

23V, 1.8A, 1.4MHz Asynchronous Step-Down **DC/DC Converter**

❖ GENERAL DESCRIPTION

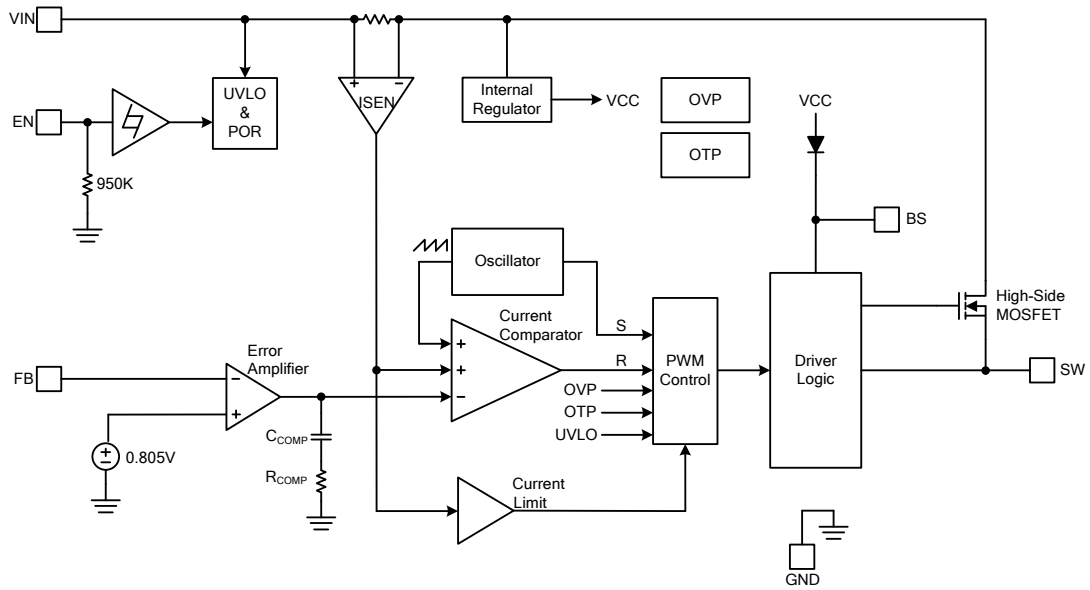
The AX3123 is a monolithic step-down switch mode converter with a built-in power MOSFET. It achieves 1.8A output current over a wide input supply range with excellent load and line regulation. Current mode operation provides fast transient response and eases loop stabilization. Fault condition protection includes cycle-by-cycle current limit and over temperature protection.

The AX3123 requires a minimum number of available standard external components. The AX3123 is available in SOT-23-6L, TSOT-23-6L packages.

❖ FEATURES

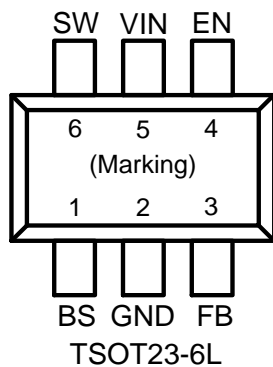
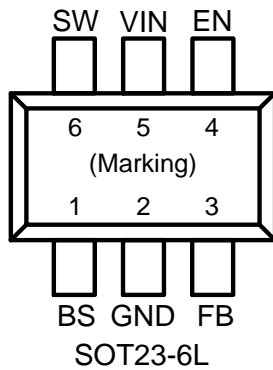
- 1.8A Output Current
- 180mΩ Internal Power MOSFET Switch
- Stable with Low ESR Output Ceramic Capacitors
- Up to 92% Efficiency
- Fixed 1.4MHz Frequency
- Current Mode Operation
- Over-Temperature Protection with Hiccup-Mode
- Cycle-by-Cycle Over Current Protection
- Wide 4.5V to 23V Operating Input Range
- Output Adjustable from 0.805V to 15V
- 10μA Shutdown Current
- Miniature Packages: SOT-23-6L and TSOT-23-6L

❖ **BLOCK DIAGRAM**



❖ **PIN ASSIGNMENT**

The package of AX3123 is SOT-23-6L and TSOT23-6L; the pin assignment is given by:



| Name | Description |
|------------|--|
| BS | Bootstrap. A 22nF capacitor is connected between SW and BS pins to drive the power switch's gate above the supply voltage. |
| GND | Ground Pin. Connect this pin to exposed pad. |
| FB | Feedback. An external resistor divider from the output to GND, tapped to the FB pin sets the output voltage. |
| EN | On/Off Control Input. Pull EN above 1.2V and below 5V to turn the device on. |
| VIN | Power Supply Input. Drive 4.5V to 23V voltage to this pin to power on this chip. Connect a 10µF ceramic bypass capacitor between VIN and GND to eliminate noise. |
| SW | Switch Output. Connect this pin to the switch end of the inductor. |
| NC | No Connect. |

❖ **ORDER/MARKING INFORMATION**

| Order Information | Top Marking | | | | | | | | |
|---|---|-------------|--------------|----------|-----|-------------|--------------|-----------|-----|
| <p>AX3123 XX X X</p> <p>Package Type Green A : Tape/Reel C: SOT-23-6L CT: TSOT-23-6L</p> | <p>SOT-23-6 Marking</p> <table border="1"> <thead> <tr> <th>Part Number</th> <th>Product Code</th> </tr> </thead> <tbody> <tr> <td>AX3123CA</td> <td>t9G</td> </tr> </tbody> </table> <p>TSOT-23-6 Marking</p> <table border="1"> <thead> <tr> <th>Part Number</th> <th>Product Code</th> </tr> </thead> <tbody> <tr> <td>AX3123CTA</td> <td>S1G</td> </tr> </tbody> </table> | Part Number | Product Code | AX3123CA | t9G | Part Number | Product Code | AX3123CTA | S1G |
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| AX3123CA | t9G | | | | | | | | |
| Part Number | Product Code | | | | | | | | |
| AX3123CTA | S1G | | | | | | | | |

❖ **ABSOLUTE MAXIMUM RATINGS** (at $T_A=25^{\circ}\text{C}$)

| | | |
|--|-------|--------------------------|
| ● Input Supply Voltage (V_{IN}) | ----- | +25V |
| ● V_{SW} | ----- | -0.3V to $V_{IN} + 0.3V$ |
| ● V_{BS} | ----- | $V_{sw} + 6V$ |
| ● All Other Pins Voltage | ----- | -0.3V to +6V |
| ● Maximum Junction Temperature (T_J) | ----- | +150°C |
| ● Storage Temperature (T_S) | ----- | -65°C to +150°C |
| ● Lead Temperature (Soldering, 10sec.) | ----- | +260°C |
| ● Power Dissipation @ $T_A=25^{\circ}\text{C}$, (P_D) | | |
| SOT-23-6L | ----- | +0.4W |
| TSOT-23-6L | ----- | +0.4W |
| ● Package Thermal Resistance, (θ_{JA}) | | |
| SOT-23-6L | ----- | 250°C/W |
| TSOT-23-6L | ----- | 250°C/W |
| ● ESD Susceptibility | | |
| HBM(Human Body Mode) | ----- | 2KV |

Note 1 : Stresses exceed those ratings may damage the device.

Recommended Operating Conditions

| | | |
|-------------------------------------|-------|-----------------|
| ● Input Supply Voltage (V_{IN}) | ----- | +4.5V to +23V |
| ● Output Voltage (V_{OUT}) | ----- | +0.805V to +15V |
| ● Operation Temperature Range | ----- | -40°C to +85°C |

Note 2 : If out of its operation conditions, the device is not guaranteed to function.

❖ ELECTRICAL CHARACTERISTICS

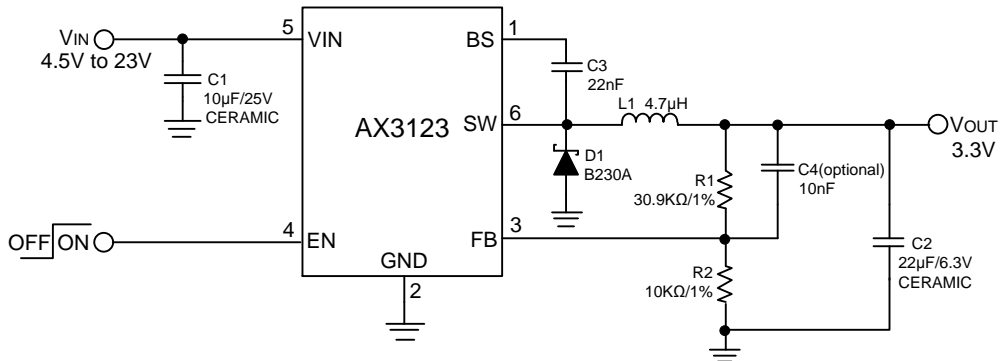
($V_{IN}=12V$, $T_A=25^{\circ}C$, unless otherwise specified.)

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|--------|----------------------------------|-------|-------|-------|-------------|
| Feedback Voltage | | $4.5V \leq V_{IN} \leq 23V$ | 0.785 | 0.805 | 0.825 | V |
| Switch-On Resistance (Note1) | | | - | 180 | - | m Ω |
| Switch Leakage | | $V_{EN} = 0V$, $V_{SW} = 0V$ | - | - | 10 | μA |
| Current Limit (Note1) | | | - | 3 | - | A |
| Oscillator Frequency | | | 1.2 | 1.4 | 1.7 | MHz |
| Fold-back Frequency | | $V_{FB} = 0V$ | - | 460 | - | KHz |
| Maximum Duty Cycle | | | - | 85 | - | % |
| Minimum On-Time (Note1) | | | - | 100 | - | ns |
| Under Voltage Lockout Threshold Rising | | | 4.1 | 4.4 | 4.7 | V |
| Under Voltage Lockout Threshold Hysteresis | | | - | 250 | - | mV |
| EN Input Low Voltage | | | - | - | 0.4 | V |
| EN Input High Voltage | | | 1.2 | - | - | V |
| EN Input Current | | $V_{EN} = 2V$ | - | 2.0 | - | μA |
| | | $V_{EN} = 0V$ | - | 0.1 | - | μA |
| Supply Current (Shutdown) | | $V_{EN} = 0V$ | - | 10 | - | μA |
| Supply Current (Quiescent) | | $V_{EN} = 2V$, $V_{FB} = 1V$ | - | 1.8 | - | mA |
| Over-Temperature Protection Threshold (Note1) | | | - | 150 | - | $^{\circ}C$ |

Note1: Guaranteed by design

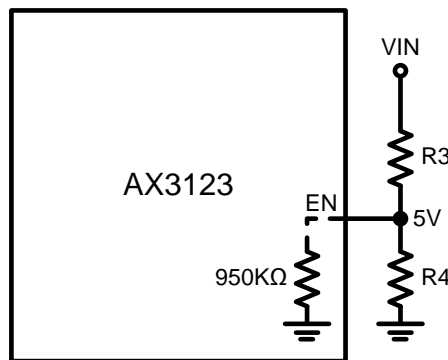
Note 2: $V_{IN} = 5V$, $V_{OUT} = 3.3V$, maximum load current is about 1.4A.

❖ APPLICATION CIRCUIT



❖ FUNCTION DESCRIPTIONS

Setting EN Automatic Startup Voltage



The external resistor divider is used to set the EN automatic startup voltage:

$$R4 = \frac{V_{EN}}{\left(\frac{V_{IN} - V_{EN}}{R3}\right)}$$

For example, $V_{IN}=12V$, $R3=100k\Omega$, thus $R4$ resistor value is:

$$R4 = \frac{5V}{\left(\frac{12V - 5V}{100k\Omega}\right)} \approx 71.5k\Omega$$

Table 1 shows a list of resistor selection for common input voltages:

Table 1 -- Resistor Selection for Common Input Voltages

| V _{IN} | R3 | R4 |
|-----------------|-------|--------|
| 5V | 100kΩ | NC |
| 12V | 100kΩ | 71.5kΩ |
| 16V | 100kΩ | 45.3kΩ |

Setting Output Voltage

The external resistor divider is used to set the output voltage. AX3123 feedback resistors are unconcerned of compensation and provide an easy way to program output voltage. Table 2 shows a list of resistor selection for common output voltages:

$$V_{OUT} = 0.805 \times \left(1 + \frac{R1}{R2} \right) V$$

Table 2 -- Resistor Selection for Common Output Voltages

| V _{OUT} | R1 | R2 |
|------------------|--------|-------|
| 5V | 43kΩ | 8.2kΩ |
| 3.3V | 30.9kΩ | 10kΩ |
| 2.5V | 21kΩ | 10kΩ |
| 1.8V | 12.4kΩ | 10kΩ |
| 1.2V | 4.99kΩ | 10kΩ |

Selecting the Inductor

A 4.7μH inductor with a DC current rating of at least 25% percent higher than the maximum load current is recommended for most applications. For highest efficiency, the inductor's DC resistance should be less than 200mΩ. For most designs, the required inductance value can be derived from the following equation.

$$\Delta I = 0.3 \times I_{L(MAX)}$$

$$L \geq (V_{IN} - V_{OUT}) \times \left(\frac{V_{OUT}}{F_{SW} \times \Delta I \times V_{IN}} \right)$$

Where ΔI is the inductor ripple current.

Choose the inductor ripple current to be 30% of the maximum load current. The maximum inductor peak current is calculated from:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

Under light load conditions below 100mA, a larger inductance is recommended for improving efficiency.

Selecting the Input Capacitor

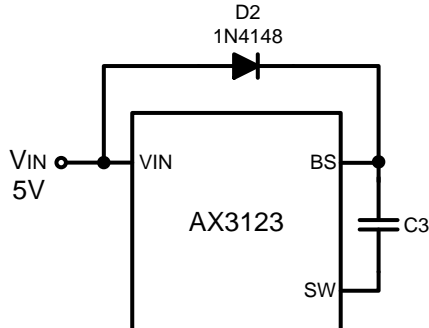
The input capacitor reduces the surge current drawn from the input supply and the switching noise from the device. The input capacitor impedance at the switching frequency should be less than the input source impedance to prevent high frequency switching current from passing through the input. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. For most applications, a 10 μ F capacitor is sufficient.

Selecting the Output Capacitor

The output capacitor keeps the output voltage ripple small, and a 22 μ F ceramic capacitor with X5R or X7R dielectrics is recommended for its low ESR characteristics.

External Bootstrap Diode

An external bootstrap diode is recommended if the input voltage is less than 5V or if there is a 5V system rail available. This diode helps improving the efficiency. Low cost diodes, such as 1N4148, are suitable for this application.



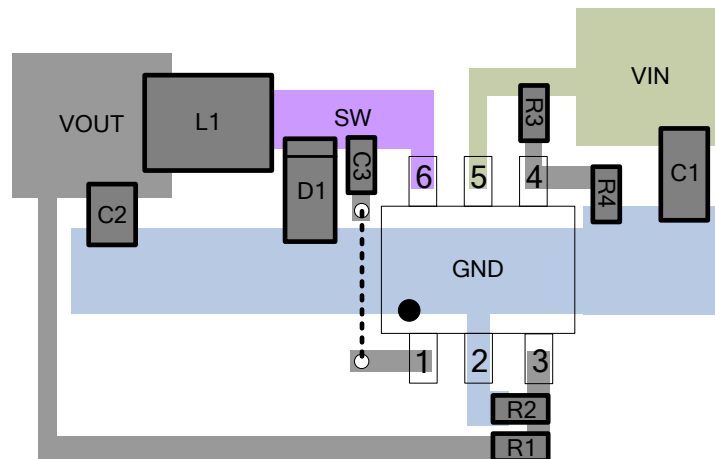
Rectifier Diode

Use a Schottky diode as the rectifier to conduct current when the high-side power MOSFET is off. The Schottky diode must have current rating higher than the maximum output current and the reverse voltage rating higher than the maximum input voltage.

PCB Layout Recommendation

The device's performance and stability are dramatically affected by PCB layout. It is recommended to follow these general guidelines shown as below:

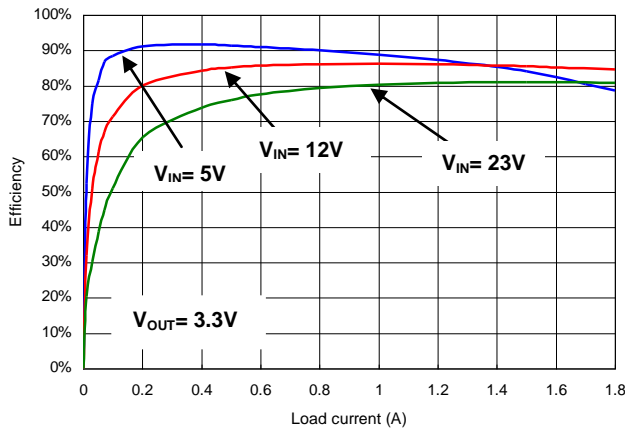
1. Place the input capacitors and output capacitors as close to the device as possible. The traces which connect to these capacitors should be as short and wide as possible to minimize parasitic inductance and resistance.
2. Place V_{IN} capacitors close to the V_{IN} pin.
3. Place feedback resistors close to the FB pin.
4. Keep the sensitive signal (FB) away from the switching signal (SW).



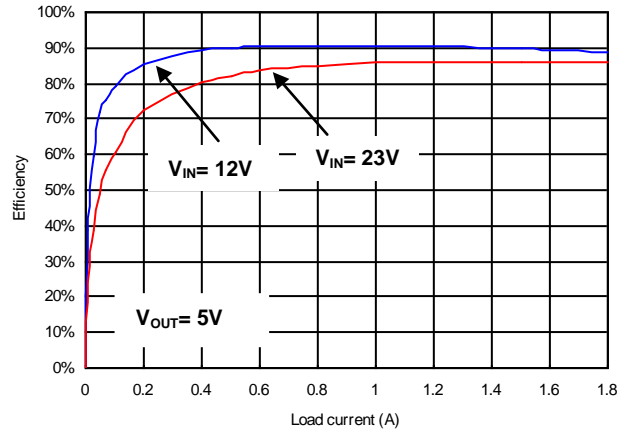
AX3123 (SOT-23-6L and TSOT-23-6L) Recommended Layout Diagram

❖ **TYPICAL CHARACTERISTICS**

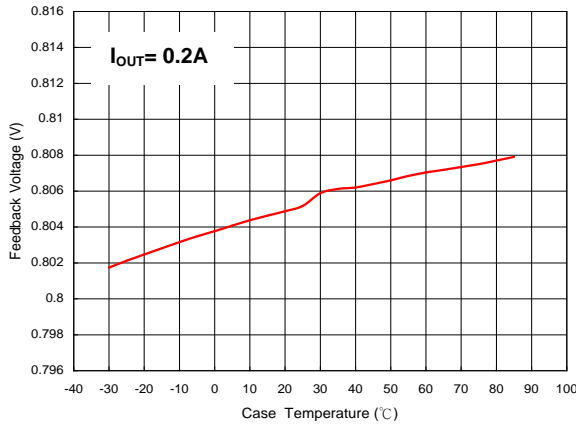
$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_1 = 10\mu F$, $C_2 = 22\mu F$, $L_1 = 4.7\mu H$, $T_A = +25^\circ C$, unless otherwise noted.



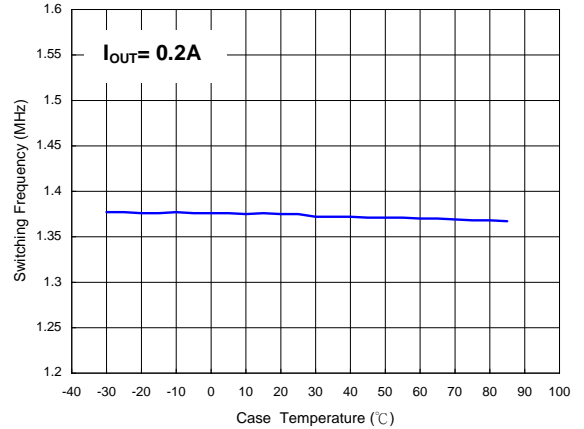
Efficiency vs. Loading



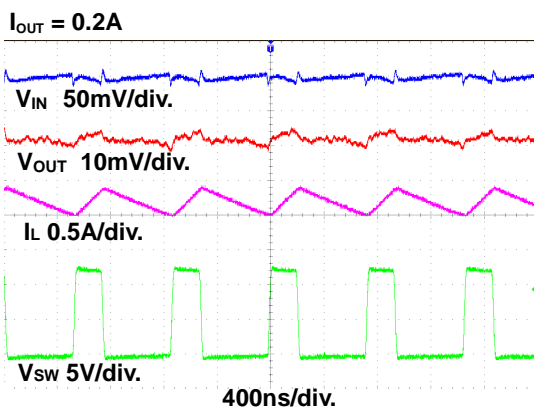
Efficiency vs. Loading



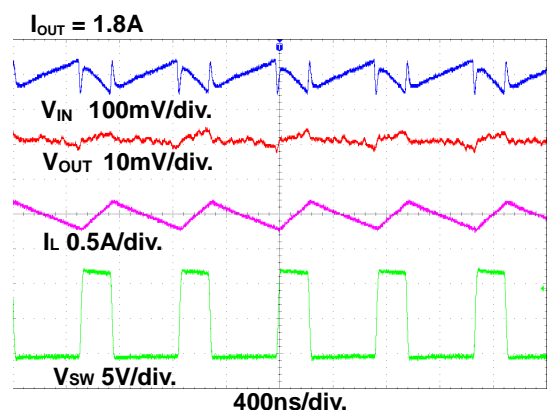
Feedback Voltage vs. Case Temperature



Switching Frequency vs. Case Temperature



DC Ripple Waveform

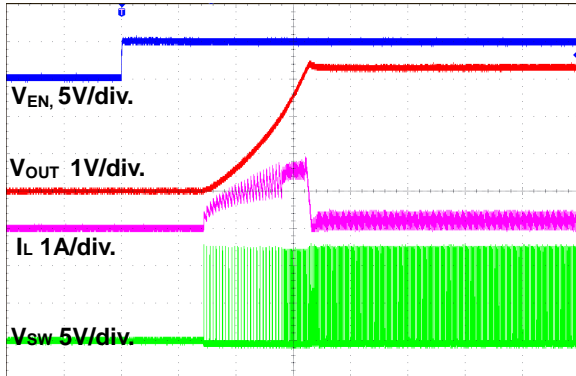


DC Ripple Waveform

❖ **TYPICAL CHARACTERISTICS (CONTINUES)**

$V_{IN} = 12V$, $V_{OUT} = 3.3V$, $C_1 = 10\mu F$, $C_2 = 22\mu F$, $L1 = 4.7\mu H$, $T_A = +25^\circ C$, unless otherwise noted.

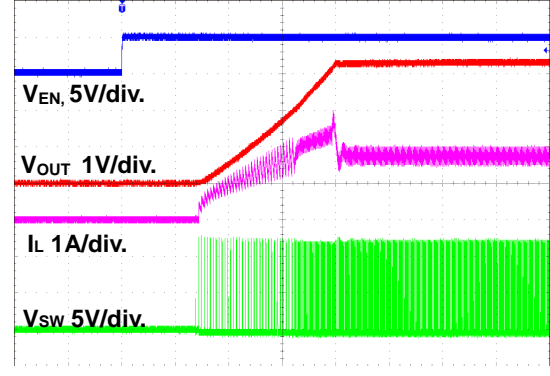
$I_{OUT}=0.2A$



40µs/div.

Startup Through Enable Waveform

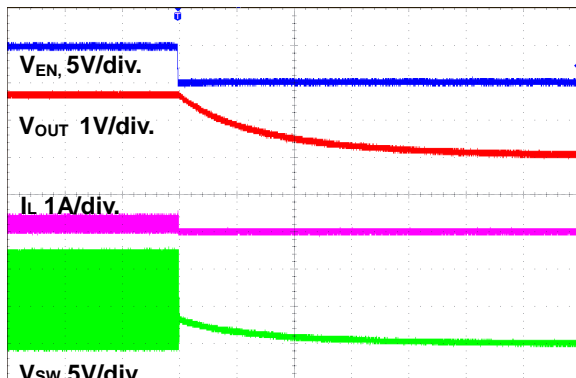
$I_{OUT}=1.8A$



40µs/div.

Startup Through Enable Waveform

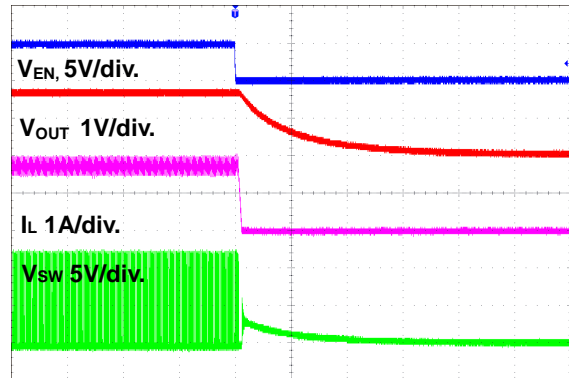
$I_{OUT}=0.2A$



200µs/div.

Shutdown Through Enable Waveform

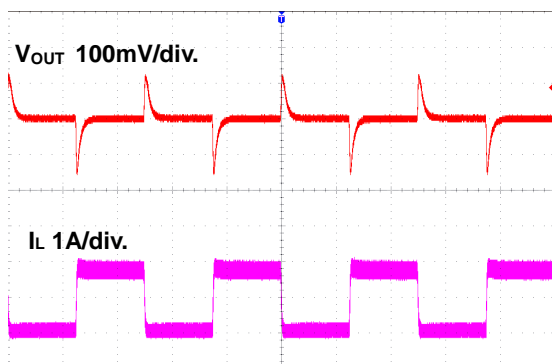
$I_{OUT}=1.8A$



40µs/div.

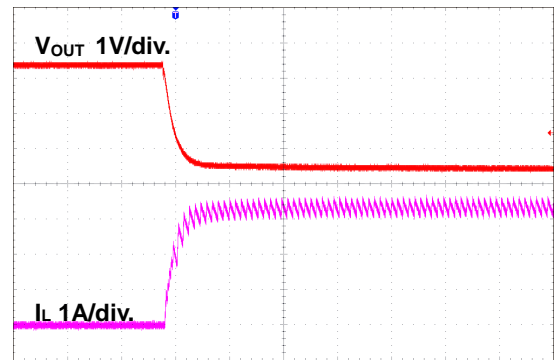
Shutdown Through Enable Waveform

$I_{OUT} = 200mA$ to $1.8A$ step



400µs/div.

Load Transient Waveform

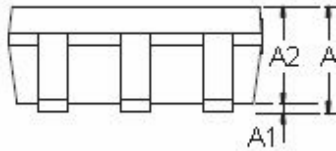
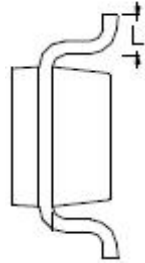
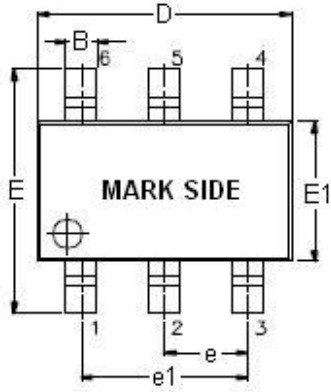


20µs/div.

Short Circuit Test

❖ **PACKAGE OUTLINES**

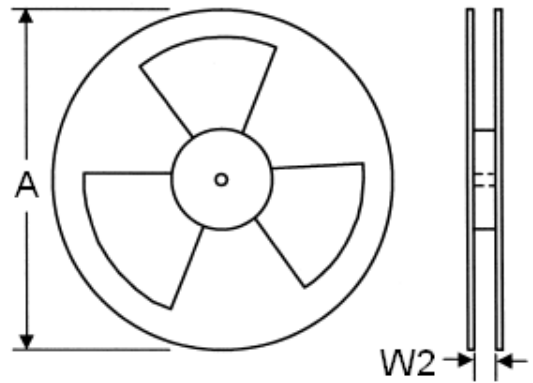
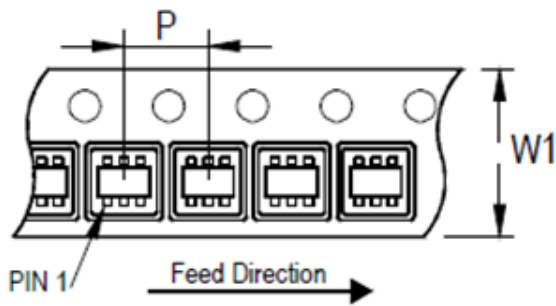
SOT-23-6L Package (Unit: mm)



| SYMBOLS UNIT | DIMENSION IN MILLIMETER | |
|--------------|-------------------------|------|
| | MIN | MAX |
| A | 0.90 | 1.45 |
| A1 | 0.00 | 0.15 |
| A2 | 0.90 | 1.30 |
| B | 0.30 | 0.50 |
| D | 2.80 | 3.00 |
| E | 2.60 | 3.00 |
| E1 | 1.50 | 1.70 |
| e | 0.90 | 1.00 |
| e1 | 1.80 | 2.00 |
| L | 0.30 | 0.60 |

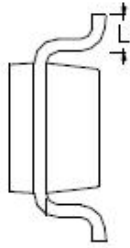
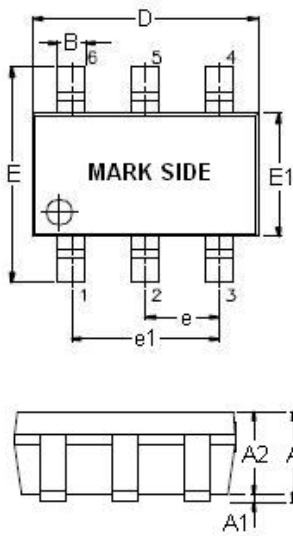
Note : Followed From JEDEC MO-178-C.

Carrier Dimensions



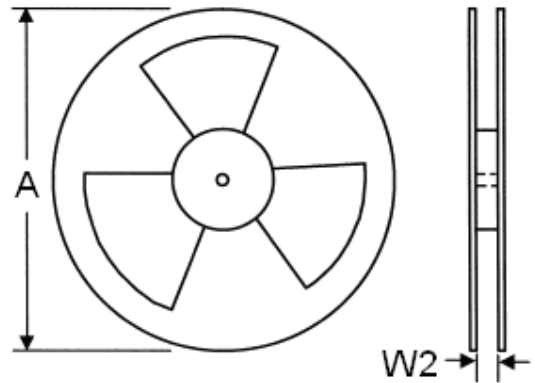
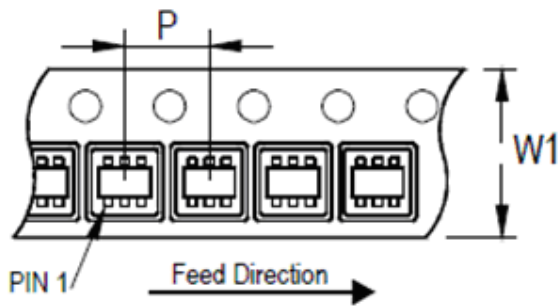
| Tape Size (W1) mm | Pocket Pitch (P) mm | Reel Size (A) | | Reel Width (W2) mm | Empty Cavity Length mm | Units per Reel |
|-------------------|---------------------|---------------|-----|--------------------|------------------------|----------------|
| | | in | mm | | | |
| 8 | 4 | 7 | 180 | 8.4 | 300~1000 | 3,000 |

TSOT-23-6L Package (Unit: mm)



| SYMBOLS UNIT | DIMENSION IN MILLIMETER | |
|--------------|-------------------------|------|
| | MIN | MAX |
| A | 0.70 | 1.10 |
| A1 | 0.00 | 0.10 |
| A2 | 0.70 | 1.00 |
| B | 0.30 | 0.50 |
| D | 2.80 | 3.00 |
| E | 2.60 | 3.00 |
| E1 | 1.50 | 1.70 |
| e | 0.90 | 1.00 |
| e1 | 1.80 | 2.00 |
| L | 0.30 | 0.60 |

Carrier Dimensions



| Tape Size (W1) mm | Pocket Pitch (P) mm | Reel Size (A) | | Reel Width (W2) mm | Empty Cavity Length mm | Units per Reel |
|----------------------|------------------------|---------------|-----|-----------------------|---------------------------|----------------|
| | | in | mm | | | |
| 8 | 4 | 7 | 180 | 8.4 | 300~1000 | 3,000 |

Life Support Policy

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