UMW LMT8x

Analog Temperature Sensor with Class AB Output

1.Description

The LMT8x are a series of analog temperature sensors with negative temperature coefficients that provide an analog voltage output which is linearly proportional to the Celsius temperature. The LMT8X performs factory calibration, so no external calibration is required, with a typical accuracy of ±0.4°C at +25°C and a maximum accuracy of ±2.7°C in the temperature range from 40°C to + 125°C.

The LMT8x (the LMT8x series only include these four models) feature low-output impedance, linear output, and factory calibration, enabling significant simplification of temperature control circuits and ADC requirements. This series of sensor components can operate with a single power supply ranging from 1.5V to 5.5V. The power supply current is below 10μA, and the self-heating effect is minimal, with a temperature change of less than 0.1°C in static air.

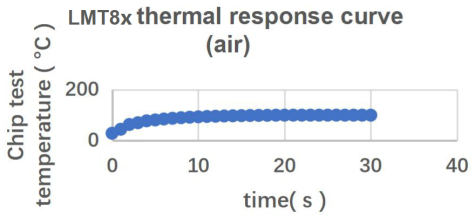
The LMT8x are available in low-cost 5-pin SOT-23 surface mount, 3-pin TO-92 and 8-pin SOIC and three packages.

2.Features

- The LMT8x are a series of analog temperature sensors with negative temperature coefficients and average sensor gains of -5.5mV/°C -8.2mV/°C, -10.9mV/°C , -13.6 mV/°C.
- Temperature range: - 55°C ~ +125°C, up to +140°C
- Temperature accuracy: ± 0.4°C (typ.)
- The output is short-circuit protected
- Power supply voltage: 2.5V ~ 5.5 V
- Low quiescent current: less than 10μA
- Analog temperature sensors compatible with LM20/19 and LM35 package

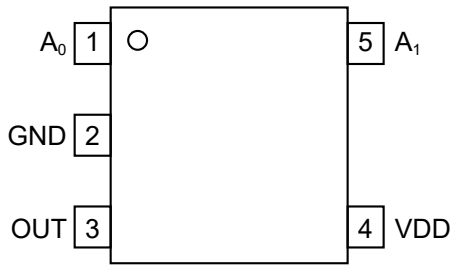
3.Applications

- Thermal management system
- Temperature control
- Home appliances

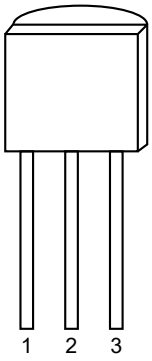


* Where X can represent 4, 5, 6, 7

4.Pinning Information



SC70-5



TO-92

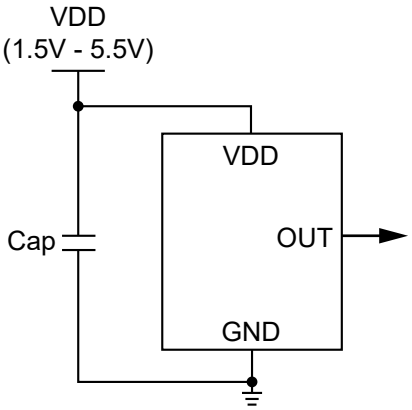


Table 1 Chip pin description

Pin name		Pin name	Description
SOT(SC70)	TO-92		
1	/	A_0	Chip enable pin 0
2	3	GND	Ground
3	2	OUT	Analog voltage output
4	1	VDD	Chip power supply port
5	/	A_1	Chip enable pin 1

Table 2 Description of theLMT8x SOT (SC70) package and connections of pin A0 and A1

SOT(SC70)	Chip model and corresponding connection method			
	LMT84	LMT85	LMT86	LMT87
A_0	GND	VDD	GND	VDD
A_1	GND	GND	VDD	VDD

5.Absolute Maximum Ratings

Parameter	Min	Max	Units
Power Supply Voltage +Vs		6	V
OUT Pin	GND	VDD+0.4	V
Junction Temperature		150	°C
Storage Temperature	-60	150	°C

6.Electrostatic Protection

		Value	Units
Electrostatic Discharge Voltage	Human Body Mode (HBM), per ANSI/ESDA/JEDEC JS-001	±4000	V
	Machine Mode (MM), per JEDEC-STD Classification	±200	V

7.Recommended Operating Conditions

Parameter	Min	Typ	Max	Units
Supply Voltage (VDD) LMT 84	1.5	3.3	5.5	V
Supply Voltage (VDD) LMT 85	1.8	3.3	5.5	V
Supply Voltage (VDD) LMT 86	2.2	3.3	5.5	V
Supply Voltage (VDD) LMT 87	2.7	3.3	5.5	V
LMT8X Operating Temperature Range (TA)	-50		140	°C

Unless otherwise noted, the specifications in the above table apply within the atmospheric temperature range.

8.Electrical Characteristic

Unless otherwise specified, the following data refer to the characteristics of the chips at +25°C and the power supply voltage is within the corresponding maximum and minimum operating voltage range of each chip. (Typical working conditions are at +25°C and 3.3V.)

Parameter	Conditions	Min	Typ	Max	Units
Supply voltage range	LMT84	1.5		5.5	V
	LMT85	1.8		5.5	V
	LMT86	2.2		5.5	V
	LMT87	2.7		5.5	V
Supply current	Normal operation		5.6	9.3	μA
Temperature range	LMT 8x	-50		140	°C
LMT8X accuracy (temperature error)	+25°C, $+V_S$=3.3V		±0.4		°C
	-50°C to +140°C, $+V_S$=3.3V		±1	±2.7	°C
Supply voltage sensitivity	T_A=25°C, 3.0V<$+V_S$<5.5V		20	100	m°C/V
Scale factor	LMT84		-5.5		mV/°C
	LMT85		-8.2		mV/°C
	LMT86		-10.9		mV/°C
	LMT87		-13.6		mV/°C
Voltage linear regulation rate	LMT8X		200		μV/V
Output load current		-50		50	μA
Capacitive load drive			1100		pF
Device turn-on time	C_L=0pF - 1nF		0.7	2	ms

9.Typical Characteristic

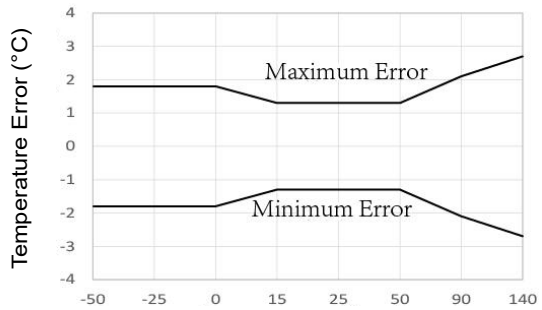


Figure 1: Temperature Error vs Temperature

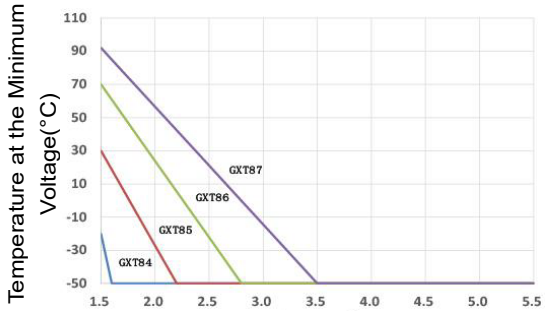


Figure 2: Operating Temperature vs Minimum Operating Voltage



Figure 3: Operating Current vs Operating Temperature

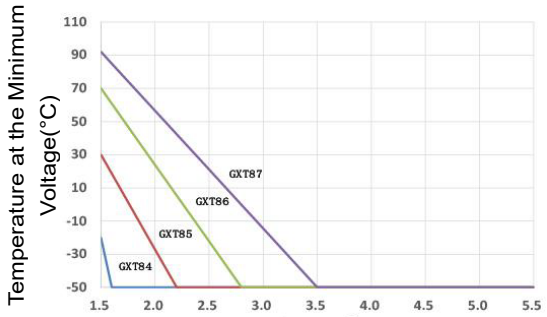


Figure 4: Operating Current vs Operating Voltage

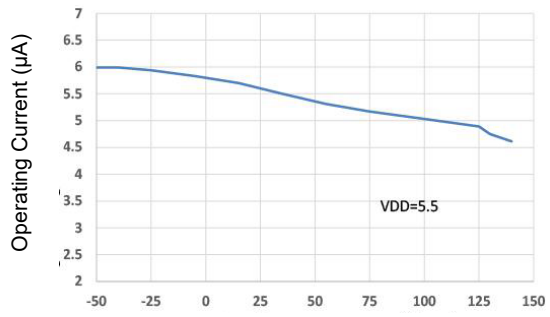


Figure 5: Current Load Adjustment

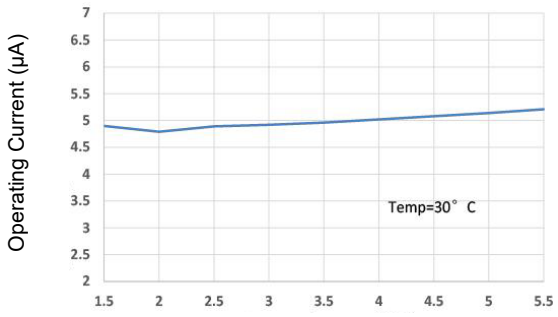


Figure 6: Sample test

10.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
-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

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)
-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	-	-
-18	1711	22	1389	62	1059	102	720	-	-
-17	1703	23	1381	63	1051	103	711	-	-
-16	1695	24	1373	64	1042	104	702	-	-
-15	1687	25	1365	65	1034	105	694		
-14	1679	26	1356	66	1025	106	685	-	-
-13	1671	27	1348	67	1017	107	677	-	-
-12	1663	28	1340	68	1008	108	668	-	-
-11	1656	29	1332	69	1000	109	660	-	-

11.Transfer Function

Table 3 gives the output voltage values corresponding to different temperatures for the LMT8X series products, and this data can be used for look-up

Table 3, LMT8X temperature and output voltage relationship.

Ambient	VOUT Output Voltage (mV)			
Temperature (°C)	LMT84	LMT85	LMT86	LMT87
-50	1299	1955	2616	3277
-40	1247	1885	2522	3160
-30	1194	1806	2418	3030
-20	1141	1727	2313	2899
-10	1088	1648	2207	2767
0	1034	1567	2100	2633
10	980	1486	1993	2500
20	925	1405	1885	2365
30	871	1324	1777	2231
40	816	1242	1668	2095
50	760	1159	1558	1958
60	704	1076	1448	1819
70	647	991	1335	1679
80	591	907	1223	1539
90	534	822	1110	1399
100	476	737	997	1257
110	419	651	883	1115
120	361	565	769	973
130	302	478	653	829
140	243	390	537	684

Although the output curve of the L0T8X series sensor is relatively linear, as can be seen from Table 3. The output voltage of the sensor be approximately expressed by the following equation:

The approximate formula for calculating the temperature of the LMT84 is as follows:

$$V_{OUT}=870.6mV-[5.506\ \frac{mV}{°C}\ (T-30°C)]-0.00176\ \frac{mV}{°C^2}\ (T-30°C)^2 \quad (1)$$

$$T_{84}=\frac{5.506-\sqrt{(5.506)^2+4x0.00176x(870.6-V_{OUT}(mV))}}{2\times(-0.00176)}+30 \quad (2)$$

If the temperature range is not wide (e.g., 0-50°C), the following equivalent formula can also be used to calculate temperature.

$$T_{84}=\frac{V_{OUT}(mV)-1035mV}{-55mV/°C} \quad (3)$$

The approximate formula for calculating the temperature of LMT85 is as follows

$$V_{OUT}=1324.0mV-[8.194\ \frac{mV}{°C}\ (T-30°C)]-0.00262\ \frac{mV}{°C^2}\ (T-30°C)^2 \quad (4)$$

$$T_{85}=\frac{8.194-\sqrt{(8.194)^2+4x0.00262x(1324-V_{OUT}(mV))}}{2\times(-0.00262)}+30 \quad (5)$$

If the temperature range is not wide (e.g., 0-50°C), the following equivalent formula can also be used to calculate temperature.

$$T_{85}=\frac{V_{OUT}(mV)-1569mV}{-8.2mV/°C} \quad (6)$$

The approximate formula for calculating the temperature of the LMT86 is as follows:

$$V_{OUT}=1777.3mV-[10.888\ \frac{mV}{°C}\ (T-30°C)]-0.00347\ \frac{mV}{°C^2}\ (T-30°C)^2 \quad (7)$$

$$T_{86}=\frac{10.888-\sqrt{(10.888)^2+4x0.00347x(1777.3-V_{OUT}(mV))}}{2\times(-0.00347)}+30 \quad (8)$$

If the temperature range is not wide (e.g., 0-50°C), the following equivalent formula can also be used to calculate temperature.

$$T_{86}= \frac{V_{OUT}(mV)-2103mV}{-10.9mV/°C} \quad (9)$$

The approximate formula for calculating the temperature of the LMT87 is as follows:

$$V_{OUT}=2230.8mV-[13.582 \frac{mV}{°C} (T-30°C)]-0.00433 \frac{mV}{°C^2} (T-30°C)^2 \quad (10)$$

$$T_{87}= \frac{13.582-\sqrt{(13.582)^2+4x0.00433x(2230.8-V_{OUT}(mV))}}{2\times(-0.00433)} +30 \quad (11)$$

If the temperature range is not wide (e.g., 0-50°C), the following equivalent formula can also be used to calculate temperature.

$$T_{87}= \frac{V_{OUT}(mV)-2637mV}{-13.6mV/°C} \quad (12)$$

12.Thermal Conduction And Installation Notes

To ensure good thermal conductivity of the L0T8X sensor, the back of the chip can be directly connected to the GND pin. At same time, the temperature of the solder pad and trace of other pins (pins) of the LMT8X will also affect the temperature reading. According to the requirements, the customer made the LMT8X into a sealed metal probe for measuring the temperature of the liquid. As with other IC applications, the LMT8X its accompanying wiring and circuitry must remain insulated and dry to avoid leakage and corrosion. In this application scenario, some protective measures are needed to prevent short circuits or damage to the, which can cause the LMT8X to operate abnormally. The formula for chip self-heating is as follows:

$T_J=T_A+\phi_{JA}[V_{DD}xI_D+(V_{DD}-V_{OUT})xI_L]$

T_J Temperature of the chip after self-heating

T_A For ambient temperature

ϕ_{JA} Thermal resistance

V_{DD} Supply voltage

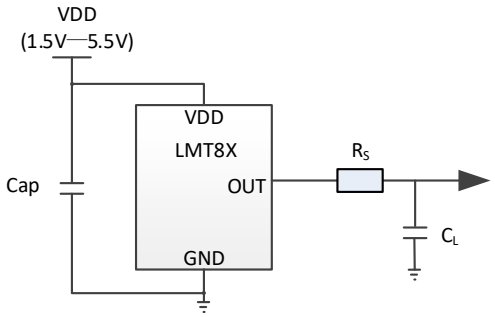
I_D Chip power consumption

V_{OUT} Chip output voltage

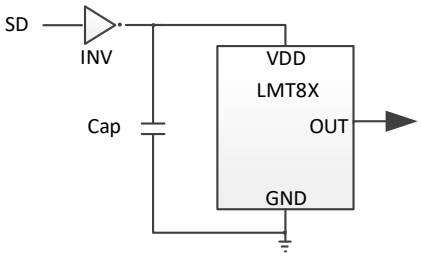
I_L Voltage output from the output pin

For example, for SOT(5), T_A=30°C, ϕ_{JA}=300 $\frac{°C}{W}$,V_{DD}=5V, I_D=5.4μA, V_{OUT}=1.7V, I_L=0μA, is calculated T=30.008°C, indicating that the chip self-heating caused a temperature rise of 0.008°C.

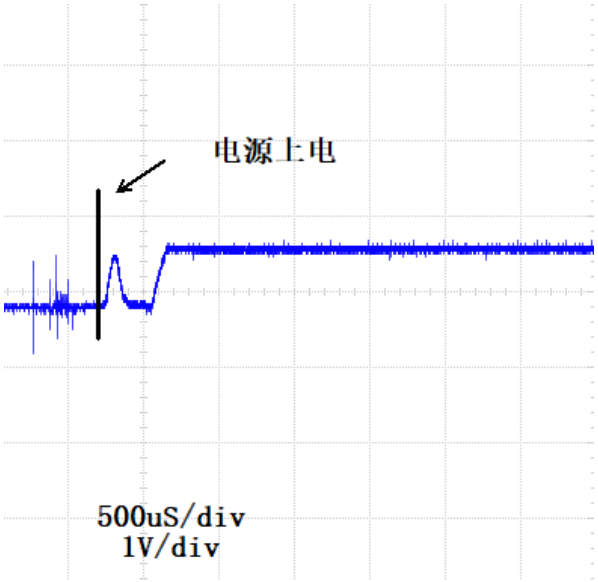
13.Filtering And Low-power Applications



LMT8X with filter capacitors application



LMT8X low power consumption application

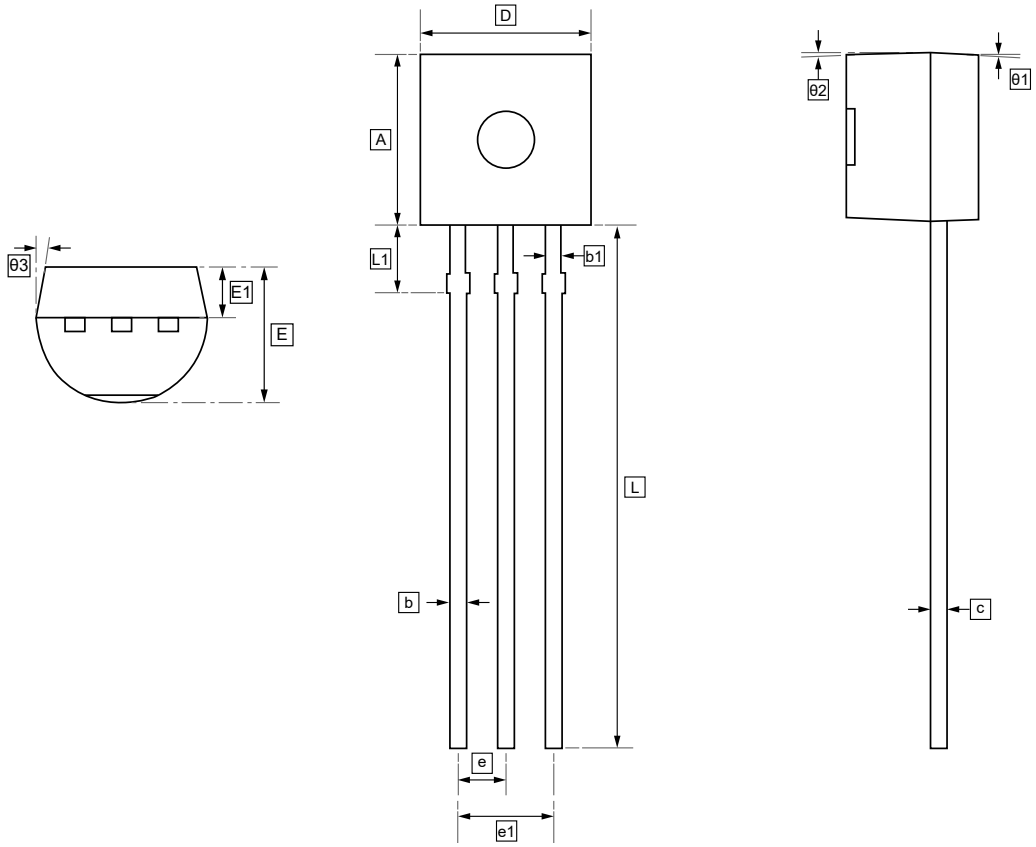


LMT8X start-up response diagram

Peripheral Circuit Recommended Value

C_L	Minimum Resistance R_S	Cap
<1.1nF	0kΩ	0.1μF
1.1nF—99nF	3kΩ	0.1μF
100nF—999nF	1.5kΩ	0.1μF
>1μF	800Ω	0.1μF

14.1 TO-92 Package Outline Dimensions

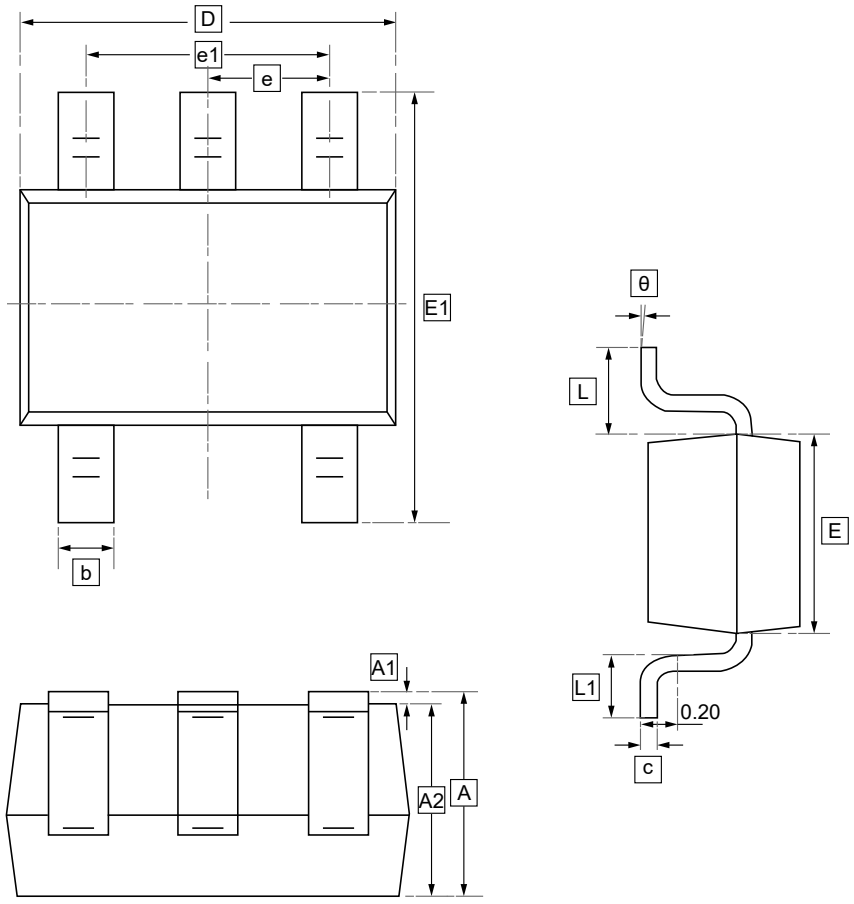


DIMENSIONS (mm are the original dimensions)

Symbol	A	b	b1	c	D	E	E1	e	e1	L	L1	θ1
Min	4.5	0.38	0.46	0.36	4.5	3.45	1.2	1.27	2.54	13.5	1.96	2°
Max	4.7	0.56		0.51	4.7	3.75	1.4			15.3		

Symbol	θ2	θ3
Min	2°	5°
Max		

14.2 SC70-5 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

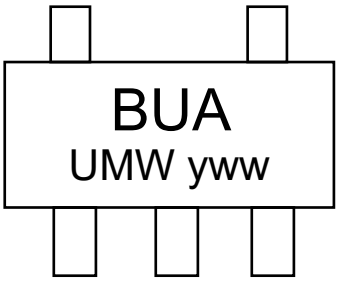
Symbol	A	A1	A2	b	c	D	E	E1	e	e1	L	θ
Min	0.90	0.00	0.90	0.15	0.08	1.80	1.15	2.15	0.65	1.20	0.26	7°
Max	1.10	0.10	1.00	0.35	0.15	2.25	1.35	2.45	TYP	1.40	0.46	REF.

15.Ordering Information

TO-92



SC70-5



yy: Year Code
ww: Week Code

Order Code	Marking	Package	Base QTY	Delivery Mode
UMW LMT84LP	LMT84	TO-92	2000	Bulk bag
UMW LMT85LP	LMT85	TO-92	2000	Bulk bag
UMW LMT86LP	LMT86	TO-92	2000	Bulk bag
UMW LMT87LP	LMT87	TO-92	2000	Bulk bag
UMW LMT84DCKR	BNA	SC70-5	3000	Tape and reel
UMW LMT85DCKR	BPA	SC70-5	3000	Tape and reel
UMW LMT86DCKR	BSA	SC70-5	3000	Tape and reel
UMW LMT87DCKR	BUA	SC70-5	3000	Tape and reel

16.Disclaimer

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