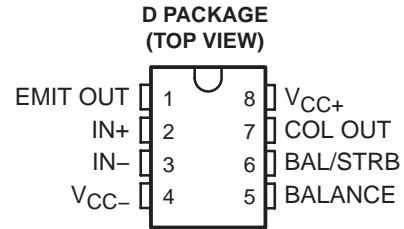


# LM211-Q1 DIFFERENTIAL COMPARATOR WITH STROBES

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- 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



## 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  $\pm 15$ -V supplies for operational amplifiers and 5-V supplies for logic systems. The output levels are compatible with most TTL and MOS circuits. 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.

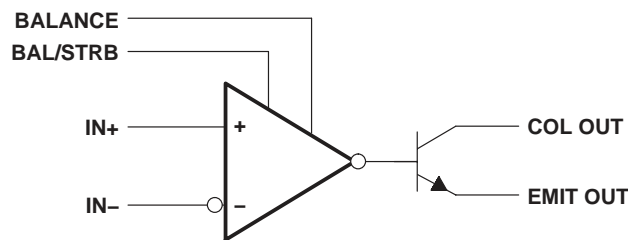
### ORDERING INFORMATION†

T <sub>A</sub>	V <sub>I/O</sub> 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



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

**PRODUCTION DATA** information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

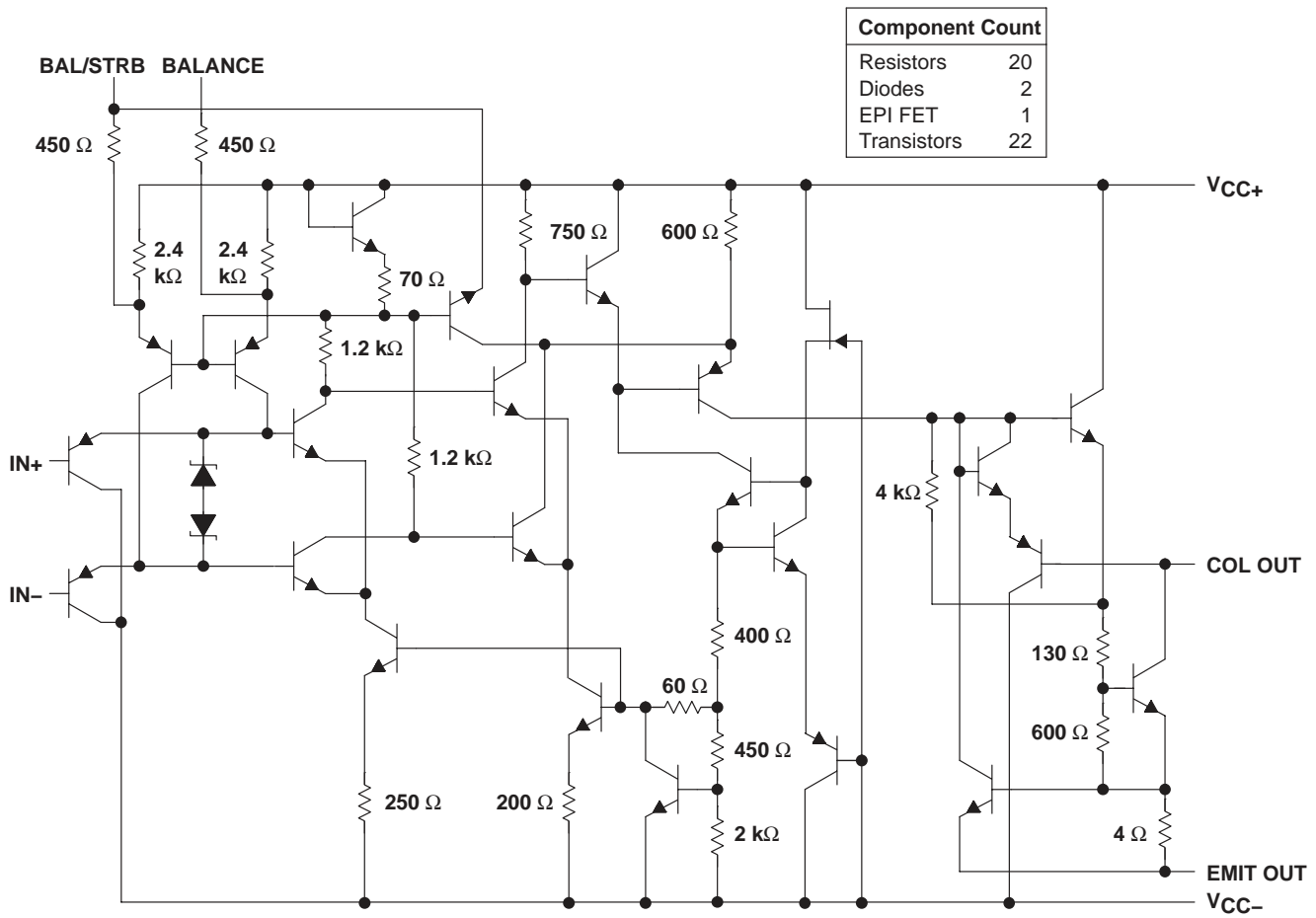
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# LM211-Q1 DIFFERENTIAL COMPARATOR WITH STROBES

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## schematic



All resistor values shown are nominal.

# LM211-Q1 DIFFERENTIAL COMPARATOR WITH STROBES

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## 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) .....	$\pm 30$ V
Input voltage, $V_I$ (either input) (see Notes 1 and 3) .....	$\pm 15$ 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  $\pm 15$  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 ( $ V_{CC\pm}  \leq 15$ V)	$V_{CC-} + 0.5$	$V_{CC+} - 1.5$	V
$T_A$ Operating free-air temperature range	-40	125	°C



# LM211-Q1

## DIFFERENTIAL COMPARATOR WITH STROBES

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### electrical characteristics at specified free-air temperature, $V_{CC\pm} = \pm 15\text{ V}$ (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	$V_O = 1\text{ V to } 14\text{ V}$	25°C		75	100	nA
		Full range			150	
$I_{IL(S)}$ Low-level strobe current (see Note 8)	$V_{(\text{strobe})} = 0.3\text{ V}, V_{ID} \leq -10\text{ mV}$	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	$V_O = 5\text{ V to } 35\text{ V}, R_L = 1\text{ k}\Omega$	25°C	40	200		V/mV
$I_{OH}$ High-level (collector) output leakage current	$I_{(\text{strobe})} = -3\text{ mA}, V_{ID} = 5\text{ mV}, V_{OH} = 35\text{ V}$	25°C		0.2	10	nA
		Full range			0.5	$\mu\text{A}$
	$V_{ID} = 5\text{ mV}, V_{OH} = 35\text{ V}$	25°C				nA
$V_{OL}$ Low-level (collector-to-emitter) output voltage	$I_{OL} = 50\text{ mA}$	$V_{ID} = -5\text{ mV}$	25°C	0.75	1.5	V
		$V_{ID} = -10\text{ mV}$	25°C			
	$V_{CC+} = 4.5\text{ V}, V_{CC-} = 0, I_{OL} = 8\text{ mA}$	$V_{ID} = -6\text{ mV}$	Full range	0.23	0.4	
		$V_{ID} = -10\text{ mV}$	Full range			
$I_{CC+}$ Supply current from $V_{CC+}$ , output low	$V_{ID} = -10\text{ mV},$ No load	25°C		5.1	6	mA
$I_{CC-}$ Supply current from $V_{CC-}$ , output high	$V_{ID} = 10\text{ mV},$ 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  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

‡ All typical values are at  $T_A = 25^\circ\text{C}$ .

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 k $\Omega$  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  $-3\text{ mA}$  to  $-5\text{ mA}$  (see Figures 13 and 27).

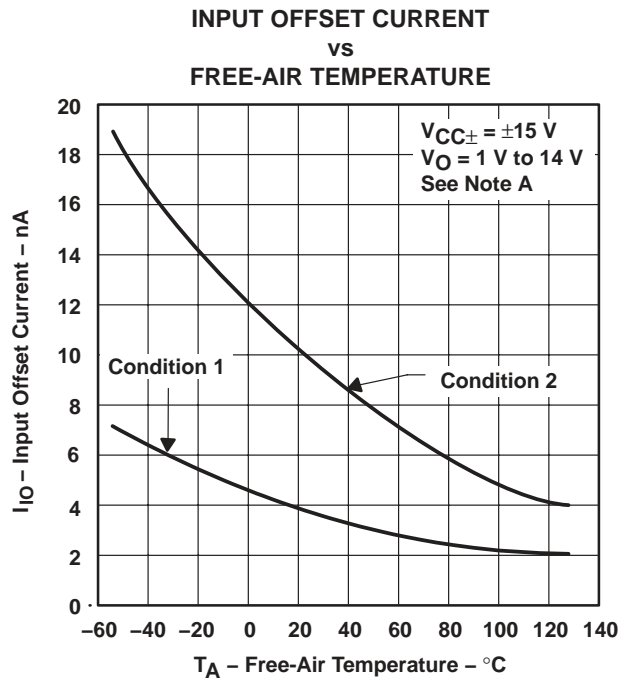
### switching characteristics, $V_{CC\pm} = \pm 15\text{ V}, T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TYP	UNIT
Response time, low-to-high-level output	$R_C = 500\ \Omega$ to 5 V, $C_L = 5\text{ pF},$ 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.

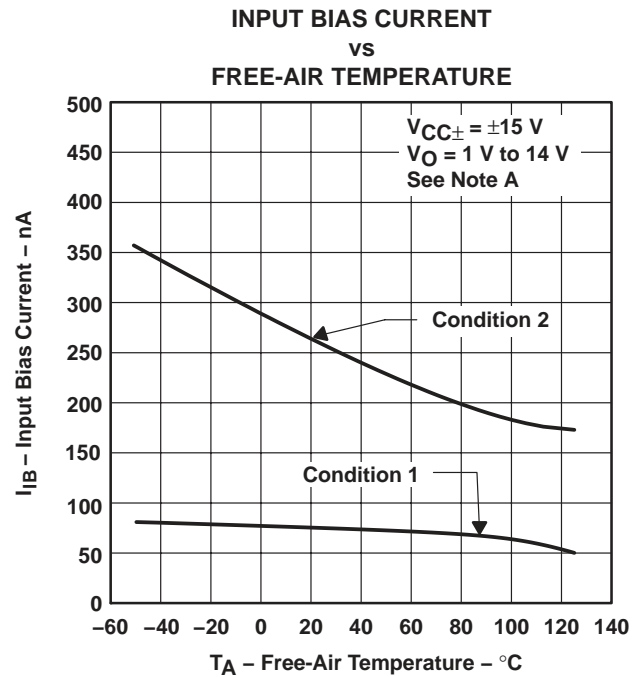


**TYPICAL CHARACTERISTICS**



NOTE A: Condition 1 is with BALANCE and BAL/STRB open. Condition 2 is with BALANCE and BAL/STRB connected to V<sub>CC+</sub>.

**Figure 1**



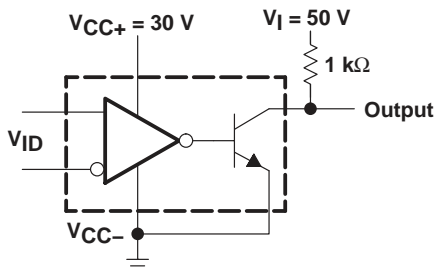
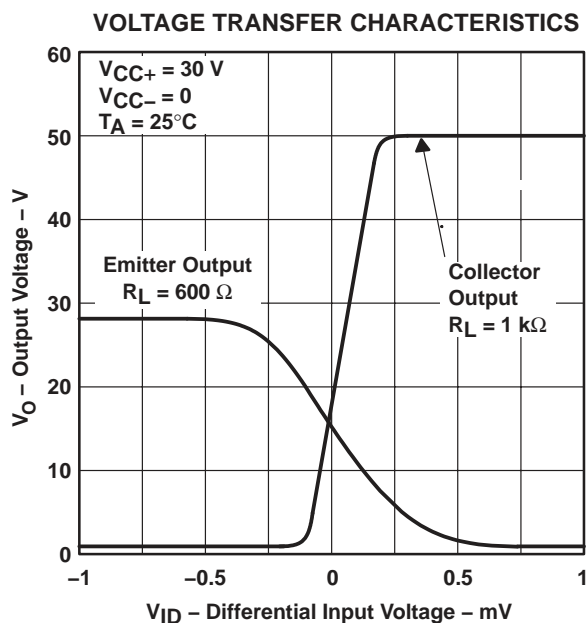
NOTE A: Condition 1 is with BALANCE and BAL/STRB open. Condition 2 is with BALANCE and BAL/STRB connected to V<sub>CC+</sub>.

**Figure 2**

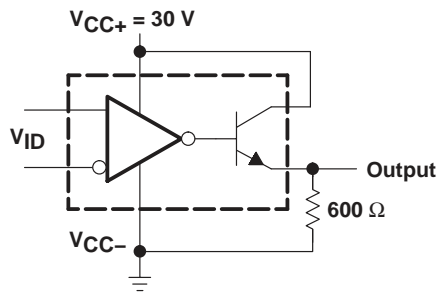
# LM211-Q1 DIFFERENTIAL COMPARATOR WITH STROBES

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## TYPICAL CHARACTERISTICS



COLLECTOR OUTPUT TRANSFER CHARACTERISTIC  
TEST CIRCUIT FOR FIGURE 3

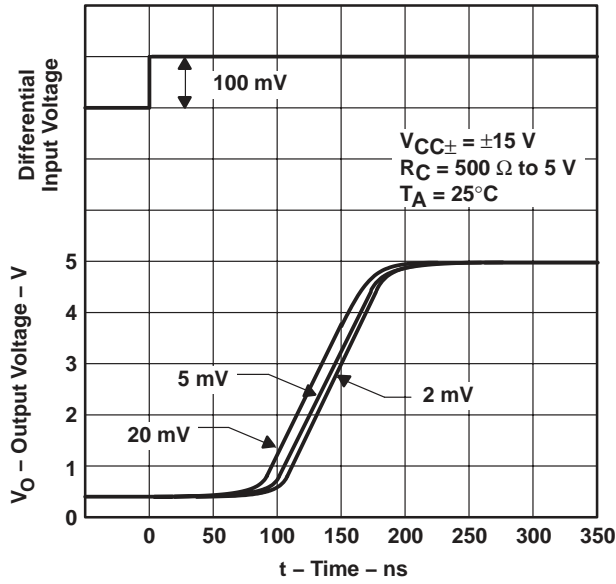


EMITTER OUTPUT TRANSFER CHARACTERISTIC  
TEST CIRCUIT FOR FIGURE 3

Figure 3

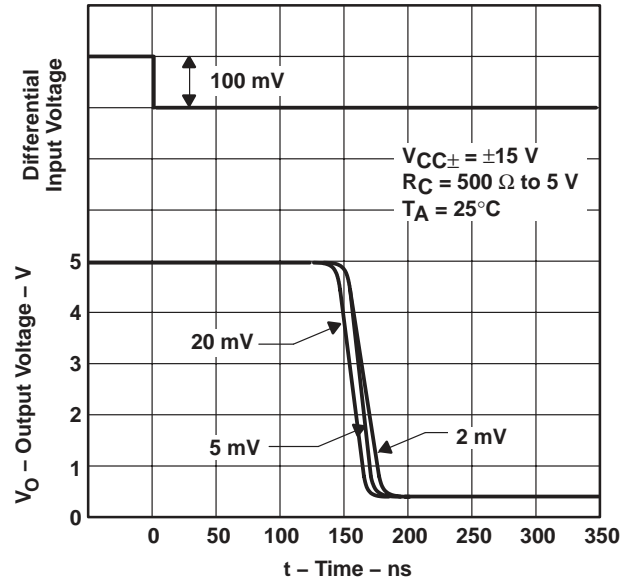
**TYPICAL CHARACTERISTICS**

**OUTPUT RESPONSE FOR  
VARIOUS INPUT OVERDRIVES**

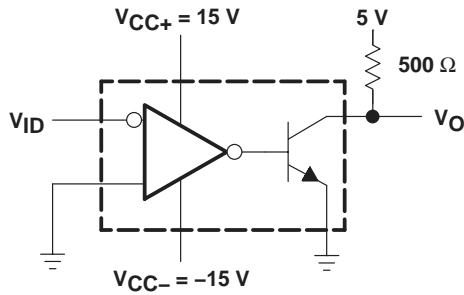


**Figure 4**

**OUTPUT RESPONSE FOR  
VARIOUS INPUT OVERDRIVES**



**Figure 5**



**TEST CIRCUIT FOR FIGURES 4 AND 5**

# LM211-Q1 DIFFERENTIAL COMPARATOR WITH STROBES

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## TYPICAL CHARACTERISTICS

OUTPUT RESPONSE FOR  
VARIOUS INPUT OVERDRIVES

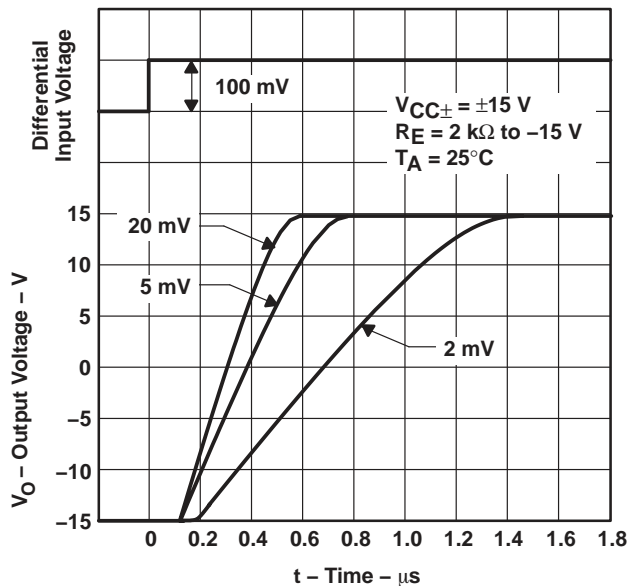


Figure 6

OUTPUT RESPONSE FOR  
VARIOUS INPUT OVERDRIVES

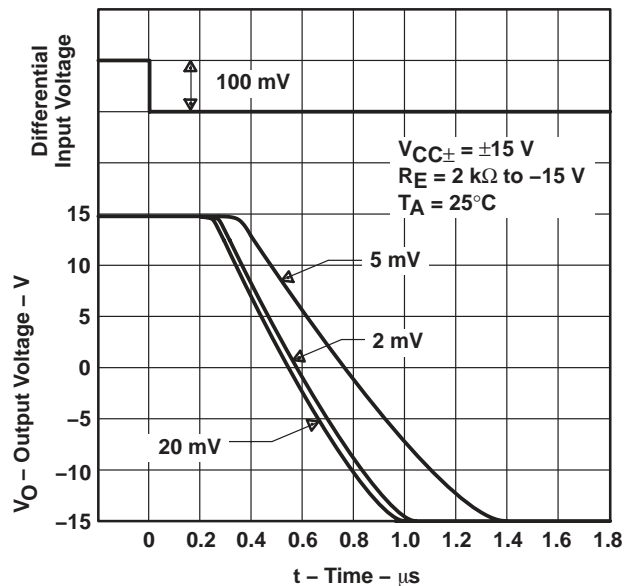
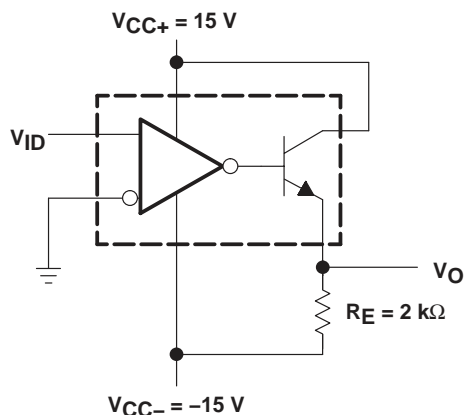


Figure 7



TEST CIRCUIT FOR FIGURES 6 AND 7



**TYPICAL CHARACTERISTICS**

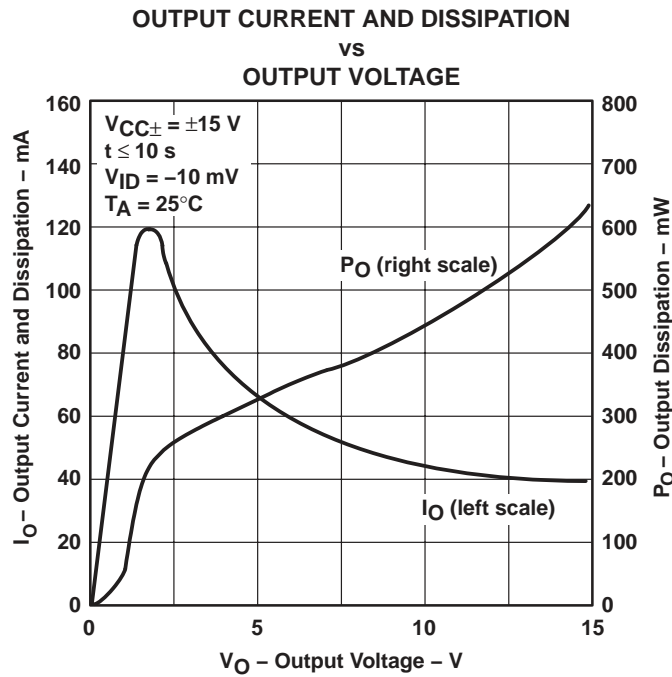


Figure 8

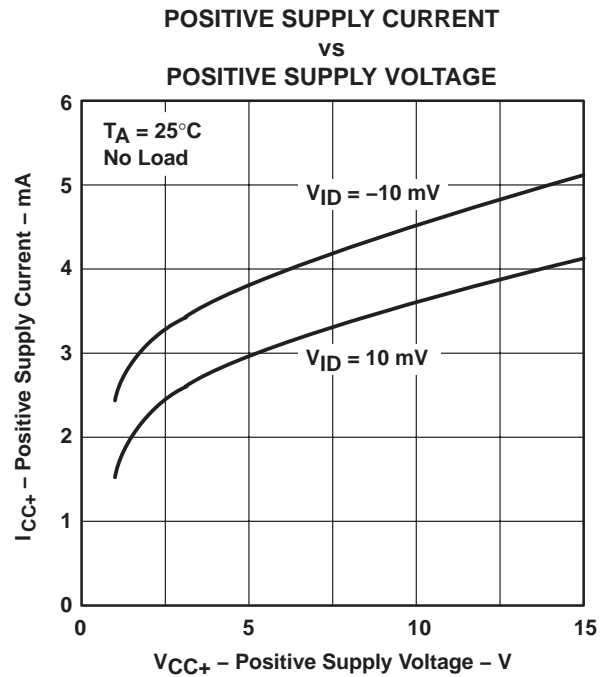


Figure 9

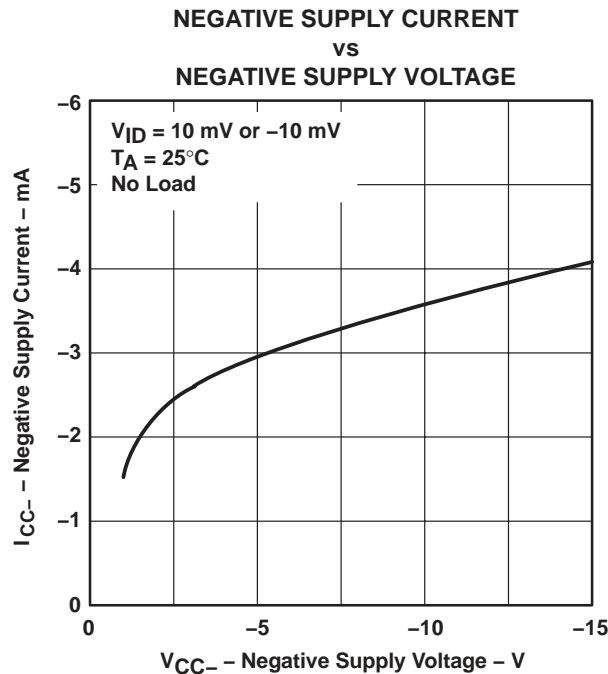


Figure 10

# LM211-Q1 DIFFERENTIAL COMPARATOR WITH STROBES

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## APPLICATION INFORMATION

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

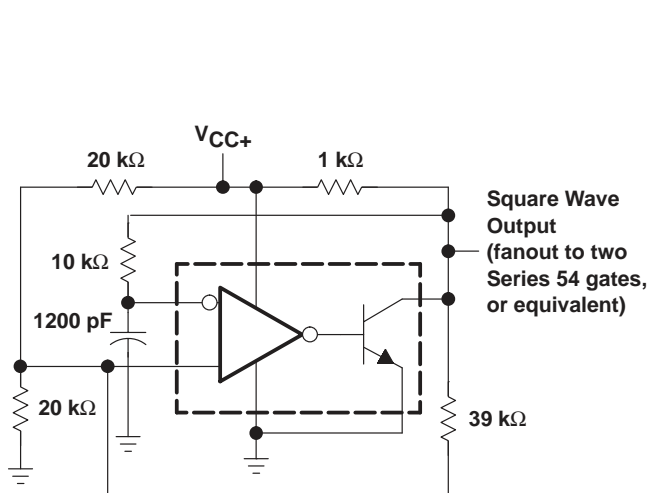
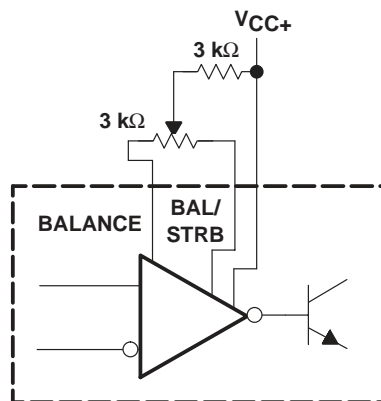
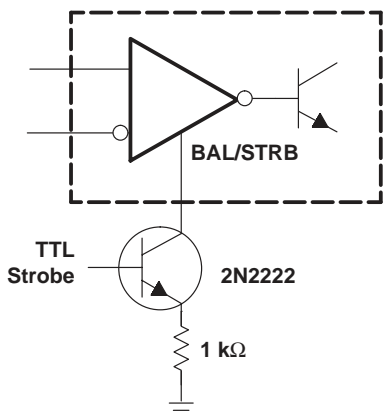


Figure 11. 100-kHz Free-Running Multivibrator



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. Strobming

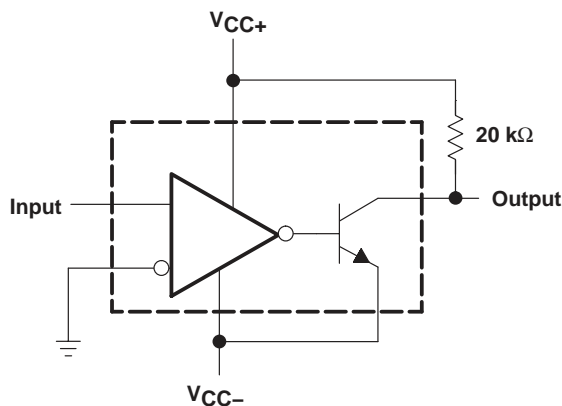
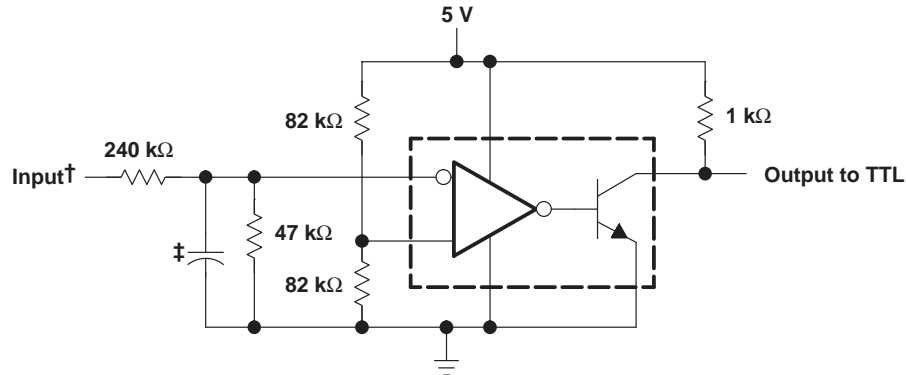


Figure 14. Zero-Crossing Detector

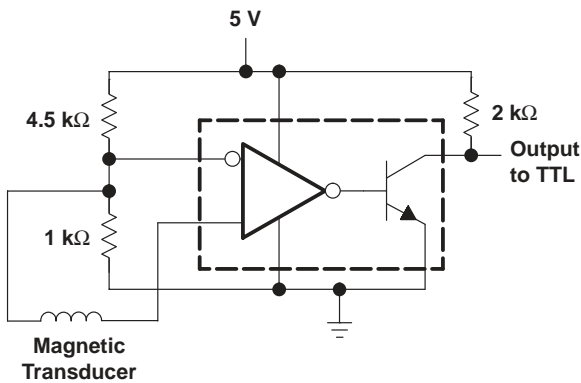
## APPLICATION INFORMATION



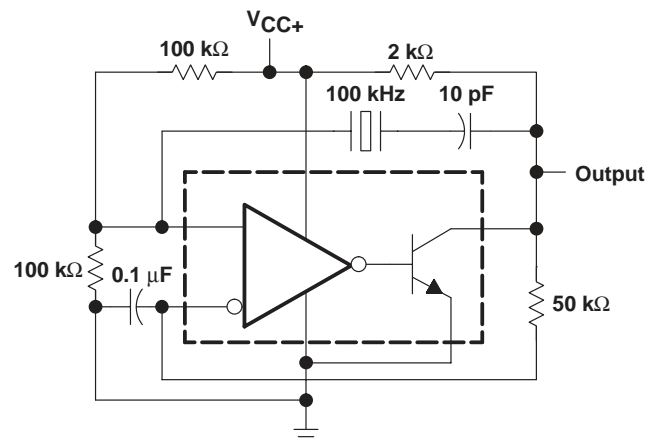
† Resistor values shown are for a 0- to 30-V logic swing and a 15-V threshold.

‡ 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**

# LM211-Q1 DIFFERENTIAL COMPARATOR WITH STROBES

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## APPLICATION INFORMATION

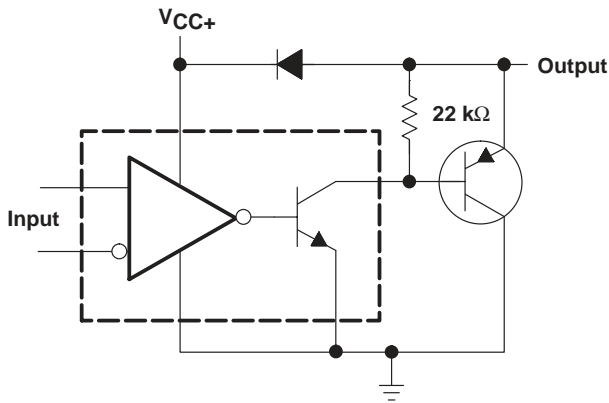
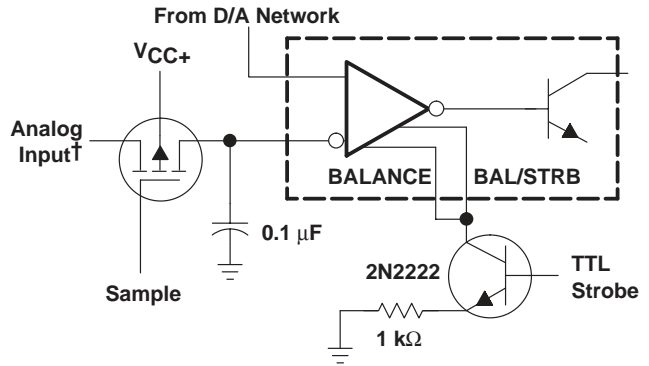


Figure 18. Comparator and Solenoid Driver



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

Figure 19. Strobing Both Input and Output Stages Simultaneously

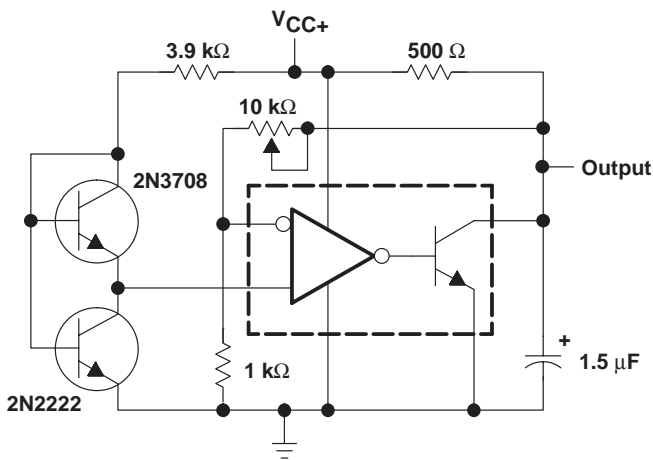


Figure 20. Low-Voltage Adjustable Reference Supply

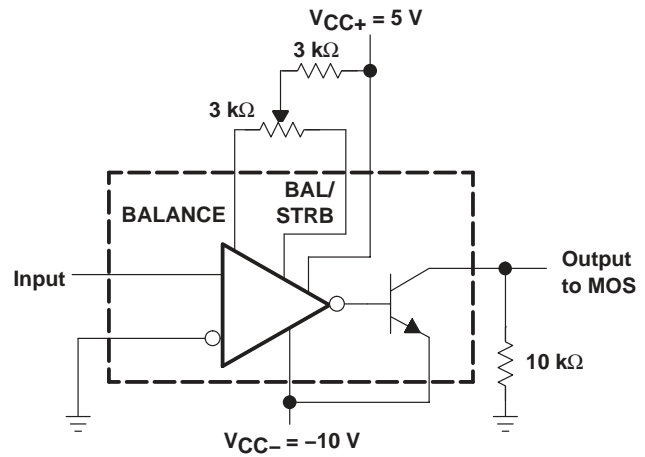
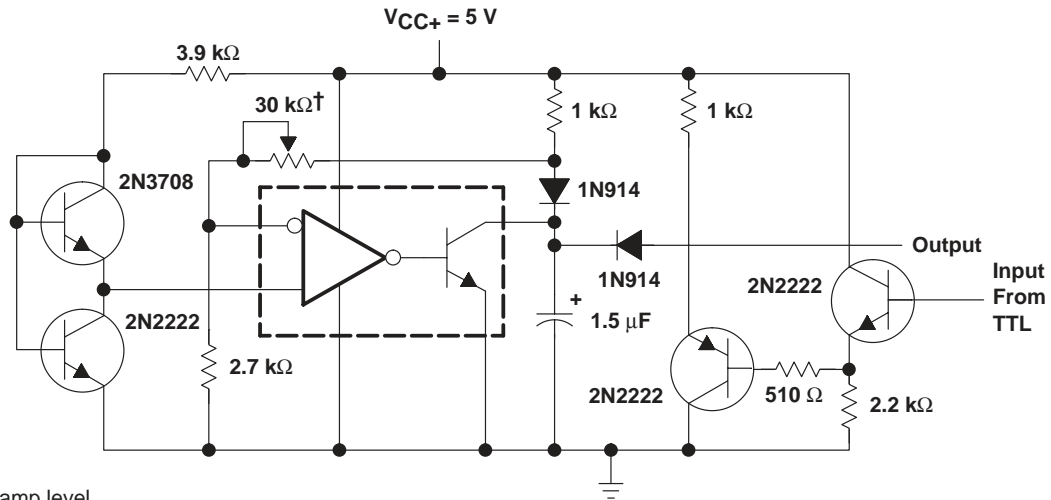


Figure 21. Zero-Crossing Detector Driving MOS Logic

APPLICATION INFORMATION



† Adjust to set clamp level

Figure 22. Precision Squarer

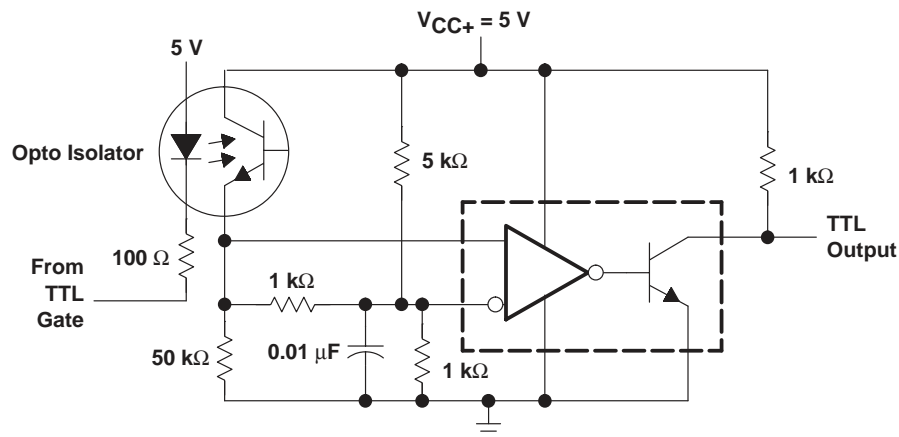


Figure 23. Digital Transmission Isolator

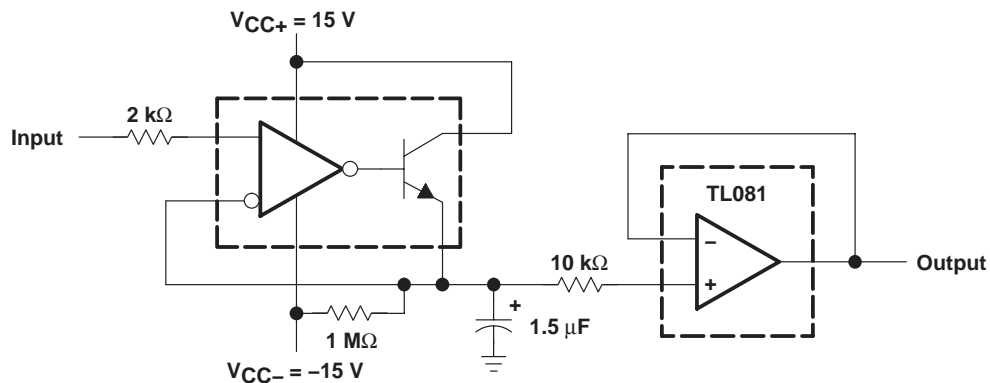


Figure 24. Positive-Peak Detector

# LM211-Q1 DIFFERENTIAL COMPARATOR WITH STROBES

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## APPLICATION INFORMATION

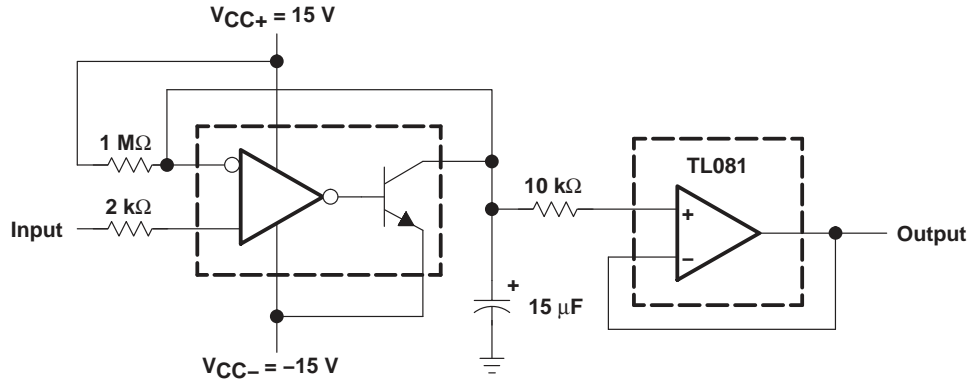
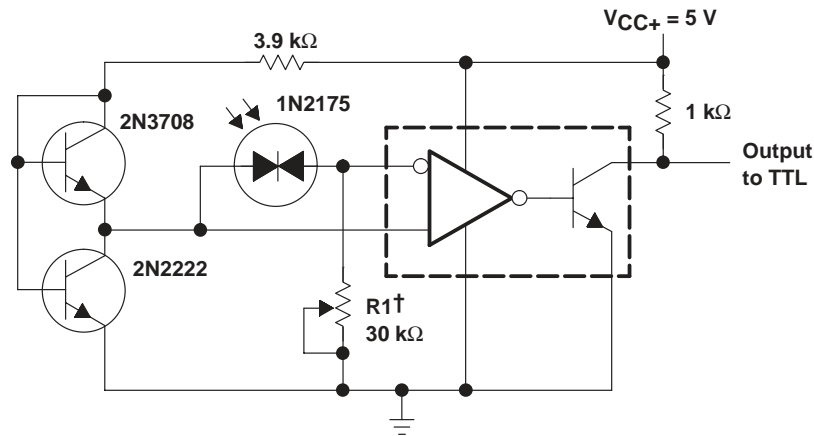
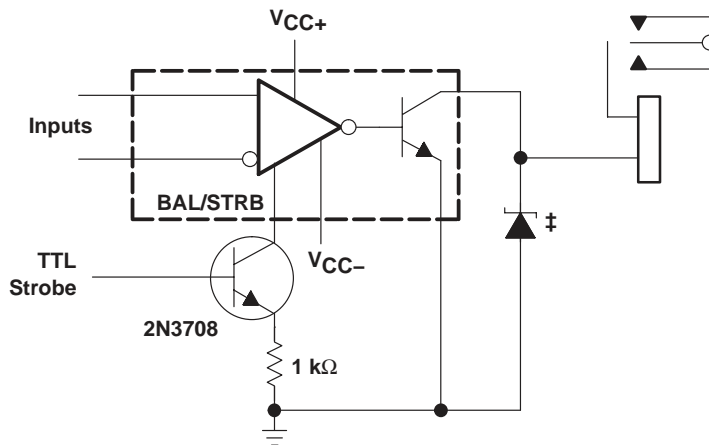


Figure 25. Negative-Peak Detector



† 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

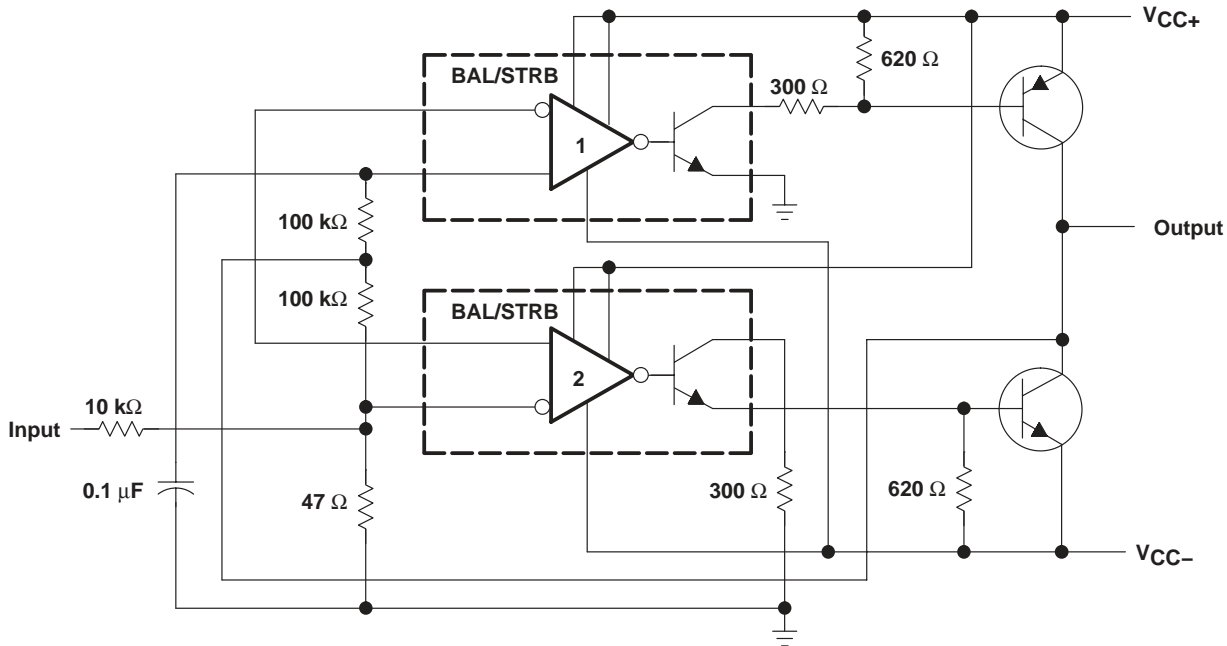


Figure 28. Switching Power Amplifier

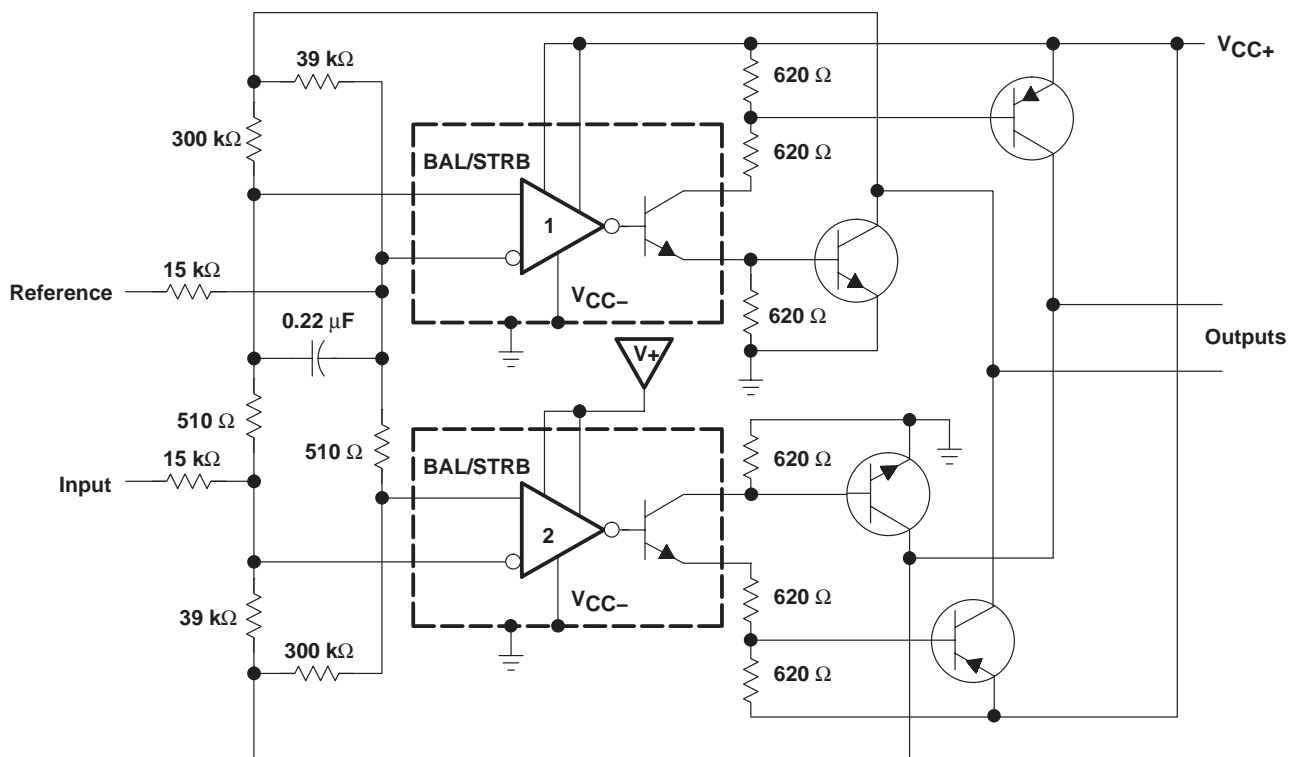


Figure 29. Switching Power Amplifiers

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM211QDRG4Q1	ACTIVE	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LM211Q	<a href="#">Samples</a>
LM211QDRQ1	ACTIVE	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LM211Q	<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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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 finish/Ball material - Orderable Devices 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.

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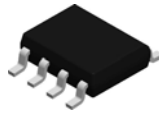
**OTHER QUALIFIED VERSIONS OF LM211-Q1 :**

- Catalog: [LM211](#)
- Enhanced Product: [LM211-EP](#)

## NOTE: Qualified Version Definitions:

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

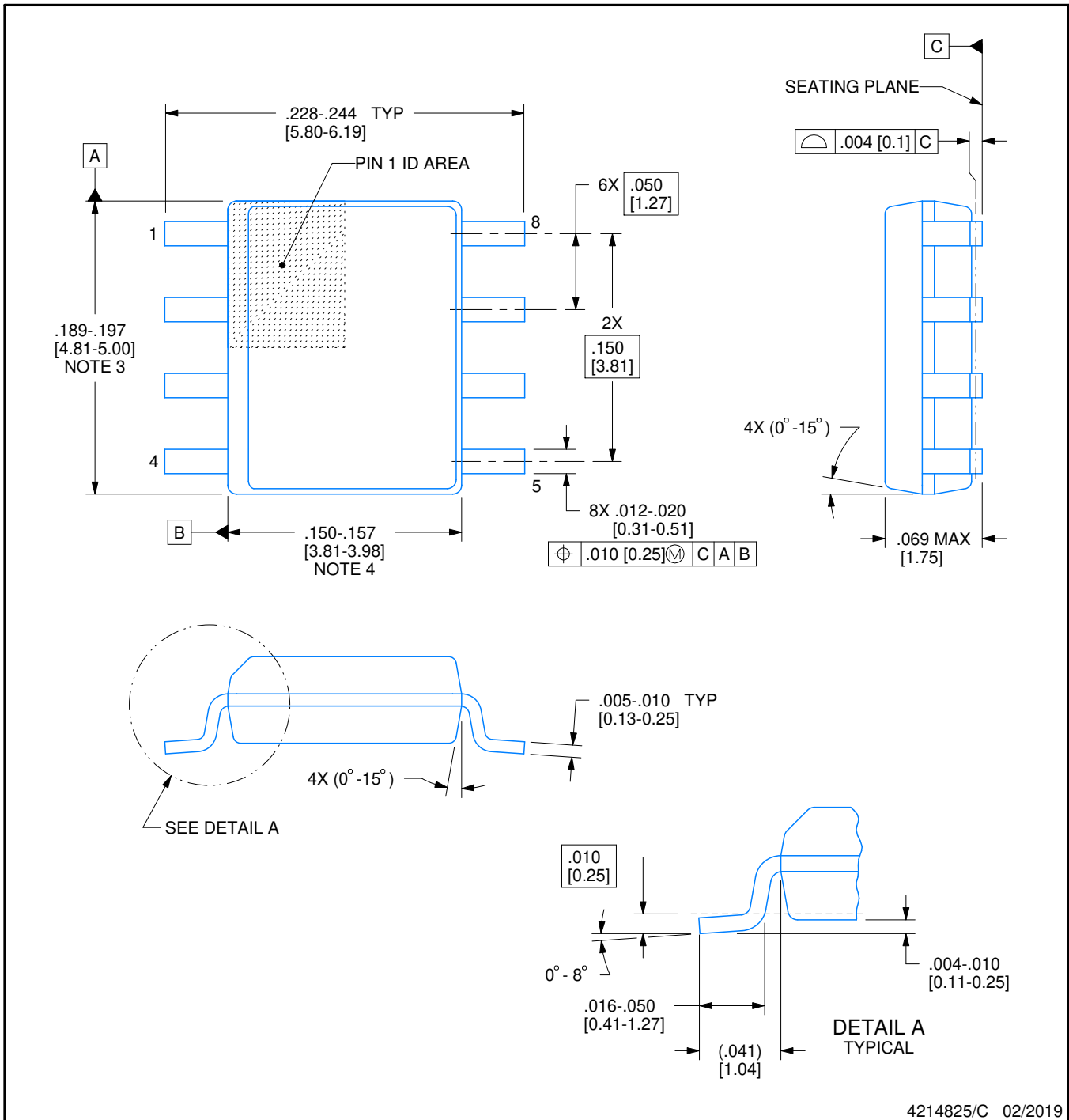
# D0008A



## PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

### 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.

# EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



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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