ACE732E

6V/3.5A, Fast Response, Step-Down Converter

Description

ACE732E belongs to a new breed of high frequency synchronous Step-Down converter that combines the advantages of voltage mode control and Constant-On-Time control. Its adaptive Constant-On-Time control dynamically changes switch on time to achieve a constant switching frequency. It does not have the minimum on-time constrain normally a fixed-frequency current mode Step-down requires, allowing it to go down to very low duty ratio without affecting loop stability. The voltage mode nature of ACE732E also provides a more superior load transient response and a seamless transition from PFM to PWM modes. ACE732E is capable of supplying output with current up to 3.5A at 1.2V output. All these features make ACE732E an excellent choice for ARM based CPU power supply.

Features

- Adaptive COT control
- Up to 95% Efficiency
- Up to 91% Efficiency for low output voltage
- Up to 3.5A Max Output current
- Feedback voltage 0.45V
- Excellent load transient response
- DFN2X2-8L Package

Application

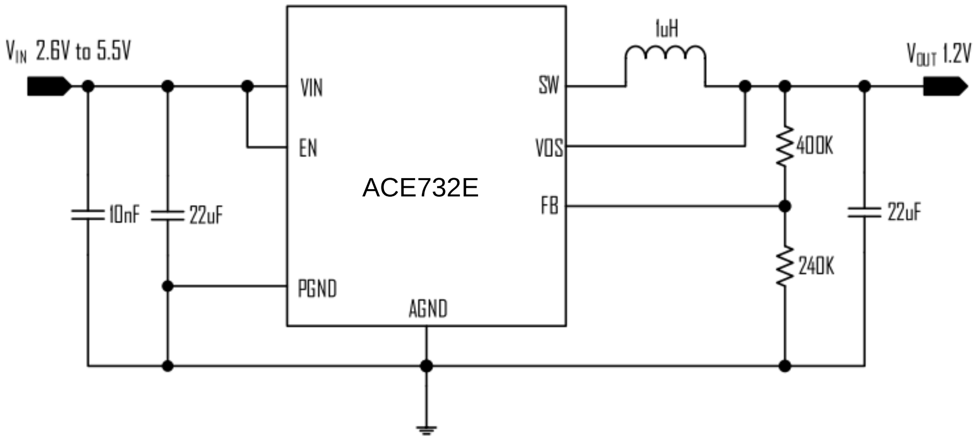
- ARM based CPUs
- Tablet, MID
- Smart Phone
- Smart Set-Top Box, OTT

Absolute Maximum Rating

Parameter	Value
VIN Voltage	-0.3V~6V
All Other Pin Voltage	VIN-0.3V~VIN0.3V
SW to ground current	Internally limited
Operating Temperature Range	-40°C~85°C
Storage Temperature Range	-55°C~150°C
Thermal Resistance	θ_{JA} 75 °C /W

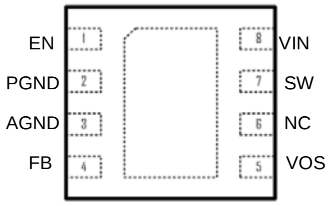
Note: Exceed these limits to damage to the device. Exposure to absolute maximum rating conditions may affect device reliability.

Typical Application



Typical Application Circuit of 1.2V Output

Packaging Type



DFN2x2-8L

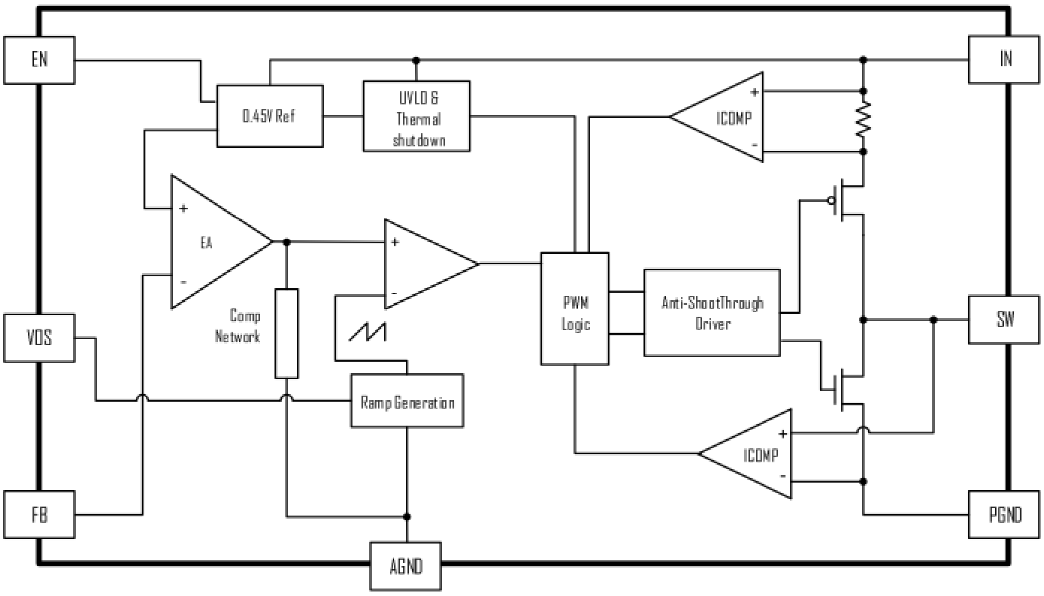
DFN2x2-8	Description	Function
1	EN	Enable pin for the IC. Drive this pin to high to enable the part, low to disable
2	PGND	Power Ground. The ground of internal power NMOS. Bypass with a 22μF ceramic capacitor to VIN
3	AGND	Analog Ground. To keep this ground free from noise by connecting a 10nF ceramic capacitor to VIN. Do not short his pin to PGND directly in PCB, but through a PCB trace to connect the 2 GND together.
4	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set the output to a voltage between 0.45V and VIN
5	VOS	Output voltage sense pin, to be connected to the output node of regulator.
6	NC	Not connected. Please do leave this pin float.
7	SW	Inductor Connection. Connect an 1uH inductor Between SW and the regulator output.
8	VIN	Supply Voltage. Bypass with a 22μF ceramic capacitor to PGND and 10nF to AGND.

Ordering information

ACE732E XX + H

- H: Halogen - free
- +: Pb - free
- XX: DN: DFN2*2-8L

Block Diagram



Electrical Characteristics

$V_{IN}=V_{EN}=5$, $T_A=25^{\circ}C$

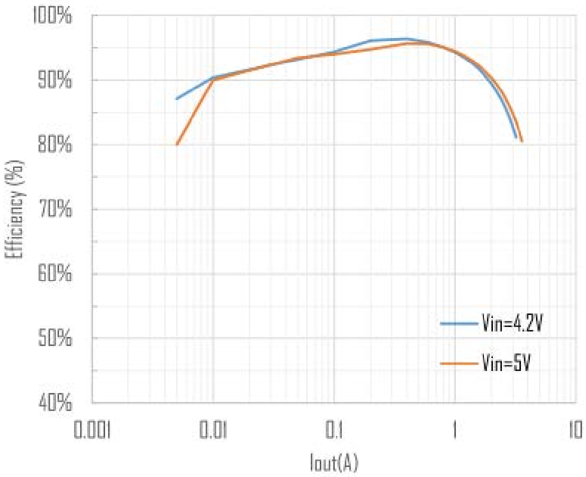
Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage Range		2.6		5.5	V
Input UVLO	Rising, Hysteresis=250mV		2.15		V
Input OVP	Rising, Hysteresis=200mV		6.25		V
Input Supply Current	V_{FB} =0.5V, Device Not Switching		50		uA
Input Shutdown Current	EN=GND		0.1	1	uA
FB Feedback Voltage		0.436	0.45	0.464	V
FB Input Current			0.01		uA
Output Voltage Range		0.45		V_{IN}	V
Load Regulation			0.18		%A
Line Regulation	V_{IN} =3V to 4V		0.1		%V

Switching Frequency		1.0	1.5	2.0	MHz
PMOS Switch On Resistance	I_{SW} =200mA		120		mΩ
NMOS Switch On Resistance	I_{SW} =200mA		60		mΩ
PMOS Switch Current Limit	V_{IN} =5V	4	4.5		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
Thermal Shutdown	Rising, Hysteresis =20°C		155		˚C

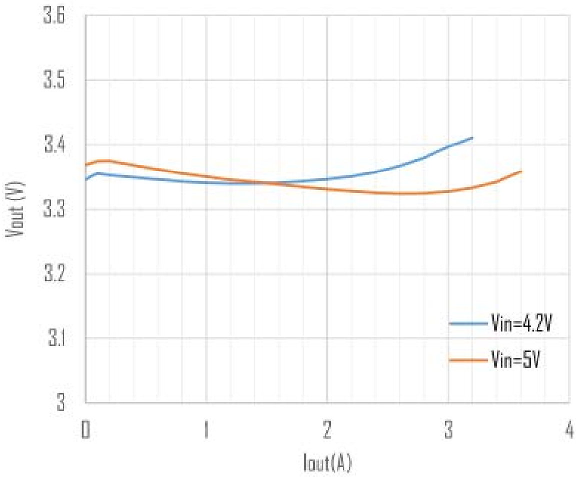
Typical Characteristics

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

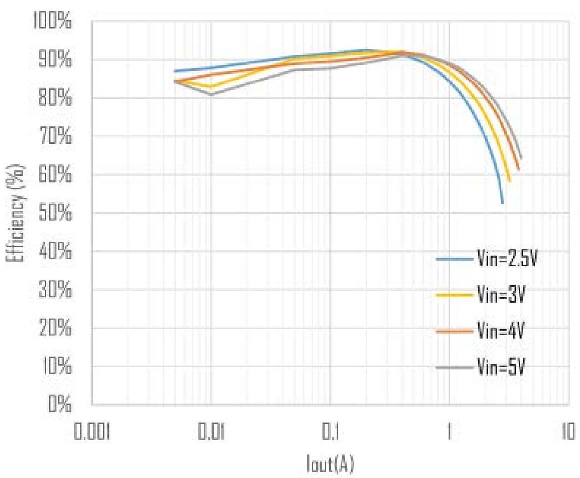
Efficiency Vs Iout, Vout=3.3V



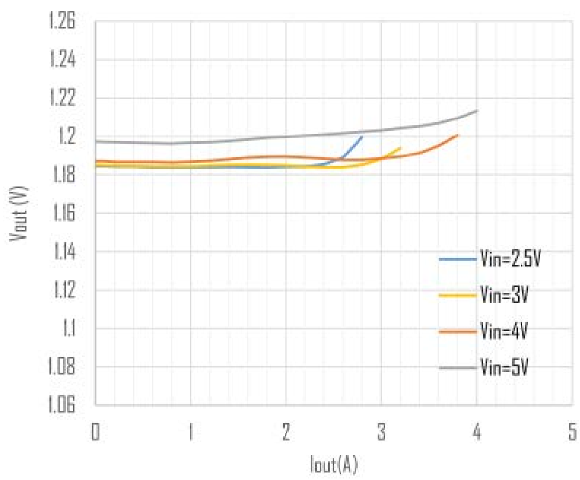
Output Voltage Vs Iout, Vout=3.3V



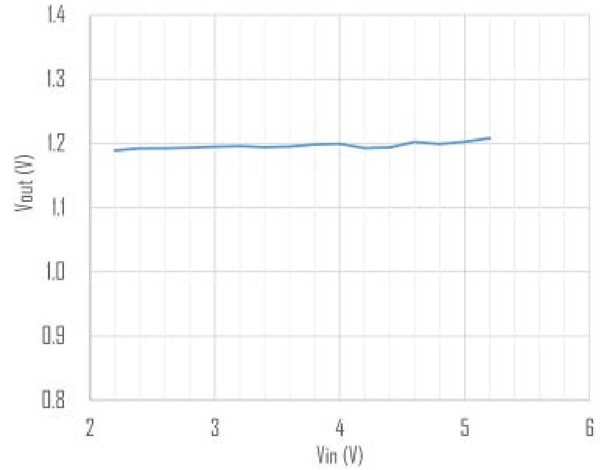
Efficiency Vs Iout, Vout=1.2V



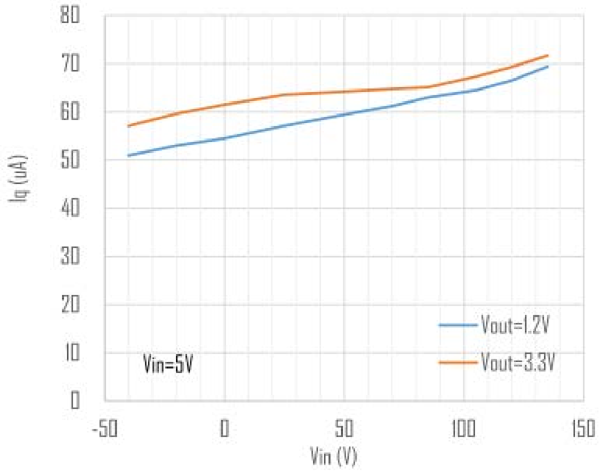
Output Voltage Vs Iout, Vout=1.2V



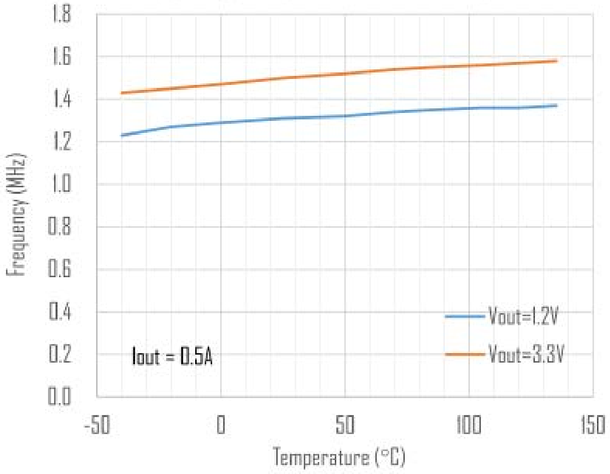
Vout Vs. Vin, Iout=0



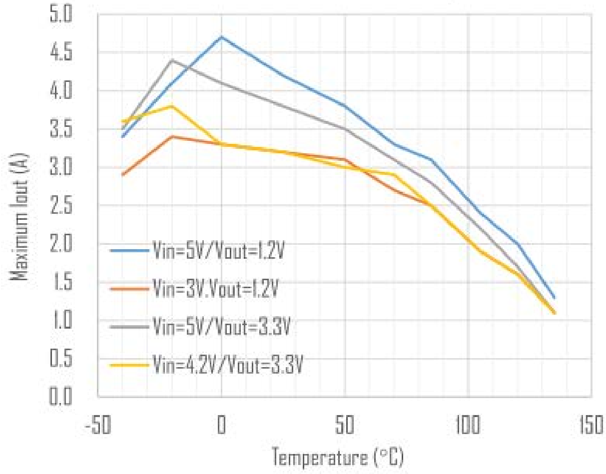
Iq Vs. Temperautre, Iout=0 and In Switching



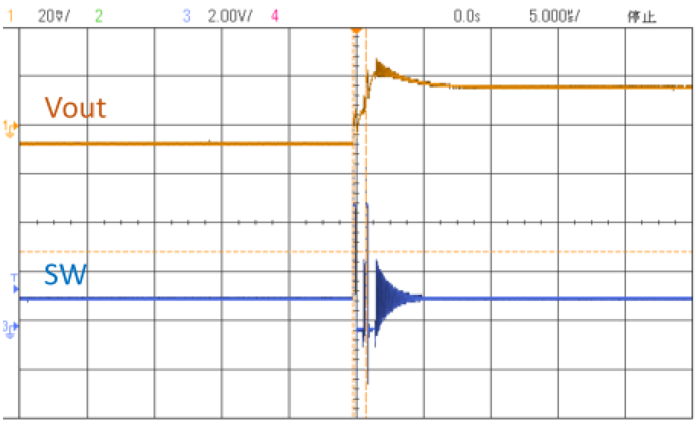
Switching Frequency Vs. Ambient Temperature



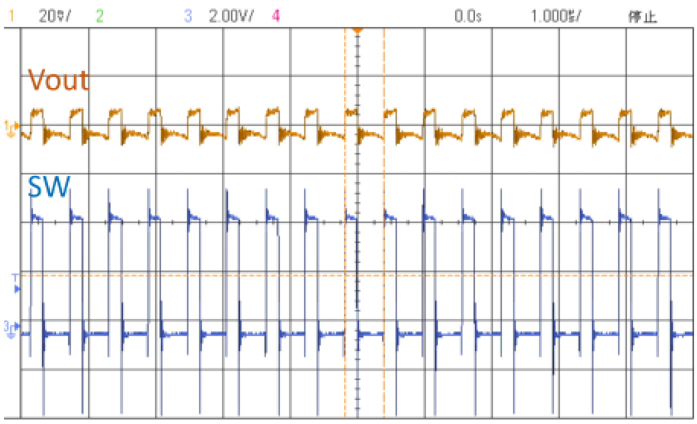
Maximum Iout Vs. Ambient Temperature



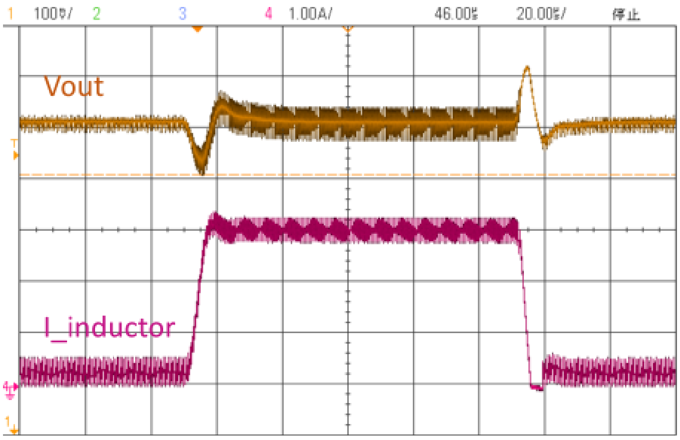
Switching Waveform: V_{IN}=5V, V_{OUT}=1.2V, I_{OUT}=0 mA



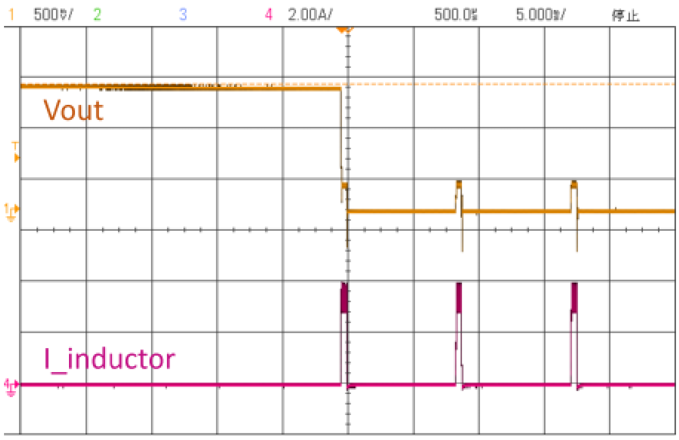
Switching Waveform: V_{IN}=5V, V_{OUT}=1.2V, I_{OUT}= 3A



Transient Response: V_{IN}=5V, V_{OUT}=1.2V, I_{OUT}=0.3-3A



Output Short Response: V_{IN}=5V, V_{OUT}=1.2V, Output short to GND



FUNCTIONAL DECRIPTIONS

ACE732E belongs to a new breed of high frequency synchronous Step-Down converter that combines the advantages of voltage mode control and Constant On time control. Its adaptive Constant-On-Time control dynamically changes switch on time to achieve a constant switching frequency. It does not have the minimum on-time constrain normally a fixed-frequency current mode Step-down requires, allowing it to go down to very low duty ratios without affecting loop stability. The voltage mode nature of ACE732E also provides a more superior load transient response as well as a seamless transition from PFM to PWM modes. It can also operate up to 100% duty. It has a cycle by cycle current limit and a hiccup mode that protects against dead-short condition. It includes soft-start, UVLO and thermal shutdown protection.

Adaptive Constant On-Time Control

ACE732E uses an adaptive Constant-On-Time control scheme that the ON time is dynamically adjusted according to VIN and VOUT so to achieve a nearly constant switching frequency. This control scheme provides simpler compensation and superior transient response over traditional constant frequency current mode control, while still maintaining the advantage of switching at a constant frequency at about 1.5MHz. It also provides a seamless transition from PFM to PWM that normally a constant frequency current mode control scheme is hard to achieve. Further mode, because it is a COT control scheme, the system can achieve high step-down ratio at ease, because lower constrain on the minimum on- time requirement existing in constant frequency scheme.

100% Duty operation

ACE732E can operate at 100% duty cycle under dropout condition for high efficiency purpose.

Current Limit and Short-Circuit protection

ACE732E employs a cycle-by-cycle peak current limit and it also has a hiccup mode that protects the circuit during dead-short condition. When the dead-short condition is removed, the IC goes back to normal operation.

Soft-start

ACE732E 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 I soft-start circuitry slowly ramps up current available at SW.

UVLO and Thermal Shutdown

If IN drops below UVLO threshold, the UVLO circuit inhibits switching. Once IN rises above ULVO threshold, 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=+155°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 0.45V.

$R_{TOP} = R_{BOTTOM} \times [(V_{OUT} / 0.45) - 1]$

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.

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

Output Capacitor Selection

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, or a MLCC 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: $V_{RIPPLE(ESR)} = IL_{(PEAK)} \times ESR$

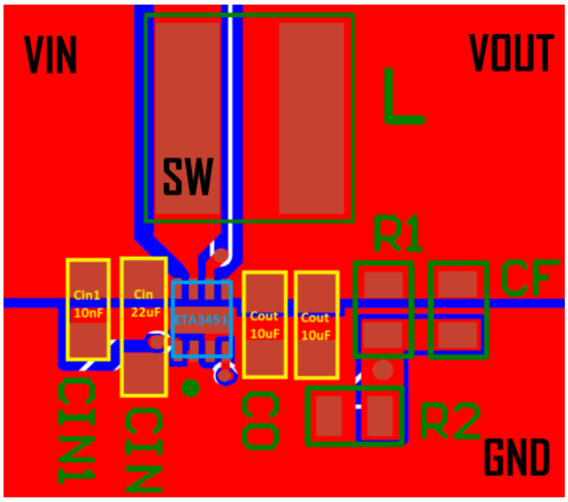
Input Capacitor Selection

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.

PCB LAYOUT

The ACE732E employs a sophisticated control scheme to achieve the fast response and other superior performances. So the PCB layout is recommended to strictly follow the proposed way shown below. The Cin (22uF) and Cout (22uF or 10uF x 2) are always to be placed closest to ACE732E. The Cin1 (10nF) is also require to be connected to AGND (not PGND) to filter out the switching noise. Please don't short Pin2 (PGND) and Pin3 (AGND) directly, but through a PCB trace, as what's shown below.

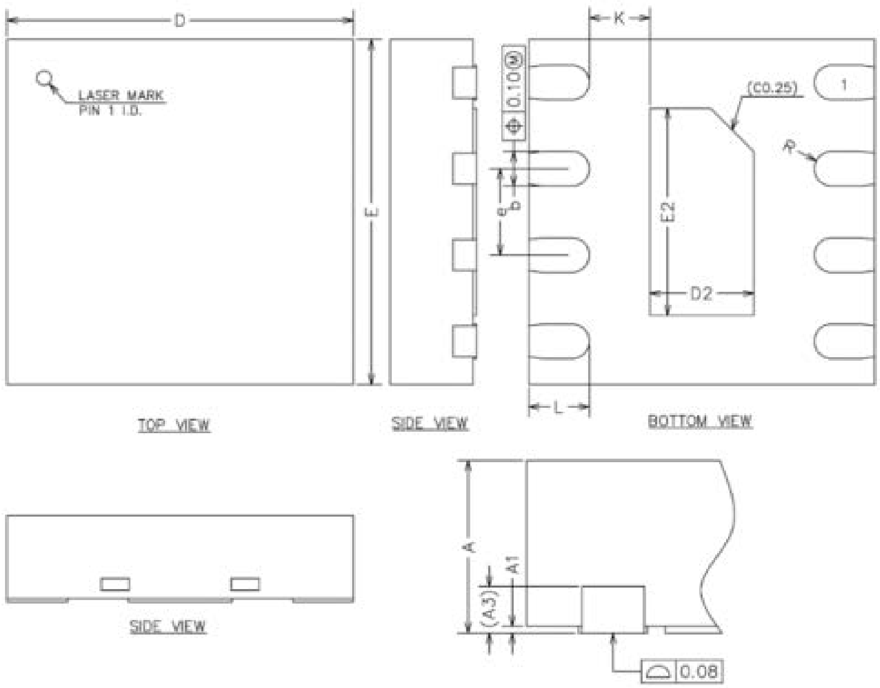
Please contact ACE engineers for confirmation if one needs to change the PCB layout.



VIN
VOUT
L
SW
R1
CF
Cin1
10nF
Cin
22uF
Cout
10uF
Cout
10uF
CIN1
CIN
CO
R2
GND

Packing Information

DFN2x2-8L



Symbol	Dimensions in millimeters		
	Min.	Nom.	Max.
A	0.70	0.75	0.80
A1	—	0.02	0.05
A3	0.20REF		
b	0.15	0.20	0.25
D	1.90	2.00	2.10
E	1.90	2.00	2.10
D2	0.50	0.60	0.70
E2	1.10	1.20	1.30
e	0.40	0.50	0.60
K	0.20	—	—
L	0.30	0.35	0.40
R	0.09	—	—

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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