3A 16V 490KHz PWM/PSM Synchronous Step-Down Converter

FEATURES

- 3A Continuous Output Current
- Wide 4.5V to 16V Operating Input Range
- Output Adjustable from 0.8V to 10V
- Up to 95% efficiency
- Low Rds(on) Internal Switch
- <1µA Supply Current in Shutdown Mode
- 490KHz Frequency
- Under Voltage Lockout
- Cycle by Cycle Over Current Protection
- Short Circuit Protection
- Thermal Shutdown
- Available in TSOT23-6 package

APPLICATIONS

- Networking
- Set Top Box
- Industrial and Commerical Low Power Systems
- LCD Monitors and TVs
- Green Electronics/Appliances
- Ponit of Load Regulation of High-Performance DSPs

DESCRIPTION

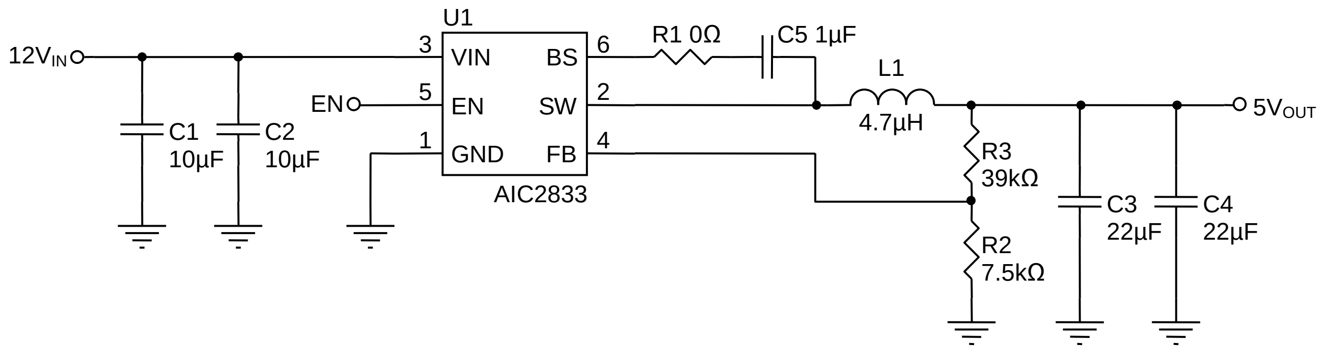
The AIC2833 is a high efficiency, monolithic synchronous step-down DC/DC converter that can deliver up to 3A output current from 4.5V to 16V input voltage.The AIC2833 current mode architecture provides fast transient response and eases loop stabilization. Low output voltage ripple and small external inductor and capacitors sizes are achieved with 490KHz switching frequency.

The AIC2833 has short circuit protection function provides protection against shorted output, and soft start function eliminates inrush current during start-up.

The AIC2833 also provides thermal shutdown protection function. The low current at shutdown mode allows output disconnection, enabling easy power management in battery-power system.

This device is available in TSOT23-6 package provides a very compact system solution with minimal external components and PCB area.

APPLICATIONS CIRCUIT



AIC2833 Typical Application Circuit

ORDERING INFORMATION

AIC2833XXX XX

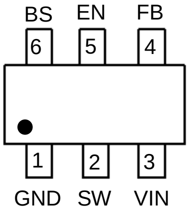
- PACKING TYPE
  TR: TAPE & REEL
  BG: BAG
- PACKAGE TYPE
  K6F: TSOT23-6
- G: Green Package

Example: AIC2833GK6FTR
→ 490KHz with TSOT23-6 Green Package and Tape & Reel Packing Type

Part No.	Marking
AIC2833GK6F	2833G

PIN CONFIGURATION

TSOT23-6
TOP VIEW



Note: Pin1 is determined by orienting the package marking as shown.

ABSOLUTE MAXIMUM RATINGS

VIN and EN Pin Voltage ………………………………………………………………………. - 0.3V to 17V

SW Pin Voltage ……………………………………………………………………………… -1V to V_{IN} + 0.3V

BS Pin Voltage ………………………………………………………………………… V_{SW} – 0.3V to V_{SW} + 6V

All other pins ………………………………………………………………………………………. - 0.3V to 6V

Junction Temperature ……………………………………………………………………………….. 150°C

Lead Temperature …………………………………………………………………………………. 260°C

Storage Temperature Range ……………………………………………………………. - 65°C ~ 150°C

Operating Ambient Temperature Range …………………………………………………. - 40°C ~ 85°C

Thermal Resistance Junction to Case TSOT23-6 ……………………………………. 60°C/W

Thermal Resistance Junction to Ambient TSOT23-6 ………………………………….110°C/W

(Assume no Ambient Airflow, no Heatsink)

Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

ELECTRICAL CHARACTERISTICS

(V_{IN}=12V, V_{EN} =5V, T_A=25°C, unless otherwise specified.) (Note1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Supply Voltage Range	V_{IN}		4.5		16	V
Shutdown Current		V_{EN}=0V		0.1	1	μA
Quiescent Current		V_{EN}=3V, V_{FB}=0.9V I_{OUT} = 0A, No Switching		0.5		mA
Reference Voltage	V_{REF}		0.788	0.804	0.820	V
High-Side Switch On-Resistance	$R_{DS(ON)1}$			100		mΩ
Low-Side Switch On-Resistance	$R_{DS(ON)2}$			52		mΩ
High-Side Switch Current Limit		Peak Current	3.5	4.2		A
High-Side Switch Leakage Current		V_{EN}=0V, V_{SW}=0V		0	10	μA
Oscillation Frequency	f_{OSC}		416	490	564	kHz
Under Voltage Lockout Threshold	V_{UVLO}	V_{IN} Rising	3.75	4	4.45	V
UVLO Hysteresis	ΔV_{UVLO}			300		mV
EN Rising Threshold Voltage		V_{EN} Rising	1.35	1.55	1.75	V
EN Falling Threshold Voltage			1.2	1.4	1.6	V
Maximum Duty Cycle	D_{MAX}	V_{FB}=0.4V		90		%
Minimum On Time	T_{ON}			100		ns
Soft Start Period	T_{SS}			2		ms
Thermal Shutdown Temperature	T_{SD}			150		°C
Thermal Shutdown Hysteresis				25		°C

Note 1: Specifications are production tested at T_A=25°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with Statistical Quality Controls (SQC).

TYPICAL PERFORMANCE CHARACTERISTICS

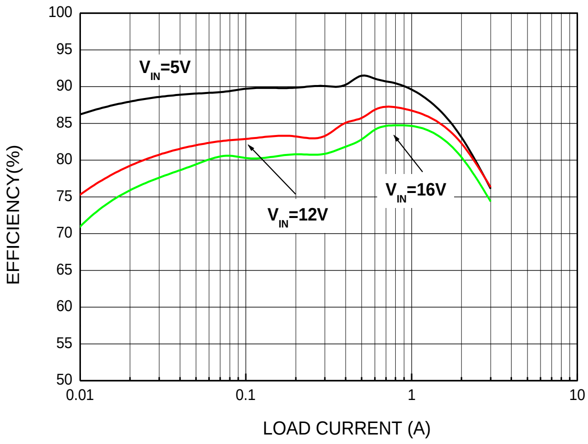


Fig. 1 Efficiency vs. Output Current (V_{OUT}=1.05V)

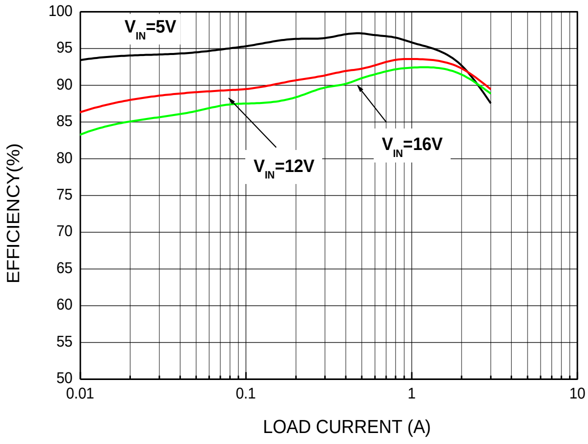


Fig. 2 Efficiency vs. Output Current (V_{OUT}=3.3V)

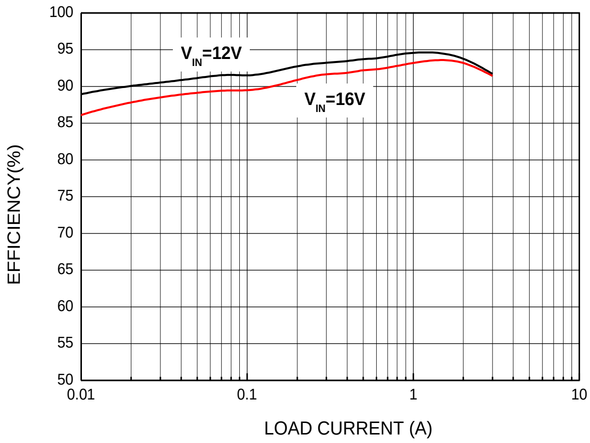


Fig. 3 Efficiency vs. Output Current (V_{OUT}=5.0V)

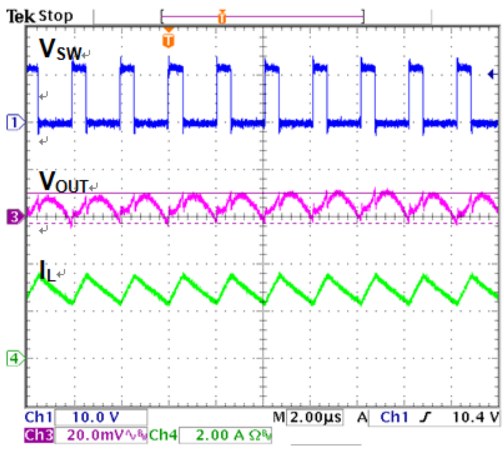


Fig. 4 Output Ripple at V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=3A

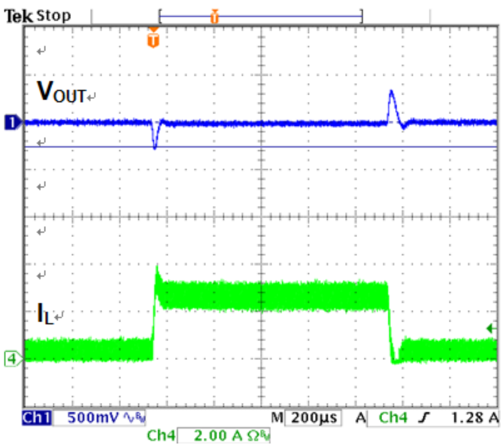


Fig. 5 Load Transient (V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=0.3-2.7A)

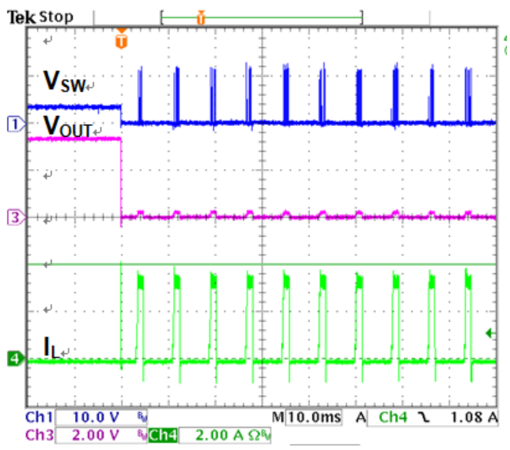


Fig. 6 Short Circuit at V_{IN}=12V, V_{OUT}=3.3V

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

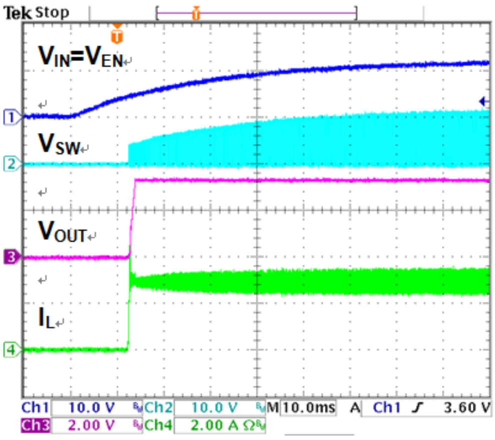


Fig. 7 V_{IN} Power On (V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=3A)

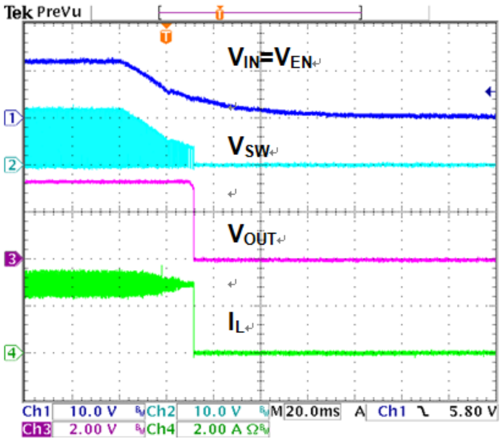


Fig. 8 V_{IN} Power Off (V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=3A)

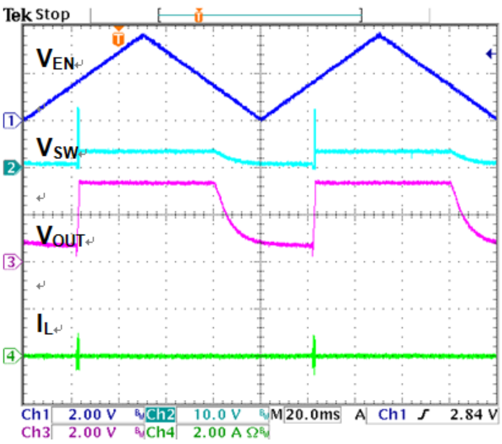


Fig. 9 Shutdown Test (V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=0A)

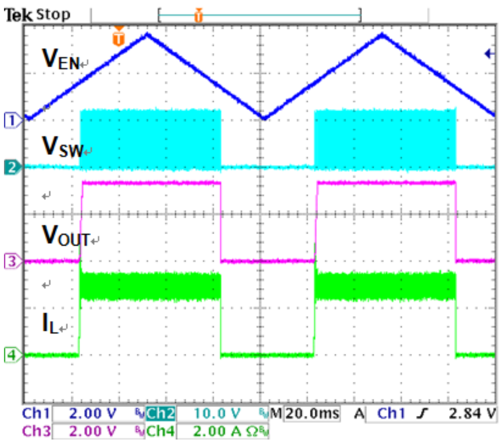


Fig. 10 Shutdown Test (V_{IN}=12V, V_{OUT}=3.3V, I_{OUT}=3A)

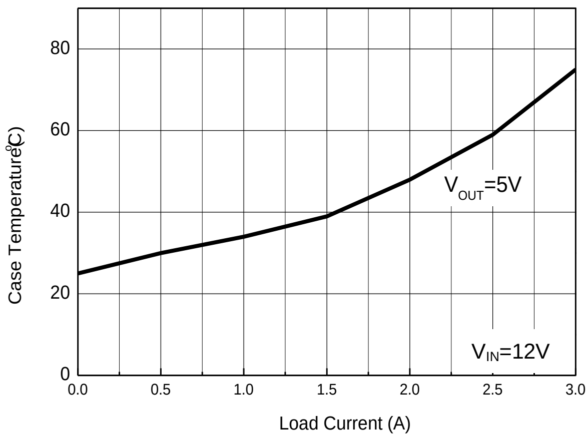
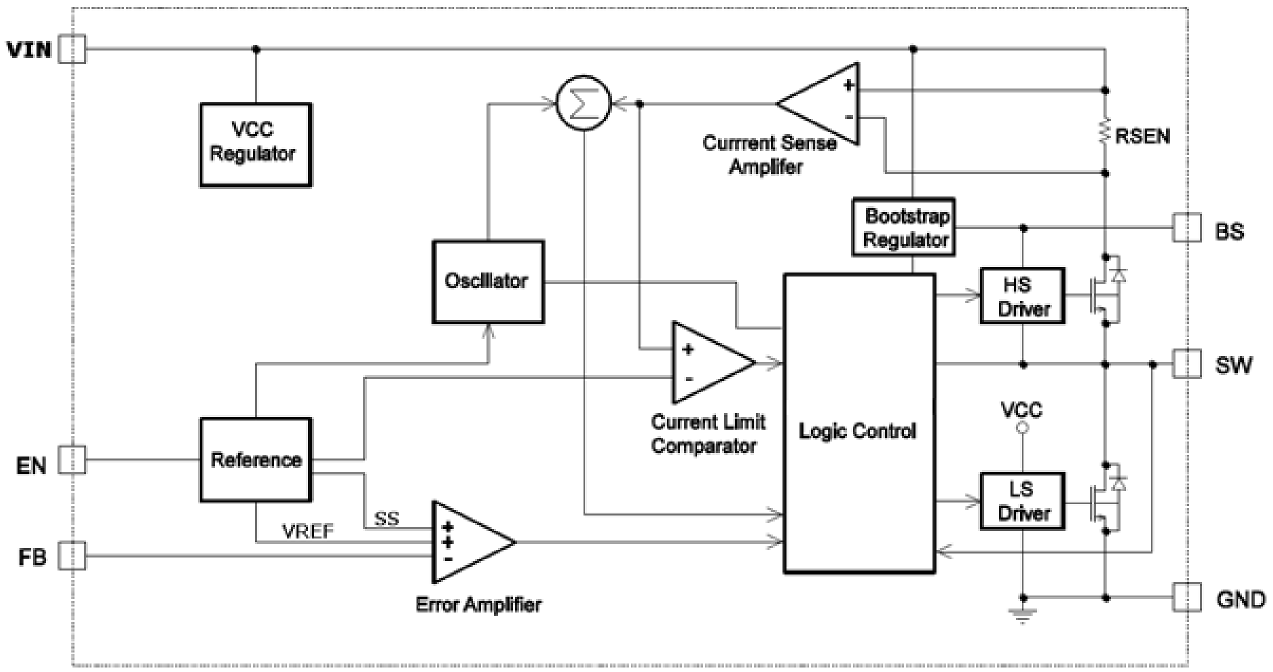


Fig. 11 Case Temperature vs. Load Current

BLOCK DIAGRAM



Functional Block Diagram of AIC2833

PIN DESCRIPTIONS

Pin No.	Pin Name	Pin Function
1	GND	Ground.
2	SW	Power Switching Output. SW is the switching node that supplies power to the output. Connect the output LC filter from switch to the output load. Note that a capacitor is required from SW to BS to power the high-side switch.
3	VIN	Power Input. VIN supplies power to the IC, as well as the step-down converter switches.Bypass VIN to GND with a suitabley large capacitor to eliminate noise on the input to the IC.
4	FB	Feedback Input. FB senses the output voltage to regulate that voltage. Drive feedback with a resistive voltage divider from the output voltage.
5	EN	Enable Input. EN is a digital input that turns the regulator on or off. Drive EN high to turn on the regulator. Drive it low to turn it off.
6	BS	High Side Gate Drive Boost Input. BS supplies the drive for the high-side N-Channel MOSFET switch. Connect a 1μF or greater capaitor from SW to BS to power the high-side switch.

APPLICATION INFORMATION

The AIC2833 is a synchronous high voltage buck converter that can support the input voltage range from 4.5V to 16V and the output current can be up to 3A.

Setting the Output Voltage

The output voltage is set using a resistive voltage divider connected from the output voltage to FB. The voltage divider divides the output voltage down to the feedback voltage by the ratio:

$$V_{FB} = V_{OUT}\frac{R_2}{R_3 + R_2}$$

Thus the output voltage is:

$$V_{OUT} = V_{FB} \times \frac{R_3 + R_2}{R_2}$$

For example, for a 3.3V output voltage and V_{FB}=0.804V, R_2 is 13kΩ, and R_3 is 40.4kΩ.

Inductor

The inductor selection depends on the current ripple of inductor, the input voltage and the output voltage.

$$L \geq \frac{V_{OUT}}{f_{OSC} \cdot \Delta I_L}\left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

Accepting a large current ripple of inductor allows the use of a smaller inductance. However, higher current ripple of inductor can cause higher output ripple voltage and large core loss. By setting an acceptable current ripple of inductor, a suitable inductance can be obtained from above equation.

In addition, it is important to ensure the inductor saturation current exceeds the peak value of inductor current in application to prevent core saturation. The peak value of inductor current can be calculated according to the following equation.

$$I_{PEAK} = I_{OUT(max)} + \frac{V_{OUT}}{2 \times f_{OSC} \cdot L}\left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

Input Capacitor and Output Capacitor

To prevent the high input voltage ripple and noise resulted from high frequency switching, the use of low ESR ceramic capacitor for the maximum RMS current is recommended. The approximated RMS current of the input capacitor can be calculated according to the following equation.

$$I_{CINRMS} \approx \sqrt{I_{OUT(MAX)}^2 \times \frac{V_{OUT}(V_{IN} - V_{OUT})}{V_{IN}^2} + \frac{\Delta I_L^2}{12}}$$

The selection of output capacitor depends on the required output voltage ripple. The output voltage ripple can be expressed as:

$$\Delta V_{OUT} = \frac{\Delta I_L}{8 \times f_{OSC} \cdot C_{OUT}} + ESR \cdot \Delta I_L$$

For lower output voltage ripple, the use of low ESR ceramic capacitor is recommended. The tantalum capacitor can also be used well, but its ESR is larger than that of ceramic capacitor.

When choosing the input and output ceramic capacitors, X5R and X7R types are recommended because they retain their capacitance over wider ranges of voltage and temperature than other types.

Over Current Protection

The AIC2833 has a cycle-by-cycle current limit to protect the internal power switches. The cycle-by-cycle current limit protection directly limits inductor peak current. While the current limitation function is activated, the duty cycle will be reduced to limit the output power to protect the internal power switches.

Short Circuit Protection

When the current limit protection is activated and output voltage becomes lower than the short circuit protection threshold, the AIC2833 will shut down the output power stage and then initiate the soft-start sequence. If over current condition still exists and the output voltage still is lower than the short circuit protection threshold after the soft-start ends, the AIC2833 will repeat this operation mode until the short circuit condition is released.

Over Temperature Protection

The AIC2833 implements an internal over temperature protection. When junction temperature exceeds the thermal shutdown threshold temperature, the regulator will be shutdown. And the hysteretic of the over temperature protection is 25°C (typ).

External Bootstrap Diode

When the output voltage is 3.3V or the duty ratio is higher than 65%, an external bootstrap diode between the external BS voltage and the BS pin is recommended to be used for efficiency or load regulation improvement. The external BS voltage must be lower than 5.5V. The external bootstrap diode can be the low cost 1N4148.

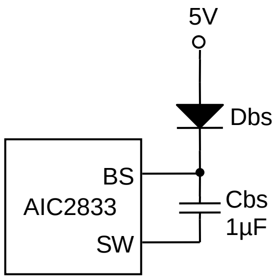


Fig. 12 Optional External Bootstrap Diode

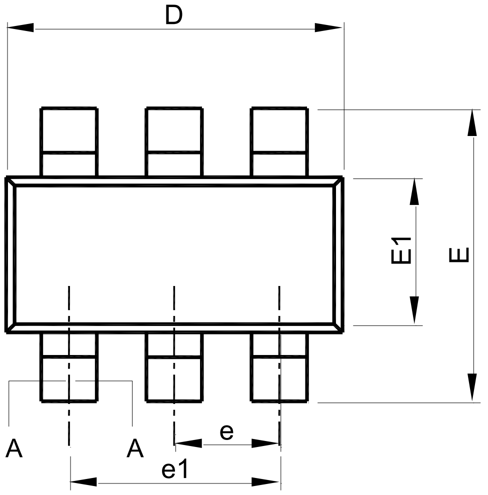
Layout Consideration

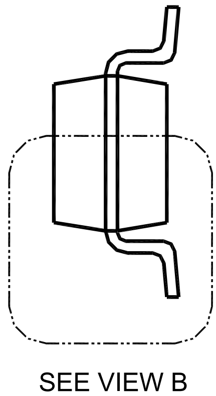
In order to ensure a proper operation of AIC2833, the following points should be managed comprehensively.

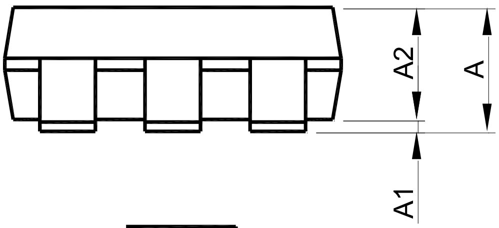
1. The input capacitor and V_{IN} should be placed as close as possible to each other to reduce the input voltage ripple and noise.
2. The output loop, which is consisted of the inductor, the internal power switch and the output capacitor, should be kept as small as possible.
3. The routes with large current should be kept short and wide.
4. Logically the large current on the converter should flow at the same direction.
5. In order to prevent the effect from noise, the IC's GND pin should be placed close to the ground of the input bypass capacitor.
6. The FB pin should be connected to the feedback resistors directly and the route should be away from the noise sources.

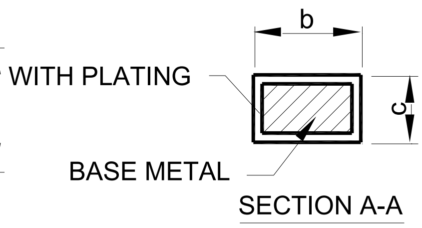
■ PHYSICAL DIMENSIONS

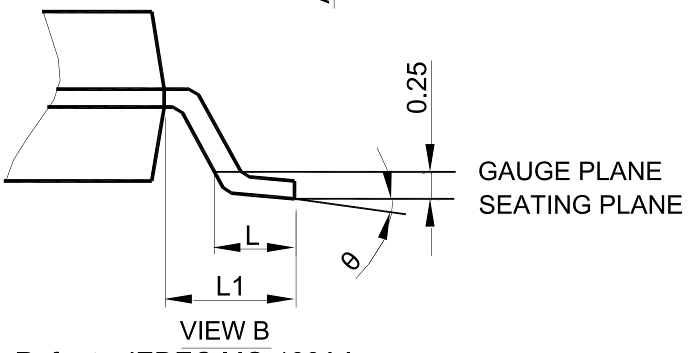
● **TSOT23-6**











SYMBOL	TSOT23-6	
	MILLIMETERS	
	MIN.	MAX.
A	-	1.00
A1	0	0.10
A2	0.70	0.90
b	0.30	0.50
c	0.08	0.22
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.95 BSC	
e1	1.90 BSC	
L	0.30	0.60
L1	0.60 REF	
θ	0°	8°

Note : 1. Refer to JEDEC MO-193AA.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.
3. Dimension "E1" does not include inter-lead flash or protrusions.
4. Controlling dimension is millimeter, converted inch dimensions are not necessarily exact.