

## LM27 SOT-23, $\pm 3^{\circ}\text{C}$ Accurate, $120^{\circ}\text{C}$ - $150^{\circ}\text{C}$ Factory Preset Thermostat

Check for Samples: [LM27](#)

### FEATURES

- Internal Comparator with Pin Selectable  $2^{\circ}\text{C}$  or  $10^{\circ}\text{C}$  Hysteresis
- No External Components Required
- Open-drain or Push-pull Digital Output; Supports CMOS Logic Levels
- Internal Temperature Sensor with  $V_{\text{TEMP}}$  Output Pin
- $V_{\text{TEMP}}$  Output Allows After-assembly System Testing
- Internal Voltage Reference and DAC for Trip-point Setting
- Currently Available in 5-pin SOT-23 Plastic Package
- Excellent Power Supply Noise Rejection

### APPLICATIONS

- Microprocessor Thermal Management
- Appliances
- Portable Battery Powered Systems
- Fan Control
- Industrial Process Control
- HVAC Systems
- Electronic System Protection

### KEY SPECIFICATIONS

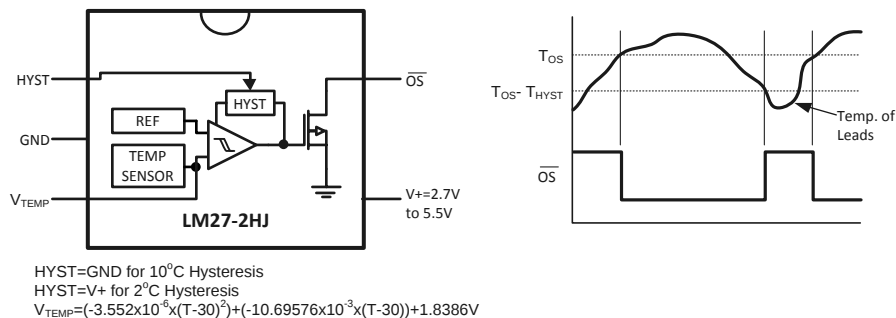
- Power Supply Voltage  $2.7\text{V}$  to  $5.5\text{V}$
- Power Supply Current  $40\mu\text{A}$  (Max),  $15\mu\text{A}$  (Typ)
- Hysteresis Temperature  $2^{\circ}\text{C}$  or  $10^{\circ}\text{C}$  (Typ)
- Temperature Trip Point Accuracy  $\pm 3^{\circ}\text{C}$  (Max)

### DESCRIPTION

The LM27 is a precision, single digital-output, low-power thermostat comprised of an internal reference, DAC, temperature sensor and comparator. Utilizing factory programming, it can be manufactured with different trip points as well as different digital output functionality. The trip point ( $T_{\text{OS}}$ ) can be preset at the factory to any temperature in the range of  $+120^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$  in  $1^{\circ}\text{C}$  increments. The LM27 has one digital output ( $\text{OS}/\overline{\text{OS}}/\text{US}/\overline{\text{US}}$ ), one digital input ( $\text{HYST}$ ) and one analog output ( $V_{\text{TEMP}}$ ). The digital output stage can be preset as either open-drain or push-pull. In addition, it can be factory programmed to be active HIGH or LOW. The digital output can be factory programmed to indicate an over temperature shutdown event ( $\text{OS}$  or  $\overline{\text{OS}}$ ) or an under temperature shutdown event ( $\text{US}$  or  $\overline{\text{US}}$ ). When preset as an overtemperature shutdown ( $\text{OS}$ ) it will go LOW to indicate that the die temperature is over the internally preset  $T_{\text{OS}}$  and go HIGH when the temperature goes below ( $T_{\text{OS}} - T_{\text{HYST}}$ ). Similarly, when preprogrammed as an undertemperature shutdown ( $\text{US}$ ) it will go HIGH to indicate that the temperature is below  $T_{\text{US}}$  and go LOW when the temperature is above ( $T_{\text{US}} + T_{\text{HYST}}$ ). The typical hysteresis,  $T_{\text{HYST}}$ , can be set to  $2^{\circ}\text{C}$  or  $10^{\circ}\text{C}$  and is controlled by the state of the  $\text{HYST}$  pin. A  $V_{\text{TEMP}}$  analog output provides a voltage that is proportional to temperature and has a  $-10.7\text{mV}/^{\circ}\text{C}$  output slope.

Currently, there are several standard parts available, see [Table 1](#). For other part options, contact a Texas Instruments Distributor or Sales Representative for information on minimum order qualification. The LM27 is currently available in a 5-lead SOT-23 package.

### Simplified Block Diagram and Connection Diagram LM27CIM5-2HJ ( $140^{\circ}\text{C}$ Trip-Point)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

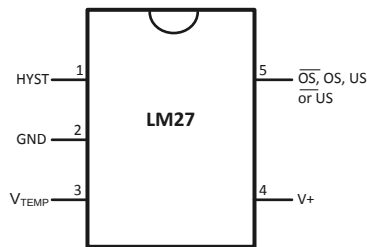
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**Table 1. Summary Table of Trip Point and Output Function Capabilities of Released Parts<sup>(1)</sup>**

| Orderable Device | Trip Point Temperature (°C) | Digital Output Function                        |
|------------------|-----------------------------|------------------------------------------------|
| LM27CIM5-ZHJ     | 120                         | Active-Low, Open-Drain, $\overline{OS}$ output |
| LM27CIM5-1HJ     | 130                         | Active-Low, Open-Drain, $\overline{OS}$ output |
| LM27CIM5-2HJ     | 140                         | Active-Low, Open-Drain, $\overline{OS}$ output |

(1) Other device options have not been released to market, contact Texas Instruments for volume and other requirements for release.

## Connection Diagram



## PIN DESCRIPTIONS

| Pin Number       | Pin Name        | Function                                                                   | Connection                                                                                                  |
|------------------|-----------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| 1                | HYST            | Hysteresis control, digital input                                          | GND for 10°C or $V^+$ for 2°C                                                                               |
| 2                | GND             | Ground, connected to the back side of the die through lead frame.          | System GND                                                                                                  |
| 3                | $V_{TEMP}$      | Analog output voltage proportional to temperature                          | Leave floating or connect to a high impedance node.                                                         |
| 4                | $V^+$           | Supply input                                                               | 2.7V to 5.5V with a 0.1μF bypass capacitor. For PSRR information see <a href="#">NOISE CONSIDERATIONS</a> . |
| 5 <sup>(1)</sup> | $\overline{OS}$ | Overtemperature Shutdown open-drain active low thermostat digital output   | Controller interrupt, system or power supply shutdown; pull-up resistor $\geq 10k\Omega$                    |
|                  | OS              | Overtemperature Shutdown totem-pull active high thermostat digital output  | Controller interrupt, system or power supply shutdown                                                       |
|                  | $\overline{US}$ | Undertemperature Shutdown open-drain active low thermostat digital output  | System or power supply shutdown; pull-up resistor $\geq 10k\Omega$                                          |
|                  | US              | Undertemperature Shutdown totem-pull active high thermostat digital output | System or power supply shutdown                                                                             |

(1) Pin 5 functionality and trip point setting are programmed during LM27 manufacture.



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.

### Absolute Maximum Ratings<sup>(1)</sup>

|                                                             |                  |                          |                  |
|-------------------------------------------------------------|------------------|--------------------------|------------------|
| Input Voltage                                               |                  |                          | 6.0V             |
| Input Current at any pin <sup>(2)</sup>                     |                  |                          | 5mA              |
| Package Input Current <sup>(2)</sup>                        |                  |                          | 20mA             |
| Package Dissipation at T <sub>A</sub> = 25°C <sup>(3)</sup> |                  |                          | 500mW            |
| Soldering Information <sup>(4)</sup>                        | SOT23 Package    | Vapor Phase (60 seconds) | 215°C            |
|                                                             |                  | Infrared (15 seconds)    | 220°C            |
| Storage Temperature                                         |                  |                          | −65°C to + 150°C |
| ESD Susceptibility <sup>(5)</sup>                           | Human Body Model |                          | 2500V            |
|                                                             | Machine Model    |                          | 250V             |

- (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 ensure specific performance limits. For ensured 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 the power supply (V<sub>I</sub> < GND or V<sub>I</sub> > V<sup>+</sup>), the current at that pin should be limited to 5mA. The 20mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of 5mA to four. Under normal operating conditions the maximum current that pins 2, 4 or 5 can handle is limited to 5mA each.
- (3) The maximum power dissipation must be derated at elevated temperatures and is dictated by T<sub>Jmax</sub> (maximum junction temperature), θ<sub>JA</sub> (junction to ambient thermal resistance) and T<sub>A</sub> (ambient temperature). The maximum allowable power dissipation at any temperature is P<sub>D</sub> = (T<sub>Jmax</sub> – T<sub>A</sub>)/θ<sub>JA</sub> or the number given in the Absolute Maximum Ratings, whichever is lower. For this device, T<sub>Jmax</sub> = 150°C. For this device the typical thermal resistance (θ<sub>JA</sub>) of the different package types when board mounted refer to [Table 2](#)
- (4) See <http://www.ti.com/packaging> for other recommendations and methods of soldering surface mount devices.
- (5) The human body model is a 100pF capacitor discharge through a 1.5kΩ resistor into each pin. The machine model is a 200pF capacitor discharged directly into each pin.

**Table 2.**

| Package Type | θ <sub>JA</sub> |
|--------------|-----------------|
| SOT23-5, DBV | 250°C/W         |

### Operating Ratings<sup>(1)</sup>

|                                           |                                                      |
|-------------------------------------------|------------------------------------------------------|
| Specified Temperature Range               | T <sub>MIN</sub> ≤ T <sub>A</sub> ≤ T <sub>MAX</sub> |
| LM27CIM                                   | –40°C ≤ T <sub>A</sub> ≤ +150°C                      |
| Positive Supply Voltage (V <sup>+</sup> ) | +2.7V to +5.5V                                       |
| Maximum V <sub>OUT</sub>                  | +5.5V                                                |

- (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 ensure specific performance limits. For ensured 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.

## LM27 Electrical Characteristics

The following specifications apply for  $V^+ = 2.7V_{DC}$  to  $5.5V_{DC}$ , and  $V_{TEMP}$  load current =  $0\mu A$  unless otherwise specified.

**Boldface limits apply for  $T_A = T_J = T_{MIN}$  to  $T_{MAX}$ ; all other limits  $T_A = T_J = 25^\circ C$  unless otherwise specified.**

| Symbol                          | Parameter                                                                                                                                                      | Conditions                                                                                     | Typical <sup>(1)</sup> | LM27CIM Limits <sup>(2)</sup>      | Units (Limits)                 |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|------------------------|------------------------------------|--------------------------------|
| <b>Temperature Sensor</b>       |                                                                                                                                                                |                                                                                                |                        |                                    |                                |
|                                 | Trip Point Accuracy (Includes $V_{REF}$ , DAC, Comparator Offset, and Temperature Sensitivity errors)                                                          | $+120^\circ C < T_A < +150^\circ C$                                                            |                        | $\pm 3$                            | $^\circ C$ (max)               |
|                                 | Trip Point Hysteresis                                                                                                                                          | HYST = GND                                                                                     | 10                     |                                    | $^\circ C$                     |
|                                 |                                                                                                                                                                | HYST = $V^+$                                                                                   | 2                      |                                    | $^\circ C$                     |
|                                 | $V_{TEMP}$ Output Temperature Sensitivity                                                                                                                      |                                                                                                | -10.82                 |                                    | mV/ $^\circ C$                 |
|                                 | $V_{TEMP}$ Temperature Sensitivity Error to Equation:<br>$V_O = (-3.552 \times 10^{-6} \times (T-30)^2 + (-10.695 \times 10^{-3} \times (T-30)) + 1.8386V$ (1) | $-30^\circ C \leq T_A \leq 150^\circ C$ , $2.7V \leq V^+ \leq 5.5V$                            |                        | <b><math>\pm 3</math></b>          | $^\circ C$ (max)               |
|                                 |                                                                                                                                                                | $-55^\circ C \leq T_A \leq 150^\circ C$ , $4.5V \leq V^+ \leq 5.5V$                            |                        | <b><math>\pm 3</math></b>          | $^\circ C$ (max)               |
|                                 |                                                                                                                                                                | $T_A = 25^\circ C$                                                                             |                        | $\pm 2.5$                          | $^\circ C$ (max)               |
|                                 |                                                                                                                                                                |                                                                                                |                        |                                    |                                |
|                                 | $V_{TEMP}$ Load Regulation                                                                                                                                     | Source $\leq 1 \mu A$                                                                          | 0.070                  |                                    | mV                             |
|                                 |                                                                                                                                                                | Sink $\leq 40 \mu A$                                                                           |                        | <b>0.7</b>                         | mV (max)                       |
|                                 | $V_{TEMP}$ Line Regulation                                                                                                                                     | $+2.7V \leq V^+ \leq +5.5V$ ,<br>$-30^\circ C \leq T_A \leq +120^\circ C$                      | -0.2                   |                                    | mV/V                           |
| $I_S$                           | Supply Current                                                                                                                                                 |                                                                                                | 15                     | 22<br><b>40</b>                    | $\mu A$ (max)<br>$\mu A$ (max) |
| <b>Digital Output and Input</b> |                                                                                                                                                                |                                                                                                |                        |                                    |                                |
| $I_{OUT("1")}$                  | Logical "1" Output Leakage Current <sup>(3)</sup>                                                                                                              | $V^+ = +5.0V$                                                                                  | 0.001                  | <b>1</b>                           | $\mu A$ (max)                  |
| $V_{OUT("0")}$                  | Logical "0" Output Voltage                                                                                                                                     | $I_{OUT} = +1.2mA$ and $V^+ \geq 2.7V$ ; $I_{OUT} = +3.2mA$ and $V^+ \geq 4.5V$ <sup>(4)</sup> |                        | <b>0.4</b>                         | V (max)                        |
| $V_{OUT("1")}$                  | Logical "1" Push-Pull Output Voltage                                                                                                                           | $I_{SOURCE} = 500\mu A$ , $V^+ \geq 2.7V$                                                      |                        | <b><math>0.8 \times V^+</math></b> | V (min)                        |
|                                 |                                                                                                                                                                | $I_{SOURCE} = 800\mu A$ , $V^+ \geq 4.5V$                                                      |                        | <b><math>V^+ - 1.5</math></b>      | V (min)                        |
| $V_{IH}$                        | HYST Input Logical "1" Threshold Voltage                                                                                                                       |                                                                                                |                        | <b><math>0.8 \times V^+</math></b> | V (min)                        |
| $V_{IL}$                        | HYST Input Logical "0" Threshold Voltage                                                                                                                       |                                                                                                |                        | <b><math>0.2 \times V^+</math></b> | V (max)                        |

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

(2) Limits are ensured to AOQL (Average Outgoing Quality Level).

(3) The  $1\mu A$  limit is based on a testing limitation and does not reflect the actual performance of the part. Expect to see a doubling of the current for every  $15^\circ C$  increase in temperature. For example, the  $1nA$  typical current at  $25^\circ C$  would increase to  $16nA$  at  $85^\circ C$ .

(4) Care should be taken to include the effects of self heating when setting the maximum output load current. The power dissipation of the LM27 would increase by  $1.28mW$  when  $I_{OUT}=3.2mA$  and  $V_{OUT}=0.4V$ . With a thermal resistance of  $250^\circ C/W$ , this power dissipation would cause an increase in the die temperature of about  $0.32^\circ C$  due to self heating. Self heating is not included in the trip point accuracy specification.

## Part Number Template

The series of digits labeled xyz in the part number LM27CIM-xyz, describe the set point value and the function of the output as follows:

The place holders xy describe the set point temperature as shown in the following table.

| x (10x) | y (1x) | Temperature (°C) |
|---------|--------|------------------|
| -       | H      | 0                |
| -       | J      | 1                |
| -       | K      | 2                |
| -       | L      | 3                |
| -       | N      | 4                |
| -       | P      | 5                |
| -       | R      | 6                |
| -       | S      | 7                |
| -       | T      | 8                |
| -       | V      | 9                |
| Z       | -      | 12               |
| 1       | -      | 13               |
| 2       | -      | 14               |
| 3       | -      | 15               |

The value of z describes the assignment/function of the output as shown in the following table:

| Active-Low/High | Open-Drain/ Push-Pull | $\overline{OS}/US$ | Value of z | Digital Output Function                        |
|-----------------|-----------------------|--------------------|------------|------------------------------------------------|
| 0               | 0                     | 0                  | J          | Active-Low, Open-Drain, $\overline{OS}$ output |
| 0               | 0                     | 1                  | K          | Active-Low, Open-Drain, $\overline{US}$ output |
| 1               | 1                     | 0                  | L          | Active-High, Push-Pull, OS output              |
| 1               | 1                     | 1                  | N          | Active-High, Push-Pull, US output              |

For example:

- the part number LM27CIM5-2SJ has  $T_{OS} = 147^{\circ}\text{C}$ , and programmed as an active-low open-drain overtemperature shutdown output.
- the part number LM27CIM5-ZLN has  $T_{US} = 123^{\circ}\text{C}$ , and programmed as an active-high, push-pull undertemperature shutdown output.

Active-high open-drain and active-low push-pull options are available, please contact Texas Instruments for more information.

**Note:** Currently, there are several standard parts available, see [Table 1](#). For other part options, contact a Texas Instruments Distributor or Sales Representative for information on minimum order qualification

## FUNCTIONAL DESCRIPTION

### LM27 OPTIONS — Output Pin Options Block Diagrams

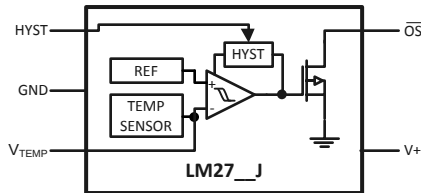


Figure 1. LM27-\_\_J

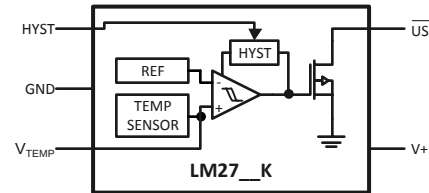


Figure 2. LM27-\_\_K

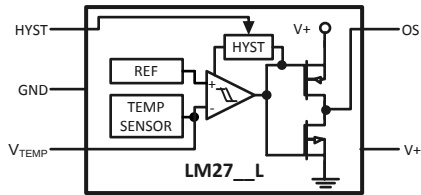


Figure 3. LM27-\_\_L

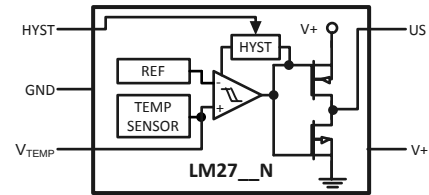


Figure 4. LM27-\_\_N

The LM27 can be factory programmed to have a trip point anywhere in-between 120°C to 150°C.

### Applications Hints

#### AFTER-ASSEMBLY PCB TESTING

The LM27's  $V_{TEMP}$  output allows after-assembly PCB testing by following a simple test procedure. Simply measuring the  $V_{TEMP}$  output voltage will verify that the LM27 has been assembled properly and that its temperature sensing circuitry is functional. The  $V_{TEMP}$  output has very weak drive capability that can be overdriven by 1.5mA. Therefore, one can simply force the  $V_{TEMP}$  voltage to cause the digital output to change state, thereby verifying that the comparator and output circuitry function after assembly. Here is a sample test procedure that can be used to test the LM27CIM5X-2HJ which has a 140°C trip point.

1. Turn on  $V^+$  and measure  $V_{TEMP}$ . Then calculate the temperature reading of the LM27 using the equation:

$$V_O = (-3.552 \times 10^{-6} \times (T-30)^2) + (-10.69576 \times 10^{-3} \times (T-30)) + 1.8386V \quad (2)$$

or

$$T = -1475.49 + \sqrt{2.2668 \times 10^6 + \frac{1.8386 - V_{TEMP}}{3.552 \times 10^{-6}}} \quad (3)$$

2. Verify that the temperature measured in step one is within ( $\pm 3^\circ\text{C}$  + error of reference temperature sensor) of the ambient/board temperature. The ambient/board temperature (reference temperature) should be measured using an extremely accurate calibrated temperature sensor, which is in close proximity to and mounted on the same PCB as the LM27 perhaps even touching the GND lead of the LM27 if possible. The LM27 will sense the board temperature not the ambient temperature (see [MOUNTING CONSIDERATIONS](#))
3.
  - (a) Observe that  $\overline{OS}$  is high.
  - (b) Drive  $V_{TEMP}$  to ground.
  - (c) Observe that  $\overline{OS}$  is now low.
  - (d) Release the  $V_{TEMP}$  pin.
  - (e) Observe that  $\overline{OS}$  is now high.
4.
  - (a) Observe that  $\overline{OS}$  is high.
  - (b) Drive  $V_{TEMP}$  voltage down gradually.
  - (c) When  $\overline{OS}$  goes low, note the  $V_{TEMP}$  voltage.
  - (d)  $V_{TEMPTrig} = V_{TEMP}$  at  $\overline{OS}$  trigger (HIGH->LOW)
  - (e) Calculate  $T_{trig}$  using [Equation 3](#).

5.

- (a) Gradually raise  $V_{TEMP}$  until OS goes HIGH. Note  $V_{TEMP}$ .
- (b) Calculate  $T_{HYST}$  using Equation 3.

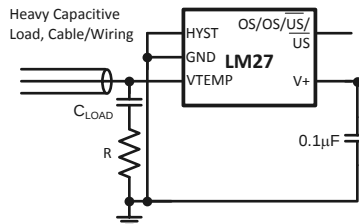
### $V_{TEMP}$ LOADING

The  $V_{TEMP}$  output has very weak drive capability (1  $\mu$ A source, 40  $\mu$ A sink). So care should be taken when attaching circuitry to this pin. Capacitive loading may cause the  $V_{TEMP}$  output to oscillate. Simply adding a resistor in series as shown in Figure 6 will prevent oscillations from occurring. To determine the value of the resistor follow the guidelines given in Table 3. The same value resistor will work for either placement of the resistor. If an additional capacitive load is placed directly on the LM27 output, rather than across  $C_{LOAD}$ , it should be at least a factor of 10 smaller than  $C_{LOAD}$ .

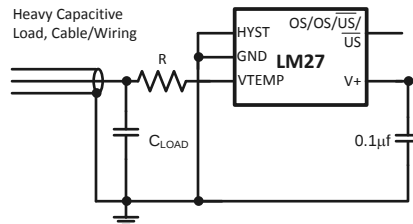
**Table 3. Resistive compensation for capacitive loading of  $V_{TEMP}$**

| $C_{LOAD}$       | R ( $\Omega$ ) |
|------------------|----------------|
| $\leq 100$ pF    | 0              |
| 1nF              | 8200           |
| 10nF             | 3000           |
| 100nF            | 1000           |
| $\geq 1$ $\mu$ F | 430            |

### Resistor placement for capacitive loading compensation of $V_{TEMP}$



**Figure 5. R in series with capacitor**



**Figure 6. R in series with signal path**

### NOISE CONSIDERATIONS

The LM27 has excellent power supply noise rejection. Listed below is a variety of signals used to test the LM27 power supply rejection. False triggering of the output was not observed when these signals were coupled into the V+ pin of the LM27.

- square wave 400kHz, 1Vp-p
- square wave 2kHz, 200mVp-p
- sine wave 100Hz to 1MHz, 200mVp-p

Testing was done while maintaining the temperature of the LM27 one degree centigrade away from the trip point with the output not activated.

**MOUNTING CONSIDERATIONS**

The LM27 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 LM27 is sensing will be within about +0.06°C of the surface temperature to which the LM27'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 measured would be at an intermediate temperature between the surface temperature and the air temperature.

To ensure good thermal conductivity, the backside of the LM27 die is directly attached to the GND pin (pin 2). The temperatures of the lands and traces to the other leads of the LM27 will also affect the temperature that is being sensed.

Alternatively, the LM27 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 LM27 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 LM27 or its connections.

The junction to ambient thermal resistance ( $\theta_{JA}$ ) is the parameter used to calculate the rise of a part's junction temperature due to its power dissipation. For the LM27 the equation used to calculate the rise in the die junction temperature is as follows:

$$T_J = T_A + \theta_{JA}(V^+I_Q + (V^+ - V_{TEMP})I_{L\_TEMP} + V_{DO}I_{DO}) \tag{4}$$

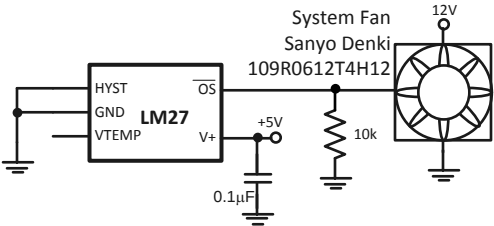
where  $T_A$  is the ambient temperature,  $V^+$  is the power supply voltage,  $I_Q$  is the quiescent current,  $I_{L\_TEMP}$  is the load current on the  $V_{TEMP}$  output,  $V_{DO}$  is the voltage on the digital output, and  $I_{DO}$  is the load current on the digital output. Since the LM27's junction temperature is the actual temperature being measured, care should be taken to minimize the load current that the LM27 is required to drive.

The tables shown in [Table 4](#) summarize the thermal resistance for different conditions and the rise in die temperature of the LM27 without any loading on  $V_{TEMP}$  and a 10k pull-up resistor on an open-drain digital output with a 5.5V power supply.

**Table 4. Thermal resistance ( $\theta_{JA}$ ) and temperature rise due to self heating ( $T_J - T_A$ )**

|            | SOT23-5<br>no heat sink |                     | SOT23-5<br>small heat sink |                     |
|------------|-------------------------|---------------------|----------------------------|---------------------|
|            | $\theta_{JA}$<br>(°C/W) | $T_J - T_A$<br>(°C) | $\theta_{JA}$<br>(°C/W)    | $T_J - T_A$<br>(°C) |
| Still Air  | 250                     | 0.11                | TBD                        | TBD                 |
| Moving Air | TBD                     | TBD                 | TBD                        | TBD                 |

**Typical Applications**



The fan's control pin has internal pull-up. The 10k pull-down sets a slow fan speed. When the output of the LM27 goes low, the fan will speed up.

**Figure 7. Two Speed Fan Speed Control**

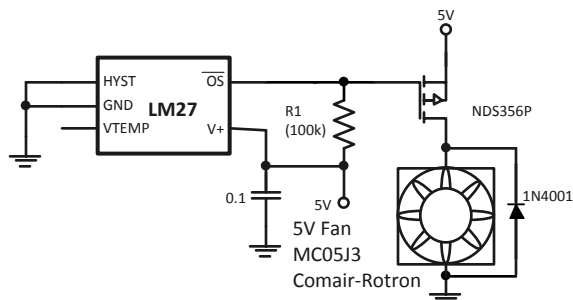


Figure 8. Fan High Side Drive

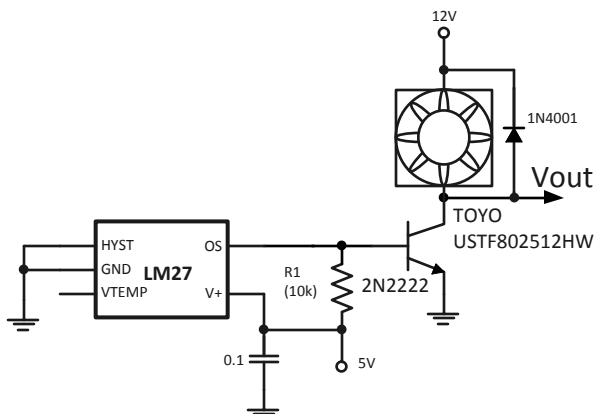


Figure 9. Fan Low Side Drive

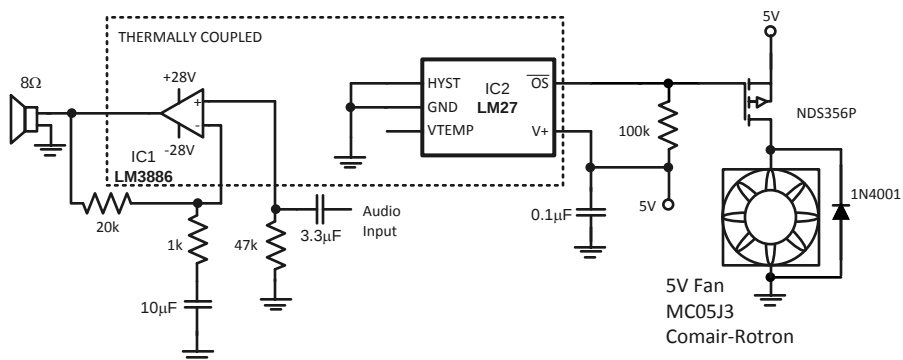


Figure 10. Audio Power Amplifier Thermal Protection

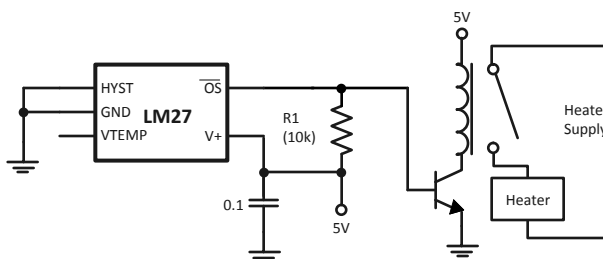


Figure 11. Simple Thermostat

## REVISION HISTORY

### Changes from Revision B (March 2013) to Revision C

### Page

- Deleted layout of National Data Sheet to TI format ..... [9](#)

## PACKAGING INFORMATION

| Orderable Device   | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|--------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|----------------------|--------------|-------------------------|-------------------------|
| LM27CIM5-1HJ/NOPB  | ACTIVE        | SOT-23       | DBV                | 5    | 1000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 120 to 150   | T1HJ                    | <a href="#">Samples</a> |
| LM27CIM5-2HJ/NOPB  | ACTIVE        | SOT-23       | DBV                | 5    | 1000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 120 to 150   | T2HJ                    | <a href="#">Samples</a> |
| LM27CIM5-ZHJ/NOPB  | ACTIVE        | SOT-23       | DBV                | 5    | 1000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 120 to 150   | TZHJ                    | <a href="#">Samples</a> |
| LM27CIM5X-1HJ/NOPB | ACTIVE        | SOT-23       | DBV                | 5    | 3000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   |              | T1HJ                    | <a href="#">Samples</a> |
| LM27CIM5X-2HJ/NOPB | ACTIVE        | SOT-23       | DBV                | 5    | 3000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   |              | T2HJ                    | <a href="#">Samples</a> |
| LM27CIM5X-ZHJ/NOPB | ACTIVE        | SOT-23       | DBV                | 5    | 3000           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   |              | TZHJ                    | <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)

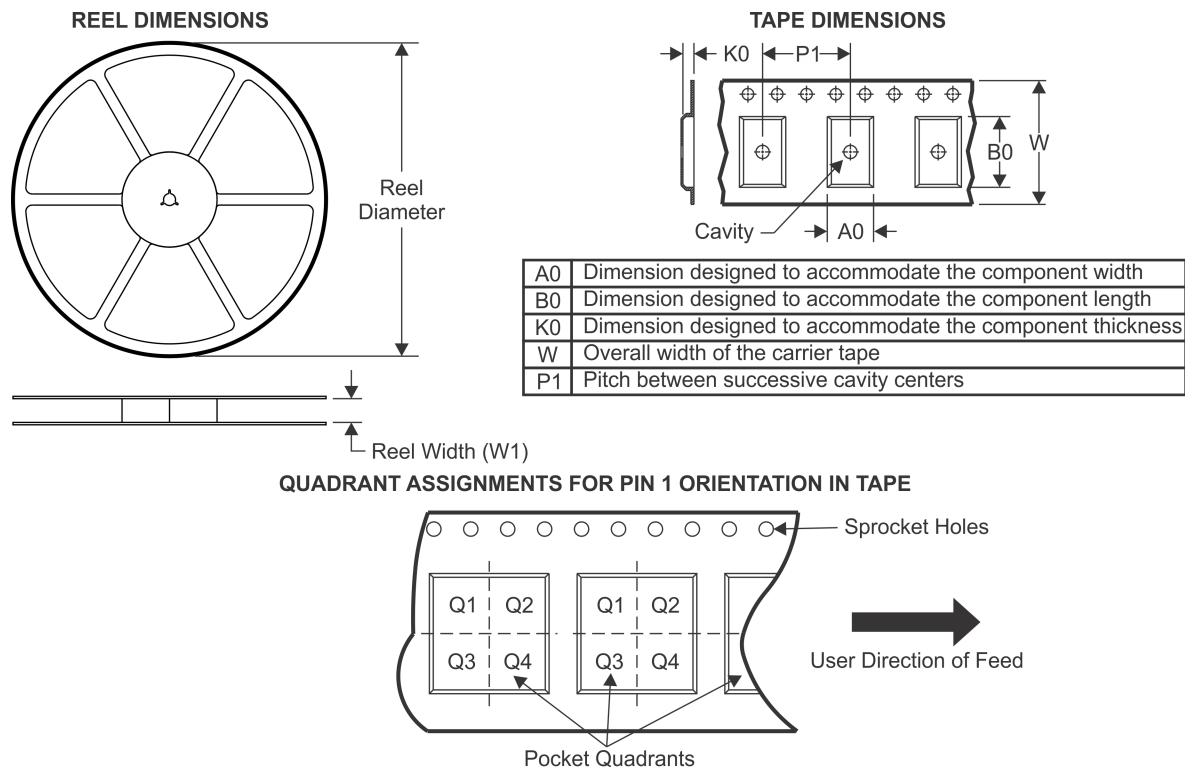
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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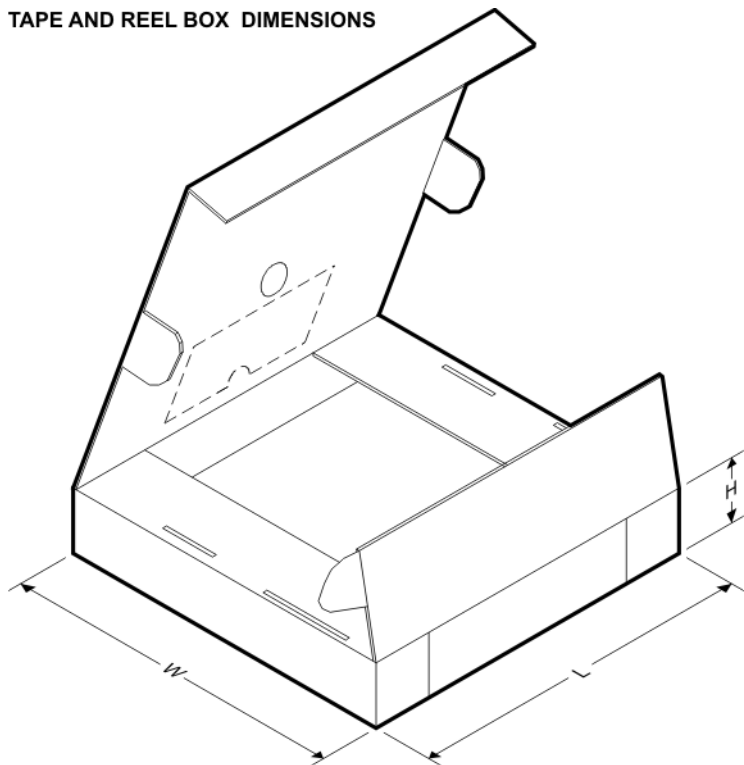
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**TAPE AND REEL INFORMATION**


\*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 |
|--------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM27CIM5-1HJ/NOPB  | SOT-23       | DBV             | 5    | 1000 | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| LM27CIM5-2HJ/NOPB  | SOT-23       | DBV             | 5    | 1000 | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| LM27CIM5-ZHJ/NOPB  | SOT-23       | DBV             | 5    | 1000 | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| LM27CIM5X-1HJ/NOPB | SOT-23       | DBV             | 5    | 3000 | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| LM27CIM5X-2HJ/NOPB | SOT-23       | DBV             | 5    | 3000 | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| LM27CIM5X-ZHJ/NOPB | SOT-23       | DBV             | 5    | 3000 | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |

## TAPE AND REEL BOX DIMENSIONS

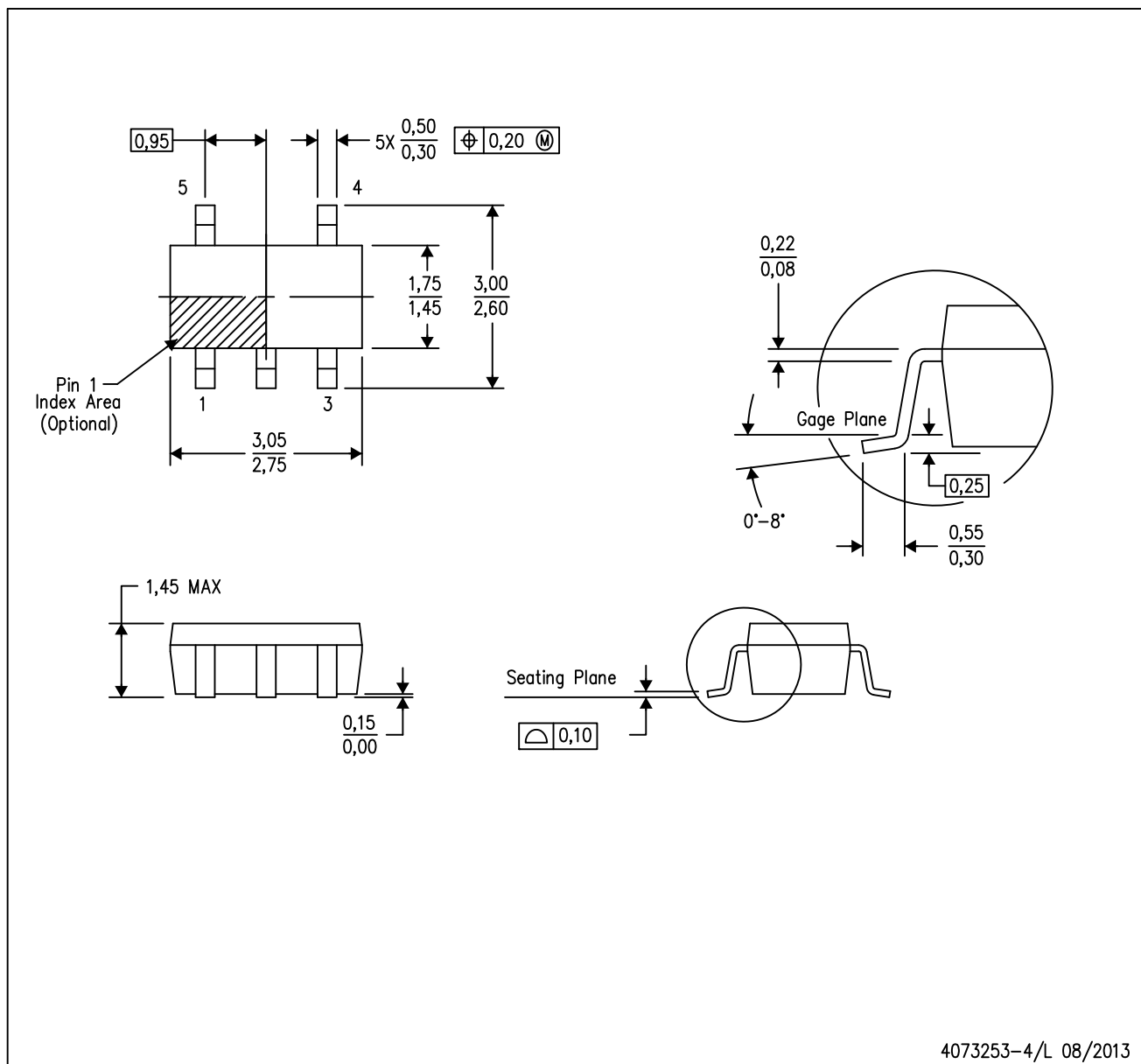


\*All dimensions are nominal

| Device             | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM27CIM5-1HJ/NOPB  | SOT-23       | DBV             | 5    | 1000 | 210.0       | 185.0      | 35.0        |
| LM27CIM5-2HJ/NOPB  | SOT-23       | DBV             | 5    | 1000 | 210.0       | 185.0      | 35.0        |
| LM27CIM5-ZHJ/NOPB  | SOT-23       | DBV             | 5    | 1000 | 210.0       | 185.0      | 35.0        |
| LM27CIM5X-1HJ/NOPB | SOT-23       | DBV             | 5    | 3000 | 210.0       | 185.0      | 35.0        |
| LM27CIM5X-2HJ/NOPB | SOT-23       | DBV             | 5    | 3000 | 210.0       | 185.0      | 35.0        |
| LM27CIM5X-ZHJ/NOPB | SOT-23       | DBV             | 5    | 3000 | 210.0       | 185.0      | 35.0        |

DBV (R-PDSO-G5)

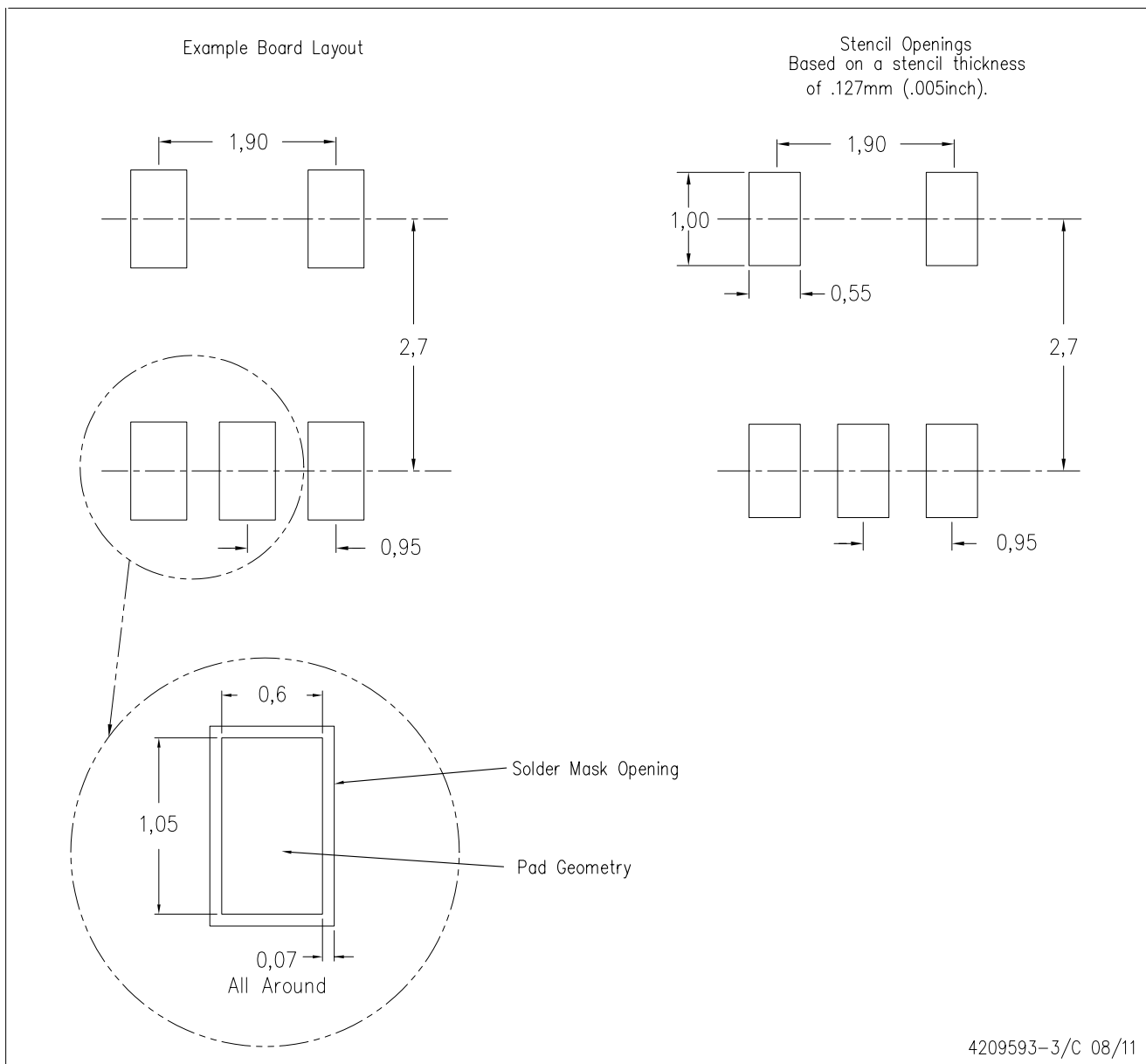
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Falls within JEDEC MO-178 Variation AA.

DBV (R-PDSO-G5)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

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| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
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