

## LM60/LM60-Q1 2.7V, SOT-23 or TO-92 Temperature Sensor

Check for Samples: [LM60/LM60-Q1](#)

### FEATURES

- Calibrated linear scale factor of +6.25 mV/°C
- Rated for full –40°C to +125°C range
- Suitable for remote applications
- Available in SOT-23 and TO-92 packages
- LM60Q is AEC-Q100 Grade 1 qualified and is manufactured on an Automotive Grade flow.

### APPLICATIONS

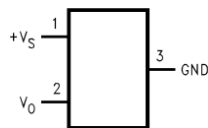
- Automotive
- Cell Phones & Computers
- Power Supply Modules
- Battery Management
- FAX Machines & Printers
- HVAC & Disk Drives
- Appliances

### KEY SPECIFICATIONS

- Accuracy at 25°C: ±2.0°C and ±3.0°C (max)
- Accuracy for –40°C to +125°C: ±4.0°C (max)
- Accuracy for –25°C to +125°C: ±3.0°C (max)
- Temperature Slope: +6.25mV/°C
- Power Supply Voltage Range: +2.7V to +10V
- Current Drain at 25°C: 110µA (max)
- Nonlinearity: ±0.8°C (max)
- Output Impedance: 800Ω (max)

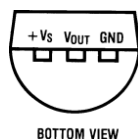
### CONNECTION DIAGRAMS

#### SOT-23 (TOP VIEW)



SVA-1268101

#### TO-92 (BOTTOM VIEW)



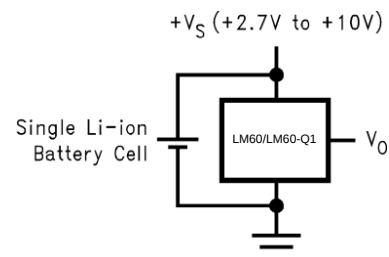
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### DESCRIPTION

The LM60/LM60-Q1 is a precision integrated-circuit temperature sensor that can sense a –40°C to +125°C temperature range while operating from a single +2.7V supply. The LM60/LM60-Q1's output voltage is linearly proportional to Celsius (Centigrade) temperature (+6.25 mV/°C) and has a DC offset of +424 mV. The offset allows reading negative temperatures without the need for a negative supply. The nominal output voltage of the LM60/LM60-Q1 ranges from +174 mV to +1205 mV for a –40°C to +125°C temperature range. The LM60/LM60-Q1 is calibrated to provide accuracies of ±2.0°C at room temperature and ±3°C over the full –25°C to +125°C temperature range.

The LM60/LM60-Q1's linear output, +424 mV offset, and factory calibration simplify external circuitry required in a single supply environment where reading negative temperatures is required. Because the LM60/LM60-Q1's quiescent current is less than 110 µA, self-heating is limited to a very low 0.1°C in still air in the SOT-23 package. Shutdown capability for the LM60/LM60-Q1 is intrinsic because its inherent low power consumption allows it to be powered directly from the output of many logic gates.

### TYPICAL APPLICATION



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$$V_O = (+6.25 \text{ mV/}^\circ\text{C} \times T^\circ\text{C}) + 424 \text{ mV}$$

| Temperature (T) | Typical VO |
|-----------------|------------|
| +125°C          | +1205 mV   |
| +100°C          | +1049 mV   |
| +25°C           | +580 mV    |
| 0°C             | +424 mV    |
| –25°C           | +268 mV    |
| –40°C           | +174 mV    |

**Figure 1. Full-Range Centigrade Temperature Sensor (–40°C to 125°C) Operating from a Single Li-Ion Battery Cell**



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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### ORDERING INFORMATION

| ORDER NUMBER | DEVICE TOP MARK | ACCURACY OVER SPECIFIED TEMPERATURE RANGE | SPECIFIED TEMPERATURE RANGE     |
|--------------|-----------------|-------------------------------------------|---------------------------------|
| LM60BIM3     | T6B             | ±3                                        | –25°C ≤ T <sub>A</sub> ≤ +125°C |
| LM60BIM3X    | T6B             |                                           |                                 |
| LM60CIM3     | T6C             | ±4                                        | –40°C ≤ T <sub>A</sub> ≤ +125°C |
| LM60CIM3X    | T6C             |                                           |                                 |
| LM60QIM3     | L60Q            | ±4                                        | –40°C ≤ T <sub>A</sub> ≤ +125°C |
| LM60QIM3X    | L60Q            |                                           |                                 |
| LM60BIZ      | LM60BIZ         | ±3                                        | –25°C ≤ T <sub>A</sub> ≤ +125°C |
| LM60CIZ      | LM60CIZ         | ±4                                        | –40°C ≤ T <sub>A</sub> ≤ +125°C |

### ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

|                                                   |                  |        | VALUE                           | UNIT |
|---------------------------------------------------|------------------|--------|---------------------------------|------|
| Supply voltage                                    |                  |        | +12 to -0.2                     | V    |
| Output voltage                                    |                  |        | (+V <sub>S</sub> + 0.6) to -0.6 | V    |
| Output current                                    |                  |        | 10                              | mA   |
| Input Current at any pin <sup>(2)</sup>           |                  |        | 5                               | mA   |
| ESD Susceptibility <sup>(3)</sup>                 | Human Body Model |        | 2500                            | V    |
|                                                   | Machine Model    | SOT-23 | 250                             | V    |
|                                                   |                  | TO-92  | 200                             | V    |
| Storage temperature                               |                  |        | -65 to +150                     | °C   |
| Maximum junction temperature (T <sub>JMAX</sub> ) |                  |        | 125                             | °C   |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do **not** guarantee specific performance limits. For specified specifications and test conditions, see the Electrical Characteristics. The specified specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
- (2) When the input voltage (V<sub>I</sub>) at any pin exceeds power supplies (V<sub>I</sub> < GND or V<sub>I</sub> > +V<sub>S</sub>), the current at that pin should be limited to 5 mA.
- (3) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin. The machine model is a 200 pF capacitor discharged directly into each pin.

### RECOMMENDED OPERATING CONDITIONS<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

|                                                    |                                                      | MIN | NOM                         | MAX | UNIT |
|----------------------------------------------------|------------------------------------------------------|-----|-----------------------------|-----|------|
| Specified Temperature Range:                       | T <sub>MIN</sub> ≤ T <sub>A</sub> ≤ T <sub>MAX</sub> |     |                             |     |      |
|                                                    | LM60B                                                |     | –25 ≤ T <sub>A</sub> ≤ +125 |     | °C   |
|                                                    | LM60C/LM60-Q1                                        |     | –40 ≤ T <sub>A</sub> ≤ +125 |     | °C   |
| Supply Voltage Range (+V <sub>S</sub> )            |                                                      | 2.7 |                             | 10  | V    |
| Thermal Resistance, θ <sub>JA</sub> <sup>(2)</sup> | SOT-23                                               |     |                             | 450 | °C/W |
|                                                    | TO-92                                                |     |                             | 180 | °C/W |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do **not** guarantee specific performance limits. For specified specifications and test conditions, see the Electrical Characteristics. The specified specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
- (2) The junction to ambient thermal resistance (θ<sub>JA</sub>) is specified without a heat sink in still air.

## ELECTRICAL CHARACTERISTICS

Unless otherwise noted, these specifications apply for  $+V_S = +3.0\text{ V}_{DC}$  and  $I_{LOAD} = 1\text{ }\mu\text{A}$ . **Boldface limits apply for  $T_A = T_J = T_{MIN}$  to  $T_{MAX}$** ; all other limits  $T_A = T_J = 25^\circ\text{C}$ .

| PARAMETER                                    | CONDITIONS                                             | TYPICAL <sup>(1)</sup> | LM60B                       | LM60C/LM60-Q1               | UNITS (Limit)                |
|----------------------------------------------|--------------------------------------------------------|------------------------|-----------------------------|-----------------------------|------------------------------|
|                                              |                                                        |                        | Limits <sup>(2)</sup>       | Limits <sup>(2)</sup>       |                              |
| Accuracy <sup>(3)</sup>                      |                                                        |                        | $\pm 2.0$                   | $\pm 3.0$                   | $^\circ\text{C}$ (max)       |
|                                              |                                                        |                        | <b><math>\pm 3.0</math></b> | <b><math>\pm 4.0</math></b> | $^\circ\text{C}$ (max)       |
| Output Voltage at $0^\circ\text{C}$          |                                                        | +424                   |                             |                             | mV                           |
| Nonlinearity <sup>(4)</sup>                  |                                                        |                        | <b><math>\pm 0.6</math></b> | <b><math>\pm 0.8</math></b> | $^\circ\text{C}$ (max)       |
| Sensor Gain (Average Slope)                  |                                                        | +6.25                  | <b>6.06</b>                 | <b>6</b>                    | mV/ $^\circ\text{C}$ (min)   |
|                                              |                                                        |                        | <b>6.44</b>                 | <b>6.5</b>                  | mV/ $^\circ\text{C}$ (max)   |
| Output Impedance                             |                                                        |                        | <b>800</b>                  | <b>800</b>                  | $\Omega$ (max)               |
| Line Regulation <sup>(5)</sup>               | $+3.0\text{ V} \leq +V_S \leq +10\text{ V}$            |                        | <b><math>\pm 0.3</math></b> | <b><math>\pm 0.3</math></b> | mV/V (max)                   |
|                                              | $+2.7\text{ V} \leq +V_S \leq +3.3\text{ V}$           |                        | <b><math>\pm 2.3</math></b> | <b><math>\pm 2.3</math></b> | mV (max)                     |
| Quiescent Current                            | $+2.7\text{ V} \leq +V_S \leq +10\text{ V}$            | 82                     | 110                         | 110                         | $\mu\text{A}$ (max)          |
|                                              |                                                        |                        | <b>125</b>                  | <b>125</b>                  | $\mu\text{A}$ (max)          |
| Change of Quiescent Current                  | $+2.7\text{ V} \leq +V_S \leq +10\text{ V}$            | $\pm 5.0$              |                             |                             | $\mu\text{A}$ (max)          |
| Temperature Coefficient of Quiescent Current |                                                        | 0.2                    |                             |                             | $\mu\text{A}/^\circ\text{C}$ |
| Long Term Stability <sup>(6)</sup>           | $T_J = T_{MAX} = +125^\circ\text{C}$<br>for 1000 hours | $\pm 0.2$              |                             |                             | $^\circ\text{C}$             |

(1) Typicals are at  $T_J = T_A = 25^\circ\text{C}$  and represent most likely parametric norm.

(2) Limits are specified to National's AOQL (Average Outgoing Quality Level).

(3) Accuracy is defined as the error between the output voltage and  $+6.25\text{ mV}/^\circ\text{C}$  times the device's case temperature plus 424 mV, at specified conditions of voltage, current, and temperature (expressed in  $^\circ\text{C}$ ).

(4) Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the device's rated temperature range.

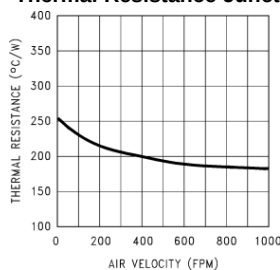
(5) Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output due to heating effects can be computed by multiplying the internal dissipation by the thermal resistance.

(6) For best long-term stability, any precision circuit will give best results if the unit is aged at a warm temperature, and/or temperature cycled for at least 46 hours before long-term life test begins. This is especially true when a small (Surface-Mount) part is wave-soldered; allow time for stress relaxation to occur. The majority of the drift will occur in the first 1000 hours at elevated temperatures. The drift after 1000 hours will not continue at the first 1000 hour rate.

## TYPICAL CHARACTERISTICS

To generate these curves the LM60/LM60-Q1 was mounted to a printed circuit board as shown in [Figure 13](#).

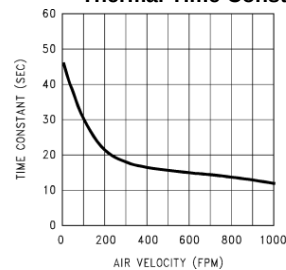
**Thermal Resistance Junction to Air**



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**Figure 2.**

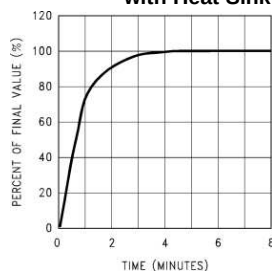
**Thermal Time Constant**



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**Figure 3.**

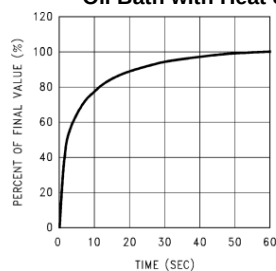
**Thermal Response in Still Air  
with Heat Sink**



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**Figure 4.**

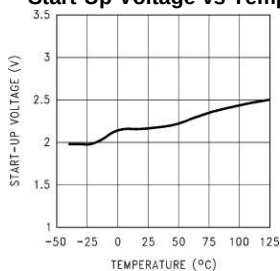
**Thermal Response in Stirred  
Oil Bath with Heat Sink**



SVA-1268106

**Figure 5.**

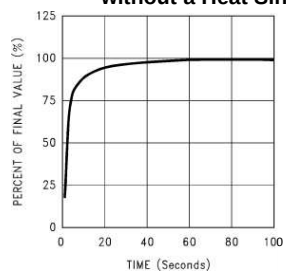
**Start-Up Voltage vs Temperature**



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**Figure 6.**

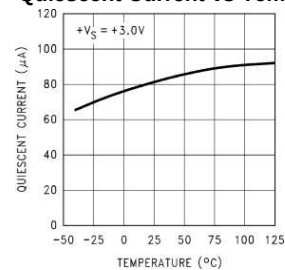
**Thermal Response in Still Air  
without a Heat Sink**



SVA-1268108

**Figure 7.**

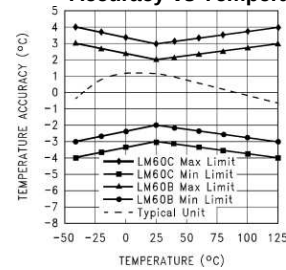
**Quiescent Current vs Temperature**



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**Figure 8.**

**Accuracy vs Temperature**

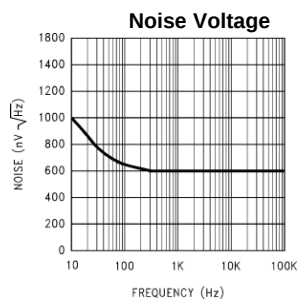


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**Figure 9.**

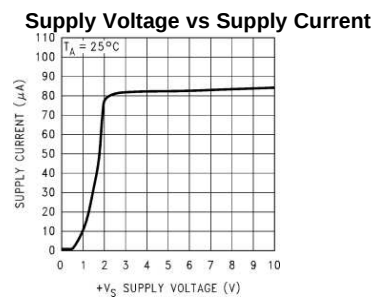
## TYPICAL CHARACTERISTICS (continued)

To generate these curves the LM60/LM60-Q1 was mounted to a printed circuit board as shown in [Figure 13](#).



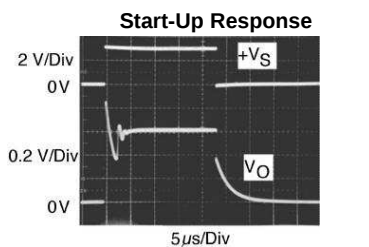
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**Figure 10.**



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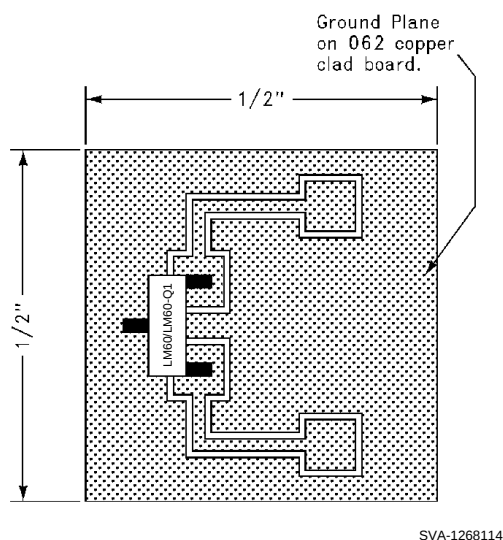
**Figure 11.**



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**Figure 12.**

## APPLICATION INFORMATION



NOTE: 1/2" Square Printed Circuit Board with 2 oz. Copper Foil or Similar.

**Figure 13. Printed Circuit Board Used for Heat Sink to Generate All Curves**

## Mounting

The LM60/LM60-Q1 can be applied easily in the same way as other integrated-circuit temperature sensors. It can be glued or cemented to a surface. The temperature that the LM60/LM60-Q1 is sensing will be within about  $\pm 0.1^\circ\text{C}$  of the surface temperature that LM60/LM60-Q1's leads are attached to.

This presumes that the ambient air temperature is almost the same as the surface temperature; if the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM60/LM60-Q1 die would be at an intermediate temperature between the surface temperature and the air temperature.

To ensure good thermal conductivity the backside of the LM60/LM60-Q1 die is directly attached to the GND pin. The lands and traces to the LM60/LM60-Q1 will, of course, be part of the printed circuit board, which is the object whose temperature is being measured. These printed circuit board lands and traces will not cause the LM60/LM60-Q1's temperature to deviate from the desired temperature.

Alternatively, the LM60/LM60-Q1 can be mounted inside a sealed-end metal tube, and can then be dipped into a bath or screwed into a threaded hole in a tank. As with any IC, the LM60/LM60-Q1 and accompanying wiring and circuits must be kept insulated and dry, to avoid leakage and corrosion. This is especially true if the circuit may operate at cold temperatures where condensation can occur. Printed-circuit coatings and varnishes such as Humiseal and epoxy paints or dips are often used to ensure that moisture cannot corrode the LM60/LM60-Q1 or its connections.

The thermal resistance junction to ambient ( $\theta_{JA}$ ) is the parameter used to calculate the rise of a device junction temperature due to the device power dissipation. For the LM60/LM60-Q1 the equation used to calculate the rise in the die temperature is as follows:

$$T_J = T_A + \theta_{JA} [(+V_S I_Q) + (+V_S - V_O) I_L]$$

where  $I_Q$  is the quiescent current and  $I_L$  is the load current on the output.

**Table 1** summarizes the rise in die temperature of the LM60/LM60-Q1 without any loading, and the thermal resistance for different conditions.

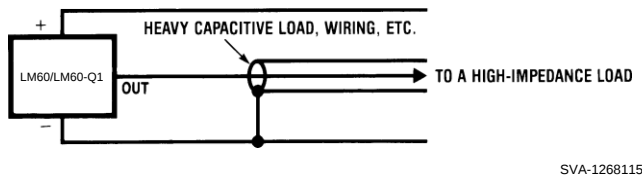
**Table 1. Temperature Rise of LM60/LM60-Q1 Due to Self-Heating and Thermal Resistance ( $\theta_{JA}$ )**

|            | SOT-23 <sup>(1)</sup><br>no heat sink |                     | SOT-23 <sup>(2)</sup><br>small heat fin |                     | TO-92 <sup>(1)</sup><br>no heat fin |             | TO-92 <sup>(3)</sup><br>small heat fin |             |
|------------|---------------------------------------|---------------------|-----------------------------------------|---------------------|-------------------------------------|-------------|----------------------------------------|-------------|
|            | $\theta_{JA}$<br>(°C/W)               | $T_J - T_A$<br>(°C) | $\theta_{JA}$<br>(°C/W)                 | $T_J - T_A$<br>(°C) | $\theta_{JA}$                       | $T_J - T_A$ | $\theta_{JA}$                          | $T_J - T_A$ |
| Still air  | 450                                   | 0.17                | 260                                     | 0.1                 | 180                                 | 0.07        | 140                                    | 0.05        |
| Moving air |                                       |                     | 180                                     | 0.07                | 90                                  | 0.034       | 70                                     | 0.026       |

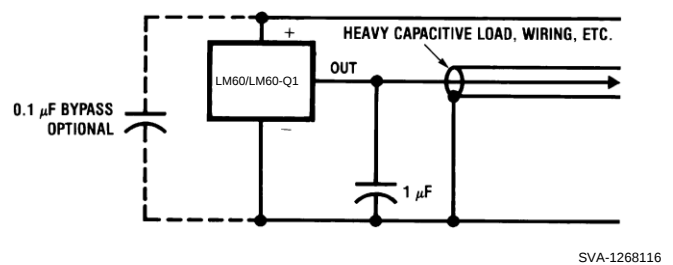
- (1) Part soldered to 30 gauge wire.  
 (2) Heat sink used is 1/2" square printed circuit board with 2 oz. foil with part attached as shown in Figure 13.  
 (3) Part glued or leads soldered to 1" square of 1/16" printed circuit board with 2 oz. foil or similar.

## Capacitive Loads

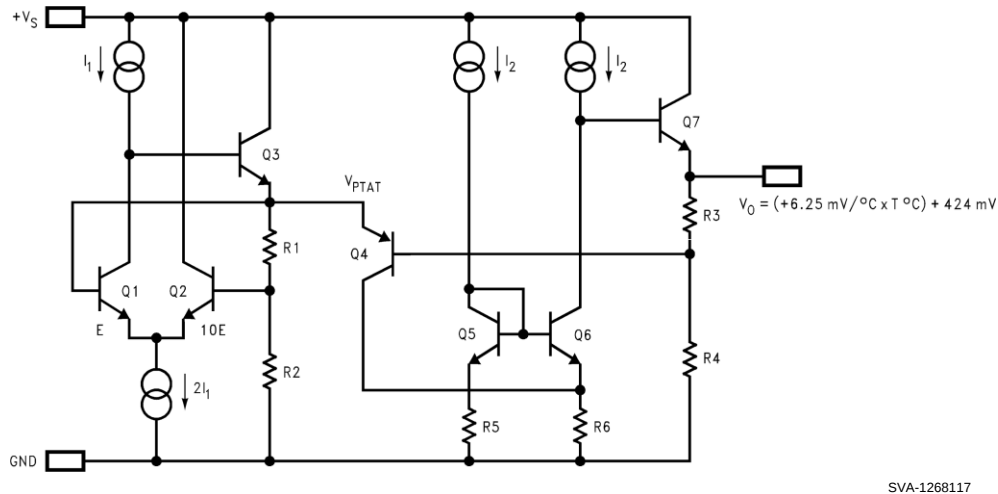
The LM60/LM60-Q1 handles capacitive loading well. Without any special precautions, the LM60/LM60-Q1 can drive any capacitive load as shown in Figure 14. Over the specified temperature range the LM60/LM60-Q1 has a maximum output impedance of 800Ω. In an extremely noisy environment it may be necessary to add some filtering to minimize noise pickup. It is recommended that 0.1 μF be added from +V S to GND to bypass the power supply voltage, as shown in Figure 15. In a noisy environment it may be necessary to add a capacitor from the output to ground. A 1 μF output capacitor with the 800Ω output impedance will form a 199 Hz lowpass filter. Since the thermal time constant of the LM60/LM60-Q1 is much slower than the 6.3 ms time constant formed by the RC, the overall response time of the LM60/LM60-Q1 will not be significantly affected. For much larger capacitors this additional time lag will increase the overall response time of the LM60/LM60-Q1.



**Figure 14. LM60/LM60-Q1 No Decoupling Required for Capacitive Load**

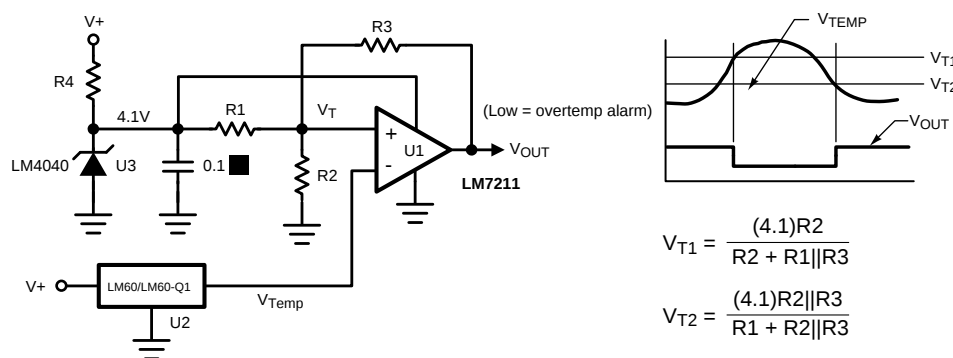


**Figure 15. LM60/LM60-Q1 with Filter for Noisy Environment**



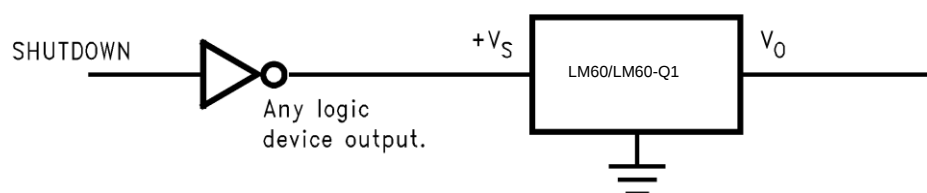
**Figure 16. Simplified Schematic**

## Applications Circuits



SVA-1268118

**Figure 17. Centigrade Thermostat**



SVA-1268119

**Figure 18. Conserving Power Dissipation with Shutdown**

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| LM60BIM3         | ACTIVE        | SOT-23       | DBZ                | 3    | 1000        | TBD                        | Call TI          | Call TI              | -25 to 125   | T6B                      | <a href="#">Samples</a> |
| LM60BIM3/NOPB    | ACTIVE        | SOT-23       | DBZ                | 3    | 1000        | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -25 to 125   | T6B                      | <a href="#">Samples</a> |
| LM60BIM3X        | ACTIVE        | SOT-23       | DBZ                | 3    | 3000        | TBD                        | Call TI          | Call TI              | -25 to 125   | T6B                      | <a href="#">Samples</a> |
| LM60BIM3X/NOPB   | ACTIVE        | SOT-23       | DBZ                | 3    | 3000        | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -25 to 125   | T6B                      | <a href="#">Samples</a> |
| LM60BIZ/LFT3     | ACTIVE        | TO-92        | LP                 | 3    | 2000        | TBD                        | Call TI          | Call TI              |              |                          | <a href="#">Samples</a> |
| LM60BIZ/NOPB     | ACTIVE        | TO-92        | LP                 | 3    | 1800        | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     | -25 to 125   | LM60<br>BIZ              | <a href="#">Samples</a> |
| LM60CIM3         | ACTIVE        | SOT-23       | DBZ                | 3    | 1000        | TBD                        | Call TI          | Call TI              | -40 to 125   | T6C                      | <a href="#">Samples</a> |
| LM60CIM3/NOPB    | ACTIVE        | SOT-23       | DBZ                | 3    | 1000        | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | T6C                      | <a href="#">Samples</a> |
| LM60CIM3X        | ACTIVE        | SOT-23       | DBZ                | 3    | 3000        | TBD                        | Call TI          | Call TI              | -40 to 125   | T6C                      | <a href="#">Samples</a> |
| LM60CIM3X/NOPB   | ACTIVE        | SOT-23       | DBZ                | 3    | 3000        | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | T6C                      | <a href="#">Samples</a> |
| LM60CIZ/NOPB     | ACTIVE        | TO-92        | LP                 | 3    | 1800        | Green (RoHS<br>& no Sb/Br) | SNCU             | Level-1-NA-UNLIM     | -40 to 125   | LM60<br>CIZ              | <a href="#">Samples</a> |
| LM60QIM3/NOPB    | ACTIVE        | SOT-23       | DBZ                | 3    | 1000        | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | L60Q                     | <a href="#">Samples</a> |
| LM60QIM3X/NOPB   | ACTIVE        | SOT-23       | DBZ                | 3    | 3000        | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | -40 to 125   | L60Q                     | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

<sup>(4)</sup> Only one of markings shown within the brackets will appear on the physical device.

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#### **OTHER QUALIFIED VERSIONS OF LM60, LM60-Q1 :**

- Catalog: [LM60](#)
- Automotive: [LM60-Q1](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM60BIM3       | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM60BIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM60BIM3X      | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM60BIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM60CIM3       | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM60CIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM60CIM3X      | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM60CIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM60QIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |
| LM60QIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 178.0              | 8.4                | 3.3     | 2.9     | 1.22    | 4.0     | 8.0    | Q3            |

## TAPE AND REEL BOX DIMENSIONS

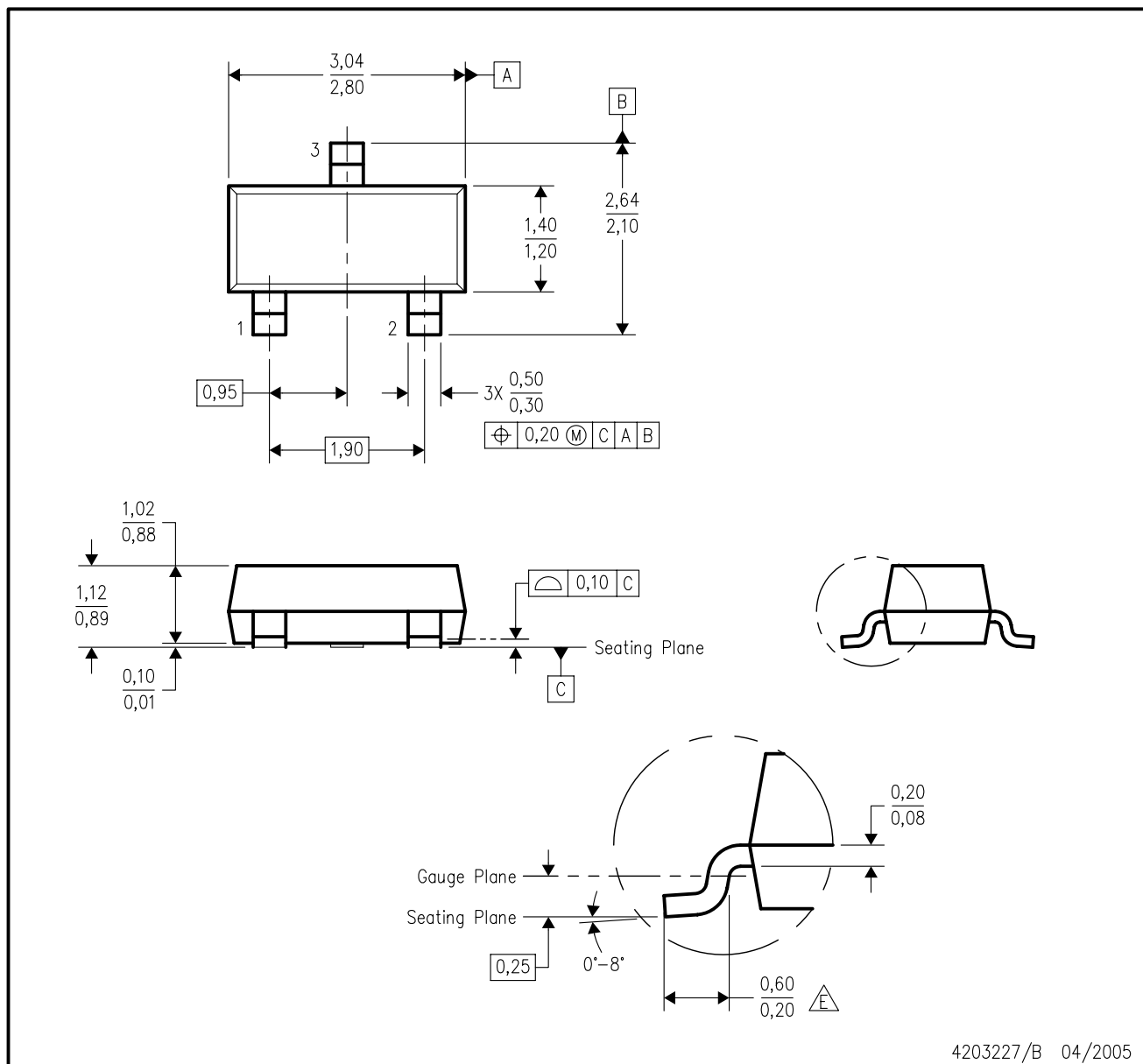


\*All dimensions are nominal

| Device         | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM60BIM3       | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM60BIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM60BIM3X      | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM60BIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM60CIM3       | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM60CIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM60CIM3X      | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM60CIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |
| LM60QIM3/NOPB  | SOT-23       | DBZ             | 3    | 1000 | 210.0       | 185.0      | 35.0        |
| LM60QIM3X/NOPB | SOT-23       | DBZ             | 3    | 3000 | 210.0       | 185.0      | 35.0        |

DBZ (R-PDSO-G3)

PLASTIC SMALL-OUTLINE



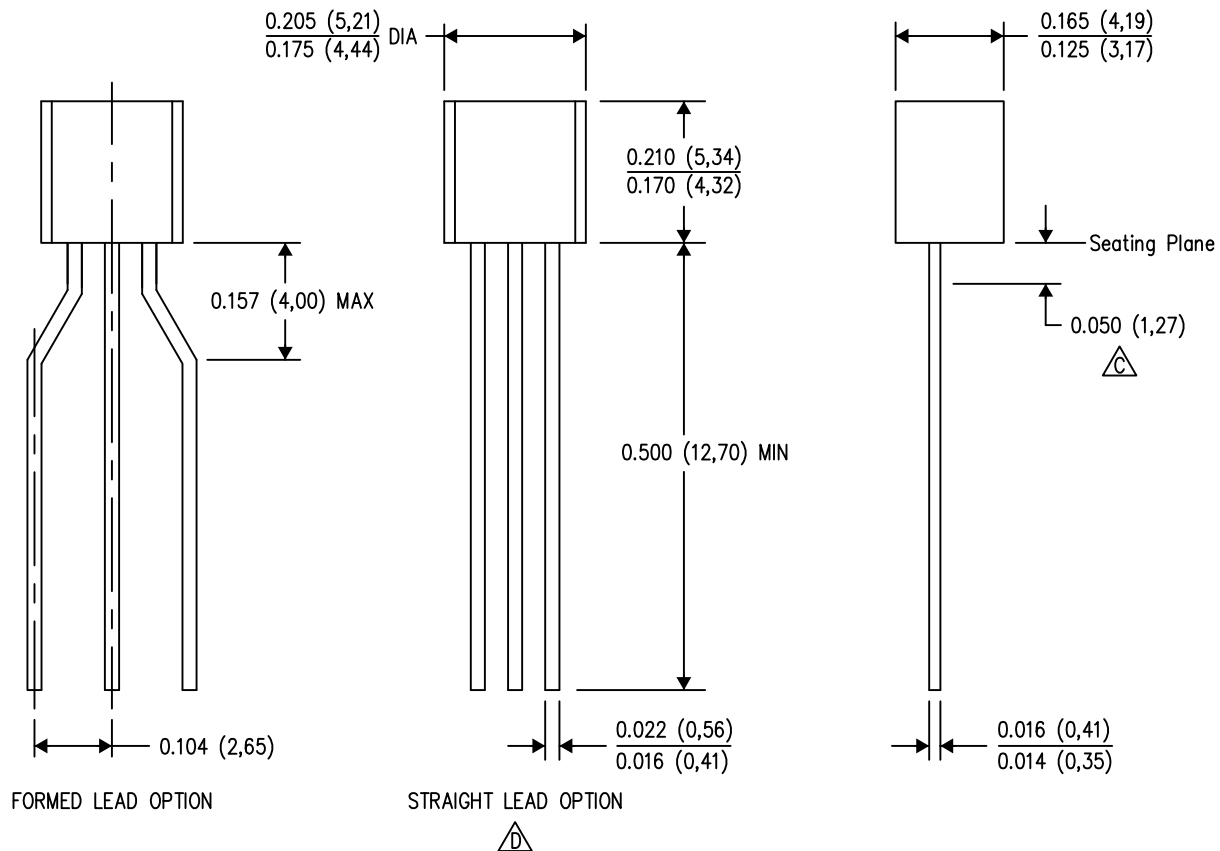
4203227/B 04/2005

NOTES:

- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
- B. This drawing is subject to change without notice.
- C. Lead dimensions are inclusive of plating.
- D. Body dimensions are exclusive of mold flash and protrusion. Mold flash and protrusion not to exceed 0.25 per side.
- E. Falls within JEDEC TO-236 variation AB, except minimum foot length.

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



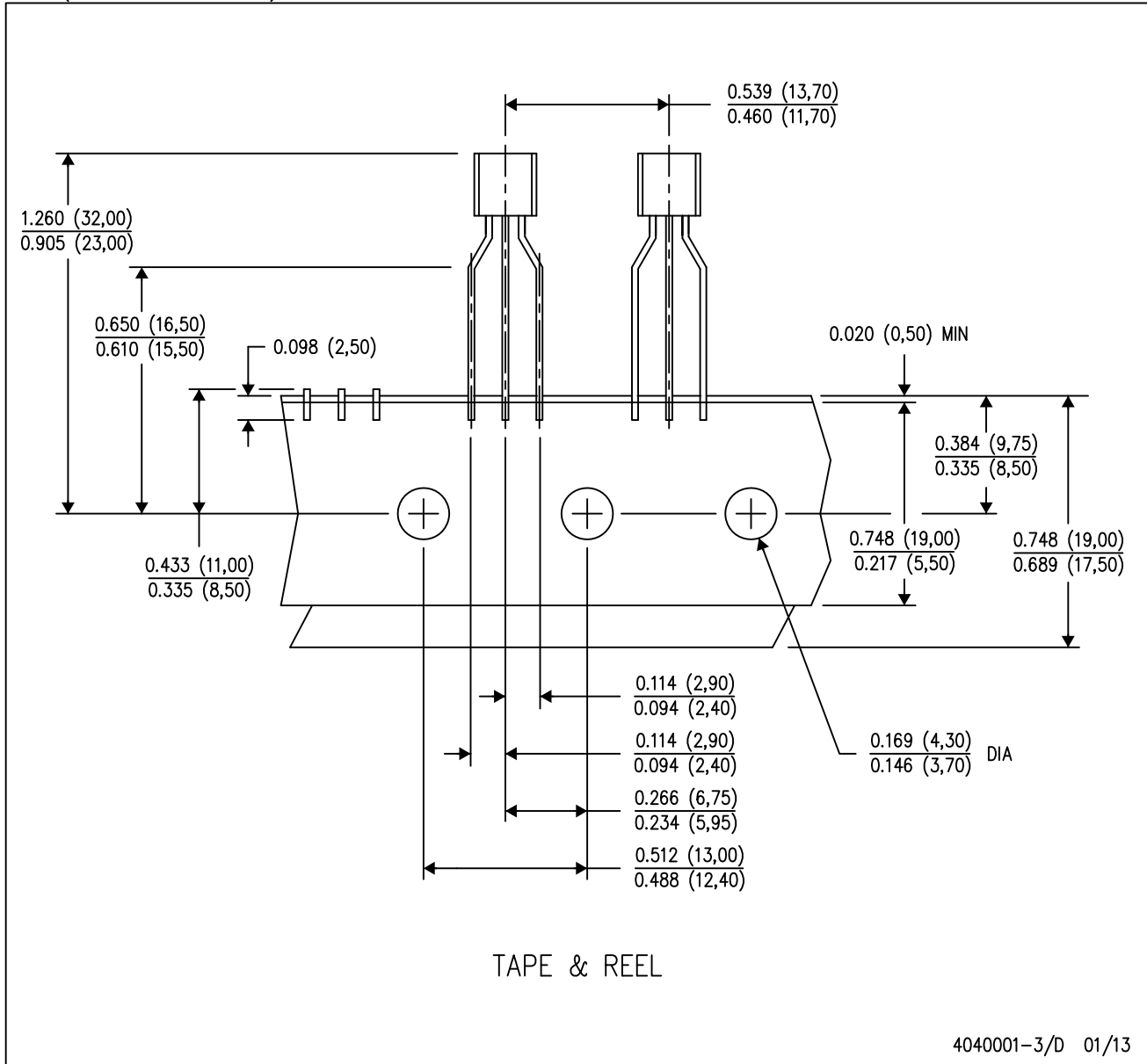
4040001-2/D 01/13

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Lead dimensions are not controlled within this area.
  - D. Falls within JEDEC TO-226 Variation AA (TO-226 replaces TO-92).
  - E. Shipping Method:
    - Straight lead option available in either bulk pack or tape & reel.
    - Formed lead option available in tape & reel or ammo pack.
    - Specific products can be offered in limited combinations of shipping mediums and lead options.
    - Consult product folder for more information on available options.

## MECHANICAL DATA

LP (O-PBCY-W3)

PLASTIC CYLINDRICAL PACKAGE



NOTES: A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.  
C. Tape and Reel information for the Formed Lead Option package.

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| Data Converters              | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>                       |
| DLP® Products                | <a href="http://www.dlp.com">www.dlp.com</a>                                         |
| DSP                          | <a href="http://dsp.ti.com">dsp.ti.com</a>                                           |
| Clocks and Timers            | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>                             |
| Interface                    | <a href="http://interface.ti.com">interface.ti.com</a>                               |
| Logic                        | <a href="http://logic.ti.com">logic.ti.com</a>                                       |
| Power Mgmt                   | <a href="http://power.ti.com">power.ti.com</a>                                       |
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| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
| Wireless Connectivity        | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |                                                                                          |
|-------------------------------|------------------------------------------------------------------------------------------|
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| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
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