VPE2037 0.5μA I_Q, 300mA Linear Regulator

Description

The VPE2037 features low quiescent current as low as 0.5μA and almost zero disable current which is ideal for powering the battery equipment to a longer service life. The VPE2037 guarantees delivery of 300mA output current and can be stable with 1μF ceramic output capacitor.

The VPE2037 is available in SOT-23-3, SOT-23-5 and uDFN1x1-4 surface mount packages.

Features

- 2.5V to 5.5V input range
- 300mA output current driving capacity
- 0.5μA typical quiescent current at no Load
- 500mV typical dropout at I_{OUT} = 250mA
- Thermal shutdown protection
- Internal short-circuit current limit
- Stable with 1μF output capacitor

Applications

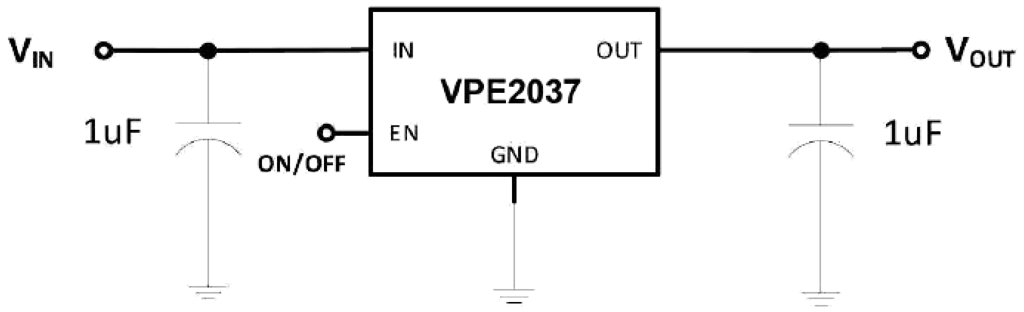
- Portable, Battery Powered Equipment
- Ultra Low Power Microcontroller
- Notebook computers

Ordering Information

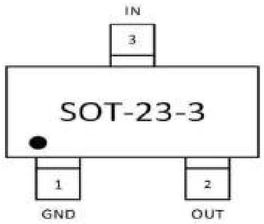
Part Number	Remark
VPE2037-XXVD03NRR	±2% output voltage tolerance
VPE2037-XXVF05NRR	±2% output voltage tolerance
VPE2037-XXDC04NRR	±2% output voltage tolerance

XX: 12=1.2V, 15=1.5V, 18=1.8V, 25=2.5V, 30=3.0V, 33=3.3V

Typical Application



Connection Diagrams



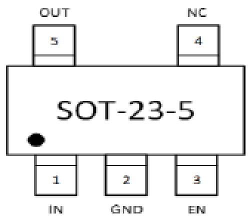
Order information

VPE2037-XXVD03NRR

XX Output voltage

VD03 SOT-23-3 Package

NRR RoHS & Halogen free package
Rating: -40 to 85℃
Package in Tape & Reel

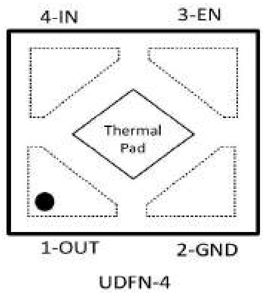


VPE2037-XXVF05NRR

XX Output voltage

VF05 SOT-23-5 Package

NRR RoHS & Halogen free package
Rating: -40 to 85℃
Package in Tape & Reel



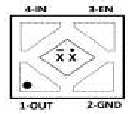
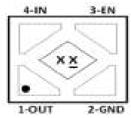
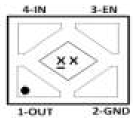
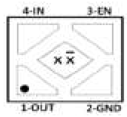
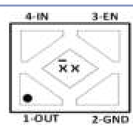
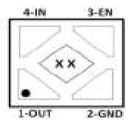
VPE2037-XXDC04NRR

XX Output voltage

DC04 uDFN1x1-4 Package

NRR RoHS & Halogen free package
Rating: -40 to 85℃
Package in Tape & Reel

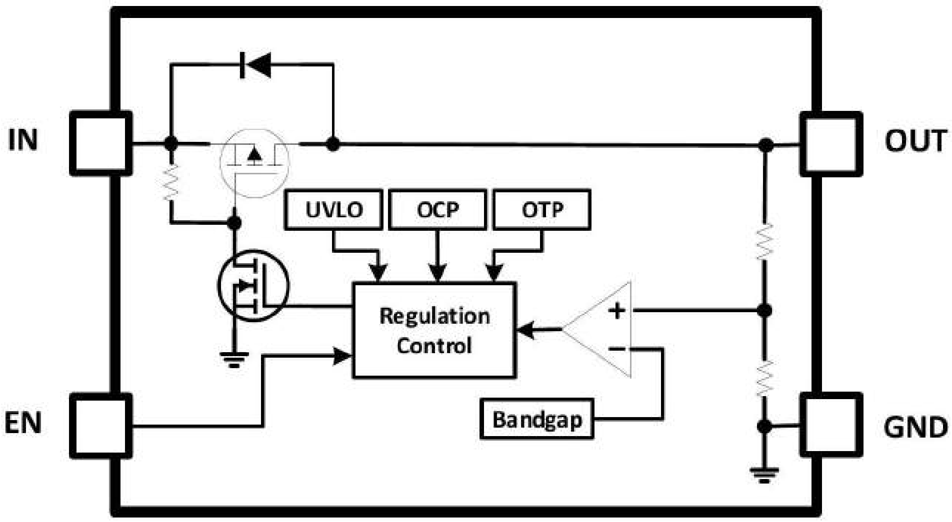
Order, Marking and Packing Information

Package	Vout	Product ID.	Marking Code	Packing
SOT-23-3	1.2V	VPE2037-12VD03NRR	2037	Tape & Reel 3Kpcs
	1.5V	VPE2037-15VD03NRR		
	1.8V	VPE2037-18VD03NRR		
	2.5V	VPE2037-25VD03NRR		
	3.0V	VPE2037-30VD03NRR		
	3.3V	VPE2037-33VD03NRR		
SOT-23-5	1.2V	VPE2037-12VF05NRR	2037	Tape & Reel 3Kpcs
	1.5V	VPE2037-15VF05NRR		
	1.8V	VPE2037-18VF05NRR		
	2.5V	VPE2037-25VF05NRR		
	3.0V	VPE2037-30VF05NRR		
	3.3V	VPE2037-33VF05NRR		
uDFN-4	1.2V	VPE2037-12DC04NRR	 XX = tracking code	Tape & Reel 8Kpcs
	1.5V	VPE2037-15DC04NRR	 XX = tracking code	
	1.8V	VPE2037-18DC04NRR	 XX = tracking code	
	2.5V	VPE2037-25DC04NRR	 XX = tracking code	
	3.0V	VPE2037-30DC04NRR	 XX = tracking code	
	3.3V	VPE2037-33DC04NRR	 XX = tracking code	

Pin Functions

Name	SOT-23-3	SOT-23-5	uDFN 1x1-4	Function
IN	3	1	4	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	2	Ground Pin
EN	N/A	3	3	Enable Input. Enable the regulator by pulling the EN pin High. To keep the regulator on during normal operation, connect the EN pin to VIN. The EN pin must not exceed VIN under all operating conditions.
NC	N/A	4	N/A	No connection
OUT	2	5	1	Regulated Output Voltage Pin. A small 1μF ceramic capacitor is needed from this pin to ground to assure stability.
Thermal Pad	N/A	N/A	YES	The thermal pad with large thermal land area on the PCB will be helpful for chip power dissipation, to connect it to GND together normally.

Functional Block Diagram



Functional Block Diagram of VPE2037

Absolute Maximum Ratings

(Note 1, 2)

IN, EN, OUT .... –0.3V to 6V
Storage Temperature Range .... –65°C to 150°C
Junction Temperature (T_J) .... 150°C
Lead Temperature (Soldering, 10 sec.) ....260°C
ESD Rating: Human Body Model 2KV

Recommended Operating Conditions

Supply Voltage ....2.5V to 5.5V
Junction Temperature Range ....–40°C to 125°C
Operating Temperature Range .... –40°C to 85°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)
uDFN1x1-4	110(°C/W)	23(°C/W)

Electrical Characteristics

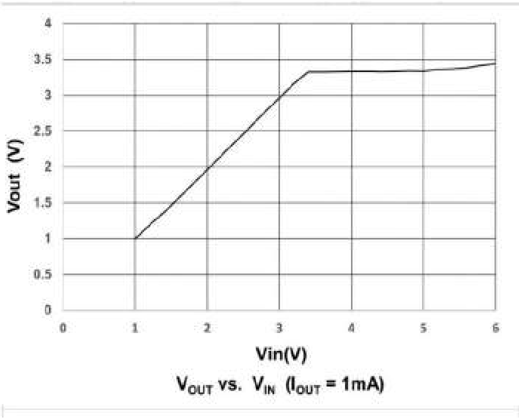
Unless otherwise specified, all limits guaranteed for V_{IN}=V_{EN}=V_{OUT}+1V, C_{IN}=C_{OUT}=1uF, T_a = 25°C

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output Voltage Accuracy	–	–	-2	–	2	%
Line Regulation	ΔV_{LINE}	V_{IN}= V_{OUT} + 1V to 5.5V	–	20	50	mV
Load Regulation	ΔV_{LOAD}	I_{OUT}= 1mA to 150mA	–	12	30	mV
		I_{OUT}= 1mA to 300mA	–	25	60	mV
Dropout Voltage	V_{DROP}	I_{OUT}= 100mA	–	150	–	mV
		I_{OUT}= 250mA	–	500	–	mV
Quiescent Current	I_Q	No load	–	0.5	1	μA
Current Limit	I_{CL}	–	–	560	–	mA
Enable high level	V_{ENHI}	–	0.6	–	–	V
Enable low level	V_{ENLO}	–	–	–	0.2	V
Thermal Shutdown	T_{SD}	–	–	150	–	°C
Thermal Shutdown Hysteresis	T_{HY}	–	–	20	–	°C
Power-supply rejection ratio	PSRR	f= 1kHz, Iout= 30mA	–	50	–	dB

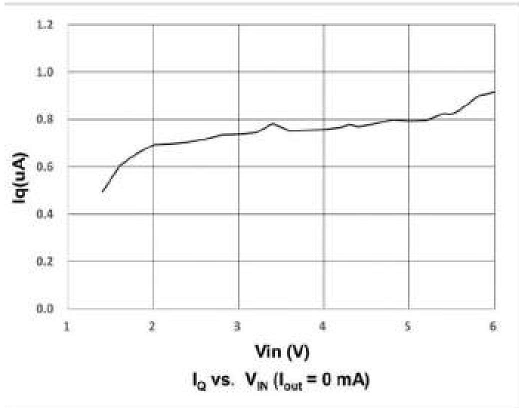
- **Note 1:** Absolute Maximum ratings indicate limits beyond which damage may occur. Electrical specifications do not apply when operating the device outside of its rated operating conditions.
- **Note 2:** All voltages are with respect to the potential at the ground pin.
- **Note 3:** θ_{JA} is measured in the natural convection at T_J=25°C 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

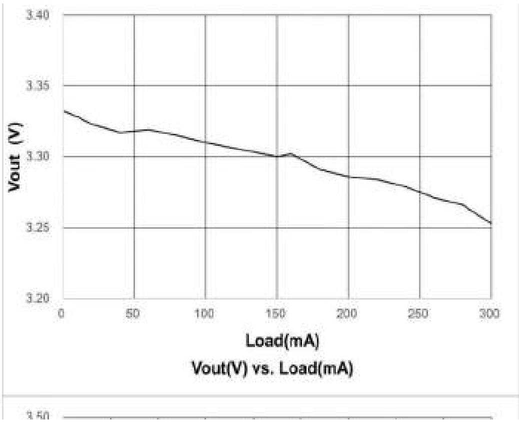
V_{IN}=V_{out}+1V, I_{OUT}=1mA, V_{OUT}=3.3V, C_{IN}=C_{OUT}=1uF, T_a=25°C, unless otherwise specified



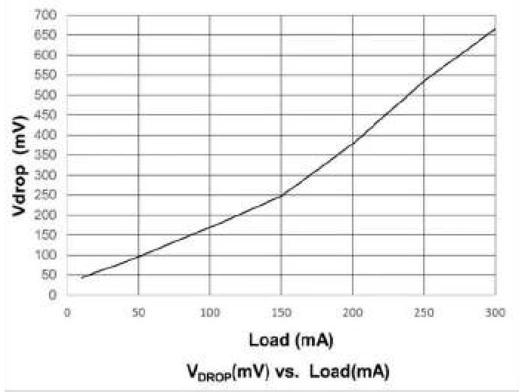
V_{OUT} vs. V_{IN} (I_{OUT} = 1mA)



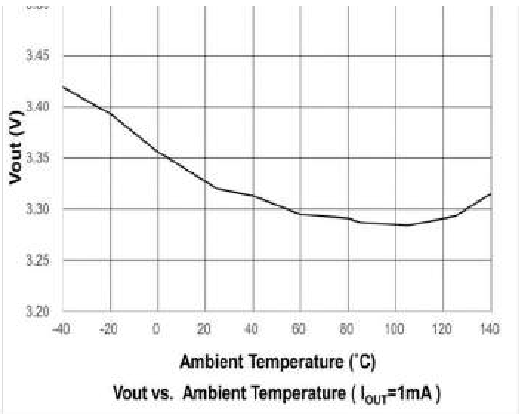
I_Q vs. V_{IN} (I_{out} = 0 mA)



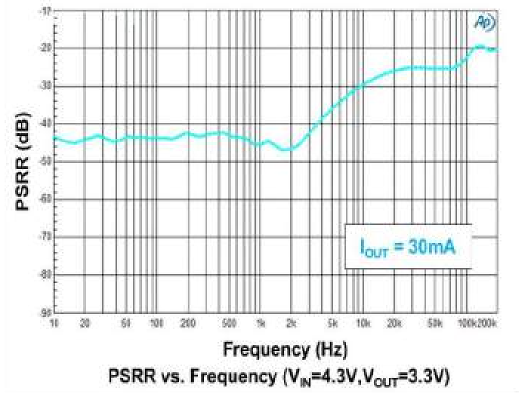
Vout(V) vs. Load(mA)



V_{DROP}(mV) vs. Load(mA)



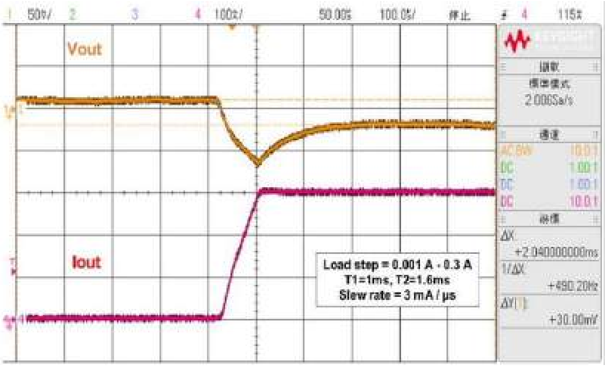
Vout vs. Ambient Temperature (I_{OUT}=1mA)



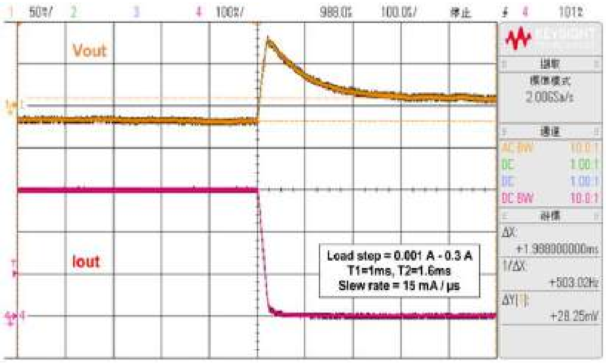
PSRR vs. Frequency (V_{IN}=4.3V, V_{OUT}=3.3V)

Typical Performance Characteristics (cont.)

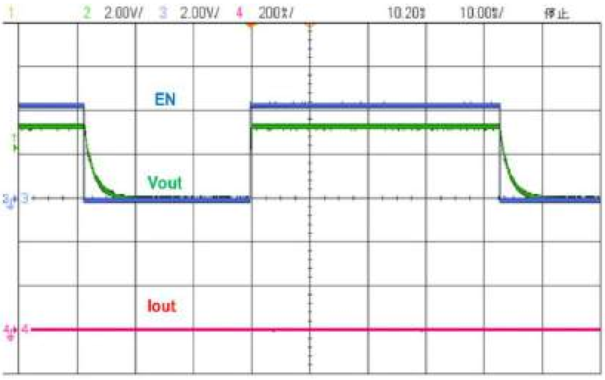
V_{IN}=V_{out}+1V, I_{OUT}=1mA, V_{OUT}=3.3V, C_{IN}=C_{OUT}=1uF, T_a=25°C, unless otherwise specified



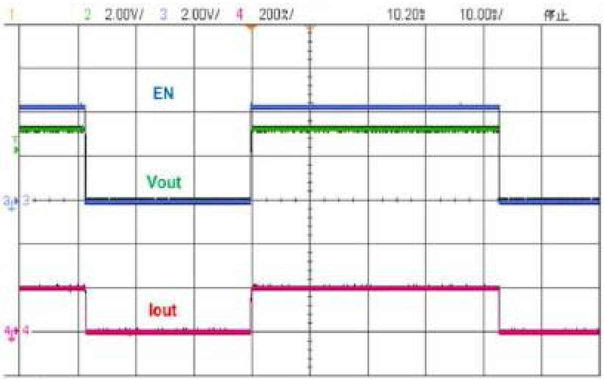
V_{OUT} Load Transient (1mA to 300mA)



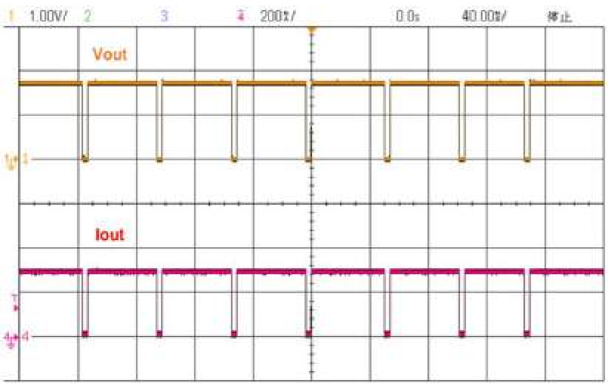
V_{OUT} Load Transient (300mA to 1mA)



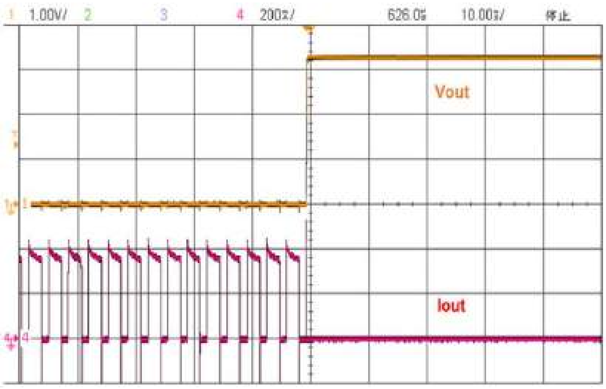
EN Start up (no load)



EN Start up (200mA load)



V_{IN} = 5V, V_{OUT} = 1.8V, heavy load OTP



V_{OUT} short to GND and release

Application Information

Output Capacitor

The VPE2037 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 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 VPE2037 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 VPE2037. 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 VPE2037 relies on dedicated thermal shutdown circuitry to limit its total power dissipation. An IC junction temperature T_J exceeding 150°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:

$$T_J = \theta_{JA}(P_D) + T_A \qquad \text{(Eq. 1)}$$

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

$$P_D = I_{OUT}(V_{IN} - V_{OUT}) \qquad \text{(Eq. 2)}$$

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 VPE2037, 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:

$$PD = \frac{TJ(max) - TA}{\theta_{JA}} \qquad \text{(Eq. 3)}$$

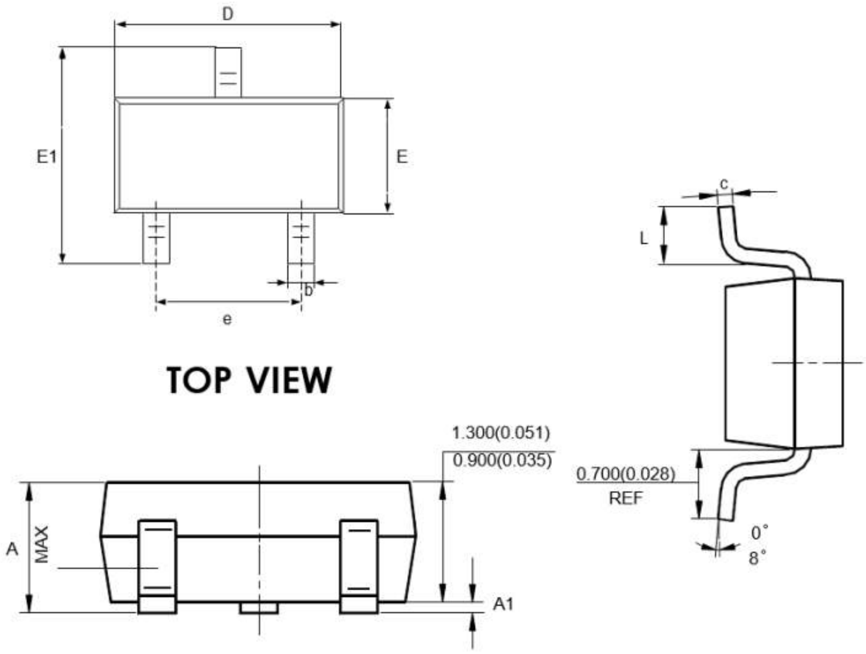
Where $T_{J(MAX)}$ is the recommended maximum junction temperature, T_A is the ambient temperature, and θ_{JA} is the junction-to-ambient thermal resistance. For example,

- 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.
- uDFN1x1-4 package, θ_{JA}=110°C/W, $T_{J(MAX)}$=125°C and using T_A=25°C, the maximum power dissipation is 0.9W.

Shutdown

The VPE2037 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 0.5µA. Such a low supply current makes the VPE2037 best suited for battery-powered applications. The maximum guaranteed voltage at the EN pin for the sleep mode to take effect is 0.2V.

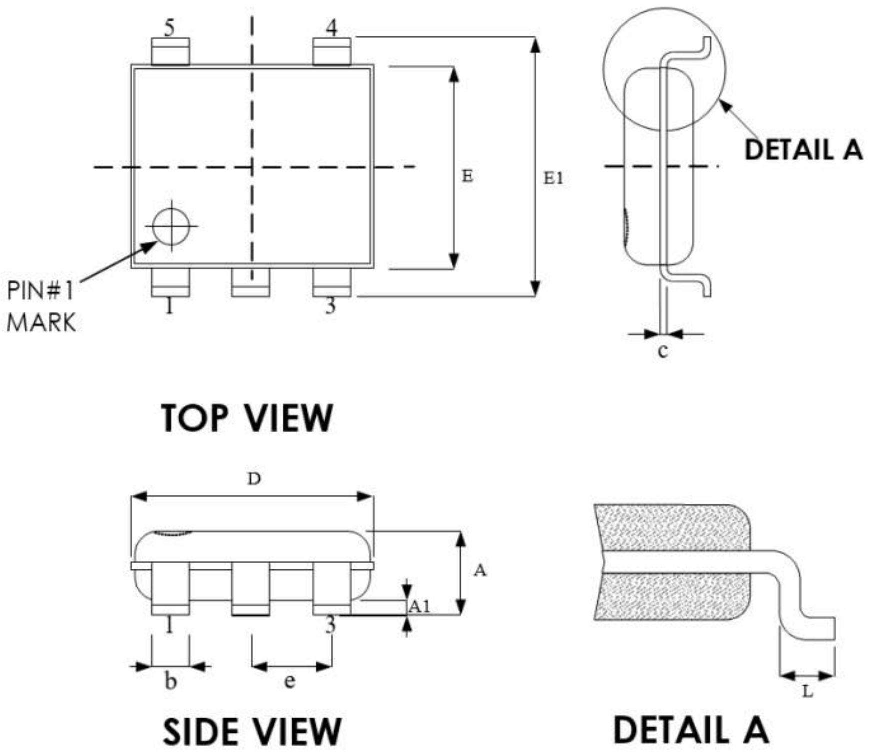
Package Outline Drawing – SOT-23-3



All dimensions are in millimeters.

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	2.65	3.00
e	1.80	2.00
L	0.30	0.60

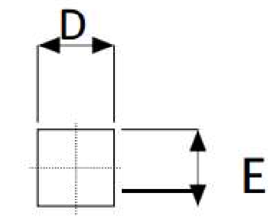
Package Outline Drawing – SOT-23-5



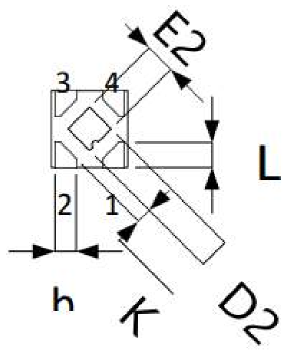
All dimensions are in millimeters.

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

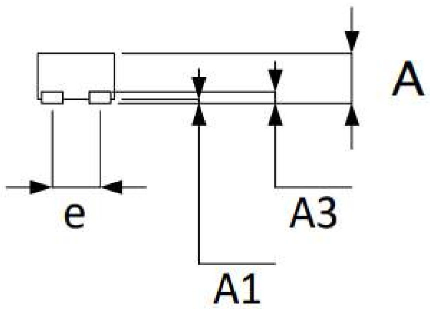
Package Outline Drawing – uDFN-4 (1mm x 1mm)



TOP VIEW



BOTTOM VIEW



SIDE VIEW

Symbol	Dimension in mm	
	Min.	Max.
A	0.35	0.60
A1	0.00	0.05
A3	0.12 REF.	
b	0.175	0.275
D	1.00 BSC	
E	1.00 BSC	
e	0.625 BSC	
L	0.200	0.300
K	0.20	–

Exposed Pad

Symbol	Dimension in mm	
	Min.	Max.
D2	0.40	0.60
E2	0.40	0.60

All dimensions are in millimeters.

Disclaimer

The information provided in this datasheet is believed to be accurate and reliable. Errors or omissions are expected. indiaVP Semiconductor Pvt. Ltd. reserves the right to make changes to the product specifications without prior notice. Users should verify the suitability of the product for their specific applications. Please visit our website for the latest datasheet.

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