LM70 SPI/MICROWIRE 10-Bit plus Sign Digital Temperature Sensor

Check for Samples: LM70

FEATURES

- **0.25°C Temperature Resolution.**
- **Shutdown Mode Conserves Power Between Temperature Reading**
- **SPI and MICROWIRE Bus Interface**
- **VSSOP-8 and WSON-8 Packages Save Space**
- **UL Recognized Component**

APPLICATIONS

- **System Thermal Management**
- **Personal Computers**
- **Disk Drives**
- **Office Electronics**
- **Electronic Test Equipment**

KEY SPECIFICATIONS

- **Supply Voltage 2.65V to 5.5V**
- **Supply Current**
  - **Operating**
    - **260 µA (typ)**
    - **490 µA (max)**
  - **Shutdown**
    - **12 µA (typ)**
- **Temperature Accuracy**
  - **−40°C to 85°C, ±2°C(max)**
  - **−10°C to 65°C, +1.5/−2°C(max)**
  - **−55°C to 125°C, +3/−2°C(max)**
  - **−55°C to 150°C, +3.5/−2°C(max)**

DESCRIPTION

The LM70 is a temperature sensor, Delta-Sigma analog-to-digital converter with an SPI and MICROWIRE compatible interface available in WSON and VSSOP 8-pin packages. The host can query the LM70 at any time to read temperature. A shutdown mode decreases power consumption to less than 10 µA. This mode is useful in systems where low average power consumption is critical.

The LM70 has 10-bit plus sign temperature resolution (0.25°C per LSB) while operating over a temperature range of −55°C to +150°C.

The LM70's 2.65V to 5.5V supply voltage range, low supply current and simple SPI interface make it ideal for a wide range of applications. These include thermal management and protection applications in hard disk drives, printers, electronic test equipment, and office electronics.

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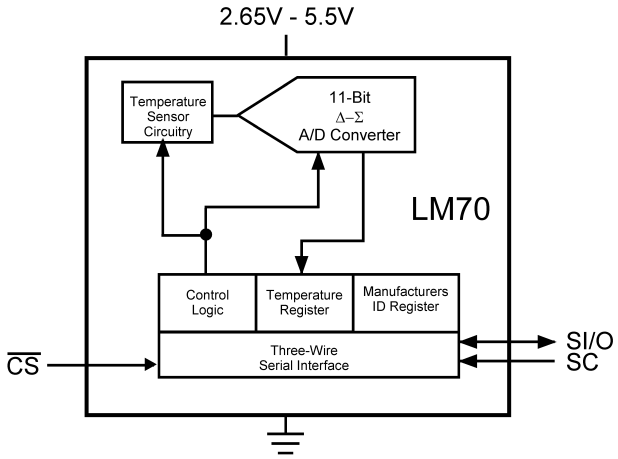
Simplified Block Diagram



Connection Diagram

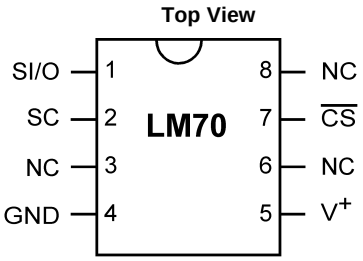


Figure 1. VSSOP-8 Package
See Package Number DGK0008A

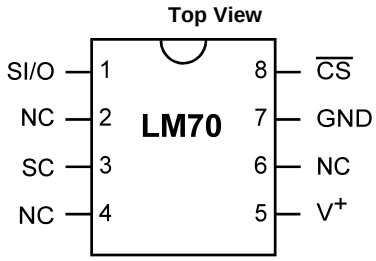


Figure 2. WSON-8 Package
See Package Number NGK0008A

PIN DESCRIPTIONS

Pin Name	VSSOP-8 Pin No.	WSON-8 Pin No.	Description	Typical Connection
SI/O	1	1	Input/Output - Serial bus bi-directional data line. Schmitt trigger input.	From and to Controller
SC	2	3	Clock - Serial bus clock Schmitt trigger input line.	From Controller
GND	4	7	Power Supply Ground	Ground
V^+	5	5	Positive Supply Voltage Input	DC Voltage from 2.65V to 5.5V. Bypass with a 0.1 µF ceramic capacitor.
$\overline{CS}$	7	8	Chip Select input.	From Controller
NC	3, 6, 8	2, 4, 6	No Connect	These pins are not connected to the LM70 die in any way.

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Typical Application

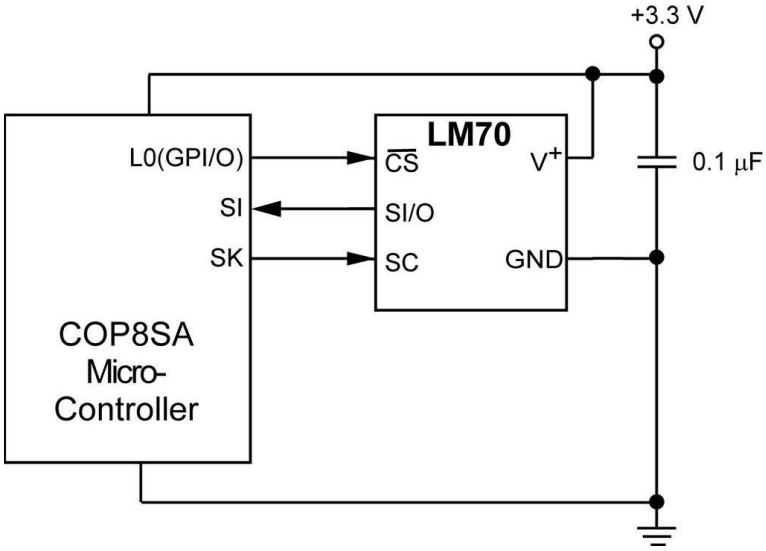

Figure 3. COP Microcontroller Interface

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(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
Package Input Current(2)	20 mA
Storage Temperature	−65°C to +150°C
Soldering Information, Lead Temperature	
VSSOP-8 and WSON-8 Packages(3) Vapor Phase (60 seconds) Infrared (15 seconds)	 215°C 220°C
ESD Susceptibility(4)	
Human Body Model	3000V
Machine Model	300V

(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. The 20 mA maximum package input current rating limits the number of pins that can safely exceed the power supplies with an input current of 5 mA to four.
(3) See the section titled “Surface Mount” found in a current Linear Data Book for other methods of soldering surface mount devices.
(4) Human body model, 100 pF discharged through a 1.5 kΩ resistor. Machine model, 200 pF discharged directly into each pin.

Operating Ratings

Specified Temperature Range	T_{MIN} to T_{MAX}
See(1)	−55°C to +150°C
Supply Voltage Range (+V_S)	+2.65V to +5.5V

(1) The life expectancy of the LM70 will be reduced when operating at elevated temperatures. LM70 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 LM70CILD Thermal Resistance (θJA), 51.3°C/W, Device Number LM70CIMM Thermal Resistance (θJA), 200°C/W

Temperature-to-Digital Converter Characteristics

Unless otherwise noted, these specifications apply for V^+ = 2.65V to 3.6V for the LM70-3 and V^+ = 4.5V to 5.5V for the LM70-5(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	Test Conditions	Typical(2)	LM70-5 Limits(3)	LM70-3 Limits(3)	Units (Limit)
Temperature Error(1)	T_A = −10°C to +65°C		**+1.5/−2.0**	**+1.5/−2.0**	°C (max)
	T_A = −40°C to +85°C		**±2.0**	**±2.0**	°C (max)
	T_A = −55°C to +125°C		**+3.0/−2.0**	**+3.0/−2.0**	°C (max)
	T_A = −55°C to +150°C		**+3.5/−2.0**	**+3.5/−2.0**	°C (max)
Resolution		11 0.25			Bits °C
Temperature Conversion Time	See(4)	140	**210**	**210**	ms (max)
Quiescent Current	Serial Bus Inactive	260	**490**	**490**	µA (max)
	Serial Bus Active	260			µA
	Shutdown Mode	12			µA

(1) Both part numbers of the LM70 will operate properly over the V^+ supply voltage range of 2.65V to 5.5V. The temperature error for temperature ranges of −10°C to +65°C, −40°C to +85°C, −55°C to +125°C and −55°C to +150°C include error induced by power supply variation of ±5% from the nominal value. Temperature error will increase by ±0.3°C for a power supply voltage (V^+) variation of ±10% from the nominal value.
(2) Typicals are at T_A = 25°C and represent most likely parametric norm.
(3) Limits are guaranteed to AOQL (Average Outgoing Quality Level).
(4) This specification is provided only to indicate how often temperature data is updated. The LM70 can be read at any time without regard to conversion state (and will yield last conversion result). A conversion in progress will not be interrupted. The output shift register will be updated at the completion of the read and a new conversion restarted.

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Logic Electrical Characteristics Digital DC Characteristics

Unless otherwise noted, these specifications apply for V^+ = 2.65V to 3.6V for the LM70-3 and V^+ = 4.5V to 5.5V for the LM70-5. **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		Test Conditions	Typical (1)	Limits (2)	Units (Limit)
$V_{IN(1)}$	Logical “1” Input Voltage			**$V^+ \times 0.7$**	V (min)
				$V^+ + 0.3$	V (max)
$V_{IN(0)}$	Logical “0” Input Voltage			**−0.3**	V (min)
				$V^+ \times 0.3$	V (max)
	Input Hysteresis Voltage	V^+ = 2.65V to 3.6V	0.8	**0.27**	V (min)
		V^+ = 4.5V to 5.5V	0.8	**0.35**	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)
$I_{O_TRI\text{-}STATE}$	TRI-STATE Output Leakage Current	V_O = GND $V_O = V^+$		**−1** **+1**	µA (min) µA (max)

(1) Typicals are at T_A = 25°C and represent most likely parametric norm.
(2) Limits are guaranteed to AOQL (Average Outgoing Quality Level).

Logic Electrical Characteristics Serial Bus Digital Switching Characteristics

Unless otherwise noted, these specifications apply for V^+ = 2.65V to 3.6V for the LM70-3 and V^+ = 4.5V to 5.5V for the LM70-5, 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.

Parameter		Test Conditions	Typical (1)	Limits (2)	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 (min)
t_6	SC (Clock) High to Data In (SI) Hold Time			**60**	ns (min)
t_7	Data In (SI) Set-Up Time to SC (Clock) High			**30**	ns (min)

(1) Typicals are at T_A = 25°C and represent most likely parametric norm.
(2) Limits are guaranteed to AOQL (Average Outgoing Quality Level).

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Timing Diagrams

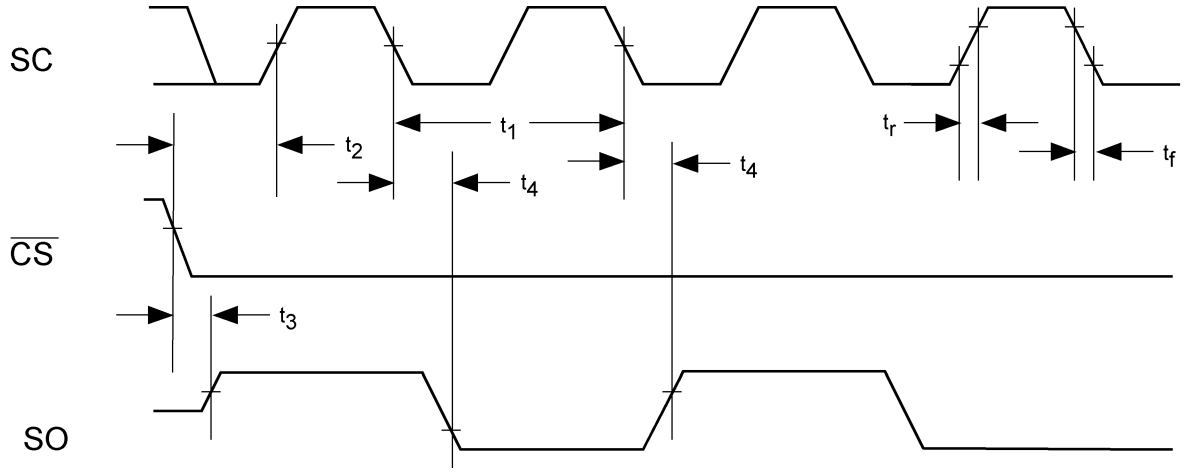

Figure 4. Data Output Timing Diagram

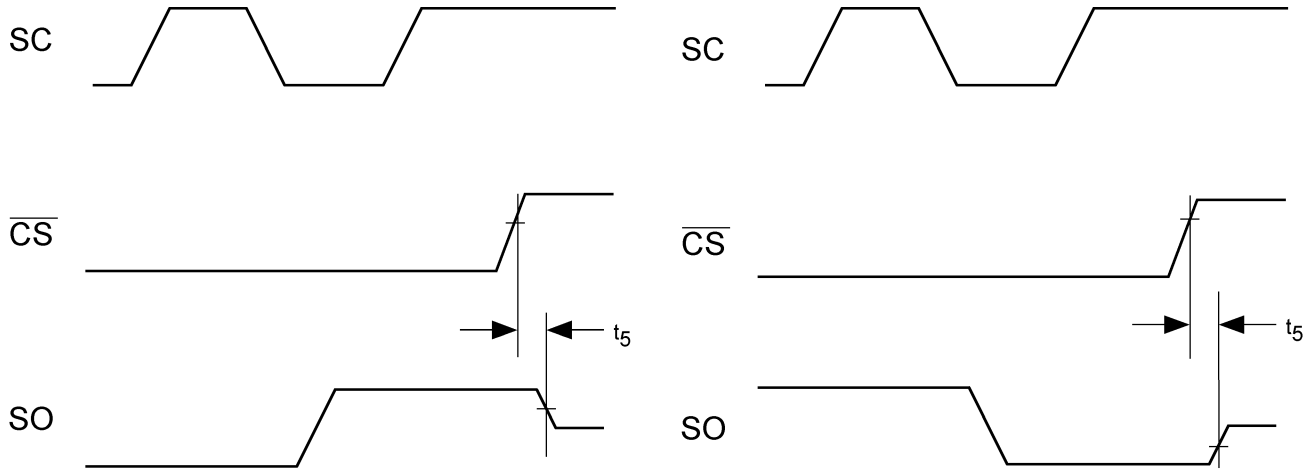

Figure 5. TRI-STATE Data Output Timing Diagram

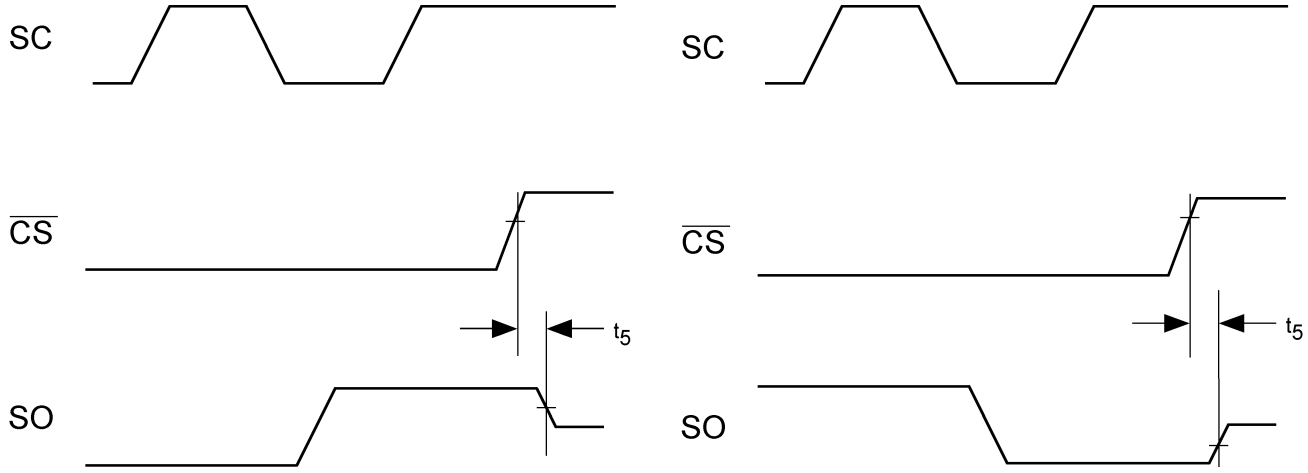

Figure 6. Data Input Timing Diagram

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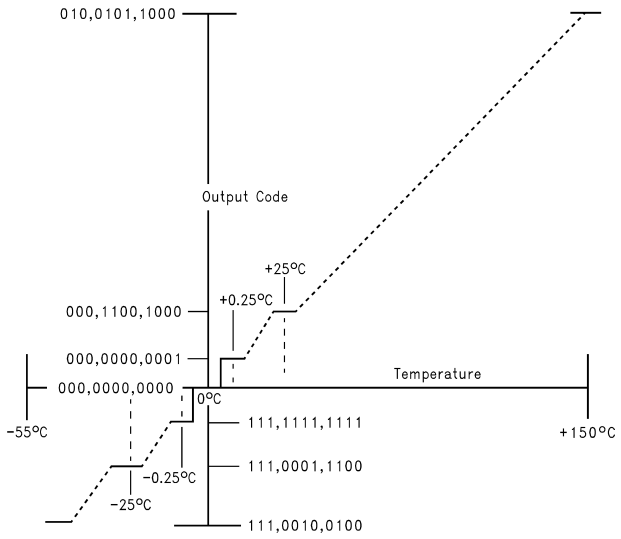

Figure 7. Temperature-to-Digital Transfer Function (Non-linear scale for clarity)

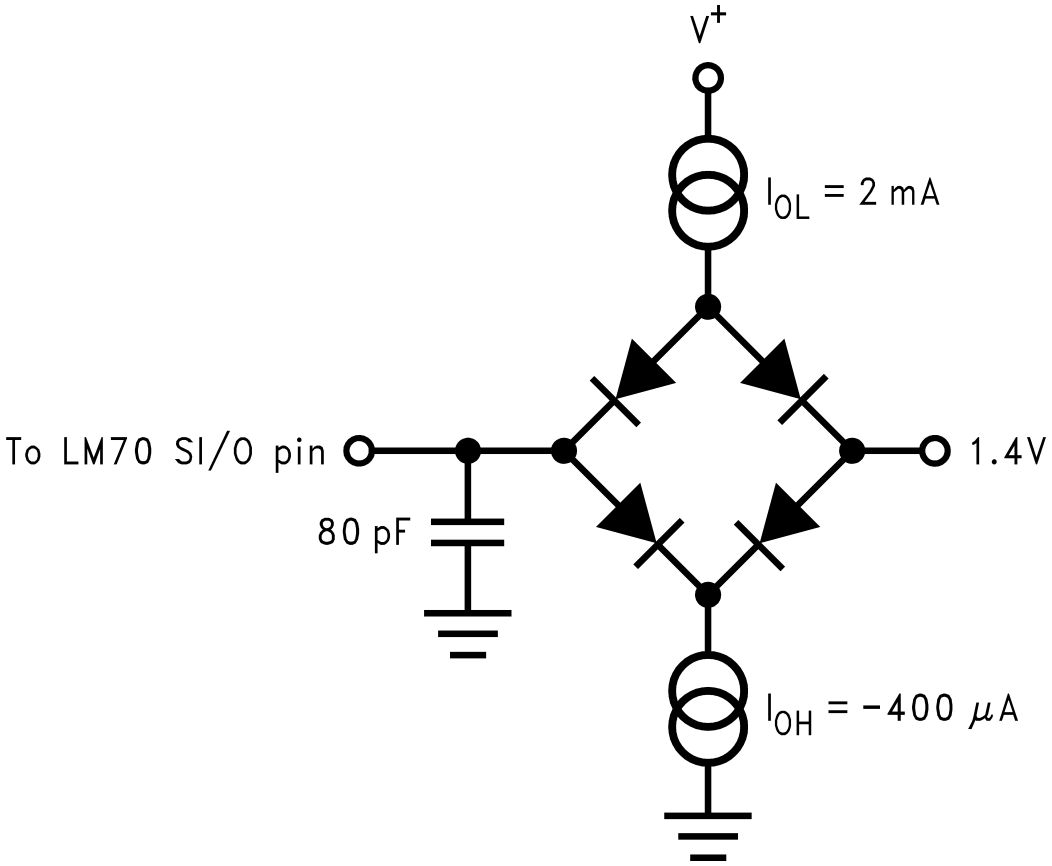

Figure 8. TRI-STATE Test Circuit

Typical Performance Characteristics

Average Power-On Reset Voltage vs Temperature

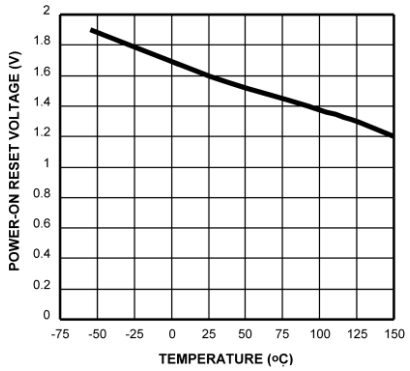

Figure 9.

Static Supply Current vs Temperature

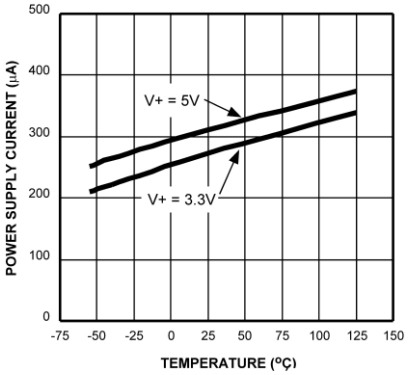

Figure 10.

Temperature Error

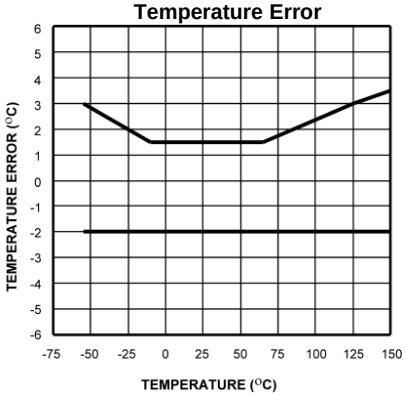

Figure 11.

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FUNCTIONAL DESCRIPTION

The LM70 temperature sensor incorporates a band-gap type temperature sensor and 10-bit plus sign ΔΣ ADC (Delta-Sigma Analog-to-Digital Converter). Compatibility of the LM70'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 ID register identifies the LM70 as a TI product.

POWER UP AND POWER DOWN

The LM70 always powers up in a known state. The power up default condition is continuous conversion mode. Immediatly after power up the LM70 will output an erroneous code until the first temperature conversion has completed.

When the supply voltage is less than about 1.6V (typical), the LM70 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.

SERIAL BUS INTERFACE

The LM70 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 TRISTATE. 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. Once the 14 bits of data (one sign bit, ten temperature bits and 3 high bits) are transmitted the SI/O line will go into TRI-STATE. $\overline{CS}$ can be taken high at any time during the transmit phase. If $\overline{CS}$ is brought low in the middle of a conversion the LM70 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 LM70 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. A zero in any location will take the LM70 out of shutdown. The following codes only should be transmitted to the LM70:

- 00 hex (normal operation)
- 01 hex (normal operation)
- 03 hex (normal operation)
- 07 hex (normal operation)
- 0F hex (normal operation)
- 1F hex (normal operation)
- 3F hex(normal operation)
- 7F hex(normal operation)
- FF hex (Shutdown, transmit manufacturer's ID)

any others may place the part into a Test Mode. Test Modes are used by TI to thoroughly test the function of the LM70 during production testing. Only eight bits have been defined above since only the last eight transmitted, before $\overline{CS}$ is taken HIGH, are detected by the LM70

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.

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Note that 210 ms will have to pass for a conversion to complete before the LM70 actually transmits temperature data.

TEMPERATURE DATA FORMAT

Temperature data is represented by a 11-bit, two's complement word with an LSB (Least Significant Bit) equal to 0.25°C:

Temperature	Digital Output	
	Binary	Hex
+150°C	0100 1011 0001 1111	4B 1Fh
+125°C	0011 1110 1001 1111	3E 9Fh
+25°C	0000 1100 1001 1111	0B 9Fh
+0.25°C	0000 0000 0011 1111	00 3Fh
0°C	0000 0000 0001 1111	00 1Fh
−0.25°C	1111 1111 1111 1111	FF FFh
−25°C	1111 0011 1001 1111	F3 9Fh
−55°C	1110 0100 1001 1111	E4 9Fh

Note: The last two bits are TRI-STATE and depicted as one in the table.

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.

SHUTDOWN MODE/MANUFACTURER'S ID

Shutdown mode is enabled by writing XX FF to the LM70 as shown in Figure 14c. and discussed in Section 1.2. The serial bus is still active when the LM70 is in shutdown. Current draw drops to less than 10 µA between serial communications. When in shutdown mode the LM70 always will output 1000 0001 0000 00XX. This is the manufacturer's ID/Device ID information. The first 5-bits of the field (1000 0XXX) are reserved for manufacturer's ID.

INTERNAL REGISTER STRUCTURE

The LM70 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.

CONFIGURATION REGISTER

(Selects shutdown or continuous conversion modes):

Table 1. (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 XX 00 hex enables continuous conversion mode.

Note: setting D0-D15 to any other values may place the LM70 into a manufacturer's test mode, upon which the LM70 will stop responding as described. These test modes are to be used for production testing only. See Section 1.2 Serial Bus Interface for a complete discussion.

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TEMPERATURE REGISTER

Table 2. (Read Only):

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

D0–D1: Undefined. TRI-STATE will be output on SI/0.

D2–D4: Always set high.

D5–D15: Temperature Data. One LSB = 0.25°C. Two's complement format.

MANUFACTURER'S/DEVICE ID REGISTER

Table 3. (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	1	0	0	0	0	0	0	X	X

D0–D1: Undefined. TRI-STATE will be output on SI/0.

D2-D4: Always set LOW.

D5–D15: Manufacturer's ID Data. This register is accessed whenever the LM70 is in shutdown mode.

Serial Bus Timing Diagrams

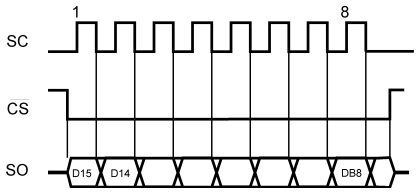

Figure 12. a) Reading Continuous Conversion - Single Eight-Bit Frame

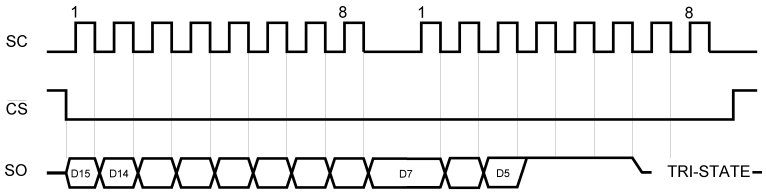

Figure 13. b) Reading Continuous Conversion - Two Eight-Bit Frames

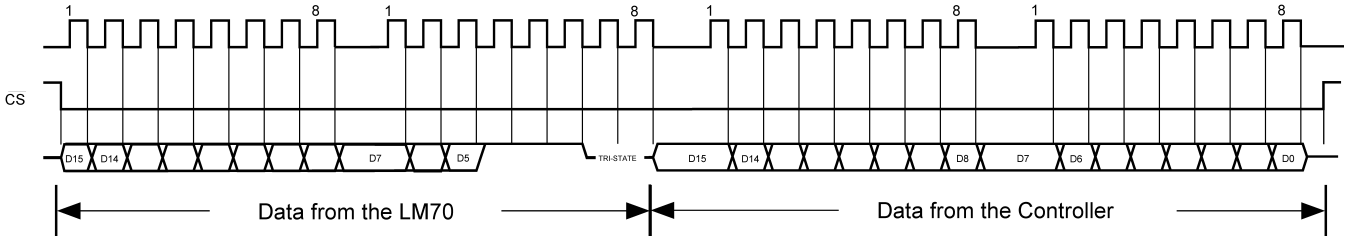

Figure 14. c) Writing Shutdown Control

Application Hints

To get the expected results when measuring temperature with an integrated circuit temperature sensor like the LM70, it is important to understand that the sensor measures its own die temperature. For the LM70, the best thermal path between the die and the outside world is through the LM70's pins. In the VSSOP-8 package the ground pin is connected to the back side of the LM70 die and thus has the most effect on the die temperature. Although the other pins will also have some effect on the LM70die temperature and therefore should not be discounted. The LM70 will provide an accurate measurement of the temperature of the printed circuit board on which it is mounted, because the pins represent a good thermal path to the die. A less efficient thermal path exists between the plastic package and the LM70 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 LM70 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 LM70 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 LM70 or its connections.

Typical Applications

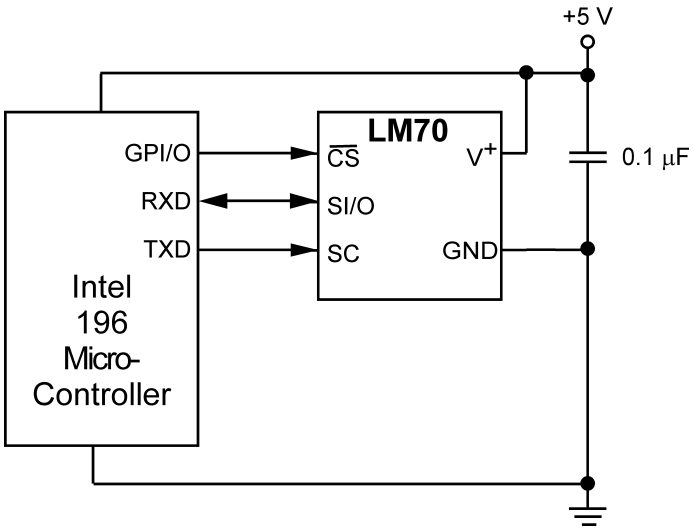

Figure 15. Temperature Monitor Using Intel 196 Processor

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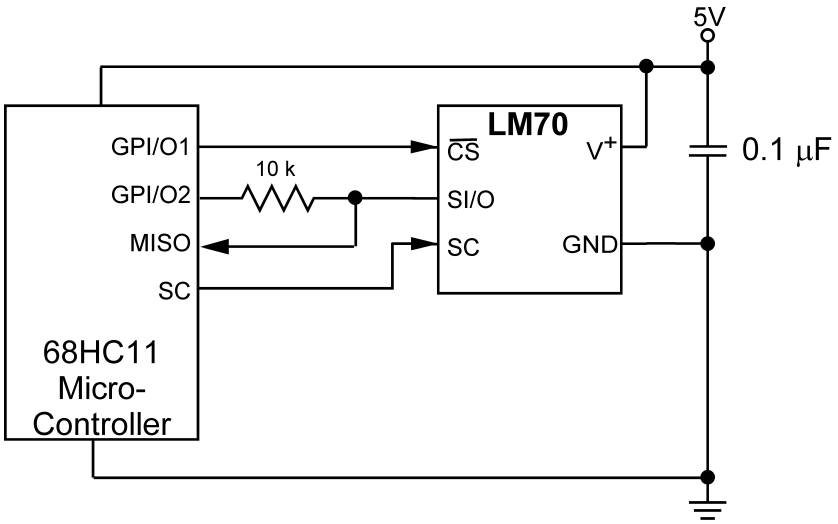

Figure 16. LM70 Digital Input Control Using Micro-Controller's General Purpose I/O

REVISION HISTORY

Changes from Revision F (March 2013) to Revision G	Page
• Changed layout of National Data Sheet to TI format	13

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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)
LM70CILD-3/NOPB	Active	Production	WSON (NGK) | 8	1000 | SMALL T&R	Yes	SN	Level-3-260C-168 HR	-55 to 150	T33
LM70CILD-3/NOPB.A	Active	Production	WSON (NGK) | 8	1000 | SMALL T&R	Yes	SN	Level-3-260C-168 HR	-55 to 150	T33
LM70CILD-5/NOPB	Active	Production	WSON (NGK) | 8	1000 | SMALL T&R	Yes	SN	Level-3-260C-168 HR	-55 to 150	T35
LM70CILD-5/NOPB.A	Active	Production	WSON (NGK) | 8	1000 | SMALL T&R	Yes	SN	Level-3-260C-168 HR	-55 to 150	T35
LM70CILDX-3/NOPB	Active	Production	WSON (NGK) | 8	4500 | LARGE T&R	Yes	SN	Level-3-260C-168 HR	-55 to 150	T33
LM70CILDX-3/NOPB.A	Active	Production	WSON (NGK) | 8	4500 | LARGE T&R	Yes	SN	Level-3-260C-168 HR	-55 to 150	T33
LM70CIMM-3	NRND	Production	VSSOP (DGK) | 8	1000 | SMALL T&R	No	Call TI	Call TI	-55 to 150	T04C
LM70CIMM-3.A	NRND	Production	VSSOP (DGK) | 8	1000 | SMALL T&R	No	Call TI	Call TI	-55 to 150	T04C
LM70CIMM-5	NRND	Production	VSSOP (DGK) | 8	1000 | SMALL T&R	No	Call TI	Call TI	-55 to 150	T03C
LM70CIMM-5.A	NRND	Production	VSSOP (DGK) | 8	1000 | SMALL T&R	No	Call TI	Call TI	-55 to 150	T03C
LM70CIMM-5/NOPB	Obsolete	Production	VSSOP (DGK) | 8	-	-	Call TI	Call TI	-55 to 150	T03C
LM70CIMMX-3/NOPB	Active	Production	VSSOP (DGK) | 8	3500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-55 to 150	T04C
LM70CIMMX-3/NOPB.A	Active	Production	VSSOP (DGK) | 8	3500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-55 to 150	T04C
LM70CIMMX-5/NOPB	Active	Production	VSSOP (DGK) | 8	3500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-55 to 150	T03C
LM70CIMMX-5/NOPB.A	Active	Production	VSSOP (DGK) | 8	3500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-55 to 150	T03C

(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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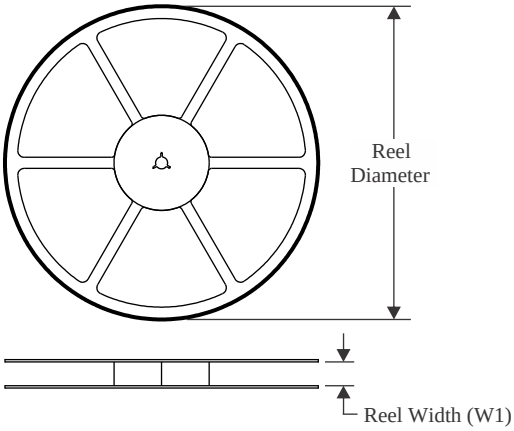
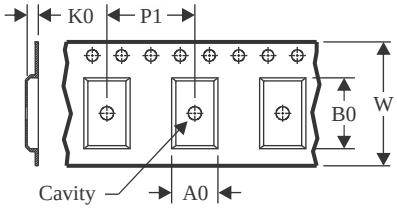
TAPE AND REEL INFORMATION

REEL DIMENSIONS

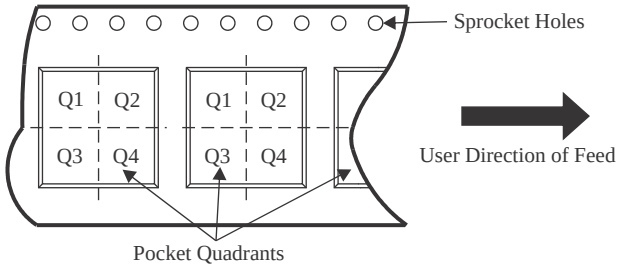


TAPE DIMENSIONS



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

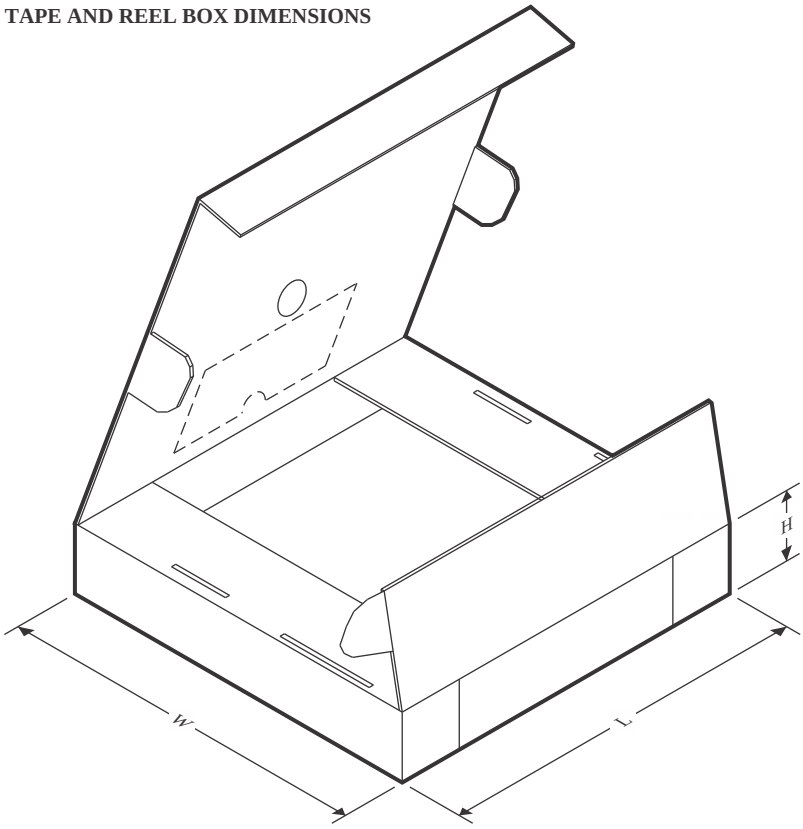
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LM70CILD-3/NOPB	WSON	NGK	8	1000	177.8	12.4	3.3	3.3	1.0	8.0	12.0	Q1
LM70CILD-5/NOPB	WSON	NGK	8	1000	177.8	12.4	3.3	3.3	1.0	8.0	12.0	Q1
LM70CILDX-3/NOPB	WSON	NGK	8	4500	330.0	12.4	3.3	3.3	1.0	8.0	12.0	Q1
LM70CIMMX-3/NOPB	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM70CIMMX-5/NOPB	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1

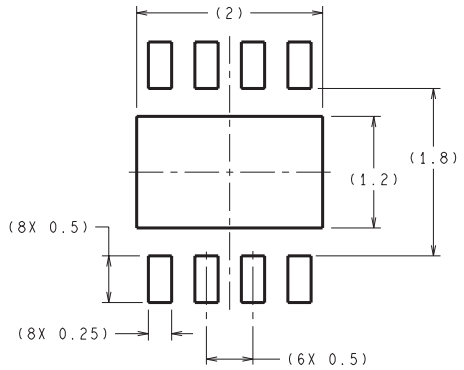
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

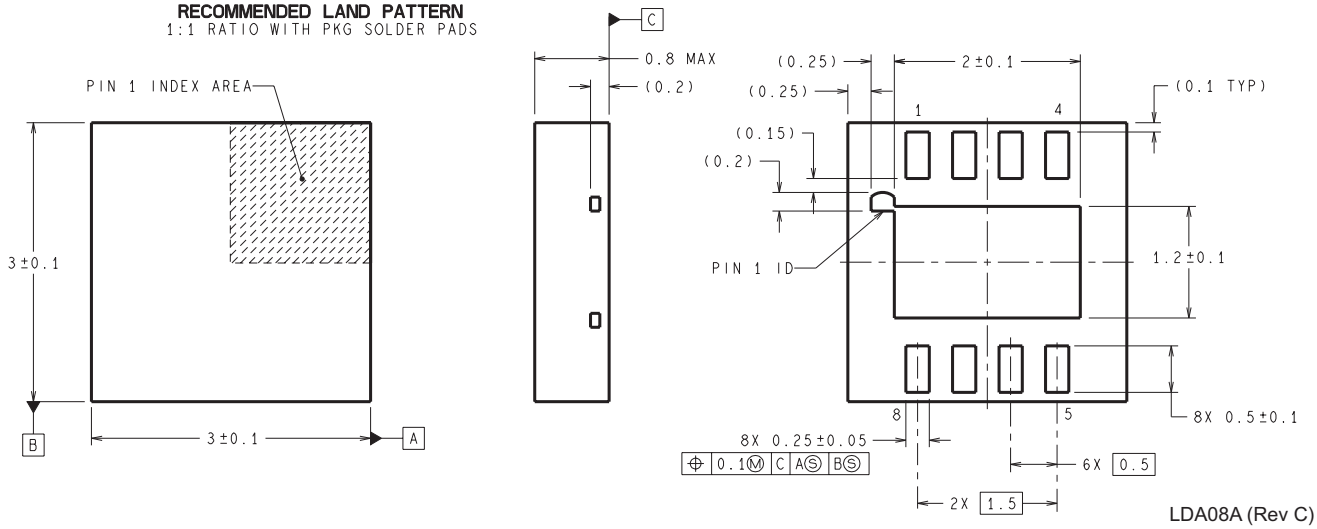
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM70CILD-3/NOPB	WSON	NGK	8	1000	367.0	367.0	35.0
LM70CILD-5/NOPB	WSON	NGK	8	1000	367.0	367.0	35.0
LM70CILDX-3/NOPB	WSON	NGK	8	4500	356.0	356.0	36.0
LM70CIMMX-3/NOPB	VSSOP	DGK	8	3500	367.0	367.0	35.0
LM70CIMMX-5/NOPB	VSSOP	DGK	8	3500	367.0	367.0	35.0

NGK0008A



RECOMMENDED LAND PATTERN
1:1 RATIO WITH PKG SOLDER PADS

DIMENSIONS ARE IN MILLIMETERS



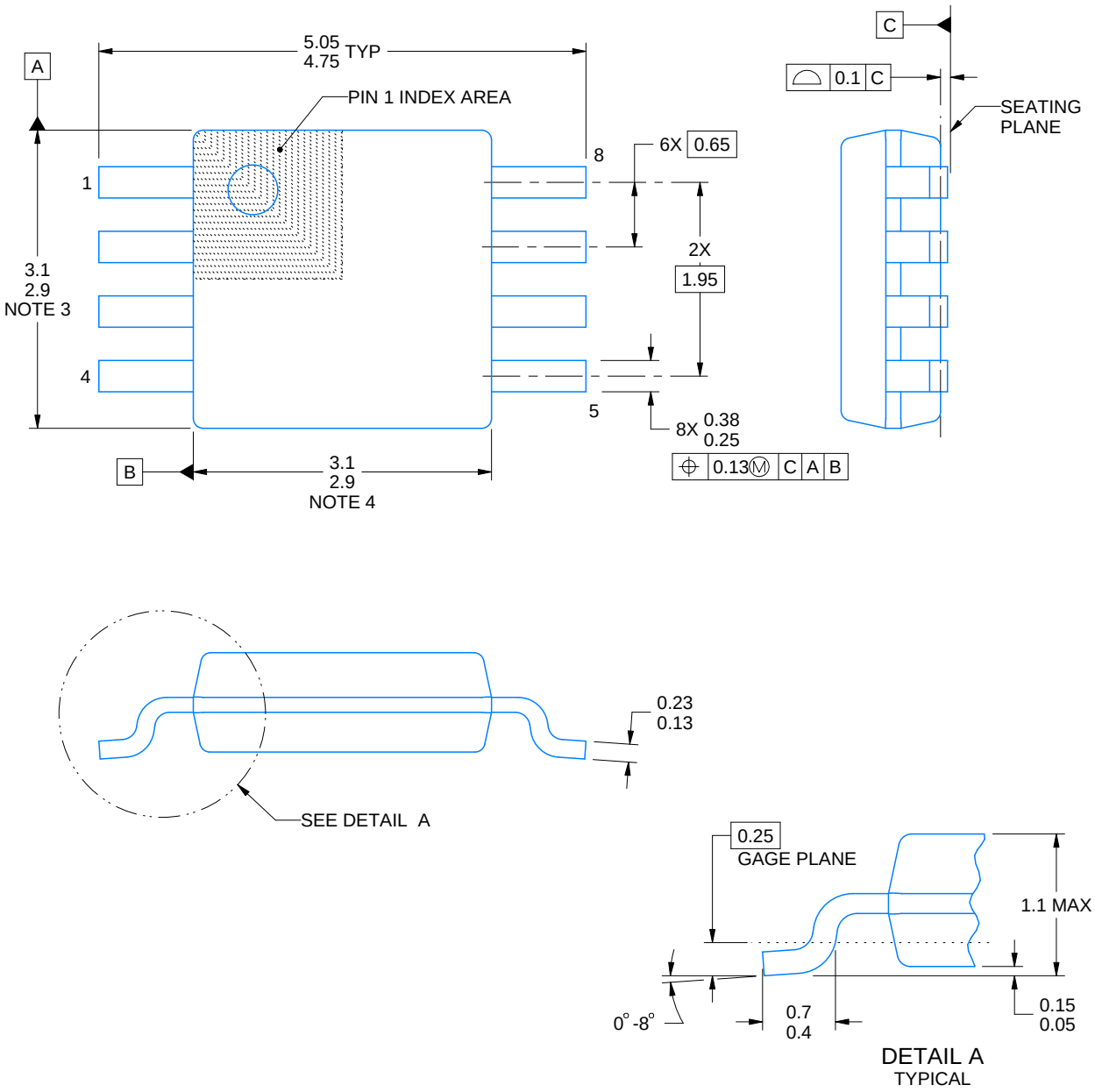
LDA08A (Rev C)

PACKAGE OUTLINE

DGK0008A

VSSOP - 1.1 mm max height

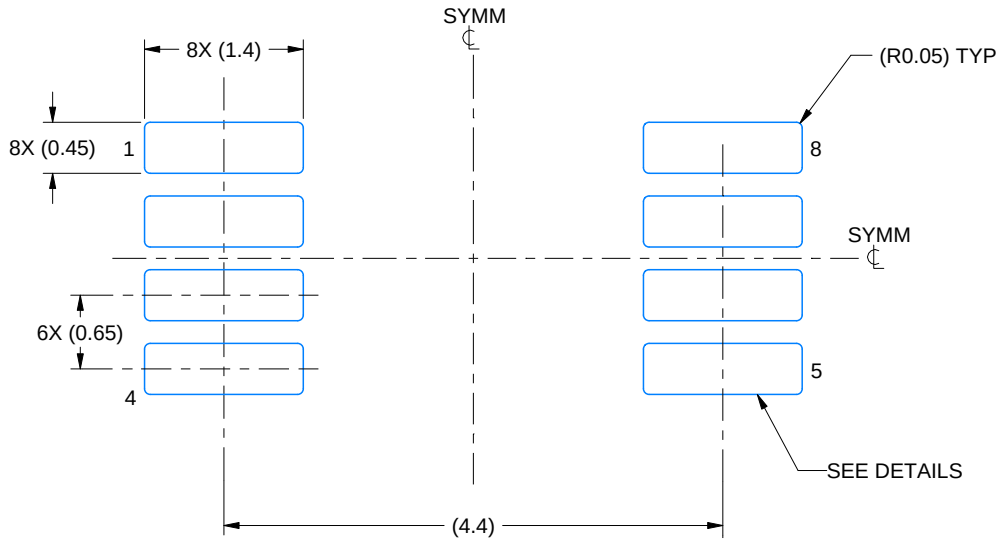
SMALL OUTLINE PACKAGE



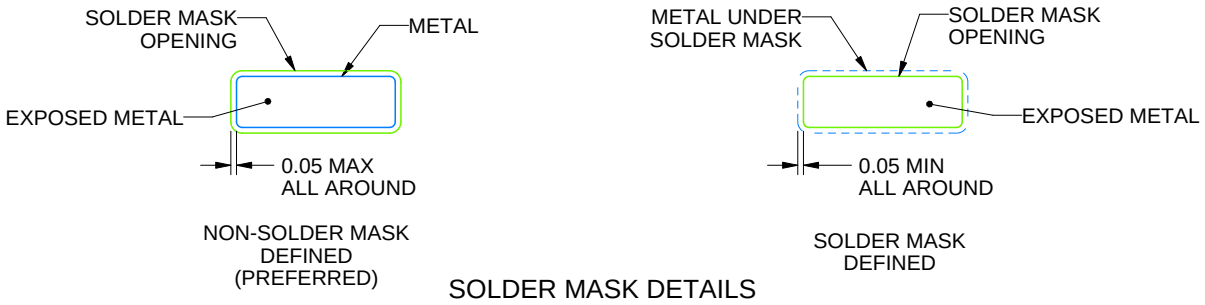
PowerPAD is a trademark of Texas Instruments.

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. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 15X



SOLDER MASK DETAILS

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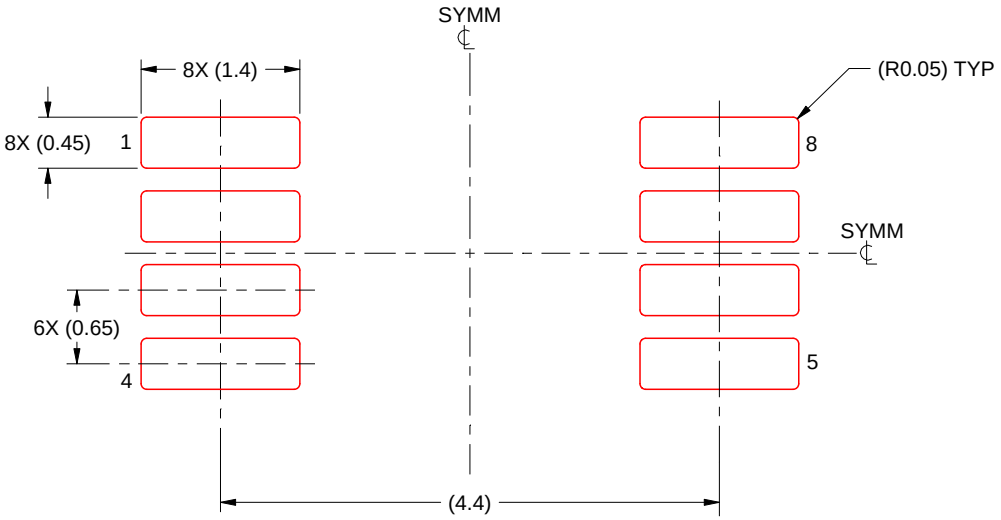
NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
9. Size of metal pad may vary due to creepage requirement.



SOLDER PASTE EXAMPLE
SCALE: 15X

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NOTES: (continued)

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

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