



## DESCRIPTION

The AP8022 combines a dedicated current mode PWM controller with a high voltage power MOSFET on the same silicon chip.

Typical Power Capability:

| Type                   | SOP8 | DIP8 |
|------------------------|------|------|
| European (195-265 Vac) | 12W  | 20W  |
| US (85-265 Vac)        | 7W   | 12W  |

The AP8022 is available in SOP8 and DIP8 package.

## ORDERING INFORMATION

| Package Type  | Part Number                                   |            |
|---|---|------------|
| SOP8  | M8  | AP8022M8U  |
|   |   | AP8022M8R  |
|   |   | AP8022M8VU |
|   |   | AP8022M8VR |
| DIP8  | P8  | AP8022P8U  |
|   |   | AP8022P8VU |
| Note  | U: Tube<br>R: Tape & Reel<br>V: Green Package |            |
| AiT provides all Pb free products<br>Suffix "V" means Green Package |   |            |

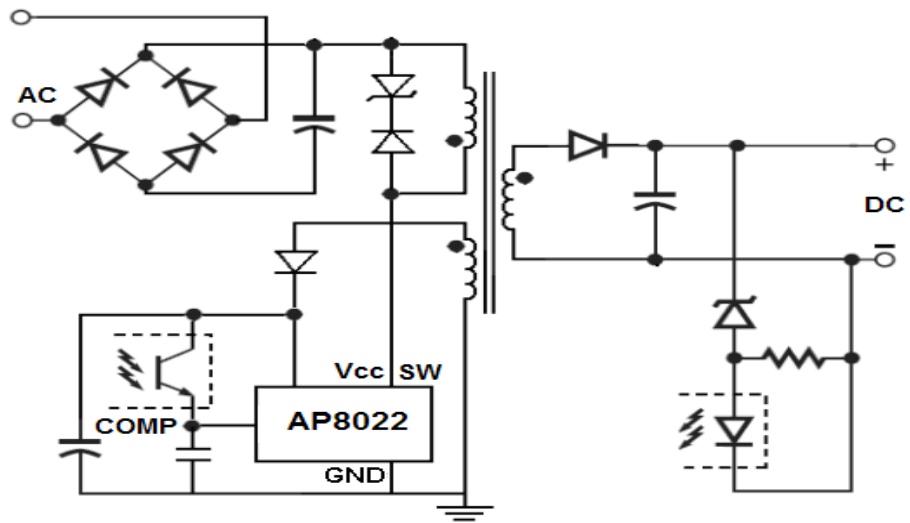
## FEATURES

- 85v to 265v wide range AC voltage input
- A 700v MOSFET on the same silicon chip
- Auto start up with high voltage current source
- PWM with current mode control
- 9v to 38v wide range VCC voltage
- Fixed 60KHz switching frequency
- Automatic skip cycle mode in low load condition.
- Over temperature, over current and over voltage protection
- Auxiliary under voltage lockout with hysteresis
- Available in SOP8 and DIP8 Package

## APPLICATION

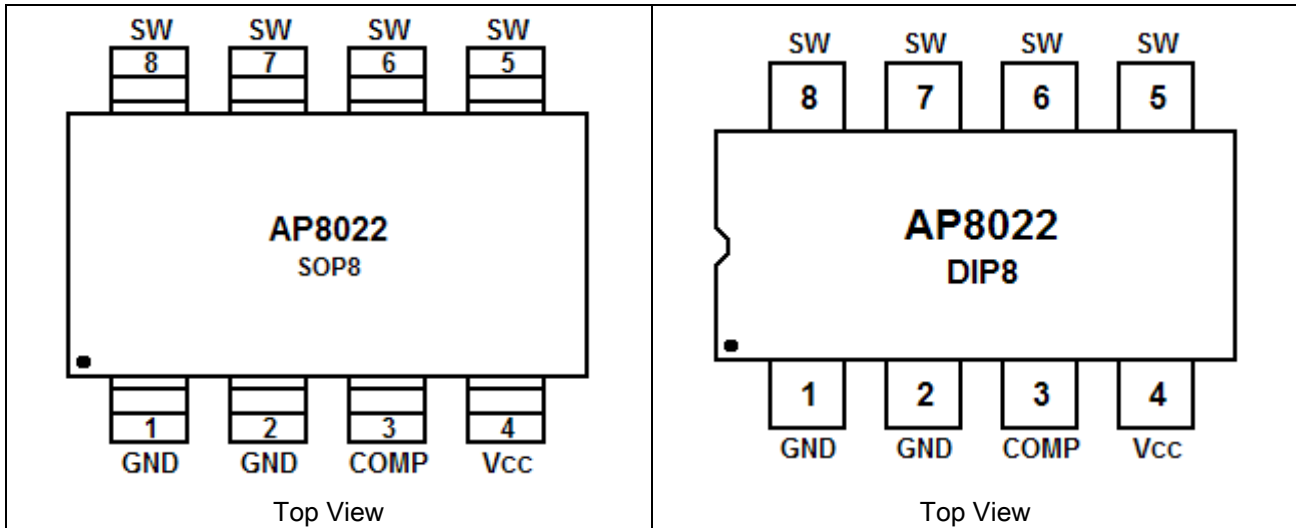
- Power AC/DC Adapters for Chargers
- DVD/VCD power supplies
- Electromagnetic Oven power supplies
- Air Conditioner power supplies
- STB power supplies
- AC/DC LED Driver Applications

### Typical Application





**PIN DESCRIPTION**



| Pin #   | Symbol | Function   |
|---------|--------|--|
| 1,2     | GND    | Sense FET source terminal on primary side and internal control ground.   |
| 3       | COMP   | Feedback input defines the peak drain MOSFET current.  |
| 4       | VCC    | Positive supply voltage input. Although connected to an auxiliary transformer winding, current is supplied from SW via an internal switch during startup (see Internal Block Diagram section). It is not until VCC reaches them UVLO upper threshold (14.5V) that the internal start-up switch opens and device power is supplied via the auxiliary transformer winding. |
| 5,6,7,8 | SW     | The SW pin is designed to connect directly to the primary lead of the transformer and is capable of switching a maximum of 700V.   |



## ABSOLUTE MAXIMUM RATINGS

(T<sub>A</sub>=25°C, unless otherwise specified)

|                     |  |                    |    |
|---------------------|--|--------------------|----|
| V <sub>SW</sub>     | SW to GND Voltage (T <sub>j</sub> =25-125°C)               | -0.3 to 730        | V  |
| I <sub>D</sub>      | Continuous VDMOS Drain Current                             | Internally limited | A  |
| V <sub>CC</sub>     | Supply Voltage   | 0 to 50            | V  |
| I <sub>COMP</sub>   | Feedback Current   | 3                  | mA |
| V <sub>ESDMM</sub>  | Electrostatic Discharge:<br>Machine Model ((R=0Ω; C=200pF) | 200                | V  |
| V <sub>ESDHBM</sub> | Electrostatic Discharge: HBM                               | 2000               | V  |
| T <sub>j</sub>      | Junction Operating Temperature                             | Internally limited | °C |
| T <sub>c</sub>      | Case Operating Temperature                                 | -40 to 150         | °C |
| T <sub>STG</sub>    | Storage Temperature  | -55 to 150         | °C |

Stresses above may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated in the Electrical Characteristics are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

### Power

| Symbol              | Parameter                         | Condition  | Min. | Typ. | Max. | Unit |
|---------------------|-----------------------------------|--|------|------|------|------|
| BV <sub>DSS</sub>   | VDMOS Breakdown Voltage           | I <sub>D</sub> =1mA;<br>V <sub>COMP</sub> =2V    | 730  |      |      | V    |
| I <sub>DSS</sub>    | Zero Gate Voltage Drain Current   | V <sub>DS</sub> =500V;<br>V <sub>COMP</sub> =2V; |      |      | 100  | μA   |
| R <sub>DS(on)</sub> | Static Drain-Source on Resistance | V <sub>GS</sub> =10V<br>I <sub>D</sub> =0.4A;    |      | 15   | 17   | Ω    |
| T <sub>r</sub>      | Rise Time                         | I <sub>D</sub> =0.1A;<br>V <sub>IN</sub> =300V   |      | 50   |      | ns   |
| T <sub>f</sub>      | Fall Time                         | I <sub>D</sub> =0.2A;<br>V <sub>IN</sub> =300V   |      | 100  |      |      |
| C <sub>OSS</sub>    | VDMOS Drain Capacitance           | V <sub>DS</sub> =25V                             |      | 40   |      | pF   |



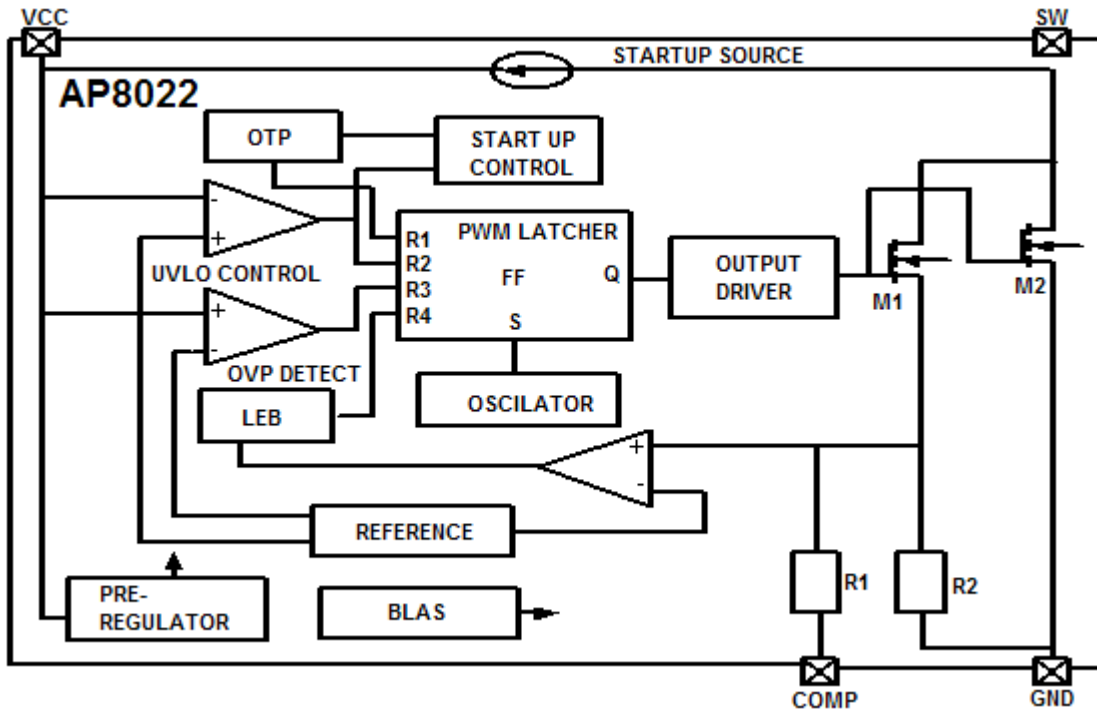
**Control**

(T<sub>A</sub>=25°C, VCC=18V, unless otherwise specified)

| Symbol                                       | Parameter  | Condition  | Min. | Typ. | Max. | Unit |
|--|--|--|------|------|------|------|
| <b>UVLO SECTION</b>                          |  |  |      |      |      |      |
| V <sub>START</sub>                           | VCC Start Threshold Voltage                                | V <sub>COMP</sub> =0V  | 13   | 14.5 | 16   | V    |
| V <sub>STOP</sub>                            | VCC Stop Threshold Voltage                                 | V <sub>COMP</sub> =0V  | 7    | 8    | 9    | V    |
| V <sub>HYS</sub>                             | VCC Threshold Hysteresis                                   |  | 5.8  | 6.5  | 7.2  | V    |
| <b>OSCILLATOR SECTION</b>                    |  |  |      |      |      |      |
| F <sub>OSC</sub>                             | Initial Accuracy   | V <sub>STOP</sub> ≤VCC≤35V;<br>0≤T <sub>j</sub> ≤ 100°C              | 54   | 60   | 66   | kHz  |
| ΔF/ΔT  | Frequency Change With Temperature                          | -25°C ≤ T <sub>j</sub> ≤ +85°C                                       |      | ±5   | ±10  | %    |
| <b>FEEDBACK SECTION</b>                      |  |  |      |      |      |      |
| I <sub>COMP</sub>                            | Feedback Shutdown Current                                  | T <sub>j</sub> =25°C,<br>V <sub>COMP</sub> = 0V                      |      | 0.9  |      | mA   |
| R <sub>COMP</sub>                            | COMP Pin Input Impedance                                   | I <sub>D</sub> =0mA  |      | 1.2  |      | kΩ   |
| <b>CURRENT LIMIT(SELF-PROTECTION)SECTION</b> |  |  |      |      |      |      |
| G <sub>ID</sub>                              | I <sub>COMP</sub> to I <sub>D</sub> Current Gain           |  |      | 560  |      |      |
| I <sub>LIM</sub>                             | Peak Current Limit   | T <sub>j</sub> = 25°C  | 0.56 | 0.70 | 0.84 | A    |
| T <sub>D</sub>                               | Current Sense Delay to Turn-Off                            | I <sub>D</sub> =0.2A   |      |      | 200  | ns   |
| T <sub>B</sub>                               | Blanking Time  |  |      |      | 500  | ns   |
| T <sub>ONMIN</sub>                           | Minimum Turn On Time                                       |  |      |      | 700  | ns   |
| <b>PROTECTION SECTION</b>                    |  |  |      |      |      |      |
| T <sub>SD</sub>                              | Thermal Shutdown Temperature                               |  | 140  | 170  | -    | °C   |
| T <sub>HYST</sub>                            | Thermal Shutdown Hysteresis                                |  |      | 40   |      | °C   |
| V <sub>OVP</sub>                             | Over Voltage Protection                                    |  | 38   | 42   | 46   | V    |
| <b>SUPPLY CURRENT SECTION</b>                |  |  |      |      |      |      |
| I <sub>CH</sub>                              | Startup Charging Current                                   |  |      | 1    |      | mA   |
| I <sub>CHOFF</sub>                           | Start Up Charging Current in Thermal Shutdown              | VCC=5V;<br>V <sub>DS</sub> =100V<br>T <sub>j</sub> > T <sub>SD</sub> |      |      | 0.2  | mA   |
| I <sub>OP0</sub>                             | Operating Supply Current (Control Part Only) Switching     | V <sub>COMP</sub> = 0V   |      | 4.5  |      | mA   |
| I <sub>OP1</sub>                             | Operating Supply Current (Control Part Only) Not Switching | V <sub>COMP</sub> = 2V   |      | 3    | 5    | mA   |



**BLOCK DIAGRAM**



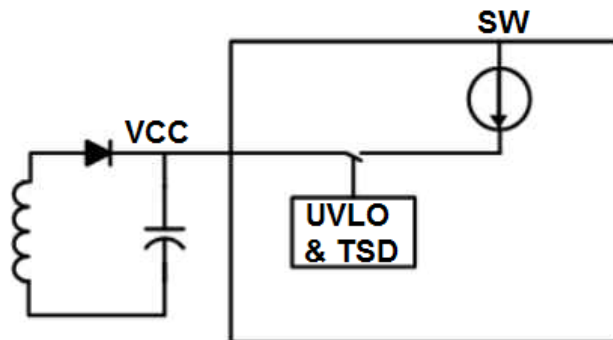


## DETAILED INFORMATION

### Startup

This device includes a high voltage start up current source connected on the SW of the device. As soon as a voltage is applied on the input of the converter, this start up current source is activated and to charge the VCC capacitor as long as VCC is lower than VSTART. When reaching VSTART, the start up current source is cut off by UVLO&TSD and the device begins to operate by turning on and off its main power MOSFET. As the COMP pin does not receive any current from the opto-coupler, the device operates at full current capacity and the output voltage rises until reaching the regulation point where the secondary loop begins to send a current in the opto-coupler. At this point, the converter enters a regulated operation where the COMP pin receives the amount of current needed to deliver the right power on secondary side.

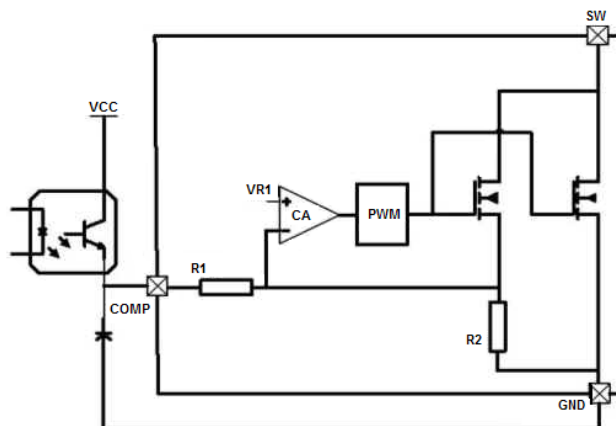
Fig 1. Startup circuit



### Feedback

A feedback pin controls the operation of the device. Unlike conventional PWM control circuits which use a voltage input, the COMP pin is sensitive to current. The Fig 2. presents the internal current mode structure.

Fig 2. Feedback Circuit





The Power MOSFET delivers a sense current which is proportional to the main current. R2 receives this current and the current coming from the COMP pin. The voltage across R2 VR2 is then compared to a fixed reference voltage. The MOSFET is switched off when VR2 equals the reference voltage.

### **Leading Edge Blanking (LEB)**

At the instant the internal Sense FET is turned on, there usually exists a high current spike through the Sense FET, caused by the primary side capacitance and secondary side rectifier diode reverse recovery.

Excessive voltage across the sense resistor would lead to false feedback operation in the current mode PWM control. To counter this effect, the device employs a leading edge blanking (LEB) circuit. This circuit inhibits the PWM comparator for a short time (typically 500ns) after the Sense FET is turned on.

### **Under Voltage Lock Out**

Once fault condition occurs, switching is terminated and the Sense FET remains off. This causes VCC to fall. When VCC reaches the UVLO stop voltage, 8V, the protection is reset and the internal high voltage current source charges the VCC capacitor. When VCC reaches the UVLO start voltage, 14.5V, the device resumes its normal operation. In this manner, the auto-restart can alternately enable and disable the switching of the power Sense FET until the fault condition is eliminated.

### **Thermal Shutdown (TSD)**

The Sense FET and the control IC are integrated in the same chip, making it easier for the control IC to detect the temperature of the Sense FET. When the temperature exceeds approximately 170°C, thermal shutdown is activated, the device turn off the Sense FET and the high voltage current source to charge VCC. The device will go back to work when the lower threshold temperature about 140°C is reached.

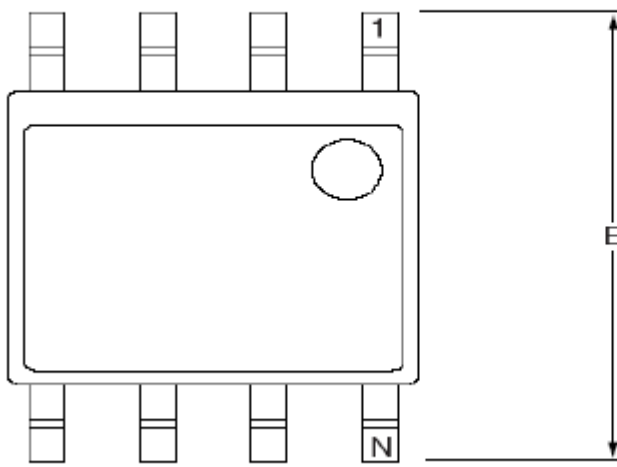
### **Over Voltage Protection (OVP)**

In case of malfunction in the secondary side feedback circuit, or feedback loop open caused by a defect of solder, the current through the opto-coupler transistor becomes almost zero. Because excess energy is provided to the output, the output voltage may exceed the rated voltage, resulting in the breakdown of the devices in the secondary side. In order to prevent this situation, an over voltage protection (OVP) circuit is employed. If VCC exceeds 42V, OVP circuit is activated resulting in termination of the switching operation. In order to avoid undesired activation of OVP during normal operation, VCC should be properly designed to be below 42V.

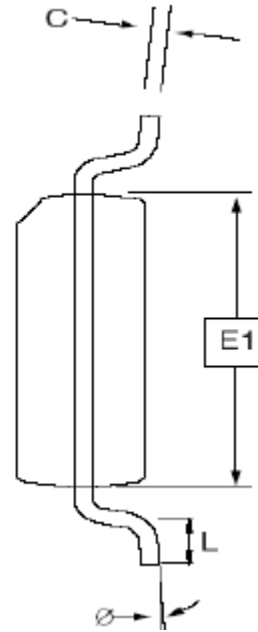


**PACKAGE INFORMATION**

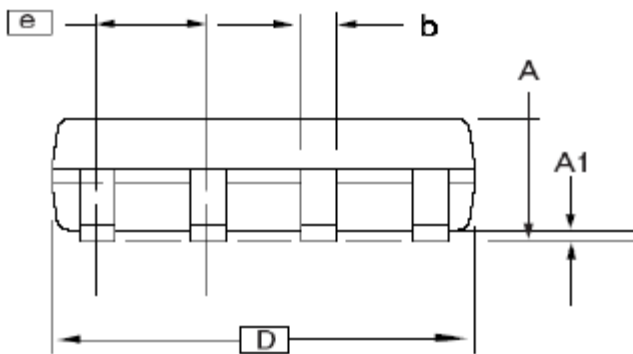
Dimension in SOP8 Package (Unit: mm)



TOP VIEW



END VIEW



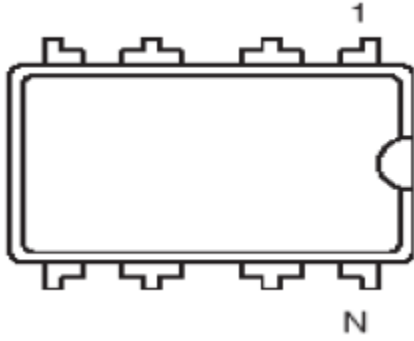
SIDE VIEW

| SYMBOL | MIN     | NOM  | MAX  |
|--------|---------|------|------|
| A      | -       | -    | 1.77 |
| A1     | 0.08    | 0.18 | 0.28 |
| B      | 0.44    | -    | 0.53 |
| C      | 0.21    | -    | 0.26 |
| D      | 4.70    | 4.90 | 5.10 |
| E      | 5.80    | 6.00 | 6.20 |
| E1     | 3.70    | 3.90 | 4.10 |
| E      | 1.27BSC |      |      |
| Φ      | 0       | -    | 8°   |

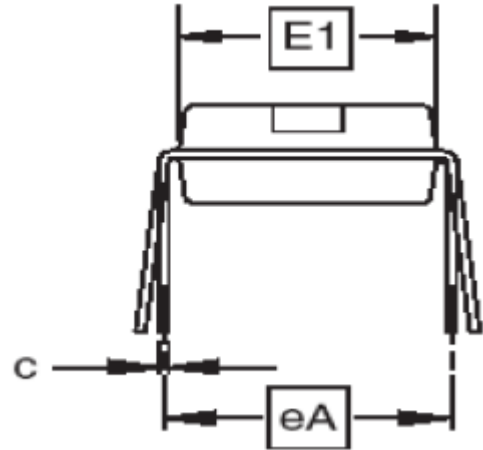




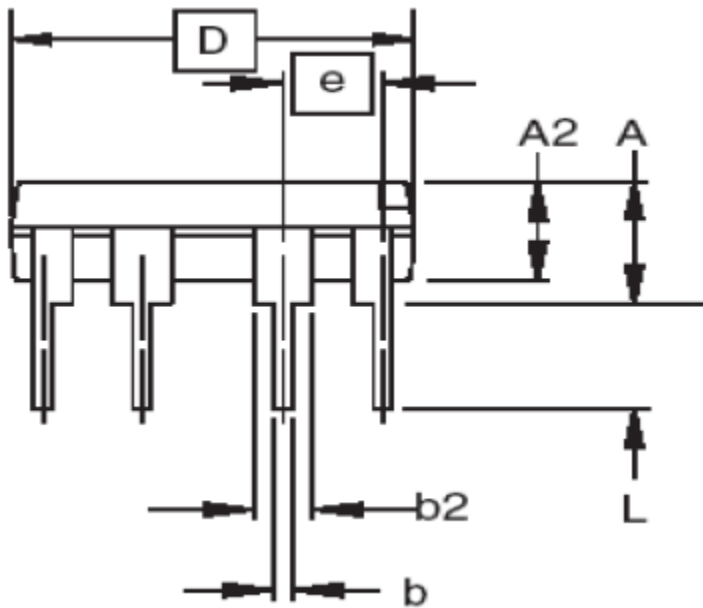
Dimension in DIP8 Package (Unit: mm)



TOP VIEW



END VIEW



SIDE VIEW

| SYMBOL | MIN     | NOM  | MAX  |
|--------|---------|------|------|
| A      | 3.60    | 3.80 | 4.00 |
| A2     | 3.10    | 3.30 | 3.50 |
| b      | 0.44    | -    | 0.53 |
| B1     | 1.52BSC |      |      |
| c      | 0.25    | -    | 0.31 |
| c1     | 0.24    | 0.25 | 0.26 |
| D      | 9.05    | 9.25 | 9.45 |
| E1     | 6.15    | 6.35 | 6.55 |
| e      | 2.54BSC |      |      |
| eA     | 7.62BSC |      |      |
| L      | 3.00    | -    | -    |



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