



# BCT2028

## 500mA, Low Dropout, Linear Regulators

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### 500mA Low Dropout Linear Regulators

#### GENERAL DESCRIPTION

The BCT2028 series low-power, low-noise, low-dropout, CMOS linear voltage regulators operate from a 2.5V to 5.5V input voltage. They are the perfect choice for low voltage, low power applications. A low ground current makes this part attractive for battery operated power systems. The BCT2028 series also offer ultra-low dropout voltage to prolong battery life in portable electronics. Output current minimum limit is 500mA, and over-current protection limit is set at 700mA typical. An external noise bypass capacitor connected to the device's BP pin can further reduce the noise level.

These devices feature a shutdown function and are offered in active low with auto discharge. The output voltage is preset to voltages in the range of 1.2V to 3.3V. Other features include a low shutdown current, fold-back current limit and thermal shutdown protection.

The BCT2028 is available in Green SOT23-5 packages. It operates over an ambient temperature range of -40°C to +85°C.

#### FEATURES

- Low Output Noise
- Low Dropout Voltage
- Thermal-Overload Protection
- Output Current Limit
- High PSRR(74dB at 1kHz)
- 500mA Current Rating
- Available in Multiple output Voltage Versions
- Fixed Outputs of 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 2.85V, 3.0V and 3.3V
- Adjustable Output from 1.2V to 3.3V
- Quick output discharge
- -40°C to 85°C Operating Temperature Range
- Available in Green SOT23-5 Packages

#### APPLICATIONS

Cellular Telephones  
Cordless Telephones  
PCMCIA Cards  
Modems  
MP3 Player  
Hand-Held Instruments  
Portable/Battery-Powered Equipment



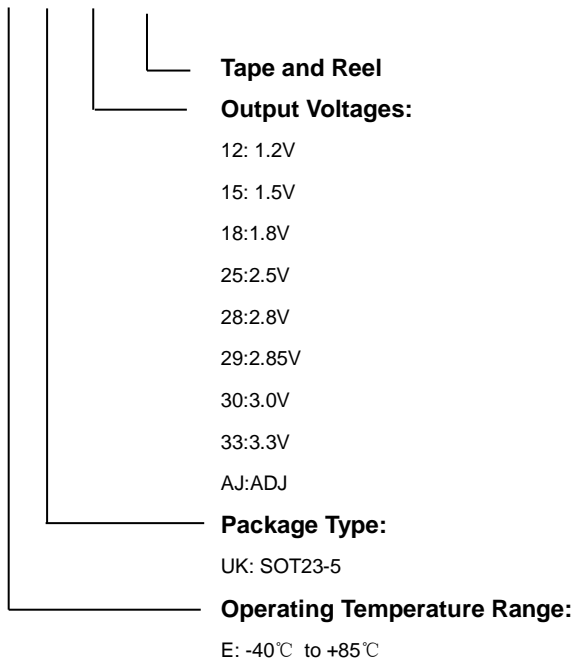
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## ORDERING INFORMATION

Order Number	V <sub>OUT</sub> (V)	Package Type	Temperature Range	Marking	QTY/Reel
BCT2028EUK12-TR	1.2	SOT23-5	-40°C to +85°C	F2ZZ	3000
BCT2028EUK15-TR	1.5	SOT23-5	-40°C to +85°C	F5ZZ	3000
BCT2028EUK18-TR	1.8	SOT23-5	-40°C to +85°C	F8ZZ	3000
BCT2028EUK25-TR	2.5	SOT23-5	-40°C to +85°C	F5ZZ	3000
BCT2028EUK28-TR	2.8	SOT23-5	-40°C to +85°C	F8ZZ	3000
BCT2028EUK29-TR	2.85	SOT23-5	-40°C to +85°C	F9ZZ	3000
BCT2028EUK30-TR	3	SOT23-5	-40°C to +85°C	F0ZZ	3000
BCT2028EUK33-TR	3.3	SOT23-5	-40°C to +85°C	F3ZZ	3000
BCT2028EUKAJ-TR	ADJ	SOT23-5	-40°C to +85°C	FJZZ	3000

## ORDER NUMBER

BCT2028 X XX XX -TR





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### MARKING DESCRIPTION

F: Product Code

X: Output Voltage Code

V <sub>OUT</sub> (V)	Code
1.2	2
1.5	5
1.8	8
2.5	$\bar{5}$
2.8	$\bar{8}$
2.85	$\bar{9}$
3.0	$\underline{0}$
3.3	$\underline{3}$
ADJ	$\underline{J}$

Z: The year of manufacturing, "1" stands for year 2011, "2" stands for year 2012, "7" stands for year 2017 and "8" stands for year 2018.

Z: The week of manufacturing. "A" stands for week 1, "Z" stands for week 26, " $\bar{A}$ " stands for week 27, " $\bar{Z}$ " stands for week 52.



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### ABSOLUTE MAXIMUM RATINGS

IN to GND.....	-0.3V to 6V
EN to GND.....	-0.3V to $V_{IN}$
OUT, BP/FB to GND.....	-0.3V to $(V_{IN}+0.3V)$
Output Short-Circuit Duration.....	Infinite
Power Dissipation, $P_D@T_A=25^\circ C$	
SOT-23-5.....	0.4W
Package Thermal Resistance	
SOT-23-5, $\theta_{JA}$ .....	250°C/W
Junction Temperature.....	150°C
Operating Temperature Range.....	-40°C to +85°C
Storage Temperature Range.....	-65°C to 150°C
Lead Temperature (Soldering, 10 sec).....	260°C
ESD Susceptibility	
HBM.....	4000V
MM.....	400V

#### NOTE:

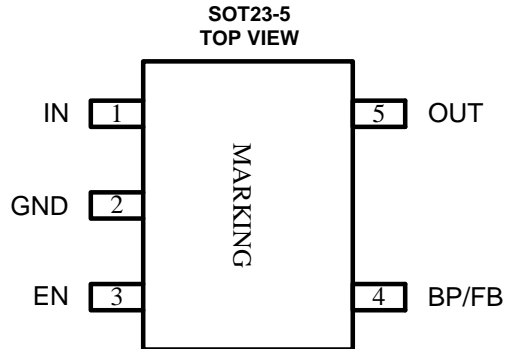
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### CAUTION

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. Broadchip recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

Broadchip reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time. Please contact Broadchip sales office to get the latest datasheet.

### PIN CONFIGURATION



### PIN DESCRIPTION

PIN	NAME	FUNCTION
1	IN	Regulator Input. Supply voltage can range from 2.5V to 5.5V. Bypass with a 1uF capacitor to GND.
2	GND	Ground.
3	EN	Shutdown Input. A logic low reduces the supply current to 10nA. Connect to IN for normal operation.
4	BP	Reference-Noise Bypass (fixed voltage version only). Bypass with a low-leakage 0.01uF ceramic capacitor for reduced noise at the output.
	FB	Adjustable Voltage Version Only. This is used to set the output voltage of the device.
5	OUT	Regulator Output.

### ELECTRICAL CHARACTERISTICS

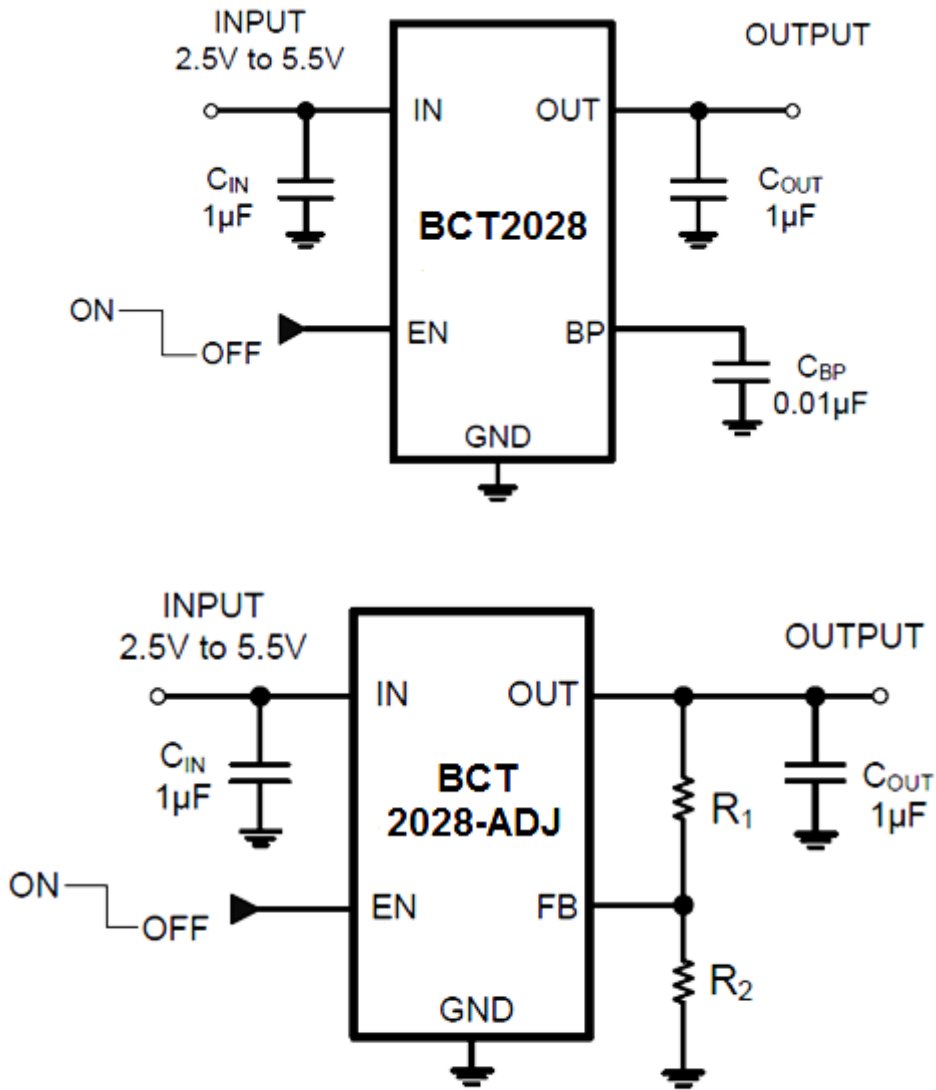
( $V_{IN} = V_{OUT(NOMINAL)} + 0.5V^{(1)}$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise specified.)

PARAMETER	SYM	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage	$V_{IN}$		2.5		5.5	V
Output Voltage Accuracy <sup>(1)</sup>		$I_{OUT} = 0.1mA$	-2.5		2.5	%
Maximum Output Current			500			mA
Current Limit	$I_{LIM}$			700		mA
Ground Pin Current	$I_Q$	No load, $EN = 2V$		100	200	$\mu A$
Dropout Voltage <sup>(2)</sup>		$I_{OUT} = 1mA$		0.9		mV
		$I_{OUT} = 500mA$		270	500	
Line Regulation	$\Delta V_{LNR}$	$V_{IN} = 2.5V$ or $(V_{OUT} + 0.5V)$ to $5.5V$ , $I_{OUT} = 1mA$		0.1		%/V
Load Regulation	$\Delta V_{LDR}$	$I_{OUT} = 0.1mA$ to $500mA$ , $C_{OUT} = 1\mu F$ , $V_{OUT} > 2V$		0.002		%/mA
		$I_{OUT} = 0.1mA$ to $500mA$ , $C_{OUT} = 1\mu F$ , $V_{OUT} \leq 2V$		0.004		
Output Voltage Noise	$e_n$	$f = 10Hz$ to $100kHz$ , $C_{BP} = 0.01\mu F$ , $C_{OUT} = 10\mu F$		50		$\mu V_{RMS}$
Power Supply Rejection Ratio	PSRR	$C_{BP} = 0.1\mu F$ , $I_{LOAD} = 50mA$ , $C_{OUT} = 1\mu F$ , $V_{IN} = V_{OUT} + 1V$	$f = 217Hz$		77	dB
			$f = 1kHz$		74	
<b>SHUTDWN<sup>(3)</sup></b>						
EN Input Threshold	$V_{IH}$	$V_{IN} = 2.5V$ to $5.5V$ , $V_{EN} = -0.3V$ to $V_{IN}$	1.5			V
	$V_{IL}$				0.3	
EN Input Bias Current	$I_{B(SHDN)}$	$EN = 0V$ or $EN = 5.5V$		0.01	1	$\mu A$
Shutdown Supply Current	$I_{Q(SHDN)}$	$EN = 0.4V$		0.01		$\mu A$
Shutdown Exit Delay <sup>(4)</sup>		$C_{BP} = 0.01\mu F$ , $C_{OUT} = 1\mu F$ , No Load		30		$\mu s$
<b>THERMAL PROTECTION</b>						
Thermal Shutdown Temperature	$T_{SHDN}$			150		$^{\circ}C$
Thermal Shutdown Hysteresis	$\Delta T_{SHDN}$			15		$^{\circ}C$

NOTES:

- $V_{IN} = V_{OUT(NOMINAL)} + 0.5V$  or  $2.5V$ , whichever is greater.
- The dropout voltage is defined as  $V_{IN} - V_{OUT}$ , when  $V_{OUT}$  is 100mV below the value of  $V_{OUT}$  for  $V_{IN} = V_{OUT} + 0.5V$ .  
(Only applicable for  $V_{OUT} = +2.5V$  to  $+5.0V$ .)
- $V_{EN} = -0.3V$  to  $V_{IN}$
- Time needed for  $V_{OUT}$  to reach 90% of final value.

### TYPICAL APPLICATION CIRCUIT



NOTE:  $V_{OUT} = (R_1 + R_2) / R_2 \times 1.207$

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## APPLICATION NOTE

### Bypass Capacitor and Low Noise

Connecting a 10nF between the BP pin and GND pin significantly reduces noise on the regulator output, it is critical that the capacitor connection between the BP pin and GND pin be direct and PCB traces should be as short as possible. There is a relationship between the bypass capacitor value and the LDO regulator turn on time. DC leakage on this pin can affect the LDO regulator output noise and voltage regulation performance.

### Enable Function

The BCT2028 features an LDO regulator enable/disable function. To assure the LDO regulator will switch on; the EN turn on control level must be greater than 1.5 volts. The LDO regulator will go into the shutdown mode when the voltage on the EN pin falls below 0.3 volts. For to protect the system, the BCT2028 have a quick discharge function. If the enable function is not needed in a specific application, it may be tied to VIN to keep the LDO regulator in a continuously on state.

### Programming the BCT2028 Adjustable LDO regulator

The output voltage of the BCT2028 adjustable regulator is programmed using an external resistor divider as show in Figure as below. The output voltage is calculated using equation as below:

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

Where:

$V_{REF}=1.207V$  typ (the internal reference voltage)

Resistors R1 and R2 should be chosen for approximately 50uA divider current. Lower value resistors can be used for improved noise performance, but the solution consumes more power. Higher resistor values should be avoided as leakage current into/out of FB across R1/R2 creates an offset voltage that artificially increases/decreases the feedback voltage and thus erroneously decrease/increases  $V_{OUT}$ .

### Thermal Considerations

Thermal protection limits power dissipation in BCT2028. When the operation junction temperature exceeds 150°C, the OTP circuit starts the thermal shutdown function turn the pass element off. The pass element turns on again after the junction temperature cools by 15°C.





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For continue operation, do not exceed absolute maximum operation junction temperature 125°C. The power dissipation definition in device is:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_Q$$

The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surroundings airflow and temperature difference between junction to ambient. The maximum power dissipation can be calculated by following formula:

$$P_D(\text{MAX}) = (T_J(\text{MAX}) - T_A) / \theta_{JA}$$

Where  $T_J(\text{MAX})$  is the maximum operation junction temperature 125°C,  $T_A$  is the ambient temperature and the  $\theta_{JA}$  is the junction to ambient thermal resistance. For recommended operating conditions specification of BCT2028, where  $T_J(\text{MAX})$  is the maximum junction temperature of the die (125°C) and  $T_A$  is the maximum ambient temperature. The junction to ambient thermal resistance ( $\theta_{JA}$  is layout dependent) for SOT-23-5 package is 250°C/W, on standard JEDEC 51-3 thermal test board. The maximum power dissipation at  $T_A = 25^\circ\text{C}$  can be calculated by following formula:

$$P_D(\text{MAX}) = (125^\circ\text{C} - 25^\circ\text{C}) / 250 = 400\text{mW (SOT-23-5)}$$

The maximum power dissipation depends on operating ambient temperature for fixed  $T_J(\text{MAX})$  and thermal resistance  $\theta_{JA}$ . It is also useful to calculate the junction of temperature of the BCT2028 under a set of specific conditions. In this example let the Input voltage  $V_{IN} = 3.3\text{V}$ , the output current  $I_O = 500\text{mA}$  and the case temperature  $T_A = 40^\circ\text{C}$  measured by a thermal couple during operation. The power dissipation for the  $V_O = 2.8\text{V}$  version of the BCT2028 can be calculated as:

$$P_D = (3.3\text{V} - 2.8\text{V}) \times 500\text{mA} + 3.6\text{V} \times 100\mu\text{A} \\ = 250\text{mW}$$

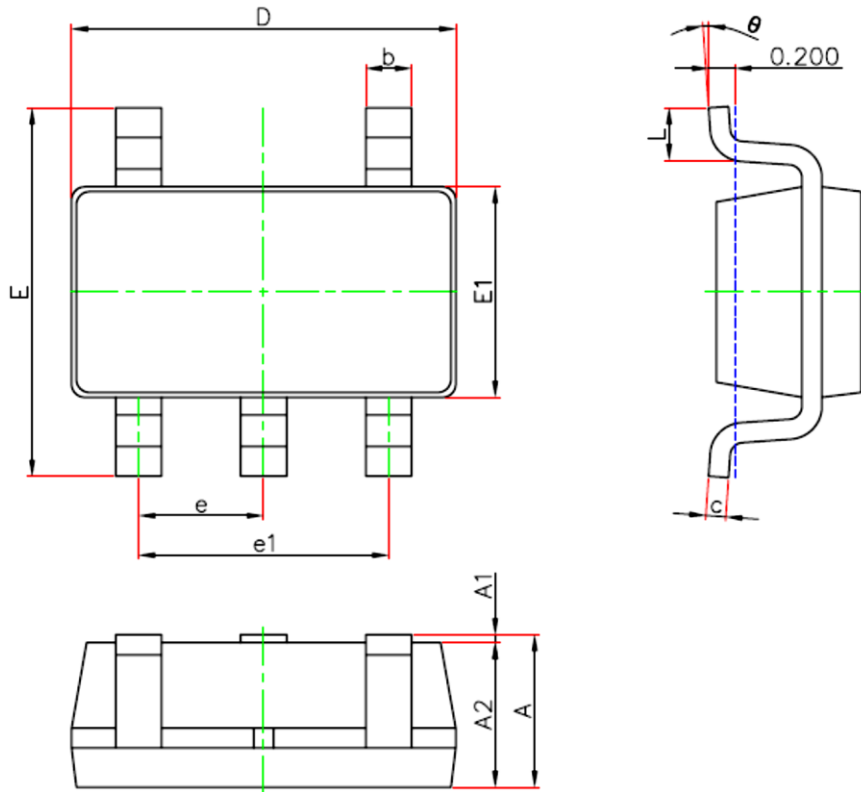
And the junction temperature,  $T_J$ , can be calculated as follows:

$$T_J = T_A + P_D \times \theta_{JA} = 40^\circ\text{C} + 0.25\text{W} \times 250^\circ\text{C/W} \\ = 40^\circ\text{C} + 62.5^\circ\text{C} = 102.5^\circ\text{C} < T_J(\text{MAX}) = 125^\circ\text{C}$$

For this operating condition,  $T_J$  is lower than the absolute maximum operating junction temperature, 125°C, so it is safe to use the BCT2028 in this configuration.

### PACKAGE OUTLINE DIMENSIONS

SOT23-5



Symbol	Dimensions In Millimeters	
	Min	Max
A	1.05	1.3
A1	0	0.15
A2	1.05	1.15
b	0.28	0.5
c	0.1	0.23
D	2.82	3.02
E1	1.5	1.7
E	2.65	3.05
e	0.95(BSC)	
e1	1.8	2
L	0.3	0.6
θ	0	8°

SOT-23-5 Surface Mount Package

## LAND PATTERN DATA

