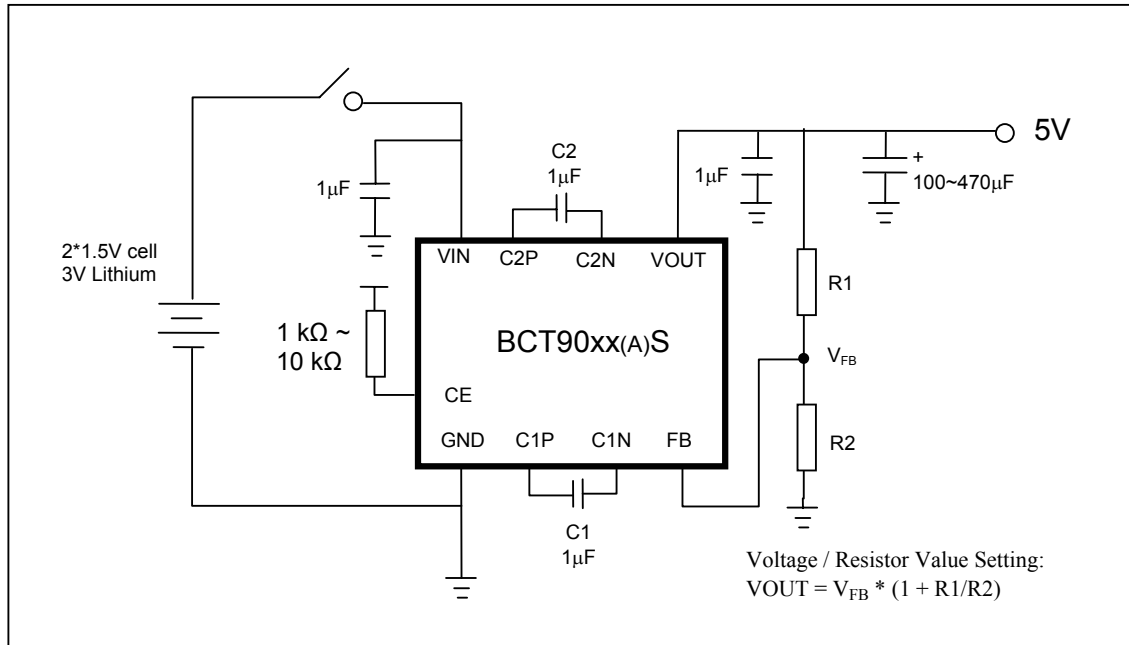
Bottom View

Traces / Via	-	Blue
Copper Outline	-	light blue
Components Outline	-	Green
Holes / Pad	-	Black

**Application Examples:**

**3V to regulated 5V Charge Pump DC/DC Step-Up Converter**

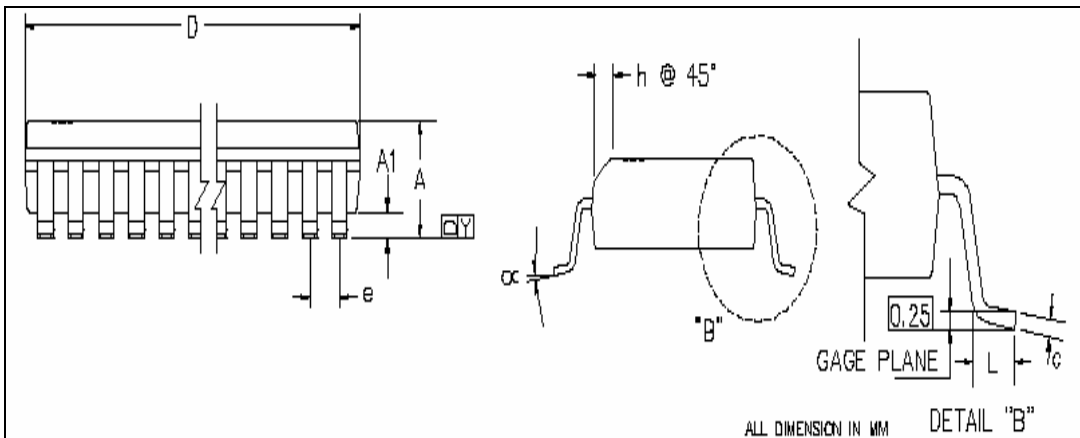
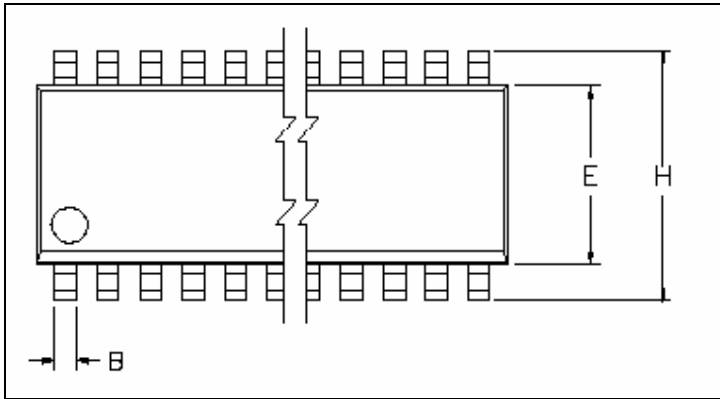
A simple 3V to 5V charge pump step up DC/DC converter can be constructed as shown in the following figure. The output voltage can be adjusted by the feedback resistors R1 and R2.



External Components	3V to regulated 5V		
	BCT9010S	BCT9020AS	BCT9030AS
R1	430KΩ + 10KΩ	470KΩ + 20KΩ	470KΩ + 5.6KΩ
R2	10KΩ	10KΩ	10KΩ
Input Capacitors	1µF	1µF    0.47µF	1µF    1µF
Output Capacitors	1µF    100µF	1µF    1µF    220µF	1µF    1µF    470µF

Table 1: The reference value of external components

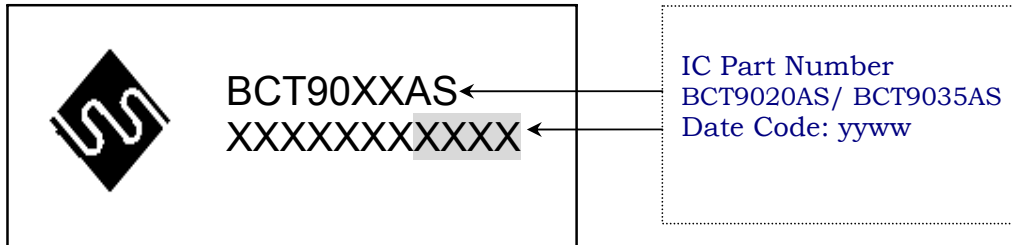
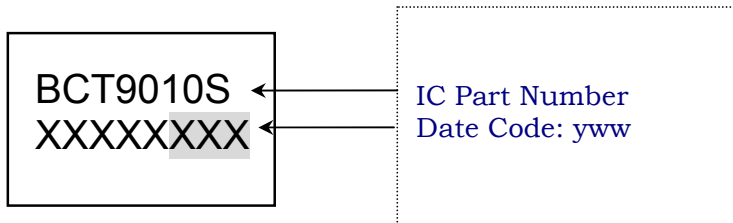
## Package Information



### CONTROL DIMENSIONS ARE IN MM

SYMBOL	MILLIMETER			INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	1.55	1.75	0.053	0.061	0.069
A1	0.10	0.15	0.25	0.004	0.006	0.010
B	0.33	0.42	0.51	0.013	0.016	0.020
C	0.19	0.22	0.25	0.007	0.008	0.010
E	3.80	3.90	4.00	0.150	0.153	0.157
e	1.27 BSC			0.050 BSC		
H	5.80	6.00	6.20	0.228	0.236	0.244
h	0.25	0.40	0.50	0.010	0.016	0.020
L	0.40	0.70	1.27	0.016	0.028	0.050
$\alpha$	0°	-	8°	0°	-	8°
Y	0	-	0.10	0	-	0.004
D8	4.80	4.90	5.00	0.189	0.193	0.197
D16	9.80	9.90	10.00	0.386	0.390	0.394

## Marking Notation / Ordering Information



## Sales Offices

<p><u><a href="#">Malaysia</a></u></p> <p><b>BCT Technology Bhd (HQ)</b></p> <p>Cyberview Garden Villa &amp; Office Complex First Floor, Rajawali Block Persiaran Multimedia 63000 Cyberjaya Selangor Darul Ehsan, Malaysia</p> <p>Tel : 603 8318 1108 Fax : 603 8318 1109</p> <p><u><a href="#">Singapore</a></u></p> <p><b>BlueChips Technology Pte Ltd</b></p> <p>3 International Business Park #03-18/19/20 Nordic European Centre Singapore 609927</p> <p>Tel : 65 6890 6938 Fax : 65 6896 0928</p>	<p><u><a href="#">Hong Kong</a></u></p> <p><b>BlueChips Technology Pte Ltd</b></p> <p>Unit 906-911, 9/F., Stanhope House 734-738 King's Road, North Point, Hong Kong</p> <p>Tel : 852 2776 7968 Fax : 852 2776 8997</p>
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