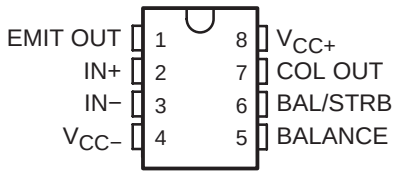
# LM211-Q1
# DIFFERENTIAL COMPARATOR WITH STROBES

SLCS143A − APRIL 2004 − REVISED APRIL 2008

- **Qualified for Automotive Applications**
- **Fast Response Times**
- **Strobe Capability**
- **Maximum Input Bias Current . . . 150 nA**
- **Maximum Input Offset Current . . . 20 nA**
- **Can Operate From Single 5-V Supply**

**D PACKAGE**
**(TOP VIEW)**




## description/ordering information

The LM211 is a single high-speed voltage comparator. This device is designed to operate from a wide range of power-supply voltages, including ±15-V supplies for operational amplifiers and 5-V supplies for logic systems. The output levels are compatible with most TTL and MOS circuits. This comparator is 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.

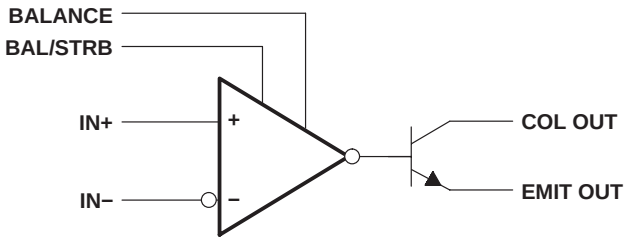
**ORDERING INFORMATION†**

| $T_A$ | $V_{IO}$ max AT 25°C | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|---|
| −40°C to 125°C | 3 mV | SOIC (D) | Reel of 2500 | LM211QDRQ1 | LM211Q1 |

† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at http://www.ti.com.

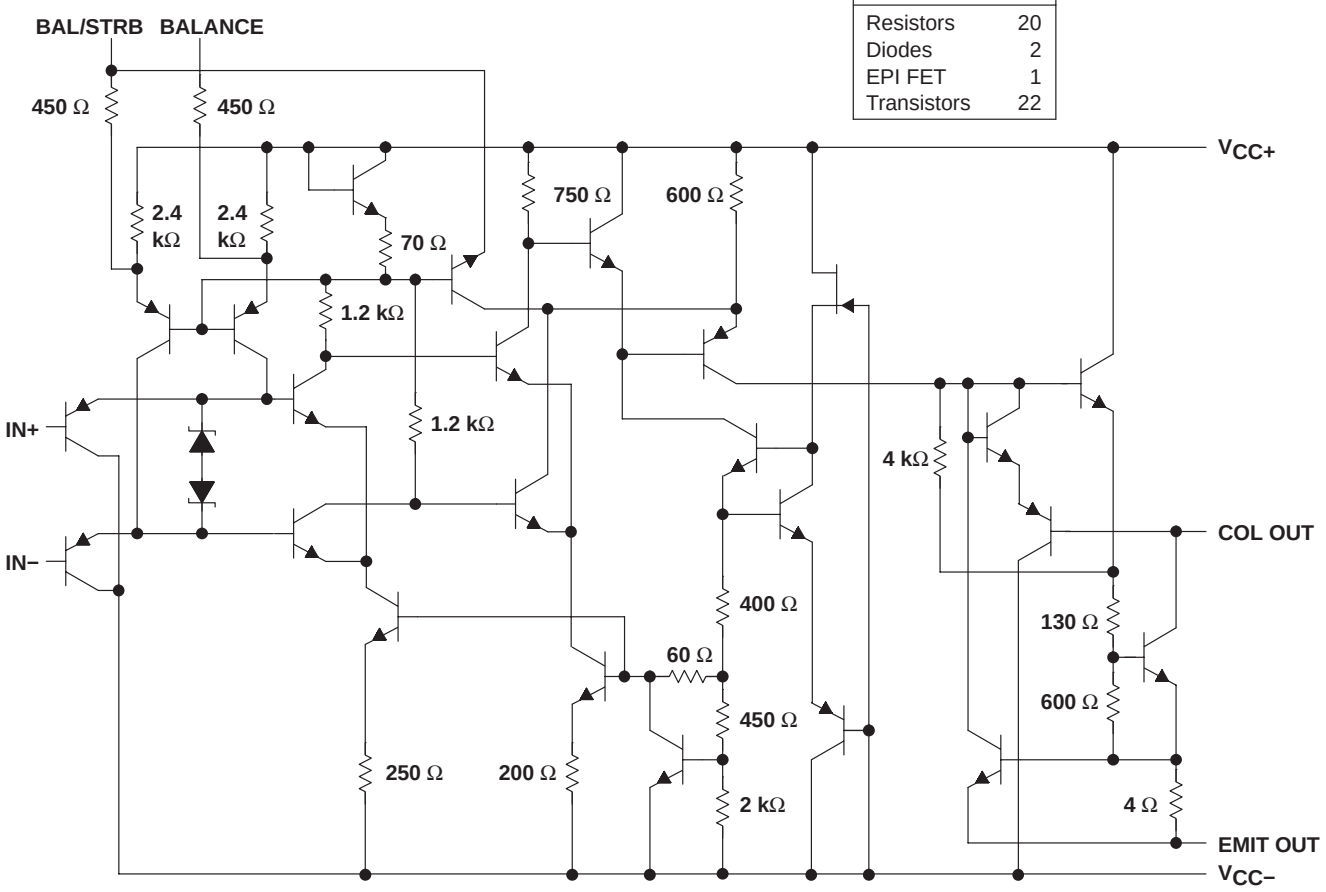
‡ Package drawings, thermal data, and symbolization are available at http://www.ti.com/packaging.

## functional block diagram



## schematic

| Component Count | |
|---|---|
| Resistors | 20 |
| Diodes | 2 |
| EPI FET | 1 |
| Transistors | 22 |




All resistor values shown are nominal.

### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage: $V_{CC+}$ (see Note 1) . . . . . 18 V
$V_{CC-}$ (see Note 1) . . . . . −18 V
$V_{CC+} - V_{CC-}$ . . . . . 36 V
Differential input voltage, $V_{ID}$ (see Note 2) . . . . . ±30 V
Input voltage, $V_I$ (either input) (see Notes 1 and 3) . . . . . ±15 V
Voltage from emitter output to $V_{CC-}$ . . . . . 30 V
Voltage from collector output to $V_{CC-}$ . . . . . 50 V
Duration of output short circuit (see Note 4) . . . . . 10 s
Package thermal impedance, $\theta_{JA}$ (see Notes 5 and 6) . . . . . 97°C/W
Operating virtual junction temperature, $T_J$ . . . . . 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds . . . . . 260°C
Storage temperature range, $T_{stg}$ . . . . . −65°C to 150°C

† 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.

NOTES:
1. All voltage values, unless otherwise noted, are with respect to the midpoint between $V_{CC+}$ and $V_{CC-}$.
2. Differential voltages are at IN+ with respect to IN−.
3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or ±15 V, whichever is less.
4. The output may be shorted to ground or either power supply.
5. Maximum power dissipation is a function of $T_J(max)$, $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum $T_J$ of 150°C can affect reliability.
6. The package thermal impedance is calculated in accordance with JESD 51-7.

### recommended operating conditions

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{CC+} - V_{CC-}$ | Supply voltage | 3.5 | 30 | V |
| $V_I$ | Input voltage ($\lvert V_{CC\pm}\rvert \le 15$ V) | $V_{CC-}$+0.5 | $V_{CC+}$−1.5 | V |
| $T_A$ | Operating free-air temperature range | −40 | 125 | °C |

## electrical characteristics at specified free-air temperature, $V_{CC\pm}$ = ±15 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | $T_A$† | MIN | TYP‡ | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input offset voltage | See Note 7 | | 25°C | | 0.7 | 3 | mV |
| | | | | Full range | | | 4 | |
| $I_{IO}$ | Input offset current | See Note 7 | | 25°C | | 4 | 10 | nA |
| | | | | Full range | | | 20 | |
| $I_{IB}$ | Input bias current | $V_O$ = 1 V to 14 V | | 25°C | | 75 | 100 | nA |
| | | | | Full range | | | 150 | |
| $I_{IL(S)}$ | Low-level strobe current (see Note 8) | $V_{(strobe)}$ = 0.3 V, | $V_{ID} \le -10$ mV | 25°C | | −3 | | mA |
| $V_{ICR}$ | Common-mode input voltage range | | | Full range | 13 to −14.5 | 13.8 to −14.7 | | V |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_O$ = 5 V to 35 V, | $R_L$ = 1 kΩ | 25°C | 40 | 200 | | V/mV |
| $I_{OH}$ | High-level (collector) output leakage current | $I_{(strobe)}$ = −3 mA, $V_{ID}$ = 5 mV, | $V_{OH}$ = 35 V | 25°C | | 0.2 | 10 | nA |
| | | | | Full range | | | 0.5 | µA |
| | | $V_{ID}$ = 5 mV, | $V_{OH}$ = 35 V | 25°C | | | | nA |
| $V_{OL}$ | Low-level (collector-to-emitter) output voltage | $I_{OL}$ = 50 mA | $V_{ID}$ = −5 mV | 25°C | | 0.75 | 1.5 | V |
| | | | $V_{ID}$ = −10 mV | 25°C | | | | |
| | | $V_{CC+}$ = 4.5 V, $V_{CC-}$ = 0, $I_{OL}$ = 8 mA | $V_{ID}$ = −6 mV | Full range | | 0.23 | 0.4 | |
| | | | $V_{ID}$ = −10 mV | Full range | | | | |
| $I_{CC+}$ | Supply current from $V_{CC+}$, output low | $V_{ID}$ = −10 mV, | No load | 25°C | | 5.1 | 6 | mA |
| $I_{CC-}$ | Supply current from $V_{CC-}$, output high | $V_{ID}$ = 10 mV, | No load | 25°C | | −4.1 | −5 | mA |

† Unless otherwise noted, all characteristics are measured with BALANCE and BAL/STRB open and EMIT OUT grounded. Full range for LM211Q is −40°C to 125°C.

‡ All typical values are at $T_A$ = 25°C.

NOTES: 7. 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 $V_{CC+}$. These parameters actually define an error band and take into account the worst-case effects of voltage gain and input impedance.

8. The strobe should not be shorted to ground; it should be current driven at −3 mA to −5 mA (see Figures 13 and 27).

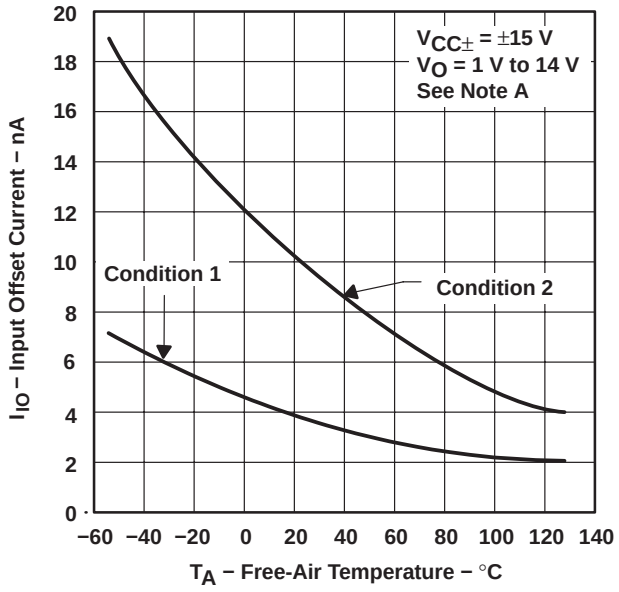
## switching characteristics, $V_{CC\pm}$ = ±15 V, $T_A$ = 25°C

| PARAMETER | TEST CONDITIONS | | | TYP | UNIT |
|---|---|---|---|---|---|
| Response time, low-to-high-level output | $R_C$ = 500 Ω to 5 V, | $C_L$ = 5 pF, | See Note 9 | 115 | ns |
| Response time, high-to-low-level output | | | | 165 | ns |

NOTE 9: 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.

## TYPICAL CHARACTERISTICS

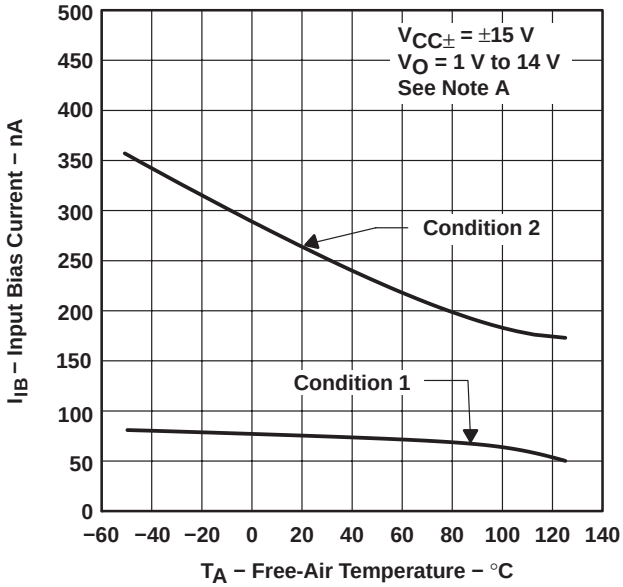
**INPUT OFFSET CURRENT vs FREE-AIR TEMPERATURE**




NOTE A: Condition 1 is with BALANCE and BAL/STRB open. Condition 2 is with BALANCE and BAL/STRB connected to $V_{CC+}$.

**Figure 1**

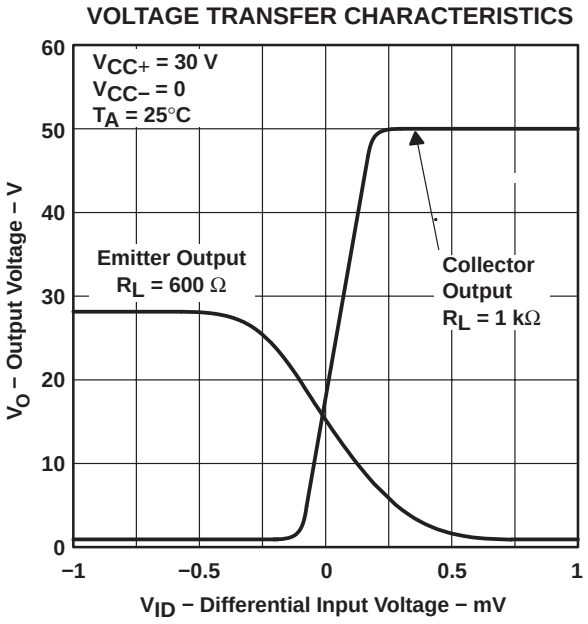
**INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE**

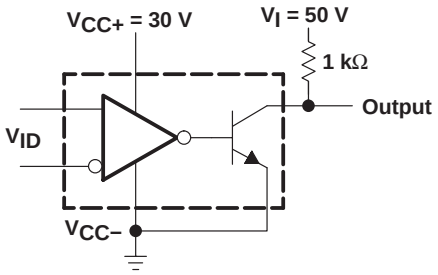



NOTE A: Condition 1 is with BALANCE and BAL/STRB open. Condition 2 is with BALANCE and BAL/STRB connected to $V_{CC+}$.

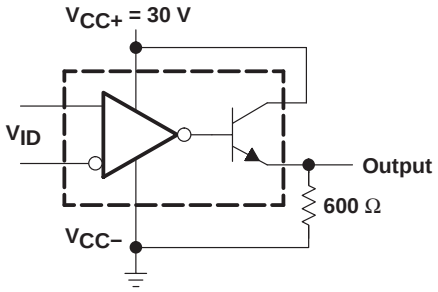
**Figure 2**

## TYPICAL CHARACTERISTICS




COLLECTOR OUTPUT TRANSFER CHARACTERISTIC
TEST CIRCUIT FOR FIGURE 3




EMITTER OUTPUT TRANSFER CHARACTERISTIC
TEST CIRCUIT FOR FIGURE 3

**Figure 3**

## TYPICAL CHARACTERISTICS

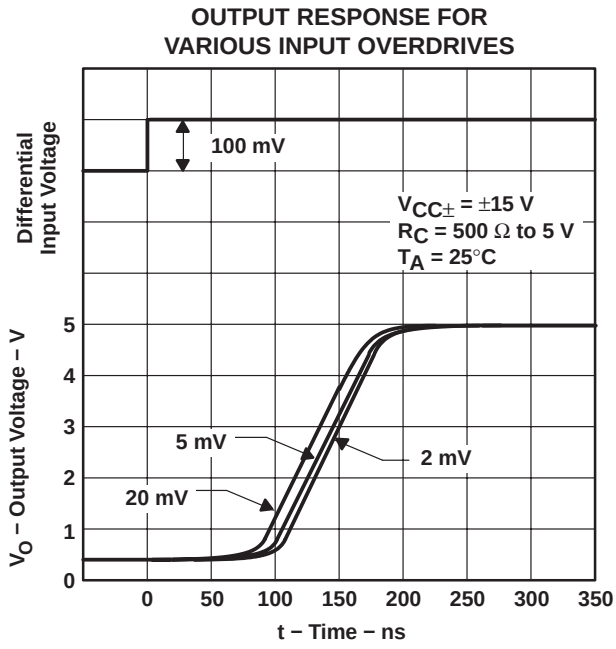



**Figure 4**

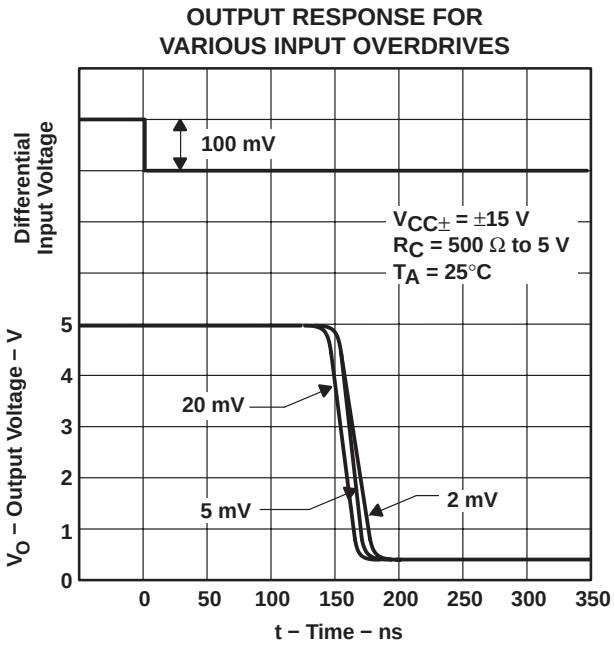
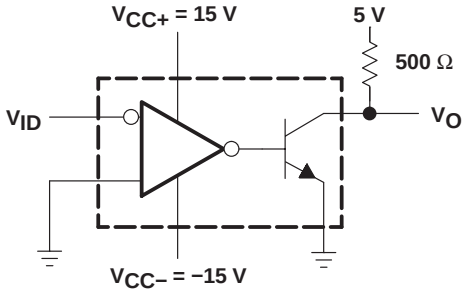



**Figure 5**




**TEST CIRCUIT FOR FIGURES 4 AND 5**

## TYPICAL CHARACTERISTICS

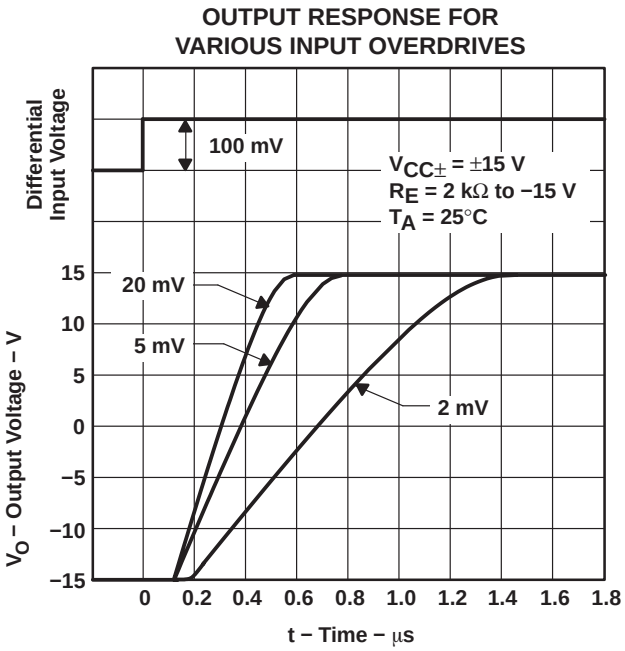



**Figure 6**

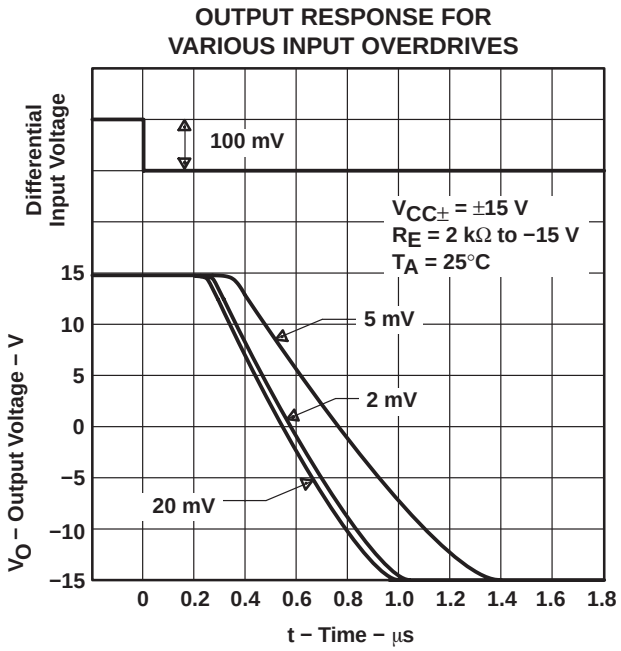
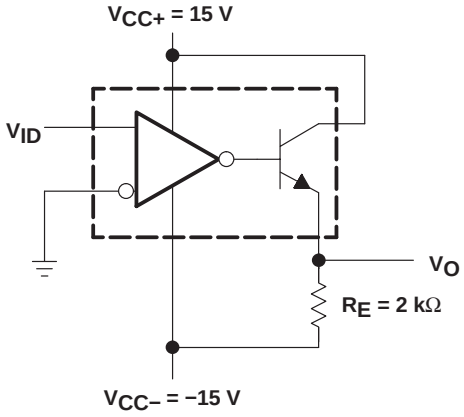



**Figure 7**




**TEST CIRCUIT FOR FIGURES 6 AND 7**

## TYPICAL CHARACTERISTICS

**OUTPUT CURRENT AND DISSIPATION vs OUTPUT VOLTAGE**

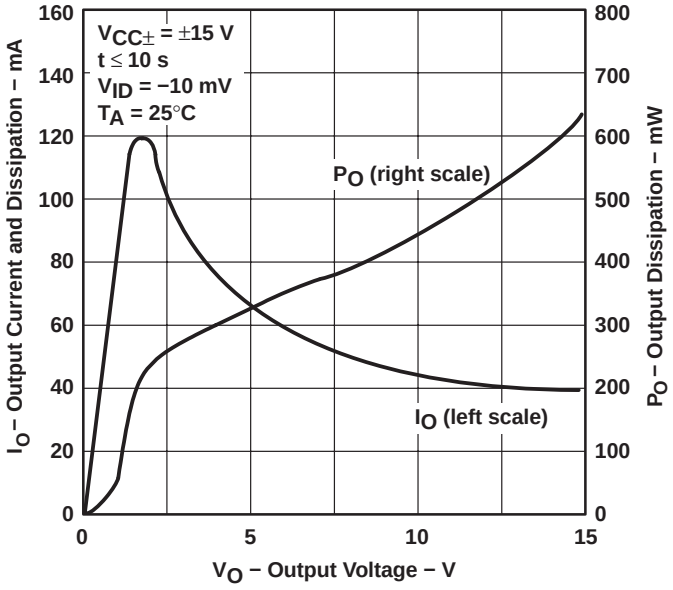



**Figure 8**

**POSITIVE SUPPLY CURRENT vs POSITIVE SUPPLY VOLTAGE**

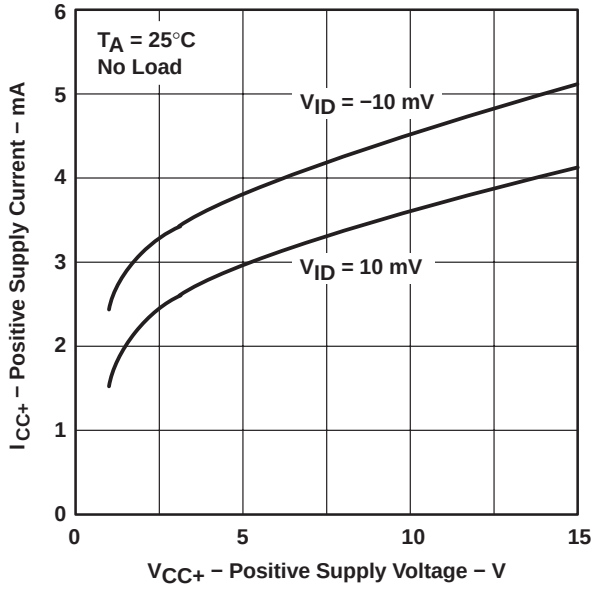



**Figure 9**

**NEGATIVE SUPPLY CURRENT vs NEGATIVE SUPPLY VOLTAGE**

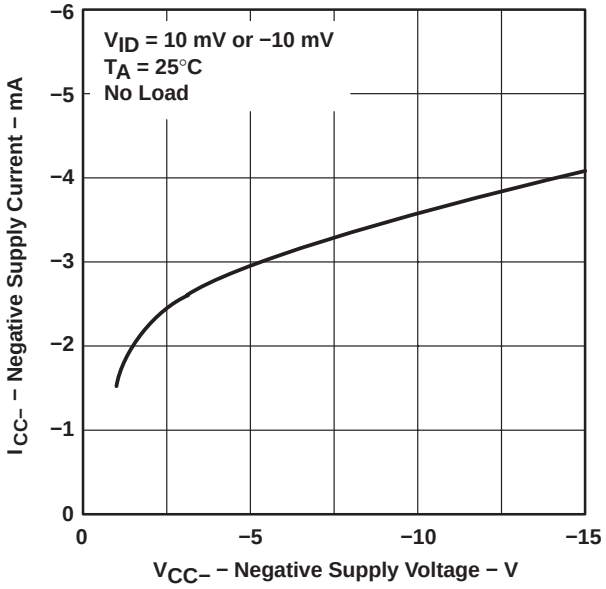



**Figure 10**

## APPLICATION INFORMATION

Figure 11 through Figure 29 show various applications for the LM211 comparator.

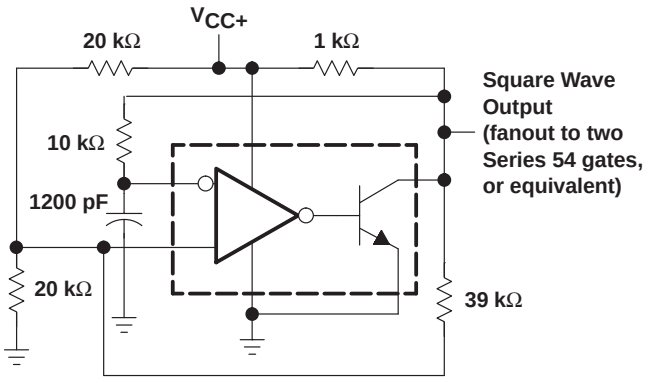
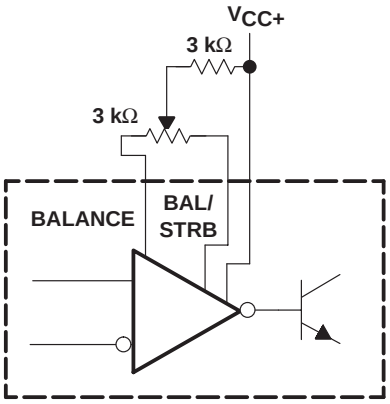
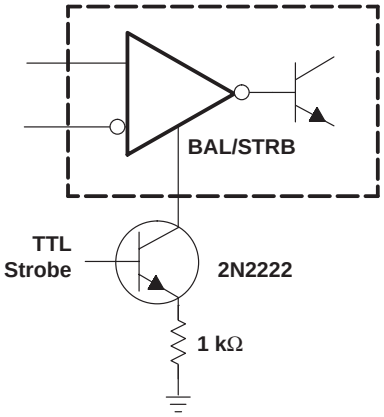



**Figure 11. 100-kHz Free-Running Multivibrator**




NOTE: If offset balancing is not used, the BALANCE and BAL/STRB pins should be shorted together.

**Figure 12. Offset Balancing**




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

**Figure 13. Strobing**

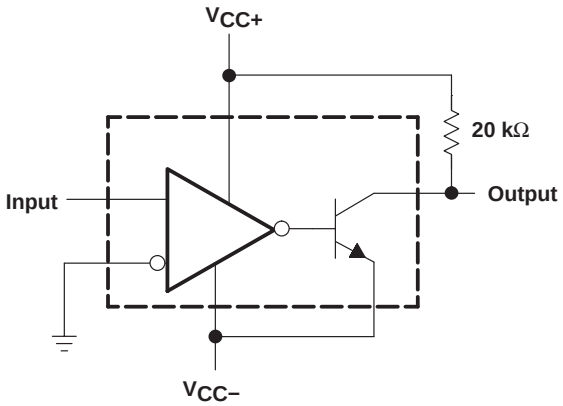
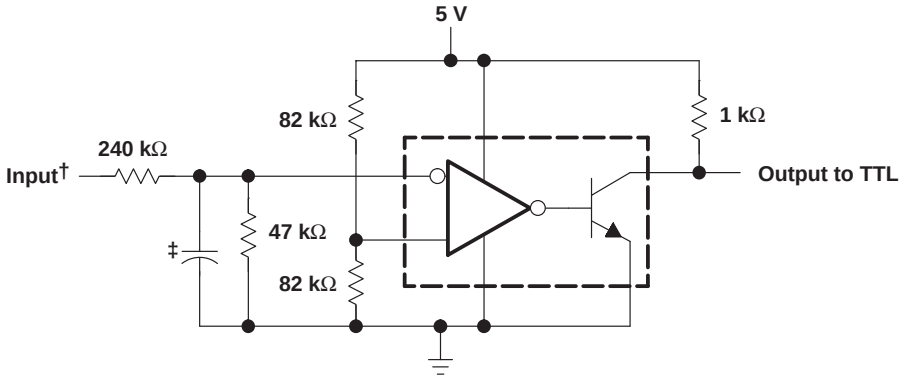



**Figure 14. Zero-Crossing Detector**

## APPLICATION INFORMATION




† 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 15. TTL Interface With High-Level Logic**

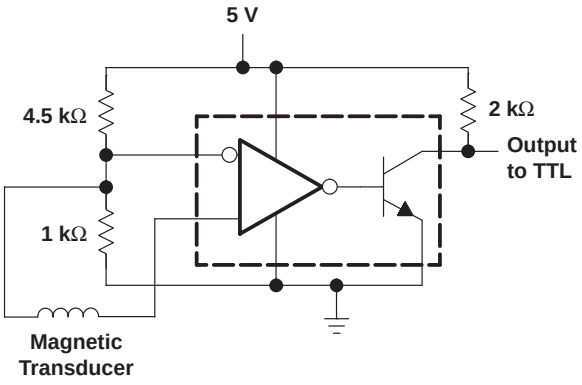



**Figure 16. Detector for Magnetic Transducer**

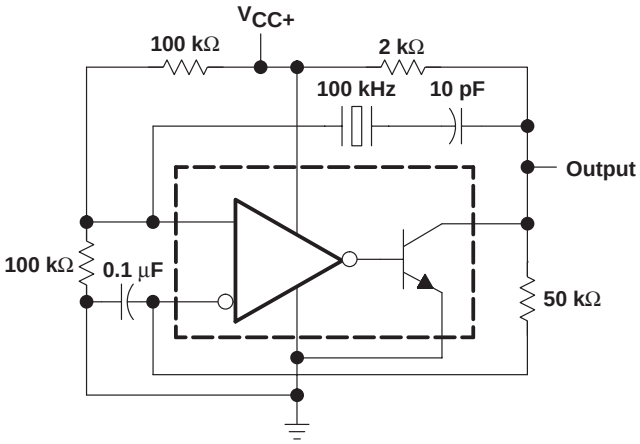



**Figure 17. 100-kHz Crystal Oscillator**

## APPLICATION INFORMATION

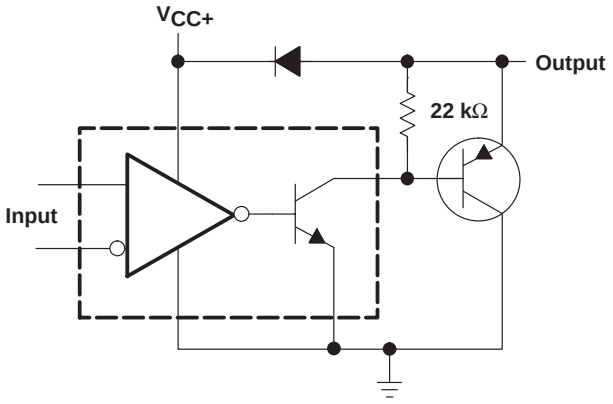
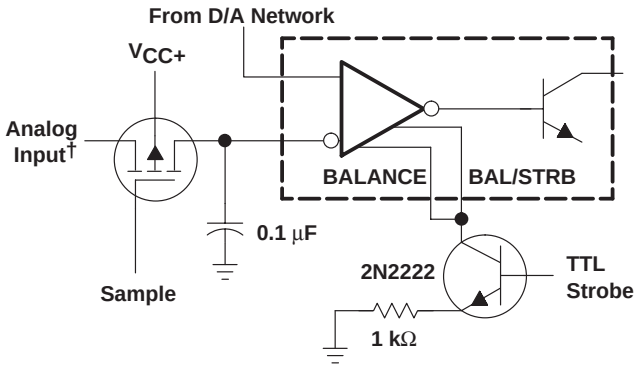



**Figure 18. Comparator and Solenoid Driver**




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

**Figure 19. Strobing Both Input and Output Stages Simultaneously**

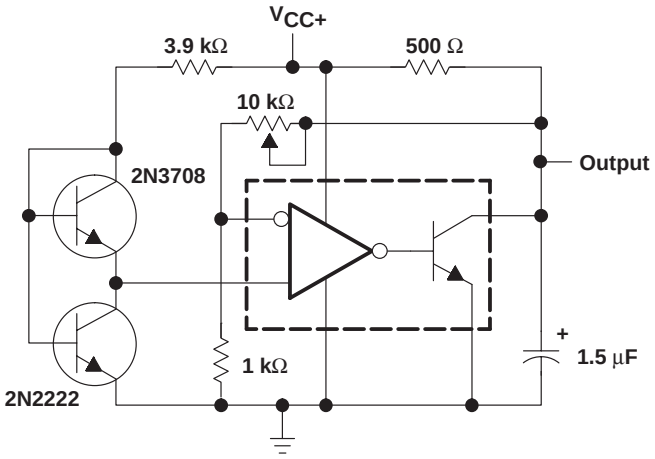



**Figure 20. Low-Voltage Adjustable Reference Supply**

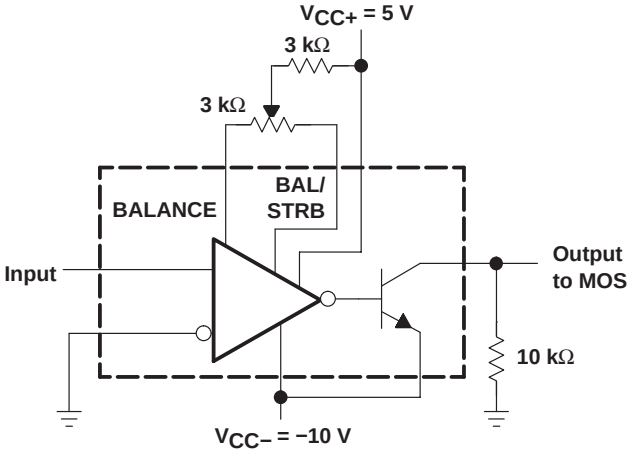
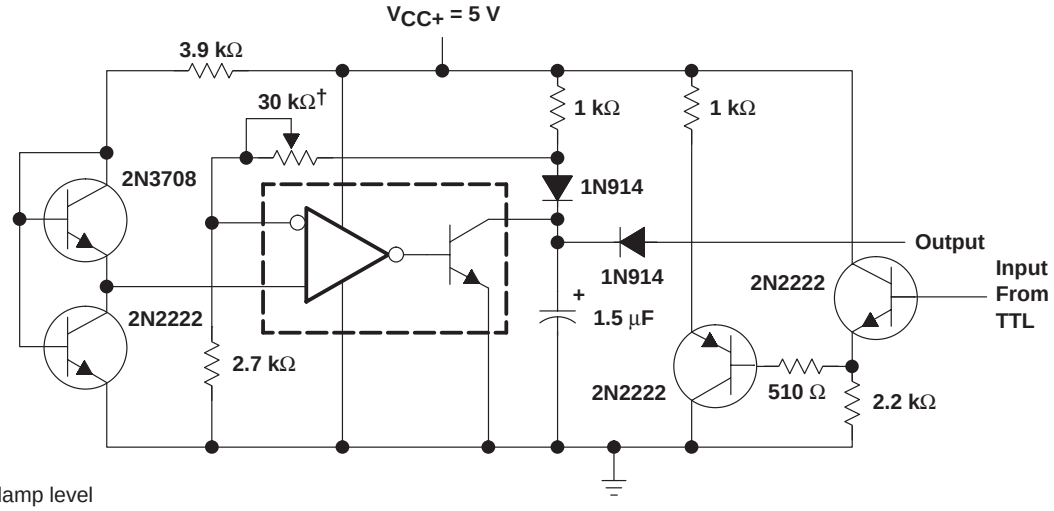



**Figure 21. Zero-Crossing Detector Driving MOS Logic**

## APPLICATION INFORMATION




† Adjust to set clamp level

**Figure 22. Precision Squarer**

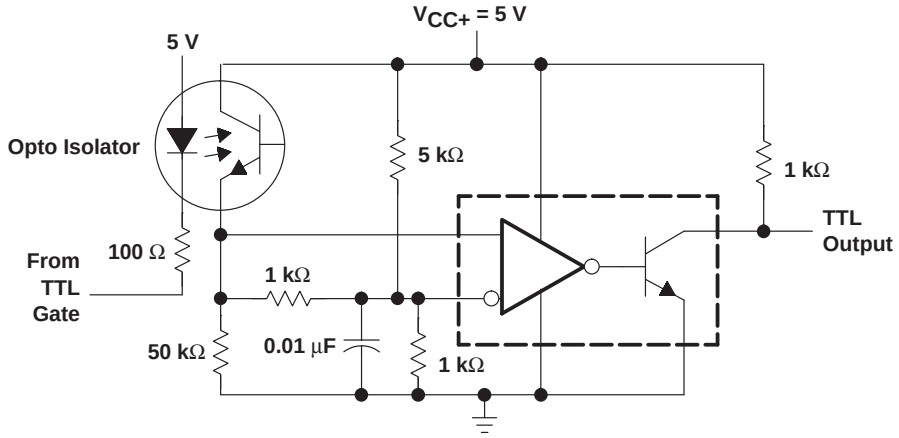



**Figure 23. Digital Transmission Isolator**

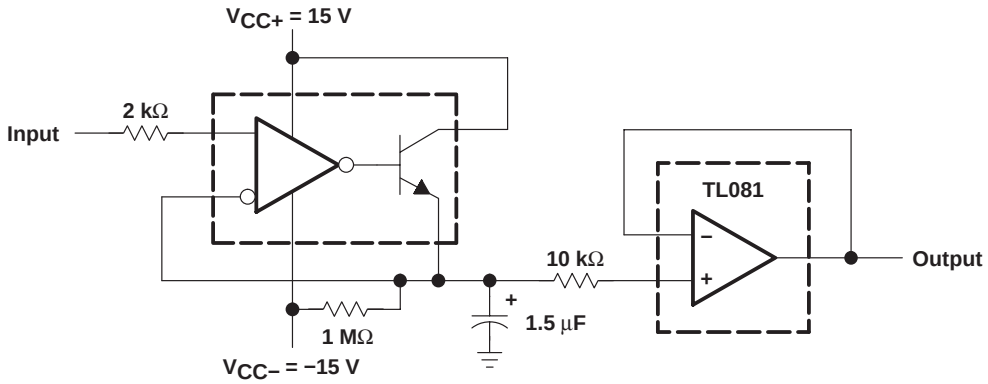



**Figure 24. Positive-Peak Detector**

## APPLICATION INFORMATION

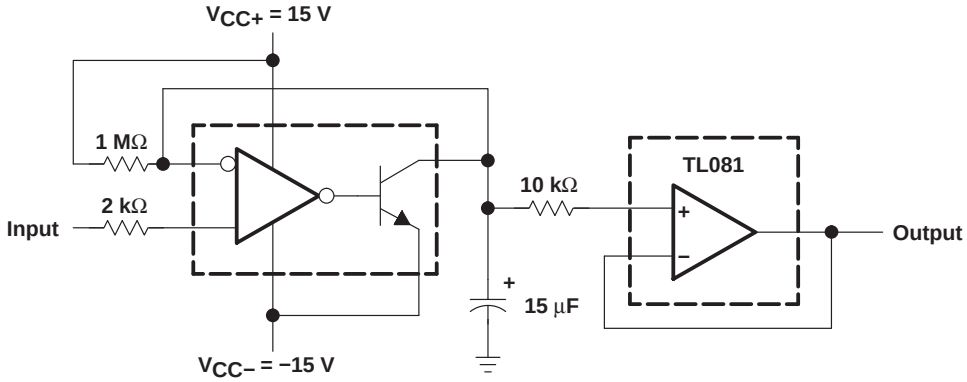
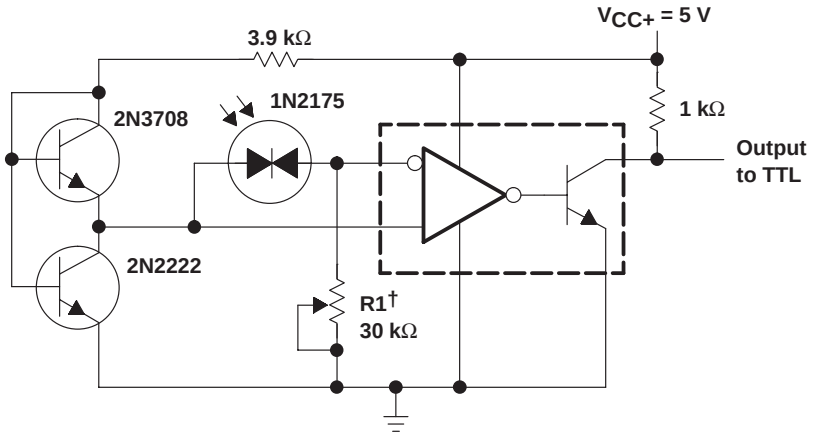
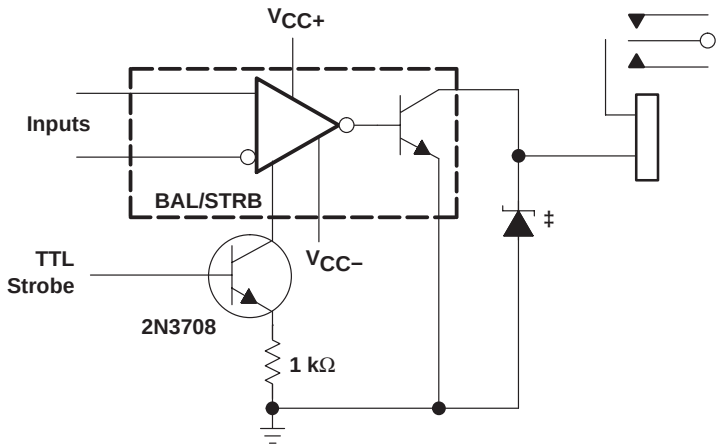



**Figure 25. Negative-Peak Detector**




† 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 26. Precision Photodiode Comparator**




‡ Transient voltage and inductive kickback protection

**Figure 27. Relay Driver With Strobe**

## APPLICATION INFORMATION

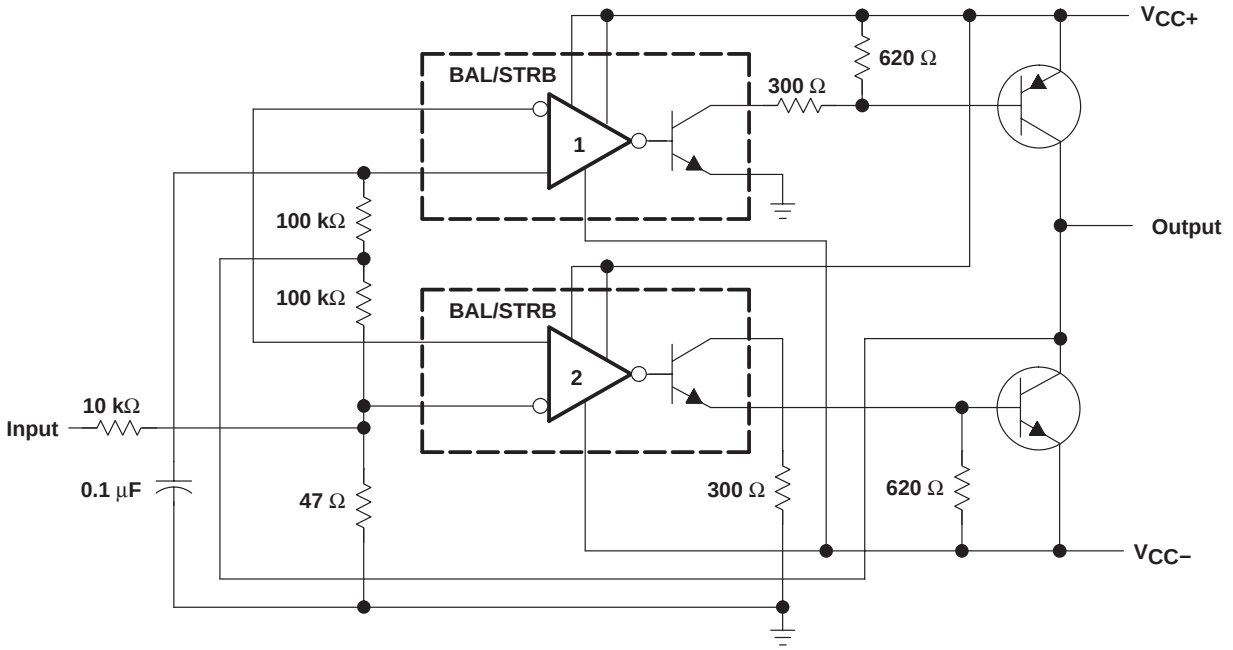



**Figure 28. Switching Power Amplifier**

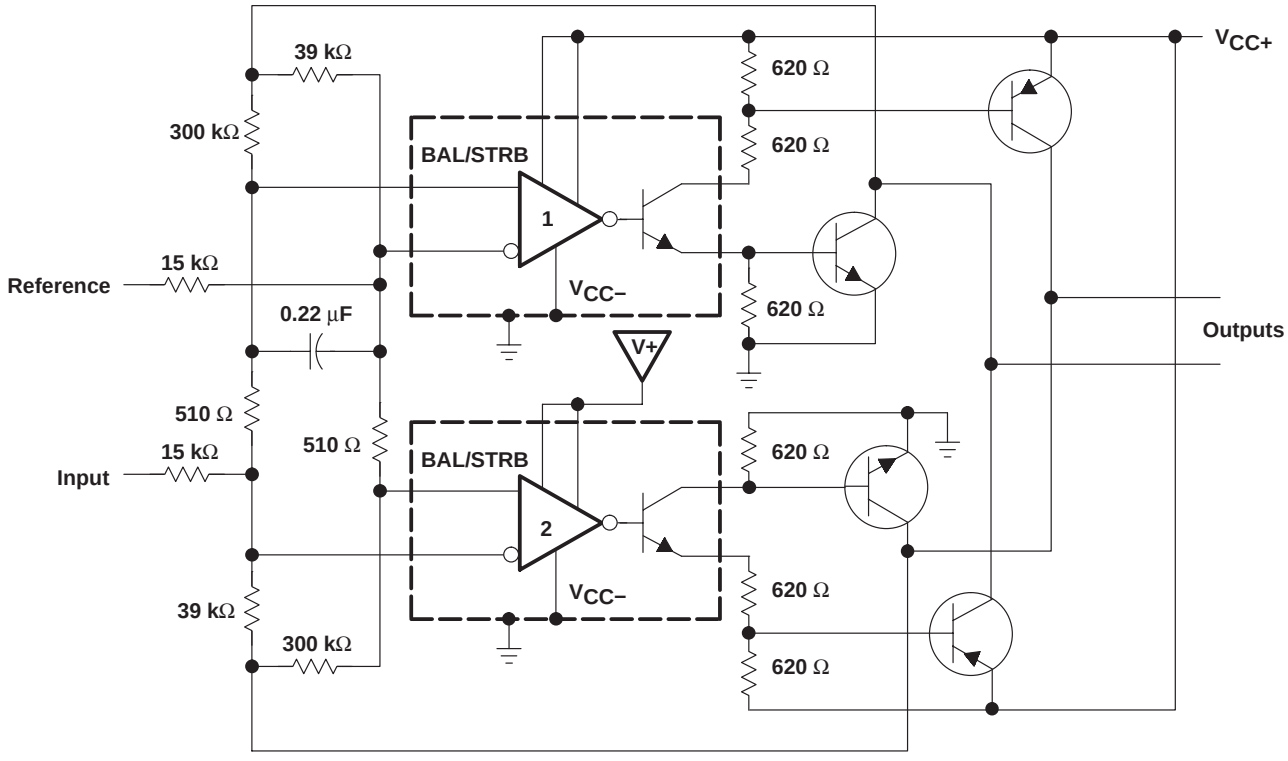



**Figure 29. Switching Power Amplifiers**

## PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package \| Pins | Package qty \| Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|---|---|---|---|---|---|---|---|---|---|
| LM211QDRG4Q1 | Active | Production | SOIC (D) \| 8 | 2500 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LM211Q |
| LM211QDRG4Q1.A | Active | Production | SOIC (D) \| 8 | 2500 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LM211Q |
| LM211QDRQ1 | Active | Production | SOIC (D) \| 8 | 2500 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LM211Q |
| LM211QDRQ1.A | Active | Production | SOIC (D) \| 8 | 2500 \| LARGE T&R | Yes | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | LM211Q |

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

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

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

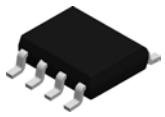


**OTHER QUALIFIED VERSIONS OF LM211-Q1 :**

- Catalog : LM211
- Enhanced Product : LM211-EP

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

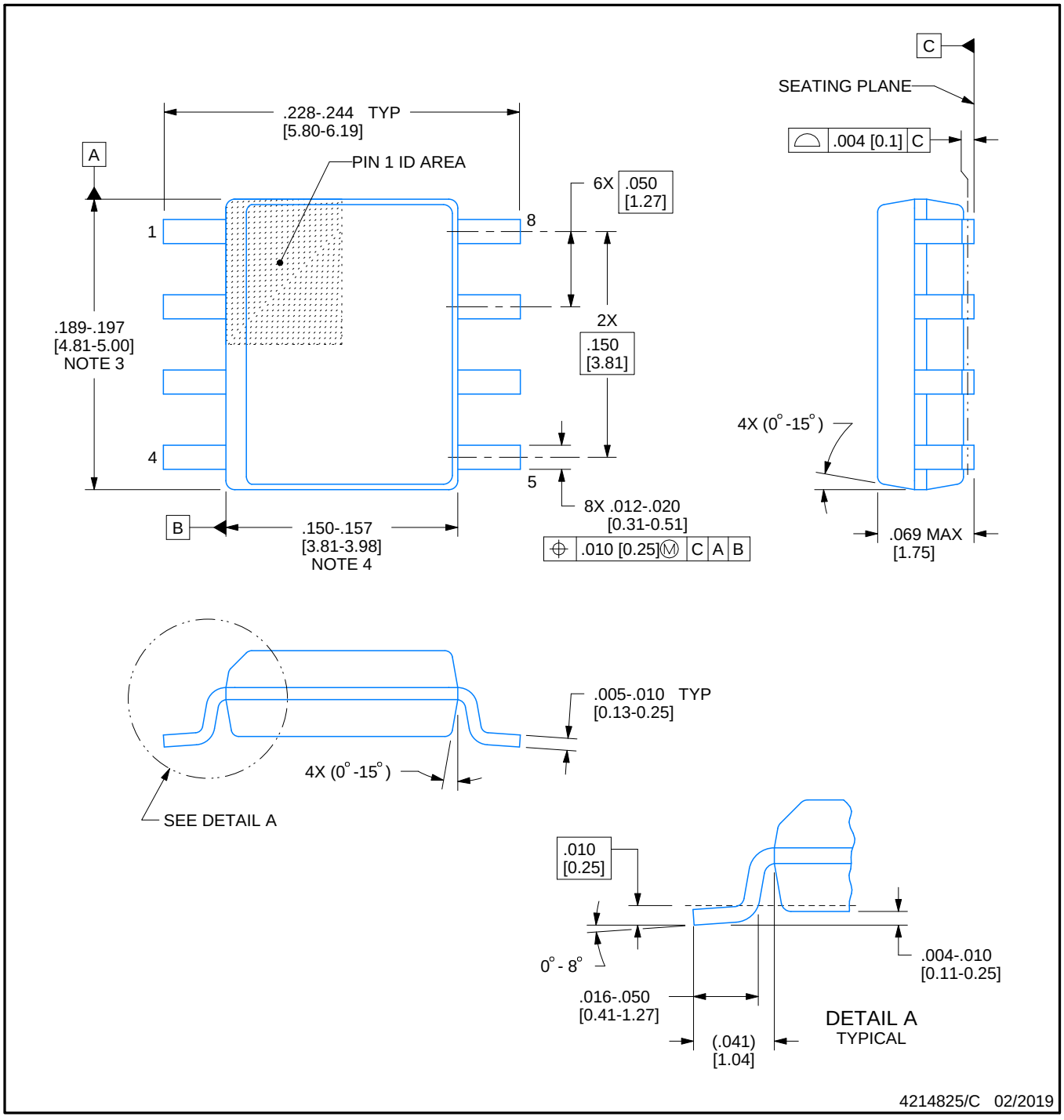


# PACKAGE OUTLINE

## D0008A

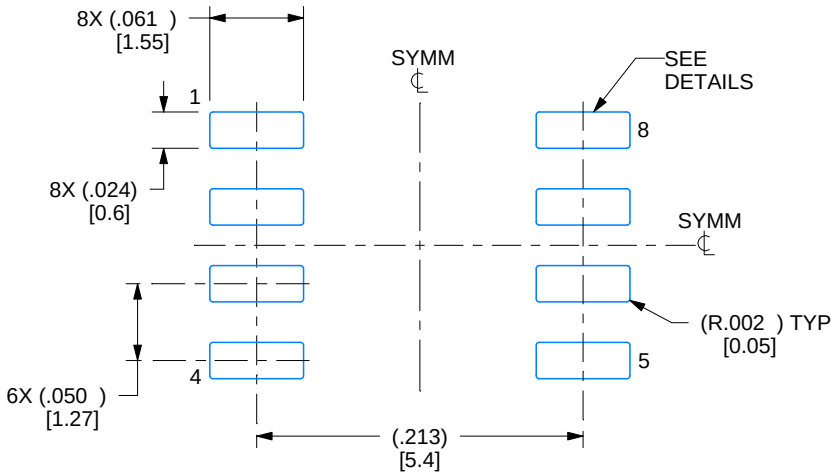
## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

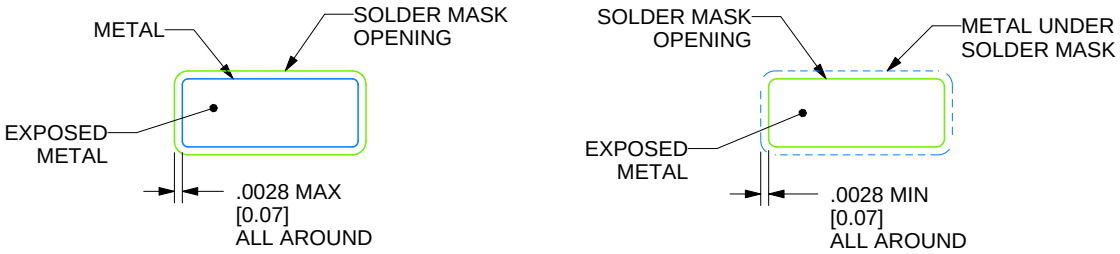



NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X




SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

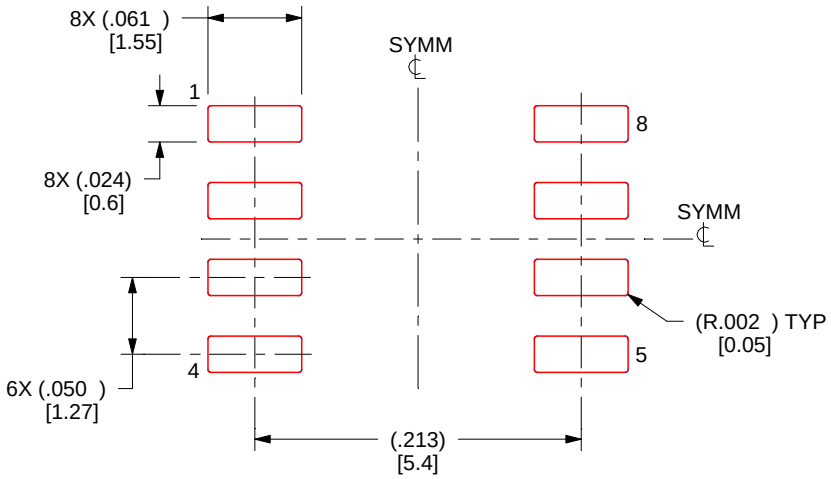
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

## D0008A

## SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT




SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

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.

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