1.5A 2MHz Synchronous Buck Converter

FEATURES

- High Efficiency: Up to 97%
- Up to 1.5A Max. Output Current
- 2MHz Switching Frequency
- Low Dropout 100% Duty Operation
- Internal Compensation and Soft-Start
- Current Mode Control
- Reference 0.6V
- Logic Control Shutdown (I_Q<1μA)
- Thermal Shutdown, UVLO
- Available in SOT23-5 and DFN-6(2x2)

APPLICATIONS

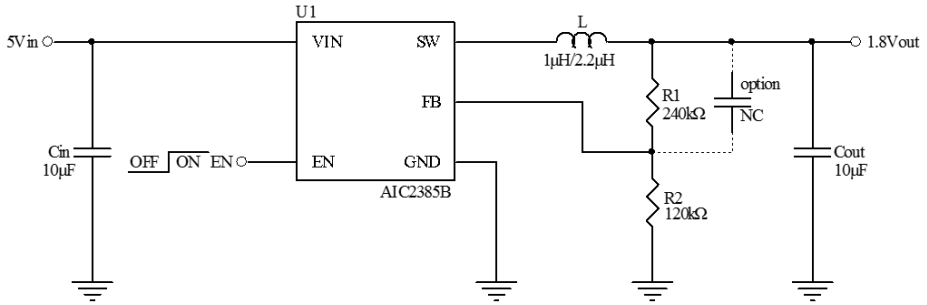
- Cellular Phones
- Digital Cameras
- MP3 and MP4 Players
- Set Top Boxes
- Wireless and DSL Modems
- USB Supplied Devices in Notebooks
- Portable Devices

DESCRIPTION

The AIC2385B is a high-efficiency, DC to DC step-down switching regulators, capable of delivering up to 1.5A of output current. The device operates from an input voltage range of 2.6V to 5.5V and provides an output voltage from 0.6V to VIN. Working at a fixed frequency of 2MHz allows the use of small external components, such as ceramic input and output capacitors, as well as small inductors, while still providing low output ripples. This low noise output along with its excellent efficiency achieved by the internal synchronous rectifier, making AIC2385B an ideal replacement for large power consuming linear regulators. Internal soft-start control circuitry reduces inrush current. Short-circuit and thermal shutdown protection improves design reliability.

The AIC2385B is available in SOT23-5 and DFN-6(2x2) package.

TYPICAL APPLICATION CIRCUIT



AIC2385B Typical Application Circuit

ORDERING INFORMATION

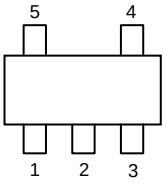
AIC2385B XXXXXX

- PACKING TYPE
  TR: TAPE & REEL
  BG: BAG
- PACKAGE TYPE
  U5: SOT23-5
  D6A: DFN-6(2x2)
- G: Green Package

Example: AIC2385BGU5TR
→ in SOT23-5 Green Package
& Tape & Reel Packing Type

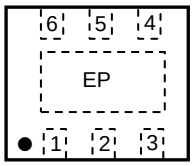
PIN CONFIGURATION

SOT23-5
TOP VIEW



1: EN
2. GND
3. SW
4. VIN
5. FB

DFN-6(2X2)
TOP VIEW



1: NC
2. EN
3. VIN
4. SW
5. GND
6. FB

Note: The exposed pad should leave floating or tie to GND.

ABSOLUTE MAXIMUM RATINGS

VIN Voltage		6.5V
Storage Temperature Range T_{STG}		-40°C to 150°C
Lead Temperature (Soldering 10 Sec.)		260°C
Operating Maximum Junction Temperature T_J		125°C
Operating Ambient Temperature Range T_A		-40°C to 85°C
Thermal Resistance Junction to Case	SOT23-5	115°C/W
	DFN-6(2x2)*	30°C/W
Thermal Resistance Junction to Ambient	SOT23-5	250°C/W
	DFN-6(2x2)*	165°C/W
Power Dissipation	SOT23-5	400mW
	DFN-6(2x2)	600mW

(Assume no Ambient Airflow, no Heat sink)

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

* The package is placed on a two layers PCB with 2 ounces copper and 2 square inch, connected by 8 vias.

ELECTRICAL CHARACTERISTICS

(V_{IN}=5V, T_A=25°C, unless otherwise specified) (Note 1)

PARAMETER	TEST CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Input Voltage Range		V_{IN}	2.6		5.5	V
Input Overvoltage Threshold		V_{OVP}		6.1		V
Feedback Voltage	V_{IN}=5V	V_{REF}	0.588	0.6	0.612	V
Feedback Leakage Current		I_{FB}		0.1	1	µA
Quiescent Current	Active, V_{FB}=0.65V, No Switching	I_Q		80		µA
Shutdown Input Current	V_{EN}=0V	$I_{SHUTDOWN}$			1	µA
Line Regulation	V_{IN}=2.6V to 5.5V	LNR		0.1	0.2	%/V
Load Regulation	I_{OUT}=0.01A to 1A	LDR		0.1	0.2	%/A
Switching Frequency		F_{SOC}		2		MHz
PMOS R_{DS_ON}		R_{DSON_P}		250	350	mohm
NMOS R_{DS_ON}		R_{DSON_N}		150	250	mohm
Under Voltage Lockout		V_{UVLO}	1.9	2.1	2.3	V
UVLO Hysteresis		V_{UVLO_HY}		100		mV
Peak Current Limit		I_{LIMIT}		2.3		A
SW Leakage Current	V_{IN}=6V, V_{SW}=0 or 6V, V_{EN}=0V	I_{SWLK}			1	µA
EN Leakage Current		I_{ENLK}			1	µA
EN Input High Voltage		V_{H_EN}	1.2			V
EN Input Low Voltage		V_{L_EN}			0.5	V
Thermal Shutdown Temperature		T_{SD}		160		°C
Thermal Shutdown Hysteresis		T_{SH}		15		°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

Tested under T_A=25°C, unless otherwise specified

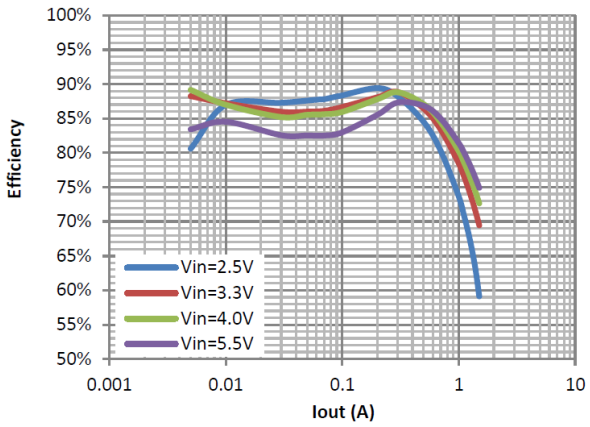


Fig. 1 Efficiency vs. Output Current (V_{OUT}=1.2V)

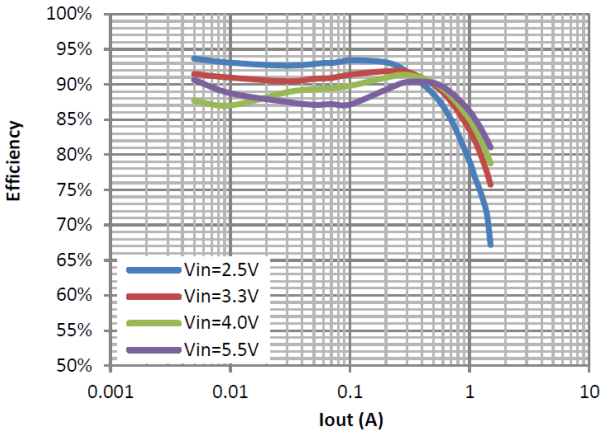


Fig. 2 Efficiency vs. Output Current (V_{OUT}=1.8V)

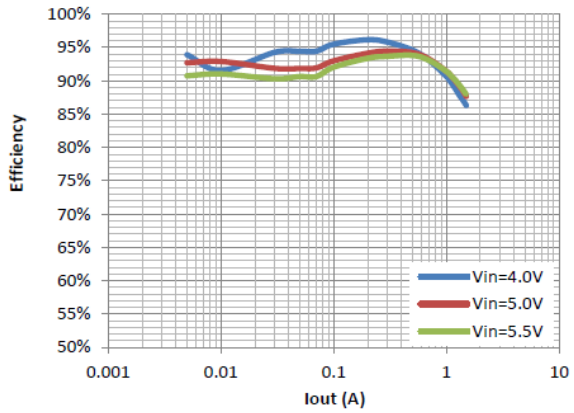


Fig. 3 Efficiency vs. Output Current (V_{OUT}=3.3V)

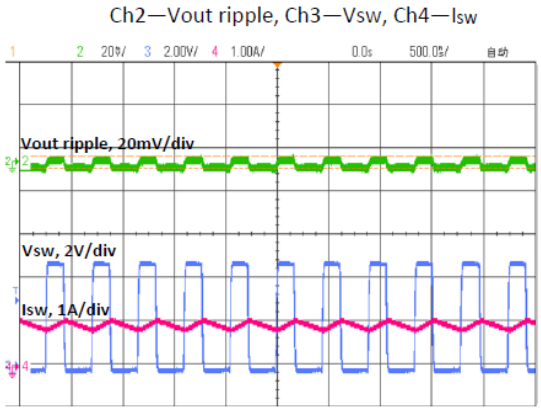


Fig. 4 Output Ripple and SW at 1A load (V_{IN}=5V / V_{OUT}=1.8V)

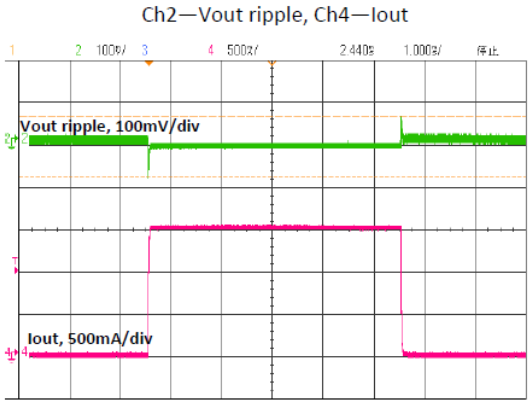


Fig. 5 Load Transient (V_{IN}=5V/ V_{OUT}=1.2V/ I_{OUT}=0.01A~1.5A)

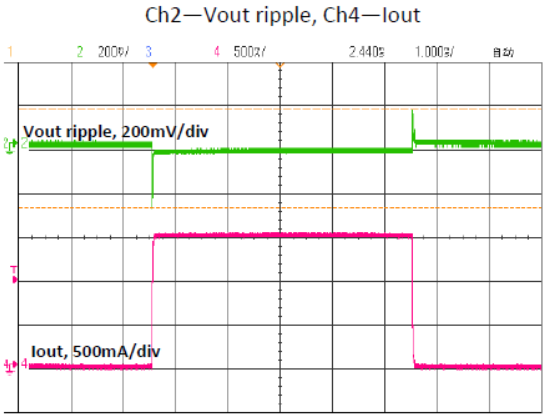
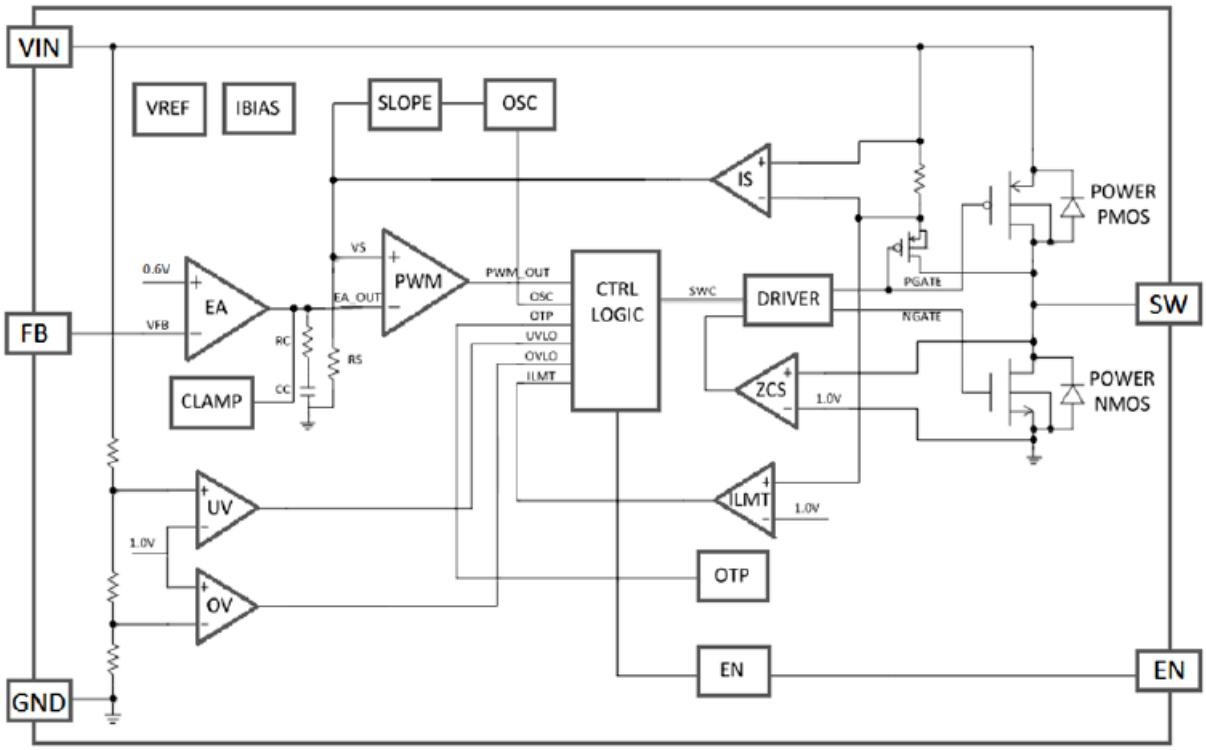


Fig. 6 Load Transient (V_{IN}=5V/ V_{OUT}=3.3V/ I_{OUT}=0.01A~1.5A)

BLOCK DIAGRAM



Functional Block Diagram of AIC2385B

PIN DESCRIPTION

EN - Enable pin for the IC. Drive the pin to high to enable the part, and low to disable

GND - Ground.

SW - Inductor connection. Connect an inductor between SW and the regulator output.

VIN - Supply Voltage.

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 V_{IN}

APPLICATION INFORMATION

The AIC2385B high-efficiency switching regulator is a small, simple, DC-to-DC step-down converter capable of delivering up to 1.5A of output current. The device operates in pulse-width modulation (PWM) at 2MHz from a 2.6V to 5.5V input voltage and provides an output voltage from 0.6V to VIN, making the AIC2385B 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

AIC2385B 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 of 2.3A (typ.). When the current flowing out of SW exceeds this limit, the high-side MOSFET turns off and the synchronous rectifier turns on. AIC2385B 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 100mV, limiting the current to 2.3A (typ.) and reducing power dissipation. Normal operation resumes upon removal of the short-circuit condition.

Soft-Start

AIC2385B 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 shutdown event, the soft-start circuitry slowly ramps up current available at SW.

UVLO

If VIN drops below 2.1V, the UVLO circuit inhibits switching. Once VIN rises above 2.2V, the UVLO clears, and the soft-start sequence activates.

Thermal Shutdown

Thermal shutdown protection limits total power dissipation in the device. When the junction temperature exceeds T_J= +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 Voltage

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

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

Input Capacitor and Output Capacitor

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. 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:

$$\Delta I_L = \frac{V_{OUT}}{L \times f_S} \times (1 - \frac{V_{OUT}}{V_{IN}})$$

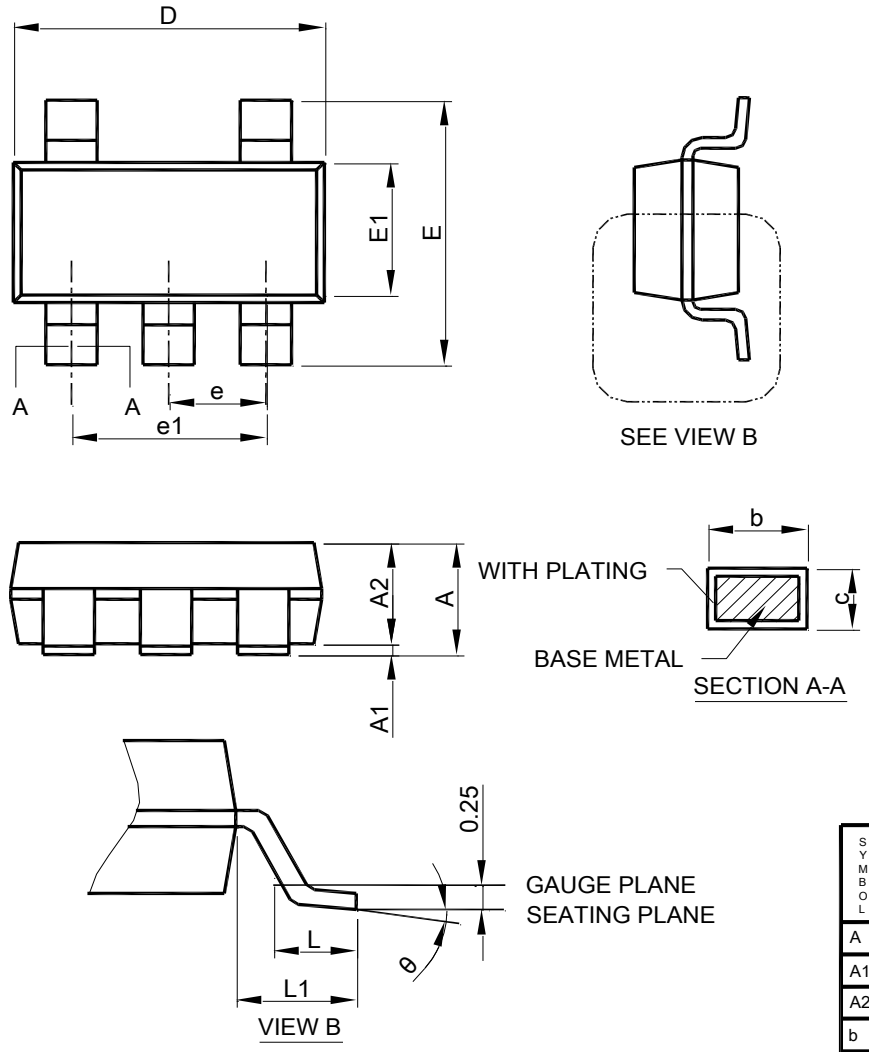
$$\Delta V_{OUT} = \frac{V_{OUT}}{8 \times f_S^2 \times L \times C_{OUT}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

If the capacitor has significant ESR, the output ripple component due to capacitor ESR is as follows:

$$\Delta V_{OUT} = \frac{V_{OUT}}{L \times f_S} \times (1 - \frac{V_{OUT}}{V_{IN}}) \times R_{ESR}$$

PHYSICAL DIMENSIONS

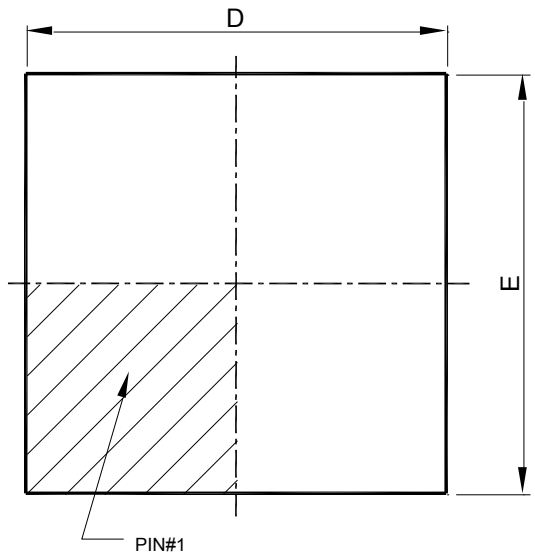
● SOT23-5



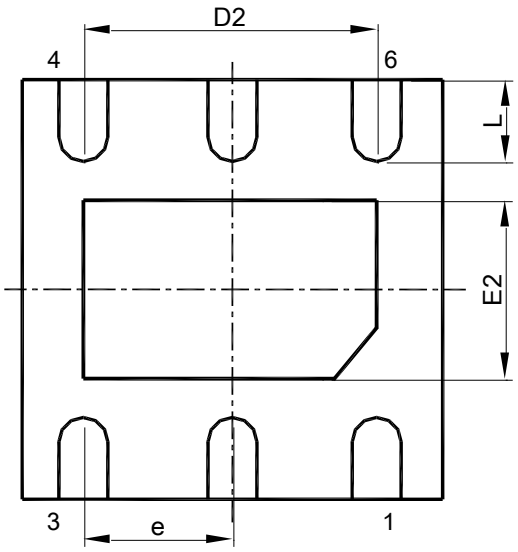
SYMBOL	SOT23-5	
	MILLIMETERS	
	MIN.	MAX.
A	0.95	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.30	0.50
c	0.08	0.22
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.70
e	0.95 BSC	
e1	1.90 BSC	
L	0.30	0.60
L1	0.60 REF	
θ	0°	8°

Note : 1. Refer to JEDEC MO-178AA.
2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 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.

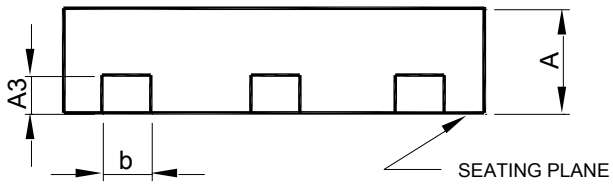
● DFN-6 (2x2x0.75-0.65mm)



TOP VIEW



BOTTOM VIEW



SIDE VIEW

SYMBOL	DFN-6 (2x2x0.75-0.65)	
	MILLIMETERS	
	MIN.	MAX.
A	0.70	0.80
A3	0.20 BSC	
b	0.20	0.35
D	2.00 BSC	
D2	1.10	1.60
E	2.00 BSC	
E2	0.55	0.85
e	0.65 BSC	
L	0.25	0.45

Note : 1. DIMENSION AND TOLERANCING CONFORM TO ASME Y14.5M-1994.
2.CONTROLLING DIMENSIONS : MILLIMETER , CONVERTED INCH
DIMENSION ARE NOT NECESSARILY EXACT.
3.DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS
MEASURED BETWEEN 0.10 AND 0.25 mm FROM TERMINAL TIP.