LMT85/LMT85-Q1 SC70/TO-92/TO-126, Analog Temperature Sensors with Class-AB Output

1 Features

- LMT85-Q1 is AEC-Q100 Grade 0 qualified and is manufactured on an automotive grade flow
- Very accurate: ±0.4°C typical
- Wide temperature range of -50°C to 150°C
- Low 5.4µA quiescent current
- Sensor gain of -8.2 mV/°C
- Packages:
  - Small SC70 (SOT 5-lead) surface mount
  - Leaded TO-92
  - Leaded heatsink or chassis screw-mount TO-126
- Output is short-circuit protected
- Push-pull output with 50 µA source current capability
- Footprint compatible with the industry-standard LM20/19 and LM35 temperature sensor
- Cost-effective alternative to thermistors

2 Applications

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

3 Description

The LMT85/LMT85-Q1 are precision CMOS integrated-circuit temperature sensors with an analog output voltage that is linearly and inversely proportional to temperature. Its features make it suitable for many general temperature sensing applications. It can operate down to 1.8V supply with 5.4 µA power consumption making it ideal for battery powered devices. Multiple package options including through-hole TO-92 and TO-126 packages also allow the LMT85 to be mounted on-board, off-board, to a heat sink, or on multiple unique locations in the same application. A class-AB output structure gives the LMT85/LMT85-Q1 strong output source and sink current capability that can directly drive up to 1.1 nF capacitive loads. This means it is well suited to drive an analog-to-digital converter sample-and-hold input with its transient load requirements. It has accuracy specified in the operating range of −50°C to 150°C. The accuracy, 3-lead package options, and other features also make the LMT85/LMT85-Q1 an alternative to thermistors.

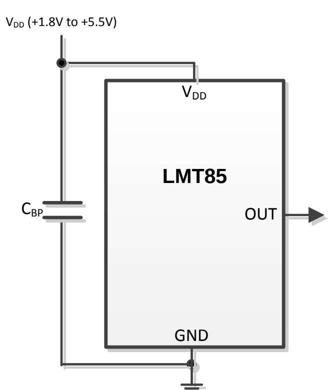
For devices with different average sensor gains and comparable accuracy the LMT84/LM84-Q1, LMT86/LMT86-Q1 and LMT87/LMT87-Q1 (For more details see Table 1 Comparable Alternative Devices.)

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LMT85	SOT (5)	2.00 mm x 1.25 mm
	TO-92 (3)	4.3 mm x 3.5 mm
	TO-126 (3)	8 mm x 11 mm
LMT85-Q1	SOT (5)	2.00 mm x 1.25 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

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



Output Voltage vs Temperature

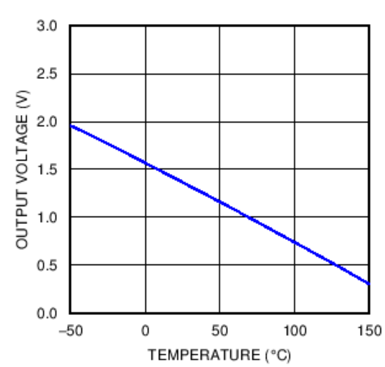


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Table of Contents

5 Revision History

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

Changes from Revision A (JUNE, 2013) to Revision B **Page**

- Changed data sheet flow and layout to conform with new TI standards. Added the following sections: Application and Implementation, Power Supply Recommendations, Layout, Device and Documentation Support, Mechanical, Packaging, and Orderable Information 1
- Added TO-92 and TO-126 package information throughout document 1
- Deleted 450 °C/W to 275 °C/W. New specification is derived using TI ' s latest methodology. 5
- Changed Temperature Accuracy Conditions from 70°C to 20°C and V_{DD} from 1.9V to 1.8V 6
- Deleted Note: The input current is leakage only and is highest at high temperature. It is typically only 0.001 µA. The 1 µA limit is solely based on a testing limitation and does not reflect the actual performance of the part 6

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Device Comparison Table[1]

ORDER NUMBER	PACKAGE	PIN	BODY SIZE (NOM)	Mounting Type
LMT85DCK	SOT (AKA[2]: SC70, DCK)	5	2.00 mm x 1.25 mm	Surface Mount
LMT85LP	TO-92 (AKA[2]: LP)	3	4.3 mm x 3.5 mm	Through-hole
LMT85LPC	TO-126 (AKA[2]: LPC)	3	8 mm x 11 mm	Screw-mount, Through-hole
LMT85DCK-Q1	SOT (AKA[2]: SC70, DCK)	5	2.00 mm x 1.25 mm	Surface Mount

(1) For all available packages and complete order numbers, see the orderable addendum at the end of the data sheet.
(2) AKA = Also Known As

Table 1. Comparable Alternative Devices

PART NUMBER	AVERAGE OUTPUT SENSOR GAIN	POWER SUPPLY RANGE
LMT84/LMT84-Q1	–5.5 mV/°C	1.5V to 5.5V
LMT85/LMT85-Q1	–8.2 mV/°C	1.8V to 5.5V
LMT86/LMT86-Q1	–10.9 mV/°C	2.2V to 5.5V
LMT87/LMT87-Q1	–13.6 mV/°C	2.7V to 5.5V

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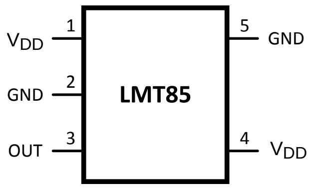
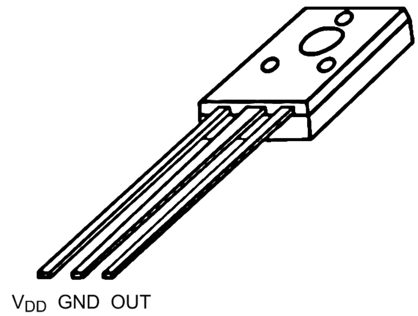
6 Pin Configuration and Functions

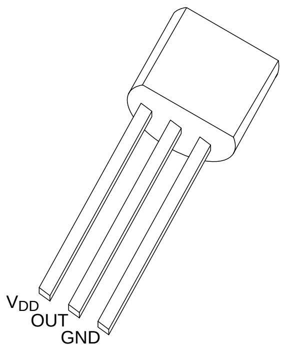
5-Pin SOT/SC70
DCK Package
(Top View)



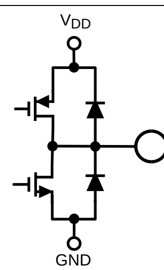
3-Pin TO-126
LPC Package



3-Pin TO-92
LP Package



Pin Functions

PIN				DESCRIPTION		
LABEL	DCK NUMBER	LP NUMBER	LPC NUMBER	TYPE	EQUIVALENT CIRCUIT	FUNCTION
GND	5			Ground		Power Supply Ground
GND	1			Ground		Power Supply Ground
OUT	3	See Pin Diagrams	See Pin Diagrams	Analog Output		Outputs a voltage which is inversely proportional to temperature
V_{DD}	4			Power		Positive Supply Voltage
GND	2			Ground		Power Supply Ground, (direct connection to the back side of the die)

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7 Specifications

7.1 Absolute Maximum Ratings [1][2]

	MIN	MAX	Unit
Supply Voltage	−0.3	6	V
Voltage at Output Pin	−0.3	(V_{DD} + 0.5)	V
Output Current	-7	7	mA
Input Current at any pin [3]	-5	5	mA
Maximum Junction Temperature (T_{JMAX})		150	°C

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not 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) *Soldering process must comply with Texas Instruments Reflow Temperature Profile specifications. Refer to* www.ti.com/packaging.. Reflow temperature profiles are different for lead-free and non-lead-free packages.
(3) 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.

7.2 Handling Ratings

			MIN	MAX	UNIT
T_{stg}	Storage temperature range		-65	150	°C
V_{ESD}	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins. [1] Applies for TO-92 package LMT85LP.	-2.5	2.5	kV
		Human Bode Mod (HBM), per JESD22-A114, all pin. Applies for SC70 package LMT85DCK and LMT85DCK-Q1.	-2.5	2.5	kV
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins. [2] Applies for all parts.	-1	1	kV
		Machine model ESD stress voltage, per JEDEC specification JESD22-A115. [3] Applies for SC70 package LMT85DCK and LMT85DCK-Q1.	-250	250	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.
(3) The machine model is a 200pF capacitor discharged directly into each pin.

7.3 Recommended Operating Ratings

		MIN	MAX	UNIT
	Specified temperature range	$T_{MIN} \le T_A \le T_{MAX}$		°C
		$-50 \le T_A \le +150$		°C
V_{DD}	Supply voltage range	1.8	5.5	V

7.4 Thermal Information [1]

THERMAL METRIC [2]		LMT85/ LMT85-Q1	LMT85	LMT85	UNIT
		DCK	LP	LPC	
		5 PIN	3 PIN	3 PIN	
$R_{\theta JA}$	Junction-to-ambient thermal resistance [3][4]	275	167	TBD	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	84	90	TBD	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	56	146	TBD	°C/W
ψ_{JT}	Junction-to-top characterization parameter	1.2	35	TBD	°C/W
ψ_{JB}	Junction-to-board characterization parameter	55	146	TBD	°C/W

(1) For information on self-heating and thermal response time see section Mounting and Thermal Conductivity.
(2) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.
(3) The junction to ambient thermal resistance, $R_{\theta JA}$, is specified without a heat sink in still air.
(4) Changes in output due to self heating can be computed by multiplying the internal dissipation by the thermal resistance.

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7.5 Accuracy Characteristics

These limits do not include DC load regulation. These stated accuracy limits are with reference to the values in Table 2.

PARAMETER	TEST CONDITIONS	MIN[(1)]	TYP[(2)]	MAX [(1)]	UNIT
Temperature accuracy [(3)]	$T_A = T_J$= 20°C to 150°C; V_{DD} = 1.8 V to 5.5 V	-2.7	±0.4	2.7	°C
	$T_A = T_J$= 0°C to 150°C; V_{DD} = 1.9 V to 5.5 V	-2.7	±0.7	2.7	°C
	$T_A = T_J$= 0°C to 150°C; V_{DD} = 2.6 V to 5.5 V		±0.3		°C
	$T_A = T_J$= –50°C to 0°C; V_{DD} = 2.3 V to 5.5 V	-2.7	±0.7	2.7	°C
	$T_A = T_J$= –50°C to 0°C; V_{DD} = 2.9 V to 5.5 V		±0.25		°C

(1) Limits are specific to TI's AOQL (Average Outgoing Quality Level).
(2) Typicals are at $T_J = T_A$ = 25°C and represent most likely parametric norm.
(3) 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.

7.6 Electrical Characteristics

Unless otherwise noted, these specifications apply for V_{DD} = +1.8V to +5.5V. MIN and MAX limits apply for $T_A = T_J = T_{MIN}$ to T_{MAX}, unless otherwise noted; typical values apply for $T_A = T_J$ = 25°C.

PARAMETER		TEST CONDITIONS	MIN [(1)]	TYP [(2)]	MAX [(1)]	UNIT
	Average sensor gain (output transfer function slope)	-30°C and 90°C used to calculate average sensor gain		–8.2		mV/°C
	Load regulation [(3)]	Source ≤ 50 µA, (V_{DD} - V_{OUT}) ≥ 200 mV	–1	–0.22		mV
		Sink ≤ 50 µA, V_{OUT} ≥ 200 mV		0.26	1	mV
	Line regulation [(4)]			200		µV/V
I_S	Supply current	$T_A = T_J$ = 30°C to 150°C, (V_{DD} - V_{OUT}) ≥ 100 mV		5.4	8.1	µA
		$T_A = T_J$ = -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 [(5)]	C_L= 0 pF to 1100 pF		0.7	1.9	ms
	Output drive	$T_A = T_J$ = 25°C	–50		+50	µA

(1) Limits are specific to TI's AOQL (Average Outgoing Quality Level).
(2) Typicals are at $T_J = T_A$ = 25°C and represent most likely parametric norm.
(3) Source currents are flowing out of the LMT85/LMT85-Q1. Sink currents are flowing into the LMT85/LMT85-Q1.
(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) Specified by design and characterization.

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7.7 Typical Characteristics

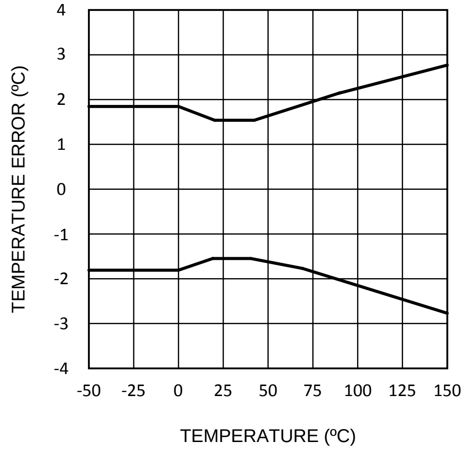

Figure 1. Temperature Error vs Temperature

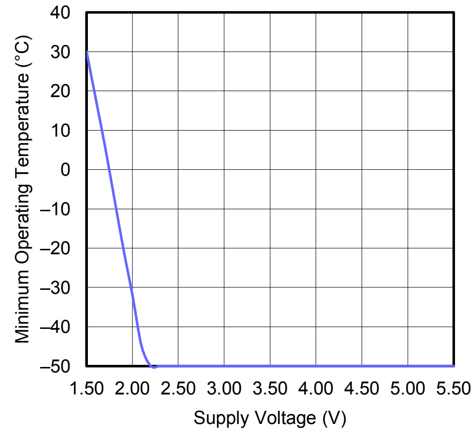

Figure 2. Minimum Operating Temperature vs Supply Voltage

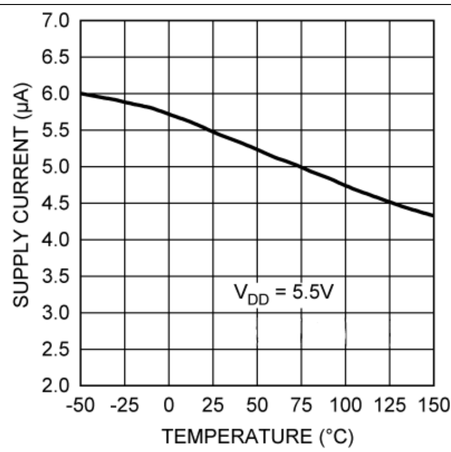

Figure 3. Supply Current vs Temperature

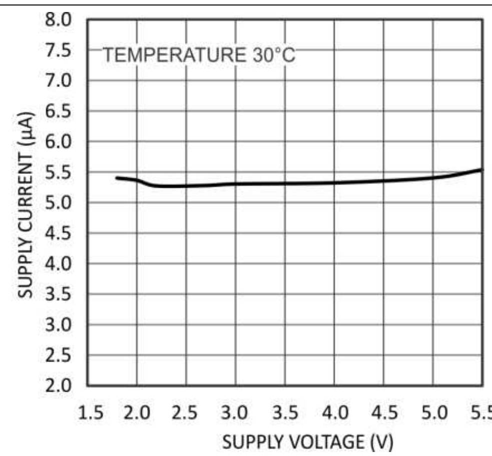

Figure 4. Supply Current vs Supply Voltage

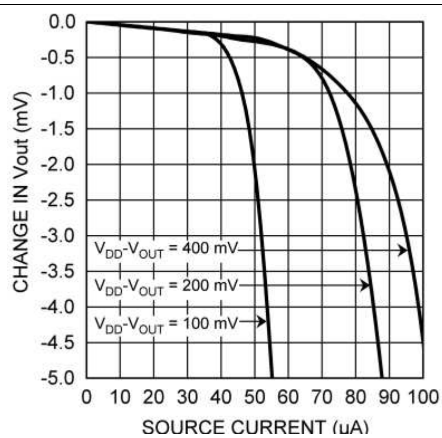

Figure 5. Load Regulation, Sourcing Current

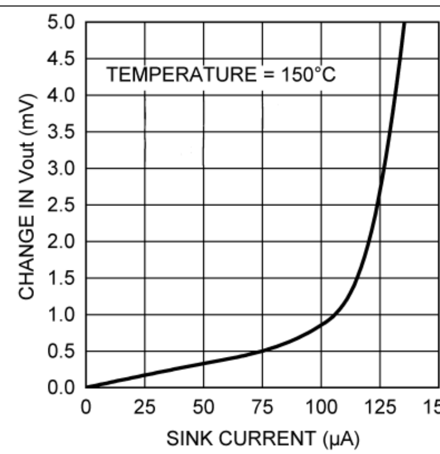

Figure 6. Load Regulation, Sinking Current

Typical Characteristics (continued)

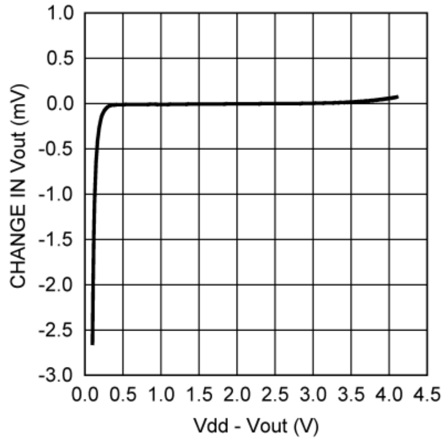

Figure 7. Change in Vout vs Overhead Voltage

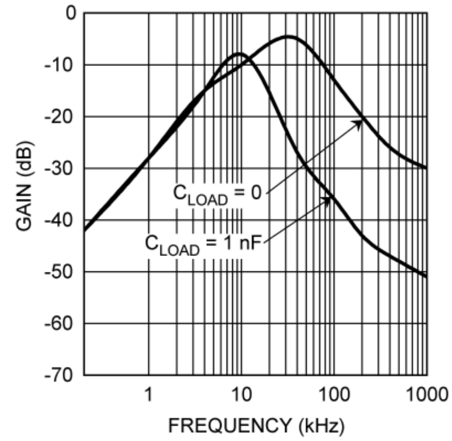

Figure 8. Supply-Noise Gain vs Frequency

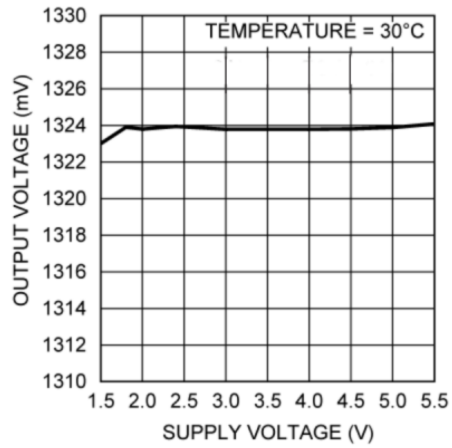

Figure 9. Output Voltage vs Supply Voltage

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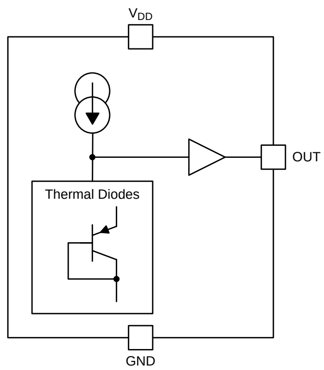
8 Detailed Description

8.1 Overview

The LMT85/LMT85-Q1 is an analog output temperature sensor. The temperature sensing element is comprised of a simple base emitter junction that is forward biased by a current source. The temperature sensing element is then buffered by an amplifier and provided to the OUT pin. The amplifier has a simple push-pull output stage thus providing a low impedance output source.

8.2 Functional Block Diagram

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



8.3 Feature Description

8.3.1 LMT85/LMT85-Q1 Transfer Function

The output voltage of the LMT85/LMT85-Q1, across the complete operating temperature range, is shown in Table 2. This table is the reference from which the LMT85/LMT85-Q1 accuracy specifications (listed in the Accuracy 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 LMT85 product folder under Tools and Software Models.

Table 2. LMT85/LMT85-Q1 Transfer Table

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	1955	-10	1648	30	1324	70	991	110	651
-49	1949	-9	1639	31	1316	71	983	111	642
-48	1942	-8	1631	32	1308	72	974	112	634
-47	1935	-7	1623	33	1299	73	966	113	625
-46	1928	-6	1615	34	1291	74	957	114	617
-45	1921	-5	1607	35	1283	75	949	115	608
-44	1915	-4	1599	36	1275	76	941	116	599
-43	1908	-3	1591	37	1267	77	932	117	591
-42	1900	-2	1583	38	1258	78	924	118	582
-41	1892	-1	1575	39	1250	79	915	119	573
-40	1885	0	1567	40	1242	80	907	120	565
-39	1877	1	1559	41	1234	81	898	121	556
-38	1869	2	1551	42	1225	82	890	122	547
-37	1861	3	1543	43	1217	83	881	123	539
-36	1853	4	1535	44	1209	84	873	124	530
-35	1845	5	1527	45	1201	85	865	125	521
-34	1838	6	1519	46	1192	86	856	126	513
-33	1830	7	1511	47	1184	87	848	127	504

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Feature Description (continued)

Table 2. LMT85/LMT85-Q1 Transfer Table (continued)

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)
-32	1822	8	1502	48	1176	88	839	128	495
-31	1814	9	1494	49	1167	89	831	129	487
-30	1806	10	1486	50	1159	90	822	130	478
-29	1798	11	1478	51	1151	91	814	131	469
-28	1790	12	1470	52	1143	92	805	132	460
-27	1783	13	1462	53	1134	93	797	133	452
-26	1775	14	1454	54	1126	94	788	134	443
-25	1767	15	1446	55	1118	95	779	135	434
-24	1759	16	1438	56	1109	96	771	136	425
-23	1751	17	1430	57	1101	97	762	137	416
-22	1743	18	1421	58	1093	98	754	138	408
-21	1735	19	1413	59	1084	99	745	139	399
-20	1727	20	1405	60	1076	100	737	140	390
-19	1719	21	1397	61	1067	101	728	141	381
-18	1711	22	1389	62	1059	102	720	142	372
-17	1703	23	1381	63	1051	103	711	143	363
-16	1695	24	1373	64	1042	104	702	144	354
-15	1687	25	1365	65	1034	105	694	145	346
-14	1679	26	1356	66	1025	106	685	146	337
-13	1671	27	1348	67	1017	107	677	147	328
-12	1663	28	1340	68	1008	108	668	148	319
-11	1656	29	1332	69	1000	109	660	149	310
								150	301

Although the LMT85/LMT85-Q1 is very linear, its response does have a slight umbrella parabolic shape. This shape is very accurately reflected in Table 2. The Transfer Table can be calculated by using the parabolic equation.

$$V_{TEMP}(mV) = 1324.0mV - \left[8.194\frac{mV}{°C}(T - 30°C)\right] - \left[0.00262\frac{mV}{°C^2}(T - 30°C)^2\right] \quad (1)$$

The parabolic equation is an approximation of the transfer table and the accuracy of the equation degrades slightly at the temperature range extremes. Equation 1 can be solved for T resulting in:

$$T = \frac{8.194 - \sqrt{(-8.194)^2 + 4 \times 0.00262 \times (1324 - V_{TEMP}(mV))}}{2 \times -0.00262} + 30 \quad (2)$$

For an even less accurate linear transfer function approximation, a line can easily be calculated over the desired temperature range using values from the Table and a two-point equation:

$$V - V_1 = \left(\frac{V_2 - V_1}{T_2 - T_1}\right) \times (T - T_1) \quad (3)$$

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:

$$V - 1405\text{ mV} = \left(\frac{1159\text{ mV} - 1405\text{ mV}}{50^{o}C - 20^{o}C}\right) \times (T - 20^{o}C) \quad (4)$$

$$V - 1405\text{ mV} = (-8.20\text{ mV} / {}^{o}C) \times (T - 20^{o}C) \quad (5)$$

$$V = (-8.20\text{ mV} / {}^{o}C) \times T + 1569\text{ mV} \quad (6)$$

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

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8.4 Device Functional Modes

8.4.1 Mounting and Thermal Conductivity

The LMT85/LMT85-Q1 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 LMT85/LMT85-Q1 die is directly attached to the GND pin (Pin 2 for the SOT/SC70/DCK package). The temperatures of the lands and traces to the other leads of the LMT85/LMT85-Q1 will also affect the temperature reading.

Alternatively, the LMT85/LMT85-Q1 can be mounted inside a sealed-end metal tube, and can then be dipped into a bath or screwed into a threaded hole in a tank. As with any IC, the LMT85/LMT85-Q1 and accompanying wiring and circuits must be kept insulated and dry, to avoid leakage and corrosion. This is especially true if the circuit may operate at cold temperatures where condensation can occur. If moisture creates a short circuit from the output to ground or V_{DD}, the output from the LMT85/LMT85-Q1 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 ($R_{\theta JA}$ or θ_{JA}) 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 LMT85/LMT85-Q1 die temperature is:

$$T_J = T_A + \theta_{JA}\left[(V_{DD}I_S) + (V_{DD} - V_{OUT})\, I_L\right] \quad (7)$$

where T_A is the ambient temperature, I_S is the supply current, $I_L$is the load current on the output, and V_O 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} = 1324 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 LMT85/LMT85-Q1's junction temperature is the actual temperature being measured, care should be taken to minimize the load current that the LMT85/LMT85-Q1 is required to drive. For the thermal resistance of the LMT85/LMT85Q1 in different packages see sectionThermal Information[(1)].

8.4.2 Output and Noise Considerations

A push-pull output gives the LMT85/LMT85-Q1 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 section for more discussion of this topic. The LMT85/LMT85-Q1 are ideal for this and other applications which require strong source or sink current.

The LMT85/LMT85-Q1's 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 Figure 8 found in the Typical 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 LMT85/LMT85-Q1.

8.4.3 Capacitive Loads

The LMT85/LMT85-Q1 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 LMT85/LMT85-Q1 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.

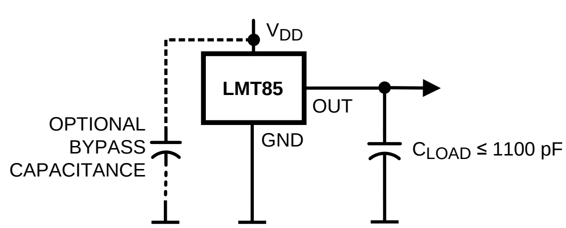

Figure 10. LMT85 No Decoupling Required for Capacitive Loads Less Than 1100 pF

(1) For information on self-heating and thermal response time see section Mounting and Thermal Conductivity.

Device Functional Modes (continued)

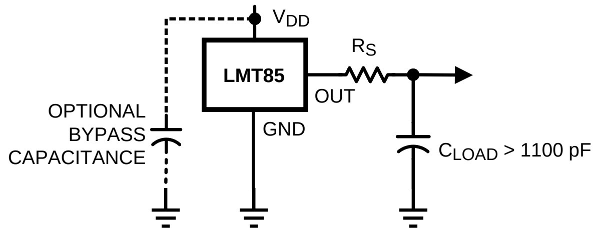

Figure 11. LMT85 with Series Resistor for Capacitive Loading Greater Than 1100 pF

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

8.4.4 Output Voltage Shift

The LMT85/LMT85-Q1 are 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 Accuracy Characteristics table already include this possible shift.

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9 Application and Implementation

9.1 Application Information

The LMT85/LMT85-Q1 features make it suitable for many general temperature sensing applications. It can operate down to 1.8V supply with 5.4 uA power consumption making it ideal for battery powered devices. Multiple package options including through-hole TO-92 and TO-126 packages also allow the LMT85 to be mounted on-board, off-board, to a heat sink, or on multiple unique locations in the same application.

9.2 Typical Applications

9.2.1 Connection to an ADC

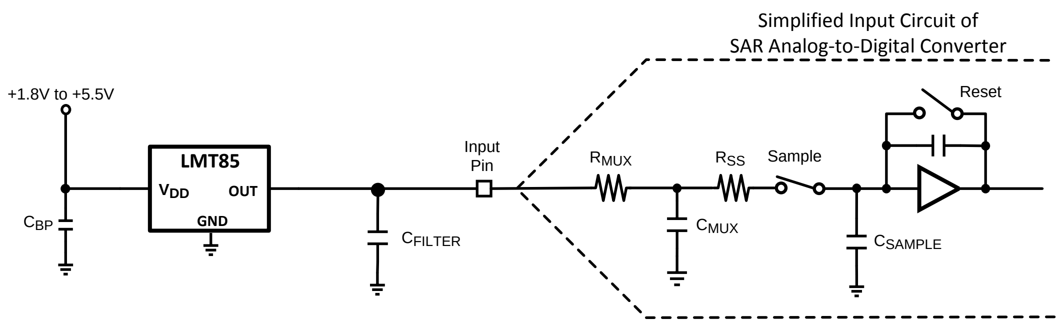


Figure 12. Suggested Connection to a Sampling Analog-to-digital Converter Input Stage

9.2.1.1 Design Requirements

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 LMT85/LMT85-Q1 temperature sensor and many op amps. This requirement is easily accommodated by the addition of a capacitor (C_{FILTER}). This general ADC application is shown as an example only.

9.2.1.2 Detailed Design Procedure

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.

9.2.1.3 Application Curves

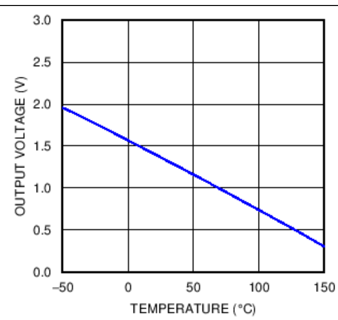


Figure 13. Analog Output Transfer Function

Typical Applications (continued)

9.2.2 Conserving Power Dissipation with Shutdown

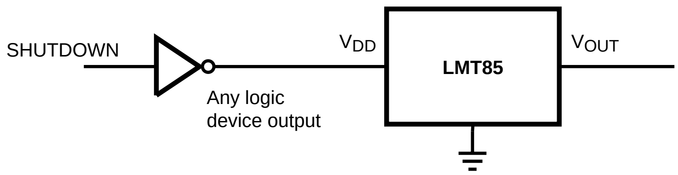


Figure 14. Simple Shutdown Connection of the LMT85

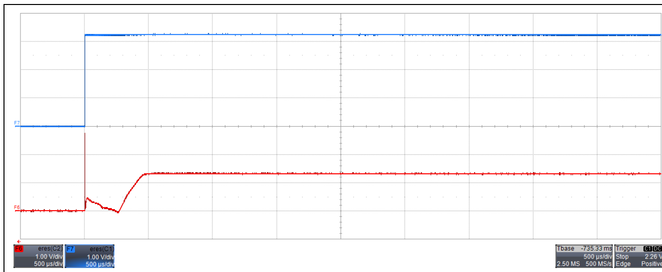
9.2.2.1 Design Requirements

Since the power consumption of the LMT85 is less than 9 µA it can simply be powered directly from any logic gate output, thus not requiring a specific shutdown pin. The device can even be powered directly from a micro controller GPIO. In this way it can easily be turned off for cases such as battery powered systems where power savings is critical.

9.2.2.2 Detailed Design Procedure

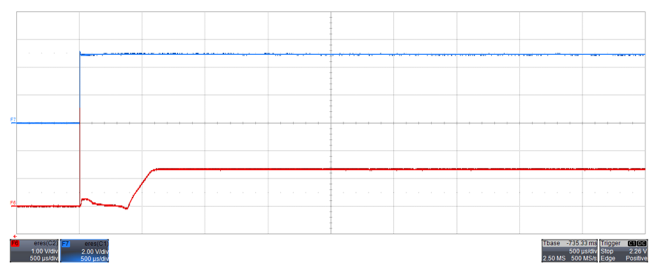
Simply connect the V_{DD} pin of the LMT85 directly to the logic shutdown signal from a microcontroller.

9.2.2.3 Application Curves



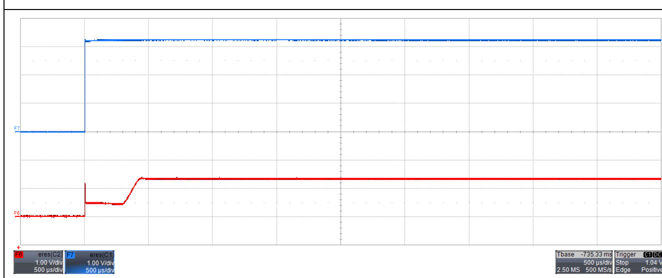
Time: 500 µsec/div; Top Trace: V_{DD} 1 V/div;
Bottom Trace: OUT 1 V/div

Figure 15. Output Turn-on Response Time without a Capacitive Load and V_{DD}= 3.3V



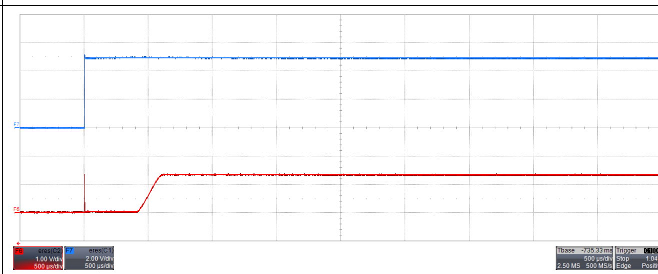
Time: 500 µsec/div; Top trace: V_{DD} 2 V/div;
Bottom trace: OUT 1 V/div

Figure 16. Output Turn-on Response Time without a Capacitive Load and V_{DD}= 5V



Time: 500 µsec/div; Top trace: V_{DD} 1V/div;
Bottom trace: OUT 1 V/div

Figure 17. Output Turn-on Response Time with 1.1 nF Capacitive Load and V_{DD}= 3.3V



Time: 500 µsec/div; Top trace: V_{DD} 2 V/div;
Bottom trace: OUT 1 V/div

Figure 18. Output Turn-on Response Time with 1.1 nF Capacitive Load and V_{DD}= 5V

10 Power Supply Recommendations

The LMT85's low supply current and supply range of 1.8V to 5.5V allow the device to easily be powered from many sources.

Power supply bypassing is optional and is mainly dependent on the noise on the power supply used. In noisy systems it may be necessary to add bypass capacitors to lower the noise that is coupled to the LMT85's output.

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11 Layout

11.1 Layout Guidelines

The LMT85 is extremely simple to layout. If a power supply bypass capacitor is used it should be connected as shown in the Layout Example.

11.2 Layout Example

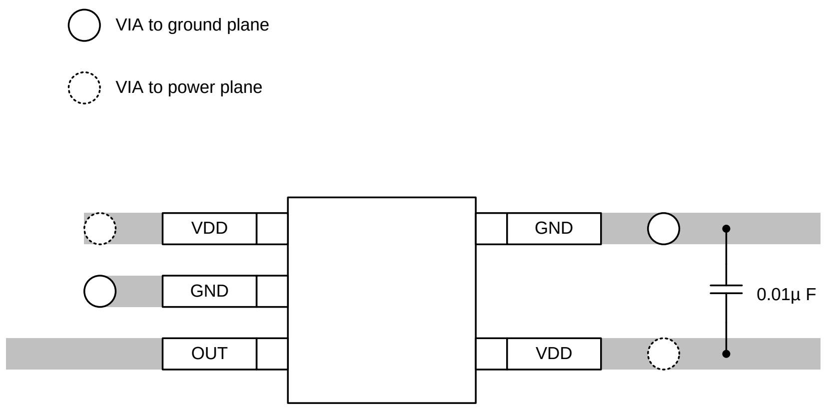

Figure 19. SC70 Package Recommended Layout

12 Device and Documentation Support

12.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 3. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
LMT85	Click here	Click here	Click here	Click here	Click here
LMT85-Q1	Click here	Click here	Click here	Click here	Click here

12.2 Trademarks

All trademarks are the property of their respective owners.

12.3 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.

12.4 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms and definitions.

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13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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PACKAGE OPTION ADDENDUM

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LMT85DCKR	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-50 to 150	BPA	Samples
LMT85DCKT	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-50 to 150	BPA	Samples
LMT85LP	ACTIVE	TO-92	LP	3	1800	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type	-50 to 150	LMT85	Samples
LMT85LPC	PREVIEW	TO-126	LPC	3	60	TBD	Call TI	Call TI	-50 to 150		
LMT85LPM	ACTIVE	TO-92	LP	3	2000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type	-50 to 150	LMT85	Samples
LMT85QDCKRQ1	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-50 to 150	BRA	Samples
LMT85QDCKTQ1	ACTIVE	SC70	DCK	5	250	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-50 to 150	BRA	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) 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.

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

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OTHER QUALIFIED VERSIONS OF LMT85, LMT85-Q1 :

- Catalog: LMT85

- Automotive: LMT85-Q1

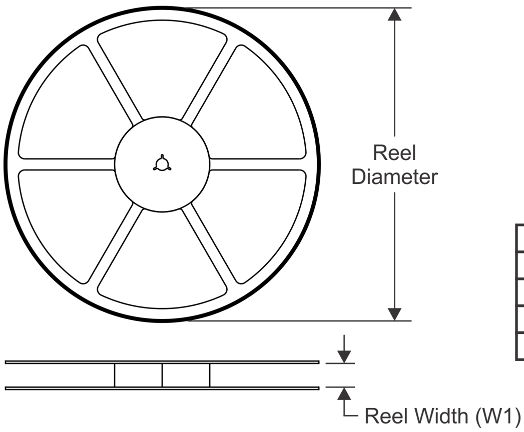
NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

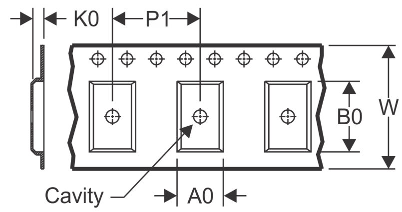
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

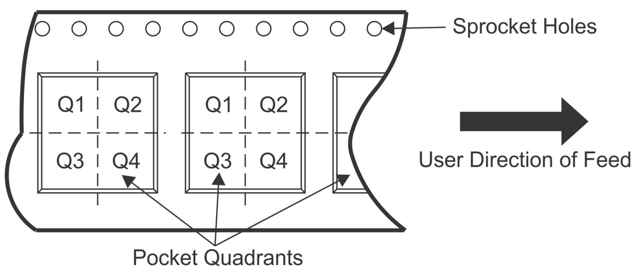


TAPE DIMENSIONS



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

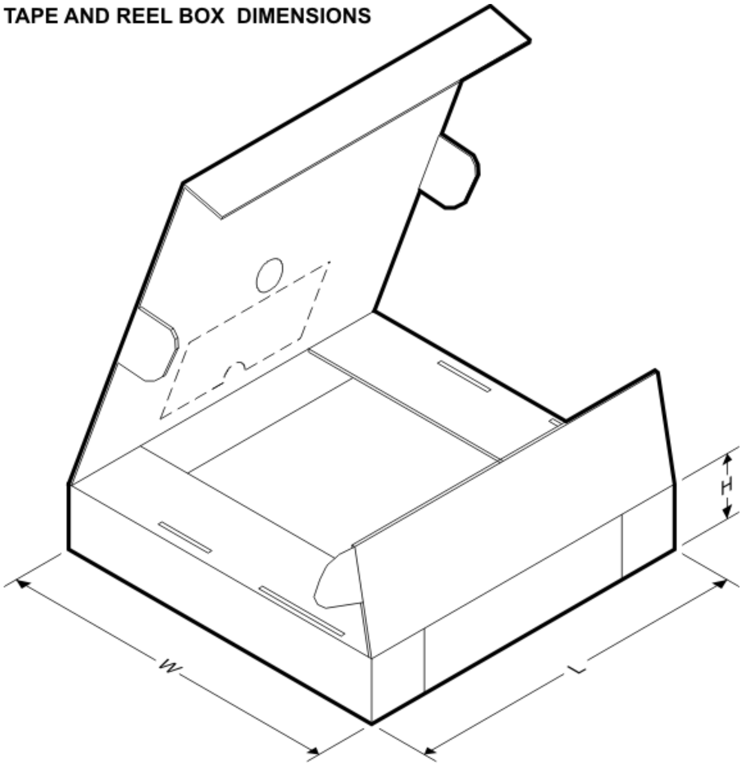
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LMT85DCKR	SC70	DCK	5	3000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMT85DCKT	SC70	DCK	5	250	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMT85QDCKRQ1	SC70	DCK	5	3000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMT85QDCKTQ1	SC70	DCK	5	250	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3

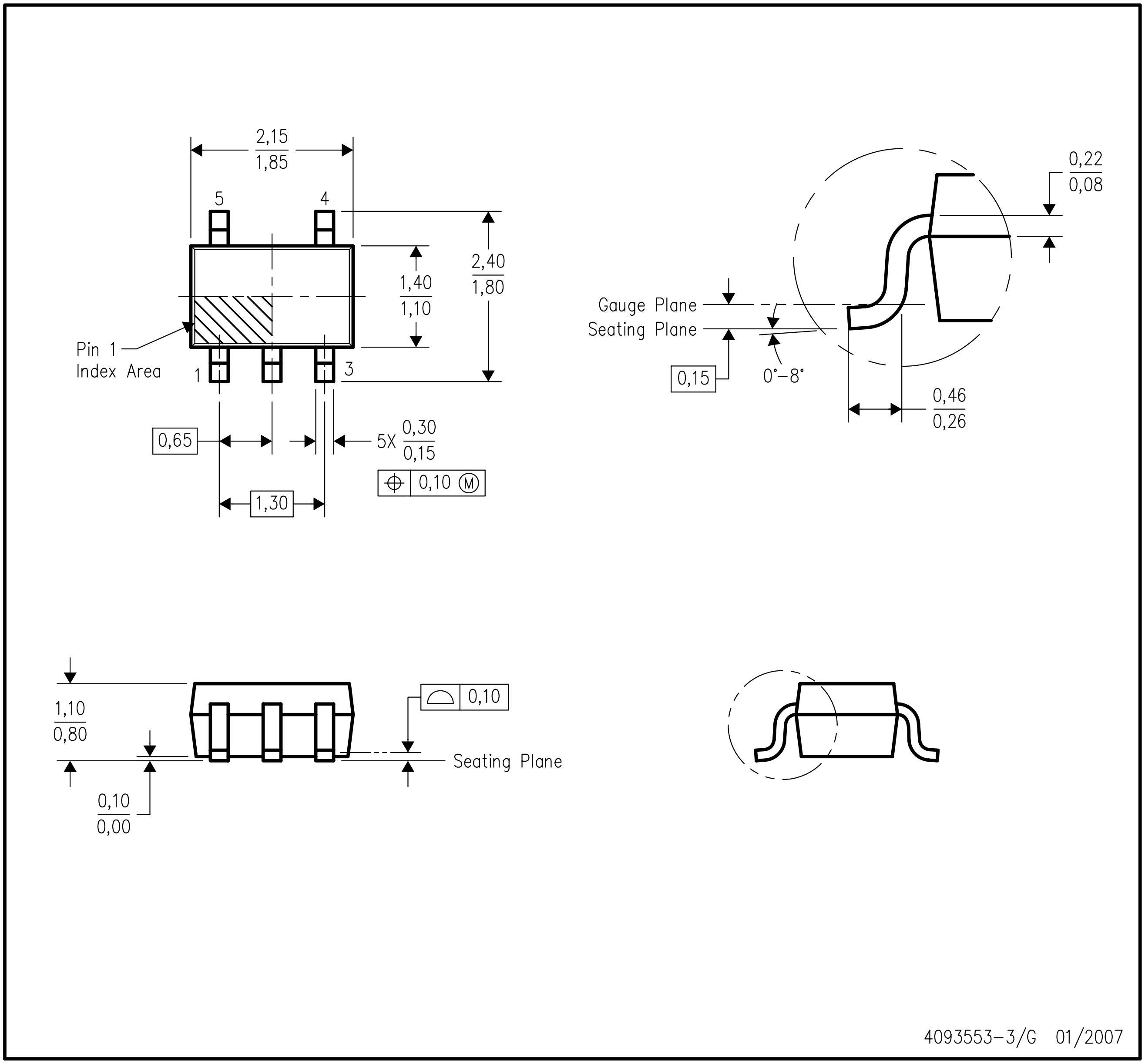
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

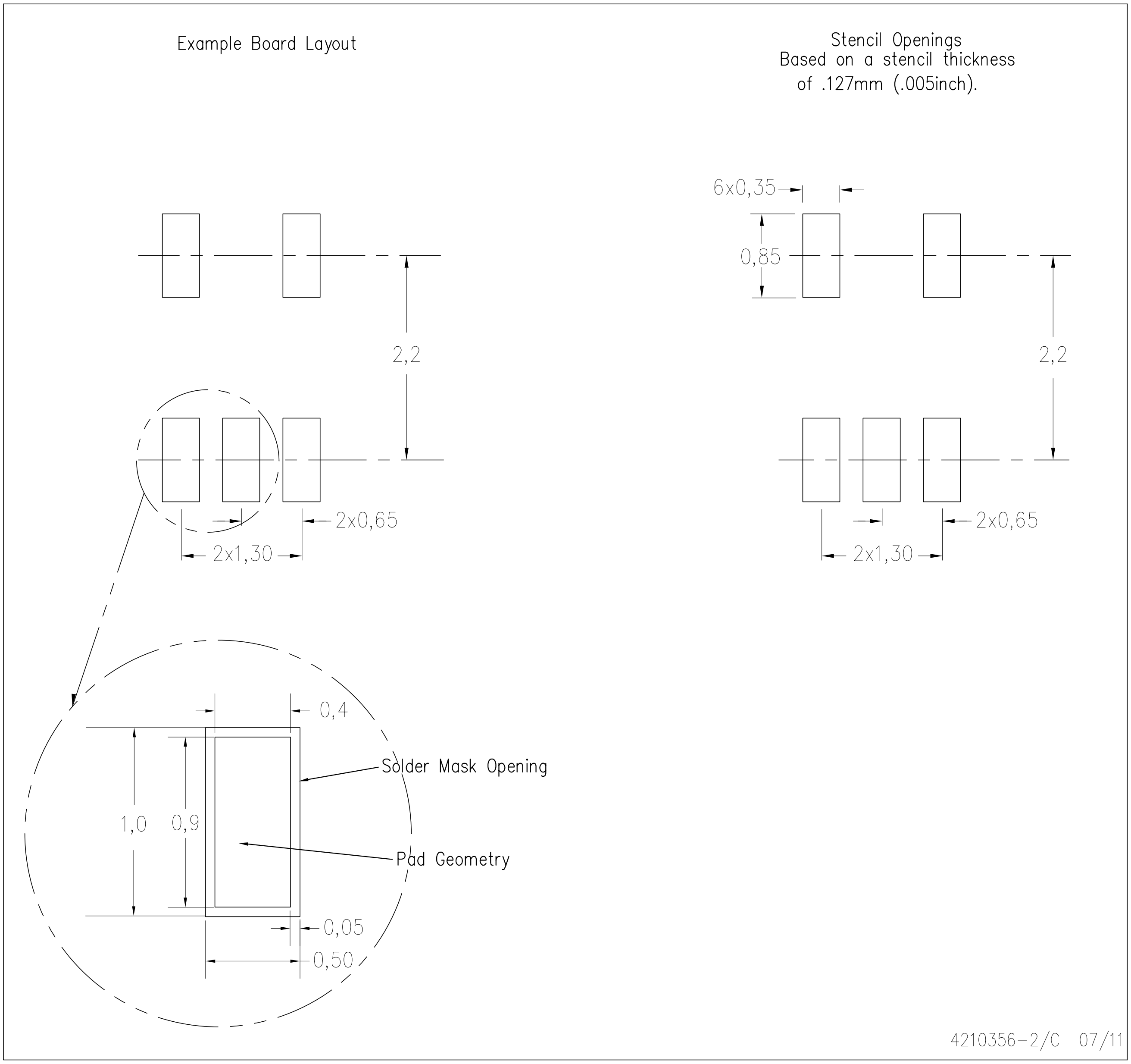
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMT85DCKR	SC70	DCK	5	3000	210.0	185.0	35.0
LMT85DCKT	SC70	DCK	5	250	210.0	185.0	35.0
LMT85QDCKRQ1	SC70	DCK	5	3000	210.0	185.0	35.0
LMT85QDCKTQ1	SC70	DCK	5	250	210.0	185.0	35.0

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



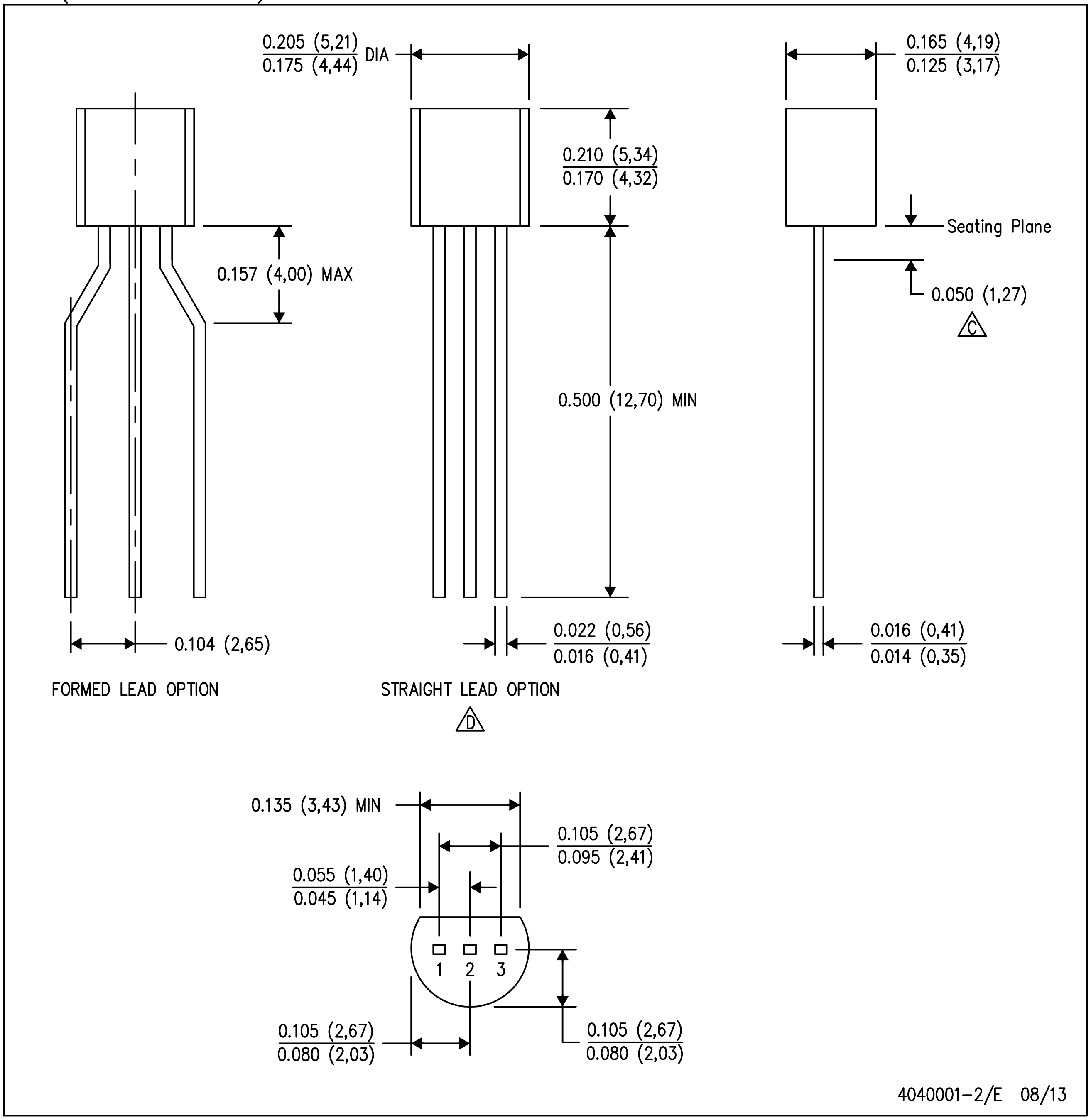
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO-203 variation AA.

DCK (R–PDSO–G5) PLASTIC SMALL OUTLINE



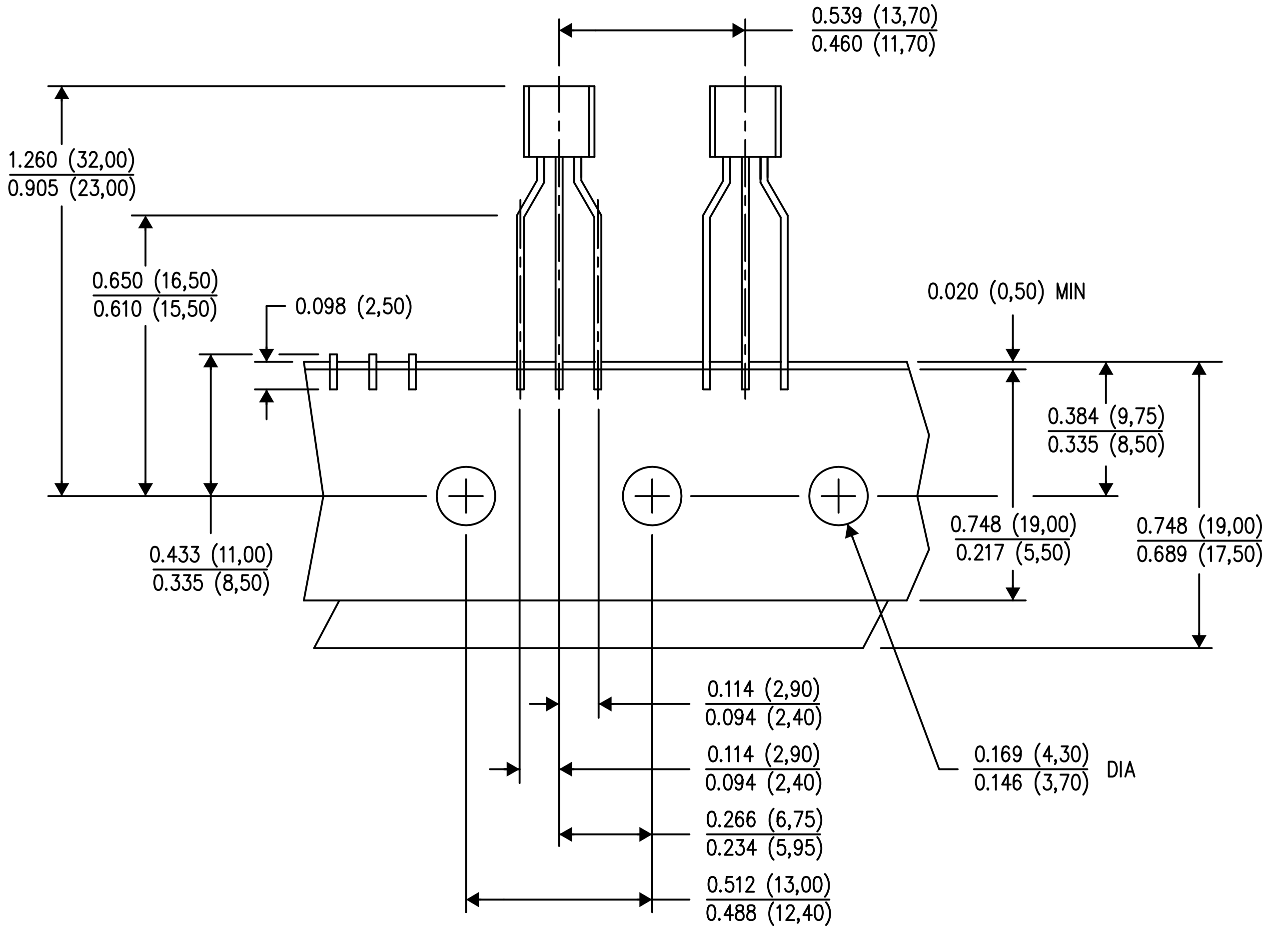
NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
- D. Publication IPC–7351 is recommended for alternate designs.
- E. 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.

LP (O-PBCY-W3) PLASTIC CYLINDRICAL PACKAGE



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

LP (O–PBCY–W3) PLASTIC CYLINDRICAL PACKAGE



TAPE & REEL

4040001–3/E 08/13

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
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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
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