

Description

The VPE2035 is a high voltage, low quiescent current, low dropout regulator with 150mA output driving capacity. The VPE2035, which operates over an input range up to 24V, is stable with any capacitors, whose capacitance is larger than 1 μ F, and suitable for powering battery-management ICs because of the virtue of its low quiescent current consumption and low dropout voltage.

The VPE2035 is available in SOT-23-3, SOT-23-5, SOT-89-3 and uDFN1x1-4 surface mount packages.

Features

- Up to 24V input voltage range
- 150mA output current driving capacity
- Ultra low quiescent current (typical 1.5 μ A)
- 1200mV typical dropout at $I_{OUT} = 150\text{ mA}$
- Thermal shutdown protection
- Short circuit protection
- Stable with 1 μ F output capacitor

Applications

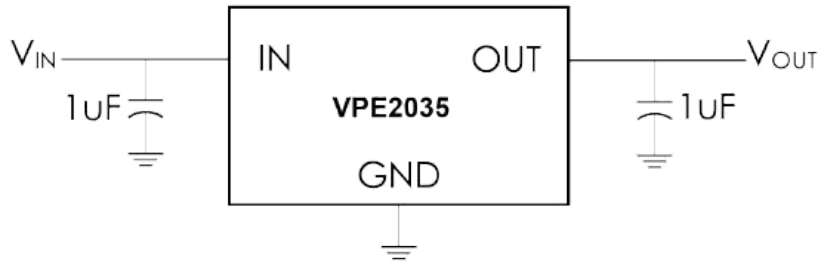
- E-meters, Water Meters and Gas Meters
- Fire Alarm, Smoke Detector
- Appliances and White Goods

Ordering Information

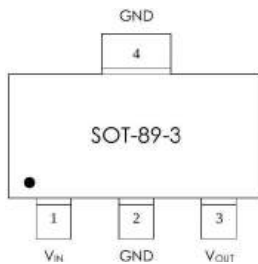
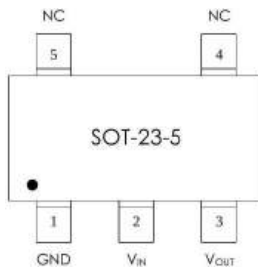
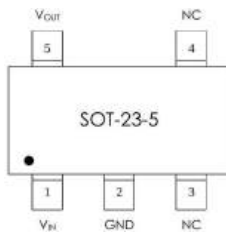
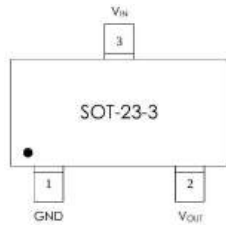
Part Number	Remark
VPE2035-XXVD03NRR	$\pm 2\%$ output voltage tolerance
VPE2035-XXVF05NRR	$\pm 2\%$ output voltage tolerance
VPE2035-XXVNP5NRR	$\pm 2\%$ output voltage tolerance
VPE2035-XXVL03NRR	$\pm 2\%$ output voltage tolerance
VPE2035-XXDC04NRR	$\pm 2\%$ output voltage tolerance

XX: 15=1.5V, 18=1.8V, 25=2.5V, 30=3.0V, 33=3.3V, 50=5.0V

Typical Application



Connection Diagrams



Order information

VPE2035-XXVD03NRR

XX Output voltage

VD03 SOT-23-3 Package

NRR RoHS & Halogen free package

Rating: -40 to 85 °C

Package in Tape & Reel

VPE2035-XXVF05NRR

XX Output voltage

VF05 SOT-23-5 Package

NRR RoHS & Halogen free package

Rating: -40 to 85 °C

Package in Tape & Reel

VPE2035-XXVNP5NRR

XX Output voltage

VNP5 SOT-23-5 Package

NRR RoHS & Halogen free package

Rating: -40 to 85 °C

Package in Tape & Reel

VPE2035-XXVL03NRR

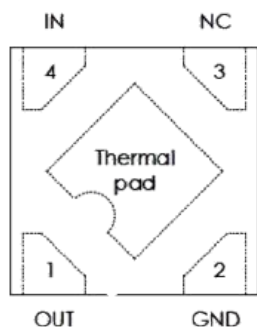
XX Output voltage

VL03 SOT-89-3 Package

NRR RoHS & Halogen free package

Rating: -40 to 85 °C

Package in Tape & Reel



VPE2035-XXDC04NRR

XX Output voltage

DC04 uDFN1x1-4 Package

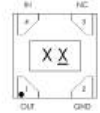
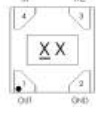
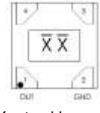
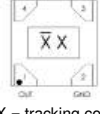
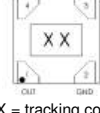
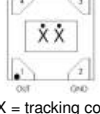
NRR RoHS & Halogen free package

Rating: -40 to 85 °C

Package in Tape & Reel

Order, Marking and Packing Information

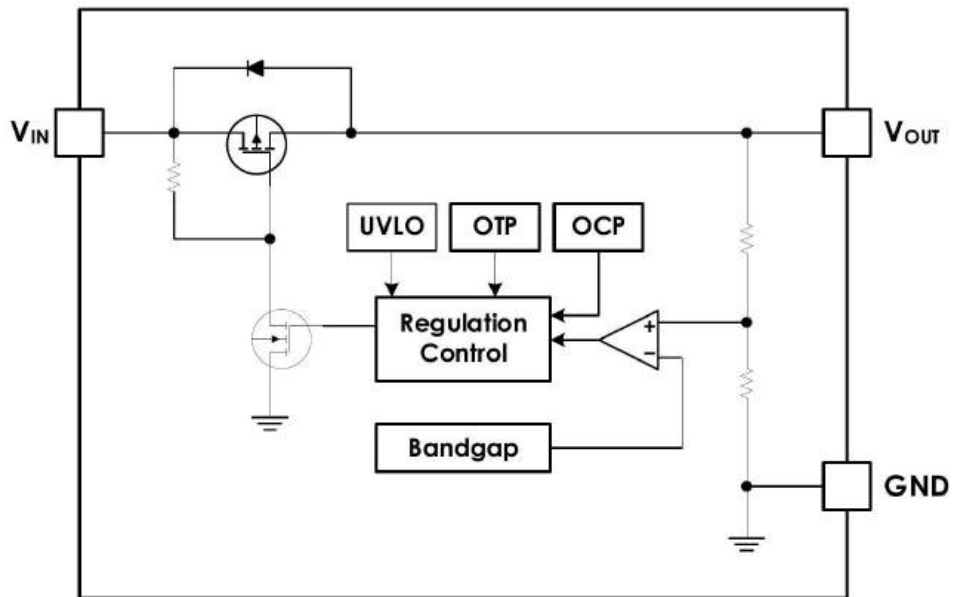
Package	Vout	Product ID.	Marking Code	Packing
SOT-23-3	1.5V	VPE2035-15VD03NRR	2035	Tape & Reel 3Kpcs
	1.8V	VPE2035-18VD03NRR		
	2.5V	VPE2035-25VD03NRR		
	3.0V	VPE2035-30VD03NRR		
	3.3V	VPE2035-33VD03NRR		
	5.0V	VPE2035-50VD03NRR		
SOT-23-5 (VF05)	1.5V	VPE2035-15VF05NRR	2035	Tape & Reel 3Kpcs
	1.8V	VPE2035-18VF05NRR		
	2.5V	VPE2035-25VF05NRR		
	3.0V	VPE2035-30VF05NRR		
	3.3V	VPE2035-33VF05NRR		
	5.0V	VPE2035-50VF05NRR		
SOT-23-5 (VNP5)	1.5V	VPE2035-15VNP5NRR	2035	Tape & Reel 3Kpcs
	1.8V	VPE2035-18VNP5NRR		
	2.5V	VPE2035-25VNP5NRR		
	3.0V	VPE2035-30VNP5NRR		
	3.3V	VPE2035-33VNP5NRR		
	5.0V	VPE2035-50VNP5NRR		
SOT-89-3	1.5V	VPE2035-15VL03NRR	2035	Tape & Reel 1Kpcs
	1.8V	VPE2035-18VL03NRR		
	2.5V	VPE2035-25VL03NRR		
	3.0V	VPE2035-30VL03NRR		
	3.3V	VPE2035-33VL03NRR		
	5.0V	VPE2035-50VL03NRR		

Package	Vout	Product ID.	Marking Code	Packing
uDFN1x1-4	1.5V	VPE2035-15DC04NRR	 XX = tracking code	Tape & Reel 8Kpcs
	1.8V	VPE2035-18DC04NRR	 XX = tracking code	
	2.5V	VPE2035-25DC04NRR	 XX = tracking code	
	3.0V	VPE2035-30DC04NRR	 XX = tracking code	
	3.3V	VPE2035-33DC04NRR	 XX = tracking code	
	5.0V	VPE2035-50DC04NRR	 XX = tracking code	

Pin Functions

Name	SOT-23-3	SOT-23-5 (VF05)	SOT-23-5 (VNP5)	SOT-89-3	uDFN 1x1-4	Function
VIN	3	1	2	1	4	Supply Voltage Input. Require a minimum input capacitor of close to 1 μ F to ensure stability and sufficient decoupling from the ground pin.
GND	1	2	1	2, 4	2	Ground Pin
NC	N/A	3, 4	4, 5	N/A	3	No connection
VOUT	2	5	3	3	1	Output Voltage. A small 1 μ F ceramic capacitor is needed from this pin to ground to assure stability.
Thermal Pad	N/A	N/A	N/A	YES	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 VPE2035

Absolute Maximum Ratings

(Note 1, 2)

V_{IN}	–0.3V to 26V	V_{out}	–0.3V to 6V
Junction Temperature (T_J)	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 V_{IN}	2.7V to 24V	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)	52(°C/W)
uDFN1x1-4	110(°C/W)	23(°C/W)

Electrical Characteristics

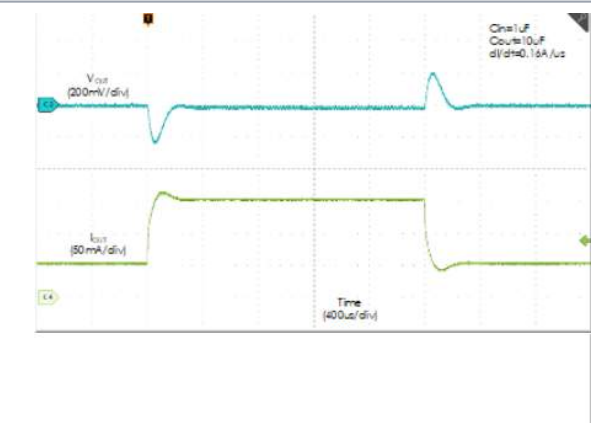
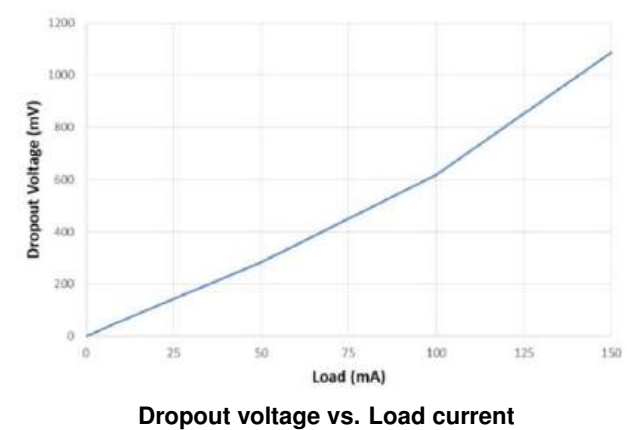
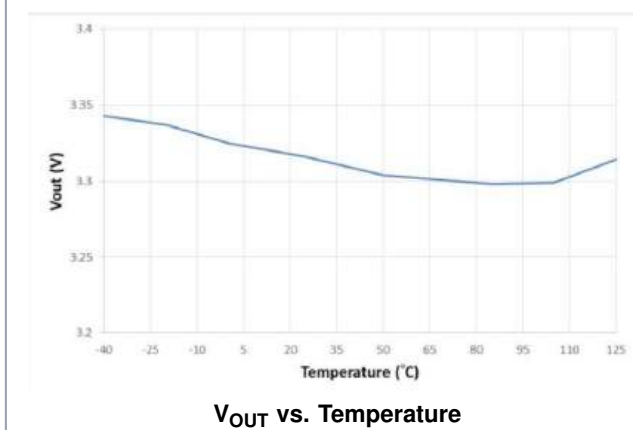
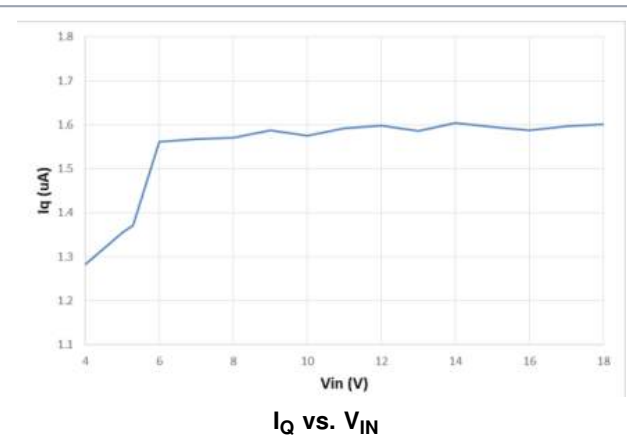
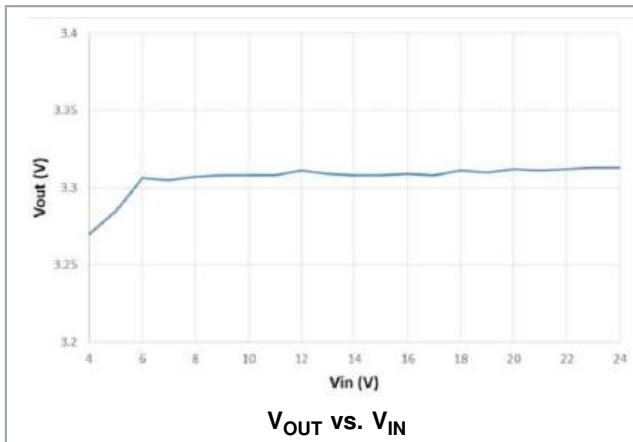
$V_{IN}=V_{OUT}+2V$, $I_{OUT}=1mA$, $C_{IN}=C_{OUT}=1\mu F$, $T_a = 25^{\circ}C$, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Output Voltage	V_{OUT}	–	-2%	–	2%	V
Line Regulation	ΔV_{LINE}	$V_{IN}=V_{OUT} + 2V$ to 24V	–	0.1	–	%
Load Regulation	ΔV_{LOAD}	$I_{OUT}= 1mA$ to 100mA	–	0.7	–	%
Dropout Voltage	V_{DROP}	$V_{out}=3.3V$, $I_{OUT}=100mA$	–	650	–	mV
		$V_{out}=3.3V$, $I_{OUT}=150mA$	–	1200	–	mV
Quiescent Current	I_Q	$T_a = 25^{\circ}C$, $I_{OUT}=0mA$	–	1.5	4.0	μA
Current Limit	I_{CL}	–	170	210	–	mA
Thermal Shutdown	T_{SD}	–	–	140	–	$^{\circ}C$
Thermal Shutdown Hysteresis	T_{HY}	–	–	20	–	$^{\circ}C$
Power-supply rejection ratio	PSRR	$f = 1kHz$, $V_{in}=4.3V$ $V_o = 3.3V$, Ripple 0.2Vp-p, $I_{out} = 1mA$	–	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 $T_J=25^{\circ}C$ 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.

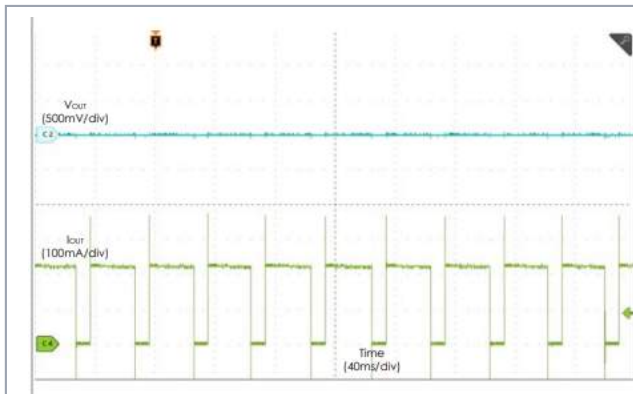
Typical Performance Characteristics

$V_{IN}=V_{OUT}+2V$, $I_{OUT}=1mA$, $V_{OUT}=3.3V$, $C_{IN}=C_{OUT}=1\mu F$, $T_a=25^{\circ}C$, unless otherwise specified

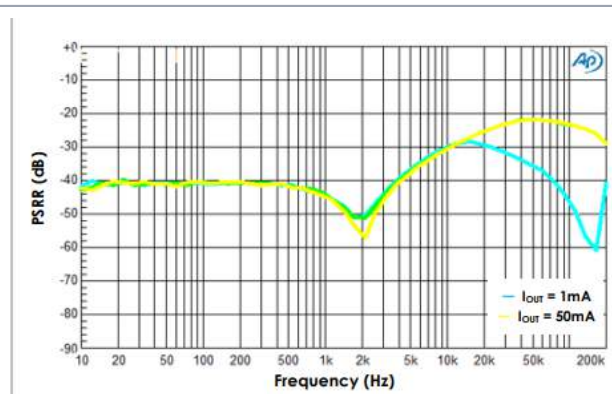


Typical Performance Characteristics

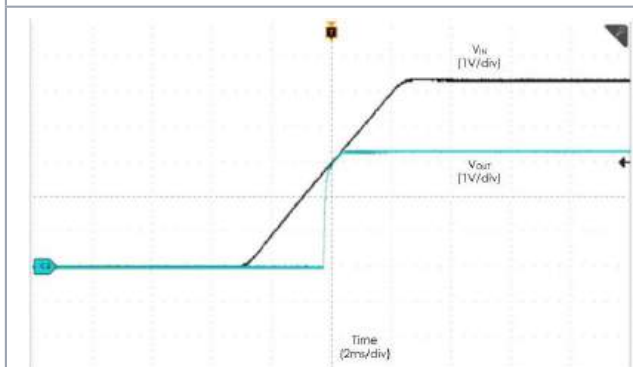
$V_{IN}=V_{OUT}+2V$, $I_{OUT}=1mA$, $V_{OUT}=3.3V$, $C_{IN}=C_{OUT}=1\mu F$, $T_a=25^{\circ}C$, unless otherwise specified



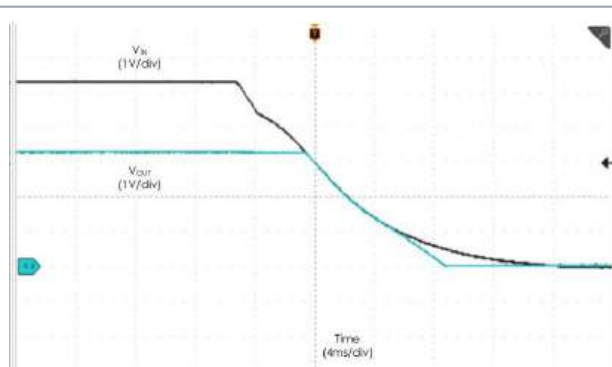
V_{OUT} Short to GND



PSRR vs. Frequency ($V_{IN}=4.3V$)



V_{IN} Power up



V_{IN} Power Off

Application Information

Output Capacitor

The VPE2035 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 VPE2035 are X5R and X7R. The X5R and the X7R capacitors are able to maintain their capacitance values to within $\pm 20\%$ and $\pm 10\%$, respectively, as the temperature increases.

Input Capacitor

A minimum input capacitance of 1 μF is required for VPE2035. 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 10 μF 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 VPE2035 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} ($^\circ\text{C}/\text{W}$) 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:

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

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

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

As the above equations show, it is desirable to work with ICs whose θ_{JA} values are small such that T_J does not increase strongly with P_D . To avoid thermally overloading the VPE2035, 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.

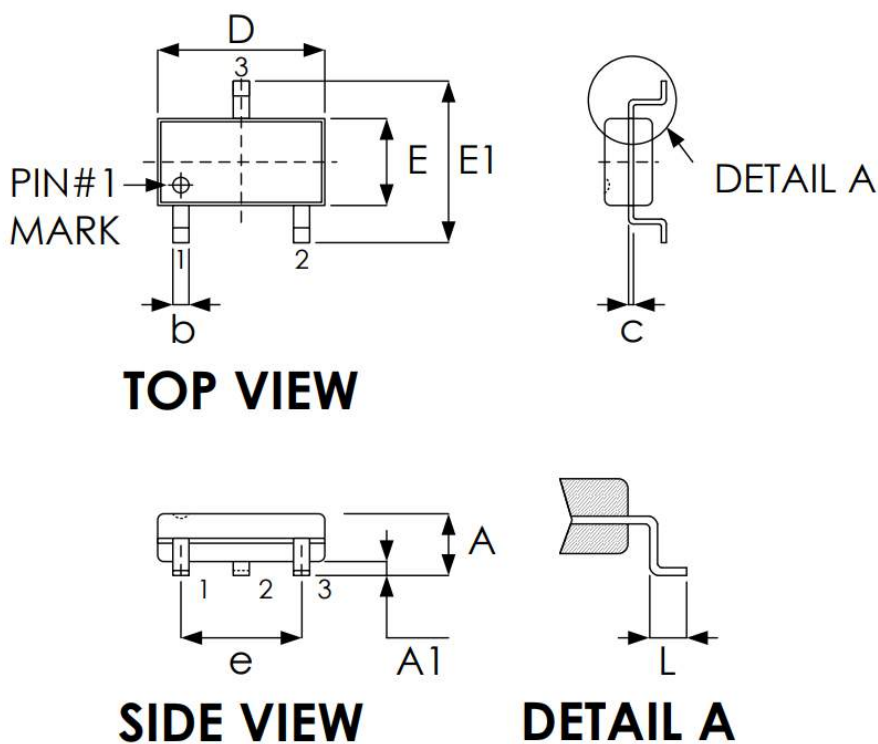
Maximum power dissipation for the device is calculated using the following equation:

$$P_D = \frac{T_{J(\text{MAX})} - T_A}{\theta_{JA}} \quad (\text{Eq. 3})$$

Where $T_{J(\text{MAX})}$ is the 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, $\theta_{JA}=250^\circ\text{C}/\text{W}$, $T_{J(\text{MAX})}=125^\circ\text{C}$ and using $T_A=25^\circ\text{C}$, the maximum power dissipation is 0.4W.
- SOT-23-5 package, $\theta_{JA}=152^\circ\text{C}/\text{W}$, $T_{J(\text{MAX})}=125^\circ\text{C}$ and using $T_A=25^\circ\text{C}$, the maximum power dissipation is 0.65W.
- SOT-89-3 package, $\theta_{JA}=90^\circ\text{C}/\text{W}$, $T_{J(\text{MAX})}=125^\circ\text{C}$ and using $T_A=25^\circ\text{C}$, the maximum power dissipation is 1.1W.
- uDFN1x1-4 package, $\theta_{JA}=110^\circ\text{C}/\text{W}$, $T_{J(\text{MAX})}=125^\circ\text{C}$ and using $T_A=25^\circ\text{C}$, the maximum power dissipation is 0.9W.

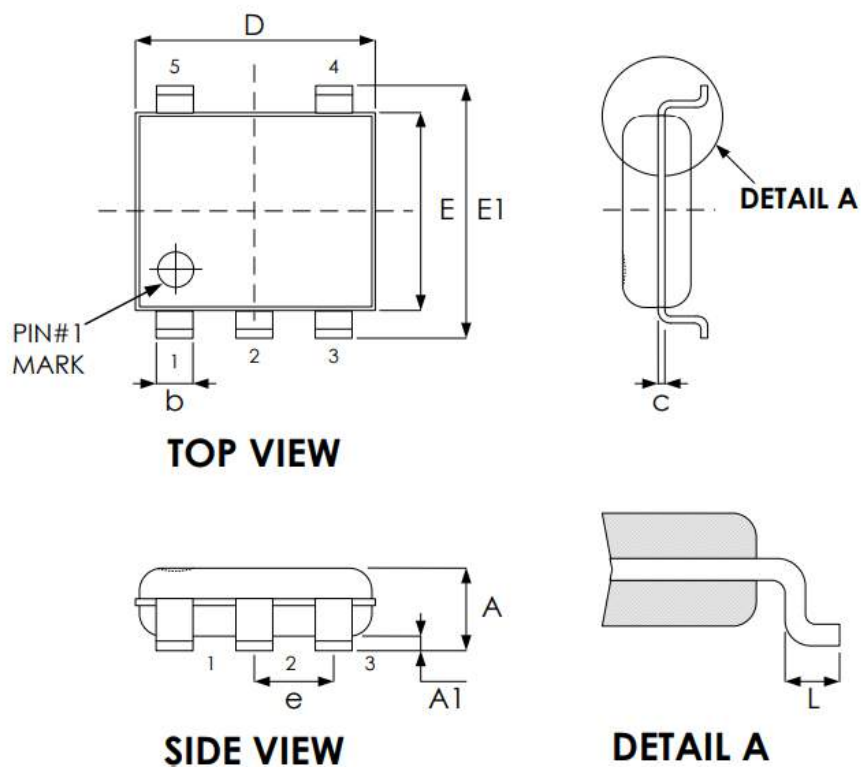
Package Outline Drawing – SOT-23-3



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	0.08	0.25
D	2.70	3.10
E	1.40	1.80
E1	2.60	3.00
e	1.90 BSC	
L	0.30	0.60

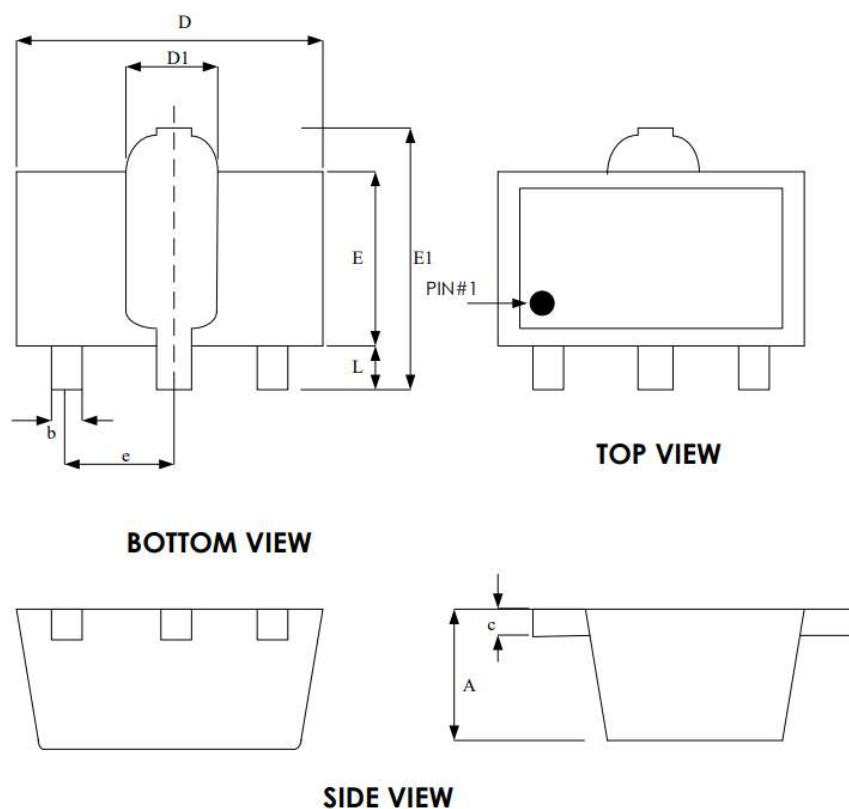
Package Outline Drawing – SOT-23-5



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

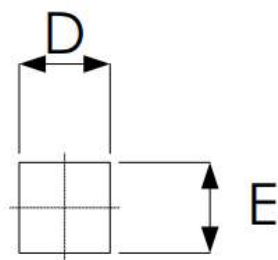
Package Outline Drawing – SOT-89-3



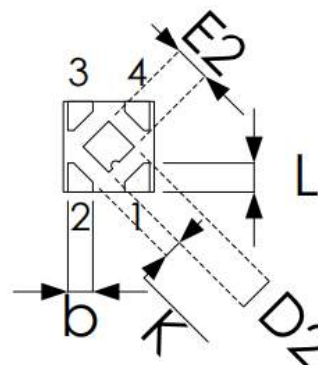
All dimensions are in millimeters.

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

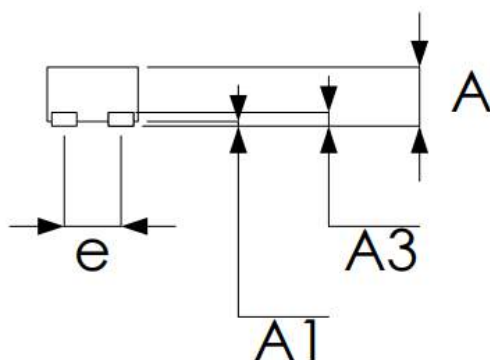
Package Outline Drawing – uDFN-4 (1mm x 1mm)



TOP VIEW



BOTTOM VIEW



SIDE VIEW

All dimensions are in millimeters.

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	0.65 BSC	
L	0.20	0.30
K	0.20 REF.	

Exposed pad

	Dimension in mm	
	Min	Max
D2	0.40	0.60
E2	0.40	0.60

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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