

TMP36: Voltage Output Temperature Sensors

Product Description

The TMP35, TMP36 and TMP37 are low voltage, precision centigrade temperature sensors. They provide a voltage output that is linearly proportional to the Celsius (Centigrade) temperature. The TMP35/TMP36/TMP37 do not require any external calibration to provide typical accuracies of $\pm 1^\circ\text{C}$ at $+25^\circ\text{C}$ and $\pm 2^\circ\text{C}$ over the -40°C to $+125^\circ\text{C}$ temperature range.

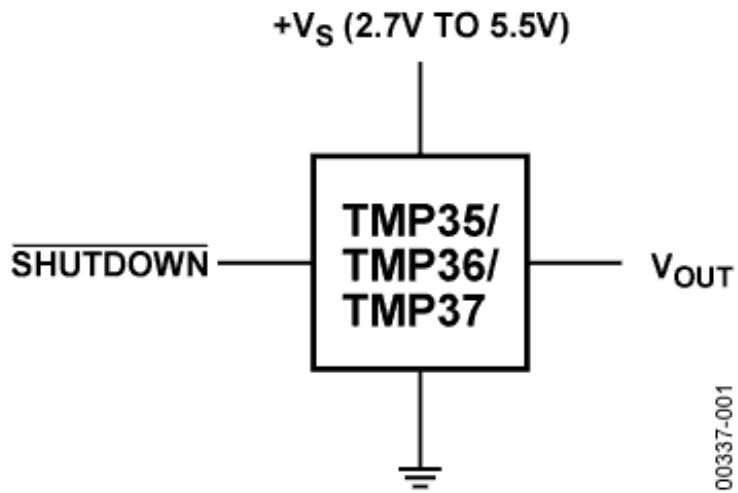
The low output impedance of the TMP35/TMP36/TMP37, and its linear output and precise calibration simplify interfacing to temperature control circuitry and A/D converters. All three devices are intended for single-supply operation from 2.7 V to 5.5 V maximum. Supply current runs well below 50 μA providing very low self-heating – less than 0.1°C in still air. In addition, a shutdown function is provided to cut supply current to less than 0.5 μA .

The TMP35 is functionally compatible with the LM35/LM45 and provides a 250 mV output at $+25^\circ\text{C}$. The TMP35 reads temperatures from $+10^\circ\text{C}$ to $+125^\circ\text{C}$. The TMP36 is specified from -40°C to $+125^\circ\text{C}$, provides a 750 mV output at $+25^\circ\text{C}$ and operates to $+125^\circ\text{C}$ from a single 2.7 V supply. The TMP36 is functionally compatible with the LM50. Both the TMP35 and TMP36 have an output scale factor of $+10\text{ mV}/^\circ\text{C}$. The TMP37 is intended for applications over the range $+5^\circ\text{C}$ to $+100^\circ\text{C}$, and provides an output scale factor of $20\text{ mV}/^\circ\text{C}$. The TMP37 provides a 500 mV output at $+25^\circ\text{C}$. Operation extends to $+150^\circ\text{C}$ with reduced accuracy for all devices when operating from a 5 V supply.

The TMP35/TMP36/TMP37 are all available in low cost 3-pin TO-92, and SO-8 and 5-pin SOT-23 surface mount packages.

Features

- Low Voltage Operation ($+2.7\text{ V}$ to $+5.5\text{ V}$)
- Calibrated Directly in $^\circ\text{C}$
- $10\text{ mV}/8^\circ\text{C}$ Scale Factor ($20\text{ mV}/8^\circ\text{C}$ on TMP37)
- $\pm 2^\circ\text{C}$ Accuracy Over Temperature (typ)
- $\pm 0.5^\circ\text{C}$ Linearity (typ)
 - Stable with Large Capacitive Loads
 - Specified -40°C to $+125^\circ\text{C}$, Operation to $+150^\circ\text{C}$
 - Less than $50\ \mu\text{A}$ Quiescent Current
 - Shutdown Current $0.5\ \mu\text{A}$ max



00337-001

Functional Block Diagram for TMP36

Specifications

Output Type	Analog
Sensor Output	+10 mV/°C
Temp Res(°C/LSB)	n/a
Supply Voltage Range	+2.7V to +5.5V
Temp Range(s)	-40 to +125

<u>Model</u>	<u>Package</u>	<u>Pins</u>	<u>ROHS Compliant</u>
TMP36FSZ	8 ld SOIC	8	Y Material Declaration
TMP36GT9Z	T092	3	Y Material Declaration

TMP35/TMP36/TMP37

FEATURES

- Low voltage operation (2.7 V to 5.5 V)
- Calibrated directly in °C
- 10 mV/°C scale factor (20 mV/°C on TMP37)
- ±2°C accuracy over temperature (typ)
- ±0.5°C linearity (typ)
- Stable with large capacitive loads
- Specified -40°C to +125°C, operation to +150°C
- Less than 50 µA quiescent current
- Shutdown current 0.5 µA max
- Low self-heating

APPLICATIONS

- Environmental control systems
- Thermal protection
- Industrial process control
- Fire alarms
- Power system monitors
- CPU thermal management

GENERAL DESCRIPTION

The TMP35, TMP36, and TMP37 are low voltage, precision, centigrade temperature sensors. They provide a voltage output that is linearly proportional to the Celsius (centigrade) temperature. The TMP35/TMP36/TMP37 do not require any external calibration to provide typical accuracies of ±1°C at +25°C and ±2°C over the -40°C to +125°C temperature range.

The low output impedance of the TMP35/TMP36/TMP37 and its linear output and precise calibration simplify interfacing to temperature control circuitry and A/D converters. All three devices are intended for single-supply operation from 2.7 V to 5.5 V maximum. The supply current runs well below 50 µA, providing very low self-heating—less than 0.1°C in still air. In addition, a shutdown function is provided to cut the supply current to less than 0.5 µA.

The TMP35 is functionally compatible with the LM35/LM45 and provides a 250 mV output at 25°C. The TMP35 reads temperatures from 10°C to 125°C. The TMP36 is specified from -40°C to +125°C, provides a 750 mV output at 25°C, and operates to 125°C from a single 2.7 V supply. The TMP36 is functionally compatible with the LM50. Both the TMP35 and TMP36 have an output scale factor of 10 mV/°C. The TMP37 is intended for applications over the range 5°C to 100°C and

provides an output scale factor of 20 mV/°C. The TMP37 provides a 500 mV output at 25°C. Operation extends to 150°C with reduced accuracy for all devices when operating from a 5 V supply.

The TMP35/TMP36/TMP37 are available in low cost 3-lead TO-92, SOIC-8, and 5-lead SOT-23 surface-mount packages.

FUNCTIONAL BLOCK DIAGRAM

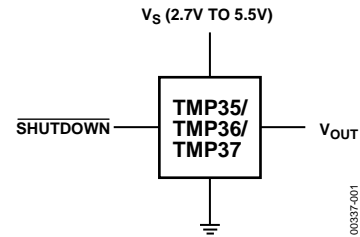


Figure 1.

PIN CONFIGURATIONS

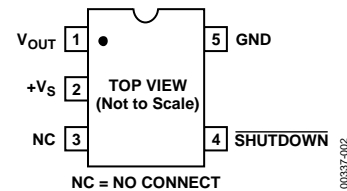


Figure 2. RT-5 (SOT-23)

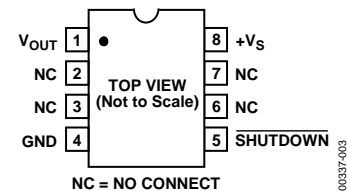


Figure 3. RN-8 (SOIC)

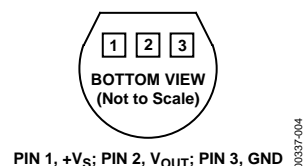


Figure 4. TO-92

SPECIFICATIONS

$V_S = 2.7\text{ V to }5.5\text{ V}$, $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$, unless otherwise noted.

Table 1.

Parameter ¹	Symbol	Conditions	Min	Typ	Max	Unit
ACCURACY						
TMP35/TMP36/TMP37F		$T_A = 25^\circ\text{C}$		± 1	± 2	$^\circ\text{C}$
TMP35/TMP36/TMP37G		$T_A = 25^\circ\text{C}$		± 1	± 3	$^\circ\text{C}$
TMP35/TMP36/TMP37F		Over rated temperature		± 2	± 3	$^\circ\text{C}$
TMP35/TMP36/TMP37G		Over rated temperature		± 2	± 4	$^\circ\text{C}$
Scale Factor, TMP35		$10^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		10		mV/ $^\circ\text{C}$
Scale Factor, TMP36		$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		10		mV/ $^\circ\text{C}$
Scale Factor, TMP37		$5^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$		20		mV/ $^\circ\text{C}$
		$5^\circ\text{C} \leq T_A \leq 100^\circ\text{C}$		20		mV/ $^\circ\text{C}$
Load Regulation		$3.0\text{ V} \leq V_S \leq 5.5\text{ V}$				
		$0\ \mu\text{A} \leq I_L \leq 50\ \mu\text{A}$				
		$-40^\circ\text{C} \leq T_A \leq +105^\circ\text{C}$		6	20	m $^\circ\text{C}/\mu\text{A}$
		$-105^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$		25	60	m $^\circ\text{C}/\mu\text{A}$
Power Supply Rejection Ratio	PSRR	$T_A = 25^\circ\text{C}$		30	100	m $^\circ\text{C}/\text{V}$
		$3.0\text{ V} \leq V_S \leq 5.5\text{ V}$		50		m $^\circ\text{C}/\text{V}$
Linearity				0.5		$^\circ\text{C}$
Long-Term Stability		$T_A = 150^\circ\text{C}$ for 1 kHz		0.4		$^\circ\text{C}$
SHUTDOWN						
Logic High Input Voltage	V_{IH}	$V_S = 2.7\text{ V}$	1.8			V
Logic Low Input Voltage	V_{IL}	$V_S = 5.5\text{ V}$			400	mV
OUTPUT						
TMP35 Output Voltage		$T_A = 25^\circ\text{C}$		250		mV
TMP36 Output Voltage		$T_A = 25^\circ\text{C}$		750		mV
TMP37 Output Voltage		$T_A = 25^\circ\text{C}$		500		mV
Output Voltage Range			100		2000	mV
Output Load Current	I_L		0		50	μA
Short-Circuit Current	I_{SC}	Note 2			250	μA
Capacitive Load Driving	C_L	No oscillations ²	1000	10000		pF
Device Turn-On Time		Output within $\pm 1^\circ\text{C}$ 100 k Ω 100 pF load		0.5	1	ms
POWER SUPPLY						
Supply Range	V_S		2.7		5.5	V
Supply Current	I_{SY} (ON)	Unloaded			50	μA
Supply Current (Shutdown)	I_{SY} (OFF)	Unloaded		0.01	0.5	μA

¹ Does not consider errors caused by self-heating.

² Guaranteed but not tested.

TMP35/TMP36/TMP37

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter ^{1,2}	Rating
Supply Voltage	7 V
Shutdown Pin	$GND \leq \overline{SHUTDOWN} \leq V_S$
Output Pin	$GND \leq V_{OUT} \leq V_S$
Operating Temperature Range	-55°C to +150°C
Die Junction Temperature	175°C
Storage Temperature Range	-65°C to +160°C
IR Reflow Soldering	
Peak Temperature	220°C (0°C/5°C)
Time at Peak Temperature	10 s to 20 s
Ramp-up Rate	3°C/s max
Ramp-down Rate	-6°C/s max
Time 25°C to Peak Temperature	6 mins max
IR Reflow Soldering—Pb-free Package	
Peak Temperature	260°C (0°C)
Time at Peak Temperature	20 s to 40 s
Ramp-up Rate	3°C/s max
Ramp-down Rate	-6°C/s max
Time 25°C to Peak Temperature	8 min max

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Package Type	θ_{JA} ¹	θ_{JC}	Unit
TO-92 (T9 Suffix)	162	120	°C/W
SOIC-8 (S Suffix)	158	43	°C/W
SOT-23 (RT Suffix)	300	180	°C/W

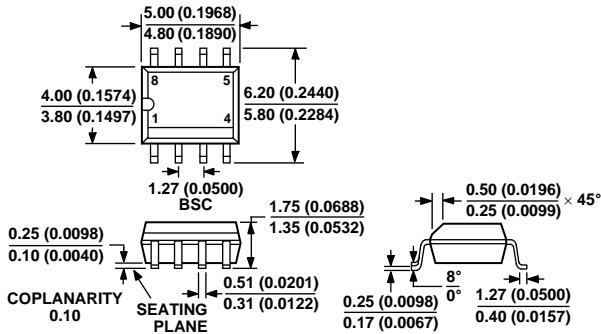
¹ θ_{JA} is specified for device in socket (worst-case conditions).

¹ Digital inputs are protected; however, permanent damage might occur on unprotected units from high energy electrostatic fields. Keep units in conductive foam or packaging at all times until ready to use. Use proper antistatic handling procedures.

² Remove power before inserting or removing units from their sockets.

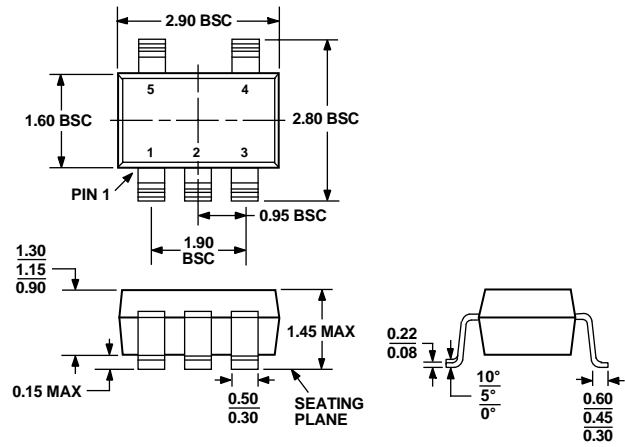
TMP35/TMP36/TMP37

OUTLINE DIMENSIONS



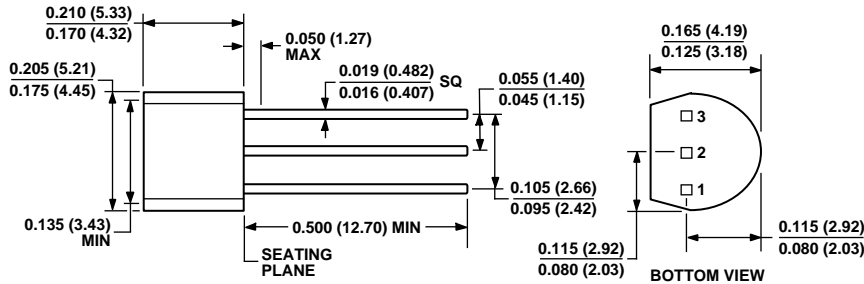
COMPLIANT TO JEDEC STANDARDS MS-012AA
 CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS
 (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR
 REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN

Figure 36. 8-Lead Standard Small Outline Package [SOIC]
 Narrow Body (RN-8)
 Dimensions shown in millimeters and (inches)



COMPLIANT TO JEDEC STANDARDS MO-178AA

Figure 37. 5-Lead Plastic Surface-Mount Package [SOT-23]
 (RT-5)
 Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS TO-226-AA
 CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS
 (IN PARENTHESES) ARE ROUNDED-OFF EQUIVALENTS FOR
 REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 38. 3-Pin Plastic Header-Style Package [TO-92]
 Dimensions shown in inches and (millimeters)

ORDERING GUIDE

Model	Accuracy at 25°C (°C max)	Linear Operating Temperature Range	Package Description	Package Option	Branding
TMP35FS	±2.0	10°C to 125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	T5G
TMP35FS-REEL	±2.0	10°C to 125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP35GRT-REEL7	±3.0	10°C to 125°C	5-Lead Plastic Surface-Mount Package (SOT-23)	RT-5	
TMP35GS	±3.0	10°C to 125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP35GS-REEL	±3.0	10°C to 125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP35GT9	±3.0	10°C to 125°C	3-Pin Plastic Header-Style Package (TO-92)	TO-92	
TMP36FS	±2.0	-40°C to +125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	T6G T6G
TMP36FS-REEL	±2.0	-40°C to +125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP36FSZ ¹	±2.0	-40°C to +125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP36FSZ-REEL ¹	±2.0	-40°C to +125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP36GRT-REEL7	±3.0	-40°C to +125°C	5-Lead Plastic Surface-Mount Package (SOT-23)	RT-5	
TMP36GRTZ-REEL7 ¹	±3.0	-40°C to +125°C	5-Lead Plastic Surface-Mount Package (SOT-23)	RT-5	
TMP36GS	±3.0	-40°C to +125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP36GS-REEL	±3.0	-40°C to +125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP36GS-REEL7	±3.0	-40°C to +125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP36GSZ ¹	±3.0	-40°C to +125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP36GSZ-REEL ¹	±3.0	-40°C to +125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP36GSZ-REEL7 ¹	±3.0	-40°C to +125°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP36GT9	±3.0	-40°C to +125°C	3-Pin Plastic Header-Style Package (TO-92)	TO-92	
TMP36CSURF			DIE		
TMP37FS	±2.0	5°C to 100°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	T7G
TMP37FS-REEL	±2.0	5°C to 100°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP37FT9	±2.0	5°C to 100°C	3-Pin Plastic Header-Style Package (TO-92)	TO-92	
TMP37FT9-REEL	±2.0	5°C to 100°C	3-Pin Plastic Header-Style Package (TO-92)	TO-92	
TMP37GRT-REEL7	±3.0	5°C to 100°C	5-Lead Plastic Surface-Mount Package (SOT-23)	RT-5	
TMP37GS	±3.0	5°C to 100°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP37GS-REEL	±3.0	5°C to 100°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP37GSZ ¹	±3.0	5°C to 100°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP37GSZ-REEL ¹	±3.0	5°C to 100°C	8-Lead Standard Small Outline Package (SOIC)	RN-8	
TMP37GT9	±3.0	5°C to 100°C	3-Pin Plastic Header-Style Package (TO-92)	TO-92	
TMP37GT9-REEL	±3.0	5°C to 100°C	3-Pin Plastic Header-Style Package (TO-92)	TO-3	

¹ Z = Pb-free part.