TEXAS
INSTRUMENTS

LM71/LM71-Q1 SPI/MICROWIRE 13-Bit Plus Sign Temperature Sensor

1 Features

- LM71Q is AEC-Q100 Grade 0 Qualified and is Manufactured on an Automotive Grade Flow
- 5-Pin SOT-23 Package or 6-Pin No-Pull-Back WSON Package
- Operates Over a Full −40°C to +150°C Range
- SPI and MICROWIRE Bus Interface
- Key Specifications:
  - Supply Voltage: 2.65V to 5.5V
  - Supply Current
    - Operating: 300 µA (typ)
    - 550 µA (max)
  - Temperature Accuracy
    - −10°C to +65°C: ±1.5°C (max)
    - −40°C to 150°C: +3/− 2°C (max)
  - Temperature Resolution: 31.25 m°C

2 Applications

- System Thermal Management
- Personal Computers
- Portable Electronic Devices
- Disk Drives
- Office Electronics
- Electronic Test Equipment
- Vending Machines
- Automotive

3 Description

The LM71 is a low-power, high-resolution digital temperature sensor with an SPI and MICROWIRE compatible interface, available in the 5-pin SOT-23 or the 6-pin WSON (no pull back) package. The host can query the LM71 at any time to read temperature. Its low operating current is useful in systems where low power consumption is critical.

The LM71 has 13-bit plus sign temperature resolution (0.03125°C per LSB) while operating over a temperature range of −40°C to +150°C.

The LM71's 2.65V to 5.5V supply voltage range, fast conversion rate, low supply current, and simple SPI interface make it ideal for a wide range of applications. The LM71Q is available in the 5-lead SOT-23 package only.

Simplified Block Diagram
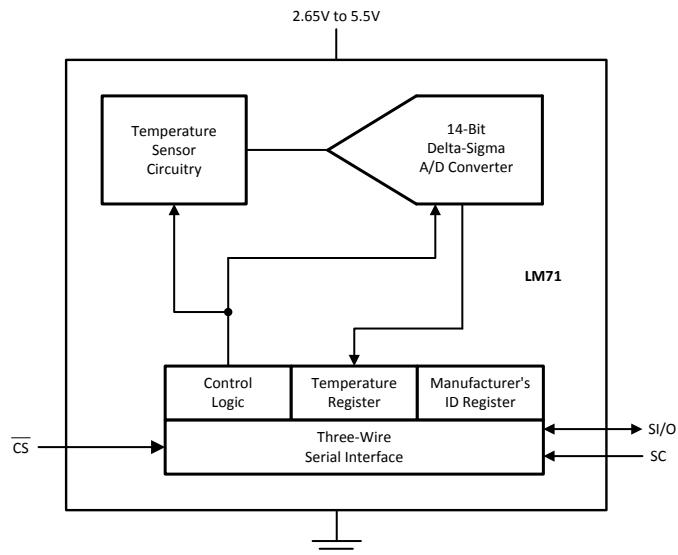
3.1 Connection Diagram
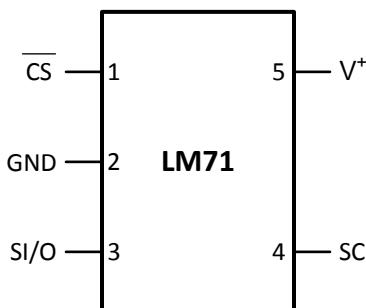

Figure 1. 5-Pin SOT-23
See Package Number DBV
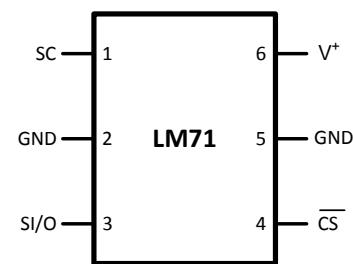
Figure 2. 6-Pin WSON No Pull-Back
See Package Number NGG0006A

Table 1. PIN DESCRIPTIONS

Label	Pin Number		Function	Typical Connection
	SOT-23-5	WSON-6		
$\overline{CS}$	1	4	Chip Select input	From controller
GND	2	2, 5	Power Supply Ground	Connect all GND Pins to ground
SI/O	3	3	Slave Input/Output - Serial bus bi-directional data line. Schmitt trigger input.	From and to controller
SC	4	1	Slave Clock - Serial bus clock Schmitt trigger input line	From controller
V+	5	6	Positive Supply Voltage Input	DC voltage from 2.65V to 5.5V. Bypass with a 0.1 μF ceramic capacitor.

## 3.2 Typical Application
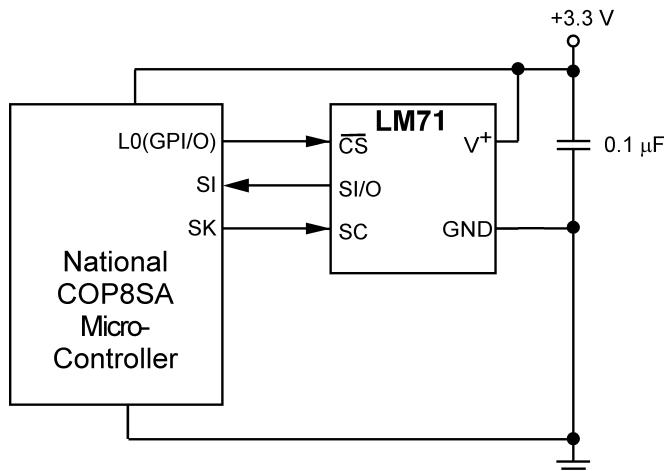
Figure 3. COP Microcontroller Interface

3.1 Electrostatic Discharge Caution

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.

3.2 Trademarks

All trademarks are the property of their respective owners.

4   Absolute Maximum Ratings[(1)]

Supply Voltage			−0.3V to 6.0V
Voltage at any Pin			−0.3V to V^+ + 0.3V
Input Current at any Pin[(2)]			5 mA
Storage Temperature			−65°C to +150°C
Soldering Information, Lead Temperature	SOT-23-5 Package	Vapor Phase (60 seconds)	215°C
		Infrared (15 seconds)	220°C
	WSON-6 Package	Infrared (5 seconds)	215°C
ESD Susceptibility[(3)]	Human Body Model		2000V
	Machine Model		200V

(1)   Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its rated operating conditions.

(2)   When the input voltage (V_I) at any pin exceeds the power supplies (V_I < GND or V_I > $+V_S$) the current at that pin should be limited to 5 mA.

(3)   Human body model, 100 pF discharged through a 1.5 kΩ resistor. Machine model, 200 pF discharged directly into each pin.

5   Operating Ratings

Specified Temperature Range[(1)] (T_{MIN} to T_{MAX})	LM71CIMF, LM71CISD, LM71QCIMF	−40°C to +150°C
Supply Voltage Range (+V_S)	LM71CIMF, LM71CISD, LM71QCIMF	+2.65V to +5.5V

(1)   The life expectancy of the LM71 will be reduced when operating at elevated temperatures. LM71 θ_{JA} (thermal resistance, junction-to-ambient) when attached to a printed circuit board with 2 oz. foil is summarized in the table below:

Device Number	Thermal Resistance (θ_{JA})
LM71CIMF/LM71QCIMF	250°C/W
LM71CISD	57.6°C/W

6 Temperature-to-Digital Converter Characteristics

Unless otherwise noted, these specifications apply for V$^+$ = 2.65V to 3.6V[1]. **Boldface limits apply for T$_A$ = T$_J$ = T$_{MIN}$ to T$_{MAX}$**; all other limits T$_A$ = T$_J$ = +25°C, unless otherwise noted.

Parameter	Conditions	Typical[2]	LM71CIMF LM71CISD Limits[3]	Units (Limit)
Temperature Error[1][4]	T$_A$ = −10°C to +65°C		**±1.5**	°C (max)
	T$_A$ = −40°C to +85°C		**±2.0**	°C (max)
	T$_A$ = −40°C to +150°C		**+3/−2**	°C (max)
Resolution		14 0.03125		Bits °C
Temperature Conversion Time	See[5]	200	**270**	ms (max)
Quiescent Current	Serial Bus Inactive	300	**550**	µA (max)

(1)   The LM71 will operate properly over the V$^+$ supply voltage range of 2.65V to 5.5V.
(2)   Typicals are at T$_A$ = 25°C and represent most likely parametric norm.
(3)   Limits are ensured to AOQL (Average Outgoing Quality Level).
(4)   For best accuracy, minimize output loading. Higher sink currents can affect sensor accuracy with internal heating. This can cause an error of 0.64°C at full rated sink current and saturation voltage based on junction-to-ambient thermal resistance.
(5)   Following a power on reset, the user must allow at least 270 ms before making the first read transaction to ensure a first valid temperature read. After the first read, in order to ensure an accurate temperature result, the time interval between any two consecutive temperature reads must be greater than the maximum conversion time of 270 ms. For more information, refer to SNLA296.

7 Logic Electrical Characteristics

DIGITAL DC CHARACTERISTICS

Unless otherwise noted, these specifications apply for V$^+$ = 2.65V to 3.6V[1]. **Boldface limits apply for T$_A$ = T$_J$ = T$_{MIN}$ to T$_{MAX}$**; all other limits T$_A$ = T$_J$ = +25°C, unless otherwise noted.

Symbol	Parameter	Conditions	Typical[2]	Limits[3]	Units (Limit)
V$_{IN(1)}$	Logical "1" Input Voltage			**V$^+$ × 0.7**	V (min)
				V$^+$ + 0.3	V (max)
V$_{IN(0)}$	Logical "0" Input Voltage			**−0.3**	V (min)
				V$^+$ × 0.3	V (max)
	Input Hysteresis Voltage	V$^+$ = 3.0V to 3.6V	0.4	**0.33**	V (min)
I$_{IN(1)}$	Logical "1" Input Current	V$_{IN}$ = V$^+$	0.005	**3.0**	µA (max)
I$_{IN(0)}$	Logical "0" Input Current	V$_{IN}$ = 0V	−0.005	**−3.0**	µA (min)
C$_{IN}$	All Digital Inputs		20		pF
V$_{OH}$	High Level Output Voltage	I$_{OH}$ = −400 µA		**2.4**	V (min)
V$_{OL}$	Low Level Output Voltage	I$_{OL}$ = +2 mA		**0.4**	V (max)
I$_{O\_TRI-STATE}$	TRI-STATE Output Leakage Current	V$_O$ = GND V$_O$ = V$^+$		**−1** **+1**	µA (min) µA (max)

(1)   The LM71 will operate properly over the V$^+$ supply voltage range of 2.65V to 5.5V.
(2)   Typicals are at T$_A$ = 25°C and represent most likely parametric norm.
(3)   Limits are ensured to AOQL (Average Outgoing Quality Level).

Product Folder Links: *LM71 LM71-Q1*

SERIAL BUS DIGITAL SWITCHING CHARACTERISTICS

Unless otherwise noted, these specifications apply for V^+ = 2.65V to 3.6V[(1)]; C_L (load capacitance) on output lines = 100 pF unless otherwise specified. **Boldface limits apply for $T_A = T_J = T_{MIN}$ to T_{MAX};** all other limits $T_A = T_J$ = +25°C, unless otherwise noted.

Symbol	Parameter	Conditions	Typical[(2)]	Limits[(3)]	Units (Limit)
t_1	SC (Clock) Period			**0.16** DC	μs (min) (max)
t_2	$\overline{CS}$ Low to SC (Clock) High Set-Up Time			**100**	ns (min)
t_3	$\overline{CS}$ Low to Data Out (SO) Delay			**70**	ns (max)
t_4	SC (Clock) Low to Data Out (SO) Delay			**70**	ns (max)
t_5	$\overline{CS}$ High to Data Out (SO) TRI-STATE			**200**	ns (max)
t_6	SC (Clock) High to Data In (SI) Hold Time			**50**	ns (min)
t_7	Data In (SI) Set-Up Time to SC (Clock) High			**30**	ns (min)
t_r	SC (Clock) Rise Time			**100**	ns (max)
t_f	SC (Clock) Fall Time			**100**	ns (max)

(1)   The LM71 will operate properly over the V^+ supply voltage range of 2.65V to 5.5V.
(2)   Typicals are at T_A = 25°C and represent most likely parametric norm.
(3)   Limits are ensured to AOQL (Average Outgoing Quality Level).
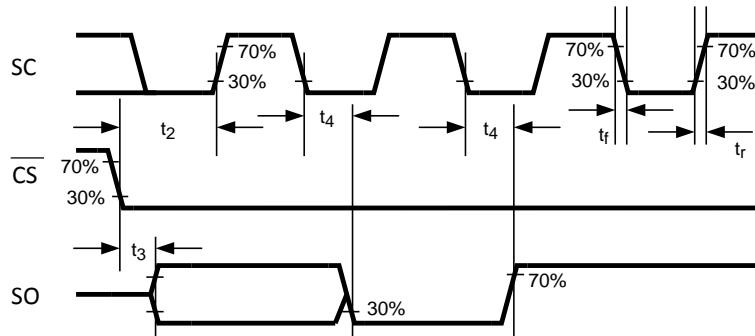

Figure 4. Data Output Timing Diagram
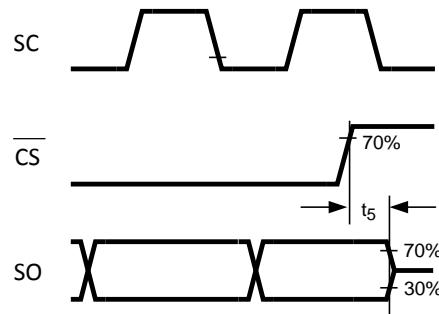
**Figure 5. TRI-STATE Data Output Timing Diagram**
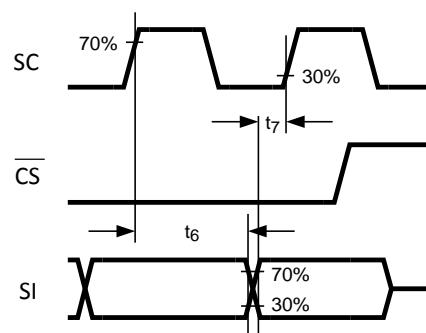
**Figure 6. Data Input Timing Diagram**
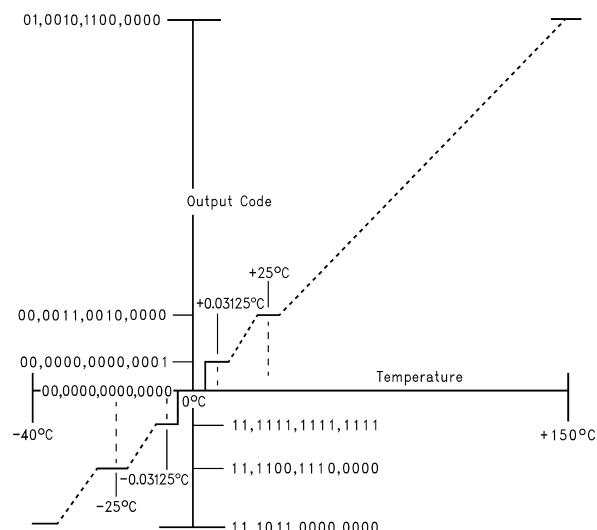
Figure 7. Temperature-to-Digital Transfer Function (Non-linear scale for clarity)
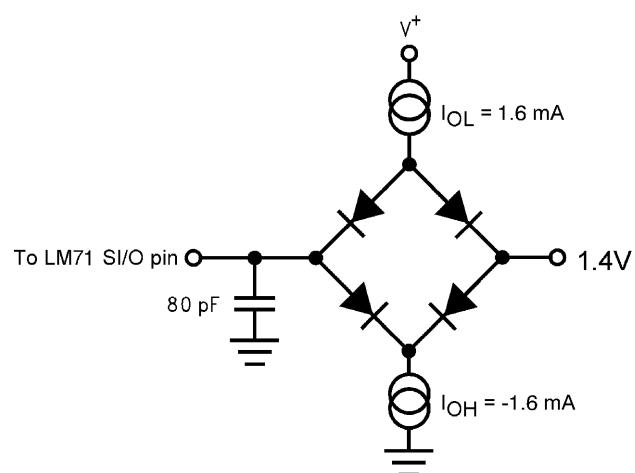

Figure 8. TRI-STATE Test Circuit

8   Typical Performance Characteristics
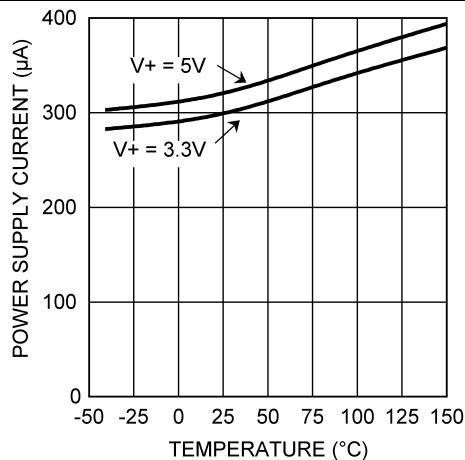
**Figure 9. Static Supply Current vs. Temperature**
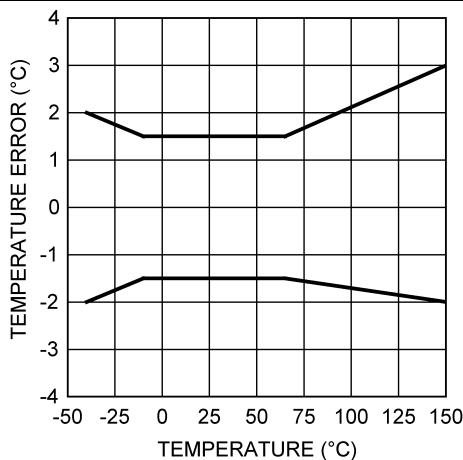
Figure 10. Temperature Error

Submit Documentation Feedback   7

Product Folder Links: *LM71 LM71-Q1*

9 Functional Description

The LM71 temperature sensor incorporates a temperature sensor and 13-bit plus sign ΔΣ ADC (Delta-Sigma Analog-to-Digital Converter). Compatibility of the LM71's three wire serial interface with SPI and MICROWIRE allows simple communications with common microcontrollers and processors. Shutdown mode can be used to optimize current drain for different applications. A Manufacture's/Device ID register identifies the LM71 as TI product.

9.1 POWER UP AND POWER DOWN

The LM71 always powers up in a known state. The power up default condition is continuous conversion mode. Immediately after power up the LM71 will output an erroneous code until the first temperature conversion has completed.

When the supply voltage is less than about 1.6V (typical), the LM71 is considered powered down. As the supply voltage rises above the nominal 1.6V power up threshold, the internal registers are reset to the power up default state described above.

9.2 SERIAL BUS INTERFACE

The LM71 operates as a slave and is compatible with SPI or MICROWIRE bus specifications. Data is clocked out on the falling edge of the serial clock (SC), while data is clocked in on the rising edge of SC. A complete transmit/receive communication will consist of 32 serial clocks. The first 16 clocks comprise the transmit phase of communication, while the second 16 clocks are the receive phase.

When $\overline{CS}$ is high SI/O will be in TRI-STATE. Communication should be initiated by taking chip select ($\overline{CS}$) low. This should not be done when SC is changing from a low to high state. Once $\overline{CS}$ is low the serial I/O pin (SI/O) will transmit the first bit of data. The master can then read this bit with the rising edge of SC. The remainder of the data will be clocked out by the falling edge of SC. $\overline{CS}$ can be taken high at any time during the transmit phase. If $\overline{CS}$ is brought low in the middle of a conversion the LM71 will complete the conversion and the output shift register will be updated after $\overline{CS}$ is brought back high.

The receive phase of a communication starts after 16 SC periods. $\overline{CS}$ can remain low for 32 SC cycles. The LM71 will read the data available on the SI/O line on the rising edge of the serial clock. Input data is to an 8-bit shift register. The part will detect the last eight bits shifted into the register. The receive phase can last up to 16 SC periods. All ones must be shifted in order to place the part into shutdown. All zeros must be shifted in order to place the LM71 into continuous conversion mode. Only the following codes should be transmitted to the LM71:

- 00 hex for continuous conversion
- FF hex for shutdown

Another code may place the part into a test mode. Test modes are used by TI to thoroughly test the function of the LM71 during production testing. Only eight bits have been defined above since only the last eight transmitted are detected by the LM71, before $\overline{CS}$ is taken HIGH.

The following communication can be used to determine the Manufacturer's/Device ID and then immediately place the part into continuous conversion mode. With $\overline{CS}$ continuously low:

- Read 16 bits of temperature data
- Write 16 bits of data commanding shutdown
- Read 16 bits of Manufacture's/Device ID data
- Write 8 to 16 bits of data commanding Conversion Mode
- Take $\overline{CS}$ HIGH.

Note that 300 ms will have to pass for a conversion to complete before the LM71 actually transmits temperature data.

9.3 TEMPERATURE DATA FORMAT

Temperature data is represented by a 14-bit, two's complement word with an LSB (Least Significant Bit) equal to 0.03125°C:

Temperature	Digital Output	
	Binary	Hex
+150°C	0100 1011 0000 0011	4B03
+125°C	0011 1110 1000 0011	3E83
+25°C	0000 1100 1000 0011	0C83
+0.03125°C	0000 0000 0000 0111	0007
0°C	0000 0000 0000 0011	0003
−0.03125°C	1111 1111 1111 1111	FFFF
−25°C	1111 0011 1000 0011	F383
−40°C	1110 1100 0000 0011	EC03

The first data byte is the most significant byte with most significant bit first, permitting only as much data as necessary to be read to determine temperature condition. For instance, if the first four bits of the temperature data indicate an overtemperature condition, the host processor could immediately take action to remedy the excessive temperatures.

9.4 SHUTDOWN MODE/MANUFACTURER'S ID

Shutdown mode is enabled by writing XX FF to the LM71 as shown in Figure 13. The serial bus is still active when the LM71 is in shutdown. When in shutdown mode the LM71 always will output 1000 0000 0000 1111. This is the manufacturer's/Device ID information. The first 5-bits of the field (1000 0XXX) are reserved for manufacturer's ID.

9.5 INTERNAL REGISTER STRUCTURE

The LM71 has three registers, the temperature register, the configuration register and the manufacturer's/device identification register. The temperature and manufacturer's/device identification registers are read only. The configuration register is write only.

9.5.1 Configuration Register

(Selects shutdown or continuous conversion modes):

Table 2. (Write Only):

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
X	X	X	X	X	X	X	X	Shutdown							

D0–D15 set to XX FF hex enables shutdown mode.

D0–D15 set to 00 00 hex sets Continuous conversion mode.

Note: setting D0-D15 to any other values may place the LM70 into a manufacturer's test mode, upon which the LM71 will stop responding as described. These test modes are to be used for TI production testing only. See SERIAL BUS INTERFACE for a complete discussion.

9.5.2 Temperature Register

Table 3. (Read Only):

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
MSB	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit1	LSB	1	1

D0–D1: Logic 1 will be output on SI/0.

D2–D15: Temperature Data. One LSB = 0.03125°C. Two's complement format.

9.5.3 Manufacturer/Device ID Register

Table 4. (Read Only):

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1

D0–D1: Logic 1 will be output on SI/0.

D2–D15: Manufacturer's/Device ID Data. This register is accessed whenever the LM71 is in shutdown mode.

9.6 Serial Bus Timing Diagrams
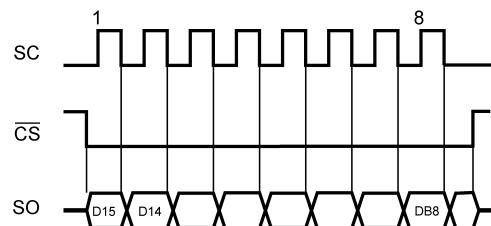
Figure 11. Reading Continuous Conversion - Single Eight-Bit Frame
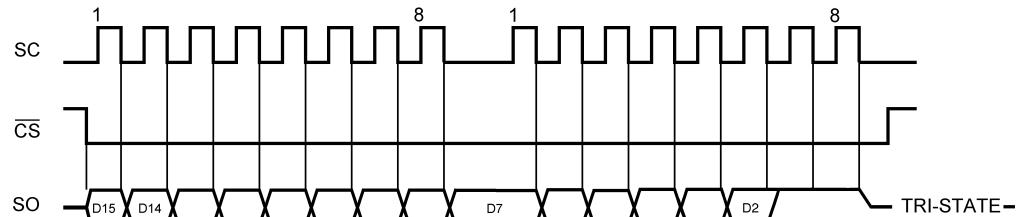
Figure 12. Reading Continuous Conversion - Two Eight-Bit Frames
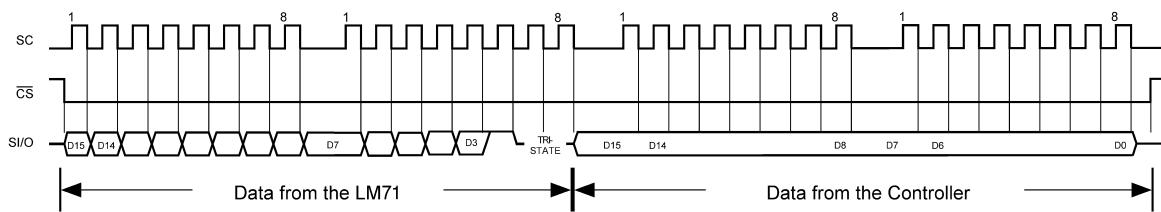
Figure 13. Writing Shutdown Control

9.7 Application Hints

To get the expected results when measuring temperature with an integrated circuit temperature sensor like the LM71, it is important to understand that the sensor measures its own die temperature. For the LM71, the best thermal path between the die and the outside world is through the LM71's pins. In the SOT-23 package, all the pins on the LM71 will have an equal effect on the die temperature. Because the pins represent a good thermal path to the LM71 die, the LM71 will provide an accurate measurement of the temperature of the printed circuit board on which it is mounted. There is a less efficient thermal path between the plastic package and the LM71 die. If the ambient air temperature is significantly different from the printed circuit board temperature, it will have a small effect on the measured temperature.

In probe-type applications, the LM71 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 LM71 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 insure that moisture cannot corrode the LM71 or its connections.

9.8 Typical Applications
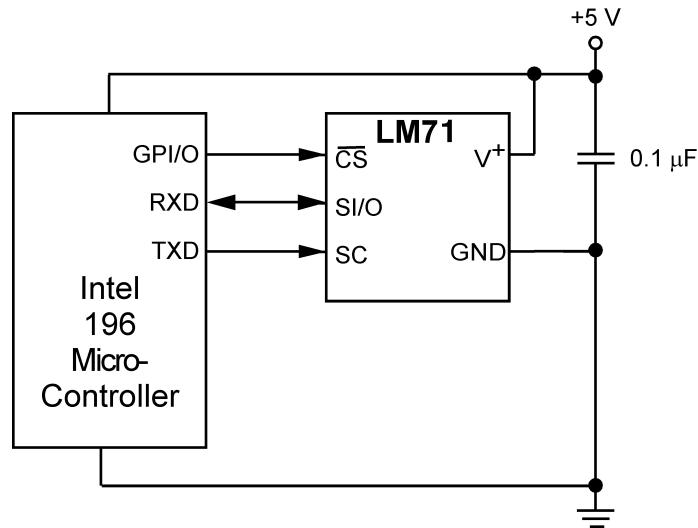
Figure 14. Temperature monitor using Intel 196 processor
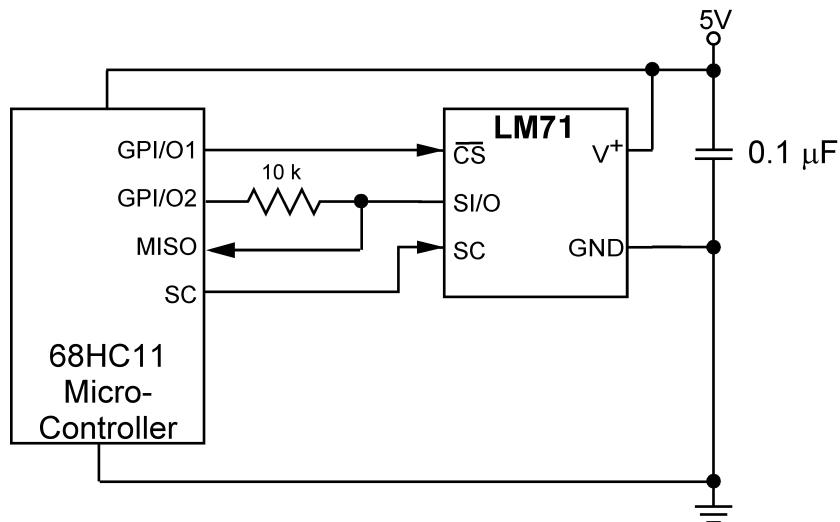
Figure 15. LM71 digital input control using micro-controller's general purpose I/O.

10 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision D (March 2013) to Revision E	Page
• Added SNLA296 ulink to the temperature conversion time tablenote... 4	

Changes from Revision C (March 2013) to Revision D	Page
• Changed layout of National Semiconductor Data Sheet to TI format 11	

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM71CIMF	NRND	Production	SOT-23 (DBV) | 5	1000 | LARGE T&R	No	SNPB	Level-1-260C-UNLIM	-	T16C
LM71CIMF.A	NRND	Production	SOT-23 (DBV) | 5	1000 | LARGE T&R	No	SNPB	Level-1-260C-UNLIM	-40 to 150	T16C
LM71CIMF/NOPB	Obsolete	Production	SOT-23 (DBV) | 5	-	-	Call TI	Call TI	-	T16C
LM71CIMFX/NOPB	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	T16C
LM71CIMFX/NOPB.A	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	T16C
LM71CISD/NOPB	Active	Production	WSON (NGG) | 6	1000 | SMALL T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	L71CI
LM71CISD/NOPB.A	Active	Production	WSON (NGG) | 6	1000 | SMALL T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	L71CI
LM71QCIMF/NOPB	Obsolete	Production	SOT-23 (DBV) | 5	-	-	Call TI	Call TI	-40 to 150	T16Q
LM71QCIMFX/NOPB	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	T16Q
LM71QCIMFX/NOPB.A	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	T16Q

(1) Status: For more details on status, see our product life cycle.

(2) Material type: When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) RoHS values: Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) Lead finish/Ball material: Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) MSL rating/Peak reflow: The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) Part marking: There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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PACKAGE OPTION ADDENDUM

and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF LM71, LM71-Q1 :

● Catalog : LM71

● Automotive : LM71-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

REEL DIMENSIONS
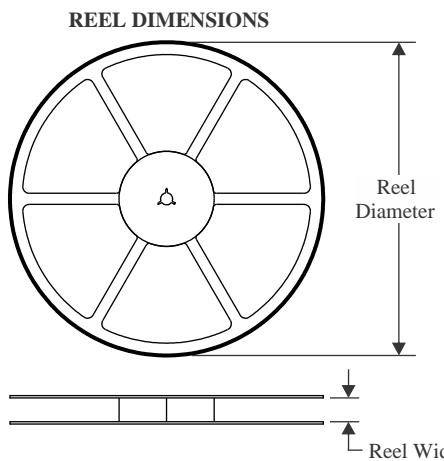
TAPE DIMENSIONS

A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

User Direction of Feed

Pocket Quadrants
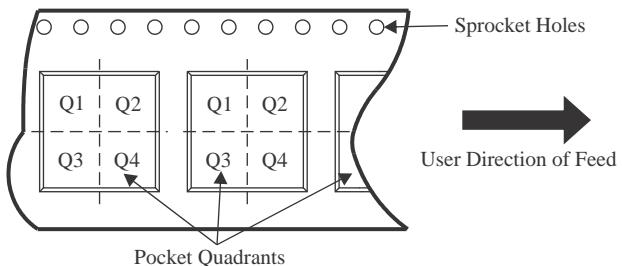
*All dimensions are nominal

| 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
LM71CIMFX/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM71CISD/NOPB	WSON	NGG	6	1000	177.8	12.4	3.3	3.3	1.0	8.0	12.0	Q1
LM71QCIMFX/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3

PACKAGE MATERIALS INFORMATION

TAPE AND REEL BOX DIMENSIONS
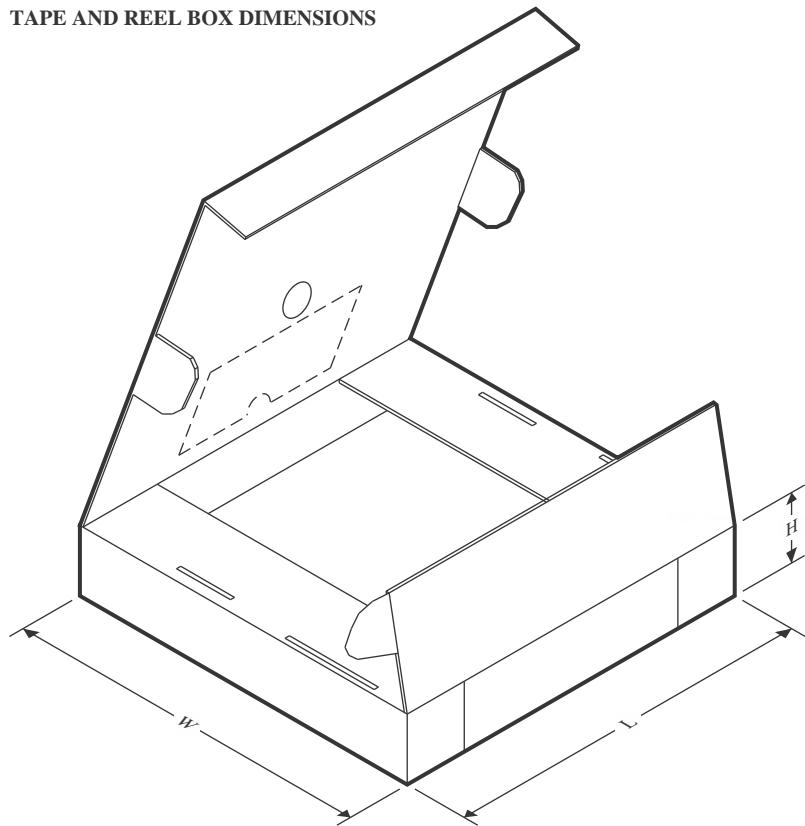
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM71CIMFX/NOPB	SOT-23	DBV	5	3000	208.0	191.0	35.0
LM71CISD/NOPB	WSON	NGG	6	1000	208.0	191.0	35.0
LM71QCIMFX/NOPB	SOT-23	DBV	5	3000	208.0	191.0	35.0
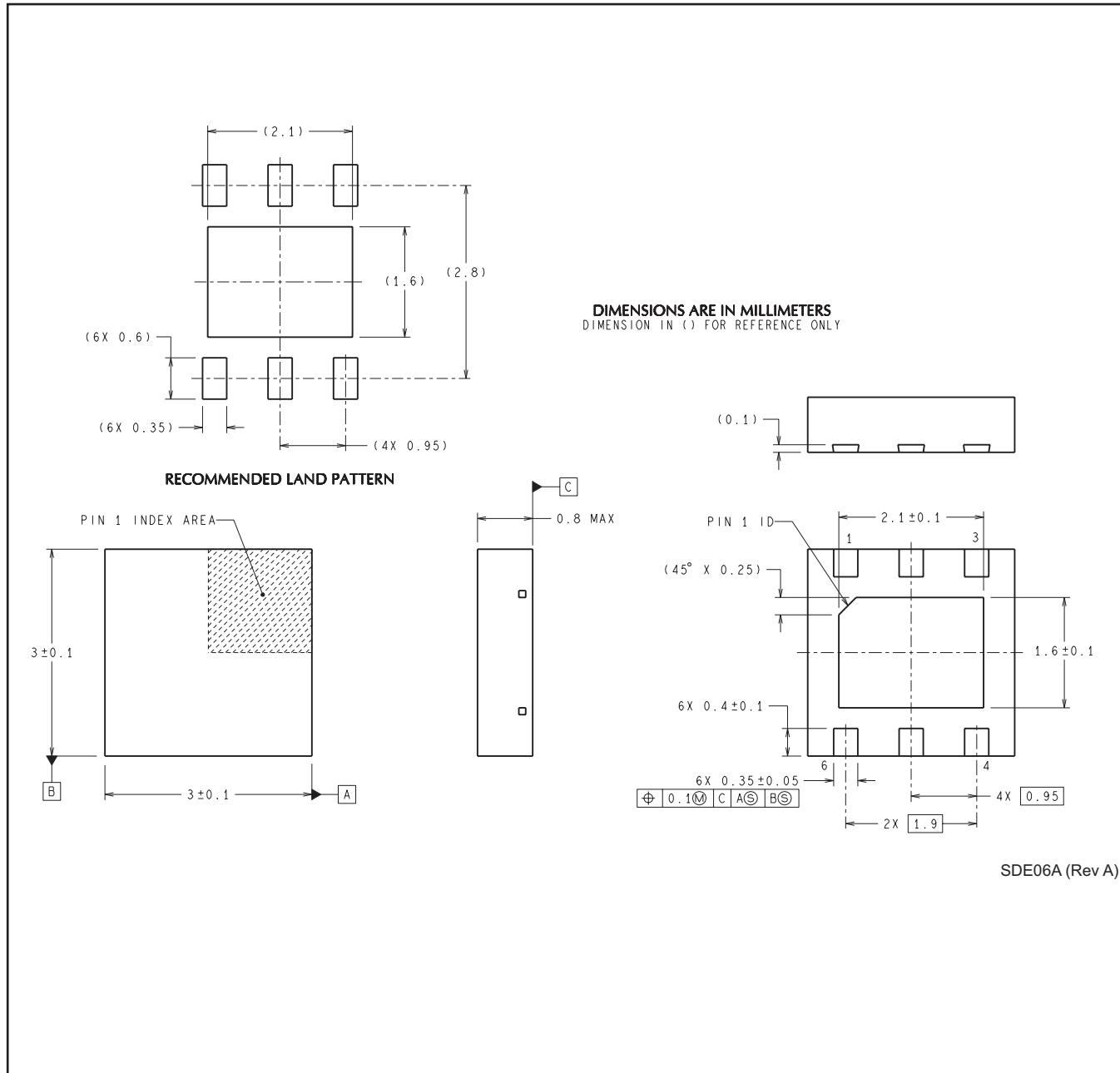
NGG0006A

DIMENSIONS ARE IN MILLIMETERS
DIMENSION IN ( ) FOR REFERENCE ONLY

RECOMMENDED LAND PATTERN

(2.1)

(1.6)

(2.8)

(6X 0.6)

(6X 0.35)

(4X 0.95)

PIN 1 INDEX AREA

3±0.1

3±0.1

B

A

(0.1)

0.8 MAX

C

PIN 1 ID

2.1±0.1

(45° X 0.25)

1.6±0.1

6X 0.4±0.1

6X 0.35±0.05

⊕ | 0.1Ⓜ | C | AⓈ | BⓈ

2X 1.9

4X 0.95

SDE06A (Rev A)

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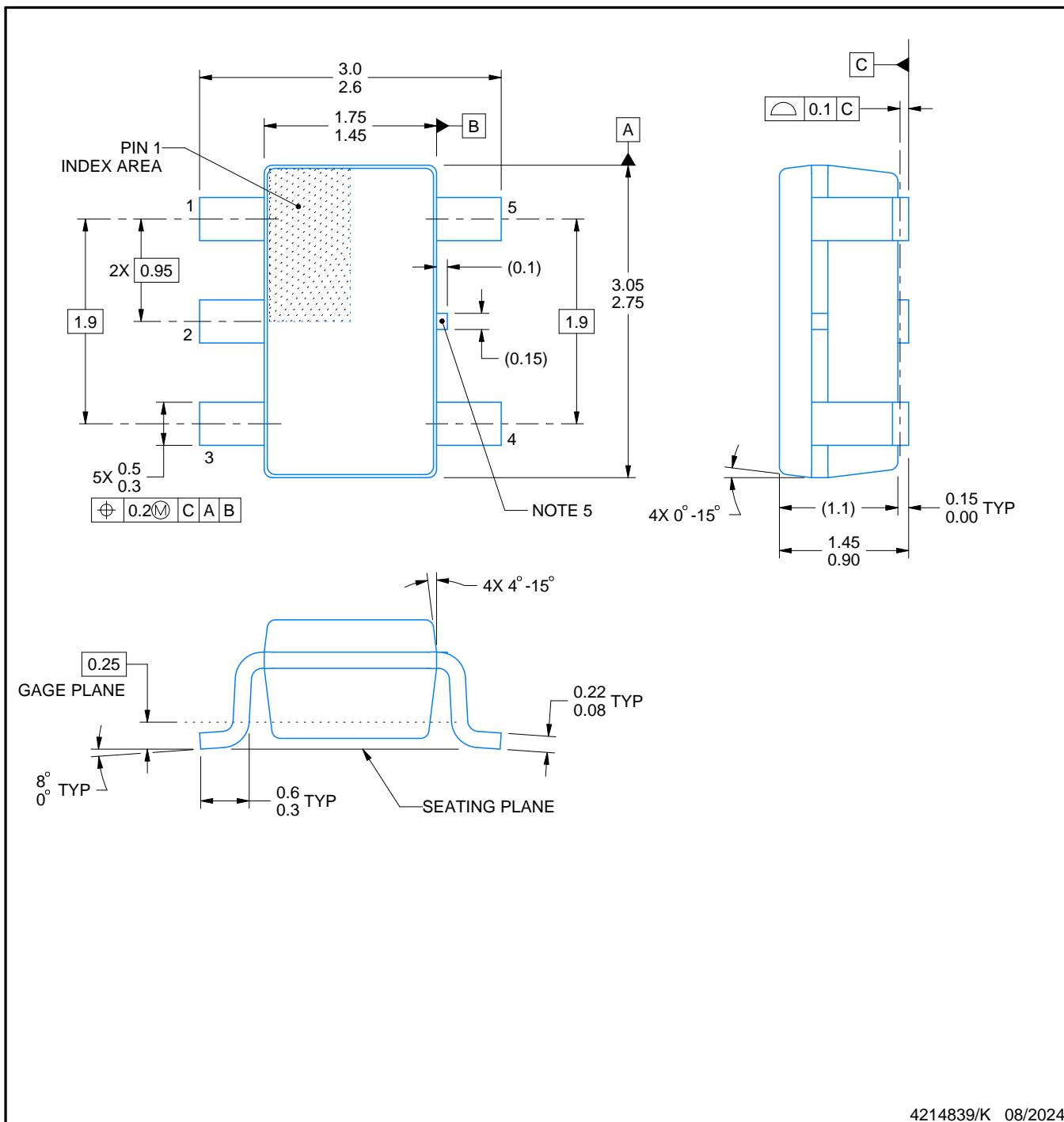
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Refernce JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25 mm per side.
5. Support pin may differ or may not be present.

PKG

5X (1.1)

1

5X (0.6)

5

SYMM

2

(1.9)

2X (0.95)

3

4

(R0.05) TYP

(2.6)
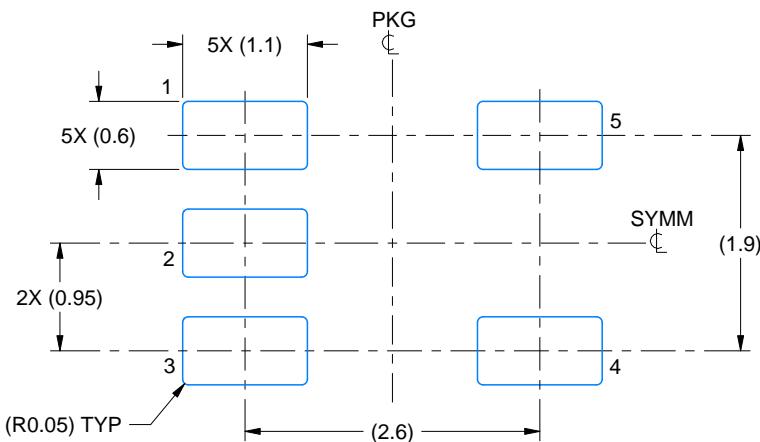
LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X

SOLDER MASK
OPENING

METAL

EXPOSED METAL

0.07 MAX
ARROUND

NON SOLDER MASK
DEFINED
(PREFERRED)

METAL UNDER
SOLDER MASK

SOLDER MASK
OPENING

EXPOSED METAL

0.07 MIN
ARROUND

SOLDER MASK
DEFINED
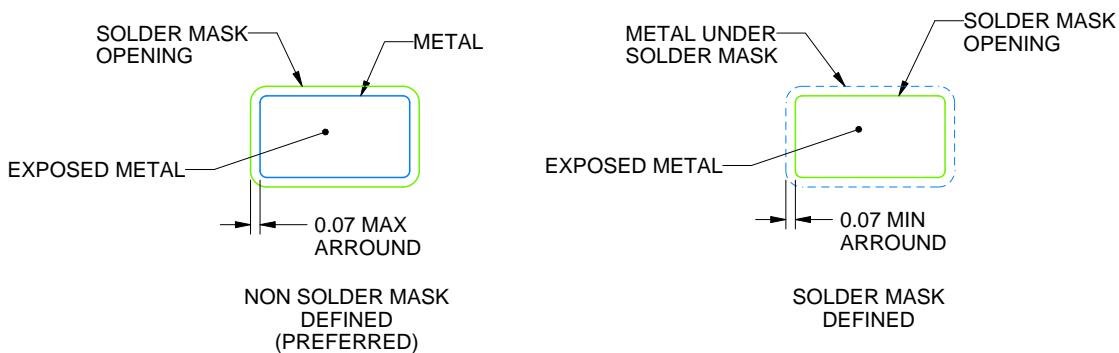
SOLDER MASK DETAILS

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NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
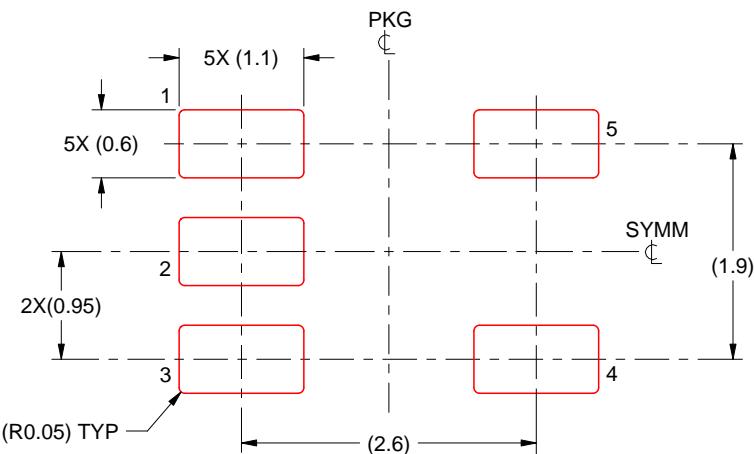
SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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