ACE725E

24V , 1.2A High Efficiency Step-Down Converter

Description

The ACE725E is a wide input range, high-efficiency, high frequency DC-to-DC step-down switching regulator, capable of delivering up to 1.2A of output current. With a fixed switching frequency of 1.4MHz, 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, while still providing low output ripples. Together with the tiny package ACE725E is in, without external compensation components, it is an ideal solution for system designer with stringent board space requirements. ACE725E 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.

ACE725E is available SOT23-6 Packages.

Features

- Wide Input Operating Range from 4.5V to 24V
- High Efficiency:Up to 94%
- Capable of Delivering 1.2A
- 1.4MHz Switching frequency
- No External Compensation Needed
- Current Mode control
- Logic Control Shutdown
- Thermal shutdown and UVLO
- Available in SOT23-6 Package

Application

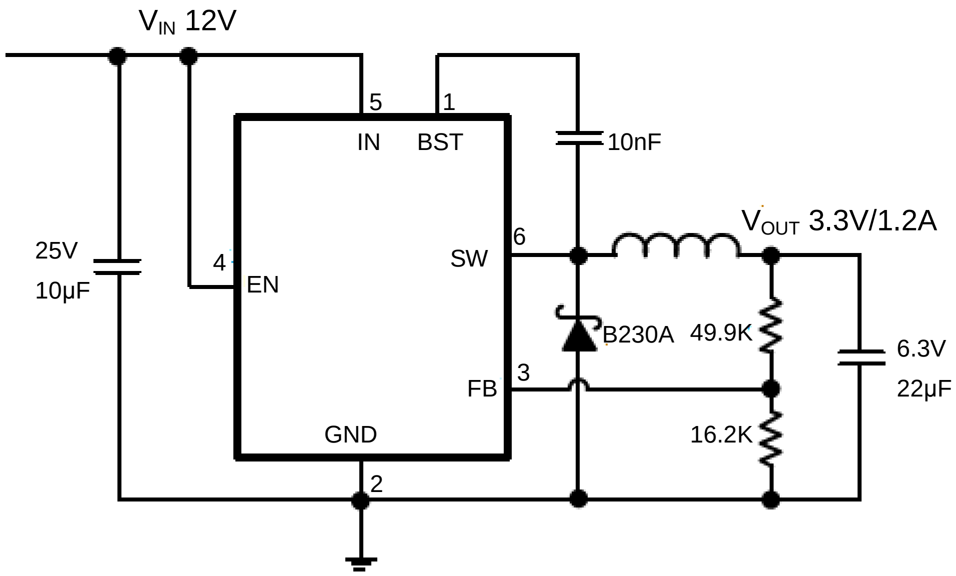
- Set top boxes
- Security Surveillance systems
- LED lighting

Absolute Maximum Rating

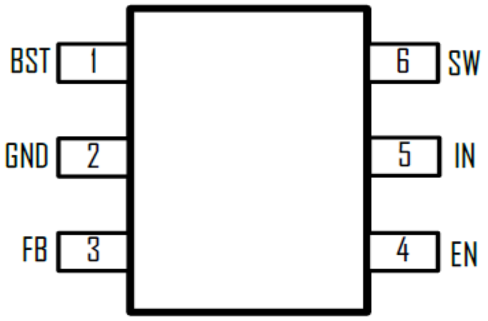
<table>
<tr><th colspan="2">Parameter</th><th colspan="3">Value</th></tr>
<tr><td colspan="2">IN Voltage</td><td colspan="3">–0.3V to 26V</td></tr>
<tr><td colspan="2">SW ,EN Voltage</td><td colspan="3">–0.3V to VIN+0.3</td></tr>
<tr><td colspan="2">BST Voltage</td><td colspan="3">–0.3V to SW+6V</td></tr>
<tr><td colspan="2">FB Voltage</td><td colspan="3">–0.3V to 6V</td></tr>
<tr><td colspan="2">SW to ground current</td><td colspan="3">Internally limited</td></tr>
<tr><td colspan="2">Operating Temperature Range</td><td colspan="3">–40°C to 85°C</td></tr>
<tr><td colspan="2">Storage Temperature Range</td><td colspan="3">.–55°C to 150°C</td></tr>
<tr><td rowspan="2">Thermal Resistance</td><td rowspan="2">SOT23-6</td><td>θ_{JA}</td><td>θ_{JC}</td><td></td></tr>
<tr><td>220</td><td>110</td><td>°C/W</td></tr>
</table>

(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

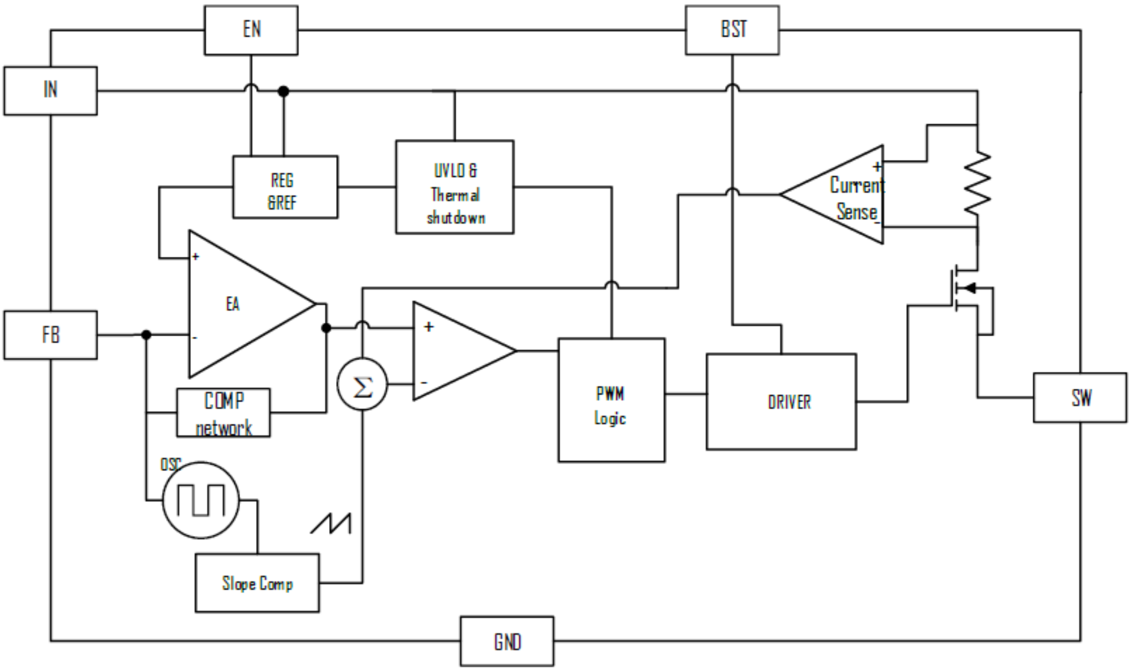
SOT-23-6	Description	Function
1	BST	Bootstrap pin. Connect a 10nF capacitor from this pin to SW.
2	GND	Ground
3	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set V_{OUT}
4	EN	Enable pin for the IC. Drive this pin high to enable the part, low to disable.
5	IN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

ACE725E XX + H

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

Block Diagram



Electrical Characteristics

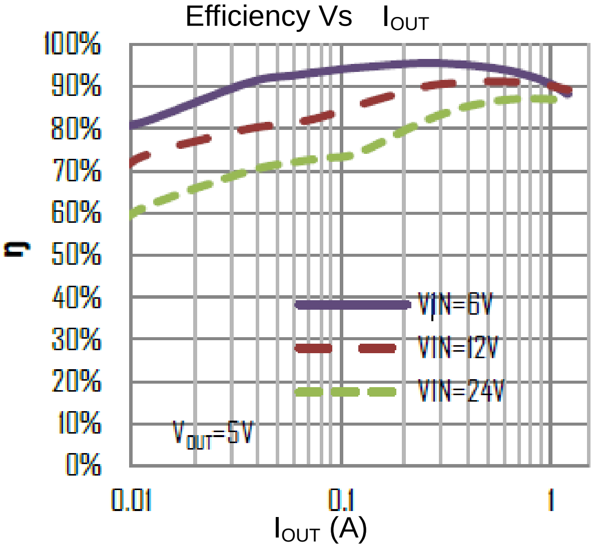
V_{IN} = 12V, unless otherwise specified. Typical values are at T_A=25°C

Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage Range		4.2		24	V
Input UVLO	Rising, Hysteresis=140mV		3.55		V
Input OVP	Rising, Hysteresis=1.3V		26		V
Input Supply Current	V_{FB}=0.9V		0.6		mA
Input Shutdown Current			6		uA
FB Feedback Voltage		0.79	0.81	0.83	V
FB Input Current			0.01		uA
Switching Frequency		1.0	1.4	1.8	MHz
Fold-Back Frequency	V_{FB}=0V		100		KHz
High side Switch ON Resistance	I_{SW}=200mA		250	500	mΩ
High side Switch Current Limit	V_{IN} = 12V,	1.5	2		A
SW Leakage Current	V_{IN}=12V, V_{SW}=0, EN=GND			10	uA
EN Input Current				1	uA
EN Input Low Voltage		1	1.5	3	V
Thermal Shutdown	Hysteresis=40℃		150		°C

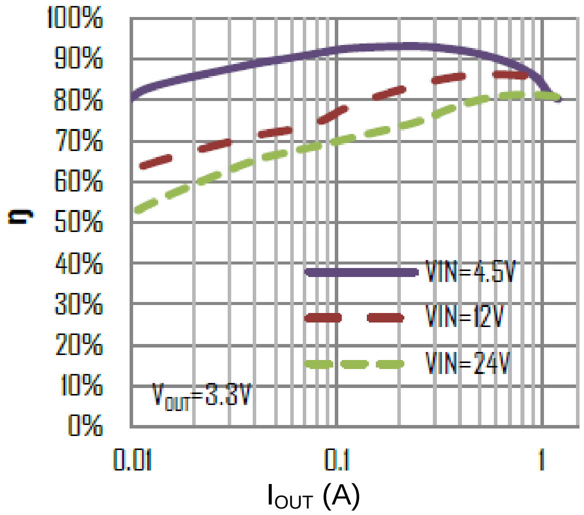
Typical Characteristics

(Typical values are at TA=25°C unless otherwise specified)

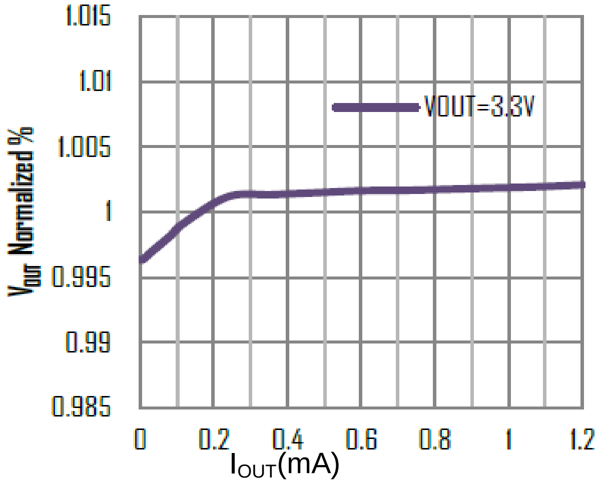
Efficiency Vs I_{OUT}



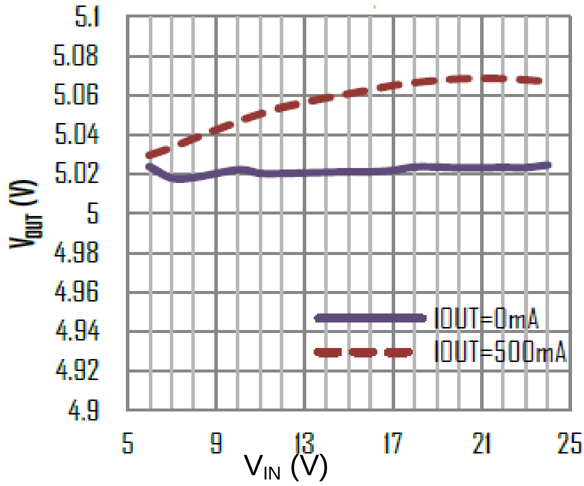
Efficiency Vs I_{OUT}



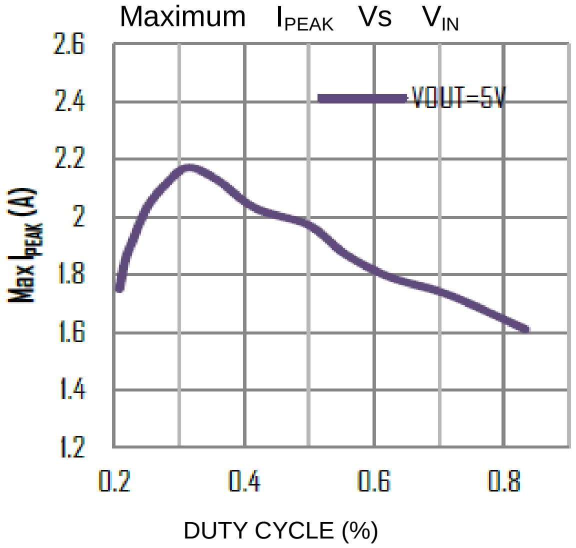
V_{OUT} Normalized % Vs I_{IOUT}



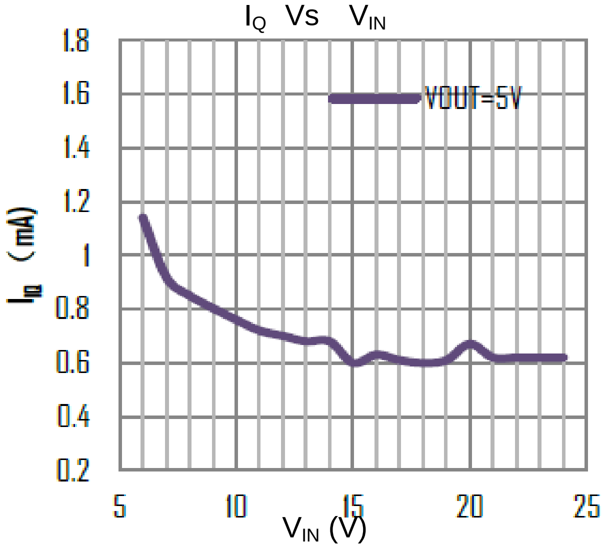
V_{OUT} Vs V_{IN}



Maximum I_{PEAK} Vs V_{IN}



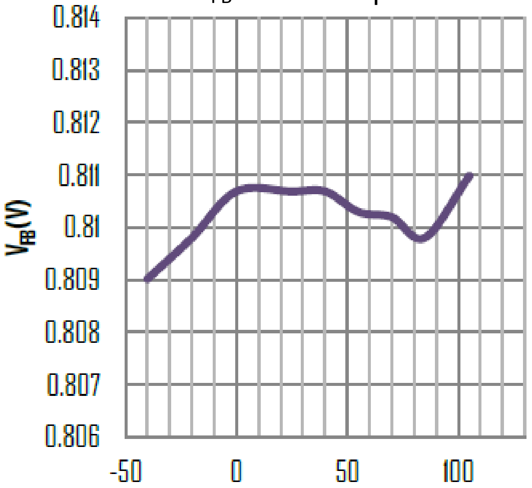
I_Q Vs V_{IN}



Typical Characteristics

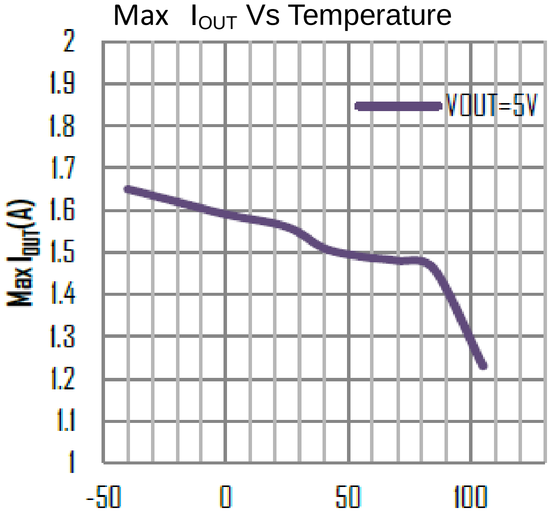
(Typical values are at TA=25°C unless otherwise specified)

V_{FB} Vs Temperature



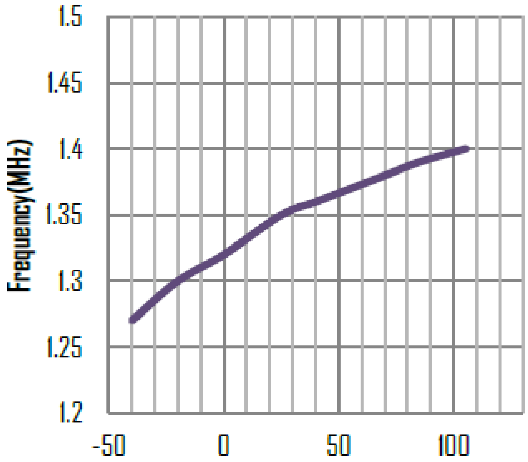
Temperature(℃)

Max I_{OUT} Vs Temperature



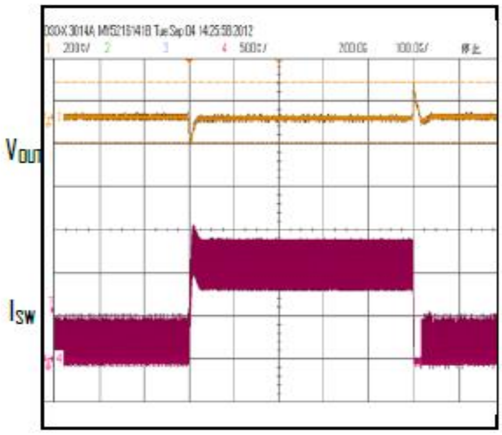
Temperature(℃)

Frequency Vs Temperature



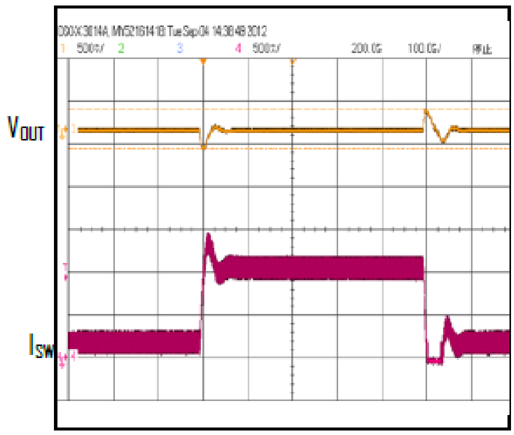
Temperature(℃)

Load Transient Response
Vin=12 V, VOUT=3.3V, IOUT= 0.2A to 1.0A



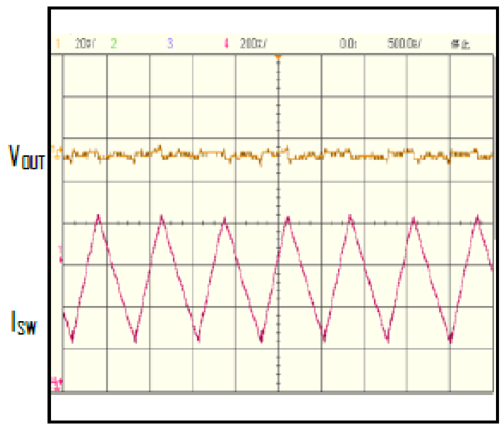
Ims/div

Load Transient Response
Vin=12 V, VOUT=5V, IOUT= 0.2A to 1.0A



2ms/div

Switching Waveform
Vin=12 V, VOUT=5V, IOUT= 0.5A

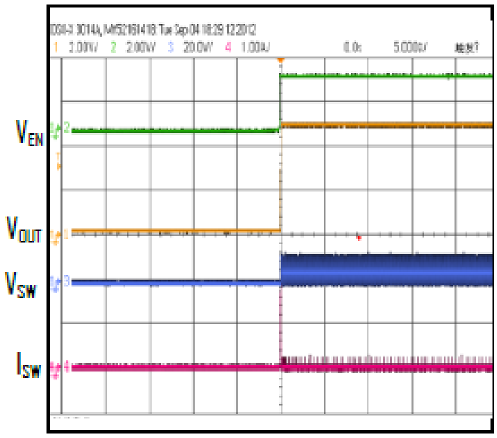


500ms/div

Typical Characteristics

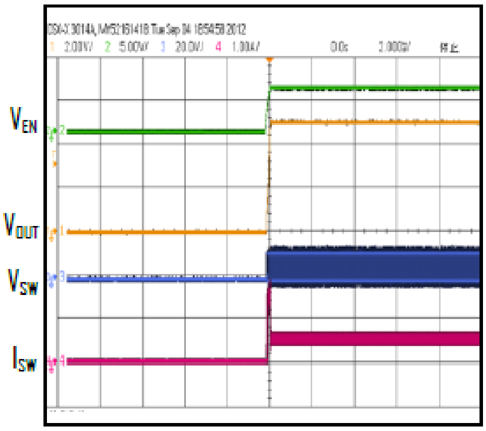
(Typical values are at TA=25°C unless otherwise specified)

Start-up Waveform through EN
Vin=12 V, VOUT=5V, IOUT= 0A



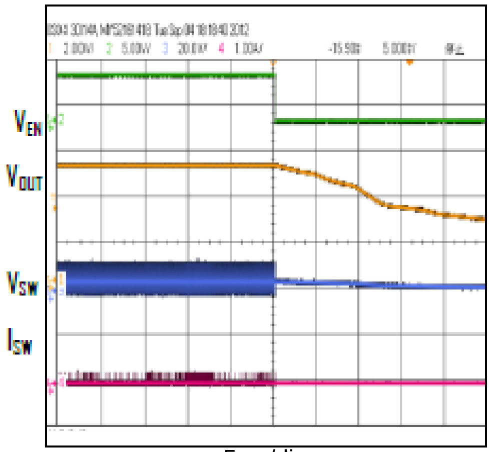
5ms/div

Start-up Waveform through EN
Vin=12 V, VOUT=5V, IOUT= 0.5A



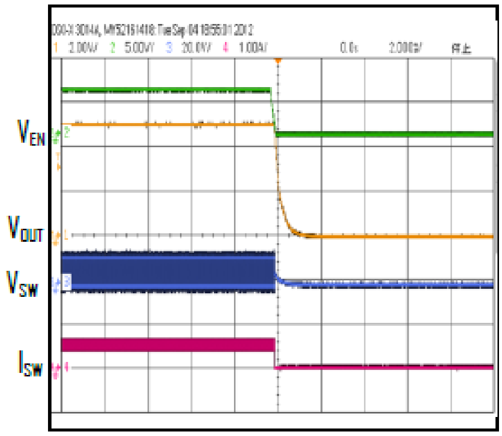
2ms/div

Shutdown Waveform through EN
Vin=12 V, VOUT=5V, IOUT= 0A



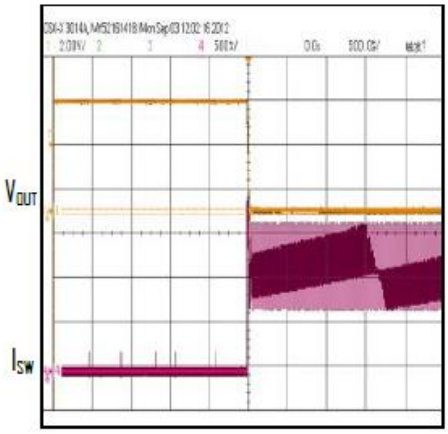
5ms/div

Shutdown Waveform through EN
Vin=12 V, VOUT=5V, IOUT=0.5A



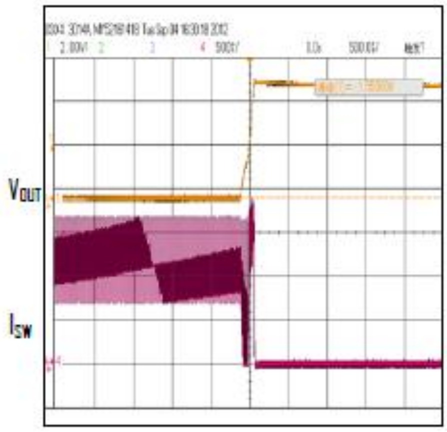
2ms/div

Short-Circuit Response
Vin=12 V, VOUT=5V, IOUT=0A to Short



0.5ms/div

Short-Circuit Recovery
Vin=12 V, VOUT=5V, IOUT=Short to 0A



0.5ms/div

FUNCTIONAL DECRIPTIONS

Loop Operation

The ACE725E is a wide input range, high-efficiency, DC-to-DC step-down switching regulator, capable of delivering up to 1.2A of output current, integrated with a 250m 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 t he 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. ACE725E 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 0.6V.
RTOP = RBOTTOM x [(VOUT / 0.6) - 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 1.2A maximum output current, the maximum inductor ripple current is 400 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 = 7μH.
Chose 6.8μH or 10μH
For V_{OUT} =3.3V,
The inductor values is calculated to be L = 4.9μH.
Chose 4.7μH

Output Capacitor Selection

For most applications a nominal 22μF or larger capacitor is suitable.

The ACE725E internal compensation is designed for a fixed corner frequency that is equal to

$$FC=\frac{1}{2*\pi\sqrt{COUT*L}}=20Khz$$

For example, for V_{OUT}=5V, L=6.8μH, 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

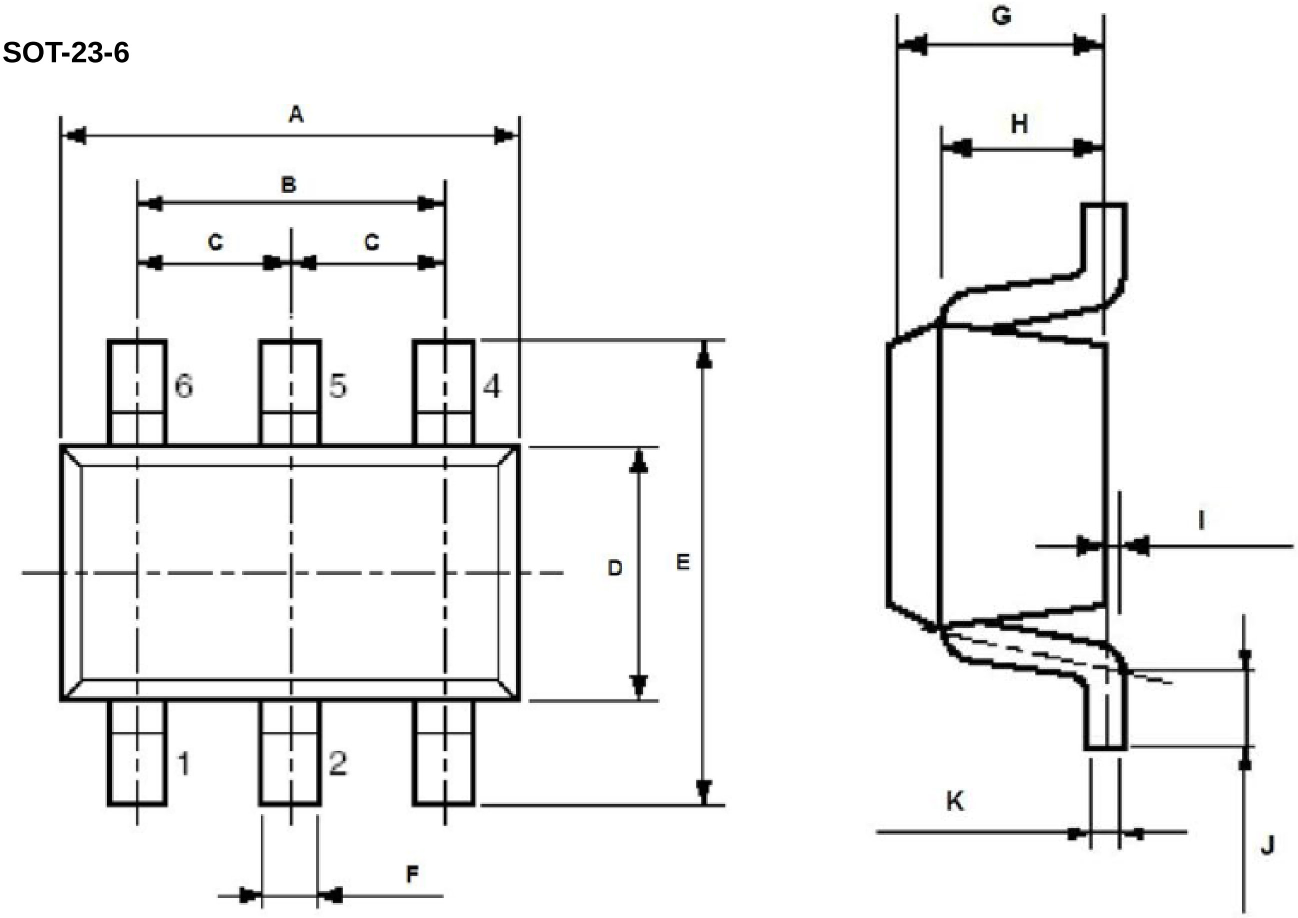
The input capacitor in a DC-to-DC converter reduces current peaks drawn from the battery or other input power source and reduces switching noise in the controller. The impedance of the input capacitor at the switching frequency should be less than that of the input source so high-frequency switching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

Components Selection

V_{OUT} (V)	C_{OUT} (μF)	L (μH)
8	22x2	10 to 15
5	22x2	6.8 to 10
3.3	22x2	4.7 to 10
2.5	22x2	3.3 to 10

Packing Information

SOT-23-6



SYMBL	MILLIMETER		
	MIN	NOM	MAX
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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