ACE721E

1A, 1.5MHz Step-Down Converter

Description

The ACE721E is a high-efficiency, DC-to-DC step-down switching regulator, capable of delivering up to 1A of output current. The devices operate from an input voltage range of 2.6V to 5.5V and provide output voltages from 0.6V to VIN, making the ACE721E ideal for low voltage power conversions. Running at a fixed frequency of 1.5MHz allows the use of small inductance value and low DCR inductors, thereby achieving higher efficiencies. Other external components, such as ceramic input and output caps, can also be small due to higher switching frequency, while maintaining exceptional low noise output voltages. Built-in EMI reduction circuitry makes this converter ideal power supply for RF applications. Internal soft-start control circuitry reduces inrush current. Short-circuit and thermal-overload protection improves design reliability.

Features

- Up to 96% Efficiency
- Up to 1A Max Output Current
- 1.5MHz Frequency
- Light Load operation
- Internal Compensation and Soft-Start
- Tiny SOT-23-5 DFN2x2-6 Package

Application

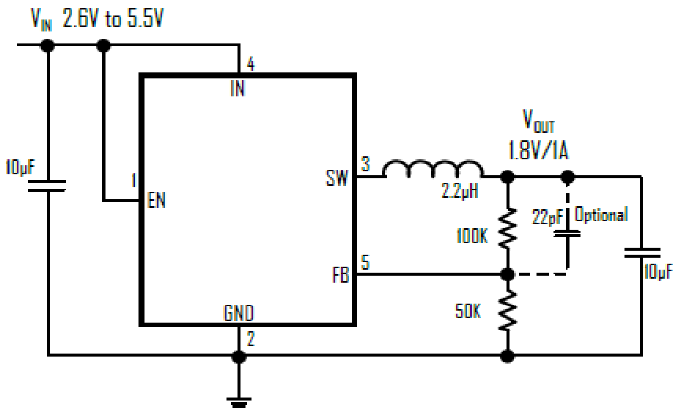
- MIDs, Tablet PC
- Set Top Boxes
- USB ports/Hubs
- Hot Swaps
- Cellphones
- Blue tooth.

Absolute Maximum Rating

Parameter		Value
IN, SW, FB, EN Voltage		-0.3V~6.5V
SW to ground current		Internally limited
Maximum Power Dissipation		400mW
Operating Temperature Range		-40°C~85°C
Storage Temperature Range		-55°C~150°C
Thermal Resistance	SOT23-5	400mW
Thermal Resistance	DFN2x2x6L	606mW

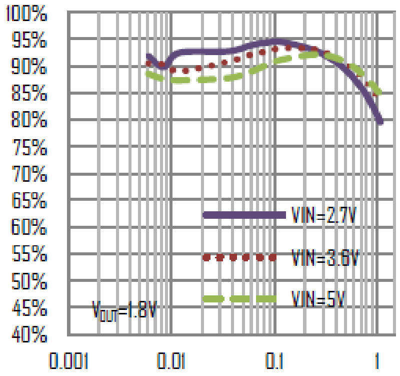
Note: Exceed these limits to damage to the device. Exposure to absolute maximum rating conditions may affect device reliability.

Typical Application

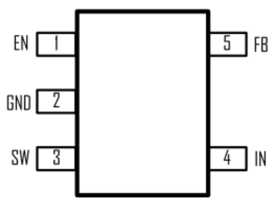


1.8V/1A 1.5MHz Step-Down Converter

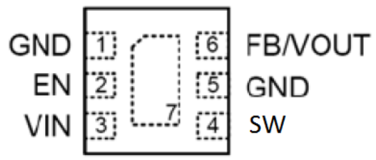
Efficiency Vs I_{OUT}



Packaging Type



SOT-23-5



(TOP VIEW)

DFN2*2-6L

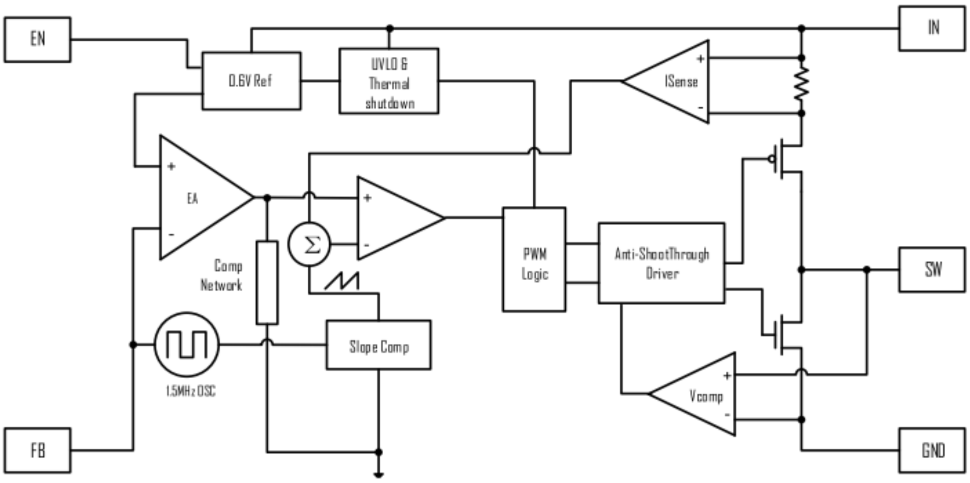
SOT-23-5	DFN2*2-6	Description	Function
1	2	EN	Enable pin for the IC. Drive this pin high to enable the part, low to disable.
2	1 / 5 / 7	GND	Ground
3	4	SW	Inductor Connection. Connect an inductor Between SW and the regulator output.
4	3	IN	Supply Voltage. Bypass with a 10μF ceramic capacitor to GND
5	6	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set the output to a voltage between 0.6V and VIN

Ordering information

ACE721E XX + H

- H: Halogen - free
- +: Pb - free
- XX: BN : SOT-23-5; MN: DFN2*2-6

Block Diagram



Electrical Characteristics

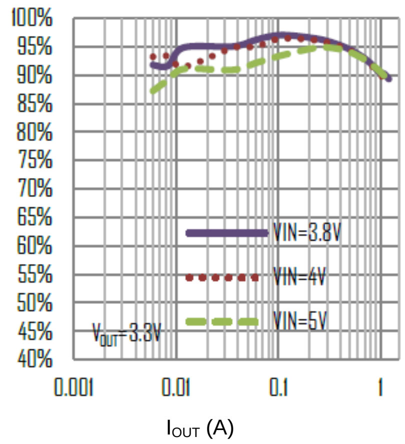
$V_{IN}=V_{EN}=5$, $T_A=25$℃

Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage Range		2.6		6	V
Input UVLO	Rising, Hysteresis=90mV	2.31	2.31	2.45	V
Input Supply Current	V_{FB} =0.65V		40	70	uA
Input Shutdown Current				1	uA
FB Feedback Voltage	V_{IN} =2.5 to 5V	0.588	0.6	0.612	V
FB Input Current			0.01		uA
Output Voltage Range		0.6		V_{IN}	V
Load Regulation	V_{OUT} =1.8V, I_{OUT} From 0.2A to 0.4A		0.1		%
Line Regulation	V_{IN} =2.7 to 5.5V		0.2		%V
Switching Frequency			1.5		MHz
NMOS Switch On Resistance	I_{SW} =200mA		200		mΩ
PMOS Switch On Resistance	I_{SW} =200mA		280		mΩ
PMOS Switch Current Limit		1.5			A
SW Leakage Current	V_{IN}=5.5V,V_{SW}=0 or 5.5V,EN= GND			10	uA
EN Input Current				1	uA
EN Input Low Voltage		0.4			V
EN Input High Voltage				1.5	V

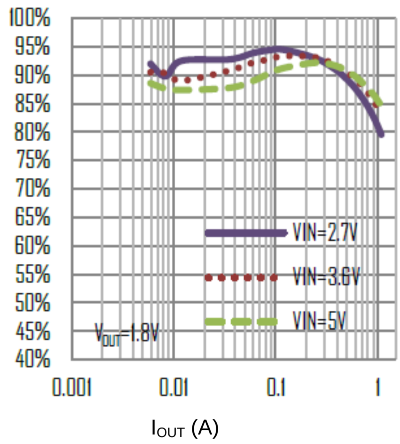
Typical Characteristics

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

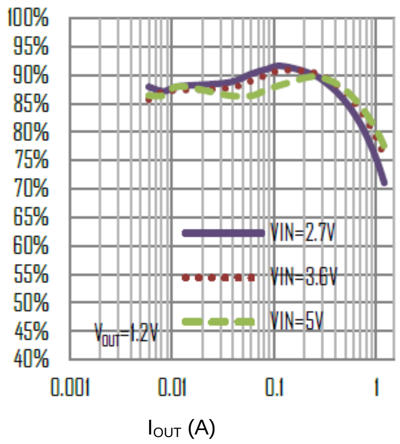
Efficiency Vs I_{OUT}



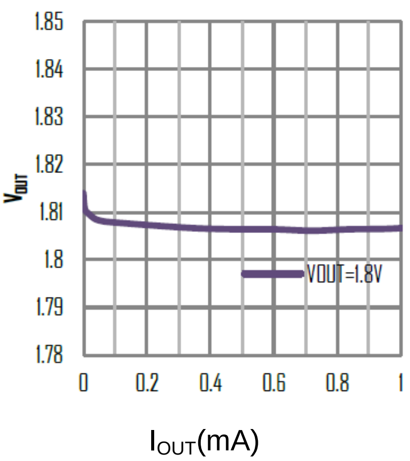
Efficiency Vs I_{OUT}



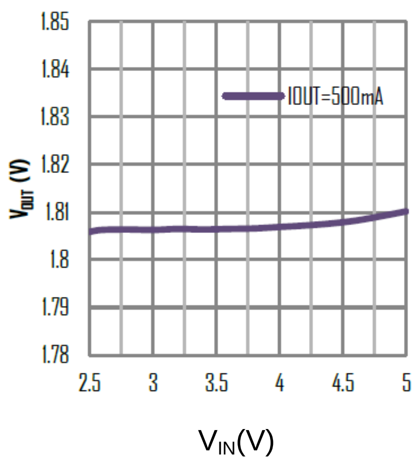
Efficiency Vs I_{OUT}



V_{OUT} VS I_{OUT}

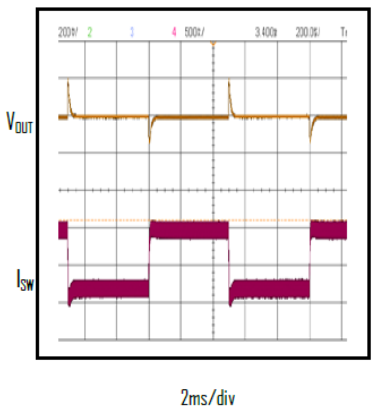


V_{OUT} Vs V_{IN}



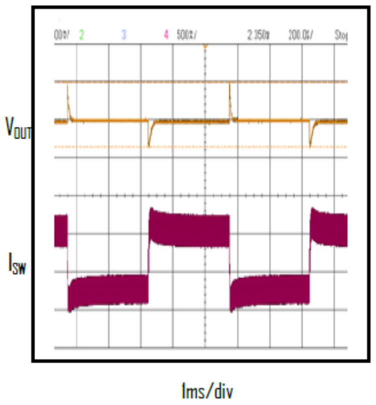
Load Transient Response

V_{IN}=3.6V,V_{OUT}=1.2V,I_{OUT}=0.2A to 1A



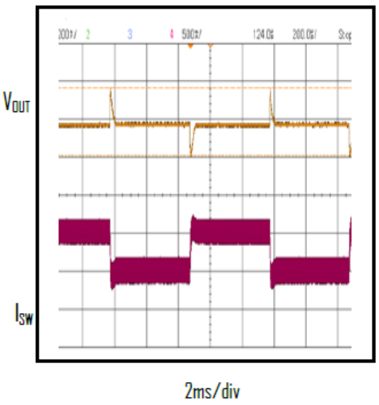
Load Transient Response

V_{IN}=3.6V, V_{OUT}=1.8V, I_{OUT}=0.2A to 1A



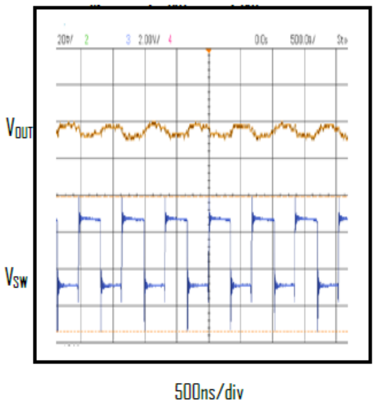
Load Transient Response

V_{IN}=5V, V_{OUT}=3.3V, I_{OUT}=0.5A to 1A



Heavy Load Switching Waveform

V_{IN}=3.6V, V_{OUT}=1.8V, I_{OUT}=0.5A

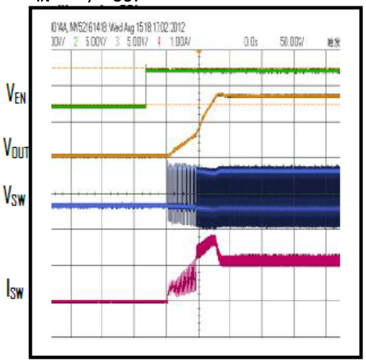


Typical Characteristics

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

Startup Waveform with EN Turn on

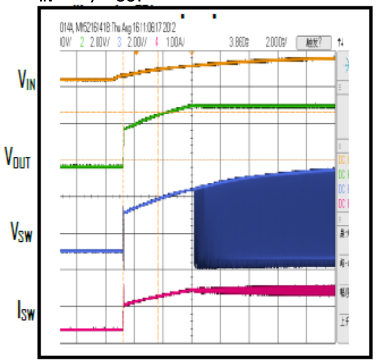
V_{IN}=5V, V_{OUT}=3.3V Into 1A Resistive



50μs/div

Startup Waveform with EN Tied to IN

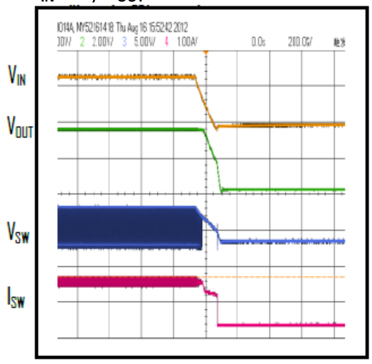
V_{IN}=5V, V_{OUT}=3.3V Into 1A Resistive



2ms/div

Startup Waveform with EN Turn on

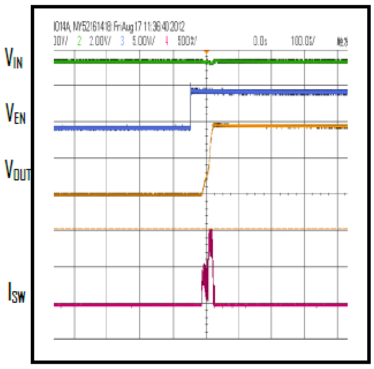
V_{IN}=5V, V_{OUT}=3.3V 1A Resistive Load



200μs/div

Startup Waveform with EN Tied to IN

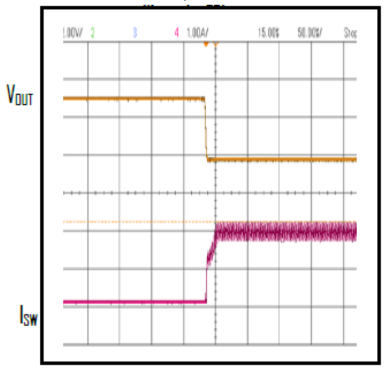
V_{IN}=5V, V_{OUT}=1.8V Into NoLoad



100μs/div

Short Circuit Response

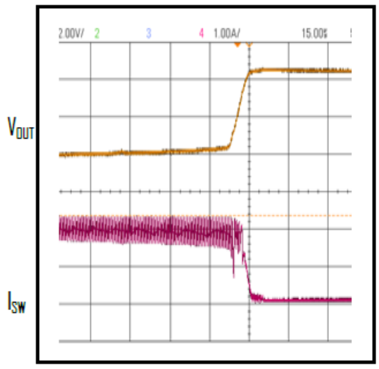
V_{IN}=5V, V_{OUT}=3.3V



50μs/div

Short Circuit Recovery

V_{IN}=5V,V_{OUT}=3.3V



50μs/div

FUNCTION DESCRIPTION

The ACE721E high efficiency switching regulator is a small, simple, DC-to-DC step-down converter capable of delivering up to 1A of output current. The device operates in pulse-width modulation (PWM) at 1.5MHz from a 2.6V to 5.5V input voltage and provides an output voltage from 0.6V to VIN, making the ACE721E ideal for on-board post-regulation applications. An internal synchronous rectifier improves efficiency and eliminates the typical Schottky free-wheeling diode. Using the on resistance of the internal high-side MOSFET to sense switching currents eliminates current-sense resistors, further improving efficiency and cost.

Loop Operation

ACE721E uses a PWM current-mode control scheme. An open-loop comparator compares the integrated voltage-feedback signal against the sum of the amplified current-sense signal and the slope compensation ramp. At each rising edge of the internal clock, the internal high-side MOSFET turns on

until the PWM comparator terminates the on cycle. During this on -time, current ramps up through the inductor, sourcing current to the output and storing energy in the inductor. The current mode feedback system regulates the peak inductor current as a function of the output voltage error signal. During the off cycle, the internal high –side P-channel MOSFET turns off, and the internal low-side N-channel MOSFET turns on. The inductor releases the stored energy as its current ramps down while still providing current to the output.

Current Sense

An internal current-sense amplifier senses the current through the high-side MOSFET during on time and produces a proportional current signal, which is used to sum with the slope compensation signal. The summed signal then is compared with the error amplifier output by the PWM comparator to terminate the on cycle.

Current Limit

There is a cycle-by-cycle current limit on the high-side MOSFET. When the current flowing out of SW exceeds this limit, the high-side MOSFET turns off and the synchronous rectifier turns on. ACE721E utilizes a frequency fold-back mode to prevent overheating during short-circuit output conditions. The device enters frequency fold-back mode when the FB voltage drops below 200mV, limiting the current to I_{PEAK} and reducing power dissipation. Normal operation resumes upon removal of the short-circuit condition.

Soft-start

ACE721E has an internal soft-start circuitry to reduce supply inrush current during startup conditions. When the device exits under-voltage lockout (UVLO), shutdown mode, or restarts following a thermal-overload event, the l soft-start circuitry slowly ramps up current available at SW.

UVLO and Thermal Shutdown

If IN drops below 2.4V, the UVLO circuit inhibits switching. Once IN rises above 2.6V, the UVLO clears, and the soft-start sequence activates. Thermal-overload protection limits total power dissipation in the device. When the junction temperature exceeds TJ=+160°C, a thermal sensor forces the device into shutdown, allowing the die to cool. The thermal sensor turns the device on again after the junction temperature cools by 15°C, resulting in a pulsed output during continuous overload conditions. Following a thermal-shutdown condition, the soft-start sequence begins.

DESIGN PROCEDURE

Setting Output Voltages

Output voltages are set by external resistors. The FB threshold is 0.6V.

$R_{TOP} = R_{BOTTOM} \times [(V_{OUT} / 0.6) - 1]$

Input Capacitor and Output 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. Input ripple with a ceramic capacitor is approximately as follows:

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

If the capacitor has significant ESR, the output ripple component due to capacitor ESR is as follows: $V_{RIPPLE(ESR)} = IL_{(PEAK)} \times ESR$

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.

Inductor Selection

A reasonable inductor value (LIDEAL) can be derived from the following:

$L_{IDEAL} = [2(VIN) \times D(1 - D)] / I_{OUT} \times f_{OSC}$

PCB LAYOUT GUIDE

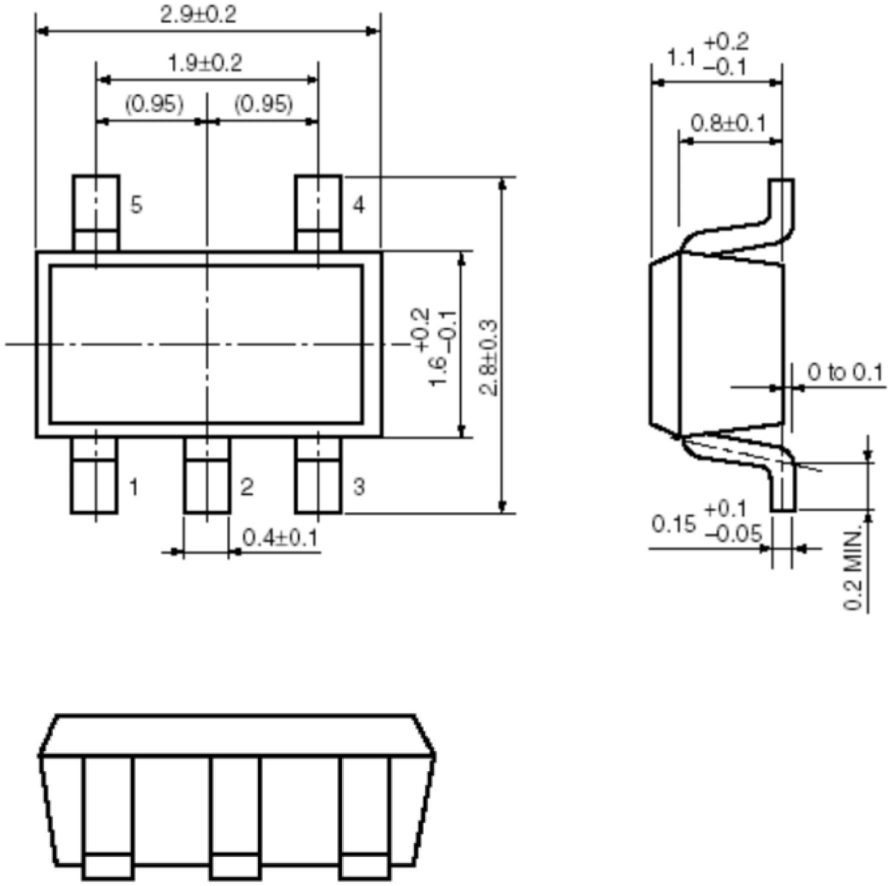
PCB layout is very important to achieve stable operation. It is highly recommended to duplicate EVB layout for optimum performance.

If change is necessary, please follow these guidelines and take Figure for reference.

1) Keep the path of switching current short and minimize the loop area formed by input cap, high-side MOSFET and low-side MOSFET.
2) Bypass ceramic capacitors are suggested to be put close to the Vin pin.
3) Ensure all feedback connections are short and direct. Place the feedback resistors and compensation components as close to the chip as possible.
4) Rout SW away from sensitive analog areas such as FB.
5) Connect IN, SW, and especially GND respectively to a large copper area to cool the chip to improve thermal performance and long-term reliability.

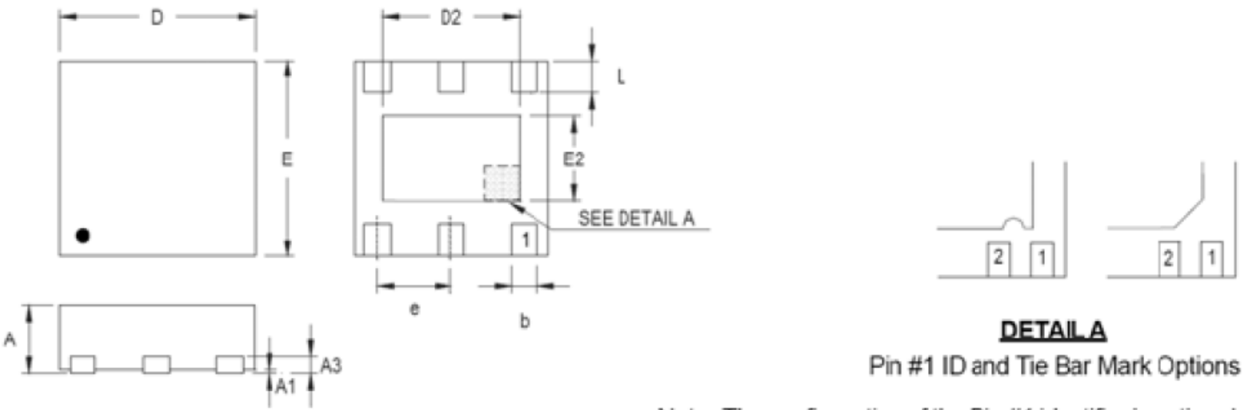
Packing Information

SOT-23-5



Packing Information

DFN2x2-6L



DETAIL A
Pin #1 ID and Tie Bar Mark Options

Note : The configuration of the Pin #1 identifier is optional, but must be located within the zone indicated.

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.175	0.250	0.007	0.010
b	0.200	0.350	0.008	0.014
D	1.950	2.050	0.077	0.081
D2	1.000	1.450	0.039	0.057
E	1.950	2.050	0.077	0.081
E2	0.500	0.850	0.020	0.033
e	0.650		0.026	
L	0.300	0.400	0.012	0.016

Notes

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http://www.ace-ele.com/