LMT87 SC70, Analog Temperature Sensor with Class-AB Output

Check for Samples: LMT87

FEATURES

- Push-Pull Output with 50 µA Source Current Capability
- Very Accurate Over Wide Temperature Range of −50°C to 150°C
- Low Quiescent Current
- Output is Short-Circuit Protected
- Extremely Small SC70 Package
- Cost-Effective Alternative to Thermistors

APPLICATIONS

- Automotive
- Industrial
- White Goods
- Battery Management
- Disk Drives
- Appliances
- Games
- Wireless Transceivers
- Cell phones

DESCRIPTION

The LMT87 is a precision analog output CMOS integrated-circuit temperature sensor. A class-AB output structure gives the LMT87 strong output source and sink current capability for driving heavy loads. This means it is well suited to source the input of a sample-and-hold analog-to-digital converter with its transient load requirements. While operating over the wide temperature range of −50°C to 150°C, the device delivers an output voltage that is inversely proportional to measured temperature. The LMT87 low supply current makes it ideal for battery-powered systems as well as general temperature sensing applications.

The LMT87 can operate with a 2.7 V supply while measuring temperature over the full −50°C to 150°C operating range.

The LMT87 is a cost-competitive alternative to thermistors.

CONNECTION DIAGRAM

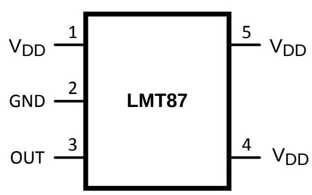
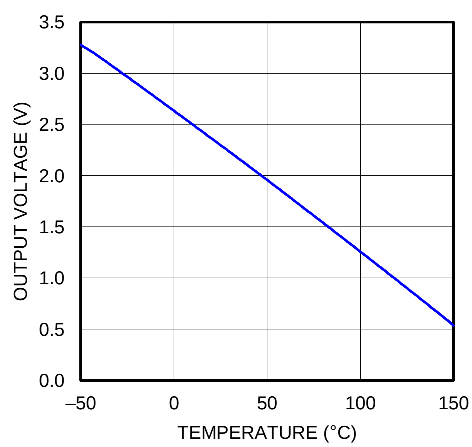


Figure 1. SOT Top View
See Package Number DCK0005A

TYPICAL TRANSFER CHARACTERISTIC

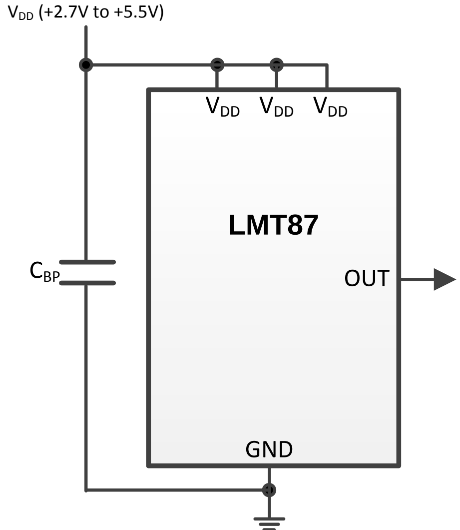
Output Voltage vs Temperature



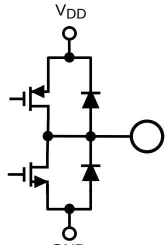
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

TYPICAL APPLICATION

Full-Range Celsius Temperature Sensor (−50°C to 150°C)



PIN DESCRIPTIONS

LABEL	PIN NUMBER	TYPE	EQUIVALENT CIRCUIT	FUNCTION
V_{DD}	5	Power		Power Supply Voltage
V_{DD}	1	Power		Power Supply Voltage
OUT	3	Analog Output		Outputs a voltage which is inversely proportional to temperature
V_{DD}	4	Power		Positive Supply Voltage
GND	2	Ground		Power Supply Ground

ABSOLUTE MAXIMUM RATINGS [1]

		VALUE		UNIT
		MIN	MAX	
Supply Voltage		−0.3	6	V
Voltage at Output Pin		−0.3	V_{DD} + 0.5	V
Output Current			±7	mA
Input Current at any pin [2]		5	5	mA
Storage Temperature		−65	150	°C
Maximum Junction Temperature (T_{JMAX})			150	°C
ESD Susceptibility [3]	Human Body Model		2500	V
	Machine Model		250	V
Soldering process must comply with TI's Reflow Temperature Profile specifications. Refer to www.ti.com/packaging. [4]				

(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 specific performance limits. For specifications and test conditions, see the Electrical Characteristics. The 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_I) at any pin exceeds power supplies (V_I < GND or V_I > V), the current at that pin should be limited to 5 mA.
(3) The human body model is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin. The machine model is a 200 pF capacitor discharged directly into each pin.
(4) Reflow temperature profiles are different for lead-free and non-lead-free packages.

OPERATING RATINGS

	VALUE	UNIT
Specified Temperature Range	$T_{MIN} \le T_A \le T_{MAX}$	°C
	$-50 \le T_A \le 150$	°C
Supply Voltage Range (V_{DD})	2.7 to 5.5	V
Thermal Resistance (θ_{JA}) [1][2] (SOT)	415	°C/W

(1) The junction to ambient thermal resistance (θ_{JA}) is specified without a heat sink in still air.
(2) Changes in output due to self heating can be computed by multiplying the internal dissipation by the thermal resistance.

ACCURACY CHARACTERISTICS

These limits do not include DC load regulation. These stated accuracy limits are with reference to the values in Table 1.

PARAMETER	CONDITIONS	TYPICAL	LIMITS (1)	UNIT
Temperature Error (2)	70°C to 150°C; V_{DD} = 3.0 V to 5.5 V	0.4	2.7	°C
	20°C to 40°C; V_{DD} = 2.7 V to 5.5 V	0.6		
	20°C to 40°C; V_{DD} = 3.4 V to 5.5 V	0.3		
	0°C ; V_{DD} = 3.0 V to 5.5 V	0.6	2.7	°C
	0°C ; V_{DD} = 3.6 V to 5.5 V	0.3		
	–50°C; V_{DD} = 3.6 V to 5.5 V	0.6	2.7	°C
	–50°C; V_{DD} = 4.2 V to 5.5 V	0.3		°C

(1) Limits are specific to TI's AOQL (Average Outgoing Quality Level).
(2) Accuracy is defined as the error between the measured and reference output voltages, tabulated in the Transfer Table at the specified conditions of supply gain setting, voltage, and temperature (expressed in °C). Accuracy limits include line regulation within the specified conditions. Accuracy limits do not include load regulation; they assume no DC load.

ELECTRICAL CHARACTERISTICS

Unless otherwise noted, these specifications apply for $+V_{DD}$ = 2.7 V to 5.5 V. **Boldface limits apply for $T_A = T_J = T_{MIN}$ to T_{MAX}**; all other limits $T_A = T_J$ = 25°C.

PARAMETER		CONDITIONS	TYP (1)	MAX (2)	UNITS
	Sensor Gain		–13.6		mV/°C
	Load Regulation (3)	Source ≤ 50 µA, (V_{DD} - V_{OUT}) ≥ 200 mV	–0.22	**–1**	mV
		Sink ≤ 50 µA, V_{OUT} ≥ 200 mV	0.26	**1**	mV
	Line Regulation (4)		200		µV/V
I_S	Supply Current (5)	T_A = 30°C to 150°C, (V_{DD} - V_{OUT}) ≥ 100 mV	5.4	**8.1**	µA
		T_A = -50°C to 150°C, (V_{DD} - V_{OUT}) ≥ 100 mV	5.4	**9**	µA
C_L	Output Load Capacitance		1100		pF
	Power-on Time (6)	C_L= 0 pF to 1100 pF	0.7	**1.9**	ms
	Output Drive			±50	µA

(1) Typicals are at $T_J = T_A$ = 25°C and represent most likely parametric norm.
(2) Limits are specific to TI's AOQL (Average Outgoing Quality Level).
(3) Source currents are flowing out of the LMT87. Sink currents are flowing into the LMT87.
(4) Line regulation (DC) is calculated by subtracting the output voltage at the highest supply voltage from the output voltage at the lowest supply voltage. The typical DC line regulation specification does not include the output voltage shift discussed in OUTPUT VOLTAGE SHIFT.
(5) The input current is leakage only and is highest at high temperature. It is typically only 0.001 µA. The 1µA limit is solely based on a testing limitation and does not reflect the actual performance of the part.
(6) Specified by design and characterization.

TYPICAL PERFORMANCE CHARACTERISTICS

Temperature Error vs Temperature

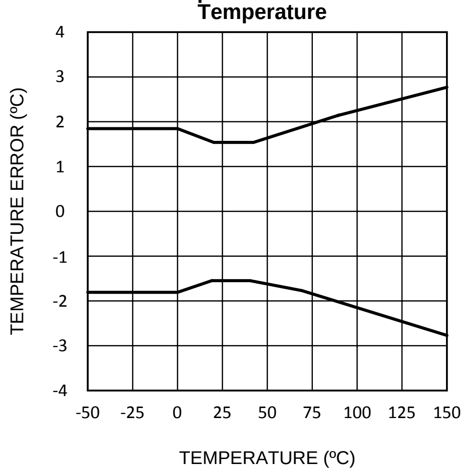


Figure 2.

Minimum Operating Temperature vs Supply Voltage

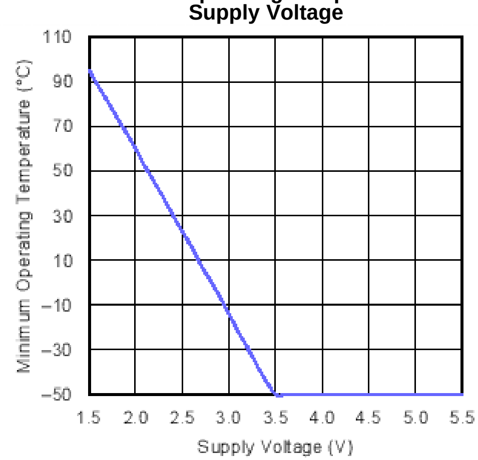


Figure 3.

Supply Current vs Temperature

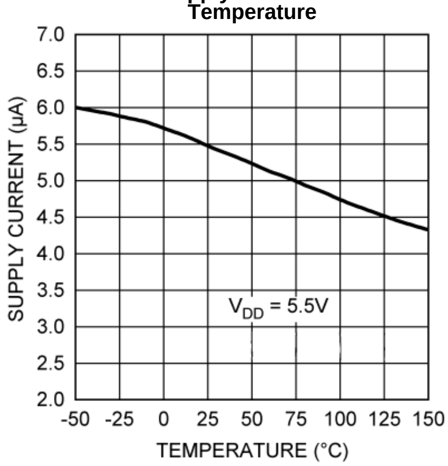


Figure 4.

Supply Current vs Supply Voltage

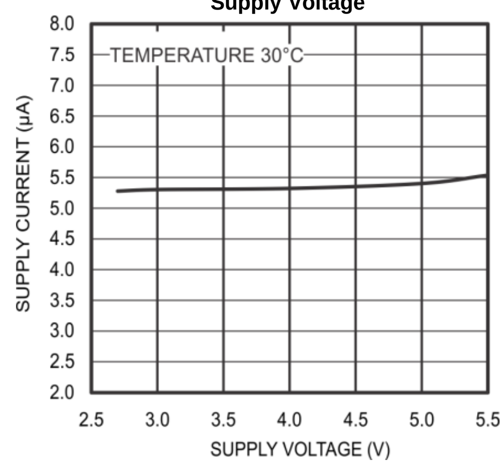


Figure 5.

Load Regulation, Sourcing Current

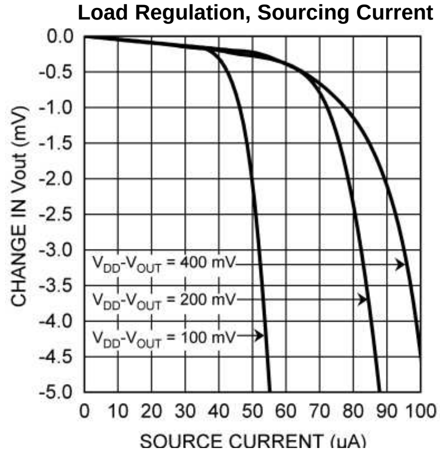


Figure .

Load Regulation, Sinking Current

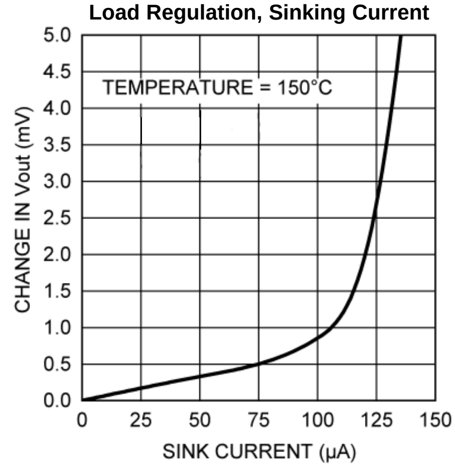


Figure 6.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

Change in Vout vs Overhead Voltage

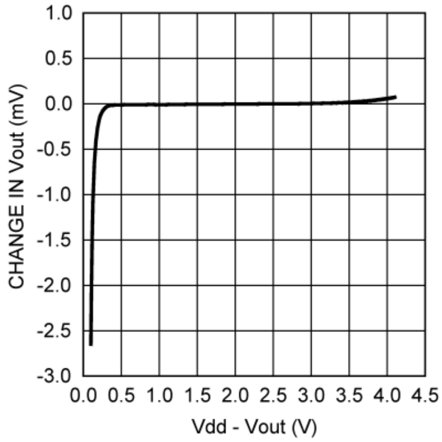


Figure 7.

Supply-Noise Gain vs Frequency

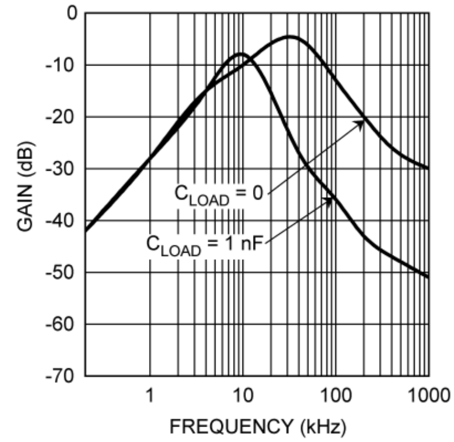


Figure 8.

Output Voltage vs Supply Voltage

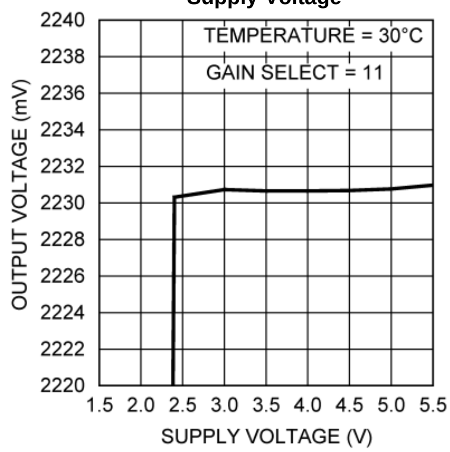


Figure 9.

LMT87 TRANSFER FUNCTION

The output voltage of the LMT87, across the complete operating temperature range is shown in Table 1. This table is the reference from which the LMT87 accuracy specifications (listed in the ELECTRICAL CHARACTERISTICS section) are determined. This table can be used, for example, in a host processor look-up table. A file containing this data is available for download at www.national.com/appinfo/tempsensors.

Table 1. LMT87 Transfer Table(1)

TEMP (°C)	V_{OUT} (mV)	TEMP (°C)	V_{OUT} (mV)	TEMP (°C)	V_{OUT} (mV)	TEMP (°C)	V_{OUT} (mV)	TEMP (°C)	V_{OUT} (mV)
-50	3277	-10	2767	30	2231	70	1679	110	1115
-49	3266	-9	2754	31	2217	71	1665	111	1101
-48	3254	-8	2740	32	2204	72	1651	112	1087
-47	3243	-7	2727	33	2190	73	1637	113	1073
-46	3232	-6	2714	34	2176	74	1623	114	1058
-45	3221	-5	2700	35	2163	75	1609	115	1044
-44	3210	-4	2687	36	2149	76	1595	116	1030
-43	3199	-3	2674	37	2136	77	1581	117	1015
-42	3186	-2	2660	38	2122	78	1567	118	1001
-41	3173	-1	2647	39	2108	79	1553	119	987
-40	3160	0	2633	40	2095	80	1539	120	973
-39	3147	1	2620	41	2081	81	1525	121	958
-38	3134	2	2607	42	2067	82	1511	122	944
-37	3121	3	2593	43	2054	83	1497	123	929
-36	3108	4	2580	44	2040	84	1483	124	915
-35	3095	5	2567	45	2026	85	1469	125	901
-34	3082	6	2553	46	2012	86	1455	126	886
-33	3069	7	2540	47	1999	87	1441	127	872
-32	3056	8	2527	48	1985	88	1427	128	858
-31	3043	9	2513	49	1971	89	1413	129	843
-30	3030	10	2500	50	1958	90	1399	130	829
-29	3017	11	2486	51	1944	91	1385	131	814
-28	3004	12	2473	52	1930	92	1371	132	800
-27	2991	13	2459	53	1916	93	1356	133	786
-26	2978	14	2446	54	1902	94	1342	134	771
-25	2965	15	2433	55	1888	95	1328	135	757
-24	2952	16	2419	56	1875	96	1314	136	742
-23	2938	17	2406	57	1861	97	1300	137	728
-22	2925	18	2392	58	1847	98	1286	138	713
-21	2912	19	2379	59	1833	99	1272	139	699
-20	2899	20	2365	60	1819	100	1257	140	684
-19	2886	21	2352	61	1805	101	1243	141	670
-18	2873	22	2338	62	1791	102	1229	142	655
-17	2859	23	2325	63	1777	103	1215	143	640
-16	2846	24	2311	64	1763	104	1201	144	626
-15	2833	25	2298	65	1749	105	1186	145	611
-14	2820	26	2285	66	1735	106	1172	146	597
-13	2807	27	2271	67	1721	107	1158	147	582
-12	2793	28	2258	68	1707	108	1144	148	568
-11	2780	29	2244	69	1693	109	1130	149	553
								150	538

(1) The output voltages in this table apply for V_{DD} = 5 V.

Although the LMT87 is very linear, its response does have a slight downward parabolic shape. This shape is very accurately reflected in Table 1. For a linear approximation, a line can easily be calculated over the desired temperature range from the Table using the two-point equation:

$$V - V_1 = \left(\frac{V_2 - V_1}{T_2 - T_1}\right) \times (T - T_1) \quad (1)$$

Where V is in mV, T is in °C, T_1 and V_1 are the coordinates of the lowest temperature, T_2 and V_2 are the coordinates of the highest temperature.

For example, if we want to resolve this equation, over a temperature range of 20°C to 50°C, we would proceed as follows:

$$V - 2365\text{ mV} = \left(\frac{1958\text{ mV} - 2365\text{ mV}}{50^{o}\text{C} - 20^{o}\text{C}}\right) \times (T - 20^{o}\text{C}) \quad (2)$$

$$V - 2365\text{ mV} = (-13.6\text{ mV} / {}^{o}\text{C}) \times (T - 20^{o}\text{C}) \quad (3)$$

$$V = (-13.6\text{ mV} / {}^{o}\text{C}) \times T + 2637\text{ mV} \quad (4)$$

Using this method of linear approximation, the transfer function can be approximated for one or more temperature ranges of interest.

MOUNTING AND THERMAL CONDUCTIVITY

The LMT87 can be applied easily in the same way as other integrated-circuit temperature sensors. It can be glued or cemented to a surface.

To ensure good thermal conductivity, the backside of the LMT87 die is directly attached to the GND pin (Pin 2). The temperatures of the lands and traces to the other leads of the LMT87 will also affect the temperature reading.

Alternatively, the LMT87 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 LMT87 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. If moisture creates a short circuit from the output to ground or V_{DD}, the output from the LMT87 will not be correct. Printed-circuit coatings are often used to ensure that moisture cannot corrode the leads or circuit traces.

The thermal resistance junction to ambient (θ_{JA}) is the parameter used to calculate the rise of a device junction temperature due to its power dissipation. The equation used to calculate the rise in the LMT87's die temperature is:

$$T_J = T_A + \theta_{JA}\left[(V_{DD} I_S) + (V_{DD} - V_{OUT})\, I_L\right] \quad (5)$$

where T_A is the ambient temperature, I_S is the supply current, I_L is the load current on the output, and V_{out} is the output voltage. For example, in an application where T_A = 30°C, V_{DD} = 5 V, I_S = 5.4 µA, V_{OUT} = 2231 mV, and I_L = 2 µA, the junction temperature would be 30.014°C, showing a self-heating error of only 0.014°C. Since the LMT87's junction temperature is the actual temperature being measured, care should be taken to minimize the load current that the LMT87 is required to drive. Table 2 shows the thermal resistance of the LMT87.

Table 2. LMT87 Thermal Resistance

DEVICE NUMBER	TI PACKAGE NUMBER	THERMAL RESISTANCE (θ_{JA})
LMT87DCK	DCK0005A	415°C/W

OUTPUT AND NOISE CONSIDERATIONS

A push-pull output gives the LMT87 the ability to sink and source significant current. This is beneficial when, for example, driving dynamic loads like an input stage on an analog-to-digital converter (ADC). In these applications the source current is required to quickly charge the input capacitor of the ADC. See the APPLICATION CIRCUITS section for more discussion of this topic. The LMT87 is ideal for this and other applications which require strong source or sink current.

The LMT87 supply-noise gain (the ratio of the AC signal on V_{OUT} to the AC signal on V_{DD}) was measured during bench tests. Its typical attenuation is shown in the TYPICAL PERFORMANCE CHARACTERISTICS section. A load capacitor on the output can help to filter noise.

For operation in very noisy environments, some bypass capacitance should be present on the supply within approximately 5 centimeters of the LMT87.

CAPACITIVE LOADS

The LMT87 handles capacitive loading well. In an extremely noisy environment, or when driving a switched sampling input on an ADC, it may be necessary to add some filtering to minimize noise coupling. Without any precautions, the LMT87 can drive a capacitive load less than or equal to 1100 pF as shown in Figure 10. For capacitive loads greater than 1100 pF, a series resistor may be required on the output, as shown in Figure 11.

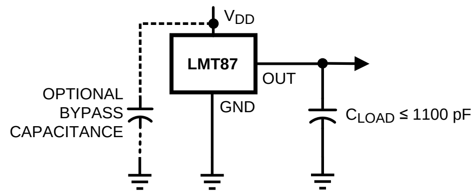


Figure 10. LMT87 No Decoupling Required for Capacitive Loads Less than 1100 pF

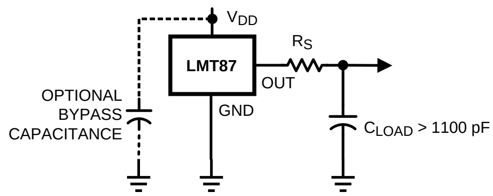


Figure 11. LMT87 with Series Resistor for Capacitive Loading Greater than 1100 pF

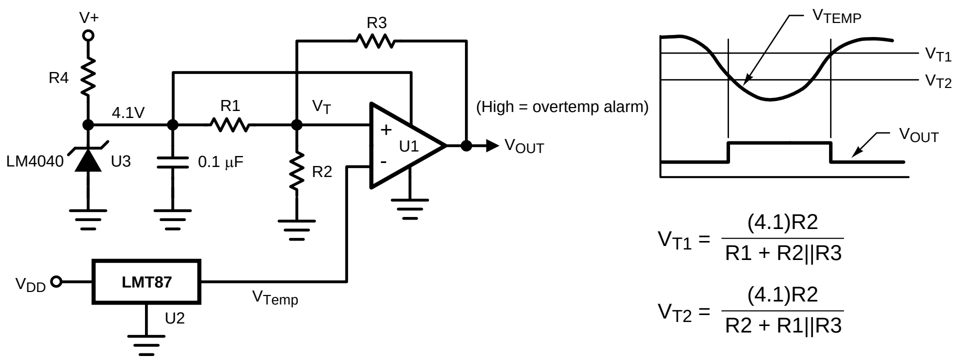
C_{LOAD}	MINIMUM R_S
1.1 nF to 99 nF	3 kΩ
100 nF to 999 nF	1.5 kΩ
1 μF	800 Ω

OUTPUT VOLTAGE SHIFT

The LMT87 is very linear over temperature and supply voltage range. Due to the intrinsic behavior of an NMOS/PMOS rail-to-rail buffer, a slight shift in the output can occur when the supply voltage is ramped over the operating range of the device. The location of the shift is determined by the relative levels of V_{DD} and V_{OUT}. The shift typically occurs when V_{DD}- V_{OUT} = 1 V.

This slight shift (a few millivolts) takes place over a wide change (approximately 200 mV) in V_{DD} or V_{OUT}. Since the shift takes place over a wide temperature change of 5°C to 20°C, V_{OUT} is always monotonic. The accuracy specifications in the ELECTRICAL CHARACTERISTICS table already include this possible shift.

APPLICATION CIRCUITS



$$V_{T1} = \frac{(4.1)R2}{R1 + R2||R3}$$

$$V_{T2} = \frac{(4.1)R2}{R2 + R1||R3}$$

Figure 12. Celsius Thermostat

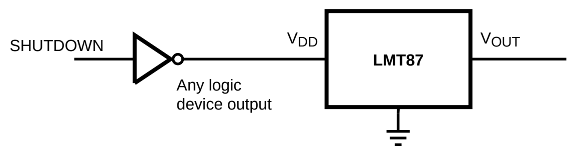
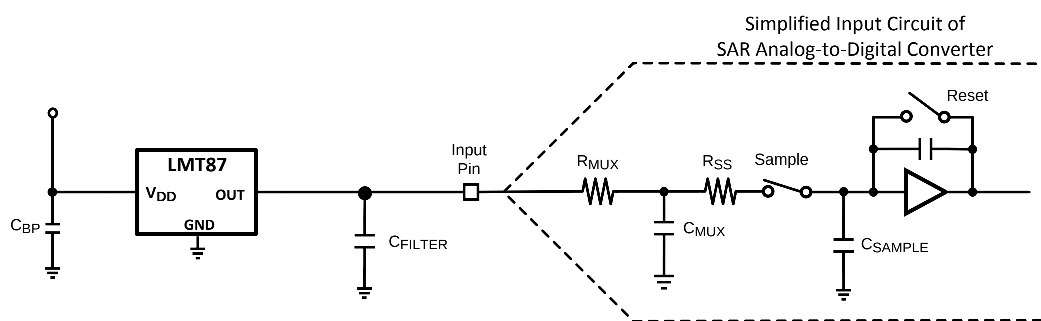


Figure 13. Conserving Power Dissipation with Shutdown



Most CMOS ADCs found in microcontrollers and ASICs have a sampled data comparator input structure. When the ADC charges the sampling cap, it requires instantaneous charge from the output of the analog source such as the LMT87 temperature sensor and many op amps. This requirement is easily accommodated by the addition of a capacitor (C_{FILTER}). The size of C_{FILTER} depends on the size of the sampling capacitor and the sampling frequency. Since not all ADCs have identical input stages, the charge requirements will vary. This general ADC application is shown as an example only.

Figure 14. Suggested Connection to a Sampling Analog-to-Digital Converter Input Stage

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LMT87DCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-50 to 150	BUA	Samples
LMT87DCKT	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-50 to 150	BUA	Samples

(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.

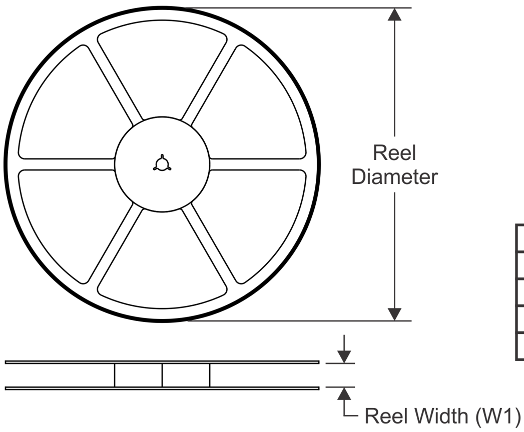
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been 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.

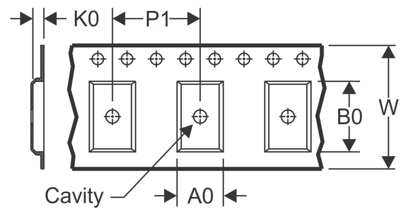
(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

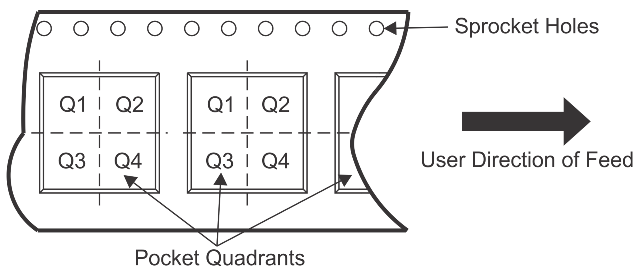


TAPE DIMENSIONS



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

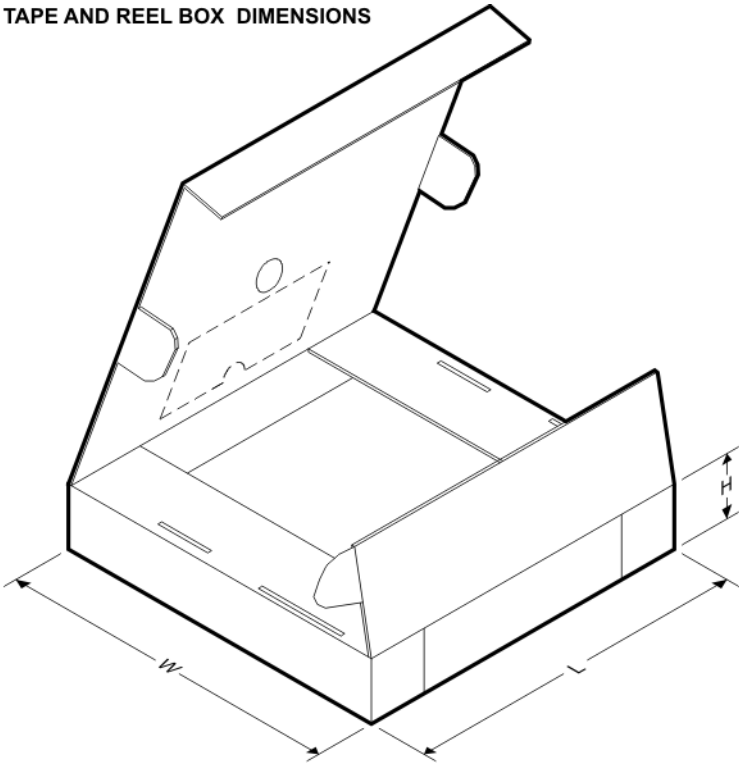
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LMT87DCKR	SC70	DCK	5	3000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMT87DCKT	SC70	DCK	5	250	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3

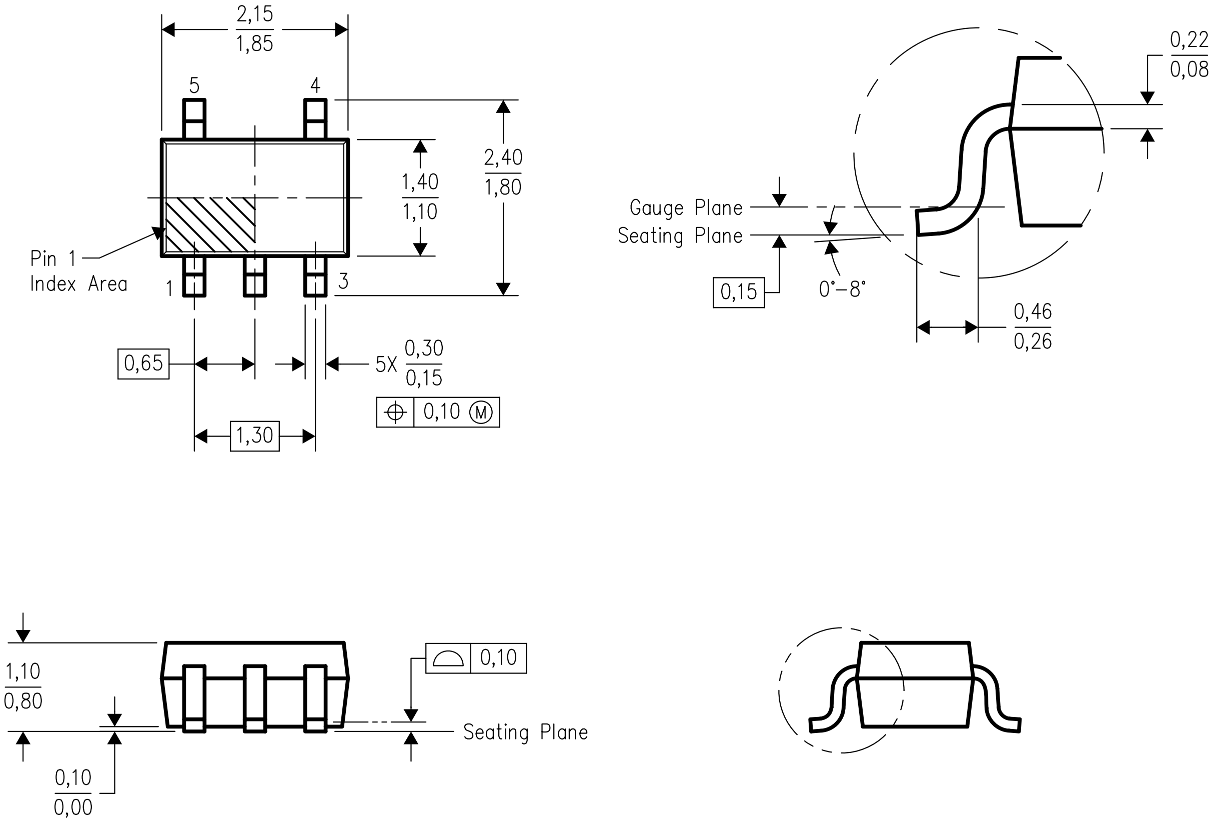
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMT87DCKR	SC70	DCK	5	3000	210.0	185.0	35.0
LMT87DCKT	SC70	DCK	5	250	210.0	185.0	35.0

DCK (R-PDSO-G5) PLASTIC SMALL-OUTLINE PACKAGE



4093553-3/G 01/2007

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-203 variation AA.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265