LMT85、LMT85-Q1 1.8V、SC70/TO-92/TO-92S 模拟温度传感器

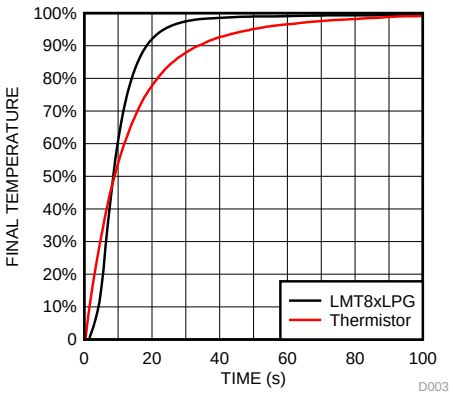
1 特性

- LMT85-Q1 符合 AEC-Q100 标准，适用于汽车 应用：
  - 器件温度等级 0：–40°C 至 +150°C
  - 器件人体放电模式 (HBM) 静电放电 (ESD) 分类等级 2
  - 器件 CDM ESD 分类等级 C6
- LMT85LPG（TO-92S 封装）具有快速热时间常量，典型值为 10s（空气流量为 1.2m/s）
- 非常精确：典型值 ±0.4°C
- 1.8V 低压运行
- -8.2mV/°C 的平均传感器增益
- 5.4µA 低静态电流
- 宽温度范围：–50°C 至 150°C
- 输出受到短路保护
- 具有 ±50µA 驱动能力的推挽输出
- 封装尺寸兼容符合行业标准的 LM20/19 和 LM35 温度传感器
- 具有成本优势的热敏电阻替代产品

2 应用

- 汽车
- 信息娱乐系统与仪表组
- 动力传动系统
- 烟雾和热量探测器
- 无人机
- 电器

热时间常量



* 快速热响应 NTC

3 说明

LMT85 和 LMT85-Q1 是精密 CMOS 温度传感器，其典型精度为 ±0.4°C（最大值为 ±2.7°C），且线性模拟输出电压与温度成反比关系。1.8V 工作电源电压、5.4µA 静态电流和 0.7ms 加电时间可实现有效的功率循环架构，以最大限度地降低无人机和传感器节点等电池供电 应用 的功耗。LMT85LPG 穿孔 TO-92S 封装快速热时间常量支持非板载时间温度敏感型 应用， 例如烟雾和热量探测器。LMT85-Q1 器件符合 AEC-Q100 0 级标准，在整个工作温度范围内可保持 ±2.7°C 的最大精度，且无需校准；因此 LMT85-Q1 适用于汽车 应用， 例如信息娱乐系统、仪表组和动力传动系统。得益于宽工作范围内的精度和其他 特性， LMT85 和 LMT85-Q1 成为热敏电阻的优质替代产品。

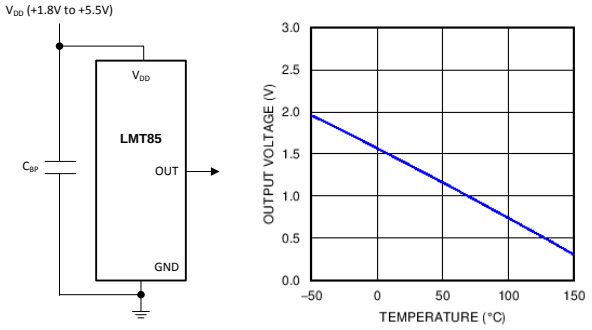
对于具有不同平均传感器增益和类似精度的器件，请参阅 *类似替代器件* 了解 LMT8x 系列中的替代器件。

器件信息 (1)

器件型号	封装	封装尺寸（标称值）
LMT85	SOT (5)	2.00mm x 1.25mm
	TO-92 (3)	4.3mm x 3.5mm
	TO-92S (3)	4.0mm x 3.15mm
LMT85-Q1	SOT (5)	2.00mm x 1.25mm

(1) 如需了解所有可用封装，请参阅产品说明书末尾的可订购产品附录。

输出电压与温度间的关系



目录

4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

Changes from Revision C (October 2015) to Revision D **Page**

- 根据最新文档和翻译标准更新了产品说明书文本 ... 1
- 将 AEC-Q100 汽车标准项目符号添加到了*"特性"中* ... 1
- 添加了时间常量图 ... 1
- 将磁盘驱动器、游戏、无线收发器和手机从*"应用"中进行了删除* ... 1
- Added LPG (TO-92S) package ... 3
- Added Figure 10 to *Typical Characteristics* ... 7

Changes from Revision B (May 2014) to Revision C **Page**

- 已删除 所有涉及 TO-126 封装的内容 ... 1
- Added TO-92 LPM pin configuration graphic ... 3
- Changed Handling Ratings to ESD Ratings and moved Storage Temperature to Absolute Maximum Ratings table ... 4
- Changed KV to V ... 4
- Added TO-92 LP and LPM layout recommendations ... 15

Changes from Revision A (June 2013) to Revision B **Page**

- 已更改 产品说明书流程和布局，以符合新的 TI 标准。已在整个文档内添加以下章节：应用范围和实施、电源建议、布局布线、器件和文档支持、机械、封装和可订购信息。 ... 1
- 已添加 在文档中增加了 TO-92 和 TO-126 封装信息。 ... 1
- Changed from 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

5 Device Comparison Tables

Table 1. Available Device Packages

ORDER NUMBER(1)	PACKAGE	PIN	BODY SIZE (NOM)	MOUNTING TYPE
LMT85DCK	SOT (AKA(2): SC70, DCK)	5	2.00 mm × 1.25 mm	Surface Mount
LMT85LP	TO-92 (AKA(2): LP)	3	4.30 mm × 3.50 mm	Through-hole; straight leads
LMT85LPG	TO-92S (AKA(2): LPG)	3	4.00 mm × 3.15 mm	Through-hole; straight leads
LMT85LPM	TO-92 (AKA(2): LPM)	3	4.30 mm × 3.50 mm	Through-hole; formed leads
LMT85DCK-Q1	SOT (AKA(2): SC70, DCK)	5	2.00 mm × 1.25 mm	Surface Mount

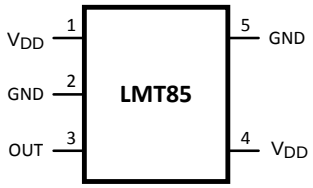
(1) For all available packages and complete order numbers, see the Package Option addendum at the end of the data sheet.
(2) AKA = Also Known As

Table 2. Comparable Alternative Devices

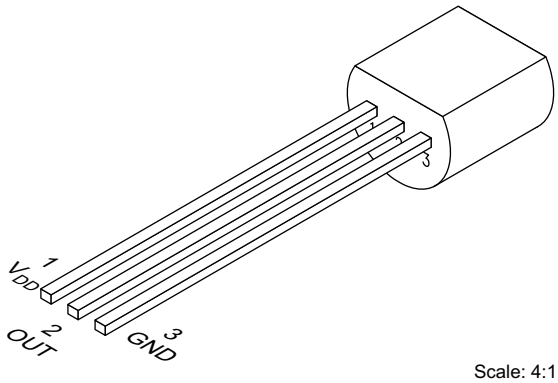
DEVICE NAME	AVERAGE OUTPUT SENSOR GAIN	POWER SUPPLY RANGE
LMT84/LMT84-Q1	–5.5 mV/°C	1.5 V to 5.5 V
LMT85/LMT85-Q1	–8.2 mV/°C	1.8 V to 5.5 V
LMT86/LMT86-Q1	–10.9 mV/°C	2.2 V to 5.5 V
LMT87/LMT87-Q1	–13.6 mV/°C	2.7 V to 5.5 V

6 Pin Configuration and Functions

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

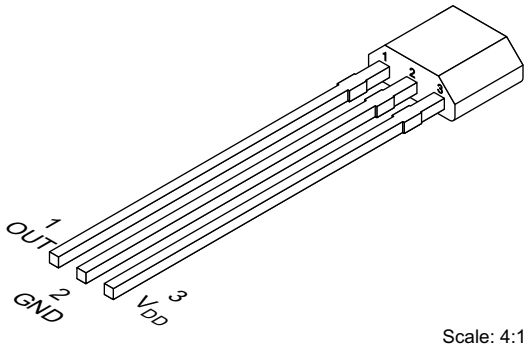


LP Package
3-Pin TO-92
(Top View)



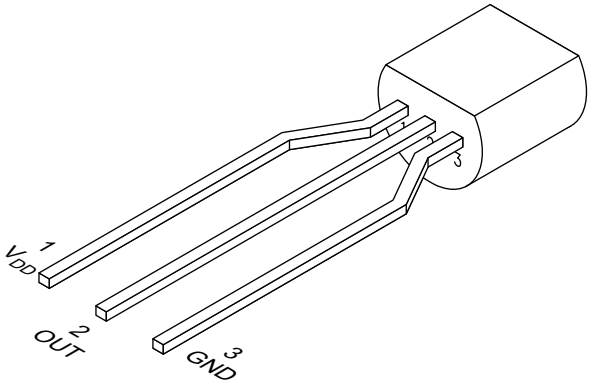
Scale: 4:1

LPG Package
3-Pin TO-92S
(Top View)



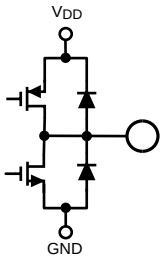
Scale: 4:1

LPM Package
3-Pin TO-92
(Top View)



Scale: 4:1

Pin Functions

PIN				DESCRIPTION		
NAME	SOT (SC70)	TO-92	TO-92S	TYPE	EQUIVALENT CIRCUIT	FUNCTION
GND	2(1) , 5	1	2	Ground	N/A	Power Supply Ground
OUT	3	2	1	Analog Output		Outputs a voltage that is inversely proportional to temperature
V_{DD}	1, 4	3	3	Power	N/A	Positive Supply Voltage

(1) Direct connection to the back side of the die

7 Specifications

7.1 Absolute Maximum Ratings

See (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
Storage temperature, T_{stg}	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability
(2) *Soldering process must comply with Reflow Temperature Profile specifications. Refer to* www.ti.com/packaging.
(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 ESD Ratings – LMT85

			VALUE	UNIT
LMT85LP in TO-92/TO-92S package				
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)(2)	±2500	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(3)	±1000	
LMT85DCK in SC70 package				
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per JESD22-A114(2)	±2500	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(3)	±1000	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) The human body model is a 100-pF capacitor discharged through a 1.5-kΩ resistor into each pin.
(3) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 ESD Ratings – LMT85-Q1

			VALUE	UNIT
LMT85DCK-Q1 in SC70 package				
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002(1)	±2500	V
		Charged-device model (CDM), per AEC Q100-011	±1000	

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

7.4 Recommended Operating Conditions

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

7.5 Thermal Information(1)

THERMAL METRIC(2)		LMT85/ LMT85-Q1	LMT85LP	LMT85LPG	UNIT
		DCK (SOT/SC70)	LP/LPM (TO-92)	LPG (TO-92S)	
		5 PINS	3 PINS	3 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance (3)(4)	275	167	130.4	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	84	90	64.2	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	56	146	106.2	°C/W
ψ_{JT}	Junction-to-top characterization parameter	1.2	35	14.6	°C/W
ψ_{JB}	Junction-to-board characterization parameter	55	146	106.2	°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.
(3) The junction to ambient thermal resistance ($R_{\theta JA}$) under natural convection is obtained in a simulation on a JEDEC-standard, High-K board as specified in JESD51-7, in an environment described in JESD51-2. Exposed pad packages assume that thermal vias are included in the PCB, per JESD 51-5.
(4) Changes in output due to self heating can be computed by multiplying the internal dissipation by the thermal resistance.

7.6 Accuracy Characteristics

These limits do not include DC load regulation. These stated accuracy limits are with reference to the values in Table 3.

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.

7.7 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.

7.8 Typical Characteristics

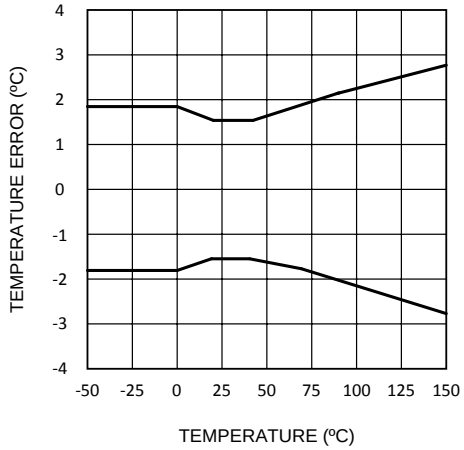


Figure 1. Temperature Error vs Temperature

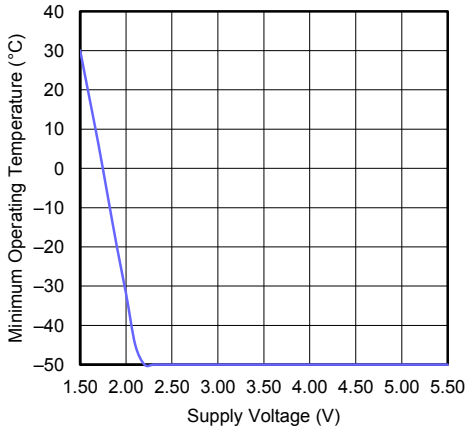


Figure 2. Minimum Operating Temperature vs Supply Voltage

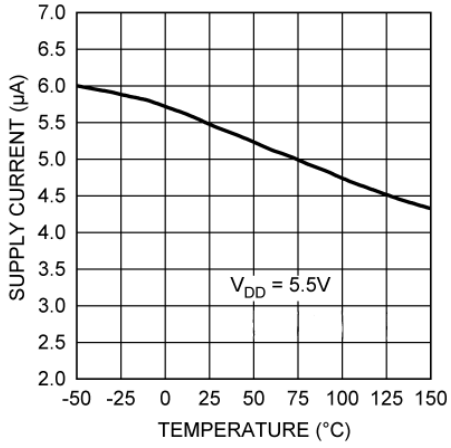


Figure 3. Supply Current vs Temperature

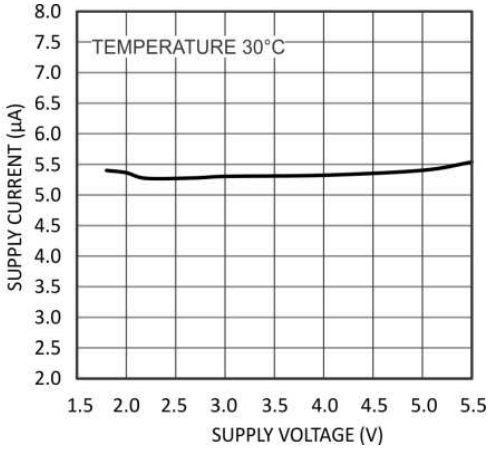


Figure 4. Supply Current vs Supply Voltage

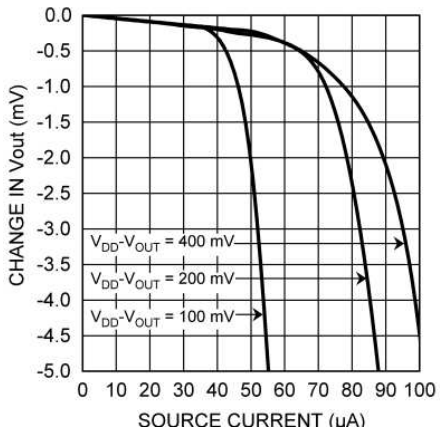


Figure 5. Load Regulation, Sourcing Current

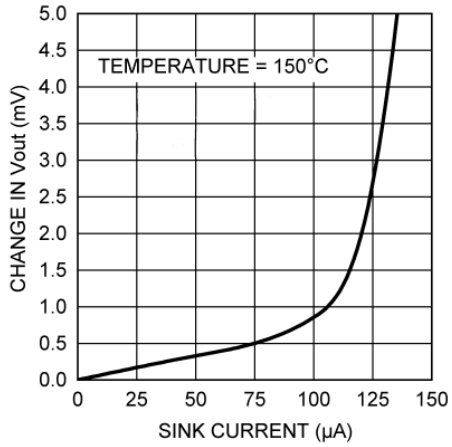


Figure 6. Load Regulation, Sinking Current

Typical Characteristics (continued)

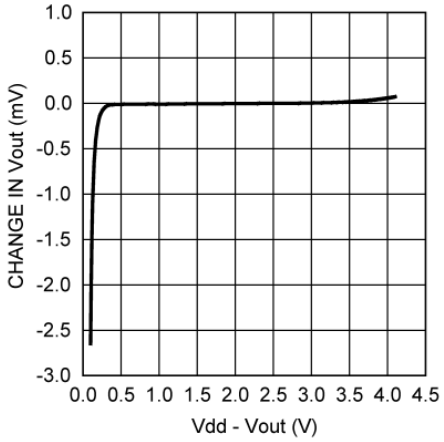


Figure 7. Change in Vout vs Overhead Voltage

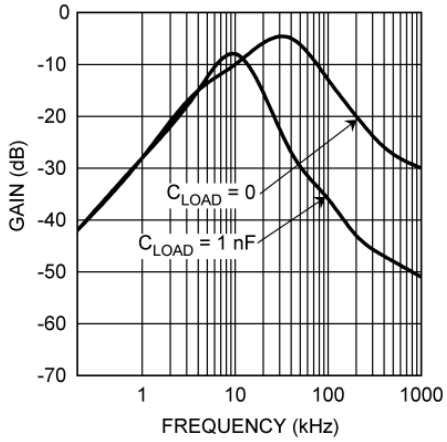


Figure 8. Supply-Noise Gain vs Frequency

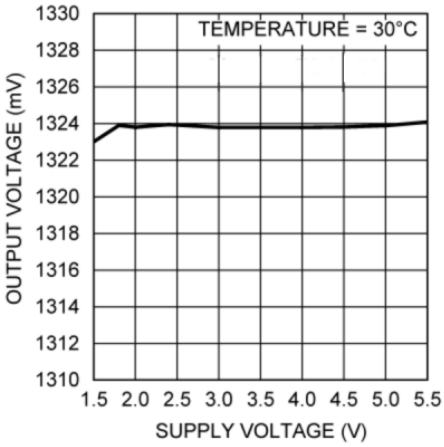


Figure 9. Output Voltage vs Supply Voltage

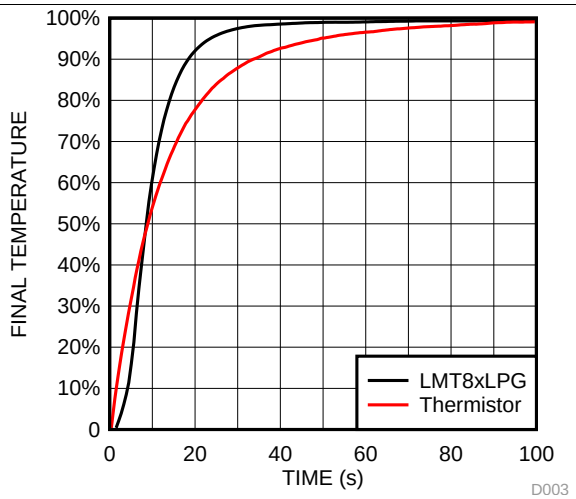


Figure 10. LMT85LPG Thermal Response vs Common Leaded Thermistor With 1.2-m/s Airflow

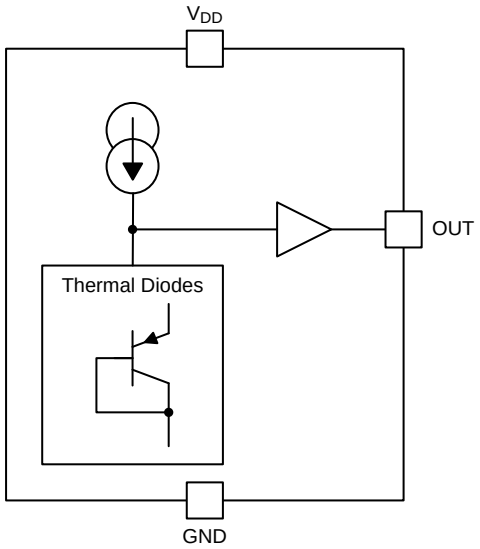
8 Detailed Description

8.1 Overview

The LMT85 and LMT85-Q1 are analog output temperature sensors. The electrical characteristics of the LMT85 and LMT85-Q1 are identical, so for clarity, the devices will be subsequently referred to as simply LMT85. 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 Transfer Function

The output voltage of the LMT85, across the complete operating temperature range, is shown in Table 3. This table is the reference from which the LMT85 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 the LMT85 product folder under *Tools and Software Models*.

Table 3. LMT85 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

Feature Description (continued)

Table 3. LMT85 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)
-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
-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 is very linear, its response does have a slight umbrella parabolic shape. This shape is very accurately reflected in Table 3. The Transfer Table can be calculated by using the parabolic equation (Equation 1).

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

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:

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

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 (Equation 3):

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

where

- V is in mV,
- T is in °C,
- T_1 and V_1 are the coordinates of the lowest temperature,

- and T_2 and V_2 are the coordinates of the highest temperature. (3)

For example, if the user wanted to resolve this equation, over a temperature range of 20°C to 50°C, they would proceed as follows:

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

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

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

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

8.4 Device Functional Modes

8.4.1 Mounting and Thermal Conductivity

The LMT85 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 die is directly attached to the GND pin. The temperatures of the lands and traces to the other leads of the LMT85 will also affect the temperature reading.

Alternatively, the LMT85 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 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 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}) is the parameter used to calculate the rise of a device junction temperature due to its power dissipation. Use Equation 7 to calculate the rise in the LMT85 die temperature:

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

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. (7)

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. Because the junction temperature of the LMT85 is the actual temperature being measured, take care to minimize the load current that the LMT85 is required to drive. *Thermal Information* shows the thermal resistance of the LMT85.

8.4.2 Output and Noise Considerations

A push-pull output gives the LMT85 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. The LMT85 are ideal for this and other applications which require strong source or sink current.

The LMT85 supply-noise gain (the ratio of the AC signal on V_{OUT} to the AC signal on V_{DD}) was measured during bench tests. The typical attenuation is shown in Figure 8 found in the *Typical Characteristics* . 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.

Device Functional Modes (continued)

8.4.3 Capacitive Loads

The LMT85 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 can drive a capacitive load less than or equal to 1100 pF as shown in Figure 11. For capacitive loads greater than 1100 pF, a series resistor may be required on the output, as shown in Figure 12.

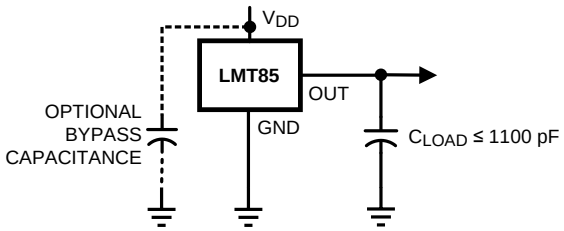


Figure 11. LMT85 No Decoupling Required for Capacitive Loads Less Than 1100 pF

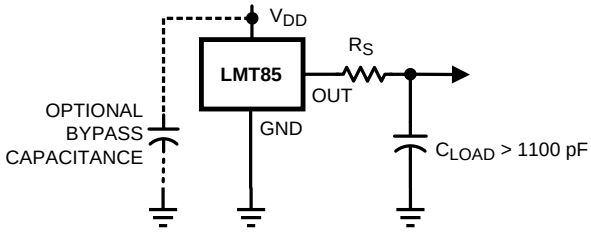


Figure 12. LMT85 with Series Resistor for Capacitive Loading Greater Than 1100 pF

Table 4. Recommended Series Resistor Values

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 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}. Because 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.

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

The LMT85 features make it suitable for many general temperature-sensing applications. It can operate down to 1.8-V supply with 5.4-µA power consumption, making it ideal for battery powered devices. Package options like the through-hole TO-92 package allow the LMT85 to be mounted onboard, 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

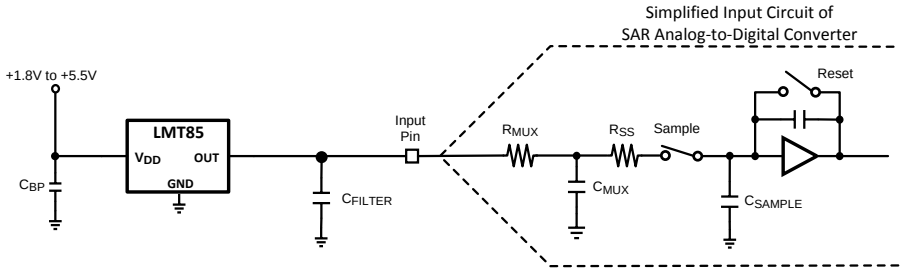


Figure 13. Suggested Connection to a Sampling Analog-to-Digital Converter Input Stage

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 temperature sensor and many op amps. This requirement is easily accommodated by the addition of a capacitor (C_{FILTER}).

9.2.1.2 Detailed Design Procedure

The size of C_{FILTER} depends on the size of the sampling capacitor and the sampling frequency. Because not all ADCs have identical input stages, the charge requirements will vary. This general ADC application is shown as an example only.

9.2.1.3 Application Curve

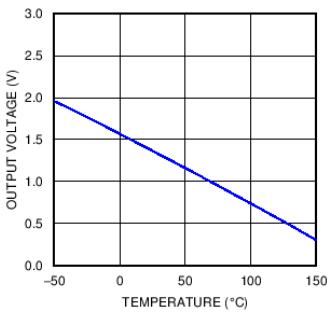


Figure 14. Analog Output Transfer Function

Typical Applications (continued)

9.2.2 Conserving Power Dissipation With Shutdown

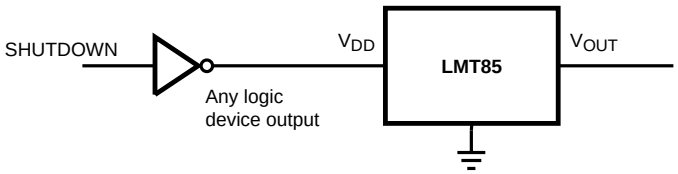


Figure 15. Simple Shutdown Connection of the LMT85

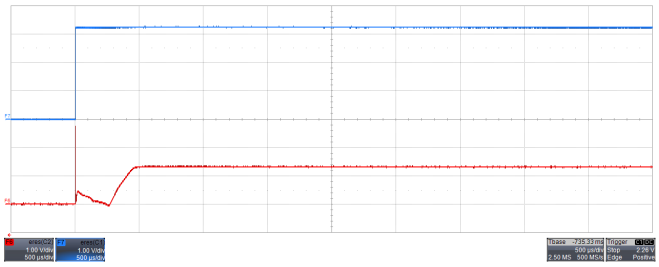
9.2.2.1 Design Requirements

Because the power consumption of the LMT85 is less than 9 µA, it can simply be powered directly from any logic gate output and therefore not require 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 are critical.

9.2.2.2 Detailed Design Procedure

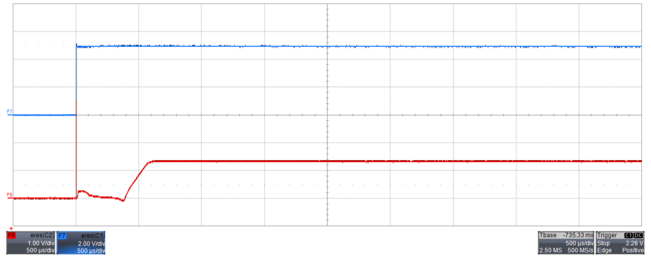
Simply connect the V_{DD} pin of the LMT85 directly to the logic shutdown signal from a microcontroller.

9.2.2.3 Application Curves



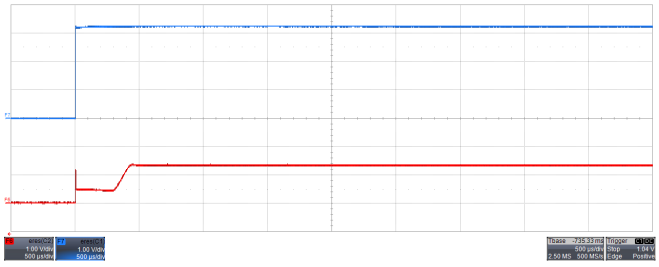
Time: 500 µs/div; Top Trace: V_{DD} 1 V/div;
Bottom Trace: OUT 1 V/div

Figure 16. Output Turnon Response Time Without a Capacitive Load and V_{DD} = 3.3 V



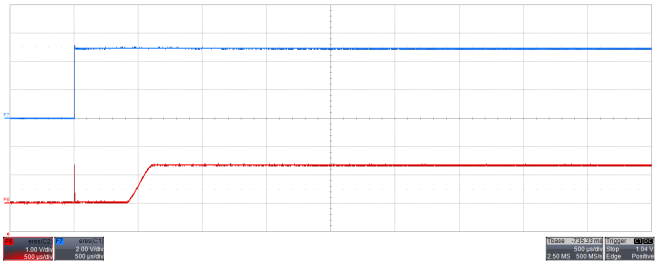
Time: 500 µs/div; Top trace: V_{DD} 2 V/div;
Bottom trace: OUT 1 V/div

Figure 17. Output Turnon Response Time Without a Capacitive Load and V_{DD} = 5 V



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

Figure 18. Output Turnon Response Time With 1.1-nF Capacitive Load and V_{DD} = 3.3 V



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

Figure 19. Output Turnon Response Time With 1.1-nF Capacitive Load and V_{DD} = 5 V

10 Power Supply Recommendations

The low supply current and supply range (1.8 V to 5.5 V) of the LMT85 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 output of the LMT85.

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

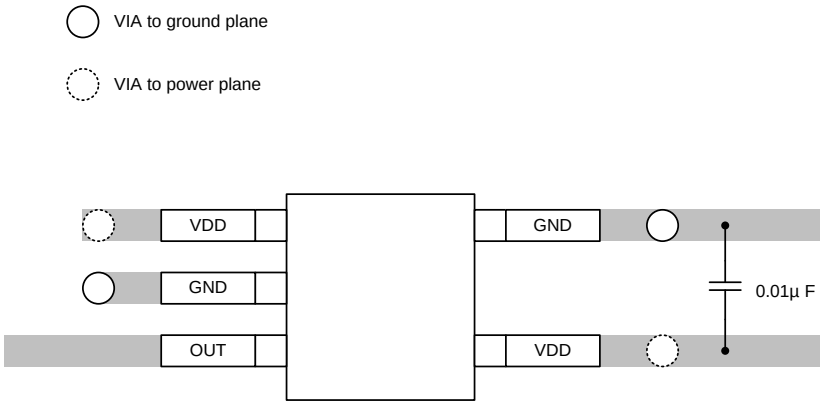


Figure 20. SC70 Package Recommended Layout

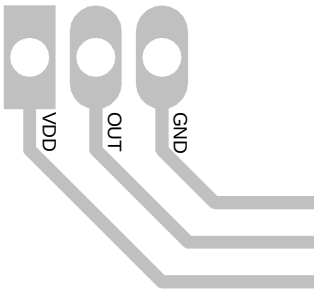


Figure 21. TO-92 LP Package Recommended Layout

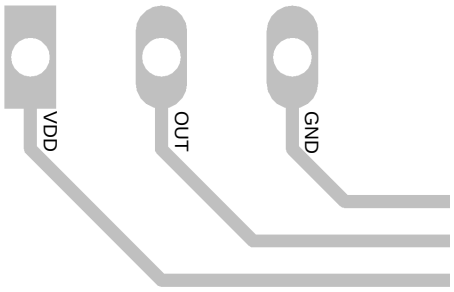


Figure 22. TO-92 LPM Package Recommended Layout

12 器件和文档支持

12.1 相关链接

下面的表格列出了快速访问链接。类别包括技术文档、支持与社区资源、工具和软件，以及申请样片或购买产品的快速链接。

表 5. 相关链接

器件	产品文件夹	样片与购买	技术文档	工具和软件	支持和社区
LMT85	请单击此处	请单击此处	请单击此处	请单击此处	请单击此处
LMT85-Q1	请单击此处	请单击此处	请单击此处	请单击此处	请单击此处

12.2 接收文档更新通知

要接收文档更新通知，请导航至德州仪器 TI.com.cn 上的器件产品文件夹。点击右上角的*提醒我* (Alert me) 注册后，即可每周定期收到已更改的产品信息。有关更改的详细信息，请查阅已修订文档中包含的修订历史记录。

12.3 社区资源

下列链接提供到 TI 社区资源的连接。链接的内容由各个分销商“按照原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 《使用条款》。

TI E2E™ 在线社区 ***TI 的工程师对工程师 (E2E) 社区。*** **此社区的创建目的在于促进工程师之间的协作。在 e2e.ti.com 中，您可以咨询问题、分享知识、拓展思路并与同行工程师一道帮助解决问题。**

设计支持 ***TI 参考设计支持*** **可帮助您快速查找有帮助的 E2E 论坛、设计支持工具以及技术支持的联系信息。**

12.4 商标

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

12.5 静电放电警告

这些装置包含有限的内置 ESD 保护。 存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

12.6 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 机械、封装和可订购信息

以下页面包括机械、封装和可订购信息。这些信息是指定器件的最新可用数据。这些数据发生变化时，我们可能不会另行通知或修订此文档。如欲获取此产品说明书的浏览器版本，请参阅左侧的导航栏。

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
LMT85LPG	ACTIVE	TO-92	LPG	3	1000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type	-50 to 150	LMT85	Samples
LMT85LPGM	ACTIVE	TO-92	LPG	3	3000	Green (RoHS & no Sb/Br)	CU SN	N / A for Pkg Type	-50 to 150	LMT85	Samples
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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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.

OTHER QUALIFIED VERSIONS OF LMT85, LMT85-Q1 :

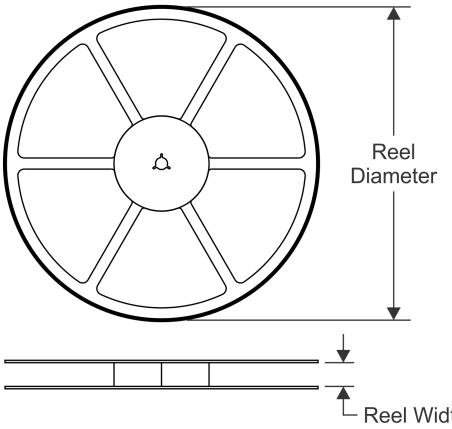
- Catalog: LMT85
- Automotive: LMT85-Q1

NOTE: Qualified Version Definitions:

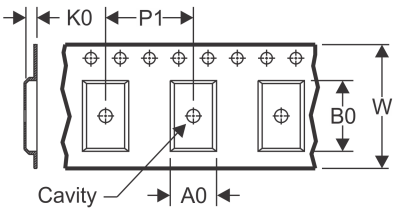
- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

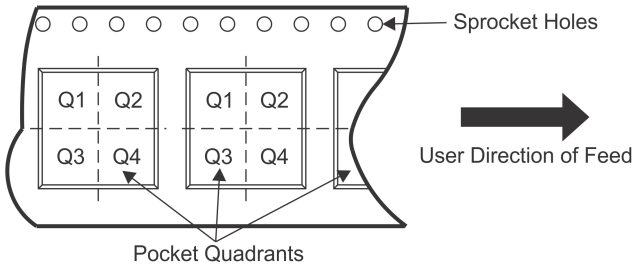


TAPE DIMENSIONS



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

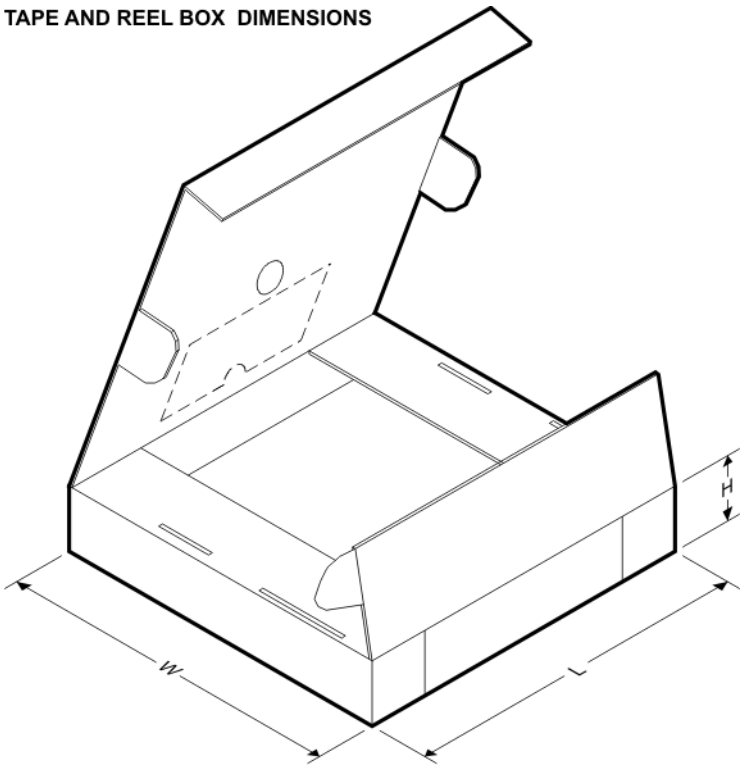
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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

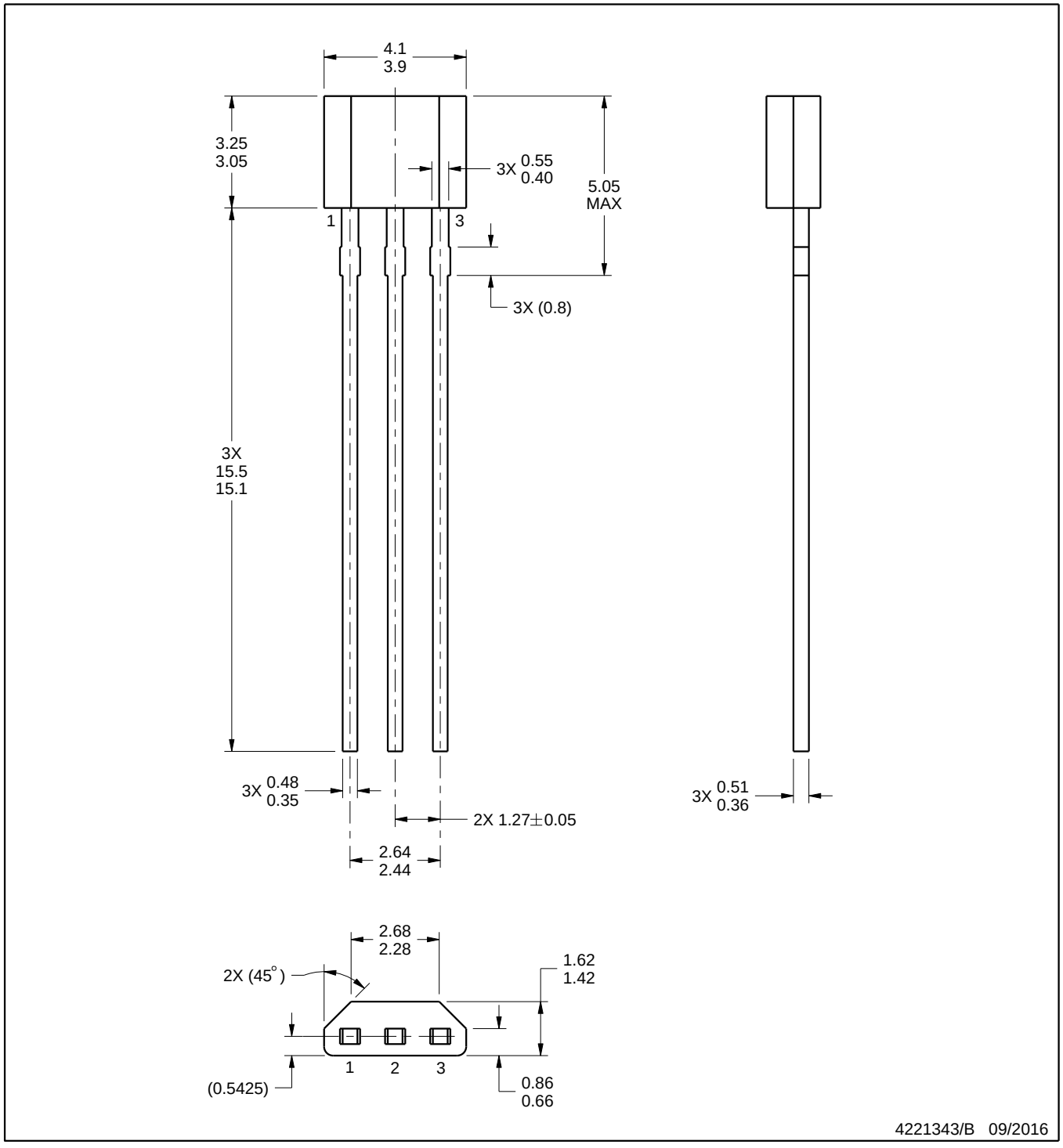
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMT85DCKR	SC70	DCK	5	3000	210.0	185.0	35.0
LMT85DCKT	SC70	DCK	5	250	210.0	185.0	35.0
LMT85QDCKRQ1	SC70	DCK	5	3000	210.0	185.0	35.0
LMT85QDCKTQ1	SC70	DCK	5	250	210.0	185.0	35.0

PACKAGE OUTLINE

LPG0003A

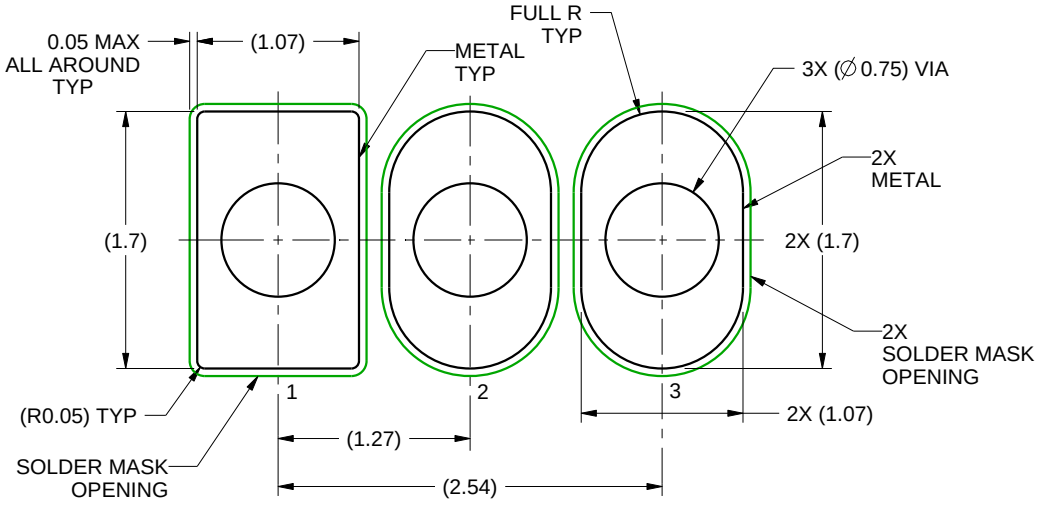
TO-92 - 5.05 mm max height

TO-92



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.



LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE:20X

4221343/B 09/2016

GENERIC PACKAGE VIEW

LP 3 TO-92 - 5.34 mm max height

TRANSISTOR OUTLINE

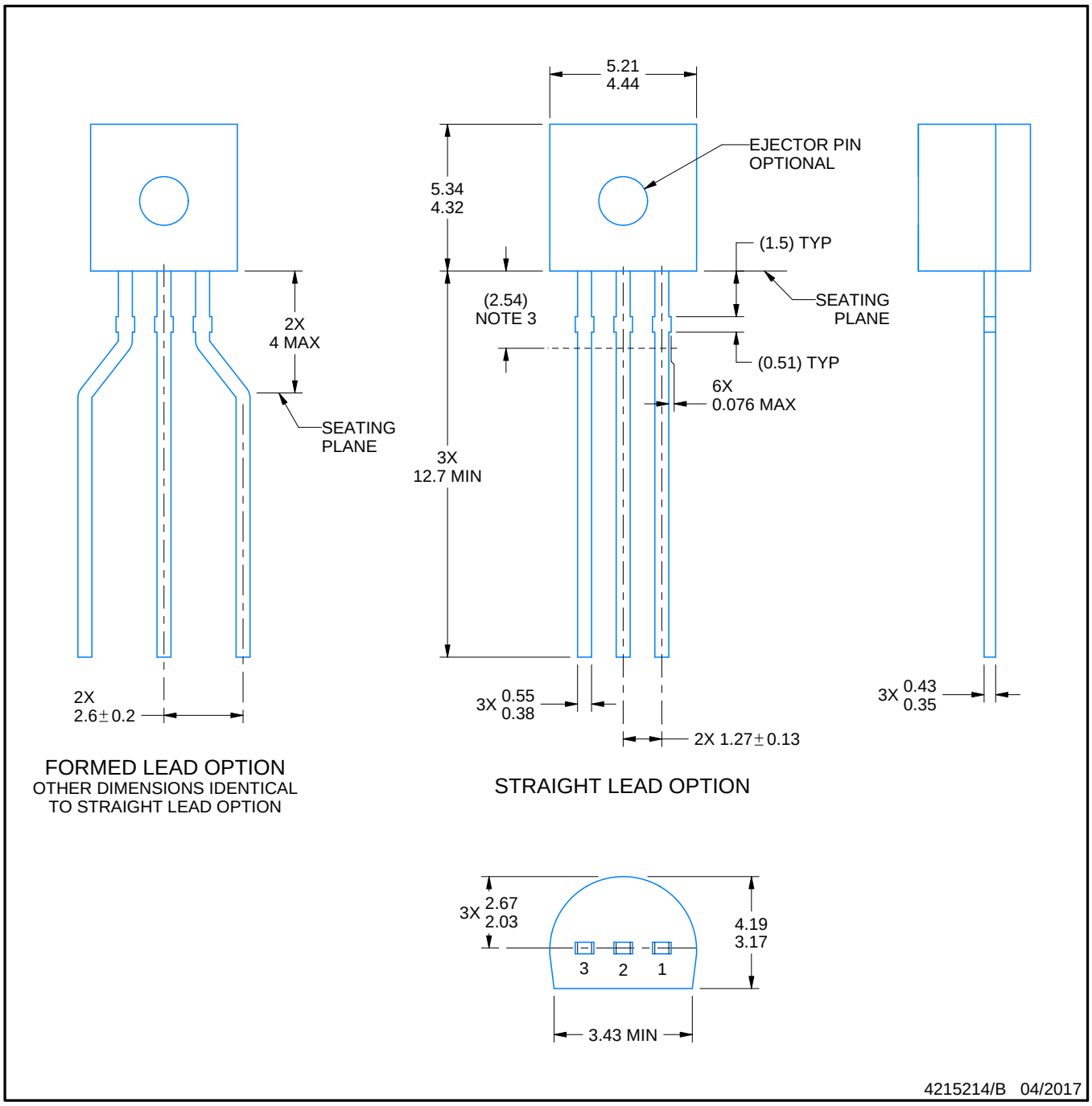
Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

LP0003A

PACKAGE OUTLINE

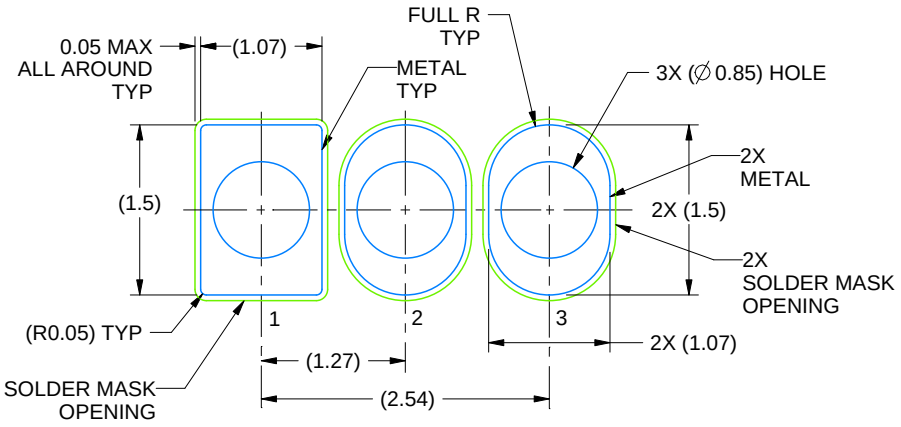
TO-92 - 5.34 mm max height

TO-92

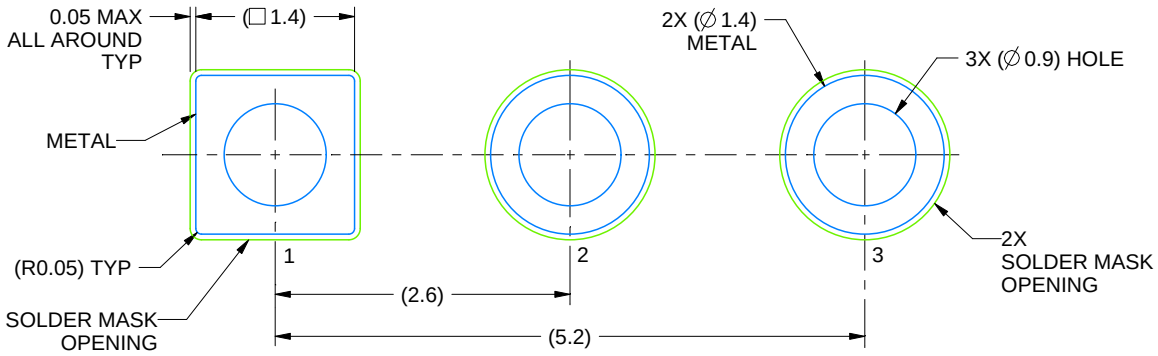


NOTES:

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. Lead dimensions are not controlled within this area.
4. Reference JEDEC TO-226, variation AA.
5. Shipping method:
   a. Straight lead option available in bulk pack only.
   b. Formed lead option available in tape and reel or ammo pack.
   c. Specific products can be offered in limited combinations of shipping medium and lead options.
   d. Consult product folder for more information on available options.



LAND PATTERN EXAMPLE
STRAIGHT LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X



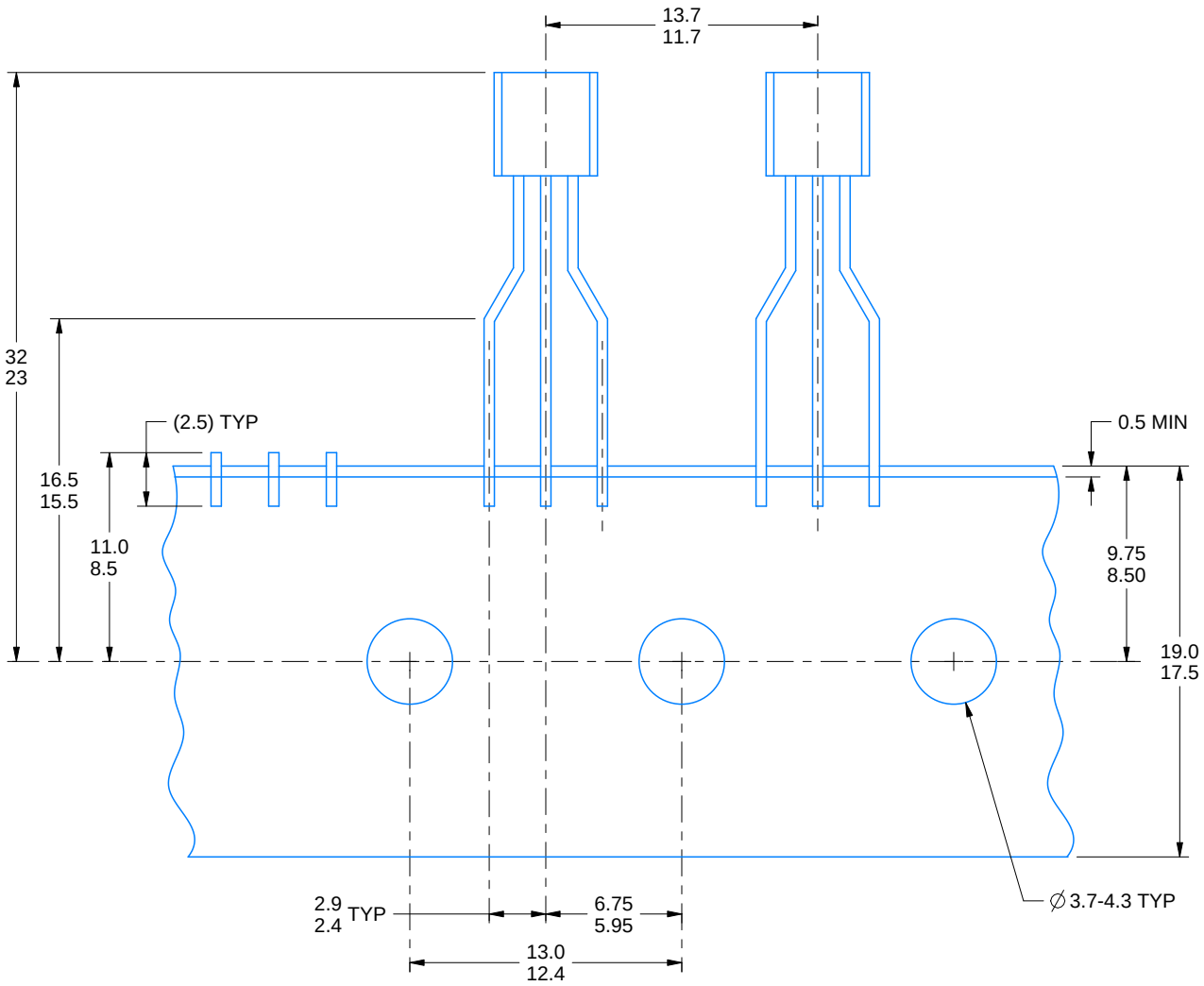
LAND PATTERN EXAMPLE
FORMED LEAD OPTION
NON-SOLDER MASK DEFINED
SCALE:15X

4215214/B 04/2017

LP0003A

TO-92 - 5.34 mm max height

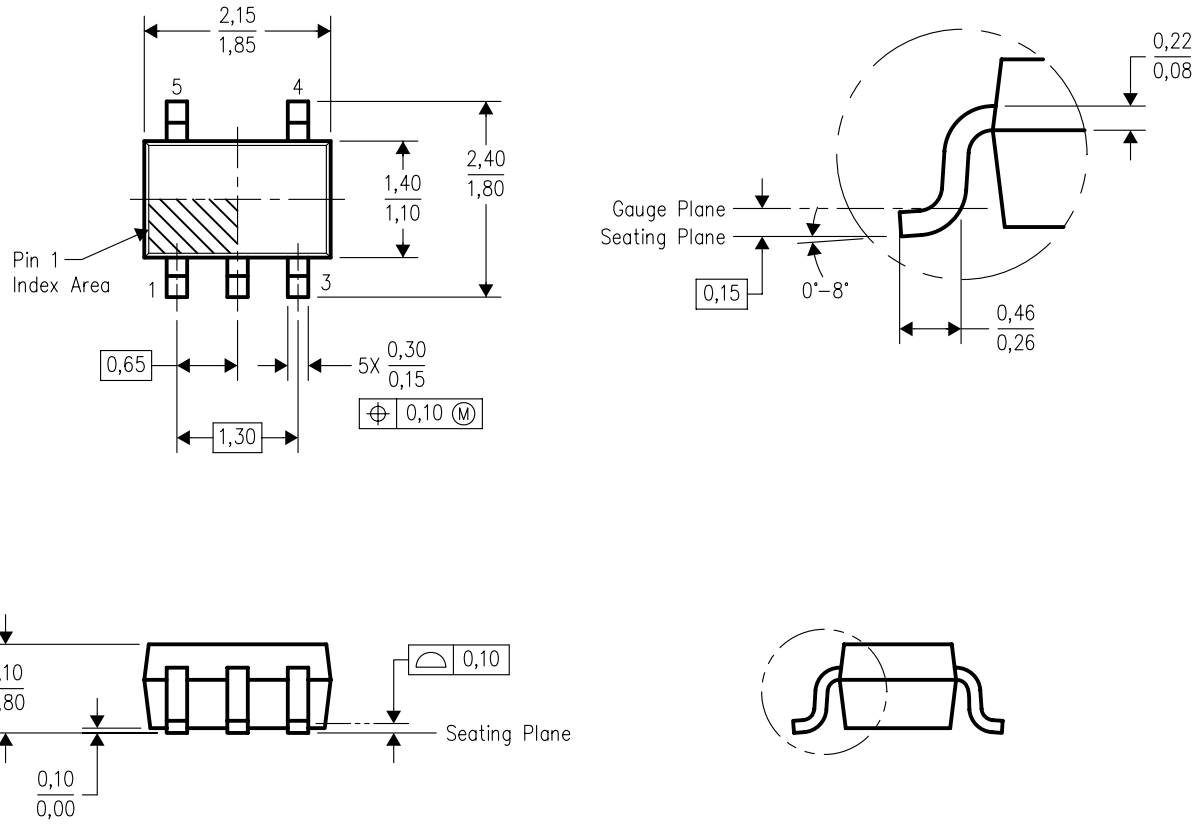
TO-92



FOR FORMED LEAD OPTION PACKAGE

4215214/B 04/2017

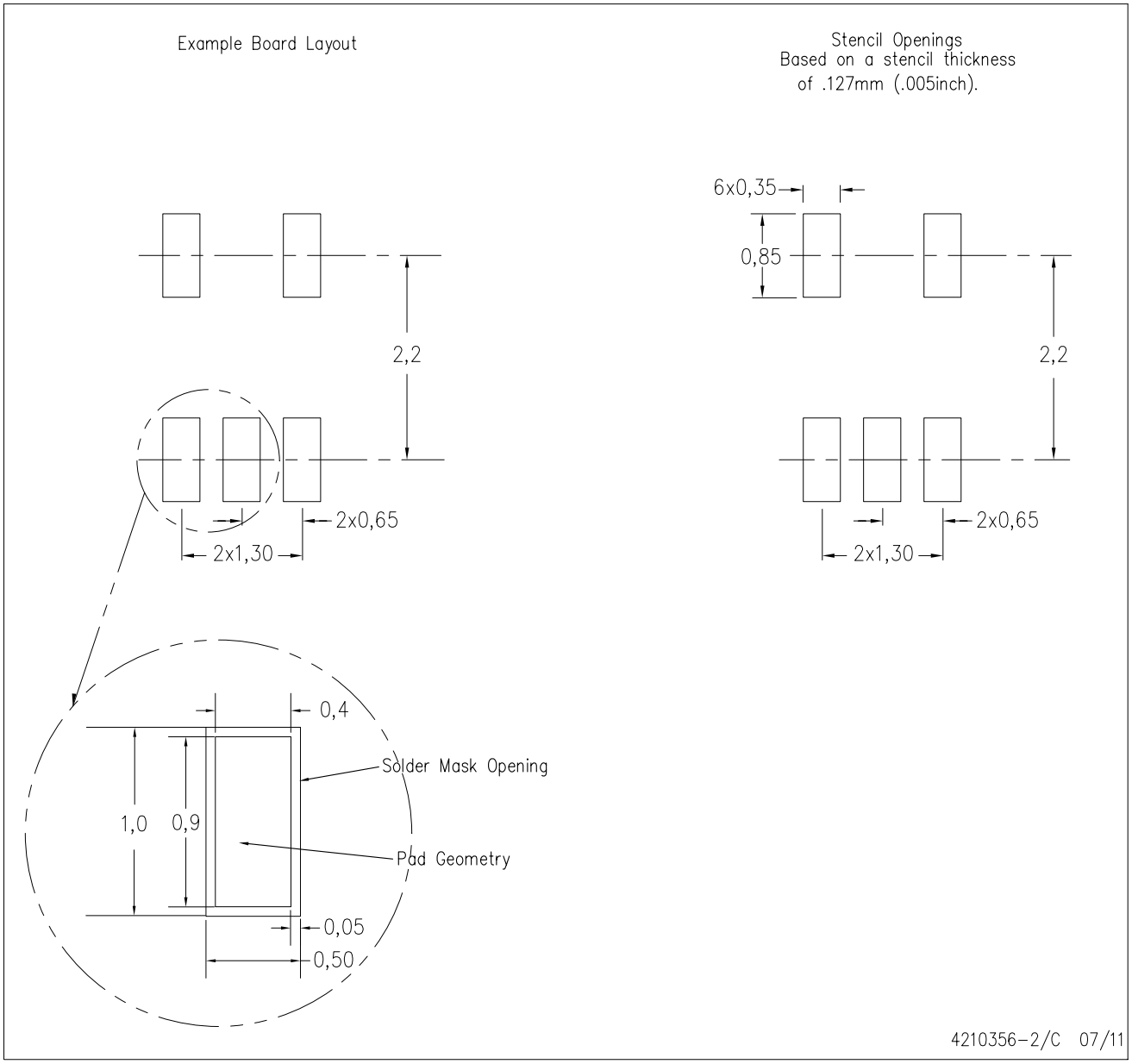
DCK (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE



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.

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.

重要声明

德州仪器 (TI) 公司有权按照最新发布的 JESD46 对其半导体产品和服务进行纠正、增强、改进和其他修改，并不再按最新发布的 JESD48 提供任何产品和服务。买方在下订单前应获取最新的相关信息，并验证这些信息是否完整且是最新的。

TI 公布的半导体产品销售条款 (http://www.ti.com/sc/docs/stdterms.htm) 适用于 TI 已认证和批准上市的已封装集成电路产品的销售。另有其他条款可能适用于其他类型 TI 产品及服务的使用或销售。

复制 TI 数据表上 TI 信息的重要部分时，不得变更该等信息，且必须随附所有相关保证、条件、限制和通知，否则不得复制。TI 对该等复制文件不承担任何责任。第三方信息可能受到其它限制条件的制约。在转售 TI 产品或服务时，如果存在对产品或服务参数的虚假陈述，则会失去相关 TI 产品或服务的明示或暗示保证，且构成不公平的、欺诈性商业行为。TI 对此类虚假陈述不承担任何责任。

买方和在系统中整合 TI 产品的其他开发人员（总称“设计人员”）理解并同意，设计人员在设计应用时应自行实施独立的分析、评价和判断，且应全权 负责并确保 应用的安全性， 及设计人员的 应用 （包括应用中使用的所有 TI 产品）应符合所有适用的法律法规及其他相关要求。设计人员就自己设计的 应用声明，其具备制订和实施下列保障措施所需的一切必要专业知识，能够 (1) 预见故障的危险后果，(2) 监视故障及其后果，以及 (3) 降低可能导致危险的故障几率并采取适当措施。设计人员同意，在使用或分发包含 TI 产品的任何 应用前， 将彻底测试该等 应用和 该等应用中所用 TI 产品的 功能。

TI 提供技术、应用或其他设计建议、质量特点、可靠性数据或其他服务或信息，包括但不限于与评估模块有关的参考设计和材料（总称“TI 资源”），旨在帮助设计人员开发整合了 TI 产品的 应用， 如果设计人员（个人，或如果是代表公司，则为设计人员的公司）以任何方式下载、访问或使用任何特定的 TI 资源，即表示其同意仅为该等目标，按照本通知的条款使用任何特定 TI 资源。

TI 所提供的 TI 资源，并未扩大或以其他方式修改 TI 对 TI 产品的公开适用的质保及质保免责声明；也未导致 TI 承担任何额外的义务或责任。TI 有权对其 TI 资源进行纠正、增强、改进和其他修改。除特定 TI 资源的公开文档中明确列出的测试外，TI 未进行任何其他测试。

设计人员只有在开发包含该等 TI 资源所列 TI 产品的 应用时， 才被授权使用、复制和修改任何相关单项 TI 资源。但并未依据禁止反言原则或其他法理授予您任何TI知识产权的任何其他明示或默示的许可，也未授予您 TI 或第三方的任何技术或知识产权的许可，该等产权包括但不限于任何专利权、版权、屏蔽作品权或与使用TI产品或服务的任何整合、机器制作、流程相关的其他知识产权。涉及或参考了第三方产品或服务的信息不构成使用此类产品或服务的许可或与其相关的保证或认可。使用 TI 资源可能需要您向第三方获得对该等第三方专利或其他知识产权的许可。

TI 资源系“按原样”提供。TI 兹免除对资源及其使用作出所有其他明确或默认的保证或陈述，包括但不限于对准确性或完整性、产权保证、无屡发故障保证，以及适销性、适合特定用途和不侵犯任何第三方知识产权的任何默认保证。TI 不负责任何申索，包括但不限于因组合产品所致或与之有关的申索，也不为或对设计人员进行辩护或赔偿，即使该等产品组合已列于 TI 资源或其他地方。对因 TI 资源或其使用引起或与之有关的任何实际的、直接的、特殊的、附带的、间接的、惩罚性的、偶发的、从属或惩戒性损害赔偿，不管 TI 是否获悉可能会产生上述损害赔偿，TI 概不负责。

除 TI 已明确指出特定产品已达到特定行业标准（例如 ISO/TS 16949 和 ISO 26262）的要求外，TI 不对未达到任何该等行业标准要求而承担任何责任。

如果 TI 明确宣称产品有助于功能安全或符合行业功能安全标准，则该等产品旨在帮助客户设计和创作自己的 符合 相关功能安全标准和要求的应用。在应用内使用产品的行为本身不会 配有 任何安全特性。设计人员必须确保遵守适用于其应用的相关安全要求和 标准。设计人员不可将任何 TI 产品用于关乎性命的医疗设备，除非已由各方获得授权的管理人员签署专门的合同对此类应用专门作出规定。关乎性命的医疗设备是指出现故障会导致严重身体伤害或死亡的医疗设备（例如生命保障设备、心脏起搏器、心脏除颤器、人工心脏泵、神经刺激器以及植入设备）。此类设备包括但不限于，美国食品药品监督管理局认定为 III 类设备的设备，以及在美国以外的其他国家或地区认定为同等类别设备的所有医疗设备。

TI 可能明确指定某些产品具备某些特定资格（例如 Q100、军用级或增强型产品）。设计人员同意，其具备一切必要专业知识，可以为自己的应用选择适合的 产品， 并且正确选择产品的风险由设计人员承担。设计人员单方面负责遵守与该等选择有关的所有法律或监管要求。

设计人员同意向 TI 及其代表全额赔偿因其不遵守本通知条款和条件而引起的任何损害、费用、损失和/或责任。

邮寄地址：上海市浦东新区世纪大道 1568 号中建大厦 32 楼，邮政编码：200122