

## DIO6305B

# High-Efficiency 1.2 MHz, 1.2 A Synchronous Step-Up Converter

### Features

- High-efficiency synchronous-mode
- 2.7 ~ 5.25 V input voltage range
- Device quiescent current: 30  $\mu$ A (typ.)
- Less than 1  $\mu$ A shutdown current with 5 V or 0 V output voltage
- Output voltage clamping: 6 V
- Adjustable output voltage up to 5.25 V
- Power-save mode for improved efficiency at low output power
- Load disconnect during shutdown
- 1.8 V logic on EN pin for control
- Thermal shutdown
- Green package: SOT23-6 is pin compatible.
- -40°C to +85°C operating temperature range

### Descriptions

The DIO6305B is a high-efficiency boost regulator targeted for general step-up applications. It can be used for generating 5 V at 600 mA from a 3.3 V rail or a Li-ion battery.

A high switching frequency minimizes the sizes of the inductor and capacitor. Integrated power MOSFETs and internal compensation make the DIO6305B simple to use and fit the total solution into a compact space.

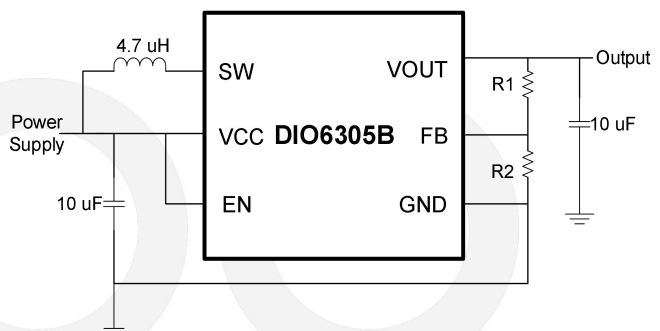
For light load current, the DIO6305B enters into the power-save mode to maintain high efficiency. Anti-ringing control circuitry reduces electromagnetic interference (EMI) concerns by damping the inductor in discontinuous mode. The DIO6305B provides true output disconnect and this allows  $V_{OUT}$  to go to zero volts during shutdown without drawing any current from the input source. The DIO6305B supports 1.8 V logic for control.

The output voltage of the DIO6305B can be programmed by an external resistor divider.

### Applications

- Single cell Li-battery powered products
- Portable audio players
- Cellular phones
- Personal medical products

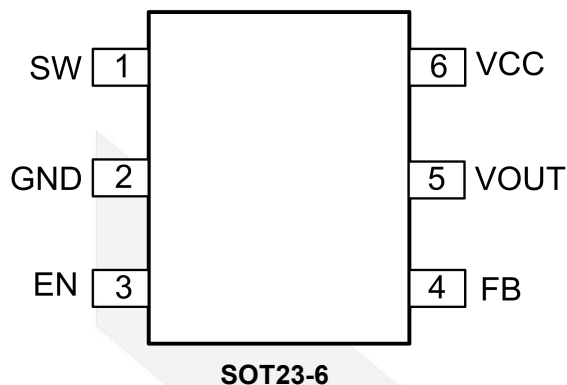
### Typical Application



### Ordering Information

Part Number	Top Marking	RoHS	T <sub>A</sub>	Package	
DIO6305BCST6	YWXH	Green	-40 to +85°C	SOT23-6	Tape & Reel, 3000

## Pin Assignments



**Figure 1. Pin Assignment (Top View)**

## Pin Definitions

Pin Name	Description
SW	Boost and rectifying switch input.
GND	Power ground.
EN	Enable control. Pull high to turn on. Do not leave it floating.
FB	Output voltage feedback pin. Voltage feedback for programming the output voltage.
V <sub>OUT</sub>	Boost converter output.
V <sub>CC</sub>	Boost converter supply voltage.



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### Absolute Maximum Ratings

Stresses beyond those listed under the Absolute Maximum Rating table may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition 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.

symbol	Parameter	Rating	Unit
$V_{IN}$	Input voltage range on SW, $V_{OUT}$ , $V_{CC}$ , FB, EN	-0.3 to 6	V
$T_J$	Junction temperature	150	°C
$\theta_{JA}$	Package thermal resistance SOT-23-6	150	°C/W
$T_{STG}$	Storage temperature	-65 to +150	°C
Operating temperature range		-40 to +85	°C
Lead temperature (soldering, 10 s)		260	°C
ESD susceptibility	HBM	4000	V
	MM	200	

### Recommend Operating Conditions

Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Dioo does not recommend exceeding them or designing to absolute maximum ratings.

Symbol	Parameter	Rating	Unit
$V_{CC}$	Supply voltage	2.7 to 5.25	V
$T_J$	Junction temperature range	-40 to 125	°C
$T_A$	Ambient temperature range	-40 to 85	°C



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### Electrical Characteristics

$T_A = 25^\circ\text{C}$ ,  $V_{OUT} = 5\text{ V}$ ,  $V_{IN} = 3.6\text{ V}$ ,  $C_{IN} = C_{OUT} = 10\text{ }\mu\text{F}$ ,  $L = 4.7\text{ }\mu\text{H}$ , unless otherwise specified.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{OUT}$	Output voltage range		3		5.25	V
$V_{IN}$	Input voltage range		2.7		5.25	
$V_{FB}$	Feedback voltage		485	500	519	mV
f	Oscillator frequency		870	1200	1470	kHz
$I_{SW}$	Switch current limit		0.8	1.2	1.6	A
$I_{START-UP}$	Start-up current limit			600		mA
	Boost switch-on resistance	$V_{OUT} = 5\text{ V}$		400		m $\Omega$
	Rectifying switch-on resistance	$V_{OUT} = 5\text{ V}$		530		m $\Omega$
	Output voltage accuracy	$V_{CC} = 2.7\text{ V}$ , $I_O = 10\text{ mA}$			3.8	%
Line <sub>Reg</sub>	Line regulation	$V_{CC} = 2.7\text{ V}$ to $V_{OUT} - 0.5\text{ V}$ , $I_O = 10\text{ mA}$		0.5	1	%
Load <sub>Reg</sub>	Load regulation			0.5		%
$I_Q$	Quiescent current	$V_{EN} = V_{CC} = 2.7\text{ V}$ , $I_O = 0$ , $V_{OUT} = 5\text{ V}$		30	55	$\mu\text{A}$
$I_{SD}$	Shutdown current	$V_{EN} = 0\text{ V}$ , $V_{CC} = 2.7\text{ V}$			1	$\mu\text{A}$
$V_{IL}$	EN input low voltage				0.4	V
$V_{IH}$	EN input high voltage		1.6			V
$I_{IN}$	EN input current	Clamped on GND			1	$\mu\text{A}$
	Over-temperature protection			150		$^\circ\text{C}$
	Over-temperature hysteresis			20		$^\circ\text{C}$

## Typical Application

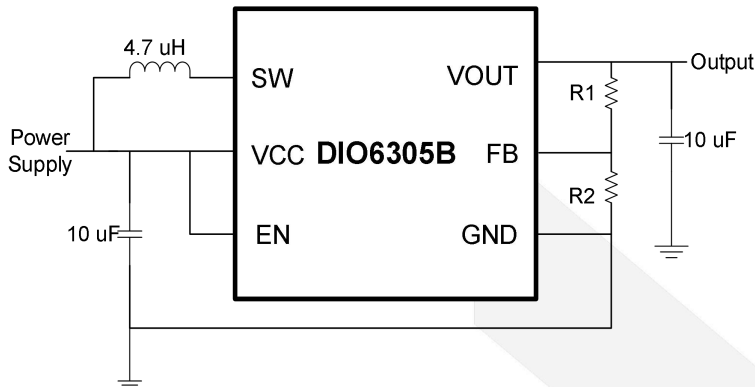


Figure 2. Typical Application

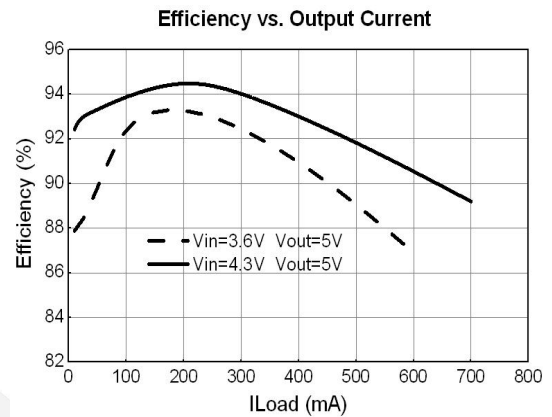


Figure 3. Efficiency vs. Output Current

## Application Information

### Design Procedure

The DIO6305B DC/DC converter is intended for systems powered by dual to triple-cell alkaline, NiCd, and NiMH batteries with a typical terminal voltage between 2.7 V and 5.25 V. It can also be used in systems powered by one-cell Li-ion or Li-polymer with a typical voltage between 3.0 V and 4.2 V.

### Programming Output Voltage

In Figure 2, the output voltage of the DIO6305B DC/DC converter can be adjusted with an external resistor divider. The typical value of the voltage at the FB pin is 500 mV. The maximum recommended value for the output voltage is 5.25 V. R1 and R2 are calculated by using Equation 1:

$$R1 = R2 \times \left( \frac{V_{OUT}}{V_{FB}} - 1 \right) = R2 \times \left( \frac{V_{OUT}}{500mV} - 1 \right) \quad 1$$

R2 is recommended to be 100 kΩ. For example, if an output voltage of 5 V is needed, a 900 kΩ resistor should be chosen for R1.

### Inductor Selection

A boost converter normally requires two main passive components for storing energy during the conversion. A boost inductor and a storage capacitor at the output are required. To select the boost inductor, it is recommended to keep the possible peak inductor current below the current limit threshold of the power switch in the chosen configuration. The highest peak current through the inductor and the switch depends on the output load, the input ( $V_{CC}$ ), and the output voltage ( $V_{OUT}$ ). Estimation of the maximum average inductor current is done by using Equation 2:

$$I_L = I_O \times \frac{V_{OUT}}{V_{CC} \times 0.8} \quad 2$$

For example, for an output current of 75 mA at 5 V, at least an average current of 170 mA flows through the inductor at a minimum input voltage of 2.7 V.

The second parameter for choosing the inductor is the desired current ripple in the inductor. Normally, it is

advisable to work with a ripple of less than 20% of the average inductor current. A smaller ripple reduces the magnetic hysteresis losses in the inductor, as well as output voltage ripple and EMI. But in the same way, regulation time rises as load changes. In addition, a larger inductor increases the total system costs. With these parameters, it is possible to calculate the value for the inductor by using Equation 3:

$$L = \frac{V_{CC} \times (V_{OUT} - V_{CC})}{\Delta I_L \times f \times V_{OUT}} \quad 3$$

Parameter f is the switching frequency and  $\Delta I_L$  is the ripple current in the inductor. In typical applications, a 4.7  $\mu\text{H}$  inductance is recommended. The device is optimized to operate with inductance values between 2.2  $\mu\text{H}$  and 10  $\mu\text{H}$ . Nevertheless, operations with higher inductance values may be possible in some applications. Detailed stability analysis is then recommended. Care must be taken because load transients and losses in the circuit can lead to higher currents as estimated in Equation 3. Also, the losses in the inductor which include magnetic hysteresis losses and copper losses are major parameters for total circuit efficiency.

### Input Capacitor

At least a 10  $\mu\text{F}$  input capacitor is recommended to improve transient behavior of the regulator and the EMI behavior of the total power supply circuit. A ceramic capacitor or a tantalum capacitor with a 100 nF ceramic capacitor in parallel, placed close to the IC, is recommended.

### Output Capacitor

The major parameter necessary to define the output capacitor is the maximum allowed output voltage ripple of the converter. This ripple is determined by two parameters of the capacitor, the capacitance, and the ESR. It is possible to calculate the minimum capacitance needed for the defined ripple, supposing that the ESR is zero, by using Equation 4:

$$C_{MIN} = \frac{I_O \times (V_{OUT} - V_{CC})}{f \times \Delta V \times V_{OUT}} \quad 4$$

Parameter f is the switching frequency and  $\Delta V$  is the maximum allowed ripple. With a chosen ripple voltage of 10 mV, a minimum capacitance of 4.5  $\mu\text{F}$  is needed. In this value range, ceramic capacitors are a good choice. The ESR and the additional ripple created are negligible. It is calculated by using Equation 5:

$$\Delta V_{ESR} = I_O \times R_{ESR} \quad 5$$

The total ripple is the sum of the ripple caused by the capacitance and the ripple caused by the ESR of the capacitor. Additional ripple is caused by load transients. This means that the output capacitor has to completely supply the load during the charging phase of the inductor.

The value of the output capacitance depends on the speed of the load transients and the load current during the load change. With the calculated minimum value of 4.5  $\mu\text{F}$  and load transient considerations, the recommended output capacitance value is in the range of 4.7  $\mu\text{F}$  to 22  $\mu\text{F}$ .

Care must be taken on capacitance loss caused by deteriorating due to the applied DC voltage and the frequency characteristic of the capacitor. For example, larger form factor capacitors (in 1206 size) have their self-resonant frequencies in the same frequency range as the DIO6305B operating frequency. So the effective capacitance of the capacitors used may be significantly lower. Therefore, the recommendation is to use smaller

capacitors in parallel instead of one larger capacitor.

### Layout Considerations

As for all switching power supplies, the layout is an important step in the design, especially at high-peak currents and high switching frequencies. If the layout is not carefully done, the regulator could show stability problems as well as EMI problems. Therefore, use wide and short traces for the main current path and for the power ground tracks. The input capacitor, output capacitor, and the inductor should be placed as close as possible to the IC. Use a common ground node for power ground and a different one for control ground to minimize the effects of ground noise. Connect these ground nodes at any place close to the ground pin of the IC.

The feedback divider should be placed as close as possible to the ground pin of the IC. To lay out the control ground, it is recommended to use short traces as well, separated from the power ground traces. This practice avoids ground shift problems, which can occur due to the superimposition of power ground current and control ground current.

### Thermal Information

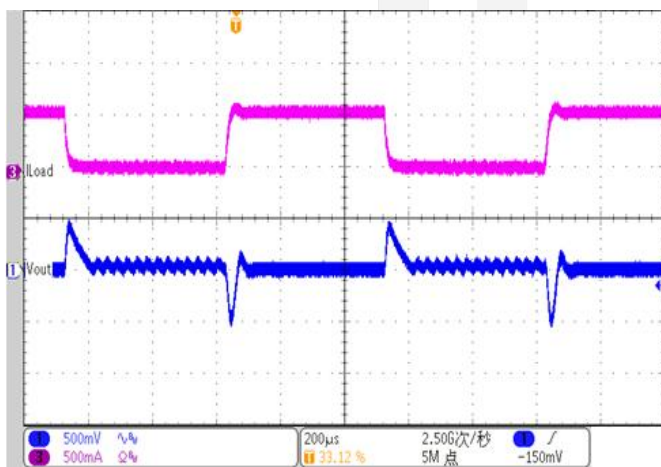
Implementation of integrated circuits in low-profile and fine-pitch surface-mount packages typically requires special attention to power dissipation. Many system-dependent issues such as thermal coupling, airflow, added heat sinks and convection surfaces, and the presence of other heat-generating components affect the power-dissipation limits of a given component.

Three basic approaches for enhancing thermal performance follow.

1. Improving the power dissipation capability of the PCB design.
2. Improving the thermal coupling of the component to the PCB.
3. Introducing airflow in the system.

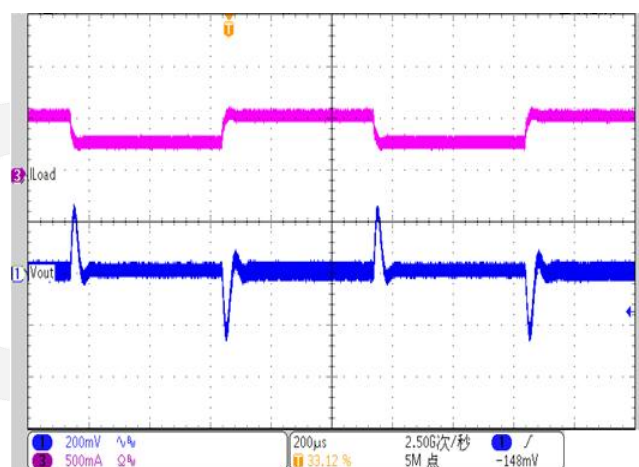
## Typical Performance Characteristics

$T_A = 25^\circ\text{C}$ ,  $V_{OUT} = 5\text{ V}$ ,  $V_{IN} = 3.6\text{ V}$ ,  $C_{IN} = C_{OUT} = 10\text{ }\mu\text{F}$ ,  $L = 4.7\text{ }\mu\text{H}$ , unless otherwise specified.



**Load Transient**

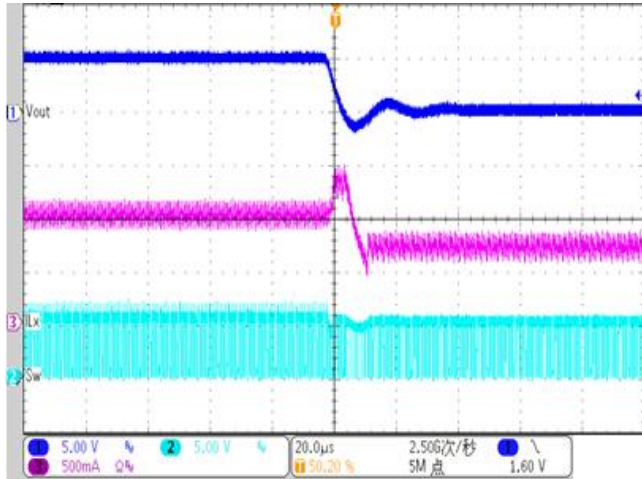
$V_{IN} = 3.6\text{ V}$ ,  $V_{OUT} = 5\text{ V}$ , Load = 0 A  $\rightarrow$  0.6 A



**Load Transient**

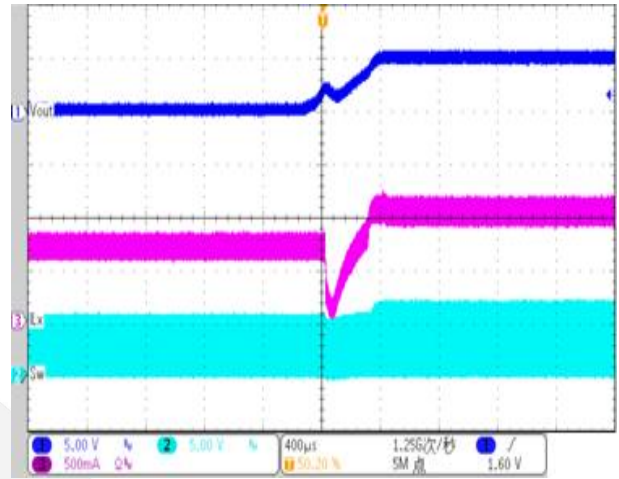
$V_{IN} = 3.6\text{ V}$ ,  $V_{OUT} = 5\text{ V}$ , Load = 0.3 A  $\rightarrow$  0.6 A





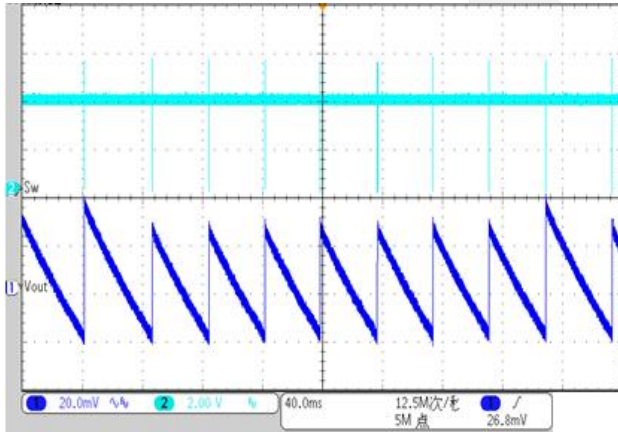
**Short Circuit Protection**

$V_{IN} = 3.6\text{ V}$ ,  $V_{OUT} = 5\text{ V}$ , Load =  $8.2\ \Omega \rightarrow$  Short



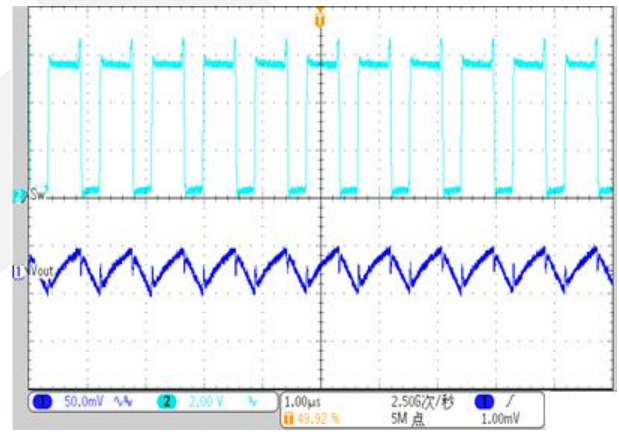
**Short Circuit Recovery**

$V_{IN} = 3.6\text{ V}$ ,  $V_{OUT} = 5\text{ V}$ , Short  $\rightarrow$  Load =  $8.2\ \Omega$



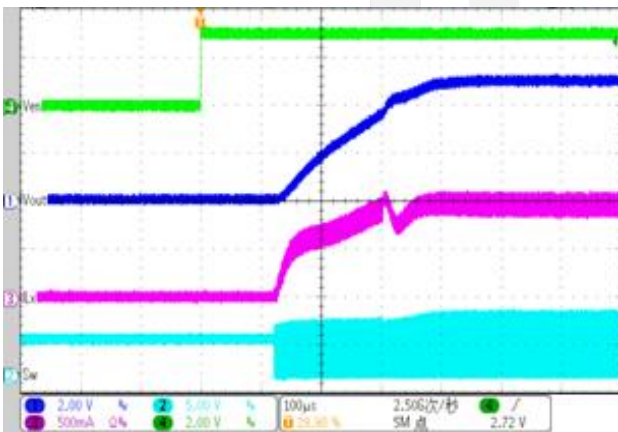
**Output Ripple**

$V_{IN} = 3.6\text{ V}$ ,  $V_{OUT} = 5\text{ V}$ , No Load



**Output Ripple**

$V_{IN} = 3.6\text{ V}$ ,  $V_{OUT} = 5\text{ V}$ , Load =  $0.6\text{ A}$



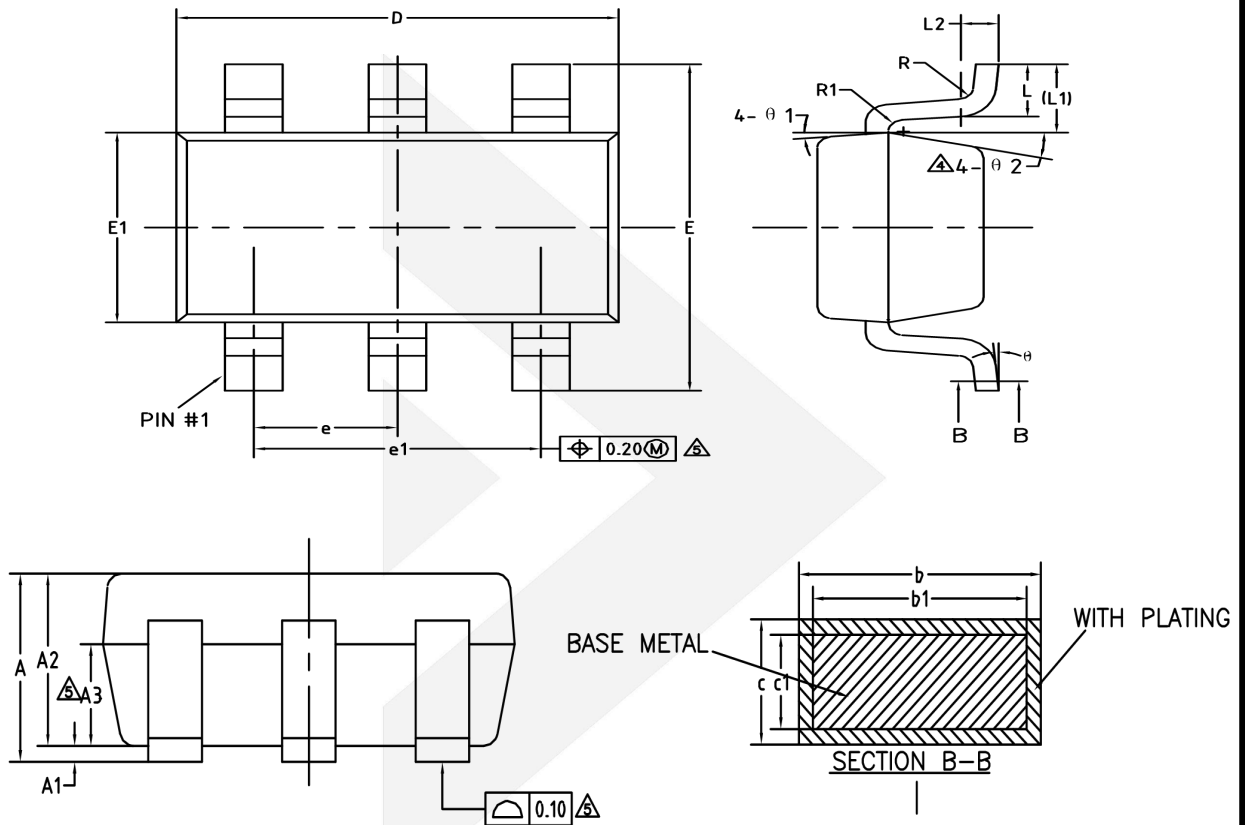
**Startup through Enable**

$V_{IN} = 3.6\text{ V}$ ,  $V_{OUT} = 5\text{ V}$ ,  $R_{LOAD} = 8.2\ \Omega$



## Physical Dimensions: SOT-23-6

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## **CONTACT US**

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