

## LMx11 Quad Differential Comparators

### 1 Features

- Fast Response Time: 165 ns
- Strobe Capability
- Maximum Input Bias Current: 300 nA
- Maximum Input Offset Current: 70 nA
- Can Operate From Single 5-V Supply
- Available in Q-Temp Automotive
  - High-Reliability Automotive Applications
  - Configuration Control and Print Support
  - Qualification to Automotive Standards
- On Products Compliant to MIL-PRF-38535, All Parameters Are Tested Unless Otherwise Noted. On All Other Products, Production Processing Does Not Necessarily Include Testing of All Parameters.

### 2 Applications

- Desktop PCs

### 3 Description

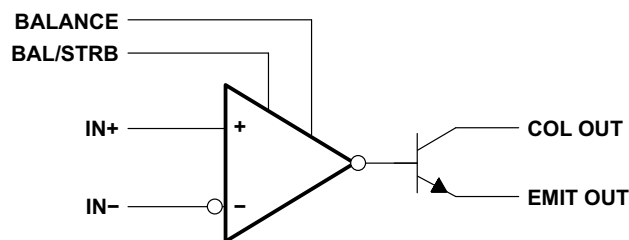
The LM111, LM211, and LM311 devices are single high-speed voltage comparators. These devices are designed to operate from a wide range of power-supply voltages, including  $\pm 15$ -V supplies for operational amplifiers and 5-V supplies for logic systems. The output levels are compatible with most TTL and MOS circuits. These comparators are capable of driving lamps or relays and switching voltages up to 50 V at 50 mA. All inputs and outputs can be isolated from system ground. The outputs can drive loads referenced to ground,  $V_{CC+}$  or  $V_{CC-}$ . Offset balancing and strobe capabilities are available, and the outputs can be wire-OR connected. If the strobe is low, the output is in the off state, regardless of the differential input.

**Device Information<sup>(1)</sup>**

PART NUMBER	PACKAGE	BODY SIZE
LMx11D	SOIC (8)	4.90 mm x 3.91 mm
LMx11DK	LCCC (20)	8.89 mm x 8.89 mm
LMx11JG	CDIP (8)	9.60 mm x 6.67 mm
LMx11P	PDIP (8)	9.81 mm x 6.35 mm
LMx11PS	SOP (8)	6.20 mm x 5.30 mm
LMx11PW	TSSOP (8)	3.00 mm x 4.40 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

### Simplified Schematic



## Table of Contents

<b>1 Features</b> ..... 1 <b>2 Applications</b> ..... 1 <b>3 Description</b> ..... 1 <b>4 Revision History</b> ..... 2 <b>5 Pin Configuration and Functions</b> ..... 3 <b>6 Specifications</b> ..... 4 6.1 Absolute Maximum Ratings ..... 4 6.2 ESD Ratings ..... 4 6.3 Recommended Operating Conditions ..... 4 6.4 Thermal Information (8-Pin Packages) ..... 5 6.5 Thermal Information (20-Pin Package) ..... 5 6.6 Electrical Characteristics ..... 5 6.7 Switching Characteristics ..... 6 6.8 Typical Characteristics ..... 7 <b>7 Parameter Measurement Information</b> ..... 9 <b>8 Detailed Description</b> ..... 10 8.1 Overview ..... 10 8.2 Functional Block Diagram ..... 10	8.3 Feature Description ..... 10 8.4 Device Functional Modes ..... 11 <b>9 Application and Implementation</b> ..... 12 9.1 Application Information ..... 12 9.2 Typical Application ..... 12 9.3 System Examples ..... 14 <b>10 Power Supply Recommendations</b> ..... 20 <b>11 Layout</b> ..... 20 11.1 Layout Guidelines ..... 20 11.2 Layout Example ..... 20 <b>12 Device and Documentation Support</b> ..... 21 12.1 Related Links ..... 21 12.2 Community Resources ..... 21 12.3 Trademarks ..... 21 12.4 Electrostatic Discharge Caution ..... 21 12.5 Glossary ..... 21 <b>13 Mechanical, Packaging, and Orderable Information</b> ..... 21
---	--

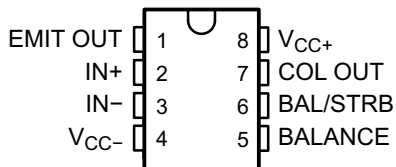
## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

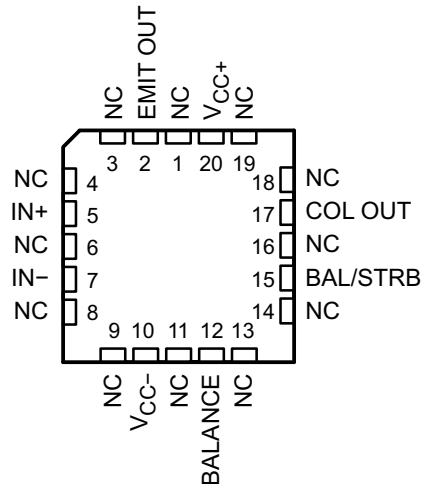
Changes from Revision H (August 2003) to Revision I	Page
<ul style="list-style-type: none"> <li>• Updated <i>Features</i> with Military Disclaimer ..... 1</li> <li>• Added <i>Applications</i>, <i>Device Information</i> table, <i>Pin Configuration and Functions</i> section, <i>ESD Ratings</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i>, <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section. No specification changes ..... 1</li> </ul>	  1 1

## 5 Pin Configuration and Functions

**D, JG, P, PS, or PW Package  
8-Pin SOIC, CDIP, PDIP, SOP or TSSOP  
Top View**



**FK Package  
20-Pin LCCC<sup>(1)</sup>  
Top View**



(1) NC = No internal connection

### Pin Functions

NAME	PIN		I/O <sup>(1)</sup>	DESCRIPTION
	SOIC, CDIP, PDIP, SOP, TSSOP	LCCC		
1IN+	2	5	I	Noninverting comparator
1IN-	3	7	I	Inverting input comparator
BALANCE	5	12	I	Balance
BAL/STRB	6	15	I	Strobe
COL OUT	7	17	O	Output collector comparator
EMIT OUT	1	2	O	Output emitter comparator
V <sub>CC-</sub>	4	10	—	Negative supply
V <sub>CC+</sub>	8	20	—	Positive supply
NC	—	1	—	No connect (No internal connection)
		3		
		4		
		6		
		8		
		9		
		11		
		13		
		14		
		16		
18				
19				

(1) I = Input, O = Output

## 6 Specifications

### 6.1 Absolute Maximum Ratings

 over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
Supply voltage	$V_{CC+}$ <sup>(2)</sup>		18	V
	$V_{CC-}$ <sup>(2)</sup>		-18	
	$V_{CC+} - V_{CC-}$		36	
$V_{ID}$	Differential input voltage <sup>(3)</sup>		±30	V
$V_I$	Input voltage (either input) <sup>(2)(4)</sup>		±15	V
	Voltage from emitter output to $V_{CC-}$		30	V
Voltage from collector output to $V_{CC-}$	LM111		50	V
	LM211		50	
	LM211Q		50	
	LM311		40	
	Duration of output short circuit to ground		10	s
$T_J$	Operating virtual-junction temperature		150	°C
	Case temperature for 60 s	FK package	260	°C
	Lead temperature 1,6 mm (1/16 inch) from case, 10 s	J or JG package	300	°C
	Lead temperature 1,6 mm (1/16 inch) from case, 60 s	D, P, PS, or PW package	260	°C
$T_{stg}$	Storage temperature range	-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values, unless otherwise noted, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .
- (3) Differential voltages are at IN+ with respect to IN-.
- (4) The magnitude of the input voltage must never exceed the magnitude of the supply voltage or ±15 V, whichever is less.

### 6.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±1000
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±750

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

		MIN	MAX	UNIT
$V_{CC+} - V_{CC-}$	Supply voltage	3.5	30	V
$V_I$	Input voltage ( $ V_{CC+}  \leq 15$ V)	$V_{CC-} + 0.5$	$V_{CC+} - 1.5$	V
$T_A$	Operating free-air temperature range	LM111	-55	125
		LM211	-40	85
		LM211Q	-40	125
		LM311	0	70

## 6.4 Thermal Information (8-Pin Packages)

THERMAL METRIC <sup>(1)</sup>	LMx11					UNIT
	D (SOIC)	P (PDIP)	PS (SOP)	PW (TSSOP)	JG (CDIP)	
	8 PINS	8 PINS	8 PINS	8 PINS	8 PINS	
R <sub>θJA</sub> Junction-to-ambient thermal resistance	97	85	95	149	—	°C/W
R <sub>θJC(top)</sub> Junction-to-case (top) thermal resistance	—	—	—	—	14.5	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).

## 6.5 Thermal Information (20-Pin Package)

THERMAL METRIC <sup>(1)</sup>	LMx11	UNIT
	FK (LCCC)	
	20 PINS	
R <sub>θJC(top)</sub> Junction-to-case (top) thermal resistance	5.61	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, [SPRA953](#).

## 6.6 Electrical Characteristics

at specified free-air temperature, V<sub>CC±</sub> = ±15 V (unless otherwise noted)

PARAMETER	TEST CONDITIONS	T <sub>A</sub> <sup>(1)</sup>	LM111 LM211 LM211Q			LM311			UNIT
			MIN	TYP <sup>(2)</sup>	MAX	MIN	TYP <sup>(2)</sup>	MAX	
V <sub>IO</sub> Input offset voltage	See <sup>(3)</sup>	25°C	0.7 3			2 7.5			mV
		Full range	4			10			
I <sub>IO</sub> Input offset current	See <sup>(3)</sup>	25°C	4 10			6 50			nA
		Full range	20			70			
I <sub>IB</sub> Input bias current	1 V ≤ V <sub>O</sub> ≤ 14 V	25°C	75 100			100 250			nA
		Full range	150			300			
I <sub>IL(S)</sub> Low-level strobe current <sup>(4)</sup>	V <sub>(strobe)</sub> = 0.3 V, V <sub>ID</sub> ≤ -10 mV	25°C	-3			-3			mA
V <sub>ICR</sub> Common-mode input-voltage range <sup>(3)</sup>	Lower range	Full range	-14.7 -14.5			-14.7 -14.5			V
	Upper range		13 13.8			13 13.8			
A <sub>VD</sub> Large-signal differential-voltage amplification	5 V ≤ V <sub>O</sub> ≤ 35 V, R <sub>L</sub> = 1 kΩ	25°C	40 200			40 200			V/mV
I <sub>OH</sub> High-level (collector) output leakage current	I <sub>(strobe)</sub> = -3 mA, V <sub>ID</sub> = 5 mV, V <sub>OH</sub> = 35 V	25°C	0.2 10						nA
		Full range	0.5						μA
V <sub>OL</sub> Low-level (collector-to-emitter) output voltage	I <sub>OL</sub> = 50 mA	V <sub>ID</sub> = -5 mV	0.75 1.5						V
		V <sub>ID</sub> = -10 mV	0.75 1.5						
	V <sub>CC+</sub> = 4.5 V, V <sub>CC-</sub> = 0 V, I <sub>OL</sub> = 8 mA	V <sub>ID</sub> = -6 mV	0.23 0.4			0.23 0.4			
		V <sub>ID</sub> = -10 mV	0.23 0.4			0.23 0.4			
I <sub>CC+</sub> Supply current from V <sub>CC+</sub> output low	V <sub>ID</sub> = -10 mV, No load	25°C	5.1 6			5.1 7.5			mA
I <sub>CC-</sub> Supply current from V <sub>CC-</sub> output high	V <sub>ID</sub> = 10 mV, No load	25°C	-4.1 -5			-4.1 -5			mA

(1) Unless otherwise noted, all characteristics are measured with BALANCE and BAL/STRB open and EMIT OUT grounded. Full range for LM111 is -55°C to 125°C, for LM211 is -40°C to 85°C, for LM211Q is -40°C to 125°C, and for LM311 is 0°C to 70°C.

(2) All typical values are at T<sub>A</sub> = 25°C.

(3) The offset voltages and offset currents given are the maximum values required to drive the collector output up to 14 V or down to 1 V with a pullup resistor of 7.5 kΩ to V<sub>CC+</sub>. These parameters actually define an error band and take into account the worst-case effects of voltage gain and input impedance.

(4) The strobe must not be shorted to ground; it must be current driven at -3 mA to -5 mA (see [Figure 18](#) and [Figure 31](#)).

## 6.7 Switching Characteristics

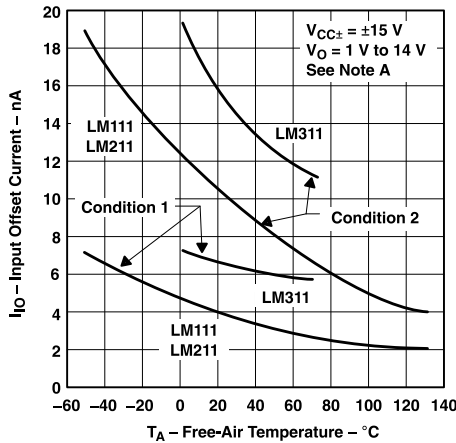
 $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$ 

PARAMETER	TEST CONDITIONS	LM111 LM211 LM211Q LM311	UNIT
		TYP	
Response time, low-to-high-level outputSee <sup>(1)</sup>	$R_C = 500\ \Omega$ to 5 V, $C_L = 5\ \text{pF}$ , see <sup>(2)</sup>	115	ns
Response time, high-to-low-level outputSee <sup>(1)</sup>		165	ns

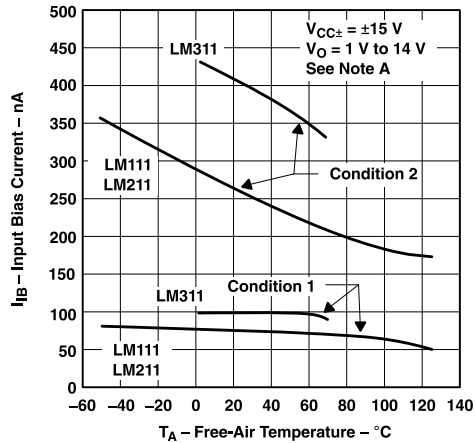
(1) The response time specified is for a 100-mV input step with 5-mV overdrive and is the interval between the input step function and the instant when the output crosses 1.4 V.

(2) The package thermal impedance is calculated in accordance with MIL-STD-883.

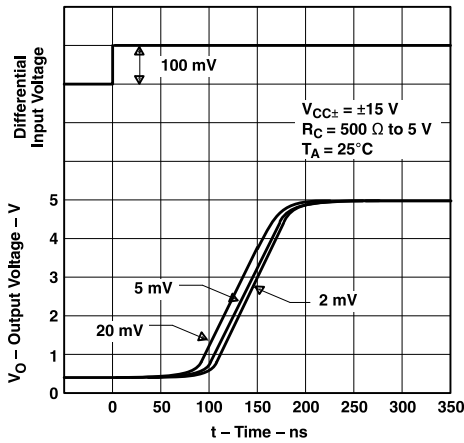
### 6.8 Typical Characteristics



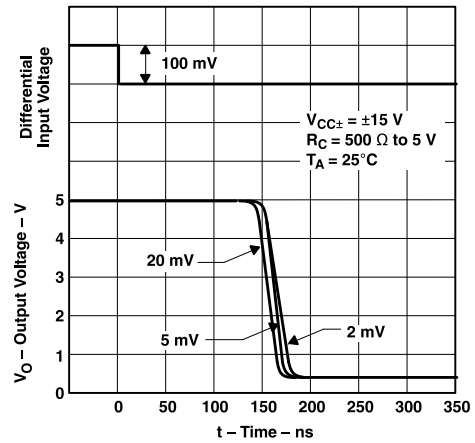
Condition 1 is with BALANCE and BAL/STRB open.  
Condition 2 is with BALANCE and BAL/STRB connected to  $V_{CC+}$ .  
**Figure 1. Input Offset Current vs Free-Air Temperature**



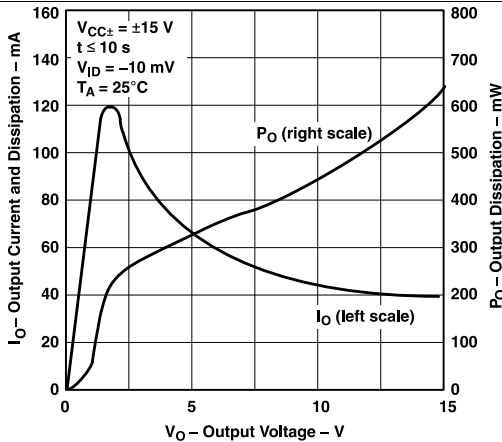
Condition 1 is with BALANCE and BAL/STRB open.  
Condition 2 is with BALANCE and BAL/STRB connected to  $V_{CC+}$ .  
**Figure 2. Input Bias Current vs Free-Air Temperature**



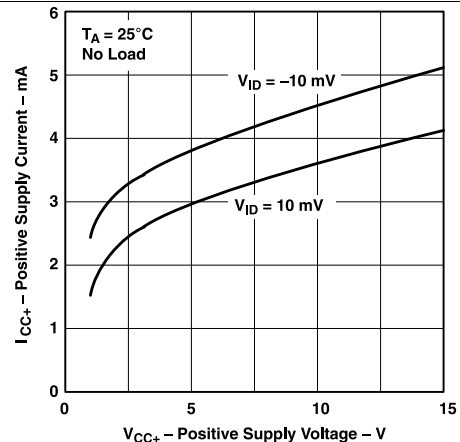
**Figure 3. Output Response for Various Input Overdrives**



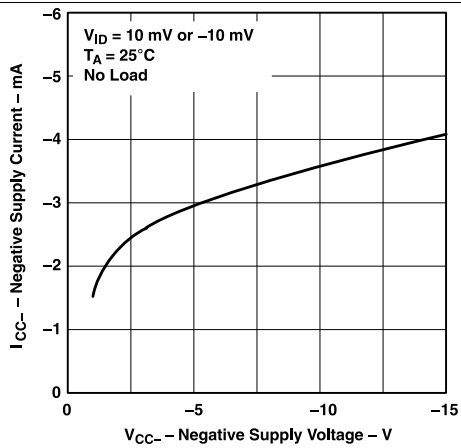
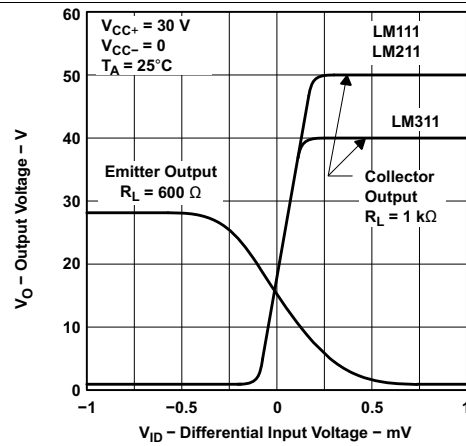
**Figure 4. Output Response for Various Input Overdrives**



**Figure 5. Output Current and Dissipation vs Output Voltage**



**Figure 6. Positive Supply Current vs Positive Supply Voltage**

**Typical Characteristics (continued)**

**Figure 7. Negative Supply Current vs Negative Supply Voltage**

**Figure 8. Voltage Transfer Characteristics and Test Circuits**



## 7 Parameter Measurement Information

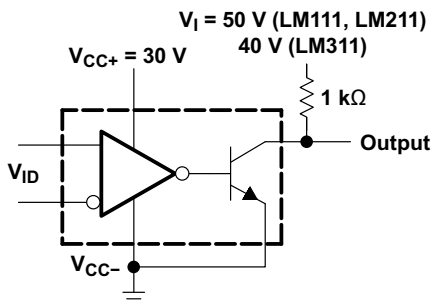


Figure 9. Collector Output Transfer Characteristic Test Circuit

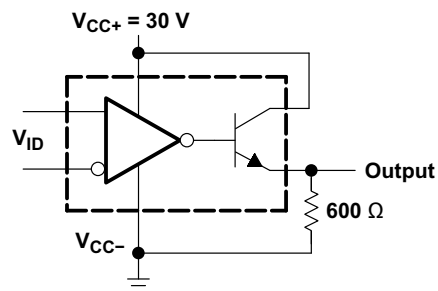


Figure 10. Emitter Output Transfer Characteristic Test Circuit

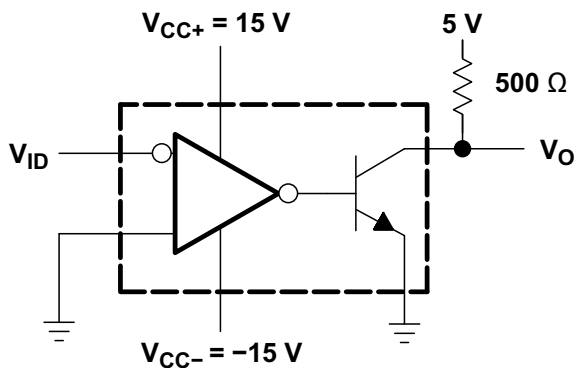


Figure 11. Test Circuit for [Figure 3](#) and [Figure 4](#)

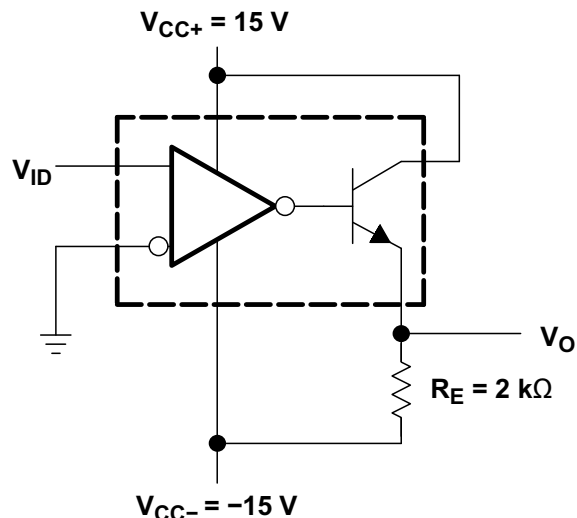


Figure 12. Test Circuit for [Figure 14](#) and [Figure 15](#)

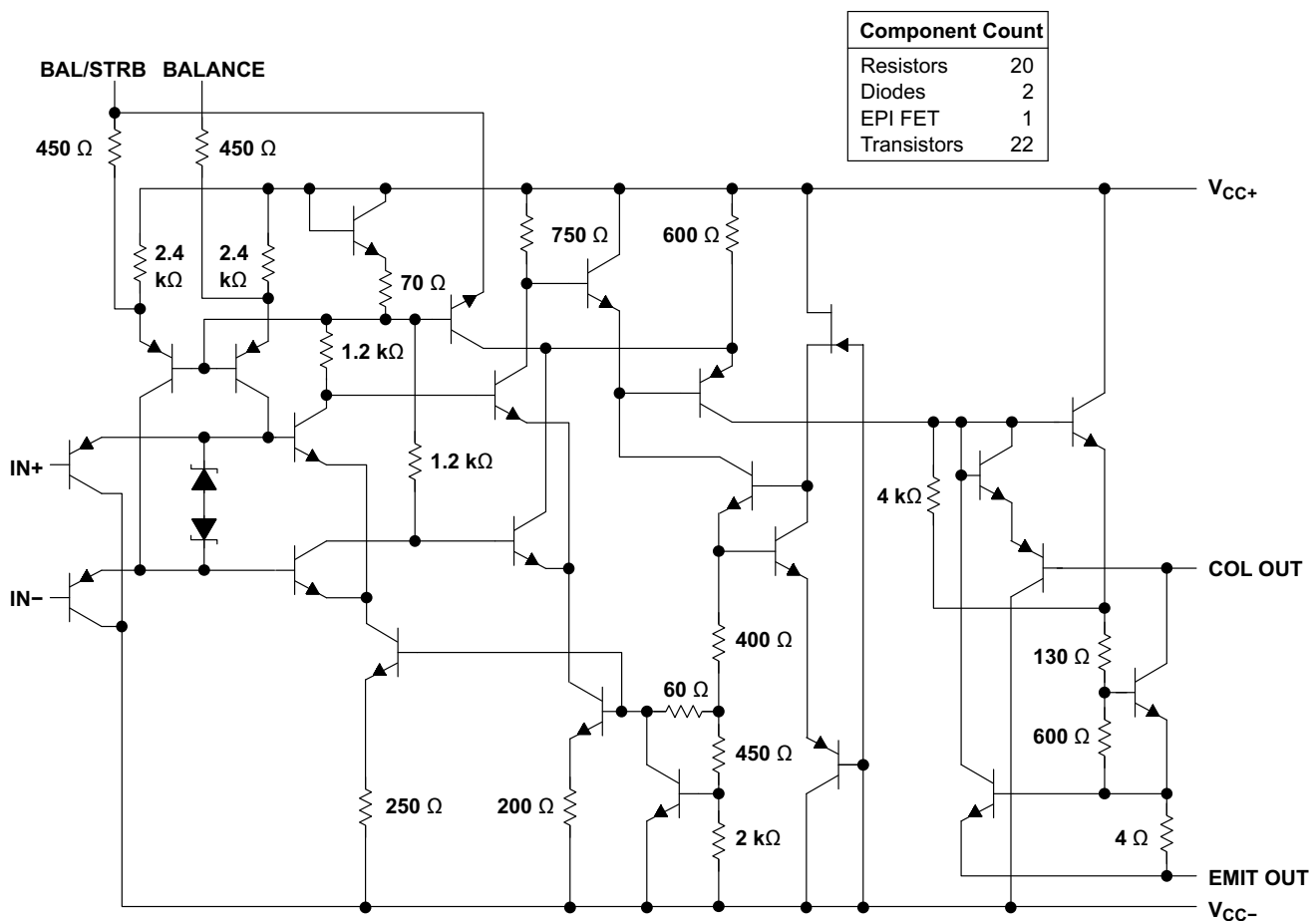
## 8 Detailed Description

### 8.1 Overview

The LM111, LM211 and LM311 are voltage comparators that have input currents nearly a thousand times lower than legacy standard devices. They are also designed to operate over a wider range of supply voltages: from standard  $\pm 15\text{V}$  op amp supplies down to the single 5-V supply used for IC logic. Their output is compatible with RTL, DTL and TTL as well as MOS circuits. Further, they can drive lamps or relays, switching voltages up to 50 V at currents as high as 50 mA.

Both the inputs and the outputs of the LM111, LM211 or the LM311 can be isolated from system ground, and the output can drive loads referred to ground, the positive supply or the negative supply. Offset balancing and strobe capability are provided and outputs can be wire ORed. The LM211 is identical to the LM111, except that its performance is specified over a  $-25^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  temperature range instead of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . The LM311 has a temperature range of  $0^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .

### 8.2 Functional Block Diagram



### 8.3 Feature Description

LMx11 consists of a PNP input stage to sense voltages near  $V_{CC-}$ . It also contains balance and strobe pins for external offset adjustment or trimming.

The input stage is followed by a very high gain stage for very fast response after a voltage difference on the input pins have been sensed.

## Feature Description (continued)

This is then followed by the output stage that consists of an open collector NPN (pulldown or low-side) transistor. Unlike most open drain comparators, this NPN output stage has an isolated emitter from  $V_{CC-}$ , allowing this device to set the  $V_{OL}$  output value for collector output.

## 8.4 Device Functional Modes

### 8.4.1 Voltage Comparison

The LMx11 operates solely as a voltage comparator, comparing the differential voltage between the positive and negative pins and outputting a logic low or high impedance (logic high with pullup) based on the input differential polarity.

## 9 Application and Implementation

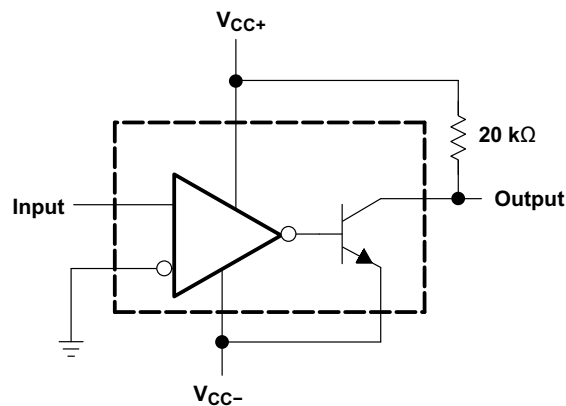
### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Validate and test the design implementation to confirm system functionality.

### 9.1 Application Information

A typical LMx11 application compares a single signal to a reference or two signals against each other. Many users take advantage of the open-drain output to drive the comparison logic output to a logic voltage level to an MCU or logic device. The wide supply range and high voltage capability makes LMx11 optimal for level shifting to a higher or lower voltage.

### 9.2 Typical Application



**Figure 13. Zero-Crossing Detector**

#### 9.2.1 Design Requirements

For this design example, use the parameters listed in [Table 1](#) as the input parameters.

**Table 1. Design Parameters**

PARAMETER		MIN	TYP	MAX	UNIT
$V_{IN}$	Input voltage range	-15		13	V
$V_{CC+}$	Positive supply voltage			15	V
$V_{CC-}$	Negative supply voltage	-15			
$I_{OUT}$	Output current			20	mA

#### 9.2.2 Detailed Design Procedure

When using LMx11 in a general comparator application, determine the following:

- Input voltage range
- Minimum overdrive voltage
- Output and drive current
- Response time

##### 9.2.2.1 Input Voltage Range

When choosing the input voltage range, consider the input common mode voltage range ( $V_{ICR}$ ). Operation outside of this range can yield incorrect comparisons.

The following list describes the outcomes of some input voltage situations.

- When both IN– and IN+ are both within the common-mode range:
  - If IN– is higher than IN+ and the offset voltage, the output is low and the output transistor is sinking current
  - If IN– is lower than IN+ and the offset voltage, the output is high impedance and the output transistor is not conducting
- When IN– is higher than common mode and IN+ is within common mode, the output is low and the output transistor is sinking current
- When IN+ is higher than common mode and IN– is within common mode, the output is high impedance and the output transistor is not conducting
- When IN– and IN+ are both higher than common mode, the output is undefined

### 9.2.2.2 Minimum Overdrive Voltage

Overdrive voltage is the differential voltage produced between the positive and negative inputs of the comparator over the offset voltage ( $V_{IO}$ ). In order to make an accurate comparison the Overdrive voltage ( $V_{OD}$ ) must be higher than the input offset voltage ( $V_{IO}$ ). Overdrive voltage can also determine the response time of the comparator, with the response time decreasing with increasing overdrive. [Figure 14](#) and [Figure 15](#) show positive and negative response times with respect to overdrive voltage.

### 9.2.2.3 Output and Drive Current

Output current is determined by the pullup resistance and pullup voltage. The output current produces a output low voltage ( $V_{OL}$ ) from the comparator, in which  $V_{OL}$  is proportional to the output current. Use [Figure 5](#) to determine  $V_{OL}$  based on the output current.

The output current can also effect the transient response.

### 9.2.2.4 Response Time

The load capacitance ( $C_L$ ), pullup resistance ( $R_{PULLUP}$ ), and equivalent collector-emitter resistance ( $R_{CE}$ ) levels determine the transient response. [Equation 1](#) approximates the positive response time. [Equation 2](#) approximates the negative response time.  $R_{CE}$  can be determine by taking the slope of [Figure 5](#) in the linear region at the desired temperature, or by [Equation 3](#).

$$\tau_P \cong R_{PULLUP} \times C_L \quad (1)$$

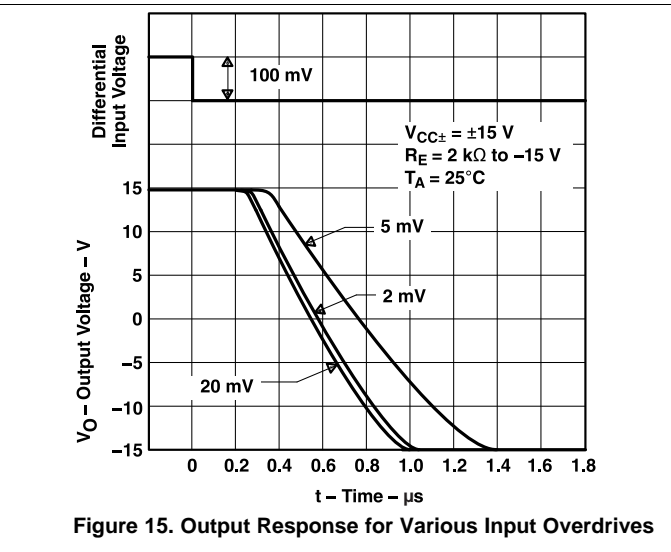
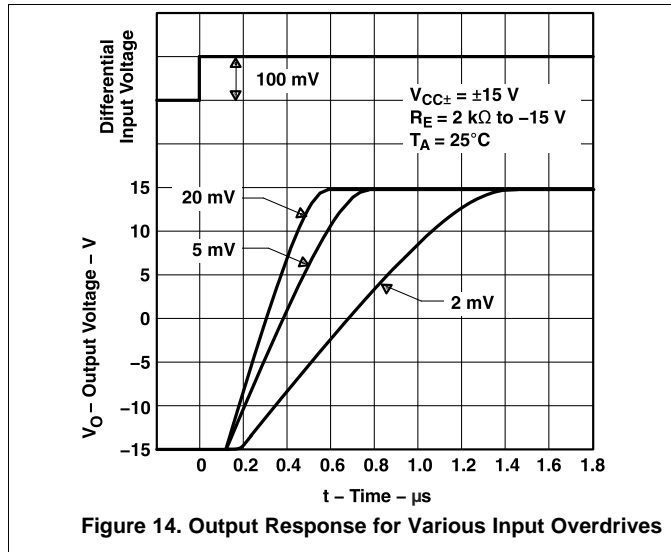
$$\tau_N \cong R_{CE} \times C_L \quad (2)$$

$$R_{CE} = \frac{V_{OL}}{I_{OUT}}$$

where

- $V_{OL}$  is the low-level output voltage
  - $I_{OUT}$  is the output current
- (3)

### 9.2.3 Application Curves



### 9.3 System Examples

Figure 16 through Figure 33 show various applications for the LM111, LM211, and LM311 comparators.

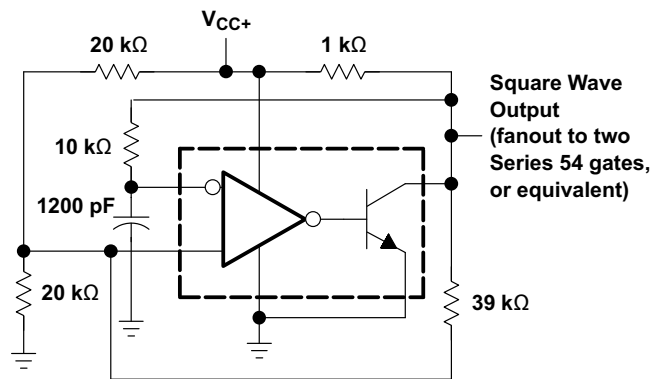
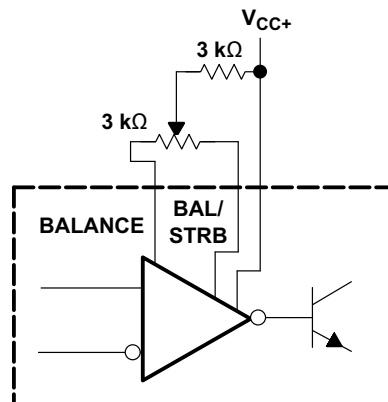


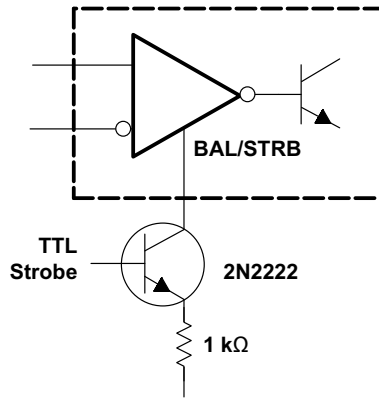
Figure 16. 100-kHz Free-Running Multivibrator



If offset balancing is not used, the BALANCE and BAL/STRB pins must be unconnected. It is also acceptable to short pins together.

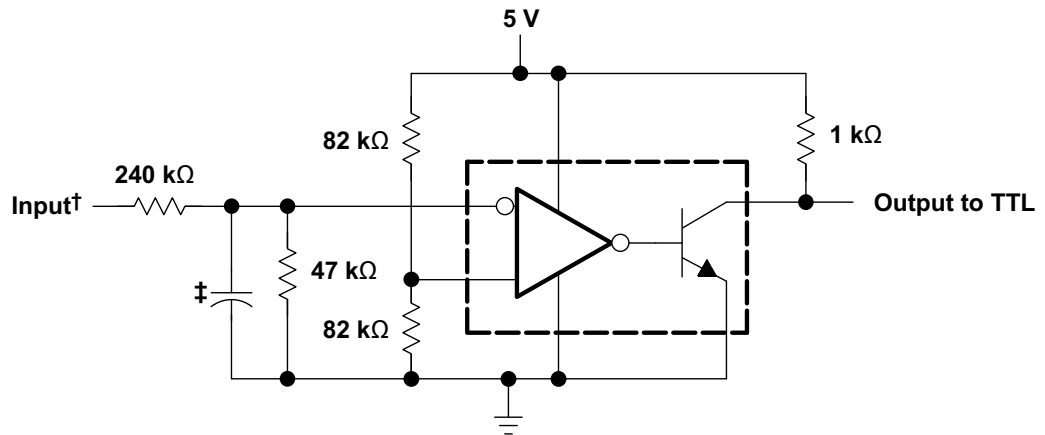
Figure 17. Offset Balancing

System Examples (continued)



Do not connect strobe pin directly to ground, because the output is turned off whenever current is pulled from the strobe pin.

Figure 18. Strobing



† Resistor values shown are for a 0- to 30-V logic swing and a 15-V threshold.  
‡ May be added to control speed and reduce susceptibility to noise spikes

Figure 19. TTL Interface With High-Level Logic

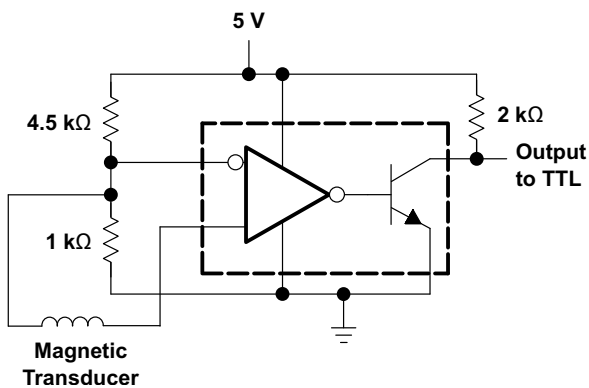


Figure 20. Detector for Magnetic Transducer

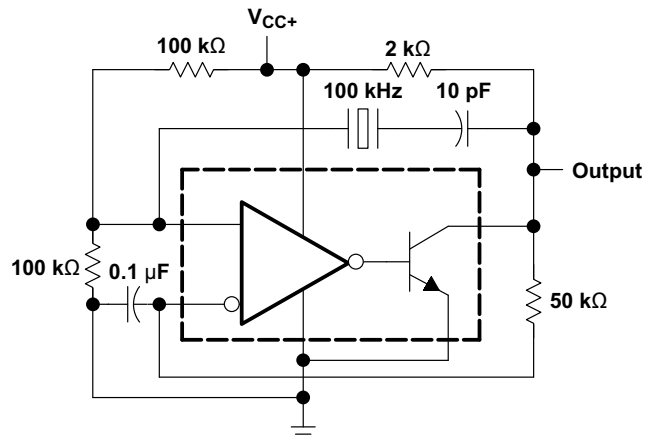


Figure 21. 100-kHz Crystal Oscillator

System Examples (continued)

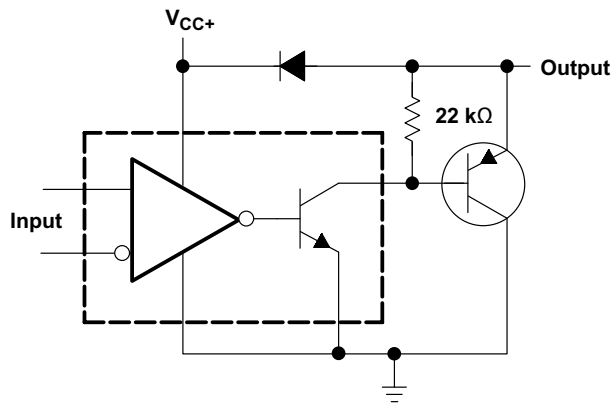
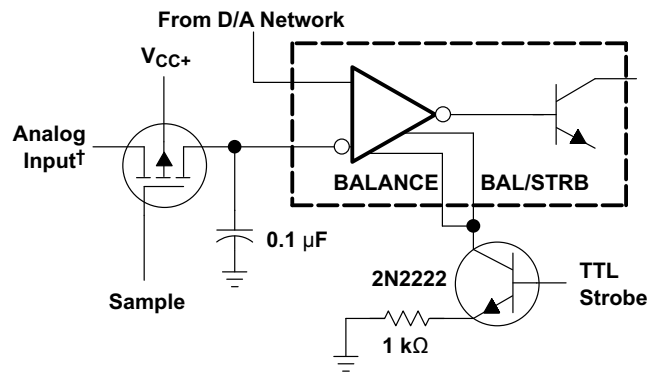


Figure 22. Comparator and Solenoid Driver



† Typical input current is 50 pA with inputs strobed off.

Figure 23. Strobing Both Input and Output Stages Simultaneously

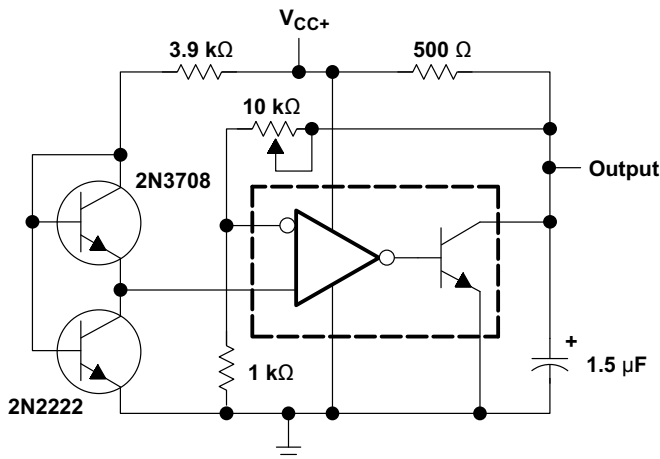


Figure 24. Low-Voltage Adjustable Reference Supply

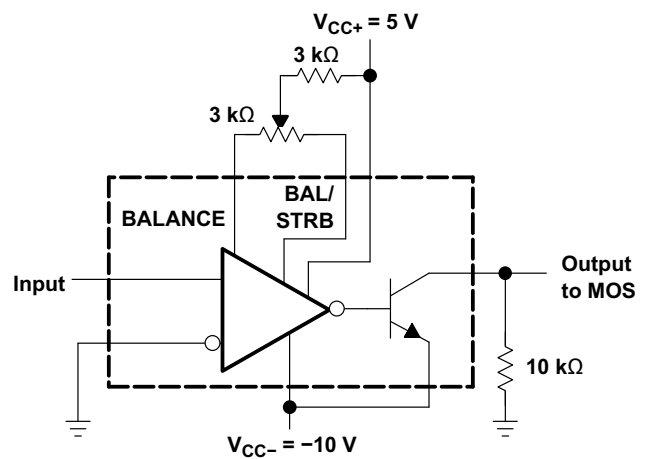
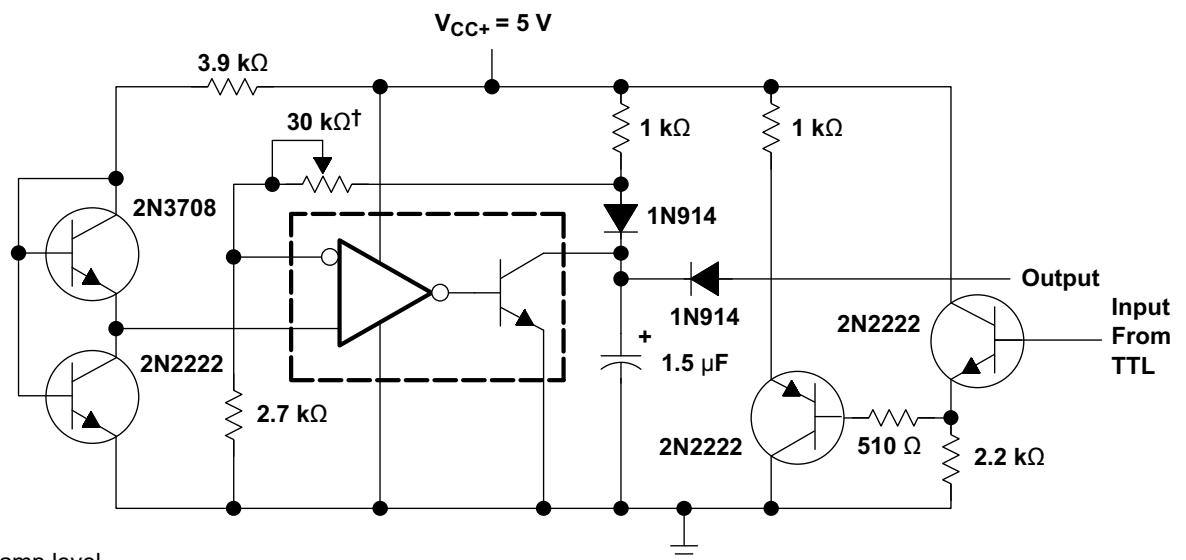


Figure 25. Zero-Crossing Detector Driving MOS Logic



† Adjust to set clamp level

Figure 26. Precision Squarer



System Examples (continued)

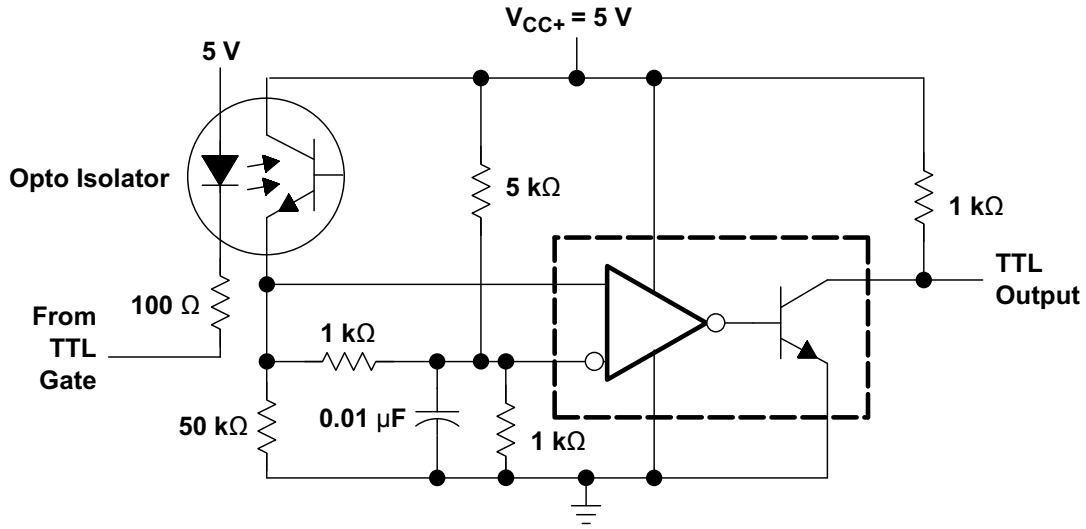


Figure 27. Digital Transmission Isolator

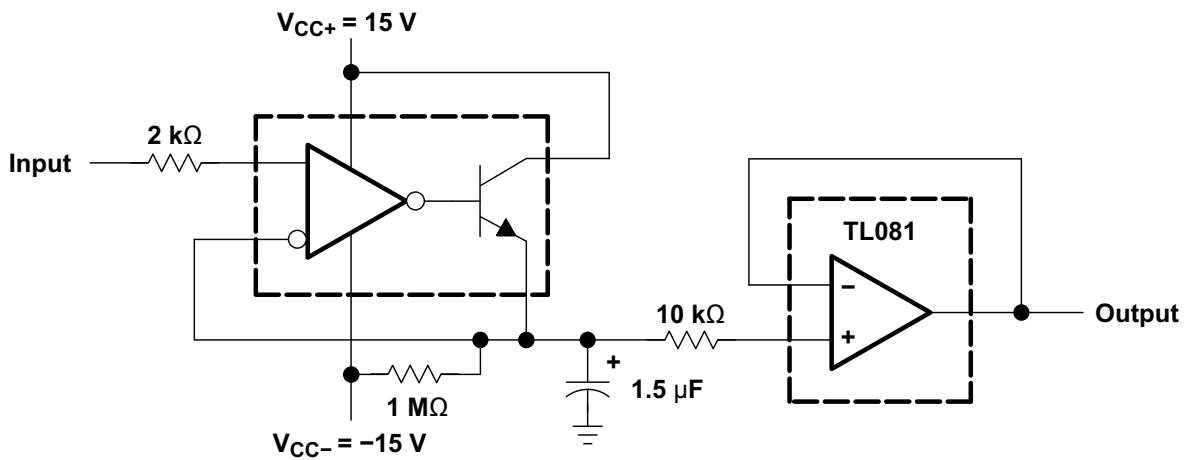


Figure 28. Positive-Peak Detector

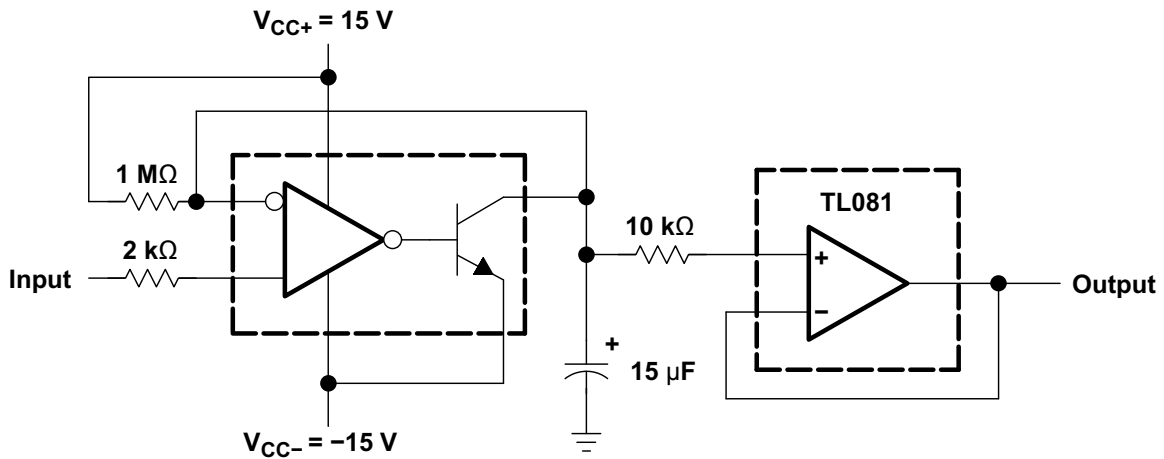
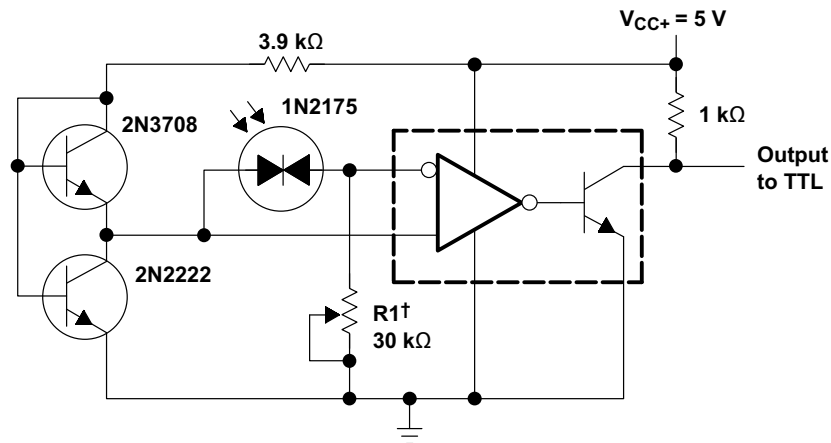


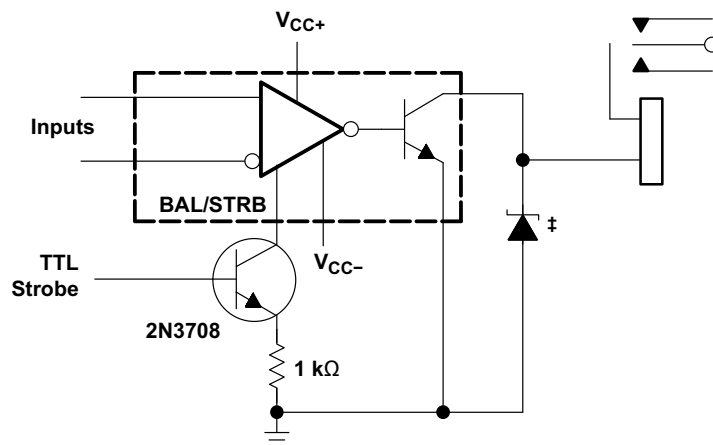
Figure 29. Negative-Peak Detector

System Examples (continued)



† R1 sets the comparison level. At comparison, the photodiode has less than 5 mV across it, decreasing dark current by an order of magnitude.

Figure 30. Precision Photodiode Comparator



‡ Transient voltage and inductive kickback protection

Figure 31. Relay Driver With Strobe

System Examples (continued)

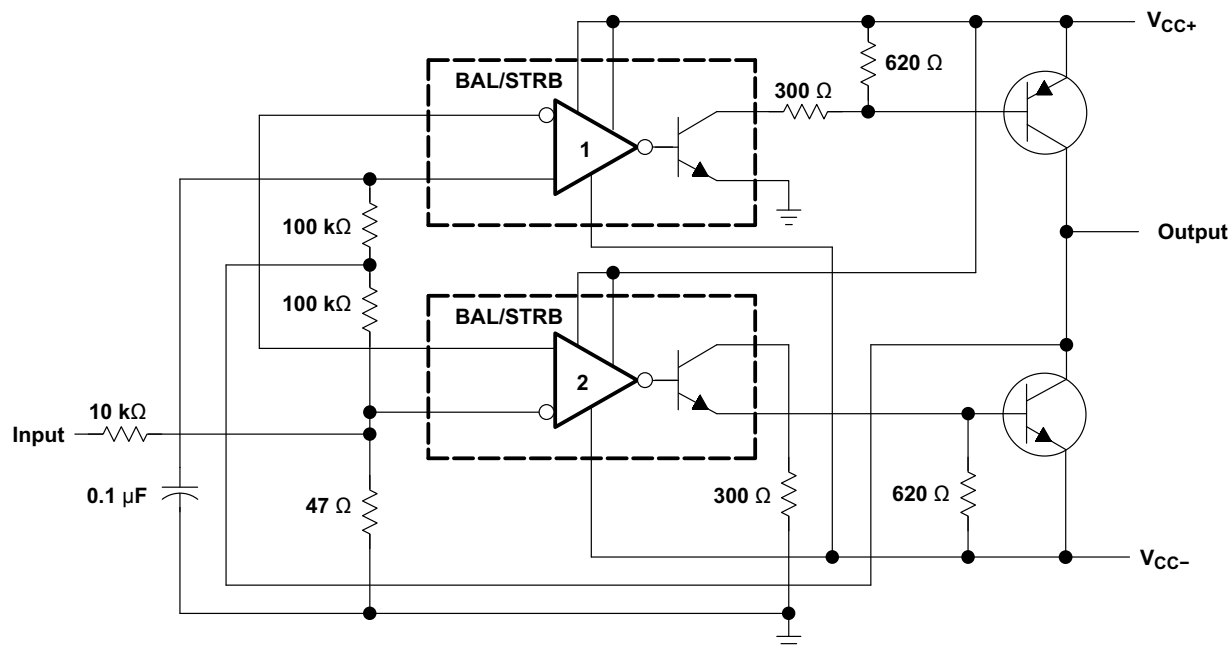


Figure 32. Switching Power Amplifier

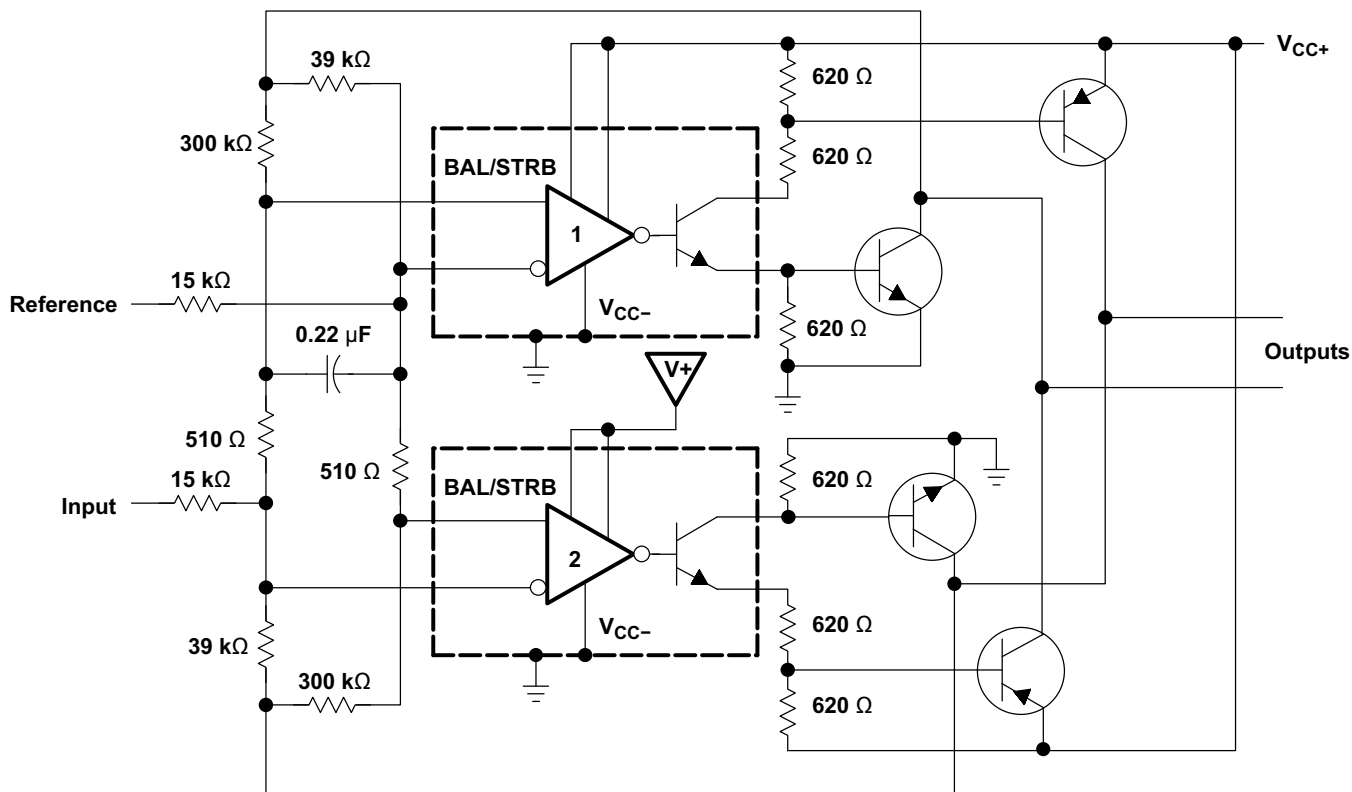


Figure 33. Switching Power Amplifiers

## 10 Power Supply Recommendations

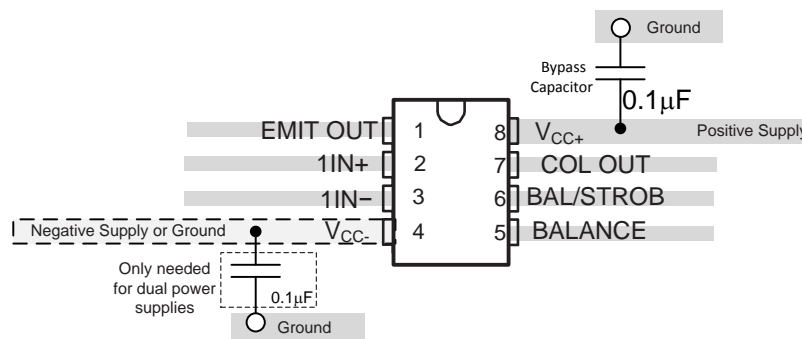
For fast response and comparison applications with noisy or AC inputs, use a bypass capacitor on the supply pin to reject any variation on the supply voltage. This variation can affect the common-mode range of the comparator input and create an inaccurate comparison.

## 11 Layout

### 11.1 Layout Guidelines

To create an accurate comparator application without hysteresis, maintain a stable power supply with minimized noise and glitches, which can affect the high level input common-mode voltage range. To achieve this accuracy, add a bypass capacitor between the supply voltage and ground. Place a bypass capacitor on the positive power supply and negative supply (if available).

### 11.2 Layout Example



**Figure 34. LMx11 Layout Example**

## 12 Device and Documentation Support

### 12.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

**Table 2. Related Links**

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
LM111	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>
LM211	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>
LM311	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>

### 12.2 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At [e2e.ti.com](http://e2e.ti.com), you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

### 12.3 Trademarks

E2E is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

### 12.4 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 12.5 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
JM38510/10304BPA	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	JM38510 /10304BPA	<a href="#">Samples</a>
LM111 MD8	ACTIVE	DIESALE	Y	0	300	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM			<a href="#">Samples</a>
LM111 MW8	ACTIVE	WAFERSALE	YS	0	1	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM			<a href="#">Samples</a>
LM111-MDE	ACTIVE	DIESALE	Y	0	40	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM			<a href="#">Samples</a>
LM111FKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	LM111FKB	<a href="#">Samples</a>
LM111JG	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	LM111JG	<a href="#">Samples</a>
LM111JGB	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	LM111JGB	<a href="#">Samples</a>
LM211D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LM211	<a href="#">Samples</a>
LM211DE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LM211	<a href="#">Samples</a>
LM211DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LM211	<a href="#">Samples</a>
LM211DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LM211	<a href="#">Samples</a>
LM211DRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LM211	<a href="#">Samples</a>
LM211DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LM211	<a href="#">Samples</a>
LM211P	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	LM211P	<a href="#">Samples</a>
LM211PE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	LM211P	<a href="#">Samples</a>
LM211PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	L211	<a href="#">Samples</a>
LM211PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	L211	<a href="#">Samples</a>

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM211PWRE4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	L211	<a href="#">Samples</a>
LM211PWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	L211	<a href="#">Samples</a>
LM211QD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LM211Q	<a href="#">Samples</a>
LM211QDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LM211Q	<a href="#">Samples</a>
LM211QDR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LM211Q	<a href="#">Samples</a>
LM211QDRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	LM211Q	<a href="#">Samples</a>
LM311-MWC	ACTIVE	WAFERSALE	YS	0	1	Green (RoHS & no Sb/Br)	Call TI	Level-1-NA-UNLIM			<a href="#">Samples</a>
LM311D	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LM311	<a href="#">Samples</a>
LM311DE4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LM311	<a href="#">Samples</a>
LM311DG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LM311	<a href="#">Samples</a>
LM311DR	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU   CU SN	Level-1-260C-UNLIM	0 to 70	LM311	<a href="#">Samples</a>
LM311DRE4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LM311	<a href="#">Samples</a>
LM311DRG4	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	LM311	<a href="#">Samples</a>
LM311P	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	LM311P	<a href="#">Samples</a>
LM311PE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	0 to 70	LM311P	<a href="#">Samples</a>
LM311PSR	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	L311	<a href="#">Samples</a>
LM311PSRE4	ACTIVE	SO	PS	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	L311	<a href="#">Samples</a>
LM311PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	L311	<a href="#">Samples</a>

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM311PWG4	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	L311	<a href="#">Samples</a>
LM311PWLE	OBSOLETE	TSSOP	PW	8		TBD	Call TI	Call TI			
LM311PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	L311	<a href="#">Samples</a>
LM311PWRG4	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	0 to 70	L311	<a href="#">Samples</a>
LM311Y	OBSOLETE	DIESALE	Y	0		TBD	Call TI	Call TI			
M38510/10304BPA	ACTIVE	CDIP	JG	8	1	TBD	A42	N / A for Pkg Type	-55 to 125	JM38510 /10304BPA	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.



**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF LM211 :**

- Automotive: [LM211-Q1](#)
- Enhanced Product: [LM211-EP](#)

**NOTE: Qualified Version Definitions:**

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM211DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM211DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM211DRG4	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM211DRG4	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM211PWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM311DR	SOIC	D	8	2500	330.0	12.8	6.4	5.2	2.1	8.0	12.0	Q1
LM311DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM311DR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM311DRG4	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM311DRG4	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM311PSR	SO	PS	8	2000	330.0	16.4	8.2	6.6	2.5	12.0	16.0	Q1
LM311PWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

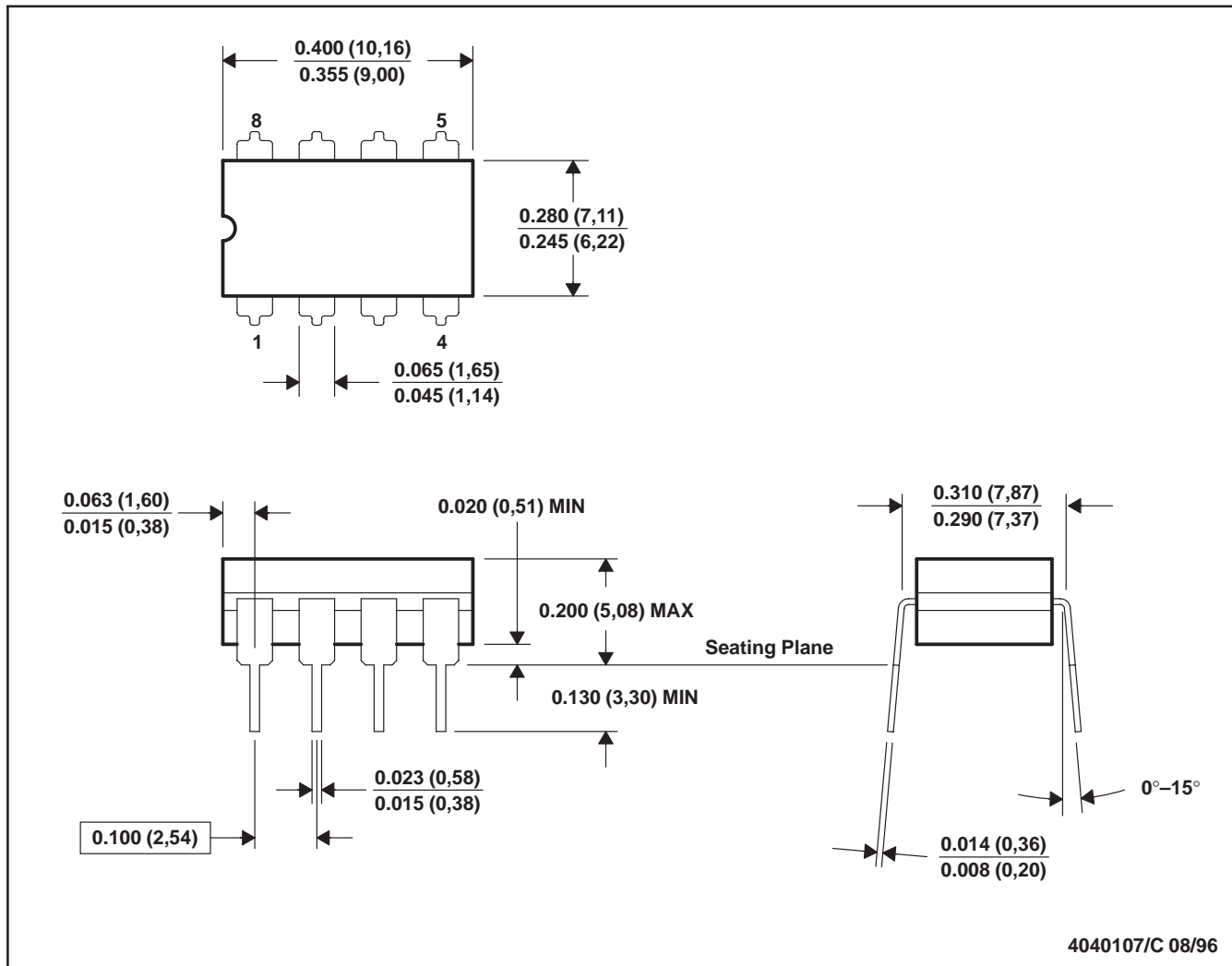
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM211DR	SOIC	D	8	2500	340.5	338.1	20.6
LM211DR	SOIC	D	8	2500	367.0	367.0	35.0
LM211DRG4	SOIC	D	8	2500	340.5	338.1	20.6
LM211DRG4	SOIC	D	8	2500	367.0	367.0	35.0
LM211PWR	TSSOP	PW	8	2000	367.0	367.0	35.0
LM311DR	SOIC	D	8	2500	364.0	364.0	27.0
LM311DR	SOIC	D	8	2500	367.0	367.0	35.0
LM311DR	SOIC	D	8	2500	340.5	338.1	20.6
LM311DRG4	SOIC	D	8	2500	367.0	367.0	35.0
LM311DRG4	SOIC	D	8	2500	340.5	338.1	20.6
LM311PSR	SO	PS	8	2000	367.0	367.0	38.0
LM311PWR	TSSOP	PW	8	2000	367.0	367.0	35.0

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification.  
 E. Falls within MIL STD 1835 GDIP1-T8

FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



4040140/D 01/11

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package can be hermetically sealed with a metal lid.
  - D. Falls within JEDEC MS-004

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

PW0008A



# PACKAGE OUTLINE

## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4221848/A 02/2015

### NOTES:

- All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
- This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
- Reference JEDEC registration MO-153, variation AA.

# EXAMPLE BOARD LAYOUT

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

4221848/A 02/2015

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



# EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:10X

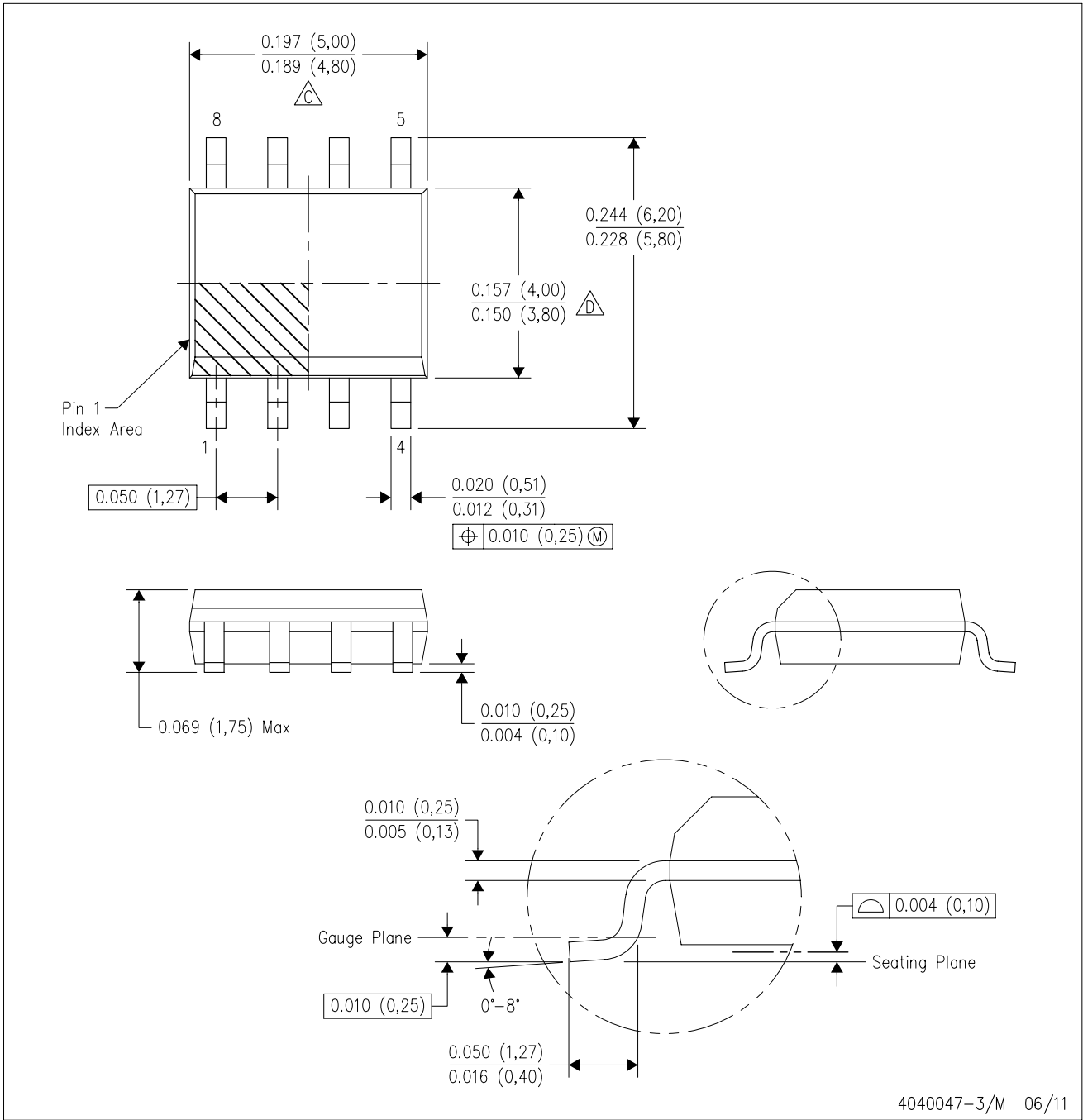
4221848/A 02/2015

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



4040047-3/M 06/11

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AA.

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

## MECHANICAL DATA

PS (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

PS (R-PDSO-G8)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

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

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license 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 significant portions 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. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### 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 Applications 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

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
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>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

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