



# MCP9700/01

## Low-Power Voltage Output Temperature Sensor

### Features

- Tiny Analog Temperature Sensor
- Available Packages: SC70-5
- Wide Temperature Measurement Range:
  - -40°C to +125°C
- Accuracy:  $\pm 4^\circ\text{C}$  (max.), 0°C to +70°C
- Optimized for Analog-to-Digital Converters (ADCs):
  - **MCP9700**: 10.0 mV/°C (typ.)
  - **MCP9701**: 19.5 mV/°C (typ.)
- Wide Operating Voltage Range:
  - **MCP9700**:  $V_{DD} = 2.3\text{V}$  to 5.5V
  - **MCP9701**:  $V_{DD} = 3.1\text{V}$  to 5.5V
- Low Operating Current: 6  $\mu\text{A}$  (typ.)
- Optimized to Drive Large Capacitive Loads

### Typical Applications

- Hard Disk Drives and Other PC Peripherals
- Entertainment Systems
- Home Appliance
- Office Equipment
- Battery Packs and Portable Equipment
- General Purpose Temperature Monitoring

### Description

The MCP9700/01 low-cost, low-power and tiny temperature sensor family converts temperature to an analog voltage. It provides an accuracy of  $\pm 4^\circ\text{C}$  from 0°C to +70°C while consuming 6  $\mu\text{A}$  (typ.) of operating current.

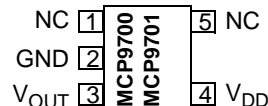
The MCP9700/01 provides a low-cost solution for applications that require measurement of a relative change of temperature. When measuring relative change in temperature from 25°C, an accuracy of  $\pm 1^\circ\text{C}$  (typ.) can be realized from 0°C to 70°C. This accuracy can also be achieved by applying system calibration at 25°C.

Unlike resistive sensors such as thermistors, this family does not require a signal conditioning circuit. The voltage output pin can be directly connected to an ADC input of a microcontroller. The MCP9700 and MCP9701 temperature coefficients are scaled to provide a 1° C/bit resolution for an 8-bit ADC with a reference voltage of 2.5V and 5V, respectively.

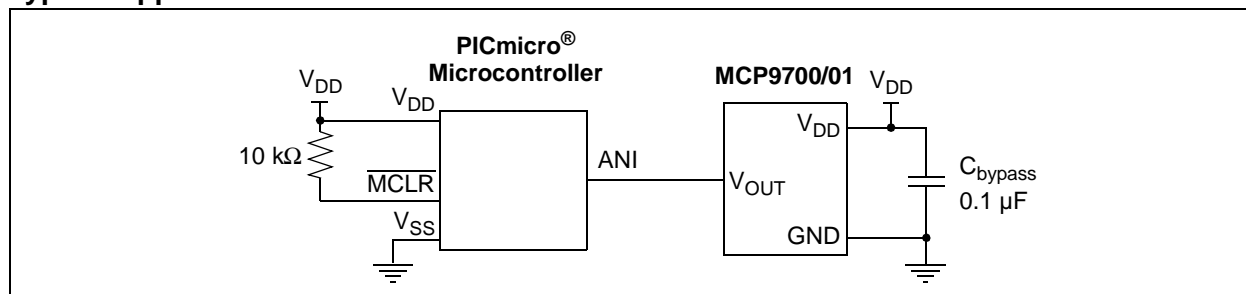
In addition, this family is immune to the effects of parasitic capacitance and can drive large capacitive loads. This provides Printed Circuit Board (PCB) layout design flexibility by enabling the device to be remotely located from the microcontroller. Adding some capacitance at the output also helps the output transient response by reducing overshoots or undershoots. However, capacitive load is not required for sensor output stability.

### Package Type

#### SC70-5



### Typical Application Circuit



# MCP9700/01

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

$V_{DD}$ : ..... 6.0V  
Storage temperature: ..... -65°C to +150°C  
Ambient Temp. with Power Applied:.. -40°C to +125°C  
Junction Temperature ( $T_J$ ):..... 150°C  
ESD Protection On All Pins: (HBM:MM):... (4 kV:200V)  
Latch-Up Current at Each Pin: ..... ±200 mA

†**Notice:** Stresses above those listed under “Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

### Pin Function

NAME	FUNCTION
NC	Not Connected
$V_{OUT}$	Voltage Output
$V_{DD}$	Power Supply
GND	Ground

## DC ELECTRICAL CHARACTERISTICS

**Electrical Specifications:** Unless otherwise indicated:

**MCP9700:**  $V_{DD}$  = 2.3V to 5.5V, GND = Ground,  $T_A$  = -40°C to +125°C and No load.

**MCP9701:**  $V_{DD}$  = 3.1V to 5.5V, GND = Ground,  $T_A$  = -10°C to +125°C and No load.

Parameter	Sym	Min	Typ	Max	Unit	Conditions
Power Supply						
Operating Voltage Range	V <sub>DD</sub>	2.3	—	5.5	V	MCP9700
	V <sub>DD</sub>	3.1	—	5.5	V	MCP9701
Operating Current	I <sub>DD</sub>	—	6	12	μA	
Power Supply Rejection	PSR	—	0.1	—	°C/V	MCP9700 V <sub>DD</sub> = 2.3V - 4.0V MCP9701 V <sub>DD</sub> = 3.1V - 4.0V
Sensor Accuracy (Notes 1, 2)						
T <sub>A</sub> = +25°C T <sub>A</sub> = 0°C to +70°C T <sub>A</sub> = -40°C to +125°C T <sub>A</sub> = -10°C to +125°C	T <sub>ACY</sub>	—	±1	—	°C	MCP9700 MCP9701
	T <sub>ACY</sub>	-4.0	—	+4.0	°C	
	T <sub>ACY</sub>	-4.0	—	+6.0	°C	
	T <sub>ACY</sub>	-4.0	—	+6.0	°C	
Sensor Output						
Output Voltage: T <sub>A</sub> = 0°C T <sub>A</sub> = 0°C	V <sub>0°C</sub>	—	500	—	mV	MCP9700
	V <sub>0°C</sub>	—	400	—	mV	MCP9701
Temperature Coefficient	T <sub>C1</sub>	—	10.0	—	mV/°C	MCP9700
	T <sub>C1</sub>	—	19.5	—	mV/°C	MCP9701
Output Non-linearity	V <sub>ONL</sub>	—	±0.5	—	°C	T <sub>A</sub> = 0°C to +70°C (Note 2)
Output Current	I <sub>OUT</sub>	—	—	100	μA	
Output Impedance	Z <sub>OUT</sub>	—	20	—	Ω	I <sub>OUT</sub> = 100 μA, f = 500 Hz
Output Load Regulation	ΔV <sub>OUT</sub> / ΔI <sub>OUT</sub>	—	1	—	Ω	T <sub>A</sub> = 0°C to +70°C, I <sub>OUT</sub> = 100 μA
Turn-on Time	t <sub>ON</sub>	—	800	—	μs	
Typical Load Capacitance (Note 3)	C <sub>LOAD</sub>	—	—	1000	pF	
Thermal Response to 63%	t <sub>RES</sub>	—	1.3	—	s	30°C (air) to +125°C (fluid bath) (Note 4)

**Note 1:** The MCP9700 accuracy is tested with  $V_{DD}$  = 3.3V, while the MCP9701 accuracy is tested with  $V_{DD}$  = 5.0V.

**2:** The MCP9700/01 is characterized using the first-order or linear equation, as shown in Equation 3-1.

**3:** The MCP9700/01 family is characterized and production-tested with a capacitive load of 1000 pF.

**4:** Thermal response with 1 x 1 inch dual-sided copper clad.

## TEMPERATURE CHARACTERISTICS

**Electrical Specifications:** Unless otherwise indicated,

**MCP9700:**  $V_{DD} = 2.3V$  to  $5.5V$ , GND = Ground,  $T_A = -40^{\circ}C$  to  $+125^{\circ}C$  and No load.

**MCP9701:**  $V_{DD} = 3.1V$  to  $5.5V$ , GND = Ground,  $T_A = -10^{\circ}C$  to  $+125^{\circ}C$  and No load.

Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>Temperature Ranges</b>						
Specified Temperature Range	$T_A$	-40	—	+125	$^{\circ}C$	MCP9700 (Note 1)
	$T_A$	-10	—	+125	$^{\circ}C$	MCP9701 (Note 1)
Operating Temperature Range	$T_A$	-40	—	+125	$^{\circ}C$	
Storage Temperature Range	$T_A$	-65	—	+150	$^{\circ}C$	
<b>Thermal Package Resistances</b>						
Thermal Resistance, 5L-SC70	$\theta_{JA}$	—	331	—	$^{\circ}C/W$	

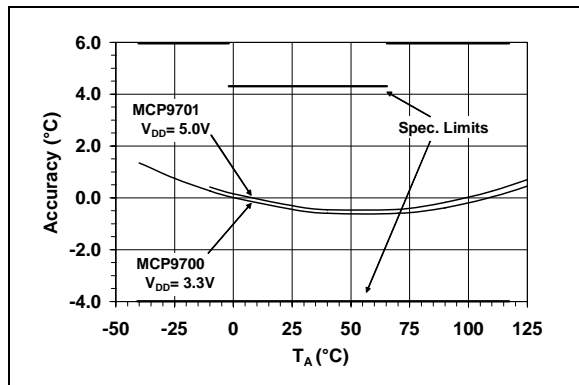
**Note 1:** Operation in this range must not cause  $T_J$  to exceed Maximum Junction Temperature ( $+150^{\circ}C$ ).

# MCP9700/01

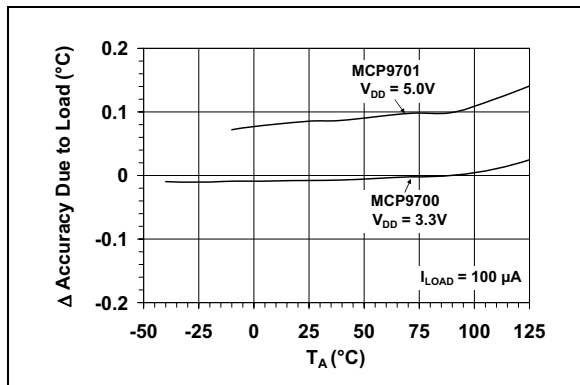
## 2.0 TYPICAL PERFORMANCE CURVES

**Note:** The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

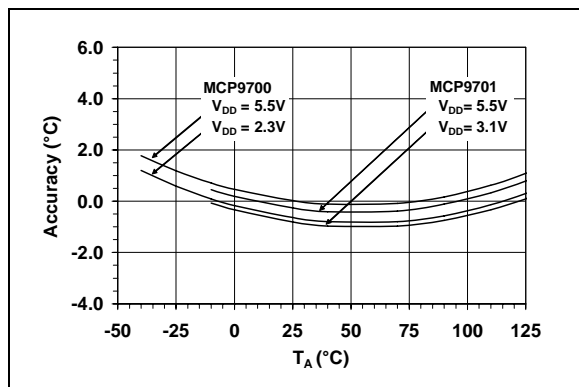
**Note:** Unless otherwise indicated, **MCP9700:**  $V_{DD} = 2.3V$  to  $5.5V$ ; **MCP9701:**  $V_{DD} = 3.1V$  to  $5.5V$ ; GND = Ground,  $C_{bypass} = 0.1 \mu F$ .



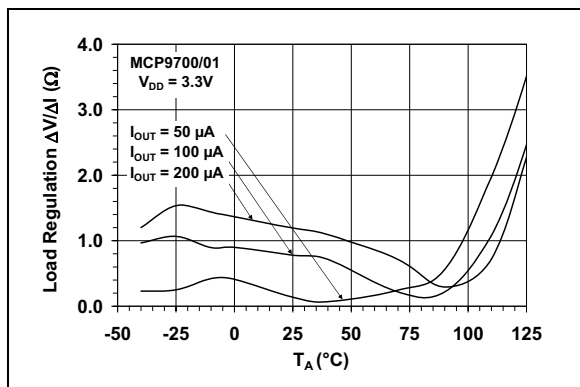
**FIGURE 2-1:** Accuracy vs. Ambient Temperature.



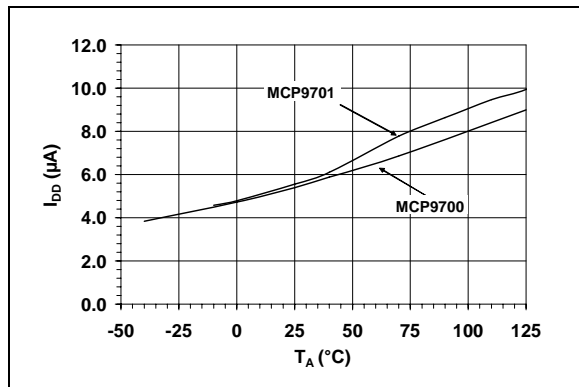
**FIGURE 2-4:** Changes in Accuracy vs. Ambient Temperature (Due to Load).



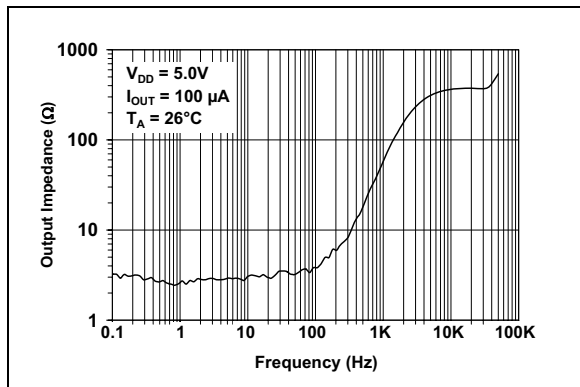
**FIGURE 2-2:** Accuracy vs. Ambient Temperature, with  $V_{DD}$ .



**FIGURE 2-5:** Load Regulation vs. Ambient Temperature.

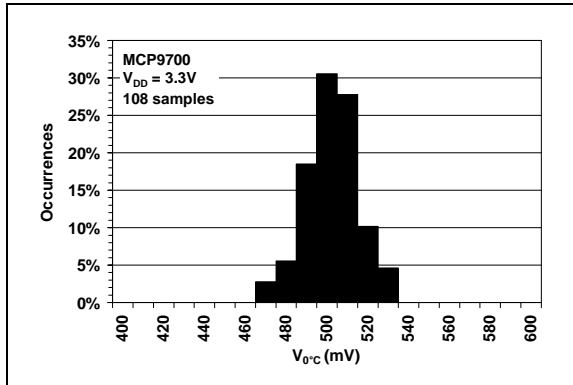


**FIGURE 2-3:** Supply Current vs. Temperature.

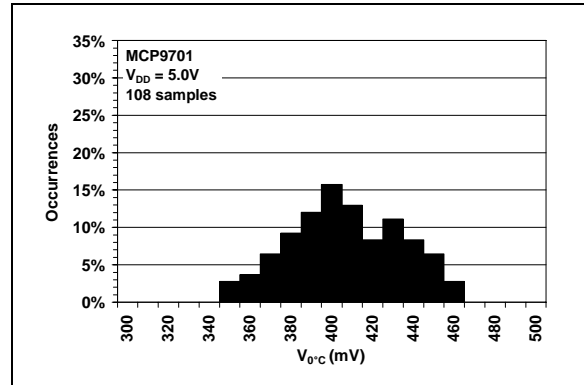


**FIGURE 2-6:** Output Impedance vs. Frequency.

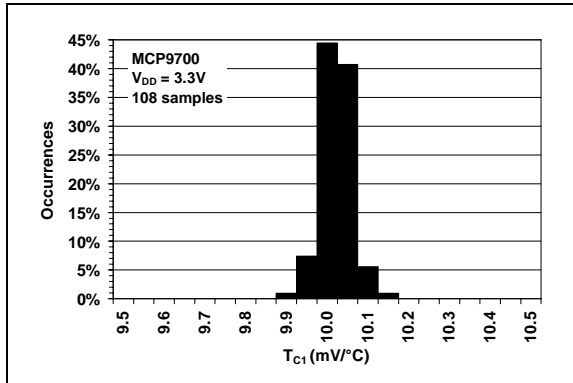
**Note:** Unless otherwise indicated, **MCP9700:**  $V_{DD} = 2.3V$  to  $5.5V$ ; **MCP9701:**  $V_{DD} = 3.1V$  to  $5.5V$ ; GND = Ground,  $C_{bypass} = 0.1 \mu F$ .



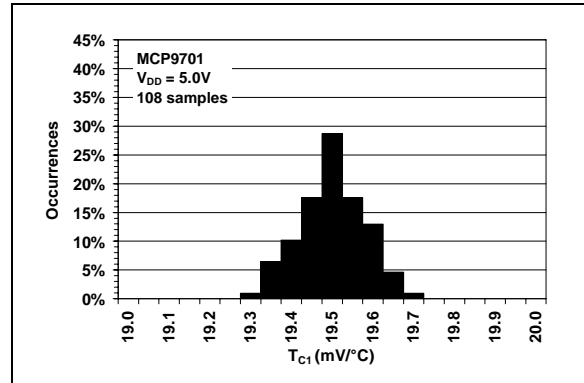
**FIGURE 2-7:** Output Voltage at  $0^{\circ}C$  (MCP9700).



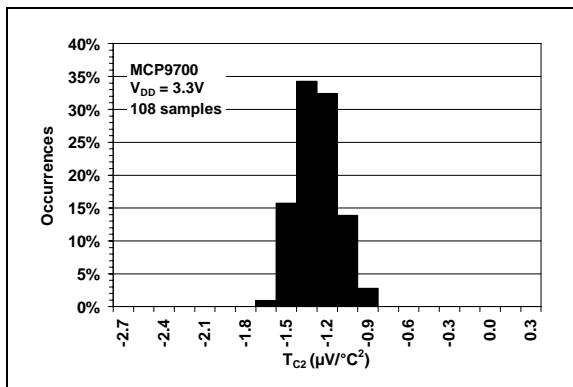
**FIGURE 2-10:** Occurrences vs. Temperature Coefficient (MCP9701).



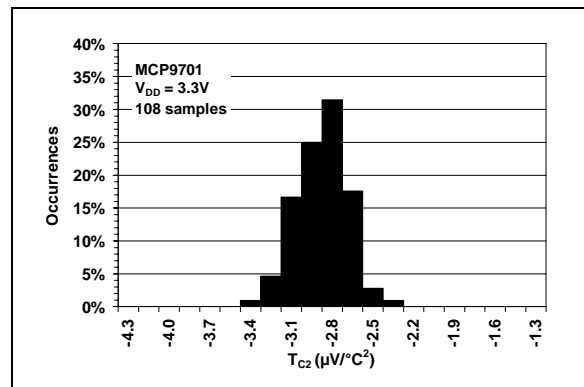
**FIGURE 2-8:** Occurrences vs. First-Order Temperature Coefficient (MCP9700).



**FIGURE 2-11:** Occurrences vs. First-Order Temperature Coefficient (MCP9701).



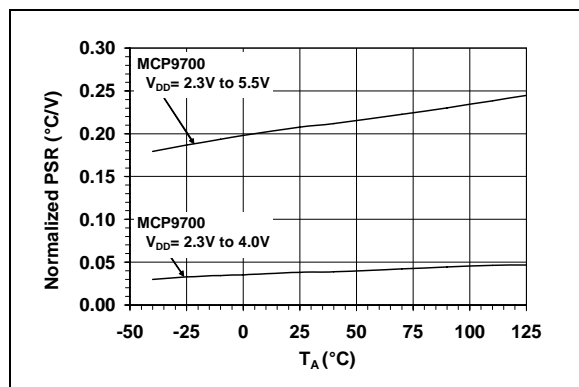
**FIGURE 2-9:** Occurrences vs. Second-Order Temperature Coefficient (MCP9700).



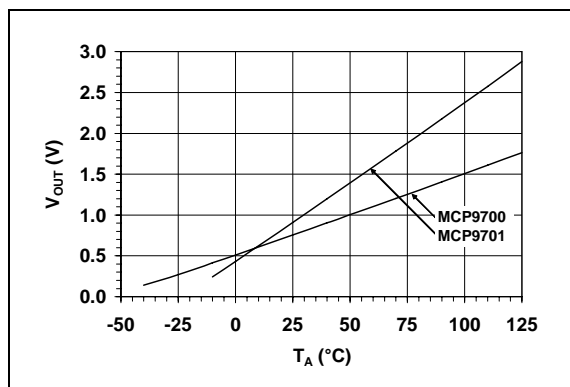
**FIGURE 2-12:** Occurrences vs. Second-Order Temperature Coefficient (MCP9701).

# MCP9700/01

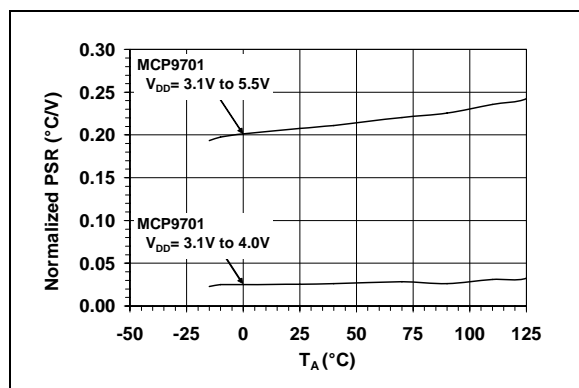
**Note:** Unless otherwise indicated, **MCP9700:**  $V_{DD} = 2.3V$  to  $5.5V$ ; **MCP9701:**  $V_{DD} = 3.1V$  to  $5.5V$ ; GND = Ground,  $C_{bypass} = 0.1 \mu F$ .



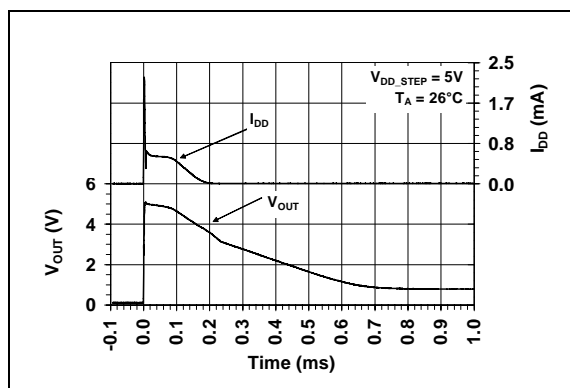
**FIGURE 2-13:** Power Supply Rejection (PSR) vs. Ambient Temperature.



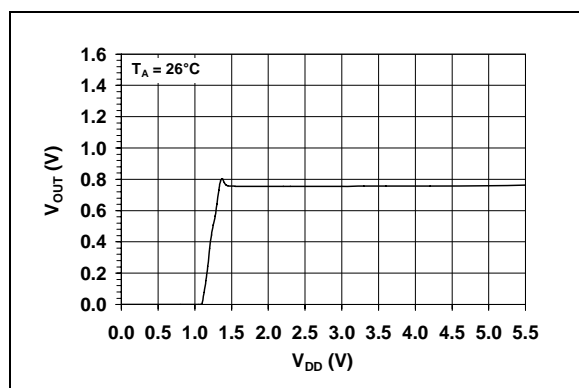
**FIGURE 2-16:** Output Voltage vs. Ambient Temperature.



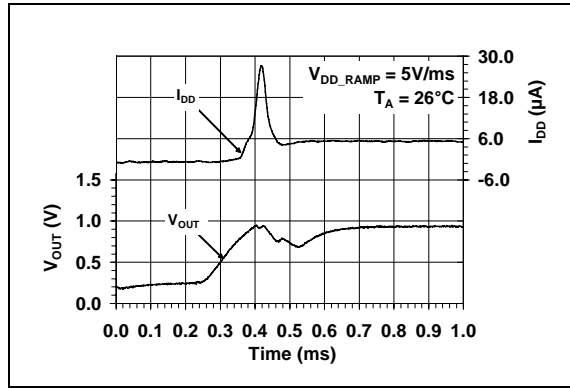
**FIGURE 2-14:** Power Supply Rejection (PSR) vs. Frequency.



**FIGURE 2-17:** Output vs. Time.

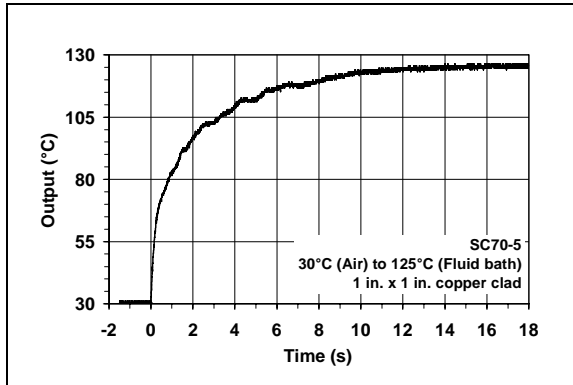


**FIGURE 2-15:** Output Voltage vs. Power Supply.



**FIGURE 2-18:** Output vs. Time

**Note:** Unless otherwise indicated, **MCP9700:**  $V_{DD} = 2.3V$  to  $5.5V$ ; **MCP9701:**  $V_{DD} = 3.1V$  to  $5.5V$ ; GND = Ground,  $C_{bypass} = 0.1 \mu F$ .



**FIGURE 2-19:** Thermal Response.

## 3.0 FUNCTIONAL DESCRIPTION

The MCP9700/01 temperature sensing element is essentially a P-N junction or a diode. The diode electrical characteristics has a temperature coefficient that provides a change in voltage based on the relative ambient temperature from -40°C to 125°C. The change in voltage is scaled to a temperature coefficient of 10.0 mV/°C (typ.) for the MCP9700 and 19.5 mV/°C (typ.) for the MCP9701. The output voltage at 0°C is also scaled to 500 mV (typ.) and 400 mV (typ.) for the MCP9700 and MCP9701, respectively. This linear scale is described in the transfer function shown in Equation 3-1.

### EQUATION 3-1: SENSOR TRANSFER FUNCTION

$$V_{OUT} = T_{C1} \cdot T_A + V_{0^{\circ}C}$$

Where:

$T_A$  = Ambient Temperature

$V_{OUT}$  = Sensor Output Voltage

$V_{0^{\circ}C}$  = Sensor Output Voltage at 0°C

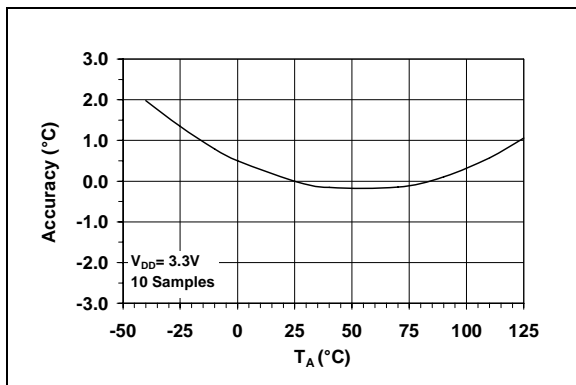
$T_{C1}$  = Temperature Coefficient



## 4.0 APPLICATIONS INFORMATION

### 4.1 Improving Accuracy

The MCP9700/01 accuracy can be improved by performing a system calibration at a specific temperature. For example, calibrating the system at 25°C ambient improves the measurement accuracy to a  $\pm 0.5^\circ\text{C}$  (typ.) from 0°C to 70°C, as shown in Figure 4-1. Therefore, when measuring relative temperature change, this family measures temperature with higher accuracy.



**FIGURE 4-1:** Relative Accuracy to +25°C vs. Temperature.

The relative change in accuracy from the calibration temperature is due to the output non-linearity from the first-order equation, specified in Equation 3-1. The accuracy can be further improved by compensating for the output non-linearity.

For higher accuracy, the sensor output transfer function is also derived using a second-order equation as shown in Equation 4-1. The equation describes the output non-linearity. This equation is not used to characterize the part as specified in the DC Electrical Characteristics table; however, it provides better accuracy.

### EQUATION 4-1: SECOND-ORDER TRANSFER FUNCTION

$$V_{OUT} = T_{C2} (T_A + 10^\circ\text{C})(125^\circ\text{C} - T_A) + T_{C1} T_A + V_{0^\circ\text{C}}$$

$$= -T_{C2} T_A^2 + (T_{C1} + 115 T_{C2}) T_A + 1250 T_{C2} + V_{0^\circ\text{C}}$$

Where:

- $T_A$  = Ambient Temperature
- $V_{OUT}$  = Sensor Output Voltage
- $V_{0^\circ\text{C}}$  = Sensor Output Voltage at 0°C  
(refer to Figure 2-7 and 2-10)
- $T_{C1}$  = Temperature Coefficient  
(refer to Figure 2-8 and 2-11)
- $T_{C2}$  = Temperature Coefficient  
MCP9700 1.4  $\mu\text{V}/^\circ\text{C}^2$  (typ.)  
MCP9701 2.7  $\mu\text{V}/^\circ\text{C}^2$  (typ.)  
(refer to Figure 2-9 and 2-12)

### 4.2 Shutdown Using Microcontroller I/O Pin

The MCP9700/01 low operating current of 6  $\mu\text{A}$  (typ.) makes it ideal for battery-powered applications. However, for applications that require tighter current budget, this device can be powered using a microcontroller Input/Output (I/O) pin. The I/O pin can be toggled to shutdown the device. In such applications, the microcontroller internal digital switching noise is emitted to the MCP9700/01 as power supply noise. This switching noise compromises measurement accuracy. Therefore, a decoupling capacitor will be necessary.

### 4.3 Layout Considerations

The MCP9700/01 does not require any additional components to operate. However, it is recommended that a decoupling capacitor of 0.1  $\mu\text{F}$  to 1  $\mu\text{F}$  be used between the  $V_{DD}$  and GND pins. In high-noise applications, connect the power supply voltage to the  $V_{DD}$  pin using a 200 $\Omega$  resistor with a 1  $\mu\text{F}$  decoupling capacitor. A high-frequency ceramic capacitor is recommended. It is necessary for the capacitor to be located as close as possible to the  $V_{DD}$  and GND pins in order to provide effective noise protection. In addition, avoid tracing digital lines in close proximity to the sensor.

## 4.4 Thermal Considerations

The MCP9700/01 measures temperature by monitoring the voltage of a diode located in the die. A low impedance thermal path between the die and the PCB is provided by the pins. Therefore, the MCP9700/01 effectively monitors the temperature of the PCB. However, the thermal path for the ambient air is not as efficient because the plastic device package functions as a thermal insulator from the die. This limitation applies to plastic-packaged silicon temperature sensors. If the application requires measuring ambient air, the PCB needs to be designed with proper thermal conduction to the sensor pins.

The MCP9700/01 is designed to source/sink 100  $\mu\text{A}$  (max.). The power dissipation due to the output current is relatively insignificant. The effect of the output current can be described using Equation 4-2.

### EQUATION 4-2: EFFECT OF SELF-HEATING

$$T_J - T_A = \theta_{JA}(V_{DD}I_{DD} + (V_{DD} - V_{OUT})I_{OUT})$$

Where:

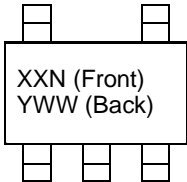
$T_J$  = Junction Temperature  
 $T_A$  = Ambient Temperature  
 $\theta_{JA}$  = Package Thermal Resistance (331°C/W)  
 $V_{OUT}$  = Sensor Output Voltage  
 $I_{OUT}$  = Sensor Output Current  
 $I_{DD}$  = Operating Current  
 $V_{DD}$  = Operating Voltage

At  $T_A = +25^\circ\text{C}$  ( $V_{OUT} = 0.75\text{V}$ ) and maximum specification of  $I_{DD} = 12\ \mu\text{A}$ ,  $V_{DD} = 5.5\text{V}$  and  $I_{OUT} = +100\ \mu\text{A}$ , the self-heating due to power dissipation ( $T_J - T_A$ ) is 0.179°C.

5.0 PACKAGING INFORMATION

5.1 Package Marking Information

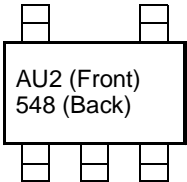
5-Lead SC-70 (MCP9700)



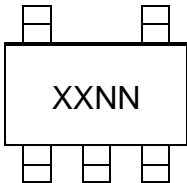
Device	Code
MCP9700	AUN
MCP9701	AVN

**Note:** Applies to 5-Lead SC-70.

Example:



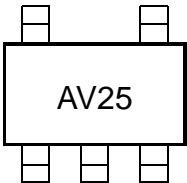
5-Lead SC-70 (MCP9701)



Device	Code
MCP9700	AUNN
MCP9701	AVNN

**Note:** Applies to 5-Lead SC-70.

Example:

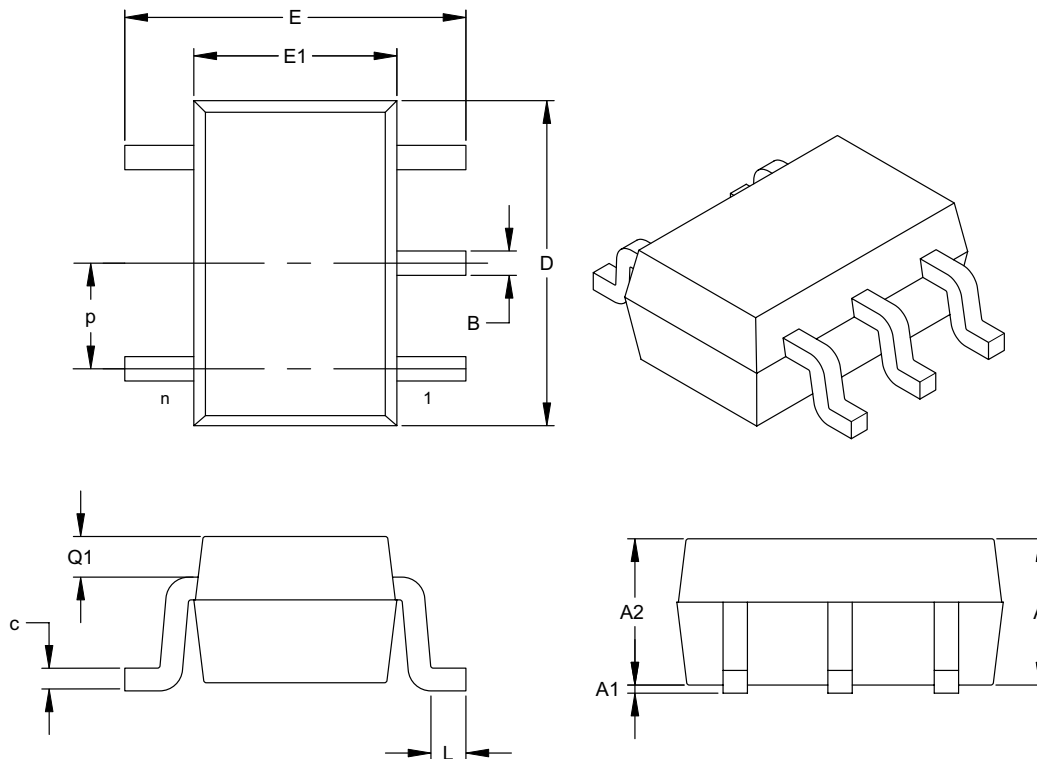


<b>Legend:</b>	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator (e3) can be found on the outer packaging for this package.

**Note:** In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

# MCP9700/01

## 5-Lead Plastic Small Outline Transistor (LT) (SC-70)



Units		INCHES			MILLIMETERS*		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n	5			5		
Pitch	p	.026 (BSC)			0.65 (BSC)		
Overall Height	A	.031		.043	0.80		1.10
Molded Package Thickness	A2	.031		.039	0.80		1.00
Standoff	A1	.000		.004	0.00		0.10
Overall Width	E	.071		.094	1.80		2.40
Molded Package Width	E1	.045		.053	1.15		1.35
Overall Length	D	.071		.087	1.80		2.20
Foot Length	L	.004		.012	0.10		0.30
Top of Molded Pkg to Lead Shoulder	Q1	.004		.016	0.10		0.40
Lead Thickness	c	.004		.007	0.10		0.18
Lead Width	B	.006		.012	0.15		0.30

\*Controlling Parameter

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" (0.127mm) per side.

JEITA (EIAJ) Standard: SC-70

Drawing No. C04-061

## APPENDIX A: REVISION HISTORY

### Revision A (March 2005)

- Original Release of this Document.

NOTES:



NOTES:



---

**Note the following details of the code protection feature on Microchip devices:**

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

---

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights.

#### **Trademarks**

The Microchip name and logo, the Microchip logo, Accuron, dsPIC, KEELOQ, microID, MPLAB, PIC, PICmicro, PICSTART, PRO MATE, PowerSmart, rfPIC, and SmartShunt are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.


Amplab, FilterLab, Migratable Memory, MXDEV, MXLAB, PICMASTER, SEEVAL, SmartSensor and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Application Maestro, dsPICDEM, dsPICDEM.net, dsPICworks, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, MPASM, MPLIB, MPLINK, MPSIM, PICKit, PICDEM, PICDEM.net, PICLAB, PICTail, PowerCal, PowerInfo, PowerMate, PowerTool, rLAB, rfPICDEM, Select Mode, Smart Serial, SmartTel, Total Endurance and WiperLock are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2005, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

**QUALITY MANAGEMENT SYSTEM**  
**CERTIFIED BY DNV**  
**== ISO/TS 16949:2002 ==**

*Microchip received ISO/TS-16949:2002 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona and Mountain View, California in October 2003. The Company's quality system processes and procedures are for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.*



---

## WORLDWIDE SALES AND SERVICE

---

### AMERICAS

#### Corporate Office

2355 West Chandler Blvd.  
Chandler, AZ 85224-6199  
Tel: 480-792-7200  
Fax: 480-792-7277  
Technical Support:  
<http://support.microchip.com>  
Web Address:  
[www.microchip.com](http://www.microchip.com)

#### Atlanta

Alpharetta, GA  
Tel: 770-640-0034  
Fax: 770-640-0307

#### Boston

Westborough, MA  
Tel: 774-760-0087  
Fax: 774-760-0088

#### Chicago

Itasca, IL  
Tel: 630-285-0071  
Fax: 630-285-0075

#### Dallas

Addison, TX  
Tel: 972-818-7423  
Fax: 972-818-2924

#### Detroit

Farmington Hills, MI  
Tel: 248-538-2250  
Fax: 248-538-2260

#### Kokomo

Kokomo, IN  
Tel: 765-864-8360  
Fax: 765-864-8387

#### Los Angeles

Mission Viejo, CA  
Tel: 949-462-9523  
Fax: 949-462-9608

#### San Jose

Mountain View, CA  
Tel: 650-215-1444  
Fax: 650-961-0286

#### Toronto

Mississauga, Ontario,  
Canada  
Tel: 905-673-0699  
Fax: 905-673-6509

### ASIA/PACIFIC

#### Australia - Sydney

Tel: 61-2-9868-6733  
Fax: 61-2-9868-6755

#### China - Beijing

Tel: 86-10-8528-2100  
Fax: 86-10-8528-2104

#### China - Chengdu

Tel: 86-28-8676-6200  
Fax: 86-28-8676-6599

#### China - Fuzhou

Tel: 86-591-8750-3506  
Fax: 86-591-8750-3521

#### China - Hong Kong SAR

Tel: 852-2401-1200  
Fax: 852-2401-3431

#### China - Shanghai

Tel: 86-21-5407-5533  
Fax: 86-21-5407-5066

#### China - Shenyang

Tel: 86-24-2334-2829  
Fax: 86-24-2334-2393

#### China - Shenzhen

Tel: 86-755-8203-2660  
Fax: 86-755-8203-1760

#### China - Shunde

Tel: 86-757-2839-5507  
Fax: 86-757-2839-5571

#### China - Qingdao

Tel: 86-532-502-7355  
Fax: 86-532-502-7205

### ASIA/PACIFIC

#### India - Bangalore

Tel: 91-80-2229-0061  
Fax: 91-80-2229-0062

#### India - New Delhi

Tel: 91-11-5160-8631  
Fax: 91-11-5160-8632

#### Japan - Kanagawa

Tel: 81-45-471- 6166  
Fax: 81-45-471-6122

#### Korea - Seoul

Tel: 82-2-554-7200  
Fax: 82-2-558-5932 or  
82-2-558-5934

#### Singapore

Tel: 65-6334-8870  
Fax: 65-6334-8850

#### Taiwan - Kaohsiung

Tel: 886-7-536-4818  
Fax: 886-7-536-4803

#### Taiwan - Taipei

Tel: 886-2-2500-6610  
Fax: 886-2-2508-0102

#### Taiwan - Hsinchu

Tel: 886-3-572-9526  
Fax: 886-3-572-6459

### EUROPE

#### Austria - Weis

Tel: 43-7242-2244-399  
Fax: 43-7242-2244-393

#### Denmark - Ballerup

Tel: 45-4450-2828  
Fax: 45-4485-2829

#### France - Massy

Tel: 33-1-69-53-63-20  
Fax: 33-1-69-30-90-79

#### Germany - Ismaning

Tel: 49-89-627-144-0  
Fax: 49-89-627-144-44

#### Italy - Milan

Tel: 39-0331-742611  
Fax: 39-0331-466781

#### Netherlands - Drunen

Tel: 31-416-690399  
Fax: 31-416-690340

#### England - Berkshire

Tel: 44-118-921-5869  
Fax: 44-118-921-5820