1.4MHz, 900mA, Dual Synchronous Buck DC/DC Converter

Description

The SC16B09 is high efficiency synchronous, dual PWM step-down DC/DC converters working under an input voltage range of 2.5V to 5.5V. This feature makes the SC16B09 suitable for single Li-Lon battery-powered applications. 100% duty cycle capability extends battery life in portable devices, while the quiescent current is 400μA with no load, and drops to < 1μA in shutdown.

The internal synchronous switch is desired to increase efficiency without an external Schottky diode. The 1.4 MHz fixed switching frequency allows the using of tiny, low profile inductors and ceramic capacitors, which minimized overall solution footprint.

The SC16B09 converters are available in the industry standard DFN3×3-10P power packages (or upon request).

Features

- **input voltage：2.5V to 5.5V**
- **Output voltage：0.6V to 5.5V**
- **Up to 93% Efficiency**
- **Current mode operation for excellent line and load transient response**
- **Low quiescent current: 400μA**
- **Shutdown quiescent current: < 1μA**
- **Low Switch on Resistance RDS(ON), Internal Switch: 0.35Ω**
- **Automatic PWM/PFM mode switching**
- **No Schottky diode required**
- **1.4MHz fixed frequency switching**
- **Short-Circuit protection**
- **Low profile DFN3×3-10P package (lead-free packaging is now available)**

Applications

- **Digital cameras and MP3**
- **Palmtop computers / PDAs**
- **Cellular phones**
- **Wireless handsets and DSL modems**
- **PC cards**
- **Portable media players**

Typical Application Circuit

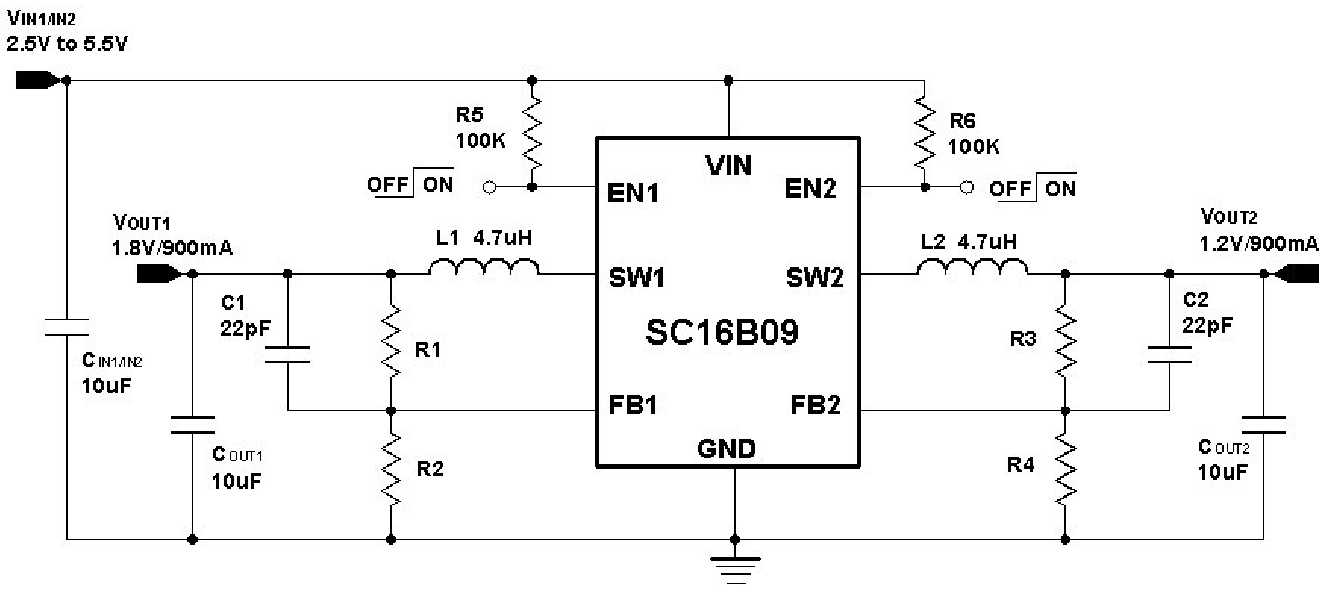
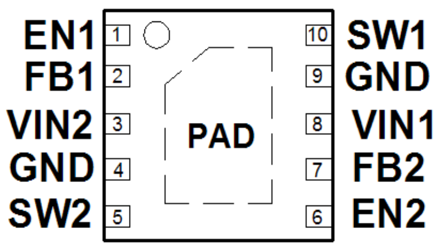


Figure 1: Typical Application Circuit

Pin Configurations

Package Type	Pin Configurations
SC16B09 DFN-10L	

Pin Description

PIN	NAME	DESCRIPTION
1.	EN1	First en control Input. Forcing this pin above 1.5V enables the part. Forcing this pin below 0.3V shuts down the device. In shutdown, all functions are disabled drawing <1uA supply current. Do not leave EN floating.
2.	FB1	Output feedback 1. Receive the feedback voltage from an external resistive divider across the output. In the adjustable version, the output voltage is set by a resistive divider according to the following formula: $V_{OUT} = 0.6V \cdot [1 + (R2/R1)]$.
3.	VIN2	Second main Supply Pin. It must be closely decoupled to GND, or with a 10µF or greaterceramic capacitor.
4、9	GND	Ground Pin.
5.	SW2	Second switch Node Connection to Inductor. This pin connects to the drains of the internal main and synchronous power MOSFET switches.
6.	EN2	Second en control Input. Forcing this pin above 1.5V enables the part. Forcing this pin below 0.3V shuts down the device. In shutdown, all functions are disabled drawing <1mA supply current. Do not leave EN floating.
7.	FB2	Output feedback 2. Receive the feedback voltage from an external resistive divider across the output. In the adjustable version, the output voltage is set by a resistive divider according to the following formula: $V_{OUT} = 0.6V \cdot [1 + (R4/R3)]$.
8.	VIN1	First main Supply Pin .It must be closely decoupled to GND, or with a 10µF or greater ceramic capacitor.
10.	SW1	First switch Node Connection to Inductor. This pin connects to the drains of the internal main and synchronous power MOSFET switches.

Absolute Maximum Ratings

- Input Supply Voltage (V_{IN}) -- –2.5V to 6V
- V_{SW}、V_{EN} -- - 0.3V～V_{sw} +0.3V
- I_{SW} -- 1.3A
- All Other Pins -- –0.3V to 6V
- Maximum Junction Temperature --- 125℃
- Operating Ambient Temperature Range -- –40℃ to 85℃
- Storage Temperature Range --- –65℃ to 150℃
- Lead Temperature (Soldering, 10 sec) --- 260℃

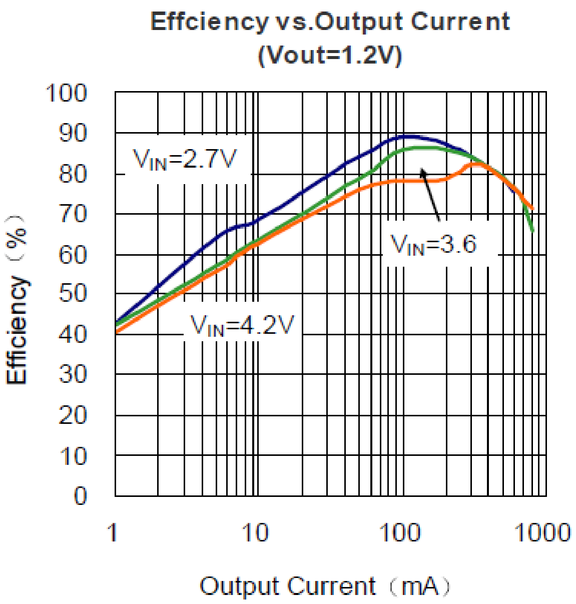
Electrical Characteristics

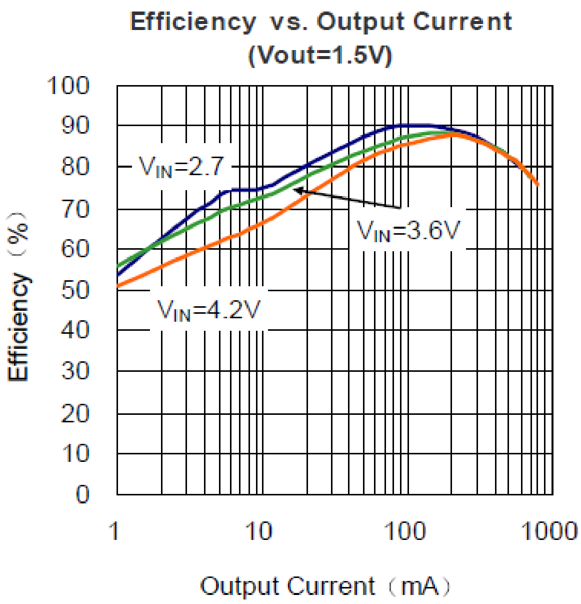
Operating Conditions: T_A=25 ℃,V_{IN}=3.6V unless otherwise specified.

PARAMETER	SYMBOL	CONDITION	SC16B09			UNITS
			MIN	TYP	MAX	
Input Voltage	V_{IN}		2.5		5.5	V
Output Voltage	V_{OUT}	I_{OUT} = 100mA,R2(4)/R1(3)=2	1.75	1.8	1.85	V
Feedback Current	I_{FB}				±30	nA
Feedback Voltage	V_{FB}	2.5V≤V_{IN}≤5.5V	0.58	0.6	0.62	V
V_{REF}	ΔV_{FB}	V_{IN}=2.5V~5.5V		0.03	0.4	%/V
Shutdown Supply Current	I_S	V_{EN} = 0V, V_{IN} = 4.2V		0.1	1	µA
Quiescent Current	I_Q	V_{FB} = 0.5V or V_{OUT} = 90%, I_{LOAD} = 0A		200	300	µA
Peak Inductor Current	I_{PK}	V_{IN} = 3V, V_{FB} = 0.5V or V_{OUT} = 90%,Duty Cycle < 35%	0.75	0.9	1	A
Oscillation Frequency	Fosc		1.2	1.4	1.6	MHz
$R_{DS(ON)}$ of P-Channel FET	R_{PFET}	I_{SW} = 100mA		0.3		Ω
$R_{DS(ON)}$ of N-Channel FET	R_{NFET}	I_{SW} = -100mA		0.39		Ω
Efficiency	EFFI	V_{IN}=EN=3.6 V, I_{OUT}=100mA		93		%
V_{OUT} Line Regulation	ΔV_{OUT}	V_{IN}=2.5V~5.5V		0.03	0.3	%/V
V_{OUT} Load Regulation	$V_{LOADREG}$			0.33		%

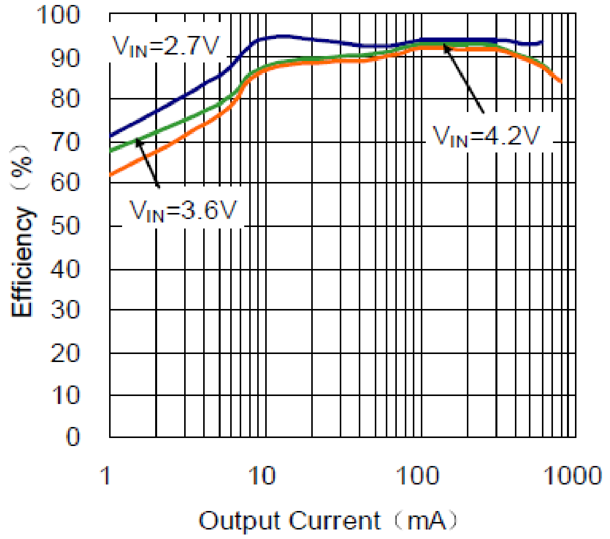
Typical Performance Characteristics

Operating Conditions:T_A=25℃, C_{IN} =10µF, C_{OUT} =10µF, L=4.7µH, unless otherwise noted.

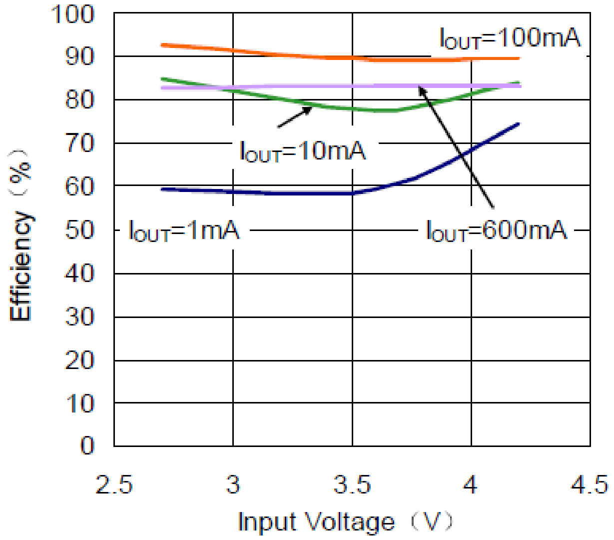




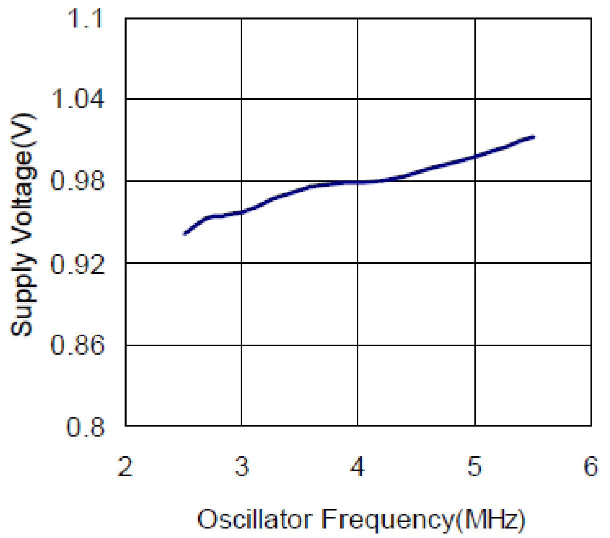
Efficiency vs. Output Current (Vout=1.8V)



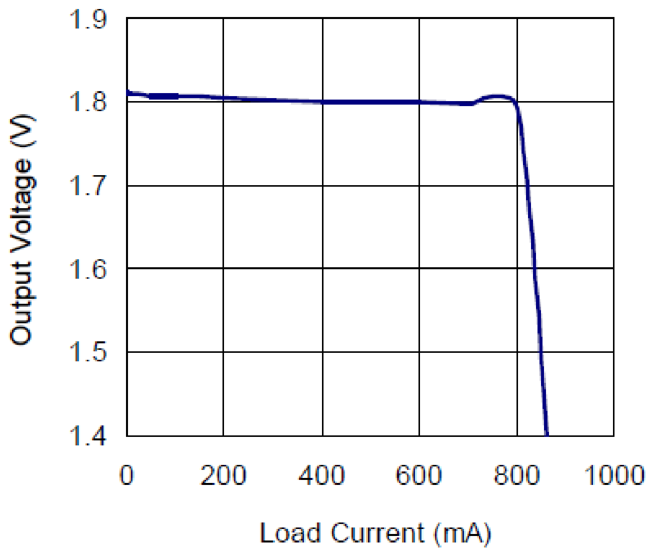
Efficiency vs. Input Voltage (Vout=1.8V)

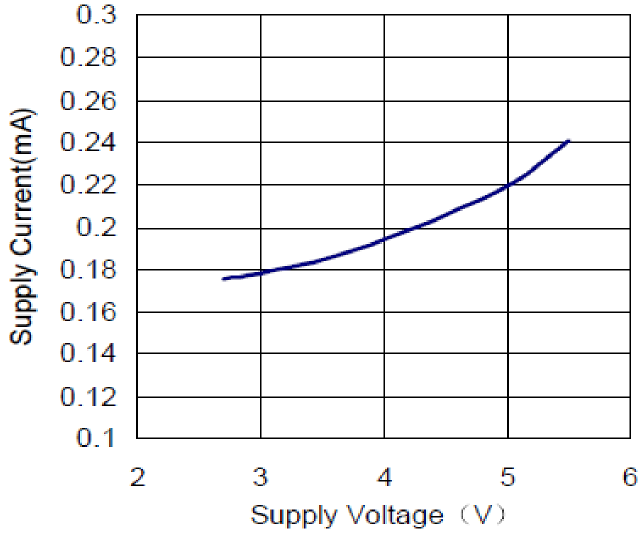


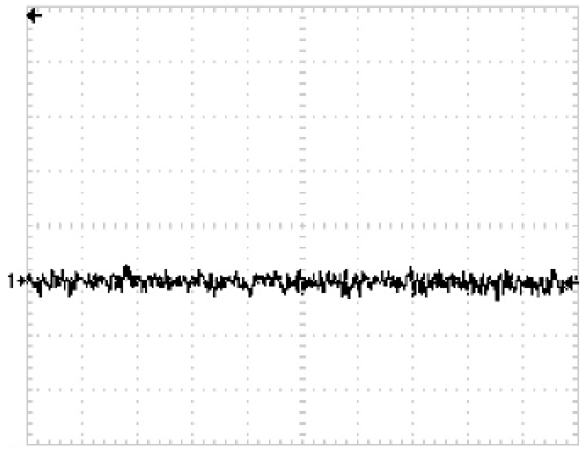
Oscillator Frequency vs. Supply Voltage(Vout=1.8V Io=100mA)



Output Voltage vs. Load Current(Vin=3.6V)







Application Information

The basic SC16B09 application circuit is shown in Typical Application Circuit. External component selection is determined by the maximum load current and begins with the selection of the inductor value and operating frequency followed by CIN and C_{OUT}.

INDUCTOR SELECTION

For most applications, the value of the inductor will fall in the range of 1mH to 4.7mH. Its value is chosen based on the desired ripple current. Large value inductors lower ripple current and small value inductors result in higher ripple currents. Higher V_{IN} or V_{OUT} also increases the ripple current as shown in equation 1. A reasonable starting point for setting ripple current is △IL = 240mA (40% of 600mA).

$$\Delta I_L = \frac{1}{(f)(L)} V_{OUT}\left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

The DC current rating of the inductor should be at least equal to the maximum load current plus halfthe ripple current to prevent core saturation. Thus,

a 720mA rated inductor should be enough for most applications (600mA +120mA). For better efficiency, choose a low DC-resistance inductor.

Different core materials and shapes will change the size/current and price/current relationship of an inductor. Toroid or shielded pot cores in ferrite or perm alloy materials are small and don't radiate much energy, but generally cost more than powdered iron core inductors with similar electrical characteristics. The choice of which style inductor to use often depends more on the price vs. size requirements and any radiated field/EMI requirements than on what the SC11A08 requires to operate. Table 1 shows some typical surface mount inductors that work well in SC16B09 applications.

OUTPUT AND INPUT CAPACITOR

SELECTION

In continuous mode, the source current of the top MOSFET is a square wave of duty cycle V_{OUT}/V_{IN}. To prevent large voltage transients, a low ESR input capacitor sized for the maximum RMS current must be used. The maximum RMS capacitor current is given by:

$$C_{IN} \text{ required } I_{RMS} \cong I_{OMAX} \frac{\left[V_{OUT}(V_{IN}-V_{OUT})\right]^{1/2}}{V_{IN}}$$

This formula has a maximum at $V_{IN} = 2V_{OUT}$, where $I_{RMS} = I_{OUT}/2$. This simple worst-case condition is commonly used for design because even significant deviations do not offer much relief. Note that the capacitor manufacturer's ripple current ratings are often based on 2000 hours of life. This makes it advisable to further derate the capacitor, or choose a capacitor rated at a higher temperature than required. Always consult the manufacturer if there is any question.

The selection of C_{OUT} is driven by the required effective series resistance (ESR). Typically, once the ESR requirement for C_{OUT} has been met, the RMS current rating generally far exceeds the IRIPPLE(P-P) requirement. The output ripple ΔV_{OUT} is determined by:

$$\Delta V_{OUT} \cong \Delta I_L \left(ESR + \frac{1}{8fC_{OUT}} \right)$$

Where f = operating frequency, C_{OUT} = output capacitance and ΔI_L = ripple current in the inductor. For a fixed output voltage, the output ripple is highest at maximum input voltage since ΔI_L increases with input voltage.

Aluminum electrolytic and dry tantalum capacitors are both available in surface mount configurations. In the case of tantalum, it is critical that the capacitors are surge tested for use in switching power supplies. An excellent choice is the AVX TPS series of surface mount tantalum. These are specially constructed and tested for low ESR so they give the lowest ESR for a given volume. Other capacitor types include Sanyo POSCAP, Kemet T510 and T495 series, and Sprague 593D and 595D series. Consult the manufacturer for other specific recommendations.

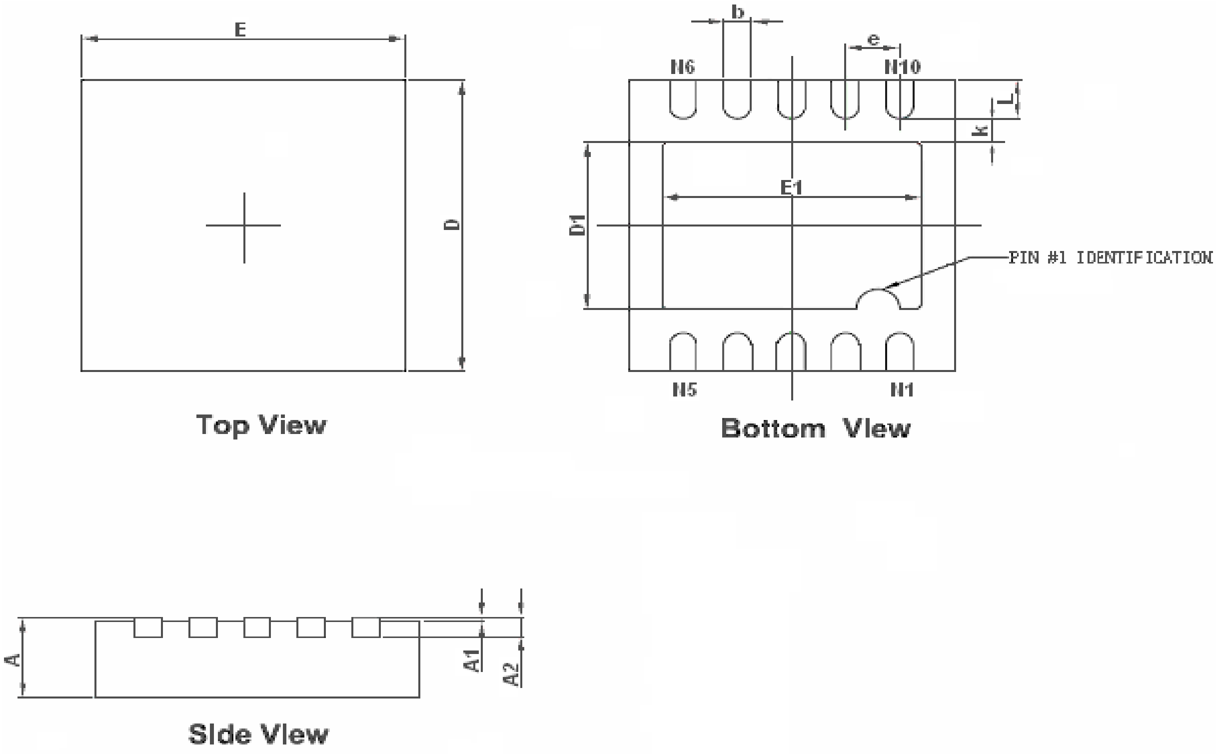
PCB LAYOUT GUIDELINES

When laying out the printed circuit board, the following checklist should be used to ensure proper operation of the SC16B09. These items are also illustrated graphically in Figures 1 and 2. Check the following in your layout:

- The power traces, consisting of the GND trace, the SW trace and the V_{IN} trace should be kept short, direct and wide.
- Does the VFB pin connect directly to the feedback resistors? The resistive divider R1/R2 must be connected between the (+) plate of C_{OUT} and ground.
- Does the (+) plate of C_{IN} connects to VIN as closely as possible? This capacitor provides the AC current to the internal power MOSFETs.
- Keep the switching node, SW, away from the sensitive V_{FB} node.
- Keep the (–) plates of C_{IN} and C_{OUT} as close as possible.

Packaging Information

DFN-10L Package Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A2	0.153	0.253	0.006	0.010
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
D1	1.600	1.800	0.063	0.071
E1	2.300	2.500	0.091	0.098
k	0.200MIN		0.008MIN	
b	0.200	0.300	0.008	0.012
e	0.500TYP		0.020TYP	
L	0.300	0.500	0.012	0.020