

Micro-Power Step-up DC/DC Converter

FEATURES

- Configurable output voltage up to 16V
- Quiescent current of 20 μ A
- Shutdown current <1 μ A
- Shutdown-pin current <1 μ A
- Supply range from 2.5V to 6.5V
- Low $V_{DS(on)}$: 250mV (I_{SW} =300mA)
- Tiny SOT-23-5 package

APPLICATIONS

- STN/TFT LCD Bias
- Personal Digital Assistants (PDAs)
- Handheld Computers
- Digital Still Cameras
- Cellular Phones
- WebPad
- White LED Driver
- Local 3V to 5V Conversion

DESCRIPTION

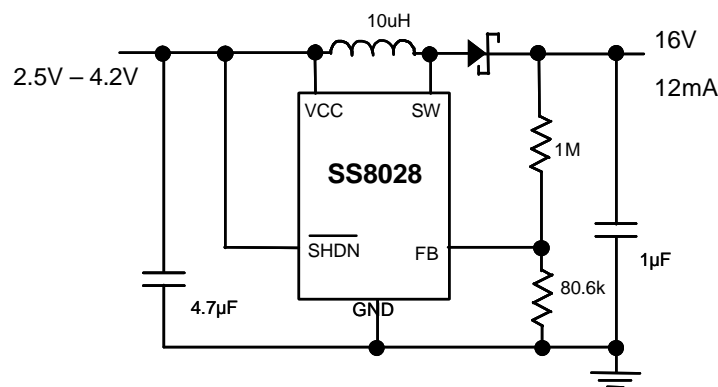
The SS8028 boost converter is designed for small and medium size LCD panels requiring high bias voltages.

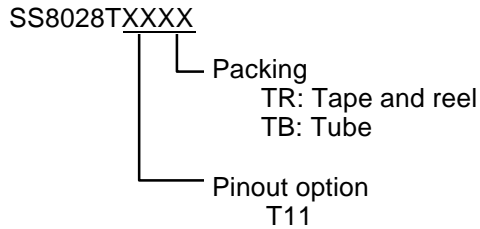
With a typical quiescent current of 20 μ A and a supply voltage range of 2.5V to 6.5V, it is suitable for battery powered portable applications, such as PDAs and handheld computers. When the SS8028 goes into shutdown mode, it consumes less than 1 μ A.

Furthermore, with a 350mA current limit, 500ns fixed minimum off-time and tiny SOT-23-5 package, the SS8028 can be used with smaller inductors and other surface-mount components to minimize the required PCB footprint in space-conscious applications.

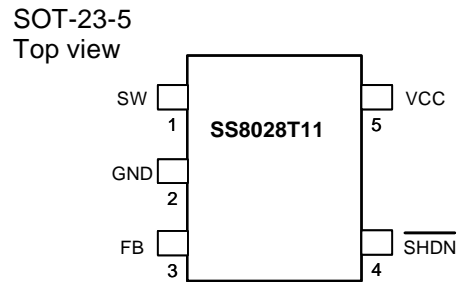
To control the SS8028, no other external current is needed for the shutdown pin, which typically consumes less than 1 μ A over the full supply range.

TYPICAL APPLICATION CIRCUIT



ORDERING INFORMATION
PIN CONFIGURATION


Example: SS8028T11TR
 → T11 pin configuration shipped in
 tape and reel packing


PIN DESCRIPTIONS

| PIN | NAME | FUNCTION |
|-----|--------------------------|---|
| 1 | SW | Switch pin. The drain of the internal N-MOSFET power switch. Connect this pin to the inductor. |
| 2 | GND | Ground. |
| 3 | FB | Feedback pin. Set the output voltage by selecting values for R1 and R2 (see the Block Diagram): $R1 = R2 \left(\frac{V_{OUT}}{1.2} - 1 \right)$ |
| 4 | $\overline{\text{SHDN}}$ | Active-low shutdown pin. Tie this pin to logic-high to enable the device, or tie it to logic-low to turn the device off. |
| 5 | VCC | Input supply pin. Bypass this pin with a capacitor as close to the device as possible. |

ABSOLUTE MAXIMUM RATINGS

SW to GND.....-0.3V to +18V
 FB to GND.....-0.3V to V_{CC}
 VCC, $\overline{\text{SHDN}}$ to GND.....-0.3V to +7V

Operating Temperature Range..... -40°C to 85°C
 Maximum Operating Junction Temperature..... +125°C
 Storage Temperature Range -65°C to 150°C
 Maximum Lead Temperature (Soldering, 10sec)..... +300°C

ELECTRICAL CHARACTERISTICS

 ($V_{CC} = 3.6V$, $V_{\overline{SHDN}} = 3.6V$, $T_A = 25^\circ C$)

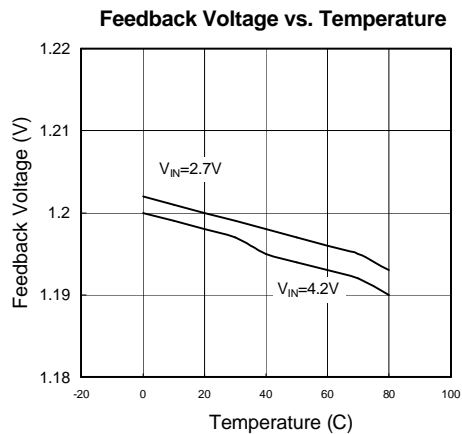
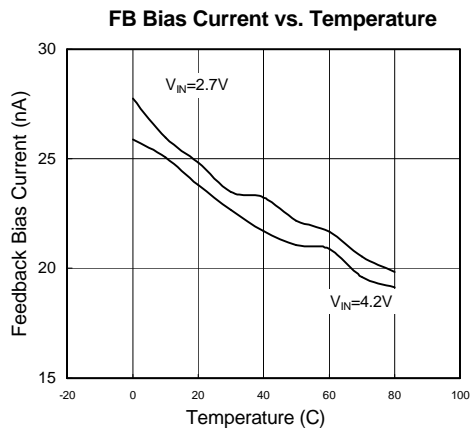
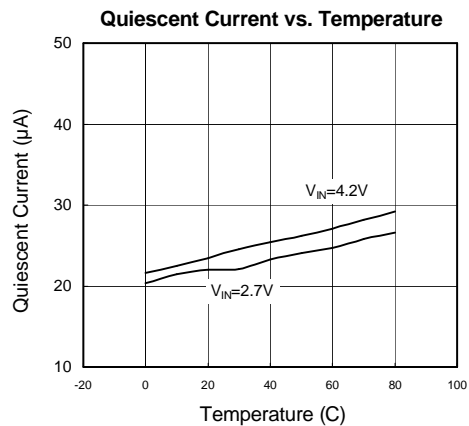
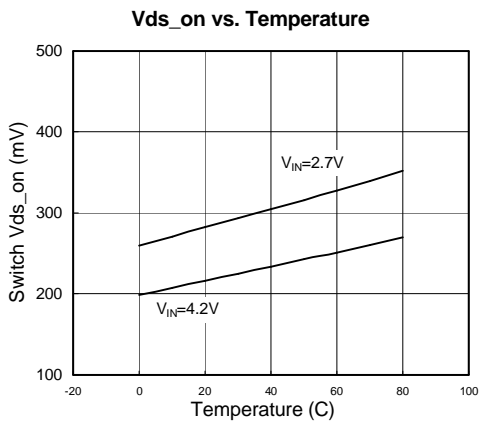
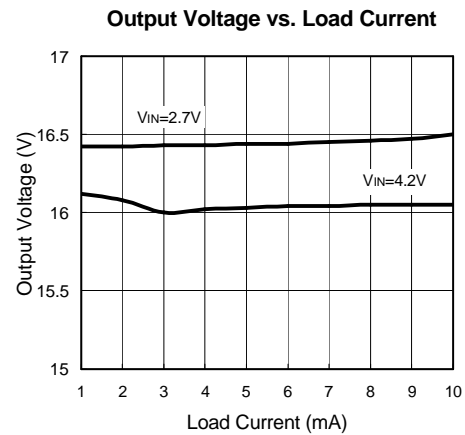
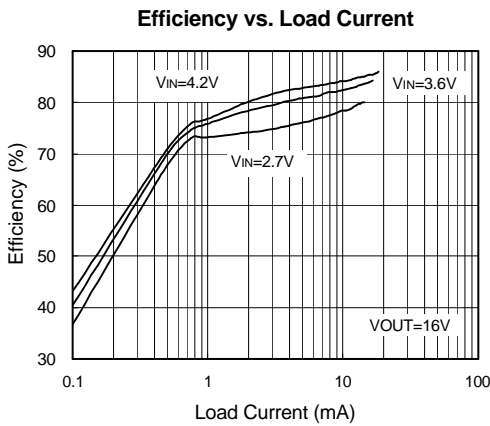
| PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|--------------------------------------|----------------------------|------|-------|------|---------|
| Input Voltage Range | | 2.5 | | 6.5 | V |
| Quiescent Current | Not switching | | 20 | 30 | μA |
| | $V_{\overline{SHDN}} = 0V$ | | 0.1 | 1 | μA |
| FB Comparator Trip Point | | 1.18 | 1.2 | 1.22 | V |
| Output Voltage Line Regulation | $2.5V < V_{IN} < 6.5V$ | | -0.05 | | %/V |
| FB Pin Bias Current (Note 2) | $V_{FB} = 1.2V$ | | 30 | 80 | nA |
| Switch Off Time | $V_{FB} > 1V$ | | 500 | | ns |
| | $V_{FB} < 0.6V$ | | 1.6 | | μs |
| Switch $V_{DS(ON)}$ | $I_{SW} = 300mA$ | | 250 | 350 | mV |
| Switch Current Limit | | 300 | 350 | 400 | mA |
| \overline{SHDN} Pin Current | | | 0.1 | 1 | μA |
| \overline{SHDN} Input Voltage High | | 0.9 | | | V |
| \overline{SHDN} Input Voltage Low | | | | 0.25 | V |
| Switch Leakage Current | Switch off, $V_{SW} = 16V$ | | 0.01 | 5 | μA |

Note 1: The SS8028 is guaranteed to meet performance specifications from $0^\circ C$ to $85^\circ C$. Specifications over the $-40^\circ C$ to $85^\circ C$ operating temperature range are assured by design, characterization and correlation with statistical process controls.

Note 2: Bias current flows into the FB pin.

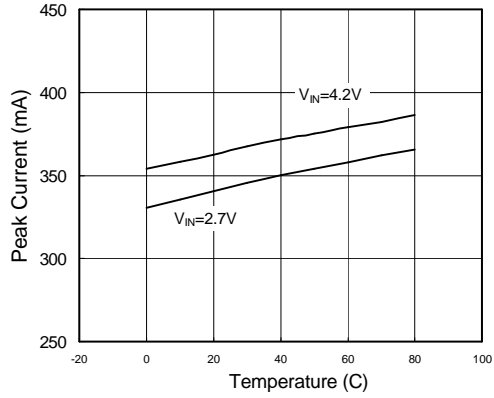
TYPICAL PERFORMANCE CHARACTERISTICS

($V_{CC}=+3.6V$, $V_{SHDN}=+3.6V$, $L=10\mu H$, $T_A=25^\circ C$, unless otherwise noted.)

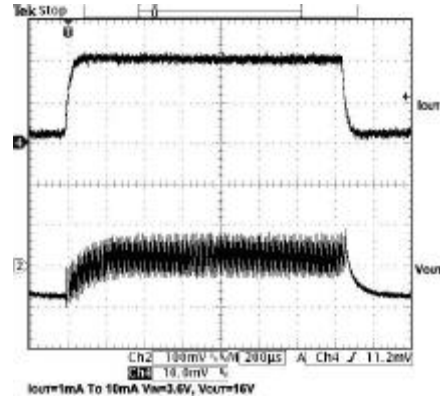


TYPICAL PERFORMANCE (cont.)

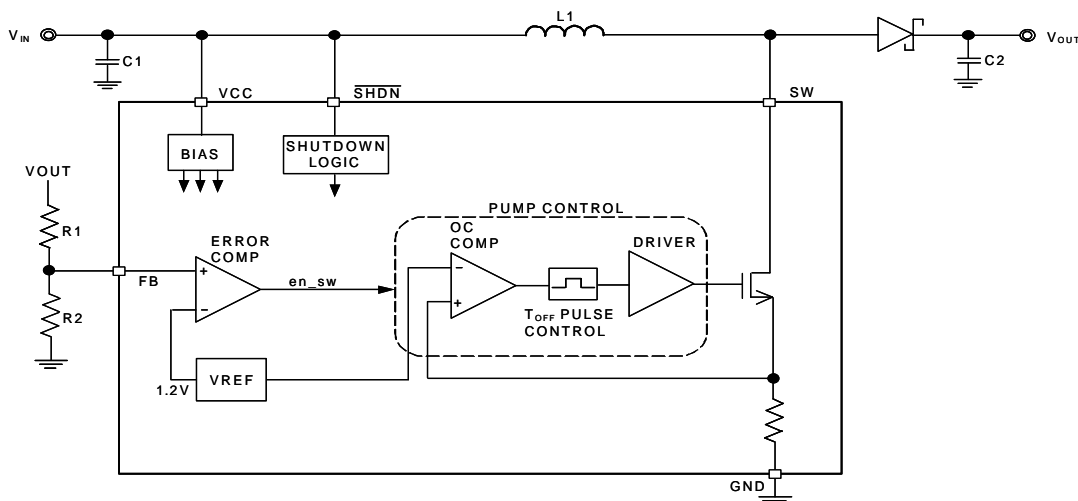
Switch Current Limit vs. Temperature



Load Transient



BLOCK DIAGRAM



APPLICATIONS INFORMATION

The SS8028 is a boost converter with an integrated N-channel MOSFET (refer to the block diagram above). The boost cycle is initiated when the FB pin voltage drops below 1.2V and the MOSFET turns on. During the period that the MOSFET is on, the inductor current ramps up until the 350mA current limit is reached. Then the MOSFET turns off and the inductor current flows through the external schottky diode, ramping down to zero. During the MOSFET off period, the inductor current charges the output capacitor and the output voltage climbs. This pumping mechanism continues cycle by cycle until the FB pin voltage exceeds 1.2V and the non-switching mode starts. In this mode, the SS8028 consumes as little as 20uA typically, saving on battery power.

Choosing an Inductor

There are several recommended inductors that work well with the SS8028 in Table 1. Use the equations and recommendations in the next few sections to find the proper inductance value for your design.

TABLE 1. RECOMMENDED INDUCTORS

| PART | VALUE(μH) | MAX DCR (Ω) | VENDOR |
|--------------|-----------|-------------|--------------------------------|
| LQH3C4R7 | 4.7 | 0.26 | Murata www.murata.com |
| LQH3C100 | 10 | 0.30 | |
| LQH3C220 | 22 | 0.92 | |
| CD43-4R7 | 4.7 | 0.11 | Sumida www.sumida.com |
| CD43-100 | 10 | 0.18 | |
| CDRH4D18-4R7 | 4.7 | 0.16 | |
| CDRH4D18-100 | 10 | 0.20 | |
| DO1608-472 | 4.7 | 0.09 | Coilcraft www.coilcraft.com |
| DO1608-103 | 10 | 0.16 | |
| DO1608-223 | 22 | 0.37 | |

Inductor Selection – Boost Regulator

The appropriate inductance value for the boost regulator application may be calculated from the following equation. Select a standard inductor close to this value.

$$L = \frac{V_{OUT} - V_{IN(MIN)} + V_D}{I_{LIM}} \times t_{OFF}$$

Here, $V_D = 0.4V$ (Schottky diode voltage), $I_{LIM} = 350mA$ and $t_{OFF} = 500ns$. A larger value can be used to slightly increase the available output current, but limit it to about twice the calculated value. When too large an inductor is used, the output voltage ripple will increase without providing much additional output current. In conditions of varying V_{IN} , such as battery power applications, use the minimum V_{IN} value in the above equation. A smaller value can be used to give smaller physical size, but overshoot of the inductor current will occur (see Current Limit Overshoot section).

Inductor Selection – SEPIC Regulator

For a SEPIC regulator using the SS8028, the approximate inductance value can be calculated using the formula below. As for the boost inductor selection, a larger or smaller value can be used.

$$L = 2 \left(\frac{V_{OUT} + V_D}{I_{LIM}} \right) \times t_{OFF}$$

Current Limit Overshoot

The SS8028 uses a constant off-time control scheme; the MOSFET is turned off after the 350mA current limit is reached. When the current limit is reached and the MOSFET actually turns off, there is a 100ns delay time. During this time, the inductor current exceeds the current limit by a small amount. The formula below can calculate the peak inductor current.

$$I_{PEAK} = I_{LIM} + \left(\frac{V_{IN(MAX)} - V_{SAT}}{L} \right) \times 100ns$$

Here, $V_{SAT} = 0.25V$ (switch saturation voltage). For systems with high input voltages and smaller inductance values, the current overshoot will be most apparent. This overshoot can be useful as it helps increase the amount of available output current. By using a small inductance value, the current limit overshoot can be quite high. Even though it is internally current limited to 350mA, the internal MOSFET of the SS8028 can handle larger currents

without any problem, but the total efficiency will suffer. For best performance, the I_{PEAK} is best kept below 500mA.

Capacitor Selection

Low ESR (Equivalent Series Resistance) capacitors should be used at the output to minimize the output ripple voltage and the peak-to-peak transient voltage. Multilayer ceramic capacitors (MLCC) are the best choice, as they have a very low ESR and are available in very small packages. Their small size makes them a good match with the SS8028's SOT-23 package. If solid tantalum capacitors (like the AVX TPS, Sprague 593D families) or OS-CON capacitors are used, they will occupy more volume than ceramic ones and the higher ESR increases the output ripple voltage. It is important to use a capacitor with a sufficient voltage rating.

A low ESR surface-mount ceramic capacitor also makes a good selection for the input bypass capacitor, which should be placed as close as possible to the SS8028. A 4.7 μF input capacitor is sufficient for most applications.

Diode Selection

For most SS8028 applications, the high switching frequency requires high-speed Schottky diodes, such as the Motorola MBR0530 (0.5A, 30V) with their low forward voltage drop and fast switching speed. Many different manufacturers make equivalent parts, but make sure that the component is rated for at least 0.35A. To achieve high efficiency, the average current rating of the Schottky diodes should be greater than the peak switching current. Choose a reverse breakdown voltage greater than the output voltage.

Lowering Output Ripple Voltage

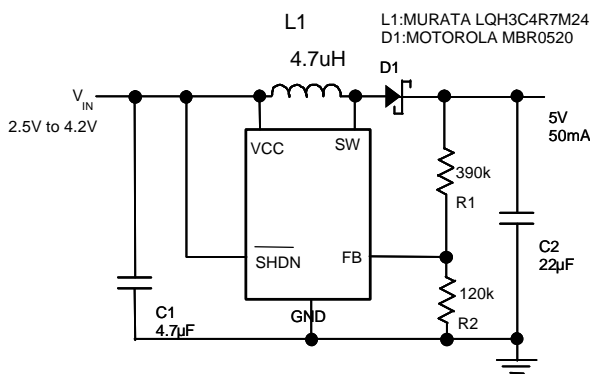
The SS8028 supplies energy to the load in bursts by ramping up the inductor current, then delivering that current to the load. Using low ESR capacitors will help

minimize the output ripple voltage, but proper selection of the inductor and the output capacitor also plays a big role. If a larger inductance value or a smaller capacitance value is used, the output ripple voltage will increase because the capacitor will be slightly overcharged each burst cycle. To reduce the

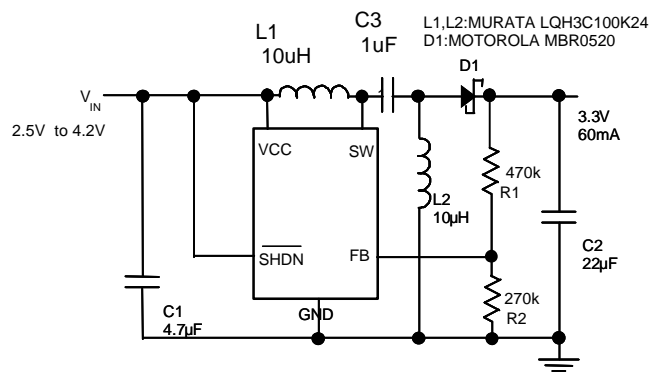
output ripple, increase the output capacitance value, or add a 10pF feed-forward capacitor in the feedback network of the SS8028 (see the circuits in the Typical Applications section). To add this small inexpensive 10pF capacitor will greatly reduce the output voltage ripple.

TYPICAL APPLICATION CIRCUITS

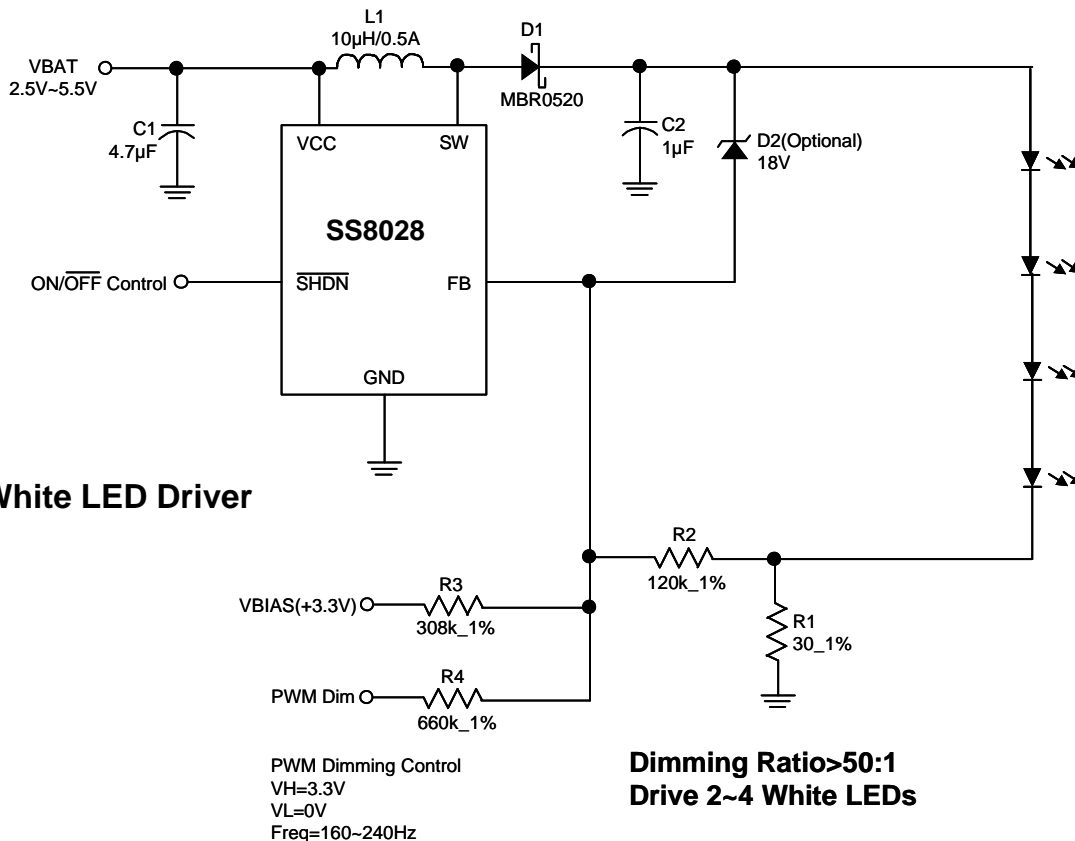
Boost Converter



SEPIC Converter

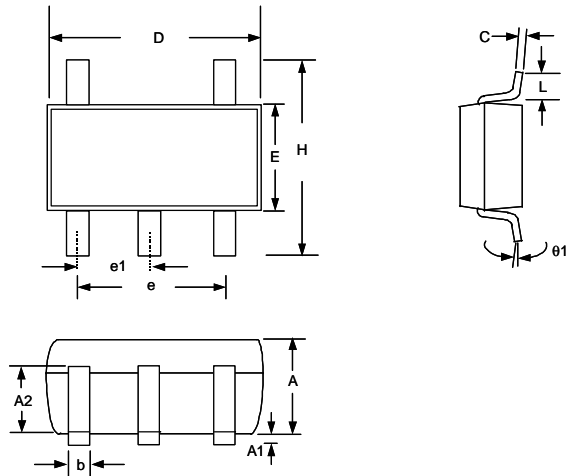


White LED Driver



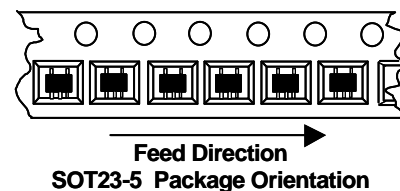
PACKAGE DIMENSIONS

SOT-23-5 (unit: mm)



| SYMBOLS | DIMENSIONS IN MILLIMETERS | | |
|---------|---------------------------|-----------|-------|
| | MIN | NOM | MAX |
| A | 1.00 | 1.10 | 1.30 |
| A1 | 0.00 | ----- | 0.10 |
| A2 | 0.70 | 0.80 | 0.90 |
| b | 0.35 | 0.40 | 0.50 |
| C | 0.10 | 0.15 | 0.25 |
| D | 2.70 | 2.90 | 3.10 |
| E | 1.40 | 1.60 | 1.80 |
| e | ----- | 1.90(TYP) | ----- |
| e1 | ----- | 0.95 | ----- |
| H | 2.60 | 2.80 | 3.00 |
| L | 0.37 | ----- | ----- |
| θ1 | 1° | 5° | 9° |

1. Package body sizes exclude mold flash protrusions or gate burrs
2. Tolerance ± 0.1000 mm (4mil) unless otherwise specified
3. Coplanarity: 0.1000mm
4. Dimension L is measured in gage plane



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