

# LM392

*LM392 Low Power Operational Amplifier/Voltage Comparator*



Literature Number: SNOSBT5C

# LM392

## Low Power Operational Amplifier/Voltage Comparator

### General Description

The LM392 series consists of 2 independent building block circuits. One is a high gain, internally frequency compensated operational amplifier, and the other is a precision voltage comparator. Both the operational amplifier and the voltage comparator have been specifically designed to operate from a single power supply over a wide range of voltages. Both circuits have input stages which will common-mode input down to ground when operating from a single power supply. Operation from split power supplies is also possible and the low power supply current is independent of the magnitude of the supply voltage.

Application areas include transducer amplifier with pulse shaper, DC gain block with level detector, VCO, as well as all conventional operational amplifier or voltage comparator circuits. Both circuits can be operated directly from the standard 5 V<sub>DC</sub> power supply voltage used in digital systems, and the output of the comparator will interface directly with either TTL or CMOS logic. In addition, the low power drain makes the LM392 extremely useful in the design of portable equipment.

### Advantages

- Eliminates need for dual power supplies
- An internally compensated op amp and a precision comparator in the same package
- Allows sensing at or near ground

- Power drain suitable for battery operation
- Pin-out is the same as both the LM358 dual op amp and the LM393 dual comparator

### Features

- Wide power supply voltage range
  - Single supply: 3V to 32V
  - Dual supply: ±1.5V to ±16V
- Low supply current drain—essentially independent of supply voltage: 600 µA
- Low input biasing current: 50 nA
- Low input offset voltage: 2 mV
- Low input offset current: 5 nA
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage

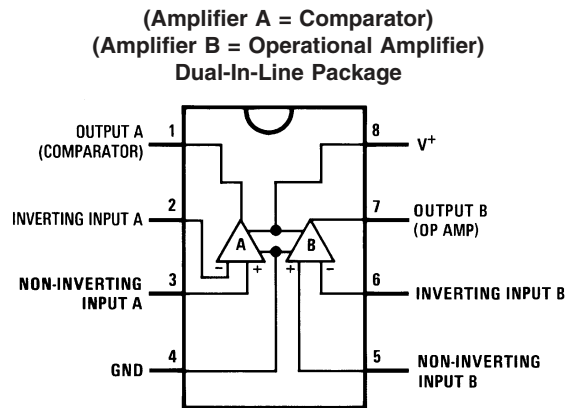
#### ADDITIONAL OP AMP FEATURES

- Internally frequency compensated for unity gain
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1 MHz
- Large output voltage swing: 0V to V<sup>+</sup> – 1.5V

#### ADDITIONAL COMPARATOR FEATURES

- Low output saturation voltage: 250 mV at 4 mA
- Output voltage compatible with all types of logic systems

### Connection Diagram



00779301

(Top View)  
Order Number LM392M or LM392MX  
See NS Package Number M08A  
Order Number LM392N  
See NS Package Number N08E

**Absolute Maximum Ratings** (Note 1)

Distributors for availability and specifications.

If Military/Aerospace specified devices are required,  
please contact the National Semiconductor Sales Office/

	<b>LM392</b>
Supply Voltage, $V^+$	32V or $\pm 16V$
Differential Input Voltage	32V
Input Voltage	-0.3V to +32V
Power Dissipation (Note 2)	
Molded DIP (LM392N)	820 mW
Small Outline Package (LM392M)	530 mW
Output Short-Circuit to Ground (Note 3)	Continuous
Input Current ( $V_{IN} < -0.3 V_{DC}$ ) (Note 4)	50 mA
Operating Temperature Range	0°C to +70°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	260°C
ESD rating to be determined.	
Soldering Information	
Dual-in-Line Package	
Soldering (10 seconds)	260°C
Small Outline Package	
Vapor Phase (60 seconds)	215°C
Infrared (15 seconds)	220°C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

**Electrical Characteristics** $(V^+ = 5 V_{DC}$ ; specifications apply to both amplifiers unless otherwise stated) (Note 5)

Parameter	Conditions	LM392			Units
		Min	Typ	Max	
Input Offset Voltage	$T_A = 25^\circ\text{C}$ , (Note 6)		$\pm 2$	$\pm 5$	mV
Input Bias Current	IN(+) or IN(-), $T_A = 25^\circ\text{C}$ , (Note 7) , $V_{CM} = 0V$		50	250	nA
Input Offset Current	IN(+) - IN(-), $T_A = 25^\circ\text{C}$		$\pm 5$	$\pm 50$	nA
Input Common-Mode Voltage Range	$V^+ = 30 V_{DC}$ , $T_A = 25^\circ\text{C}$ , (Note 8)	0		$V^+ - 1.5$	V
Supply Current	$R_L = \infty$ , $V^+ = 30 V$		1	2	mA
Supply Current	$R_L = \infty$ , $V^+ = 5 V$		0.5	1	mA
Amplifier-to-Amplifier Coupling	$f = 1 \text{ kHz to } 20 \text{ kHz}$ , $T_A = 25^\circ\text{C}$ , Input Referred, (Note 9)		-100		dB
Input Offset Voltage	(Note 6)			$\pm 7$	mV
Input Bias Current	IN(+) or IN(-)			400	nA
Input Offset Current	IN(+) - IN(-)			150	nA
Input Common-Mode Voltage Range	$V^+ = 30 V_{DC}$ , (Note 8)	0		$V^+ - 2$	V
Differential Input Voltage	Keep All $V_{IN}^{\text{'s}} \geq 0 V_{DC}$ (or $V^-$ , if used ) (Note 10)			32	V

**Electrical Characteristics** (Continued) $(V^+ = 5 V_{DC}$ ; specifications apply to both amplifiers unless otherwise stated) (Note 5)

Parameter	Conditions	LM392			Units
		Min	Typ	Max	
<b>OP AMP ONLY</b>					
Large Signal Voltage Gain	$V^+ = 15 V_{DC}$ , $V_o$ swing = $1 V_{DC}$ to $11 V_{DC}$ , $R_L = 2 k\Omega$ , $T_A = 25^\circ C$	25	100		V/mV
Output Voltage Swing	$R_L = 2 k\Omega$ , $T_A = 25^\circ C$	0		$V^+ - 1.5$	V
Common-Mode Rejection Ratio	DC, $T_A = 25^\circ C$ , $V_{CM} = 0$ , $V_{DC}$ to $V^+ - 1.5 V_{DC}$	65	70		dB
Power Supply Rejection Ratio	DC, $T_A = 25^\circ C$	65	100		dB
Output Current Source	$V_{IN(+)} = 1 V_{DC}$ , $V_{IN(-)} = 0 V_{DC}$ , $V^+ = 15 V_{DC}$ , $V_o = 2 V_{DC}$ , $T_A = 25^\circ C$	20	40		mA
Output Current Sink	$V_{IN(-)} = 1 V_{DC}$ , $V_{IN(+)} = 0 V_{DC}$ , $V^+ = 15 V_{DC}$ , $V_o = 2 V_{DC}$ , $T_A = 25^\circ C$	10	20		mA
	$V_{IN(-)} = 1 V_{DC}$ , $V_{IN(+)} = 0 V_{DC}$ , $V^+ = 15 V_{DC}$ , $V_o = 200 mV$ , $T_A = 25^\circ C$	12	50		$\mu A$
Input Offset Voltage Drift	$R_S = 0\Omega$		7		$\mu V/^\circ C$
Input Offset Current Drift	$R_S = 0\Omega$		10		$pA_{DC}/^\circ C$
<b>COMPARATOR ONLY</b>					
Voltage Gain	$R_L \geq 15 k\Omega$ , $V^+ = 15 V_{DC}$ , $T_A = 25^\circ C$	50	200		V/mV
Large Signal Response Time	$V_{IN} = TTL$ Logic Swing, $V_{REF} = 1.4 V_{DC}$ $V_{RL} = 5 V_{DC}$ , $R_L = 5.1 k\Omega$ , $T_A = 25^\circ C$		300		ns
Response Time	$V_{RL} = 5 V_{DC}$ , $R_L = 5.1 k\Omega$ , $T_A = 25^\circ C$		1.3		$\mu s$
Output Sink Current	$V_{IN(-)} = 1 V_{DC}$ , $V_{IN(+)} = 0 V_{DC}$ , $V_o \geq 1.5 V_{DC}$ , $T_A = 25^\circ C$	6	16		mA
Saturation Voltage	$V_{IN(-)} \geq 1 V_{DC}$ , $V_{IN(+)} = 0$ , $I_{SINK} \leq 4 mA$ , $T_A = 25^\circ C$		250	400	mV
	$V_{IN(-)} \geq 1 V_{DC}$ , $V_{IN(+)} = 0$ , $I_{SINK} \leq 4 mA$			700	mV
Output Leakage Current	$V_{IN(-)} = 0$ , $V_{IN(+)} \geq 1 V_{DC}$ , $V_o = 5 V_{DC}$ , $T_A = 25^\circ C$		0.1		nA
	$V_{IN(-)} = 0$ , $V_{IN(+)} \geq 1 V_{DC}$ , $V_o = 30 V_{DC}$			1.0	$\mu A$

**Note 1:** "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.

**Note 2:** For operating at temperatures above  $25^\circ C$ , the LM392 must be derated based on a  $125^\circ C$  maximum junction temperature and a thermal resistance of  $122^\circ C/W$  which applies for the device soldered in a printed circuit board, operating in still air ambient. The dissipation is the total of both amplifiers — use external resistors, where possible, to allow the amplifier to saturate or to reduce the power which is dissipated in the integrated circuit.

**Note 3:** Short circuits from the output to  $V^+$  can cause excessive heating and eventual destruction. When considering short circuits to ground, the maximum output current is approximately 40 mA for the op amp and 30 mA for the comparator independent of the magnitude of  $V^+$ . At values of supply voltage in excess of 15V, continuous short circuits can exceed the power dissipation ratings and cause eventual destruction.

**Note 4:** This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the amplifiers to go to the  $V^+$  voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than  $-0.3V$  (at  $25^\circ C$ ).

**Note 5:** These specifications apply for  $V^+ = 5V$ , unless otherwise stated. For the LM392, temperature specifications are limited to  $0^\circ C \leq T_A \leq +70^\circ C$ .

**Note 6:** At output switch point,  $V_o = 1.4V$ ,  $R_S = 0\Omega$  with  $V^+$  from 5V to 30V; and over the full input common-mode range (0V to  $V^+ - 1.5V$ ).

**Note 7:** The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

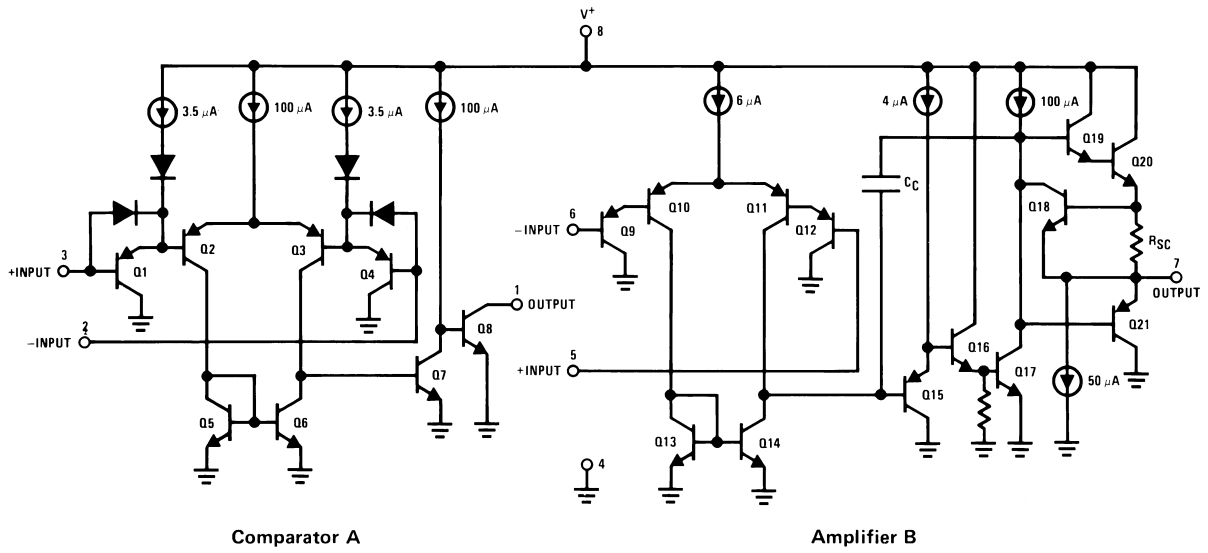
**Note 8:** The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is  $V^+ - 1.5V$ , but either or both inputs can go to 32V without damage.

**Note 9:** Due to proximity of external components, insure that coupling is not originating via the stray capacitance between these external parts. This typically can be detected as this type of capacitive coupling increases at higher frequencies.

**Note 10:** Positive excursions of input voltage may exceed the power supply level. As long as the other input voltage remains within the common-mode range, the comparator will provide a proper output state. The input voltage to the op amp should not exceed the power supply level. The input voltage state must not be less than  $-0.3V$  (or 0.3V below the magnitude of the negative power supply, if used) on either amplifier.

**Note 11:** The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals 300 ns can be obtained.

## Schematic Diagram



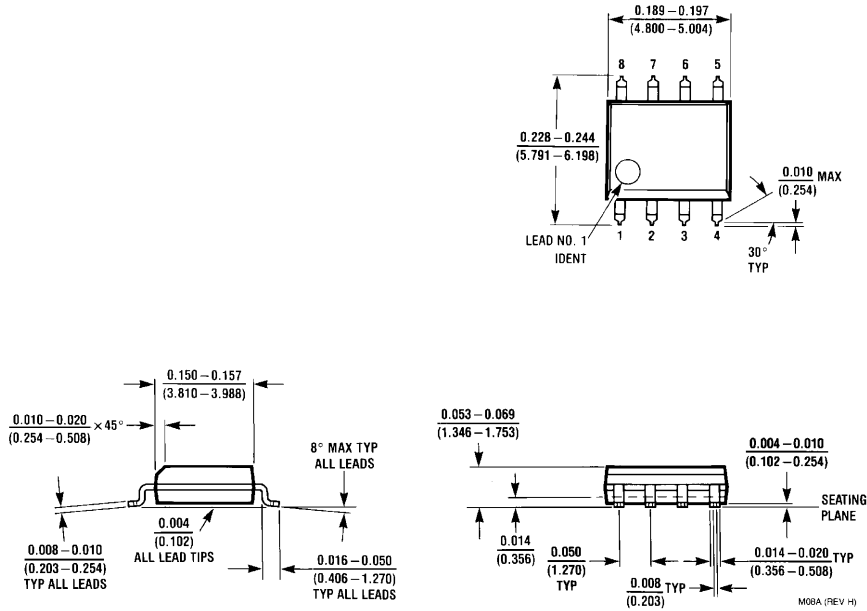
00779302

## Application Hints

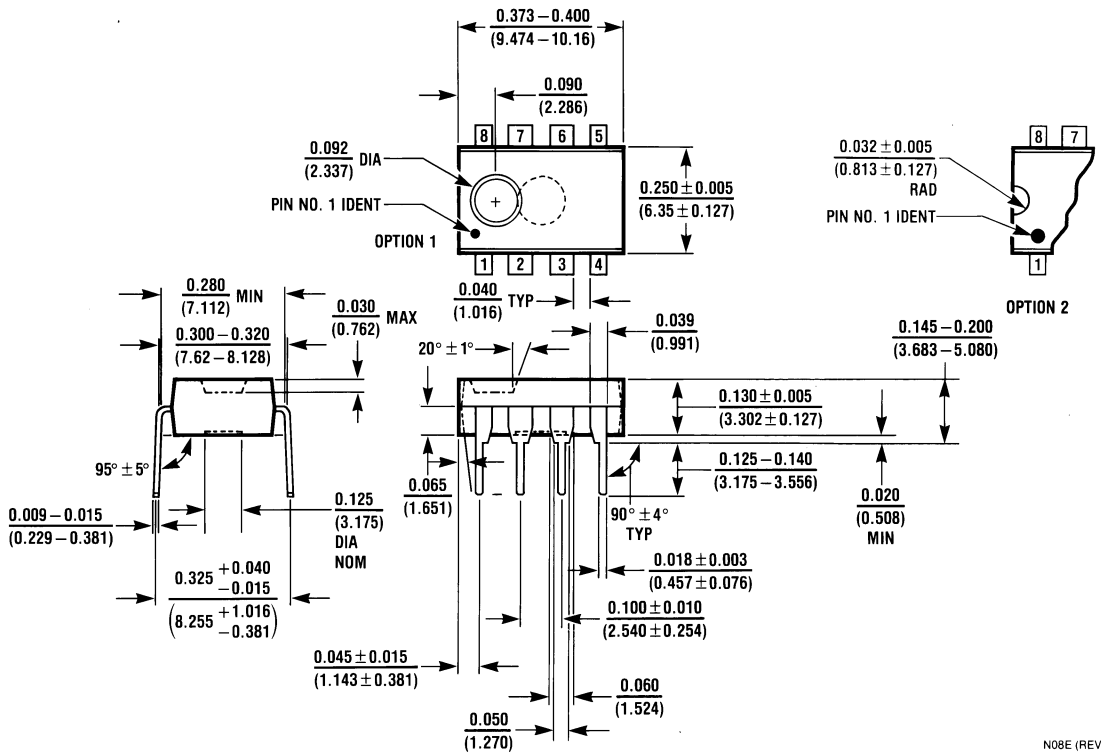
Please refer to the application hints section of the LM193 and the LM158 datasheets.

**Physical Dimensions** inches (millimeters)

unless otherwise noted



**S.O. Package (M)**  
 Order Number LM392M or LM392MX  
 NS Package Number M08A



**Molded Dual-In-Line Package (N)**  
 Order Number LM392N  
 NS Package Number N08E

## Notes

### LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

### BANNED SUBSTANCE COMPLIANCE

National Semiconductor certifies that the products and packing materials meet the provisions of the Customer Products Stewardship Specification (CSP-9-111C2) and the Banned Substances and Materials of Interest Specification (CSP-9-111S2) and contain no "Banned Substances" as defined in CSP-9-111S2.



**National Semiconductor**  
**Americas Customer**  
**Support Center**  
 Email: [new.feedback@nsc.com](mailto:new.feedback@nsc.com)  
 Tel: 1-800-272-9959

**National Semiconductor**  
**Europe Customer Support Center**  
 Fax: +49 (0) 180-530 85 86  
 Email: [europa.support@nsc.com](mailto:europa.support@nsc.com)  
 Deutsch Tel: +49 (0) 69 9508 6208  
 English Tel: +44 (0) 870 24 0 2171  
 Français Tel: +33 (0) 1 41 91 8790

**National Semiconductor**  
**Asia Pacific Customer**  
**Support Center**  
 Email: [ap.support@nsc.com](mailto:ap.support@nsc.com)

**National Semiconductor**  
**Japan Customer Support Center**  
 Fax: 81-3-5639-7507  
 Email: [jpn.feedback@nsc.com](mailto:jpn.feedback@nsc.com)  
 Tel: 81-3-5639-7560

[www.national.com](http://www.national.com)

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Mobile Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Transportation and Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

TI E2E Community Home Page

[e2e.ti.com](http://e2e.ti.com)

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2011, Texas Instruments Incorporated