



# ACE719E

## 3W, 0.85V Startup Voltage, Synchronous Step-Up Converter with Real-Shutdown and Short-Circuit Protection

### Description

The ACE719E is a high efficiency synchronous step-up converter that can provide up to 3W of power to a boosted output from a low voltage source. Unlike most step-up converter, not only it starts up at a very low input voltage as low as 0.85V, it also incorporates circuits that disconnect the input from output, during shutdown, short-circuit, output current overloading, or other events when output is higher than the input. This eliminates the need for an external MOSFET and its control circuitry to disconnect the input from output, and provides robust output overload protection.

The ACE719E starts up from a voltage as low as 0.85V making it ideal for applications with single-cell or two-cell alkaline, NiCd, and NiMh batteries. A switching frequency of 2MHz minimizes solution footprint by allowing the use of tiny and low profile inductors and ceramic capacitors. An internal synchronous MOSFET provides highest efficiency and with a current mode control that is internally compensated, external parts count is reduced to minimal.

### Features

- Output Disconnect
- Short-circuit Protection
- 3W Output Power
- Output to Input Reversed Current Protection
- 0.85V Low Start-up Voltage
- VIN range from 0.6V to 4.5V
- Up to 96% Efficiency
- 40 $\mu$ A No load IQ and light load PFM Mode
- Internal Synchronous Rectifier
- Current Mode control
- Logic Control Shutdown and Thermal shutdown
- DFN2x2-6 Package

### Application

- USB OTG for MIDs, Smartphones
- Mobile back-up Battery Chargers
- Alkaline, NiCd, and NiMh batteries applications
- USB powered devices



# ACE719E

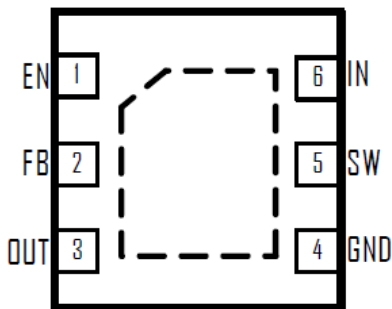
## 3W, 0.85V Startup Voltage, Synchronous Step-Up Converter with Real-Shutdown and Short-Circuit Protection

### Absolute Maximum Ratings

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

| Parameter                      | Value                                  |
|--------------------------------|--|
| SW Voltage                     | -0.3V~5.5V                             |
| All Other PIN Voltages         | -0.3V~5V                               |
| SW to ground current           | Internally limited                     |
| Operating Temperature Range    | -40°C ~85°C                            |
| Storage Temperature Range      | -55°C ~150°C                           |
| Thermal Resistance<br>DFN2x2-6 | $\Theta_{JA}$ 80 $\Theta_{JC}$ 30 °C/W |

### Packaging Type



DFN2x2-6

| PIN # | NAME | DESCRIPTION   |
|-------|------|---|
| 1     | EN   | Enable pin for the IC. Drive this pin high to enable the part, low to disable.                      |
| 2     | FB   | Feedback Input. Connect an external resistor divider from the output to FB and GND to set $V_{OUT}$ |
| 3     | OUT  | Output pin. Bypass with a 22 $\mu$ F or larger ceramic capacitor closely between this pin and GND   |
| 4     | GND  | Ground Pin  |
| 5     | SW   | Inductor Connection. Connect an inductor Between SW and the regulator output.                       |
| 6     | IN   | Input Supply Voltage. Bypass with a 4.7 $\mu$ F ceramic capacitor to GND                            |

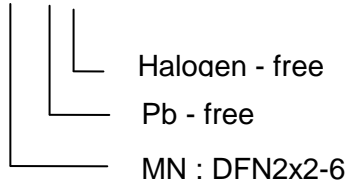


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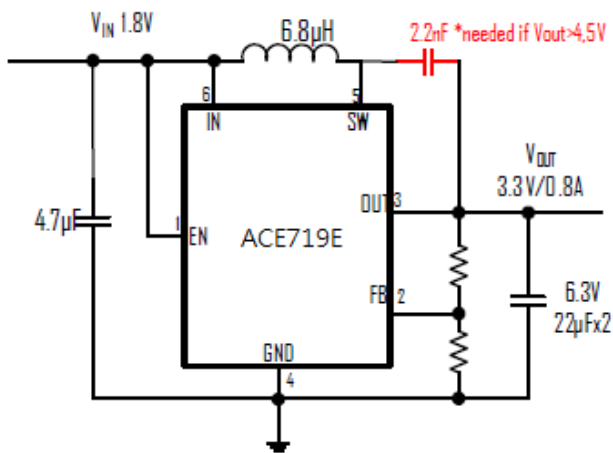
3W, 0.85V Startup Voltage, Synchronous Step-Up Converter  
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## Ordering information

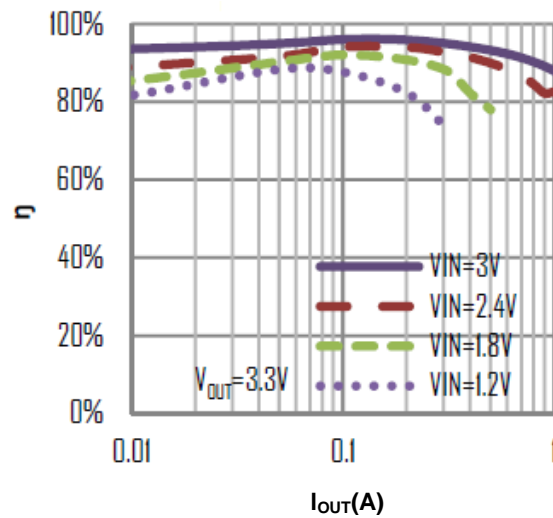
ACE719E XX + H



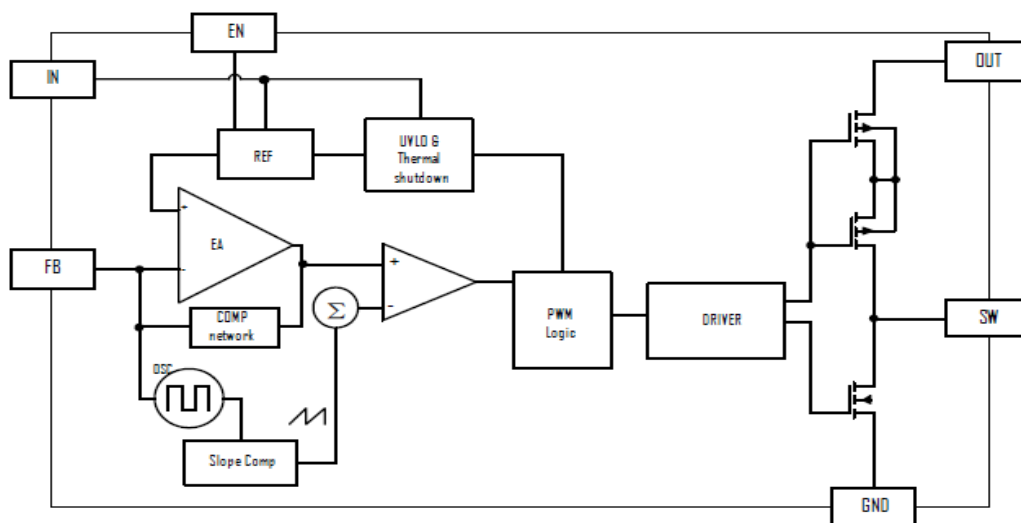
## Typical Application



Efficiency Vs I<sub>OUT</sub>



## Block Diagram





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## 3W, 0.85V Startup Voltage, Synchronous Step-Up Converter with Real-Shutdown and Short-Circuit Protection

### Electrical Characteristics

( $V_{IN} = 1.8V$ ,  $V_{OUT} = 3.3V$ , unless otherwise specified. Typical values are at  $T_A = 25^{\circ}C$ .)

| Parameter                               | Conditions                                       | Min   | Typ  | Max   | Units       |
|---|--|-------|------|-------|-------------|
| Minimum Input Voltage                   |  |       | 0.6  |       | V           |
| Startup Voltage                         | $I_{OUT}=0A$                                     |       | 0.85 | 1.1   | V           |
| FB Feedback Voltage                     | $V_{OUT} = 2.1$ to $5V$                          | 0.582 | 0.6  | 0.618 | V           |
| FB Input Current                        |  |       |      | 50    | nA          |
| Output Voltage Range                    | External divider                                 | 2.1   |      | 5     | V           |
| Quiescent Current at IN                 | $V_{FB}=0.7V$                                    |       | 40   |       | $\mu A$     |
| Shutdown Supply Current at IN           | $V_{EN}=GND$                                     |       | 0.5  | 5     | $\mu A$     |
| Switching Frequency                     | $V_{IN}<4.3V$                                    | 1.2   | 2    | 2.4   | MHz         |
| Maximum Duty Cycle                      |  | 90    |      |       | %           |
| NMOS Switch On Resistance               | $I_{SW} = 100mA$                                 |       | 0.15 | 0.35  | $\Omega$    |
| PMOS Switch On Resistance               | $I_{SW} = 100mA$                                 |       | 0.15 | 0.35  | $\Omega$    |
| NMOS Switch Current Limit               |  | 1.2   | 1.5  |       | A           |
| Start-up Current Limit                  |  |       | 0.5  |       | A           |
| Output to Input Reverse Leakage Current | $V_{EN}=GND$ , Measure at IN pin                 |       | 0.1  | 5     | $\mu A$     |
| SW Leakage Current                      | $V_{OUT}=5V, V_{SW}=0$ or $5V$ ,<br>$V_{EN}=GND$ |       |      | 10    | $\mu A$     |
| EN Input Current                        |  |       | 0.1  | 1     | $\mu A$     |
| EN Input Low Voltage                    |  |       |      | 0.3   | V           |
| EN Input High Voltage                   |  | 0.6   |      |       | V           |
| Thermal Shutdown                        | Rising, Hysteresis= $10^{\circ}C$                |       | 165  |       | $^{\circ}C$ |

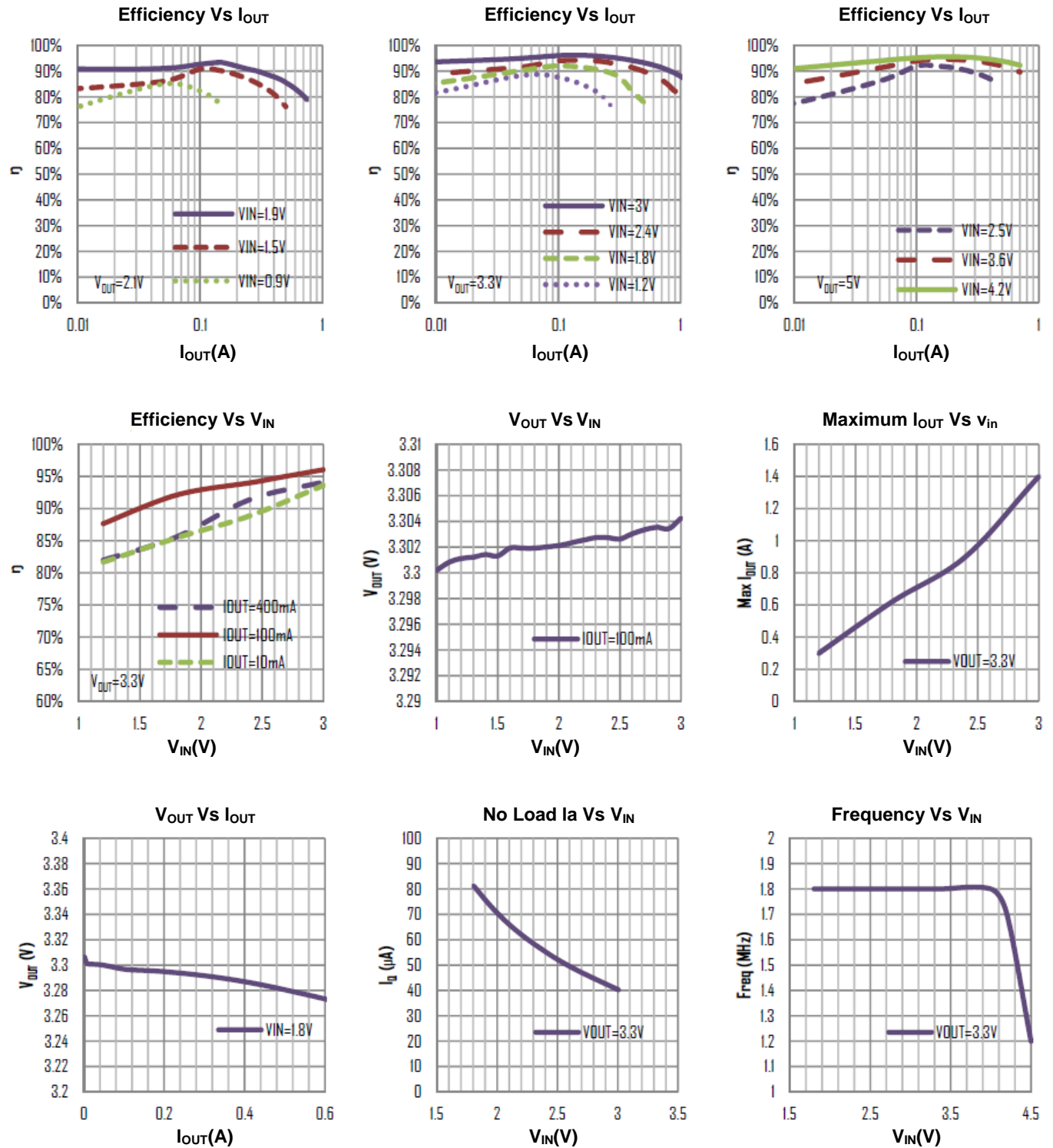


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## 3W, 0.85V Startup Voltage, Synchronous Step-Up Converter with Real-Shutdown and Short-Circuit Protection

### Typical Characteristics

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

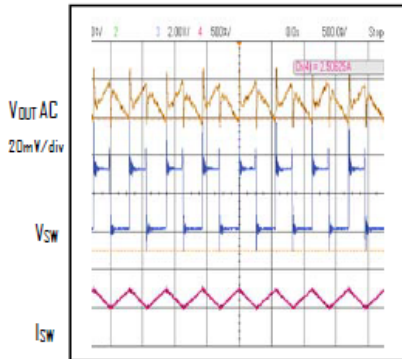




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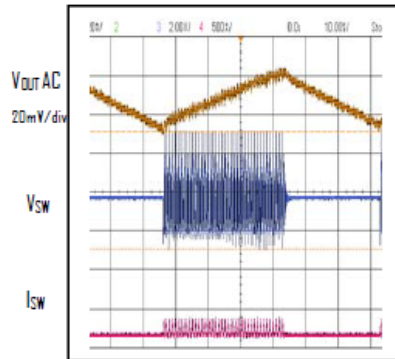
## 3W, 0.85V Startup Voltage, Synchronous Step-Up Converter with Real-Shutdown and Short-Circuit Protection

**Heavy load Switching Waveform**  
 $V_{IN}=1.8V$   $V_{OUT}=3.3V$   $I_{OUT}=500mA$



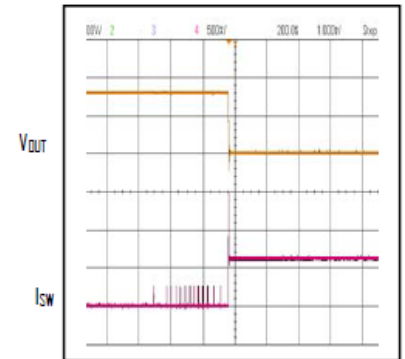
500ns/div

**Light load Switching Waveform**  
 $V_{IN}=1.8V$   $V_{OUT}=3.3V$   $I_{OUT}=10mA$



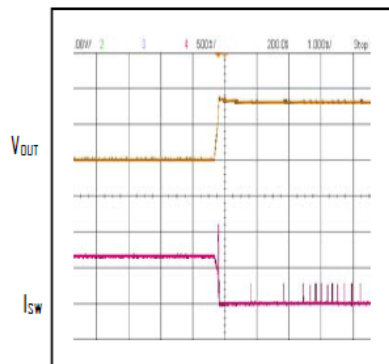
100ms/div

**Short-Circuit Response**  
 $V_{IN}=3V$   $V_{OUT}=3.3V$



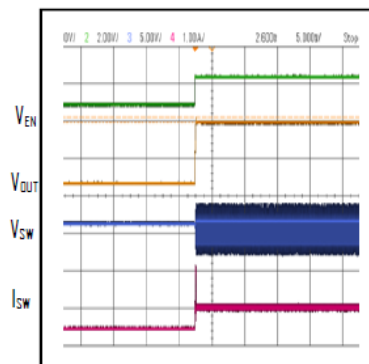
200µs/div

**Short-Circuit Recovery**  
 $V_{IN}=3V$   $V_{OUT}=3.3V$



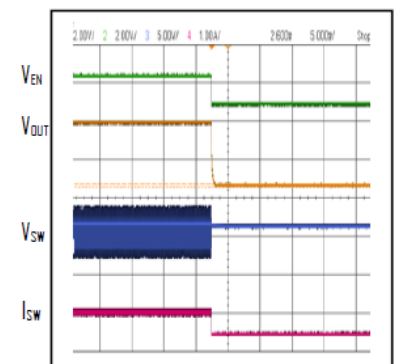
500ns/div

**Star-Up Waveform**  
 $V_{IN}=3.0V$   $V_{OUT}=3.3V$   $I_{OUT}=500mA$



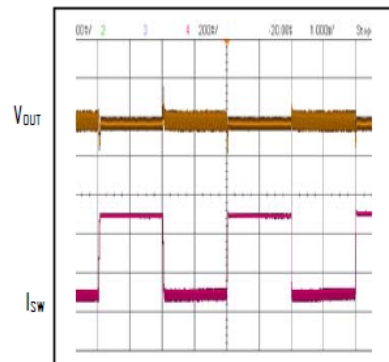
5ms/div

**Shut Down Waveform**  
 $V_{IN}=3.0V$   $V_{OUT}=3.3V$   $I_{OUT}=500mA$



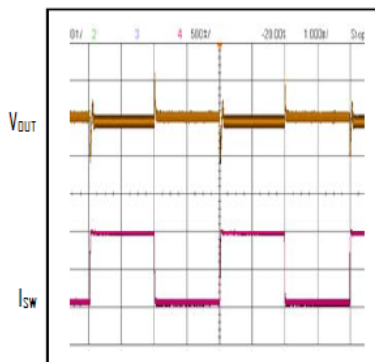
5ms/div

**Load Transient Response**  
 $V_{IN}=3V$   $V_{OUT}=3.3V$   $I_{OUT}=0.1A$  to  $0.5A$



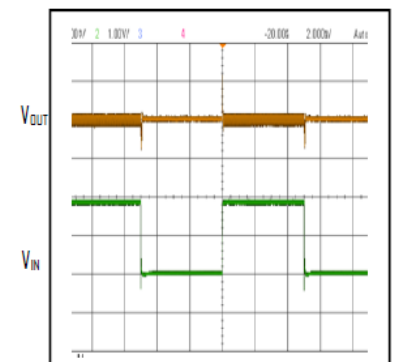
1ms/div

**Load Transient Response**  
 $V_{IN}=3V$   $V_{OUT}=3.3V$   $I_{OUT}=0.1A$  to  $1A$



1ms/div

**Line Transient Response**  
 $V_{OUT}=3.3V$   $I_{OUT}=100mA$   $V_{IN}=1.2V$  to  $3V$



2ms/div



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### FUNCTIONAL DESCRIPTIONS

#### Loop Operation

The ACE719E is a wide input range, high-efficiency, DC-to-DC step-up switching regulator, capable of delivering up to 3W of output power, integrated with a 150mΩ high side MOSFET and 150 mΩ synchronous rectifier. 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 RDS(ON)s of the MOSFETs and parasitic capacitances. At light load, this loss is prominent and efficiency is therefore very low. ACE719E 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.

#### Short-Circuit Protection

Unlike most step-up converters, the ACE719E allows for short circuits on the output. In the event of a short circuit, the device first turns off the NMOS when the sensed current reaches the current limit. After  $V_{OUT}$  drops below  $V_{IN}$  the device then enters a linear charge period with the current limited same as with the start-up period. In addition, the thermal shutdown circuits disable switching if the die temperature rises above 165°C.

#### Down Mode ( $V_{IN} > V_{OUT}$ ) Operation

The ACE719E will continue to supply the output voltage even when the input voltage exceeds the output voltage. Since the PMOS no longer acts as a low-impedance switch in this mode, power dissipation increases within the IC to cause a sharp drop in efficiency. Limit the maximum output current to maintain an acceptable junction temperature.

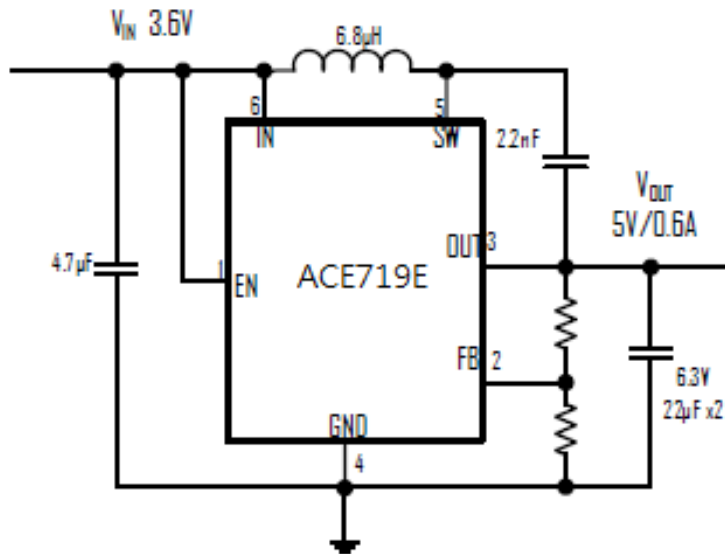


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### 5V APPLICATIONS

When output voltage is programmed to above 4.5V, in order to maintain an acceptable peak voltage at SW, a small parallel capacitor snubber between SW and OUT is necessary, and an output cap of greater than 44 $\mu$ F is also required as shown in below figure.





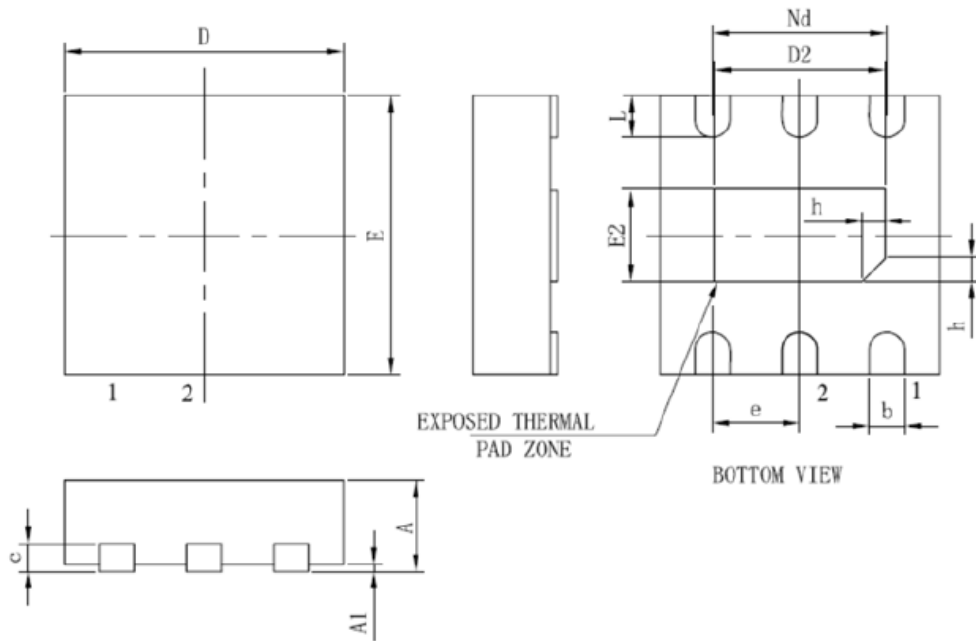


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## Packing Information

### DFN2x2-6



| SYMBOL | MILLIMETER |      |      |
|--------|------------|------|------|
|        | MIN        | NOM  | MAX  |
| A      | 0.70       | 0.75 | 0.80 |
| A1     |            | 0.02 | 0.05 |
| b      | 0.25       | 0.30 | 0.35 |
| c      | 0.18       | 0.20 | 0.25 |
| D      | 1.95       | 2.00 | 2.05 |
| D2     | 1.00       |      | 1.45 |
| e      | 0.65BSC    |      |      |
| Nd     | 1.30BSC    |      |      |
| E      | 1.95       | 2.00 | 2.05 |
| E2     | 0.50       |      | 0.85 |
| L      | 0.25       | 0.30 | 0.40 |
| h      | 0.10       | 0.15 | 0.20 |



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#### 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 whose 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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