18V 400mA Ultralow Quiescent Current LDO

General Description

The EHP8043 is a high voltage, low quiescent current, low dropout regulator with 400mA output driving capacity. The EHP8043, which operates over an input range up to 18V, is stable with any capacitors, whose capacitance is larger than 1μF, and suitable for powering battery-management ICs because of the virtue of its low quiescent current consumption and low dropout voltage.

The EHP8043 is available in SOT-23-3, SOT-23-5, SOT-89-3 and SOT-223 surface mount packages.

Applications

- Logic Supply for High Voltage Batteries
- Battery Powered Equipments

Features

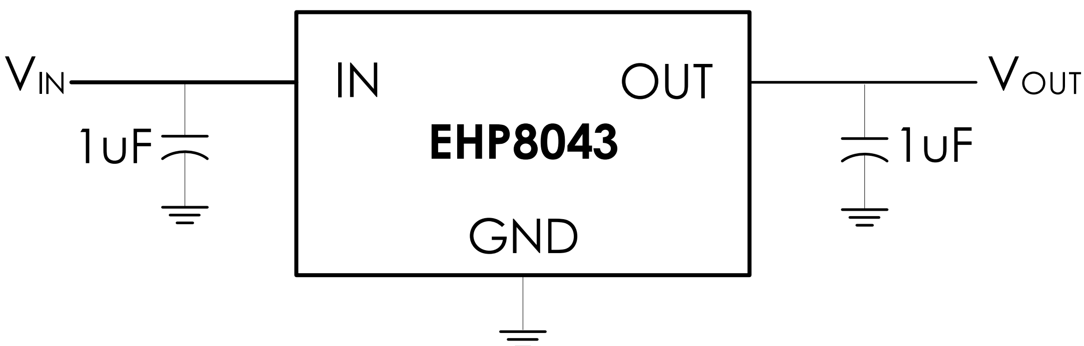
- Up to 18V input voltage range
- 400mA output current driving capacity
- Ultra low quiescent current (typical 1.5μA)
- 2400mV typical dropout at I_{OUT} = 400 mA
- Thermal shutdown protection
- Short circuit protection
- Stable with 1μF output capacitor

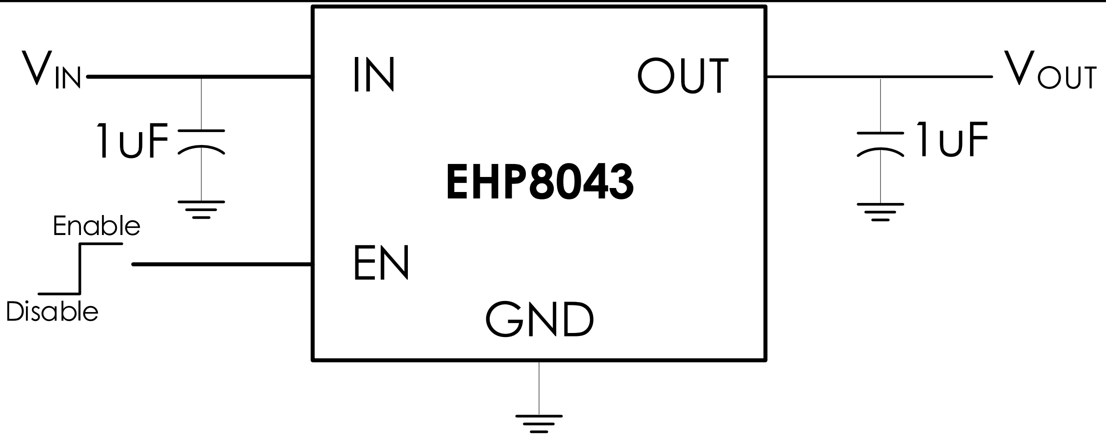
Ordering Information

Part Number	Remark
EHP8043-XXVD03NRR	±2% output voltage tolerance
EHP8043-XXVF05NRR	±2% output voltage tolerance
EHP8043-XXVLP3NRR EHP8043-XXVLX3NRR	±2% output voltage tolerance
EHP8043-XXVKP3NRR EHP8043-XXVKX3NRR	±2% output voltage tolerance

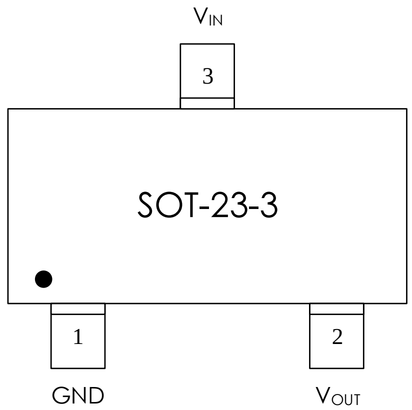
XX: 15=1.5V, 18=1.8V, 25=2.5V, 33=3.3V, 50=5.0V

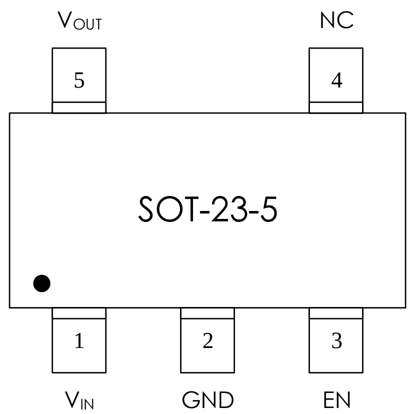
Typical Application

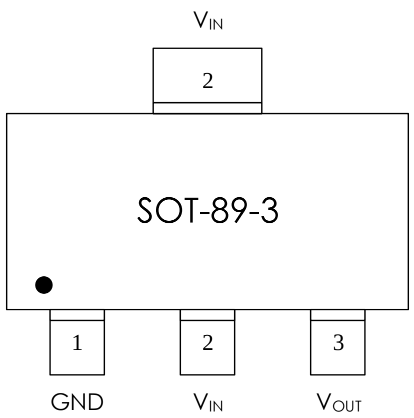




Connection Diagrams







Order information

EHP8043-XXVD03NRR

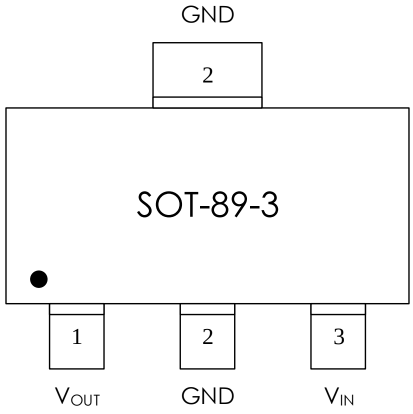
XX	Output voltage
VD03	SOT-23-3 Package
NRR	RoHS & Halogen free package Rating: -40 to 85°C Package in Tape & Reel

EHP8043-XXVF05NRR

XX	Output voltage
VF05	SOT-23-5 Package
NRR	RoHS & Halogen free package Rating: -40 to 85°C Package in Tape & Reel

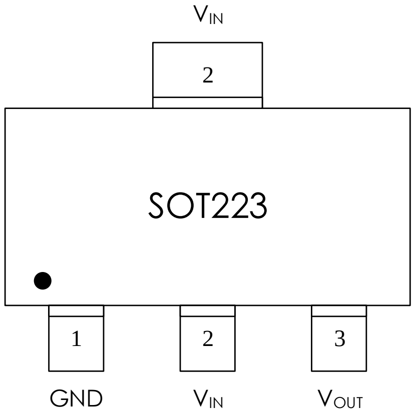
EHP8043-XXVLP3NRR

XX	Output voltage
VLP3	SOT-89-3 Package
NRR	RoHS & Halogen free package Rating: -40 to 85°C Package in Tape & Reel



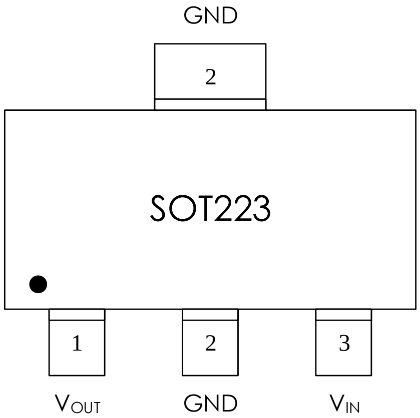
EHP8043-XXVLX3NRR

XX	Output voltage
VLX3	SOT-89-3 Package
NRR	RoHS & Halogen free package Rating: -40 to 85°C Package in Tape & Reel



EHP8043-XXVKP3NRR

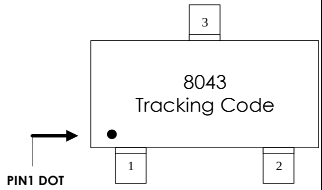
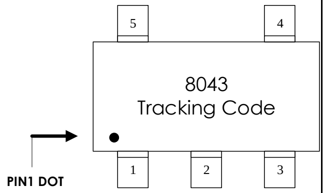
XX	Output voltage
VKP3	SOT-223 Package
NRR	RoHS & Halogen free package Rating: -40 to 85°C Package in Tape & Reel



EHP8043-XXVKX3NRR

XX	Output voltage
VKX3	SOT-223 Package
NRR	RoHS & Halogen free package Rating: -40 to 85°C Package in Tape & Reel

Order, Marking and Packing Information

<table>
<tr><th>Package</th><th>Vout</th><th>Product ID.</th><th>Marking</th><th>Packing</th></tr>
<tr><td rowspan="5">SOT-23-3</td><td>1.5V</td><td>EHP8043-15VD03NRR</td><td rowspan="5">
</td><td rowspan="5">Tape & Reel
3Kpcs</td></tr>
<tr><td>1.8V</td><td>EHP8043-18VD03NRR</td></tr>
<tr><td>2.5V</td><td>EHP8043-25VD03NRR</td></tr>
<tr><td>3.3V</td><td>EHP8043-33VD03NRR</td></tr>
<tr><td>5.0V</td><td>EHP8043-50VD03NRR</td></tr>
<tr><td rowspan="5">SOT-23-5</td><td>1.5V</td><td>EHP8043-15VF05NRR</td><td rowspan="5">
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3Kpcs</td></tr>
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<tr><td>2.5V</td><td>EHP8043-25VF05NRR</td></tr>
<tr><td>3.3V</td><td>EHP8043-33VF05NRR</td></tr>
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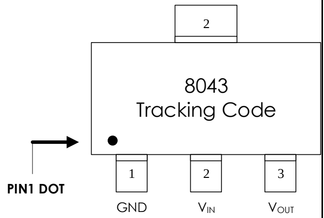
<tr><td rowspan="5">SOT-89-3</td><td>1.5V</td><td>EHP8043-15VLP3NRR</td><td rowspan="5">
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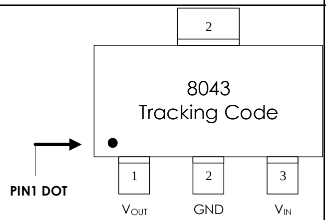
<tr><td>3.3V</td><td>EHP8043-33VLP3NRR</td></tr>
<tr><td>5.0V</td><td>EHP8043-50VLP3NRR</td></tr>
<tr><td rowspan="5">SOT-89-3</td><td>1.5V</td><td>EHP8043-15VLX3NRR</td><td rowspan="5">
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<tr><td>2.5V</td><td>EHP8043-25VLX3NRR</td></tr>
<tr><td>3.3V</td><td>EHP8043-33VLX3NRR</td></tr>
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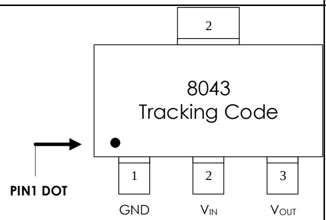
<tr><td rowspan="5">SOT-223</td><td>1.5V</td><td>EHP8043-15VKP3NRR</td><td rowspan="5">
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2.5Kpcs</td></tr>
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<tr><td>3.3V</td><td>EHP8043-33VKP3NRR</td></tr>
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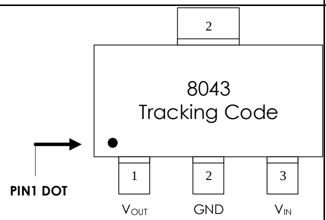
<tr><td rowspan="5">SOT-223</td><td>1.5V</td><td>EHP8043-15VKX3NRR</td><td rowspan="5">
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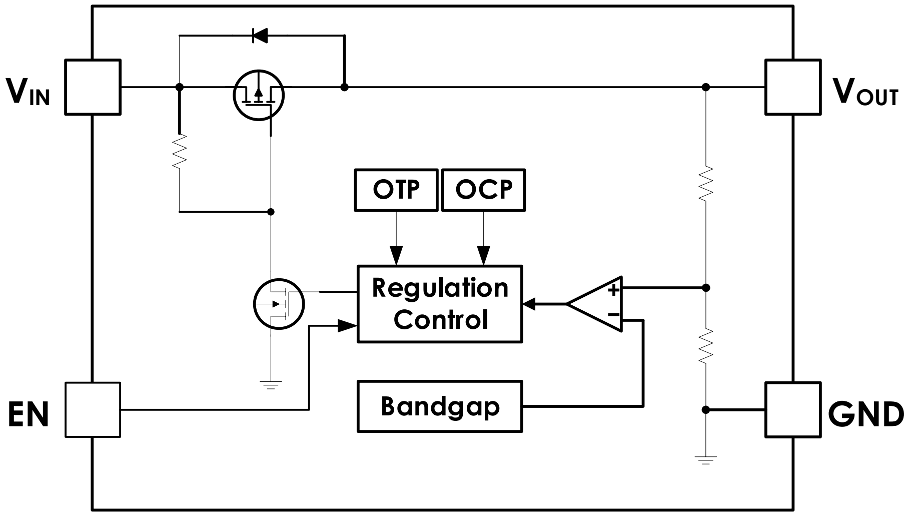
2.5Kpcs</td></tr>
<tr><td>1.8V</td><td>EHP8043-18VKX3NRR</td></tr>
<tr><td>2.5V</td><td>EHP8043-25VKX3NRR</td></tr>
<tr><td>3.3V</td><td>EHP8043-33VKX3NRR</td></tr>
<tr><td>5.0V</td><td>EHP8043-50VKX3NRR</td></tr>
</table>

Pin Functions

Name	SOT-23-3	SOT-23-5	SOT-89-3 SOT-223		Function
			P	X	
VIN	3	1	2	3	Supply voltage input Require a minimum input capacitor of close to 1μF to ensure stability and sufficient decoupling from the ground pin.
GND	1	2	1	2	Ground pin
EN	N/A	3	N/A	N/A	Enable input.
NC	N/A	4	N/A	N/A	No connection
VOUT	2	5	3	1	Output voltage

Functional Block Diagram



Functional Block Diagram of EHP8043

Absolute Maximum Ratings (Note 1, 2)

V_{IN}, EN	-0.3V to 20V	Vout	-0.3V to 6V
Junction Temperature	150°C	Lead Temperature (Soldering, 10 sec.)	260°C
Storage Temperature Range	-65°C to 150°C	ESD Rating: Human Body Model	2KV

Recommended Operating Conditions (Note 1, 2)

Supply Voltage	2.7V to 18V	Operating Temperature Range	-40°C to 85°C
Junction Temperature Range	-40°C to 125°C		

Thermal Resistance:

Symbol	θ_{JA}(Note 3)	θ_{JC}(Note 4)
SOT-23-3	250(°C/W)	81(°C/W)
SOT-23-5	152(°C/W)	81(°C/W)
SOT-89-3	90(°C/W) (package VLX3)	52(°C/W) (package VLX3)
	101(°C/W) (package VLP3)	54(°C/W) (package VLP3)
SOT-223	55(°C/W) (package VKX3)	67.7(°C/W) (package VKX3)
	70(°C/W) (package VKP3)	67.7(°C/W) (package VKP3)

Electrical Characteristics

V_{IN}=12V, I_{OUT}=1mA, C_{IN}=C_{OUT}=1uF, T_a = 25°C, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output Voltage	V_{OUT}		-2%		2%	V
Line Regulation	$\triangle V_{LINE}$	V_{IN}=V_{OUT} + 1V to 18V,		0.1		%
Load Regulation	$\triangle V_{LOAD}$	I_{OUT}= 1mA to 100mA(Vin=Vout+2.4V)		0.6		%
		I_{OUT}= 1mA to 400mA(Vin=Vout+2.4V)		2.4		
Dropout Voltage	V_{DROP}	I_{OUT}=100mA		400		mV
		I_{OUT}=400mA		2400		
Quiescent Current	I_Q	T_a= 25℃, No load		1.5	4.0	uA
Current Limit	I_{CL}		500	600		mA
Enable high level	V_{ENHI}		1.0			V
Enable low level	V_{ENLO}				0.4	V
Enable pin pull high current	I_{EN}			0.1		uA
Thermal Shutdown	T_{SD}			140		℃
Thermal Shutdown Hysteresis	T_{HY}			20		℃
Power-supply rejection ratio	PSRR	f = 1kHz, Iout = 1mA, Ripple 0.2Vp-p		55		dB

Note 1: Absolute Maximum ratings indicate limits beyond which damage may occur. Electrical specifications do not apply when operating the device outside of its rated operating conditions.

Note 2: All voltages are with respect to the potential at the ground pin.

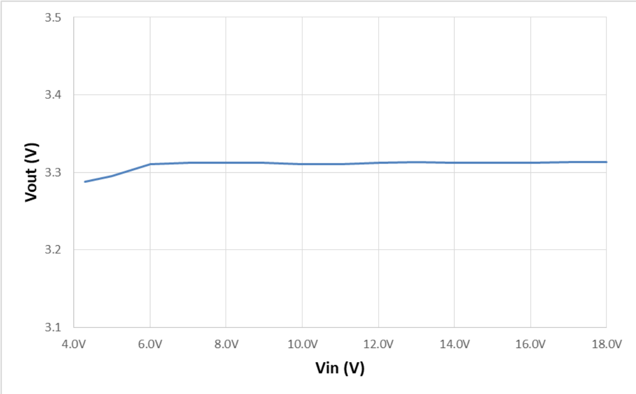
Note 3: θ_{JA} is measured in the natural convection at T_A=25℃ on a high effective thermal conductivity test board (2 layers, 2S0P).

Note 4: θ_{JC} represents the resistance to the heat flows the chip to package top case.

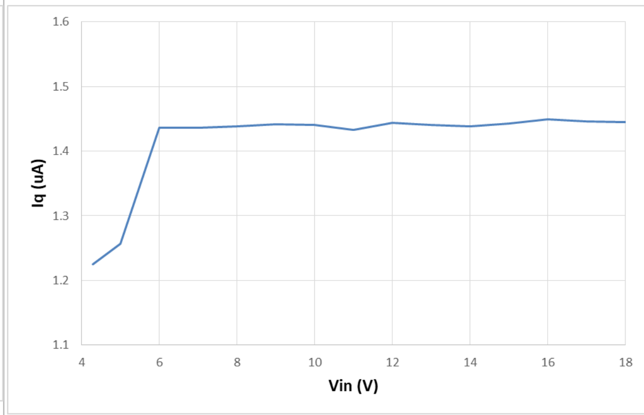
Typical Performance Characteristics

V_{IN}=12V, I_{OUT}=1mA, V_{OUT}=3.3V, C_{IN}=C_{OUT}=1uF, T_a=25℃, unless otherwise specified

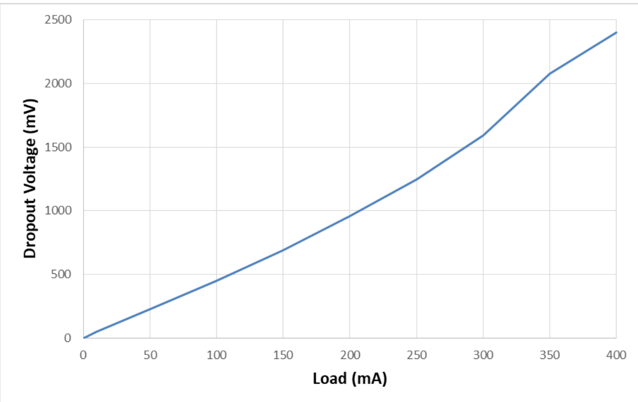
V_{OUT} vs. V_{IN}



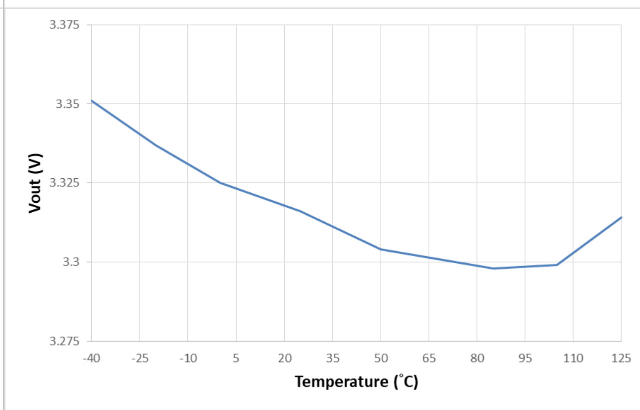
I_Q vs. V_{IN} (I_{OUT}=0mA)



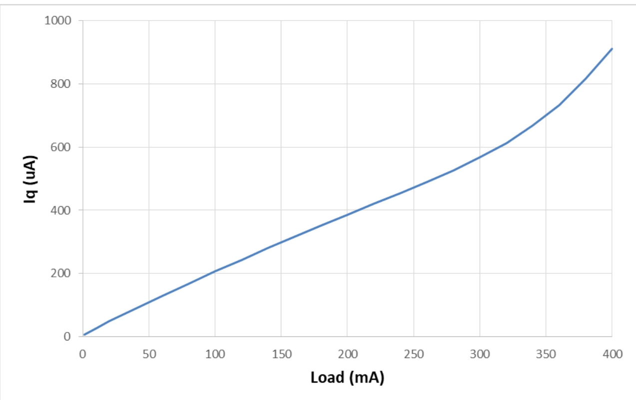
Dropout vs. Load (V_{IN}=5.8V)



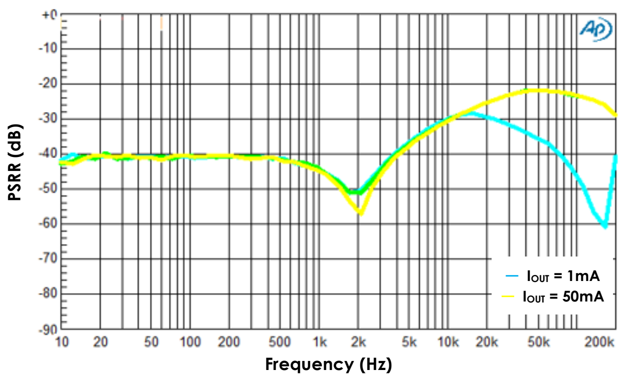
V_{OUT} vs. Temperature



I_Q vs. Load (V_{IN}=5.8V)



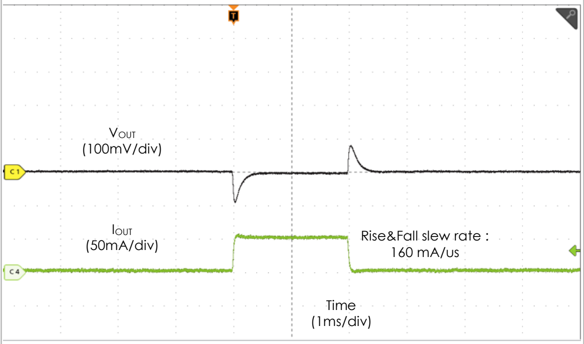
PSRR vs. Frequency (Vin=4.3V)



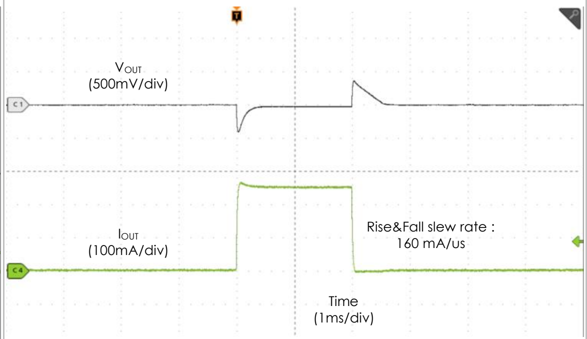
Typical Performance Characteristics (cont.)

V_{IN}=12V, I_{OUT}=1mA, V_{OUT}=3.3V, C_{IN}=C_{OUT}=1uF, T_J=25℃, unless otherwise specified

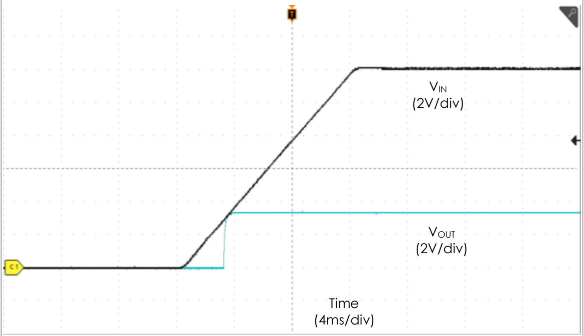
V_{OUT} Load Transient (0mA to 50mA)



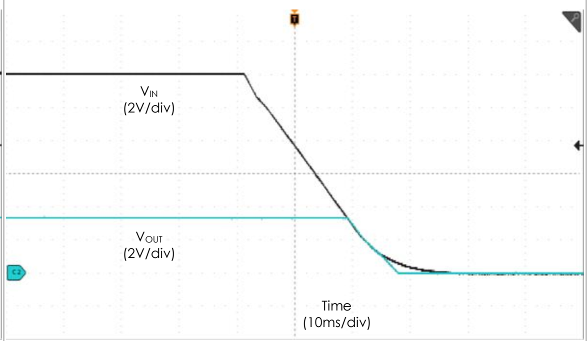
V_{OUT} Load Transient (1mA to 250mA)



V_{IN} Start up



V_{IN} Power Off



Application Information

Output Capacitor

The EHP8043 is specially designed for use with ceramic output capacitors of as low as 1 μF to take advantage of the savings in cost and space as well as the superior filtering of high frequency noise. Capacitors of higher value or other types may be used, but it is important to make sure its equivalent series resistance (ESR) is restricted to less than 0.5Ω. The use of larger capacitors with smaller ESR values is desirable for applications involving large and fast input or output transients, as well as for situations where the application systems are not physically located immediately adjacent to the battery power source. Typical ceramic capacitors suitable for use with the EHP8043 are X5R and X7R. The X5R and the X7R capacitors are able to maintain their capacitance values to within ±20% and ±10%, respectively, as the temperature increases.

Input Capacitor

A minimum input capacitance of 1μF is required for EHP8043. The capacitor value may be increased without limit. Improper workbench set-ups may have adverse effects on the normal operation of the regulator. A case in point is the instability that may result from long supply lead inductance coupling to the output through the gate capacitance of the pass transistor. This will establish a pseudo LCR network, and is likely to happen under high current conditions or near dropout. A 10μF tantalum input capacitor will dampen the parasitic LCR action thanks to its high ESR. However, cautions should be exercised to avoid regulator short-circuit damage when tantalum capacitors are used, for they are prone to fail in short-circuit operating conditions.

Power Dissipation and Thermal Shutdown

Thermal overload results from excessive power dissipation that causes the IC junction temperature to increase beyond a safe operating level. The EHP8043 relies on dedicated thermal shutdown circuitry to limit its total power dissipation. An IC junction temperature T_J exceeding 140°C will trigger the thermal shutdown logic, turning off the P-channel MOS pass transistor. The pass transistor turns on again after the junction cools off by about 20°C. When continuous thermal overload conditions persist, this thermal shutdown action then results in a pulsed waveform at the output of the regulator. The concept of thermal resistance θ_{JA} (°C/W) is often used to describe an IC junction's relative readiness in allowing its thermal energy to dissipate to its ambient air. An IC junction with a low thermal resistance is preferred because it is relatively effective in dissipating its thermal energy to its ambient, thus resulting in a relatively low and desirable junction temperature. The relationship between θ_{JA} and T_J is as follows:

$$\mathbf{T_J = \theta_{JA} \times (P_D) + T_A}$$

T_A is the ambient temperature, and P_D is the power generated by the IC and can be written as:

$$\mathbf{P_D = I_{OUT} (V_{IN} - V_{OUT})}$$

As the above equations show, it is desirable to work with ICs whose θ_{JA} values are small such that TJ does not increase strongly with P_D. To avoid thermally overloading the EHP8043, refrain from exceeding the recommended maximum junction temperature rating of 125°C under continuous operating conditions. Overstressing the regulator with high loading currents and elevated input-to-output differential voltages can increase the IC die temperature significantly.

Maximum power dissipation for the device is calculated using the following equation:

$$PD = \frac{\mathrm{TJ(max)} - \mathrm{TA}}{\Theta\mathrm{JA}}$$

Where $T_{J(MAX)}$ is the recommended maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction-to-ambient thermal resistance. For example,

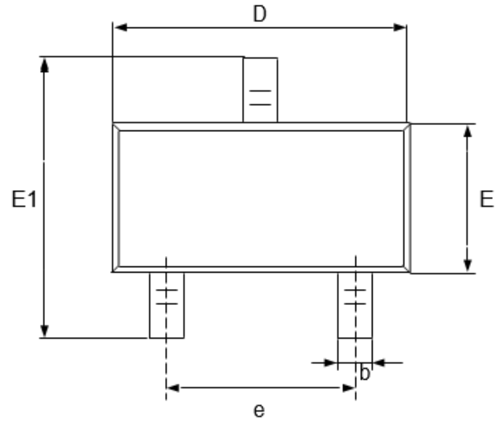
- SOT-23-3 package, θ_{JA}=250°C/W, $T_{J(MAX)}$=125°C and using T_A=25°C, the maximum power dissipation is 0.4W.
- SOT-23-5 package, θ_{JA}=152°C/W, $T_{J(MAX)}$=125°C and using T_A=25°C, the maximum power dissipation is 0.65W.
- SOT-89-3 package VLP3, θ_{JA}=101°C/W, $T_{J(MAX)}$=125°C and using T_A=25°C, the maximum power dissipation is 0.99W.
- SOT-89-3 package VLX3, θ_{JA}=90°C/W, $T_{J(MAX)}$=125°C and using T_A=25°C, the maximum power dissipation is 1.11W.
- SOT-223 package VKP3, θ_{JA}=70°C/W, $T_{J(MAX)}$=125°C and using T_A=25°C, the maximum power dissipation is 1.42W.
- SOT-223 package VKX3, θ_{JA}=55°C/W, $T_{J(MAX)}$=125°C and using T_A=25°C, the maximum power dissipation is 1.81W.

Shutdown

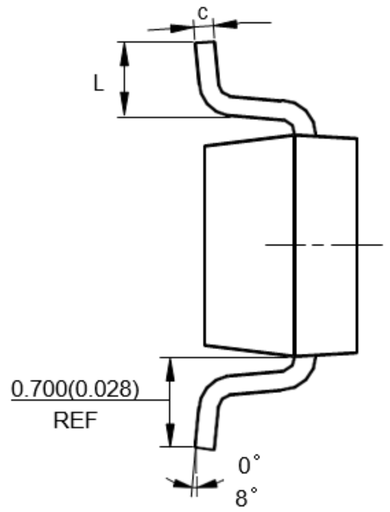
The EHP8043 enters the sleep mode when the EN pin is low. When this occurs, the pass transistor, the error amplifier, and the biasing circuits, including the bandgap reference, are turned off, thus reducing the supply current to typically 1μA. Such a low supply current makes the EHP8043 best suited for battery-powered applications. The maximum guaranteed voltage at the EN pin for the sleep mode to take effect is 0.4V.

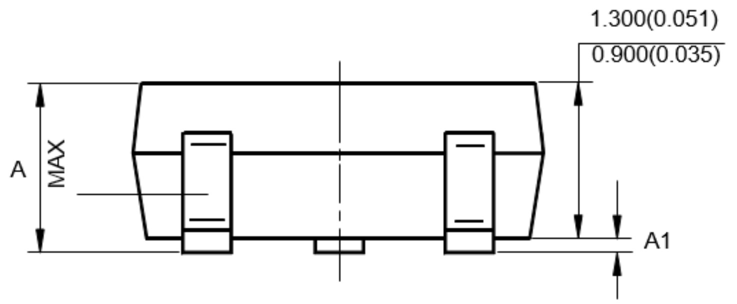
Package Outline Drawing

SOT-23-3



TOP VIEW



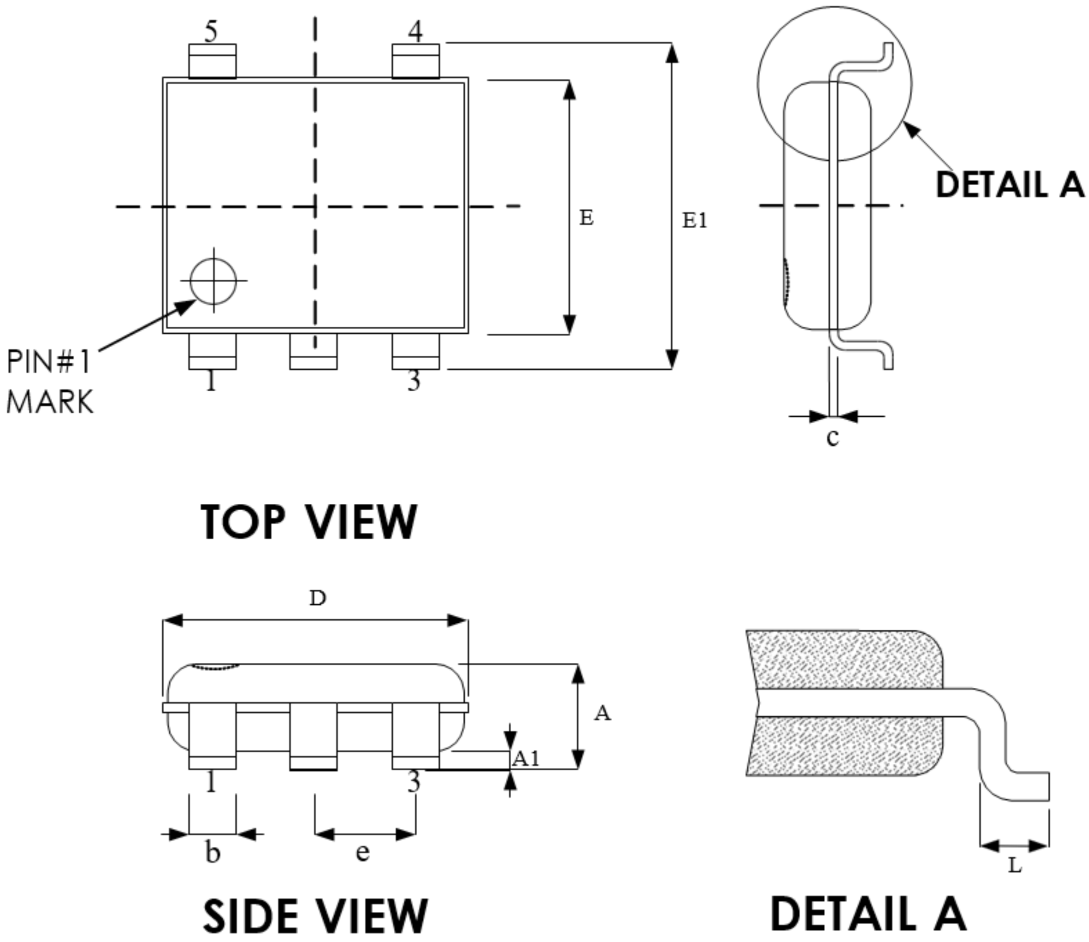


SIDE VIEW

Symbol	Dimension in mm	
	Min.	Max.
A	0.90	1.45
A1	0.00	0.15
b	0.30	0.50
c	0.10	0.20
D	2.82	3.10
E	1.50	1.70
E1	2.60	3.00
e	1.80	2.00
L	0.30	0.60

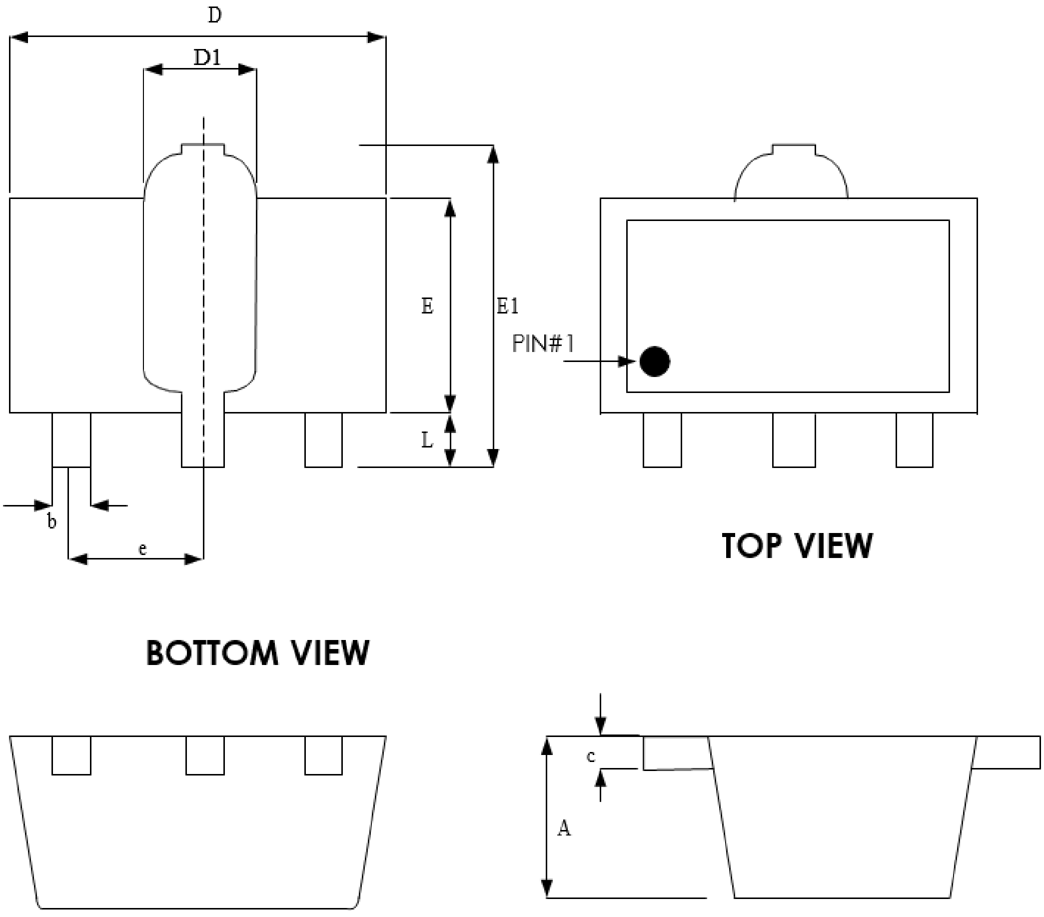
Package Outline Drawing

SOT-23-5



Symbol	Dimension in mm	
	Min.	Max.
A	0.90	1.45
A1	0.00	0.15
b	0.30	0.50
c	0.08	0.25
D	2.70	3.10
E	1.40	1.80
E1	2.60	3.00
e	0.95 BSC	
L	0.30	0.60

Package Outline Drawing
SOT-89-3

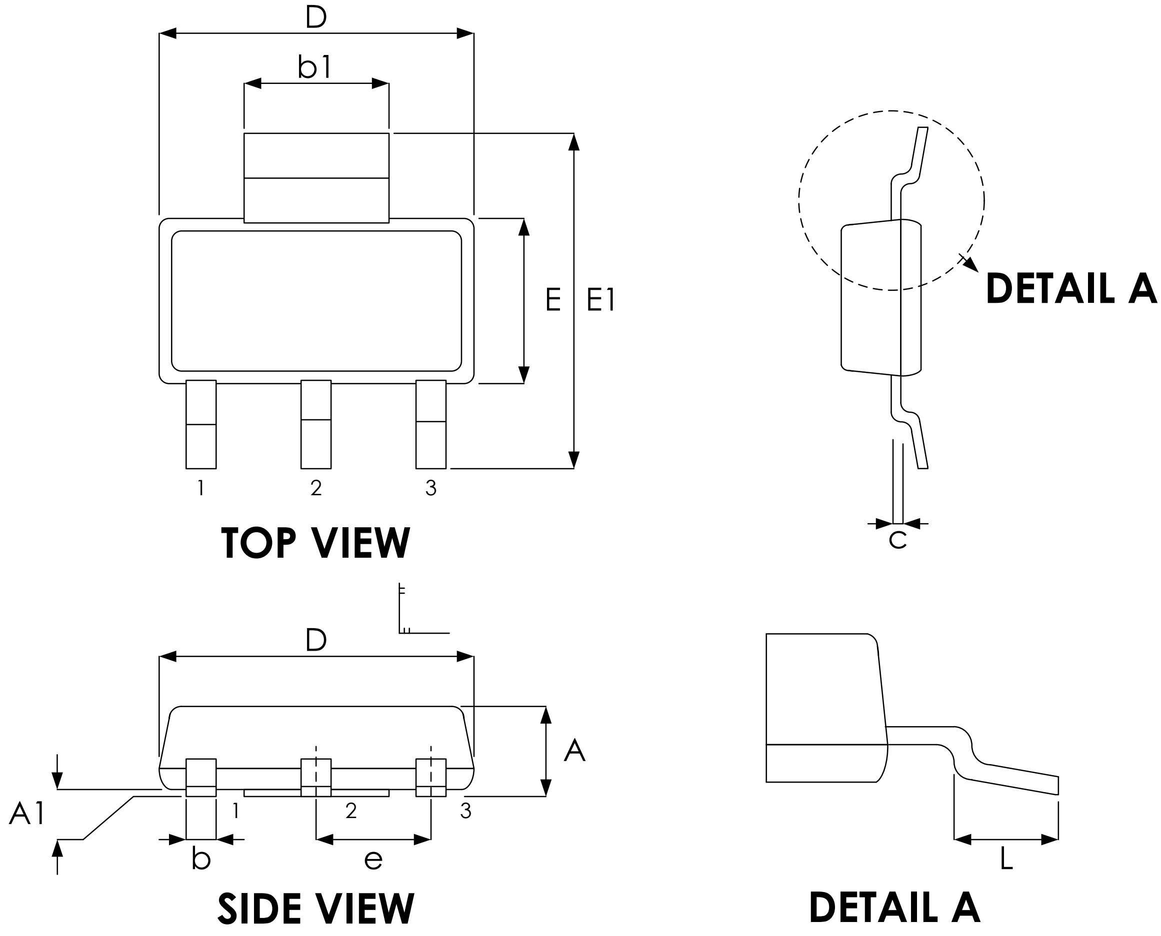


SIDE VIEW

Symbol	Dimension in mm	
	Min.	Max.
A	1.4	1.6
b	0.4	0.56
c	0.35	0.41
D	4.4	4.6
D1	1.5	1.83
E	2.29	2.6
E1	3.94	4.25
e	1.50 BSC	
L	0.89	1.2

Package Outline Drawing

SOT223



Symbol	Dimension in mm	
	Min.	Max.
A	--	1.80
A1	0.02	0.10
b	0.60	0.80
b1	2.90	3.10
c	0.23	0.35
D	6.30	6.80
E	3.30	3.70
E1	6.70	7.30
e	2.30 BSC	
L	0.90	--

Revision History

Revision	Date	Description
1.0	2024.08.05	Original

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