ACE735E

36V Input Standoff Voltage, 1.5A Step-Down Converter

Description

The ACE735E is a wide input range, high-efficiency, and high frequency DC-to-DC step-down switching regulator, capable of delivering up to 1.5A of output current. With a fixed switching frequency of 650KHz, this current mode PWM controlled converter allows the use of small external components, such as ceramic input and output caps, as well as small inductors. ACE735E also employs a proprietary control scheme that switches the device into a power save mode during light load, thereby extending the range of high efficiency operation. An OVP function protects the IC itself and its downstream system against input voltage surges. With this OVP function, the IC can stand off input voltage as high as 42V, making it an ideal solution for industrial applications such as smart meters as well as automotive applications.

In automotive systems, power comes from the battery, with its voltage typically between 9V and 24V. Including cold crank and double battery jump-starts, the minimum input voltage may be as low as 4V and the maximum up to 36V, with even higher transient voltages. With these high input voltages, linear regulators cannot be used for high supply currents without overheating the regulator. Instead, high efficiency switching regulators such as ACE735E must be used to minimize thermal dissipation.

ACE735E is available in a space-saving SOT23-6 package.

Features

- Wide Input Operating Range from 4V to 36V
- Standoff Input Voltage: 38V
- High Efficiency at 12V In 5V Out: Up to 91%
- High Efficiency PFM mode at light load
- Capable of Delivering 1.5A
- No External Compensation Needed
- Current Mode control
- Logic Control Shutdown
- Thermal shutdown and UVLO
- Available in SOT23-6 Package

Application

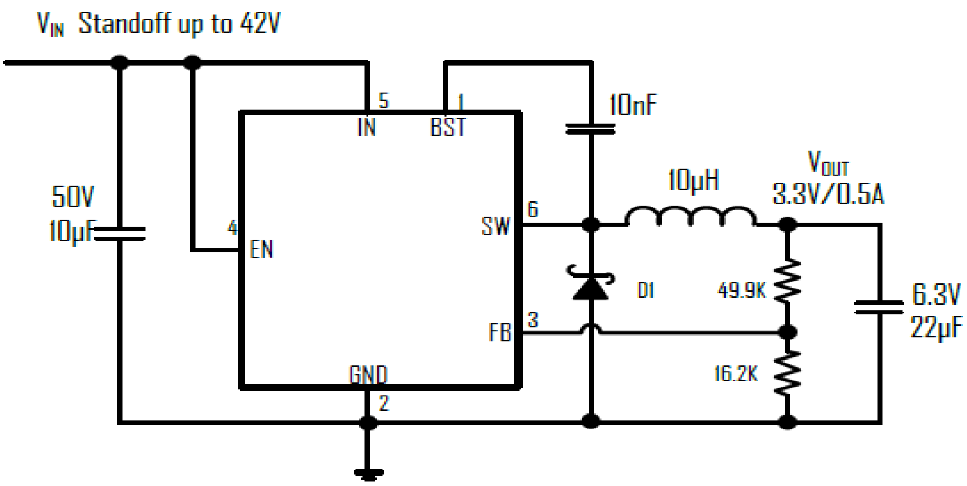
- Smart Meters
- Industrial Applications
- Automotive Applications

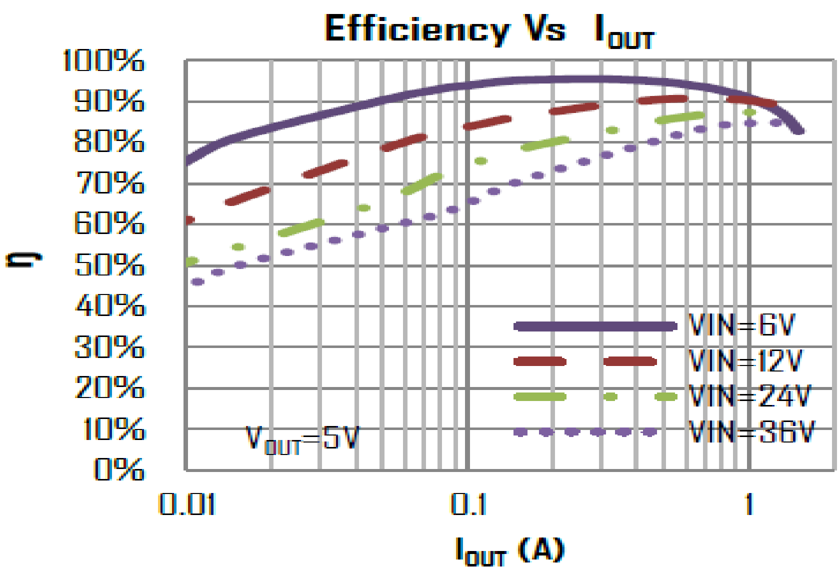
Absolute Maximum Rating

Parameter	Value
IN Voltage	–0.3V to 42V
SW ,EN Voltage	–0.3V to VIN+0.3
BST Voltage	–0.3V to SW+6V
FB Voltage	–0.3V to 6V
SW to ground current	Internally limited
Operating Temperature Range	–40°C to 85°C
Storage Temperature Range	.–55°C to 150°C
Thermal Resistance	θ_{JA} θ_{JC}
SOT23-6	220 110 °C/W

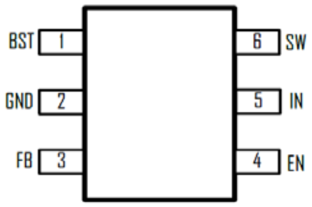
(Note: Exceeding these limits may damage the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

Typical Application





Packaging Type



SOT-23-6

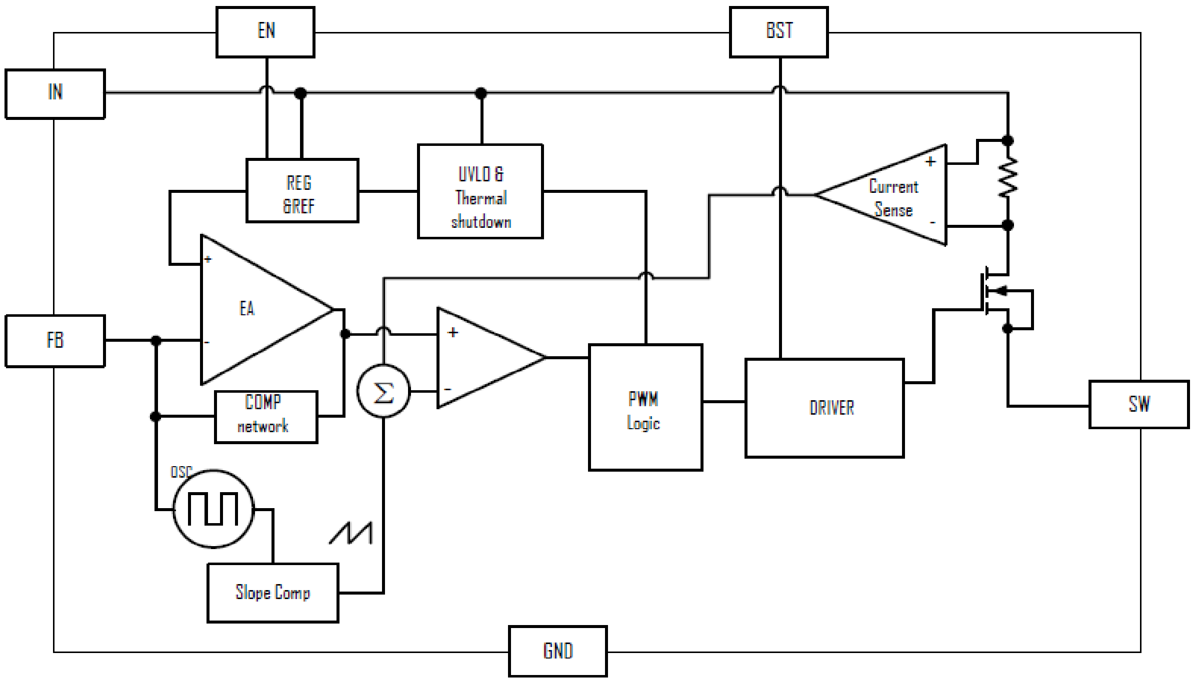
SOT-23-6	Description	Function
1	BST	Bootstrap pin. Connect a 10nF capacitor from this pin to SW.
2	GND	Ground
3	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set V_{OUT}
4	EN	Enable pin for the IC. Drive this pin high to enable the part, low to disable.
5	IN	Supply Voltage. Bypass with a 10μF ceramic capacitor to GND.
6	SW	Inductor Connection. Connect an inductor between SW and the regulator output.

Ordering information

ACE735E XX + H

- H: Halogen - free
- +: Pb - free
- XX: GM : SOT-23-6

Block Diagram



Electrical Characteristics

$V_{IN}=V_{EN}=5$, $T_A=25$℃

Parameter	Conditions	Min	Typ	Max	Unit
Input Standoff Voltage		38			V
Input Voltage Range		4		36	V
Input UVLO	Rising, Hysteresis=140mV		3.8		V
Input OVP	Rising, Hysteresis=1.3V		38		V
Input Supply Current	V_{FB}=0.85V		0.6		mA
Input Shutdown Current			6		μA
FB Feedback Voltage			0.8		V
FB Input Current			0.01		μA
Switching Frequency			650		KHz
Maximum Duty Cycle		90			%
Fold-Back Frequency	V_{FB}=0 V		60		KHz
High side Switch On Resistance	I_{SW} =200mA		300		mΩ
High side Switch Current Limit			2.5		A
SW Leakage Current	V_{IN}=12V,V_{SW}=0,EN=GND			10	μA
EN Input Current	V_{IN}=12V,V_{EN}=5V		1	5	μA
EN Input Low Voltage	Rising, Hysteresis=100mV	0.8	1.1	1.4	V
Thermal Shutdown	Hysteresis=40℃		150		℃

FUNCTIONAL DESCRIPTIONS

Loop Operation

The ACE735E is a wide input range, high-efficiency, DC-to-DC step-down switching regulator, capable of delivering up to 1.5A of output current, integrated with a 300mΩ high side MOSFET. It uses a PWM current-mode control scheme. An error amplifier integrates error between the FB signal and the internal reference voltage. The output of the integrator is then compared to the sum of a current-sense signal and the slope compensation ramp. This operation generates a PWM signal that modulates the duty cycle of the power MOSFETs to achieve regulation for output voltage.

Light Load Operation

Traditionally, a fixed constant frequency PWM DC-DC regulator always switches even when the output load is small. When energy is shuffling back and forth through the power MOSFETs, power is lost due to the finite RDSONs of the MOSFETs and parasitic capacitances. At light load, this loss is prominent and efficiency is therefore very low. ACE735E employs a proprietary control scheme that improves efficiency in this situation by enabling the device into a power save mode during light load,thereby extending the range of high efficiency operation.

APPLICATION INFORMATION

Setting Output Voltages

Output voltages are set by external resistors. The FB threshold is 0.8V.

$R_{TOP} = R_{BOTTOM} \times [(V_{OUT} / 0.8) - 1]$

Inductor Selection

The peak-to-peak ripple is limited to 30% of the maximum output current. This places the peak current far enough from the minimum overcurrent trip level to ensure reliable operation while providing enough current ripples for the current mode converter to operate stably. In this case, for 1.5A maximum output current, the maximum inductor ripple current is 500 mA. The inductor size is estimated as following equation:

$L_{IDEAL}=(V_{IN(MAX)}-V_{OUT})/I_{RIPPLE}*D_{MIN}*(1/F_{OSC})$ Therefore, for V_{OUT}=5V,

The inductor values is calculated to be L = 13μH. Chose 10μH or 15μH

For V_{OUT} =3.3V,

The inductor values is calculated to be L = 9.2μH. Chose 10μH

Output Capacitor Selection

For most applications a nominal 22μF or larger capacitor is suitable. The ACE735E internal compensation is designed for a fixed corner frequency that is equal to $FC=\frac{1}{2*\pi\sqrt{COUT*L}} = 8.7Khz$

For example, for V_{OUT}=5V, L=15μH, C_{OUT}=22μF.

The output capacitor keeps output ripple small and ensures control-loop stability. The output capacitor must also have low impedance at the switching frequency. Ceramic, polymer, and tantalum capacitors are suitable, with ceramic exhibiting the lowest ESR and high-frequency impedance. Output ripple with a ceramic output capacitor is approximately as follows:

$V_{RIPPLE} = IL_{(PEAK)}[1 / (2\pi \times f_{OSC} \times C_{OUT})]$

If the capacitor has significant ESR, the output ripple component due to capacitor ESR is as follows:

$V_{RIPPLE(ESR)} = IL_{(PEAK)} \times ESR$

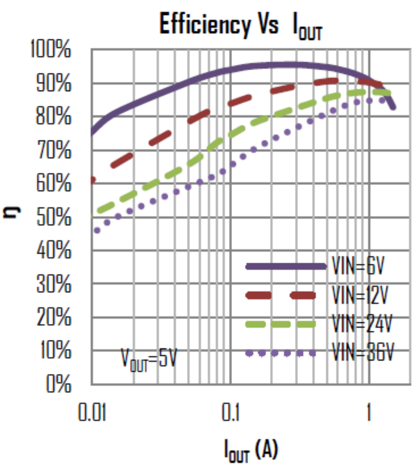
Input Capacitor Selection

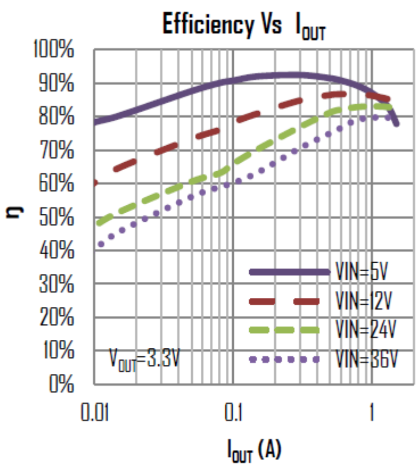
The input capacitor in a DC-to-DC LED Driver reduces current peaks drawn from the battery or other input power source and reduces switching noise in the controller. The impedance of the input capacitor at the switching frequency should be less than that of the input source so high-frequency switching currents do not pass through the input source.The output capacitor keeps output ripple small and ensures control-loop stability

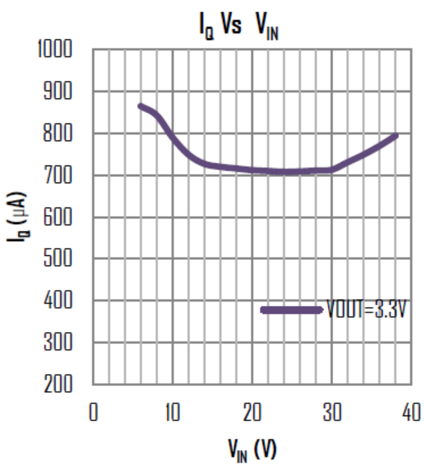
Dimming Control

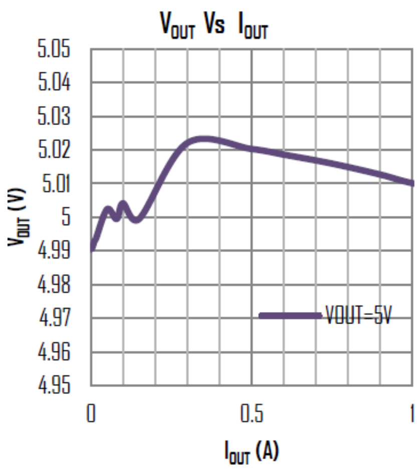
V_{OUT} (V)	C_{OUT} (μF)	C_{OUT} (μF)
8	22	15 to 22
5	22	10 to 15
3.3	22	6.8 to 10

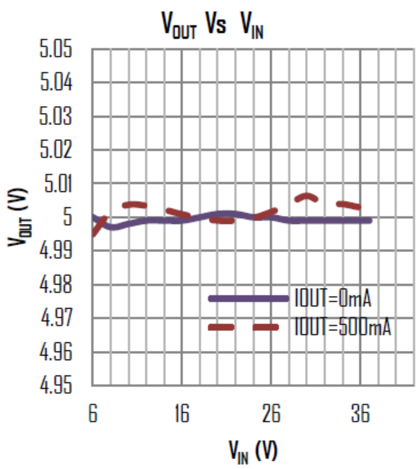
TYPICAL CHARACTERISTICS

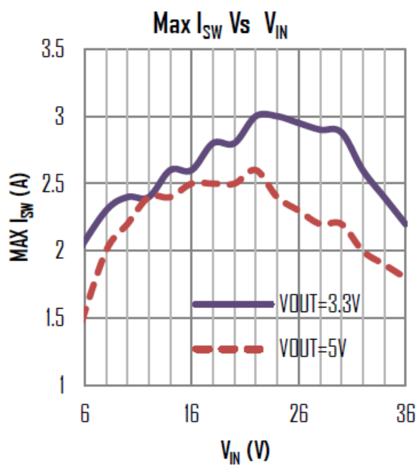




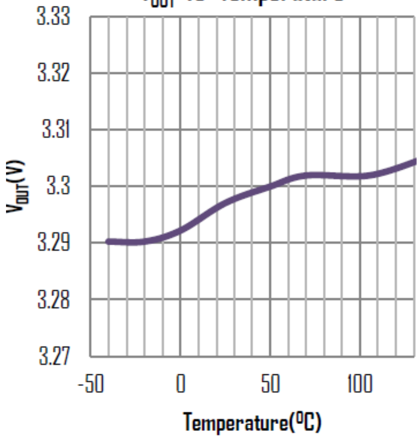




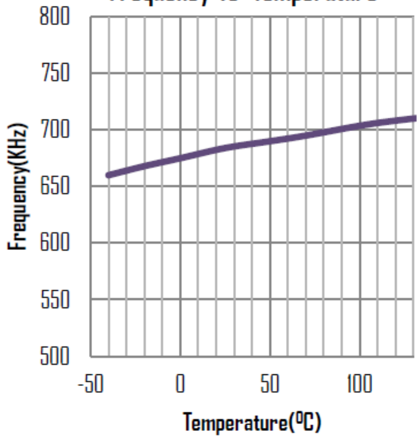




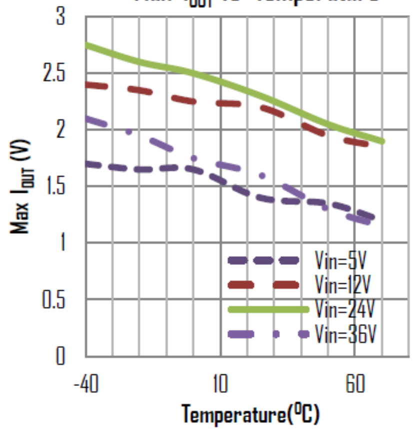
V_{OUT} Vs Temperature



Frequency Vs Temperature

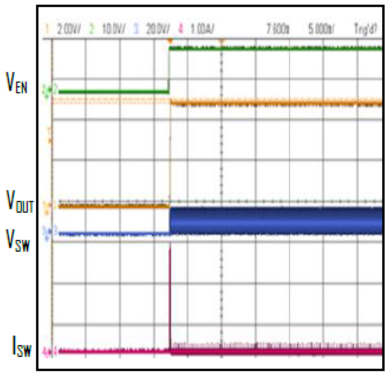


Max I_{OUT} Vs Temperature



Start-up Waveform with EN

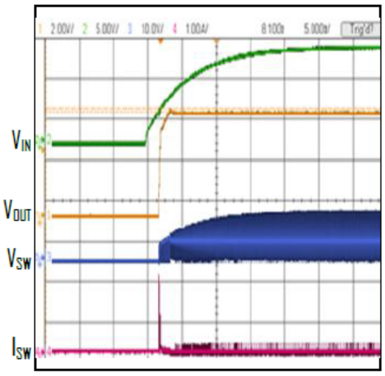
V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0A



5ms/div

Start-up Waveform with EN=V_{IN}

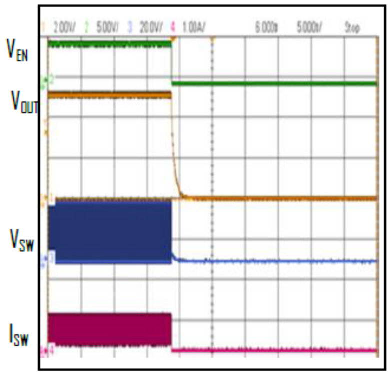
V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0A



5ms/div

Shutdown Waveform with EN

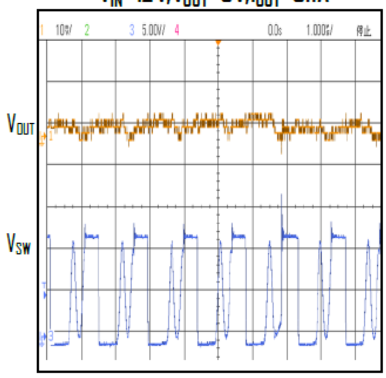
V_{IN}=30V, V_{OUT}=5V, I_{OUT}=0.5A



5ms/div

Switching Waveform

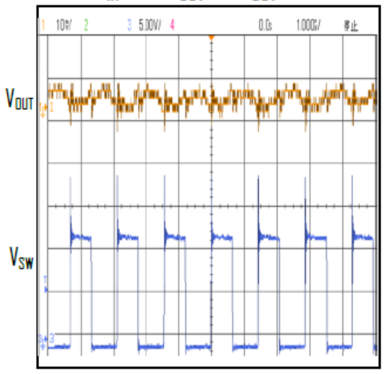
V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.1A



5ms/div

Switching Waveform

V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0.3A



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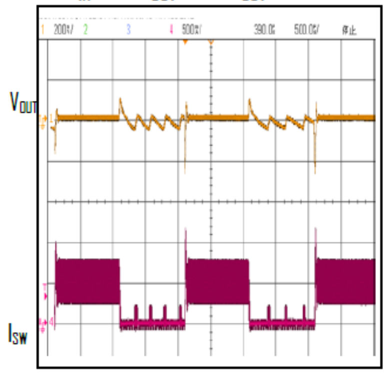
Load Transient Response

V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=0 to 0.5A



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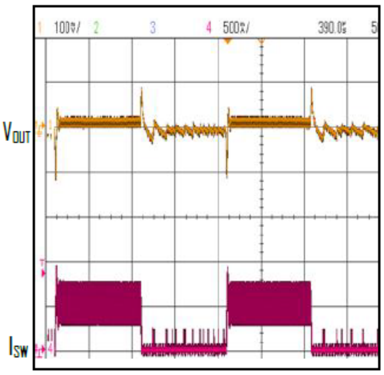
Load Transient Response

V_{IN}=12V, V_{OUT}=5V, I_{OUT}=0 to 0.5A



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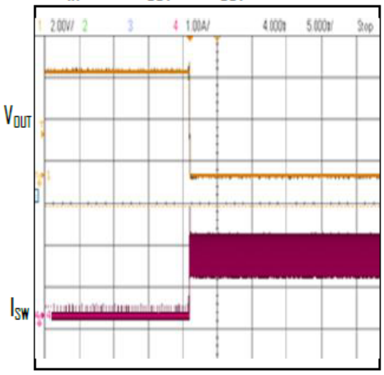
Short-Circuit Response

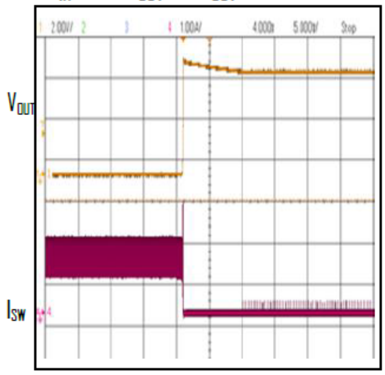
V_{IN}=24V, V_{OUT}=5V, I_{OUT}=0A to Short



5ms/div

Short-Circuit Recovery

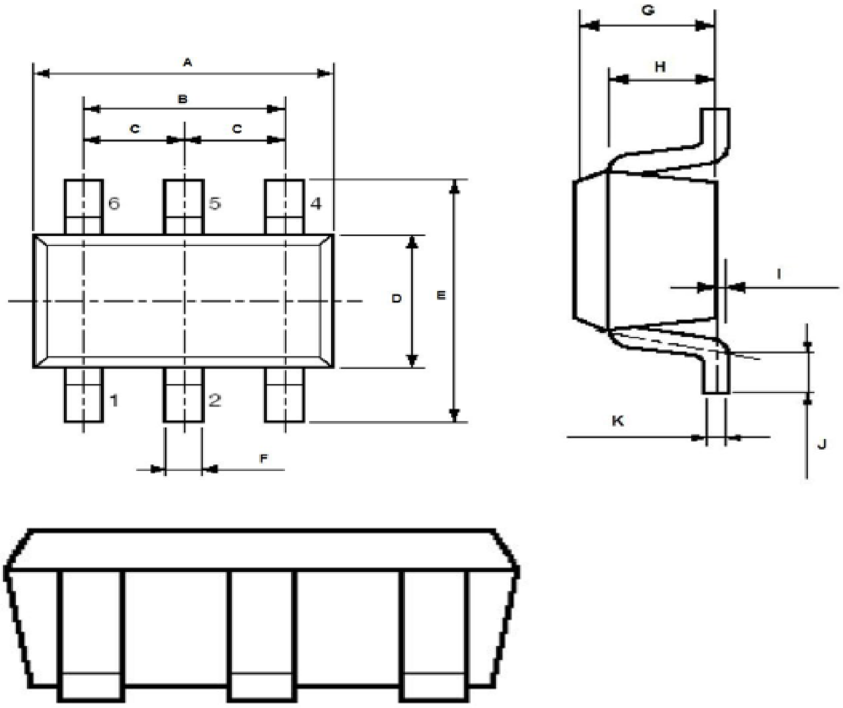
V_{IN}=24V, V_{OUT}=5V, I_{OUT}= Short to 0A



5ms/div

Packing Information

SOT-23-6



A	2.7	2.9	3.1
B	1.7	1.9	2.1
C	--	0.95	--
D	1.5	1.6	1.8
E	2.5	2.8	3.1
F	0.2	0.4	0.5
G	1	1.1	1.3
H	0.7	0.8	0.9
I	0	--	0.1
J	0.2	--	--
K	0.1	0.15	0.25

Notes

ACE does not assume any responsibility for use as critical components in life support devices or systems without the express written approval of the president and general counsel of ACE Electronics Co., LTD. As sued herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and shoes failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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