TOKO

TK11052

THERMOSTAT IC

FEATURES

- **Internal Temperature Sensor, Voltage Reference and Two Comparators with**
- **Temperature Threshold and Hysteresis Set by Only Two External Resistors**
- **Output Logic:**
  Low to High with Increasing Temp. by OUTPUT1
  High to Low with Increasing Temp. by OUTPUT2
- **Very Wide Operating Supply Range (V_{CC} = 2.7 to 6.0 V)**
- **Miniature Package (SOT23L-8)**
- **Minimum External Parts Count**
- **Low Power Consumption**
- **Very Wide Temperature Range**

APPLICATIONS

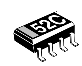
- **Home and Industrial Thermostats**
- **Home Appliance Temperature Control**
- **Notebook Computer Temperature Monitor**
- **Pentium Processor Temperature Monitor**
- **Power Supply Overtemperature Protection**
- **Copy Machine Overtemperature Protection**
- **System Overtemperature Protection**

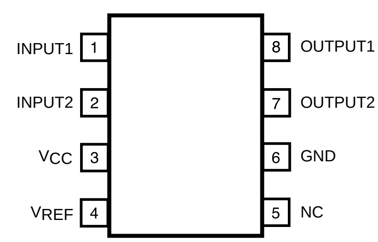
DESCRIPTION

The TK11052 is an accurate temperature controller IC for use over the -30 to +105 °C temperature range. The TK11052 monolithic bipolar integrated circuit contains a temperature sensor, stable voltage reference and two comparators, making the device very useful as an on/off thermostat. Two external resistors easily set the sensing temperature threshold and hysteresis of each thermostat. Its wide operating voltage range of 2.7 to 6.0 V makes this IC suitable for a number of applications requiring an accurate thermostat.

The TK11052 is available in a miniature SOT23L-8 surface mount package.

TK11052





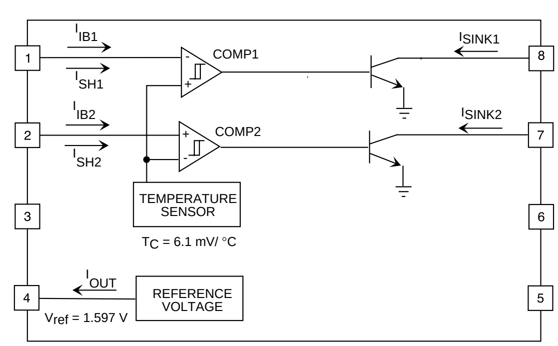
ORDERING INFORMATION

TK11052MTL

Tape/Reel Code

TAPE/REEL CODE
TL: Tape Left

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Supply Voltage .... 10 V
Power Dissipation .... 200 mW
Storage Temperature Range .... -55 to +150 °C
Operating Temperature Range ....-30 to +105 °C
Operating Voltage Range.............................. 2.7 to 6.0 V
Junction Temperature .... 150 °C
Lead Soldering Temperature (10 s) .... 235 °C

TK11052 ELECTRICAL CHARACTERISTICS

Test conditions: T_A = 25 °C, V_{CC} = 3.0 V, I_{OUT} = 80 µA, R_{OUT1} = 300 kΩ, R_{OUT2} = 300 kΩ, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
I_{CC}	Supply Current	OUT1: C_{LH}, OUT2: C_{LL}		280	350	µA
V_{ref}	Reference Voltage	(Pin 4)		1.597		V
I_{OUT}	Output Current (V_{ref})	Load Reg < 12 mV (Pin 4)		80	500	µA
Line Reg	Line Regulation (V_{ref})	V_{CC} = 3 V to 6 V (Pin 4)	-9	0	+9	mV
Load Reg	Load Regulation (V_{ref})	I_{OUT} = 0 µA to 500 µA (Pin 4)		3	12	mV
V_{TEMP}	Temperature Sensor (internal)	T_A = 25 ° C		645		mV
		T_A = 85 ° C		1011		mV
		T_A = 0 ° C		492.5		mV
T_C	Temperature Coefficient (internal)	T_A = 0 ° C to 85 ° C		6.1		mV/° C
T_{ERR}	Total Temperature Error	T_A = 0 ° C to 85 ° C (Note 1)	-4.0	0	4.0	° C
C_{LH}	Comparator Output High Level	(Note 2)	2.8			V
C_{LL}	Comparator Output Low Level	I_{SINK} ≤ 500 µA (Note 2)			0.3	V
I_{IB1}	Input Bias Current 1	OUT1: C_{LH}	-50	0	50	nA
I_{SH1}	Hysteresis Set Current 1	OUT1: C_{LL}	0.9	1.35	1.8	µA
I_{IB2}	Input Bias Current 2	OUT2: C_{LL}	-50	0	50	µA
I_{SH2}	Hysteresis Set Current 2	OUT2: C_{LH}	0.9	1.35	1.8	µA
I_{SINK}	Output Sink Current	C_{LL} ≤ 0.3 V, (Pin 7, Pin 8)		10	500	µA

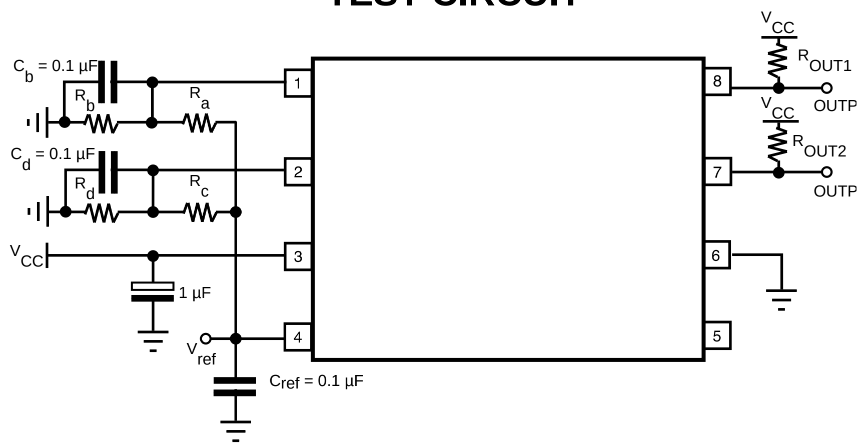
Note 1: This spec. is an error between a temp. to which the comparator reverses and a set temp. The resistance values of R_a, R_b, R_c, R_d can be calculated as follows:

$$R_a \text{ or } R_c = \frac{V_{REF} \times T_{SM} \times T_C}{(0.4925 + T_{SET} \times T_C) \times I_{SH}}$$

$$R_b \text{ or } R_d = \frac{V_{REF} \times T_{SH} \times T_C}{(V_{REF} - 0.4925 - T_{SET} \times T_C) \times I_{SH}}$$

Note 2: When V_{TEMP} < INPUT1, OUTPUT1 > 2.8 V (C_{LH}). When V_{TEMP} > INPUT1, OUTPUT1 < 0.3 V (C_{LL}).
When V_{TEMP} < INPUT2, OUTPUT2 < 0.3 V (C_{LL}). When V_{TEMP} > INPUT2, OUTPUT2 > 2.8 V (C_{LH}).

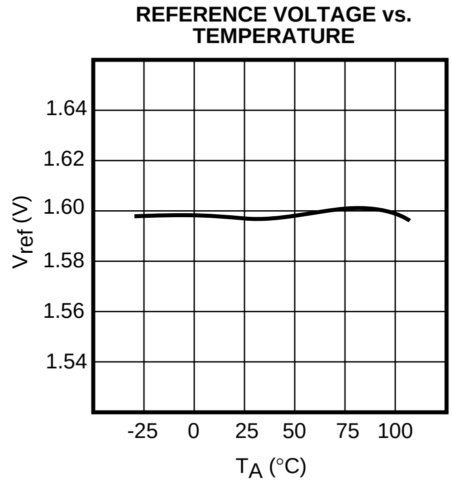
TEST CIRCUIT

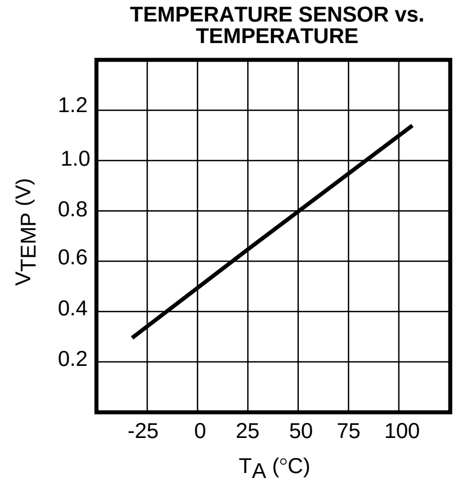


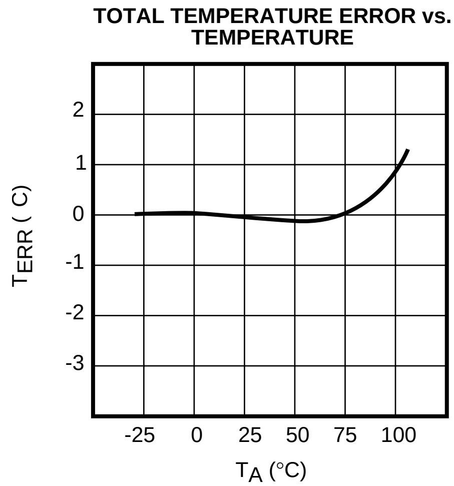
Note: For information on C_b and C_d, see Applications Hints Section.

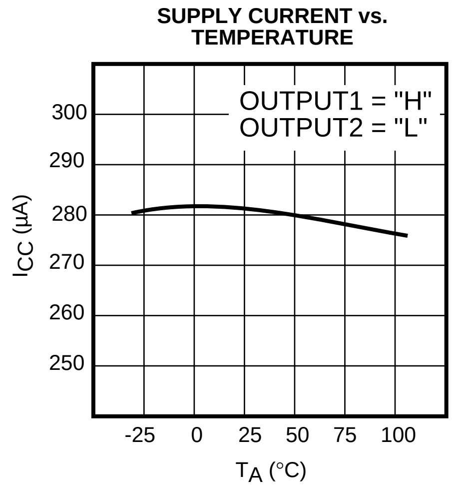
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

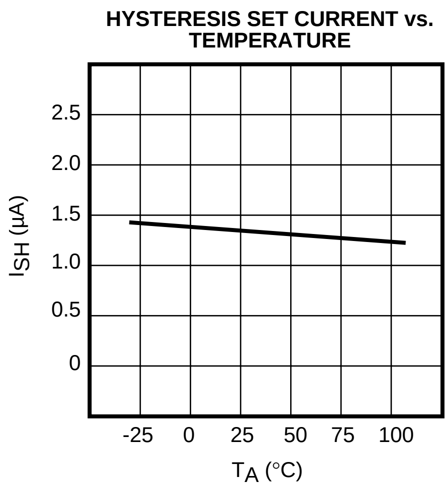
T_A = 25 °C, V_{CC} = 3 V, I_{OUT} = 80 µA, unless otherwise specified.

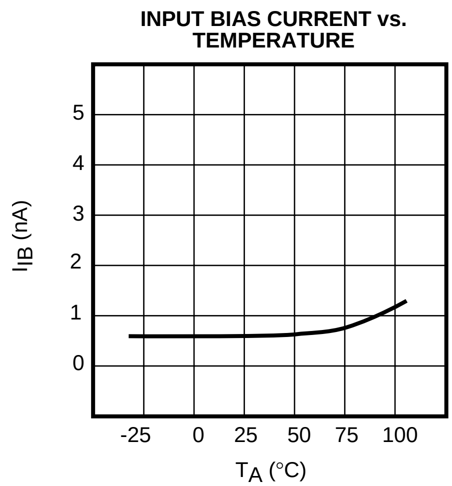






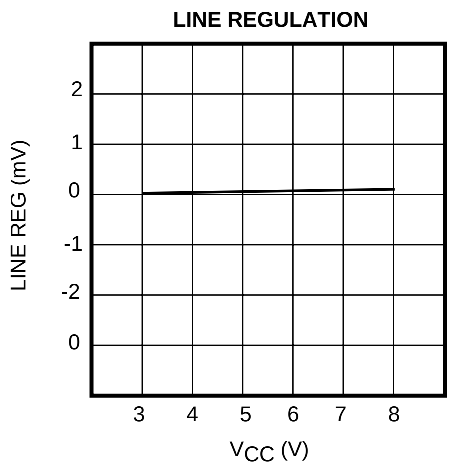


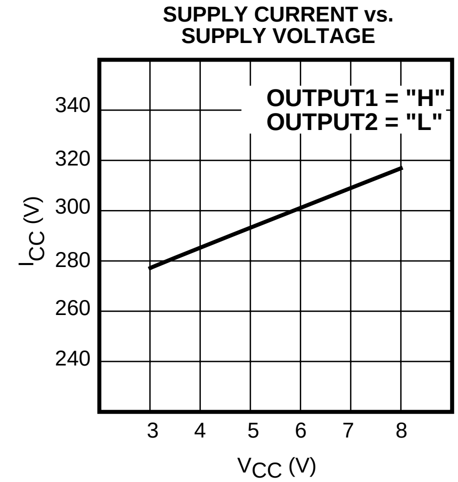


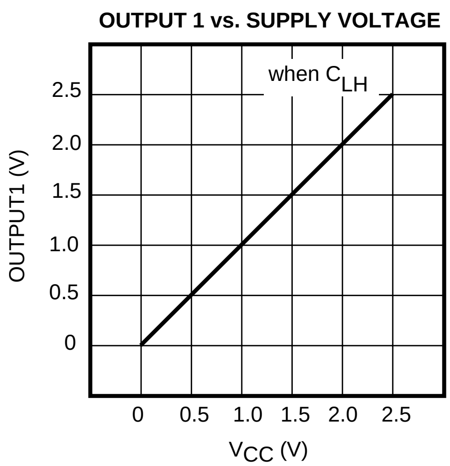


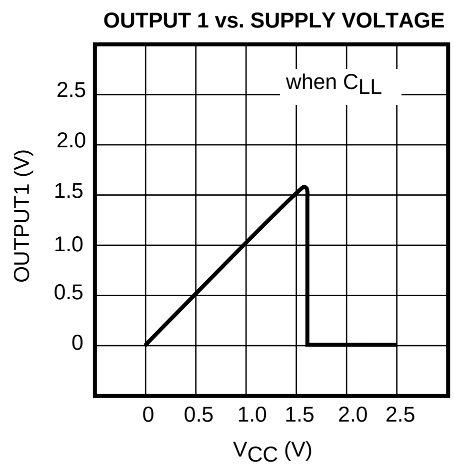
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

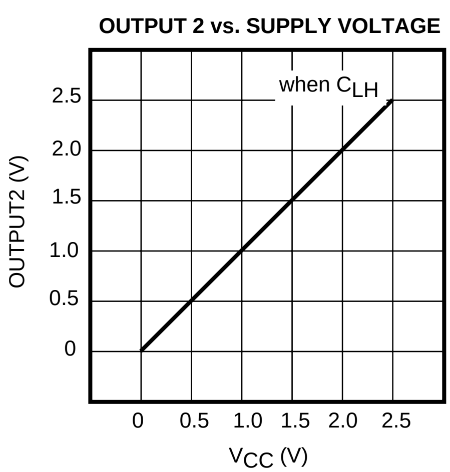
T_A = 25 °C, V_{CC} = 3 V, I_{OUT} = 80 µA, unless otherwise specified.

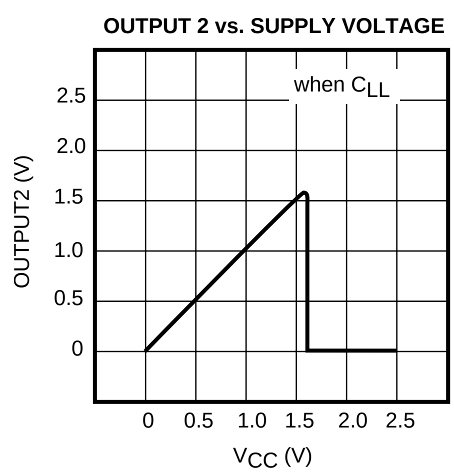








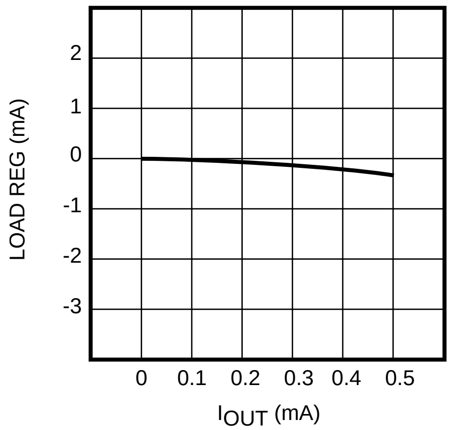




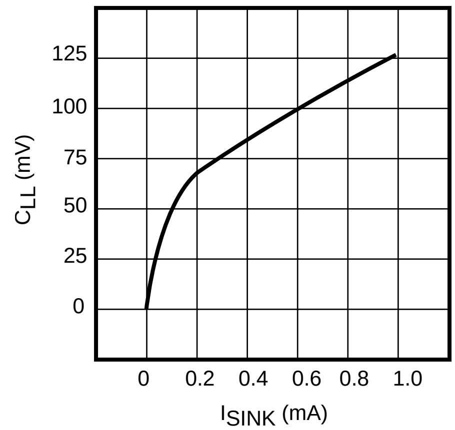
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

T_A = 25 °C, V_{CC} = 3 V, I_{OUT} = 80 µA, unless otherwise specified.

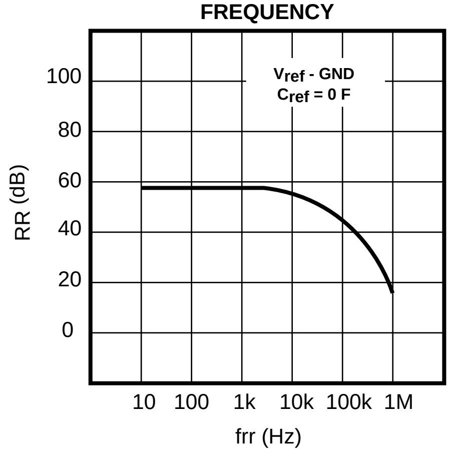
LOAD REGULATION



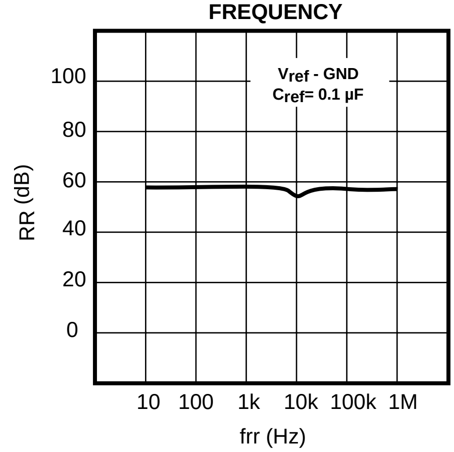
COMPARATOR OUTPUT LOW LEVEL vs. OUTPUT SINK CURRENT



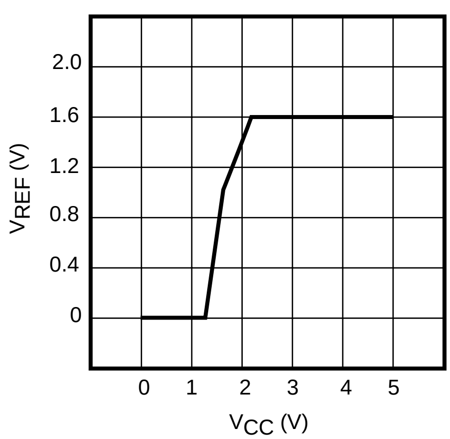
RIPPLE REJECTION (V_{ref}) vs. FREQUENCY



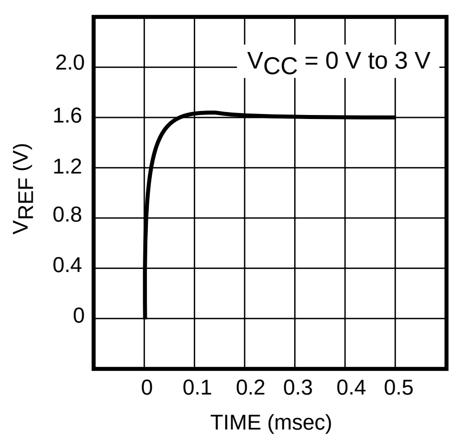
RIPPLE REJECTION (V_{ref}) vs. FREQUENCY



REFERENCE VOLTAGE vs. SUPPLY VOLTAGE



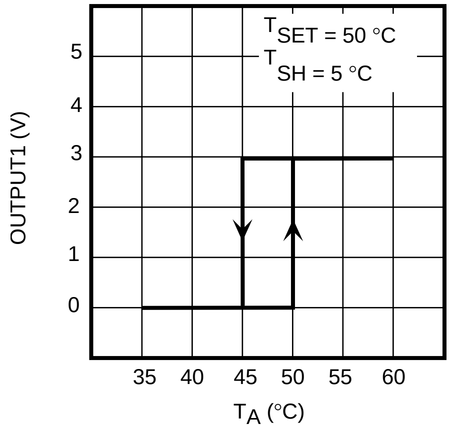
SUPPLY VOLTAGE RESPONSE



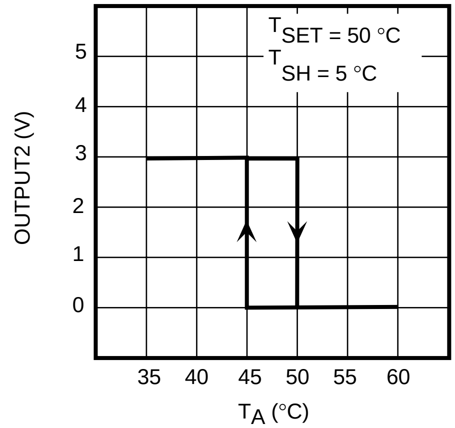
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

T_A = 25 °C, V_{CC} = 3 V, I_{OUT} = 80 µA, unless otherwise specified.

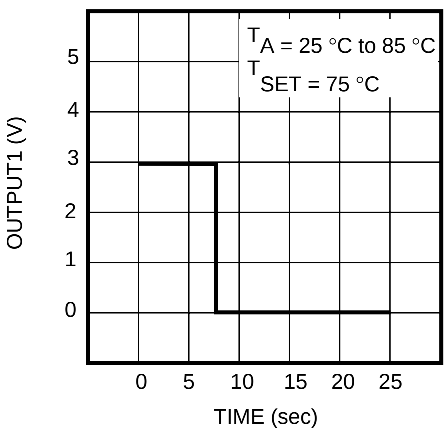
OUTPUT 1 vs. TEMPERATURE



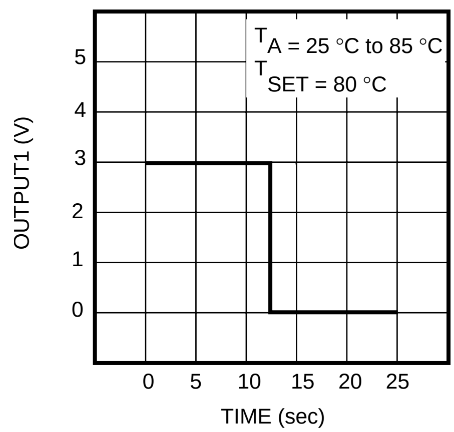
OUTPUT 2 vs. TEMPERATURE



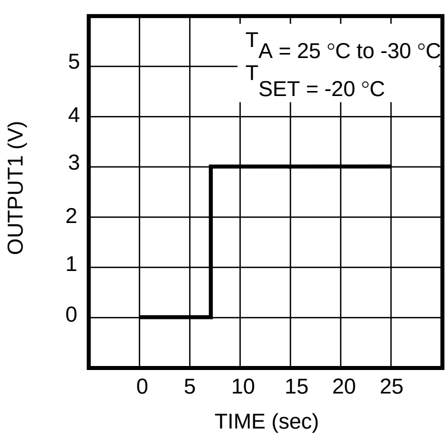
TEMPERATURE RESPONSE A



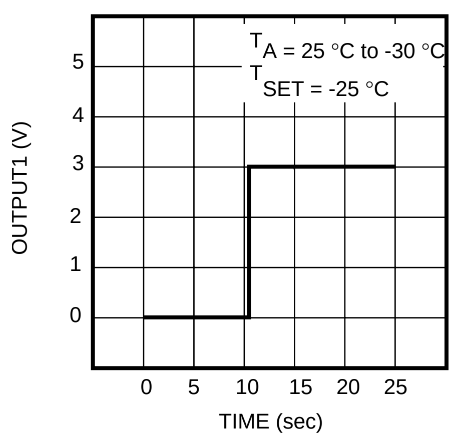
TEMPERATURE RESPONSE B



TEMPERATURE RESPONSE C



TEMPERATURE RESPONSE D



APPLICATION HINTS

EXTERNAL RESISTORS R_a , R_b , R_c , and R_d

The temperature set point (T_{SET}) and hysteresis (T_{SH}) of the TK11052 are easily set by external resistors R_a , R_b , R_c , and R_d. See Figure 1 for clarification of T_{SET} and T_{SH}.

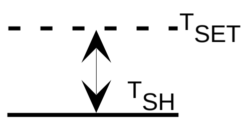


FIGURE 1

The set voltage (V_{SET}) of the comparator at the set temperature (T_{SET}) is calculated as follows:

(1) $$V_{SET} = 0.4925 + T_{SET} \times T_C$$

where T_C = 6.1 mV/°C

1. For Set Temperatures ≥ 25 °C

The set voltage (V_{SET}) of the comparator at the reference voltage and external resistances is calculated as follows:

(2) $$V_{SET} = \frac{R_b}{R_a + R_b} \times V_{REF}$$

Rb is calculated by Equations (1) and (2), resulting in:

(3) $$R_b = \frac{0.4925 + T_{SET} \times T_C}{V_{REF} - 0.4925 - T_{SET} \times T_C} \times R_a$$

The hysteresis voltage (V_{SH}) of the comparator can be calculated as follows:

(4) $$V_{SH} = \left(\frac{R_a \times R_b}{R_a + R_b}\right) \times I_{SH}$$

where I_{SH} = 1.35 µA

Rb is calculated by Equation (4)

(5) $$R_b = \frac{R_a \times V_{SH}}{R_a \times I_{SH} - V_{SH}}$$

Ra is calculated by Equations (3) and (5)

(6) $$R_a = \frac{V_{ref} \times T_{SH} \times T_C}{(0.4925 + T_{SET} \times T_C) \times I_{SH}}$$

$$= \frac{1.597 \times T_{SH} \times 6.1\ m}{(0.4925 + T_{SET} \times 6.1\ m) \times 1.35\ \mu}$$

$$\approx \frac{1183 \times T_{SH}}{80.74 + T_{SET}} \times 10^3$$

where I_{SH} = 1.35 µA, T_C = 6.1 mV and V_{REF} = 1.597 V

Rb is calculated by Equations (3) and (6)

(7) $$R_b = \frac{V_{ref} \times T_{SH} \times T_C}{(VREF - 0.4925 - T_{SET} \times T_C) \times I_{SH}}$$

$$= \frac{1.597 \times T_{SH} \times 6.1\ m}{(1.597 - 0.4925 - T_{SET} \times 6.1\ m) \times 1.35\ \mu}$$

$$\approx \frac{1183 \times T_{SH}}{181.07 - T_{SET}} \times 10^3$$

Example:

R_a and R_b when set temperature is 85 °C and temperature hysteresis is 5 °C.

$$R_a = \frac{1183 \times T_{SH}}{80.74 + T_{SET}} \times 10^3 = \frac{1183 \times 5}{80.74 + 85} \times 10^3$$

$$= 35.69\ k \approx 36\ k\Omega$$

$$R_b = \frac{1183 \times T_{SH}}{181.07 - T_{SET}} \times 10^3 = \frac{1183 \times 5}{181.07 - 85} \times 10^3$$

$$= 61.57\ k \approx 62\ k\Omega$$

2. For Set Temperatures < 25 °C

(8) $$R_a = \frac{V_{REF} \times T_{SH} \times T_C}{(0.4925 + T_{SET} \times T_C - T_{SH} \times T_C) \times I_{SH}}$$

$$= \frac{1183 \times T_{SH}}{80.74 + (T_{SET} - T_{SH})} \times 10^3$$

APPLICATION HINTS (CONT.)

(9)
$$R_b = \frac{V_{REF} \times T_{SH} \times T_C}{(0.4925 + T_{SET} \times T_C - T_{SH} \times T_C) \times I_{SH}} = \frac{1183 \times T_{SH}}{181.07 - (T_{SET} - T_{SH})} \times 10^3$$

Example:
R_a and R_b when set temperature is 0 °C and temperature hysteresis is 5 °C.

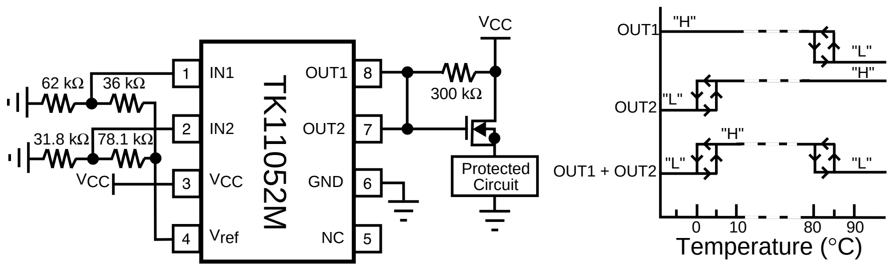
$$R_a = \frac{1183 \times T_{SH}}{80.74 + (T_{SET} - T_{SH})} \times 10^3 = 78.096 \times 10^3 \approx 78.1\ k\Omega$$

$$R_b = \frac{1183 \times T_{SH}}{181.07 - (T_{SET} - T_{SH})} \times 10^3 = 31.789 \times 10^3 \approx 31.8\ k\Omega$$

Thermostat IC Application

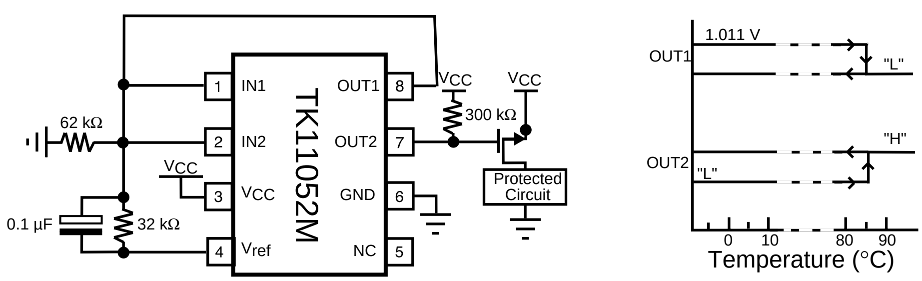
Example:
- WINDOW TYPE OUTPUT

The following application protects the circuit within the operating temperature range of 0 to 85 °C. When the temperature is 0 °C or less, or 85 °C or more, the N channel Mos transistor is turned OFF.
When the temperature returns to between 5 and 80 °C by the hysteresis function, the N channel Mos transistor is turned ON.



- TEMPERATURE FUSE

The following application is a temperature fuse circuit. The output of the TK11052M becomes a High Level when the surrounding temperature exceeds 85 °C and the P channel Mos transistor is turned off. Even if the surrounding temperature drops, the P channel Mos transistor remains off.

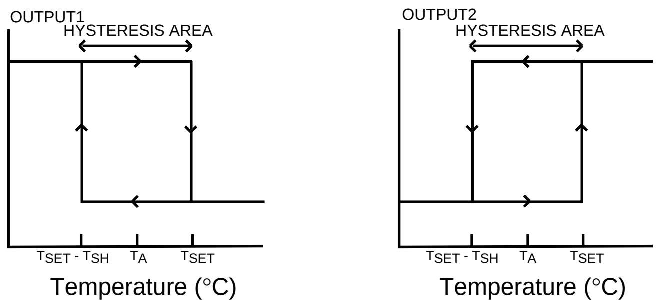


APPLICATION HINTS (CONT.)

Comparator Output Level in the Hysteresis Area

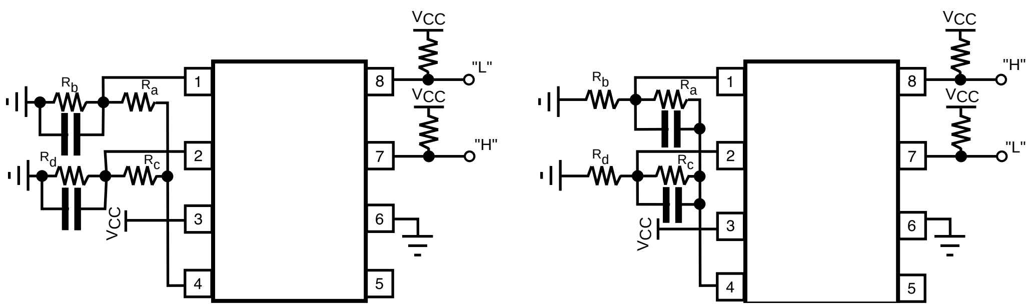
When the power supply voltage is applied with the ambient temperature in the hysteresis area, the state of the comparator output level is uncertain.

A capacitor is connected between Pin1 (Pin 2) to GND or Pin 4 to Pin 1 (Pin 2) to fix the comparator output level.



Pin1 to GND — OUTPUT1: Low Level
Pin 2 to GND — OUTPUT2: High Level

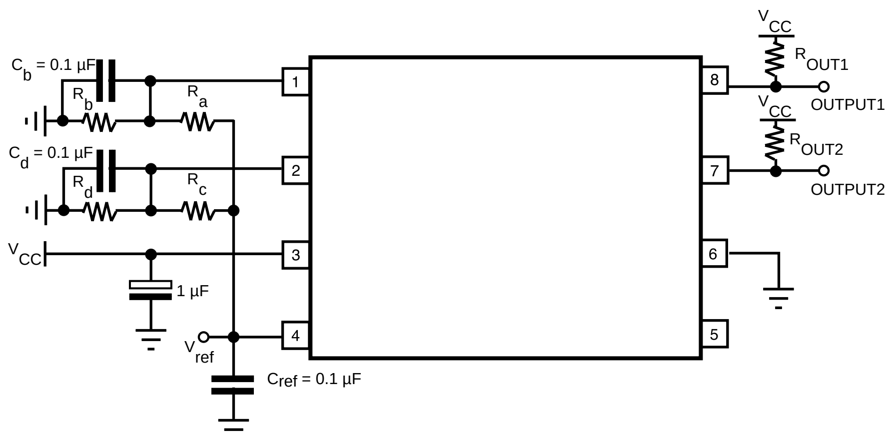
Pin 1 to Pin 4 — OUTPUT1: High Level
Pin 2 to Pin 4 — OUTPUT 2: Low Level
See following



APPLICATION HINTS (CONT.)

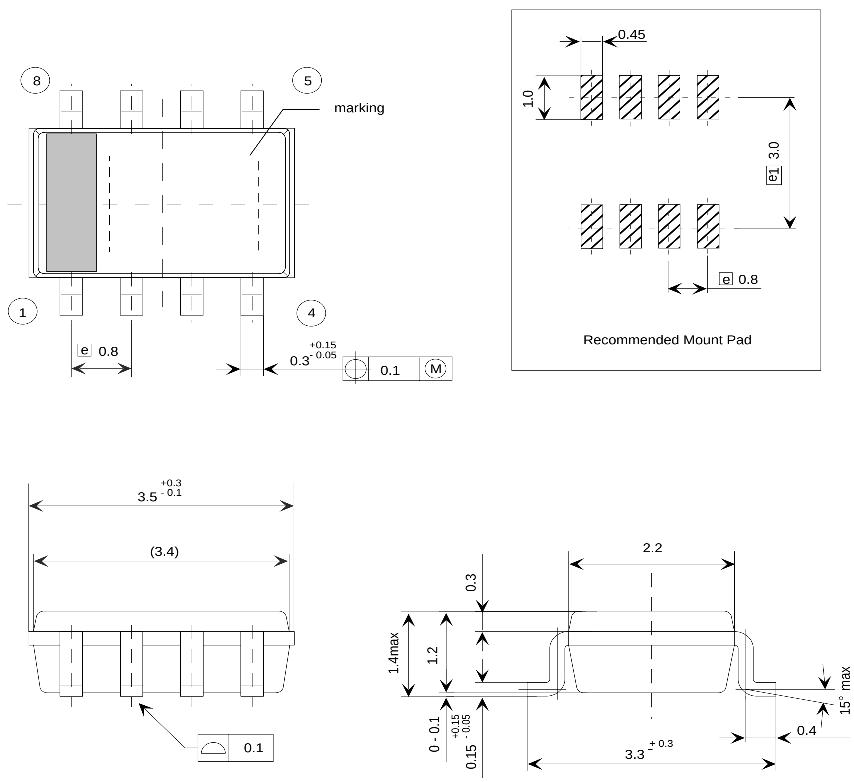
Noise Reduction

When the thermostat IC is operated in a noisy environment (e.g., motor, fan, etc.), the noise on the signal lines may exceed the limits of the comparator hysteresis window. This results in erratic comparator output levels. This can be corrected by adding 0.1 µF capacitors from Pin 1 to GND (or Pin 4), Pin 2 to GND (or Pin 4), and Pin 4 to GND as shown below. The configuration is determined by the desired comparator output level during power-up in the hysteresis area as described earlier.



PACKAGE OUTLINE

SOT-23L (SOT23L-8)



Dimensions are shown in millimeters
Tolerance: x.x = ± 0.2 mm (unless otherwise specified)

Marking Information

	Marking
TK11052	52C

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