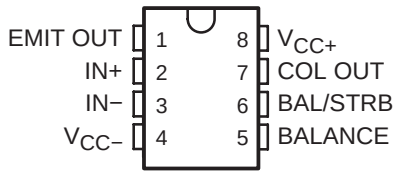
LM211-Q1
DIFFERENTIAL COMPARATOR WITH STROBES

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.

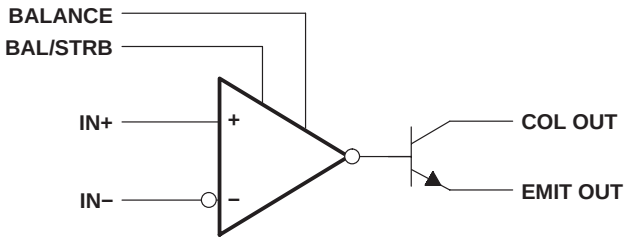
ORDERING INFORMATION†

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.

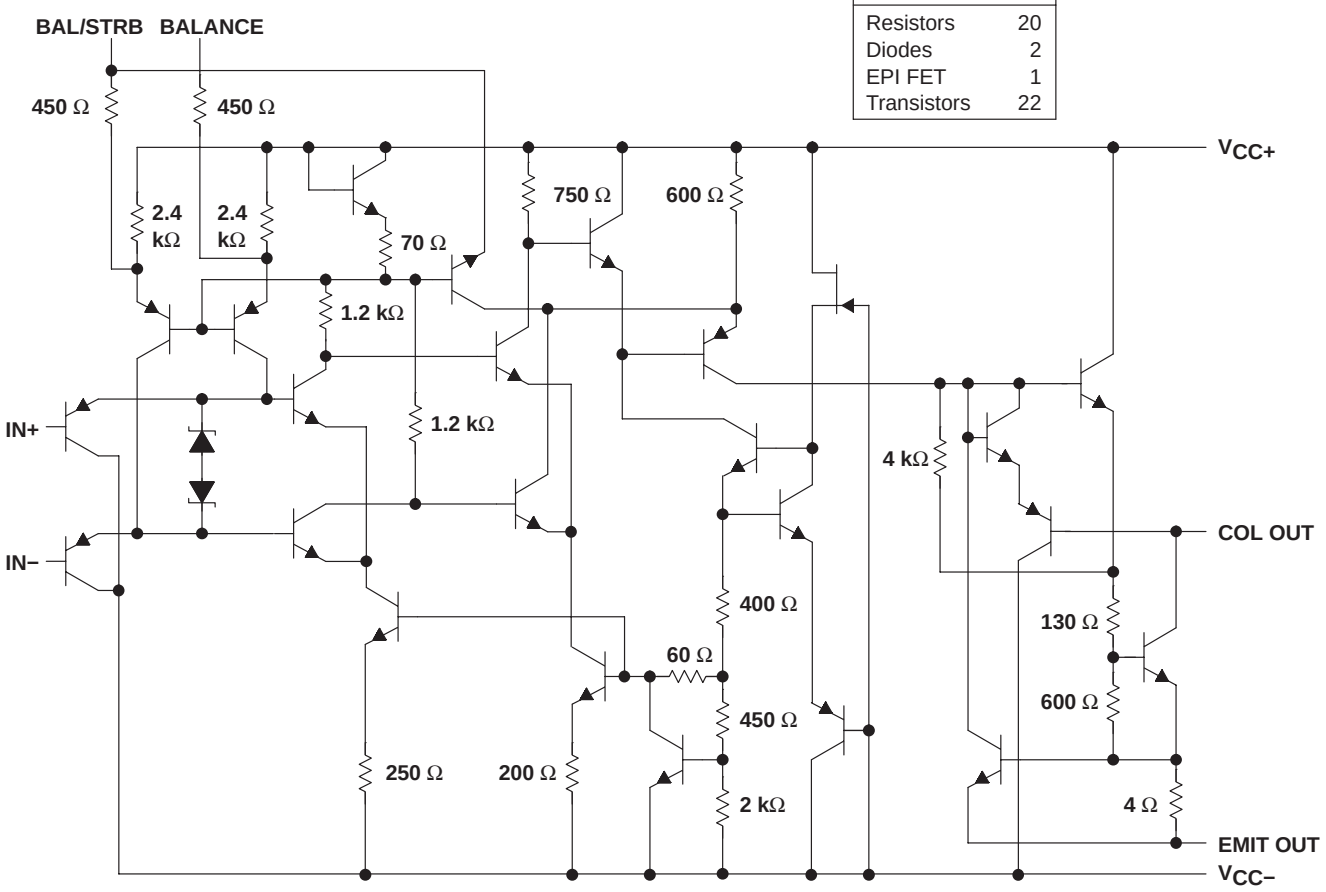
‡ Package drawings, thermal data, and symbolization are available at http://www.ti.com/packaging.

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, θ_{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 $T_J(max)$, θ_{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).

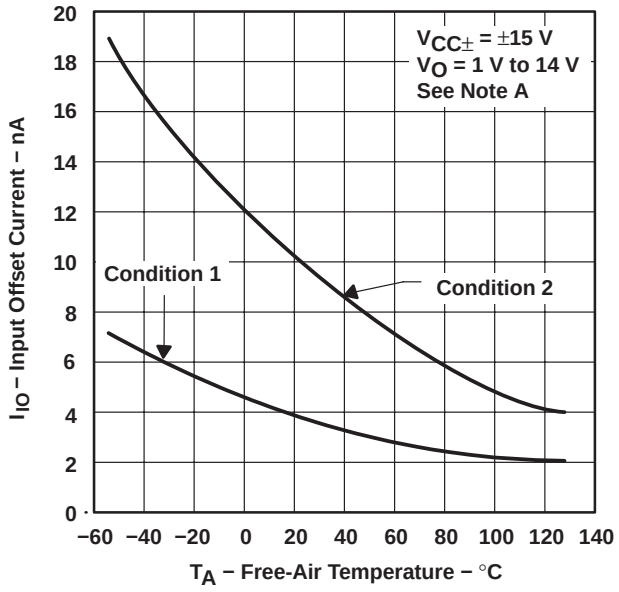
switching characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25°C

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

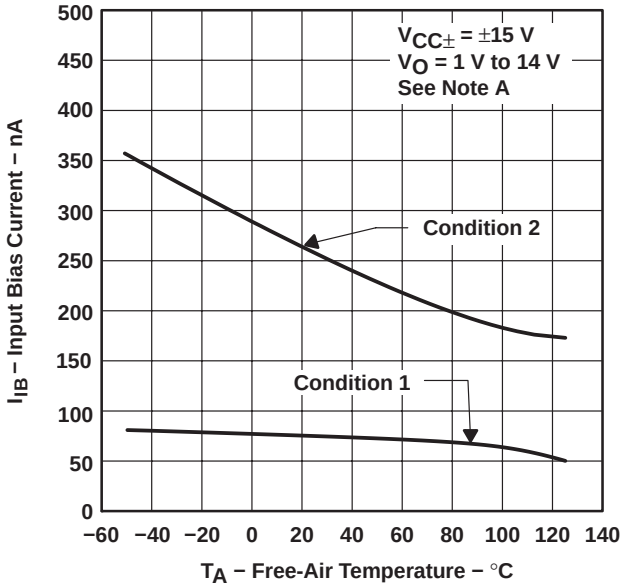
INPUT OFFSET CURRENT vs FREE-AIR TEMPERATURE



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

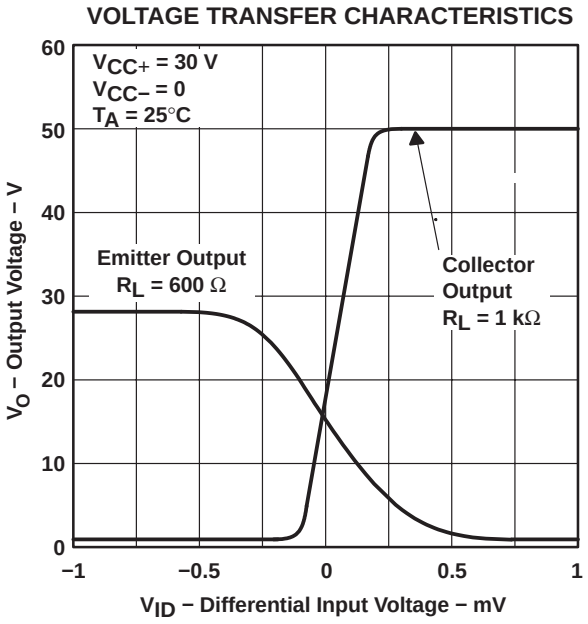
INPUT BIAS CURRENT vs FREE-AIR TEMPERATURE

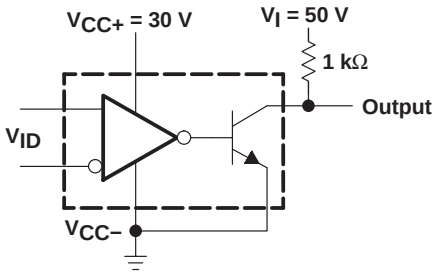


NOTE A: Condition 1 is with BALANCE and BAL/STRB open. Condition 2 is with BALANCE and BAL/STRB connected to V_{CC+}.

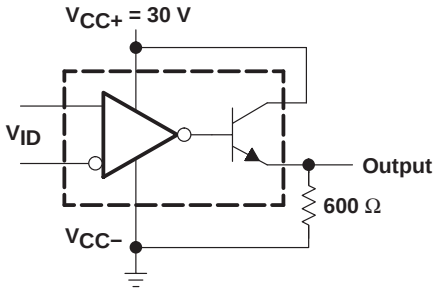
Figure 2

TYPICAL CHARACTERISTICS





COLLECTOR OUTPUT TRANSFER CHARACTERISTIC
TEST CIRCUIT FOR FIGURE 3



EMITTER OUTPUT TRANSFER CHARACTERISTIC
TEST CIRCUIT FOR FIGURE 3

Figure 3

TYPICAL CHARACTERISTICS

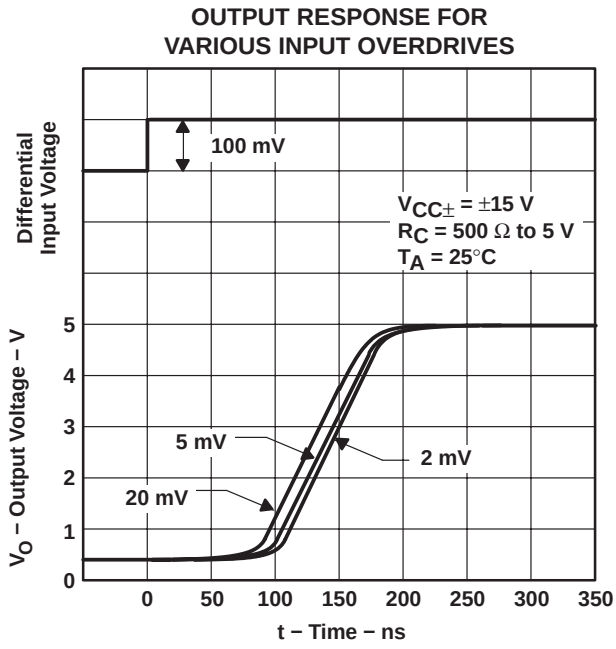


Figure 4

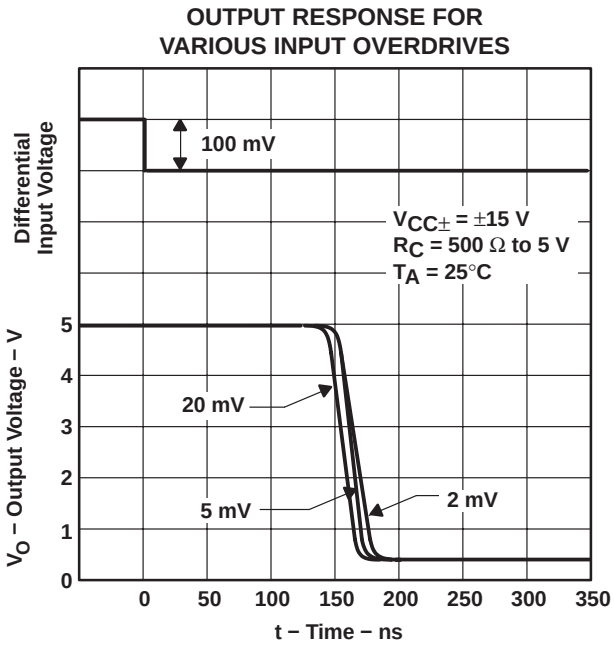
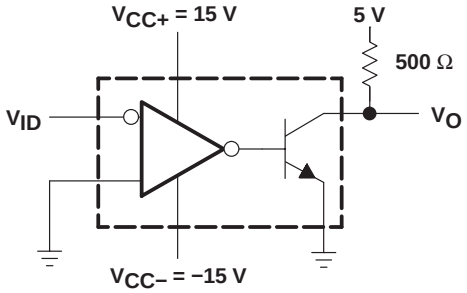


Figure 5



TEST CIRCUIT FOR FIGURES 4 AND 5

TYPICAL CHARACTERISTICS

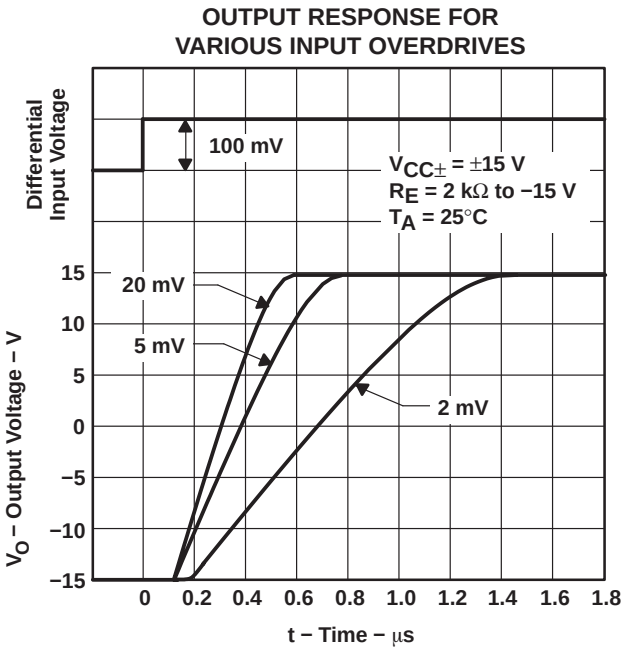


Figure 6

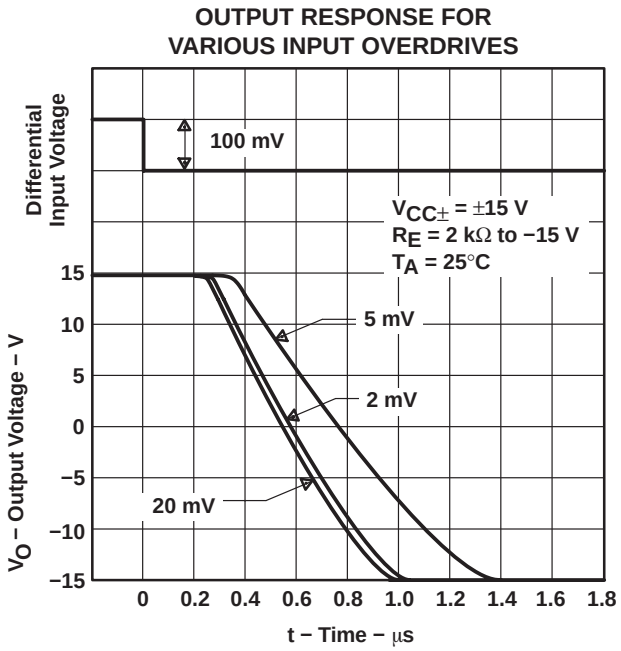
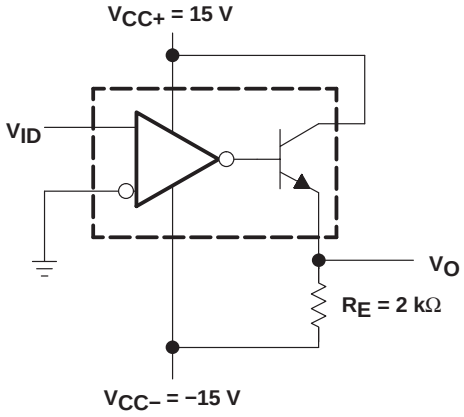


Figure 7



TEST CIRCUIT FOR FIGURES 6 AND 7

TYPICAL CHARACTERISTICS

OUTPUT CURRENT AND DISSIPATION vs OUTPUT VOLTAGE

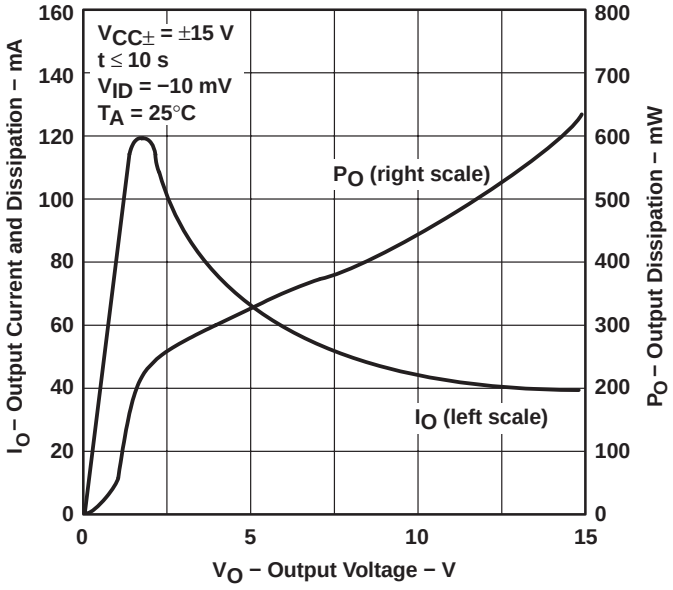


Figure 8

POSITIVE SUPPLY CURRENT vs POSITIVE SUPPLY VOLTAGE

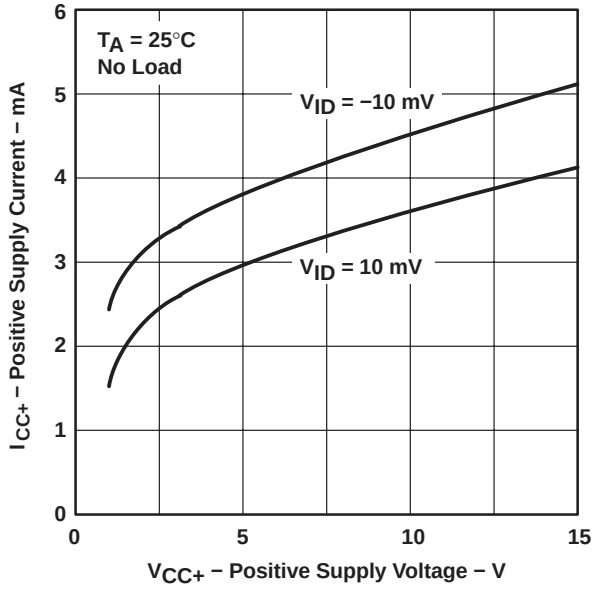


Figure 9

NEGATIVE SUPPLY CURRENT vs NEGATIVE SUPPLY VOLTAGE

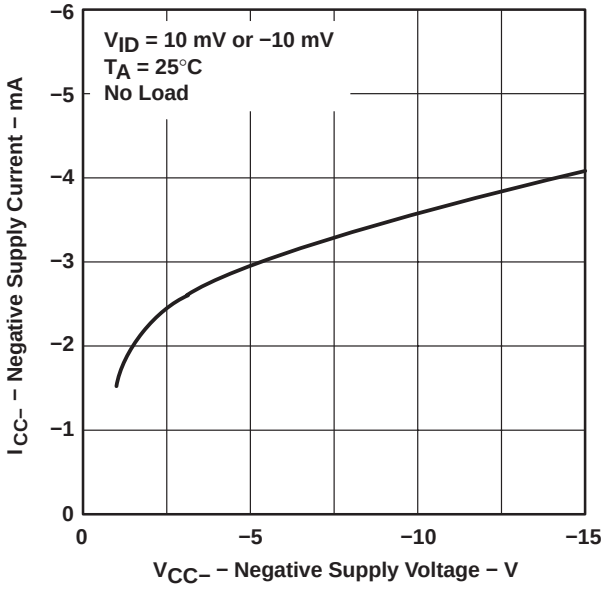


Figure 10

APPLICATION INFORMATION

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

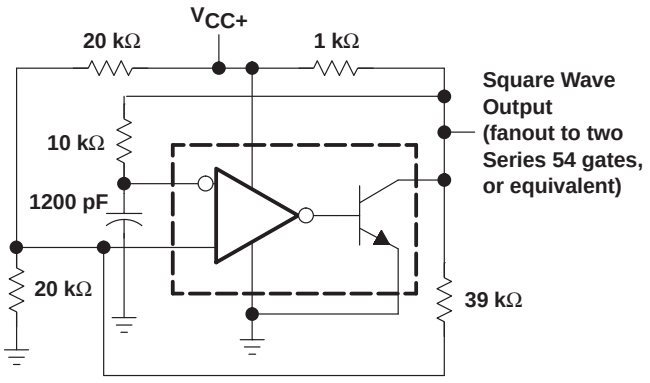
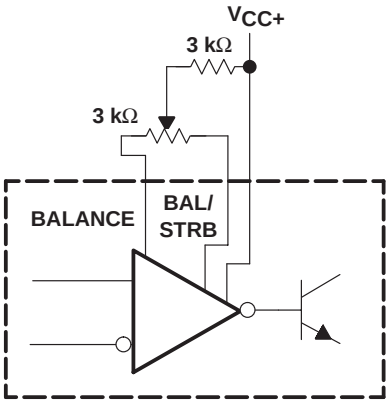
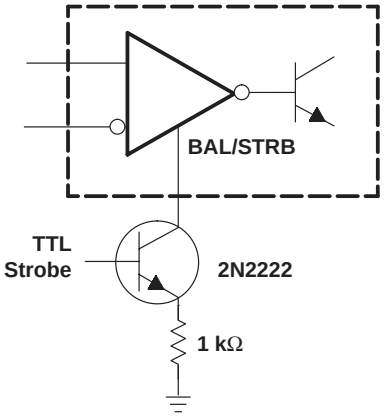


Figure 11. 100-kHz Free-Running Multivibrator



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

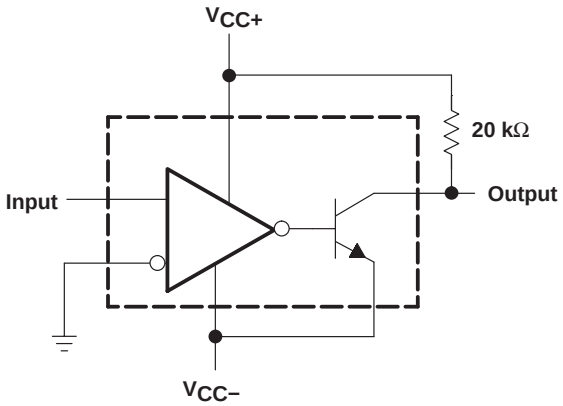
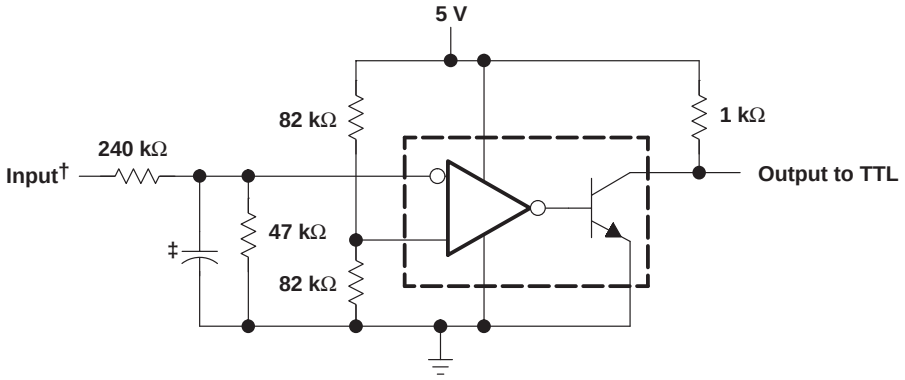


Figure 14. Zero-Crossing Detector

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

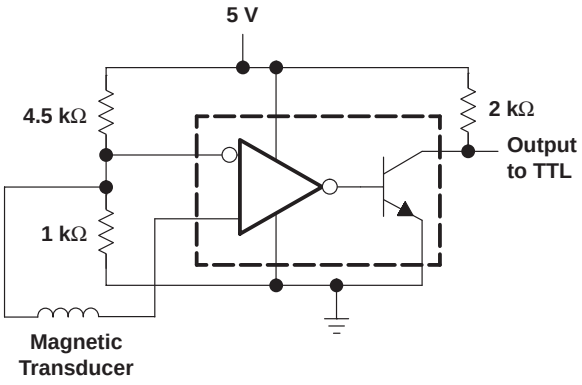


Figure 16. Detector for Magnetic Transducer

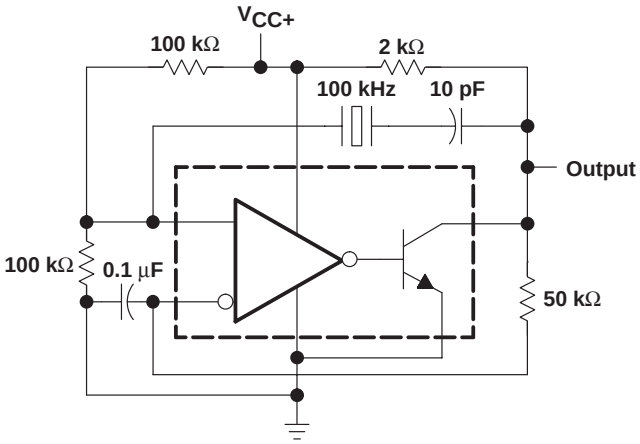


Figure 17. 100-kHz Crystal Oscillator

APPLICATION INFORMATION

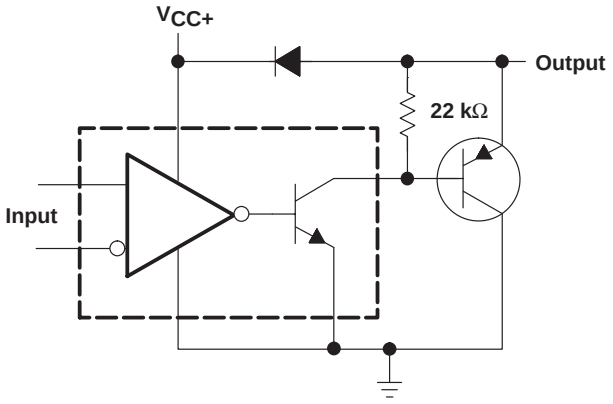
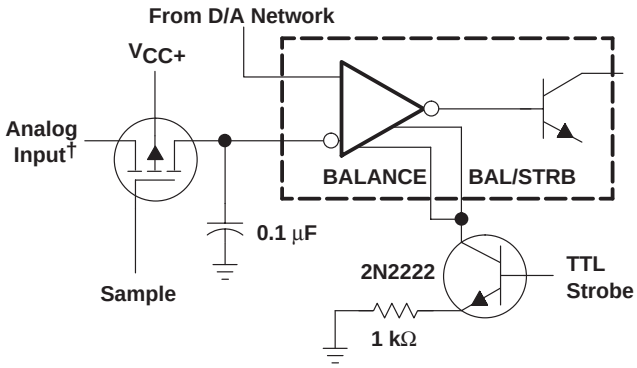


Figure 18. Comparator and Solenoid Driver



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

Figure 19. Strobing Both Input and Output Stages Simultaneously

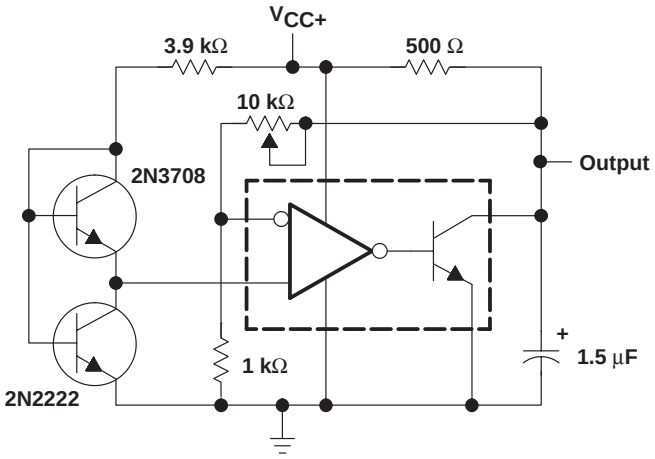


Figure 20. Low-Voltage Adjustable Reference Supply

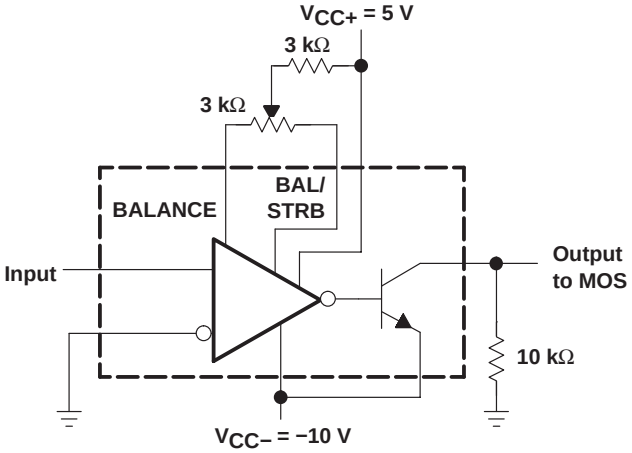
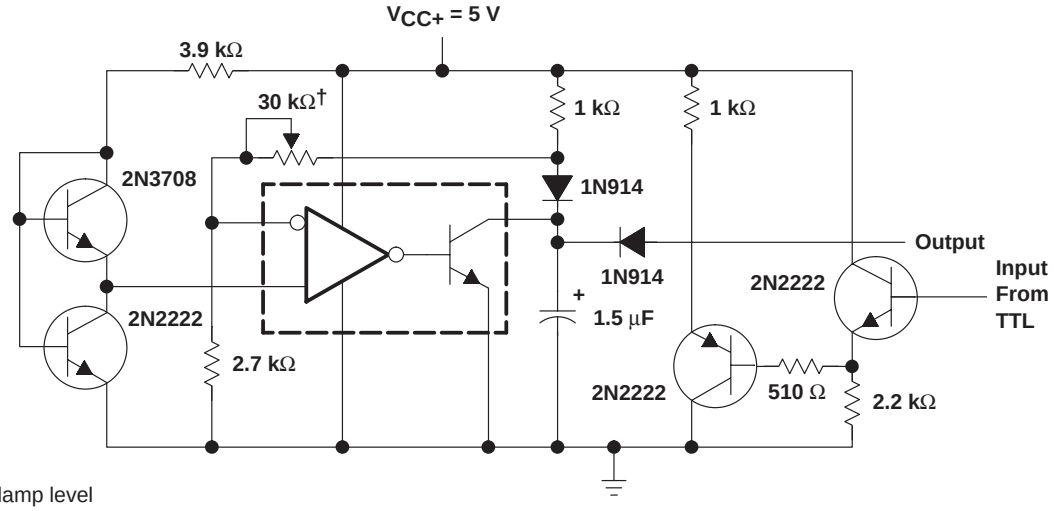


Figure 21. Zero-Crossing Detector Driving MOS Logic

APPLICATION INFORMATION



† Adjust to set clamp level

Figure 22. Precision Squarer

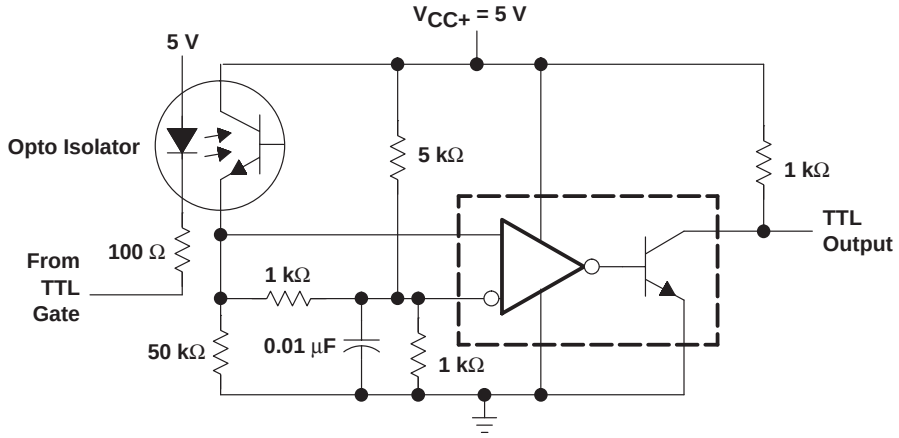


Figure 23. Digital Transmission Isolator

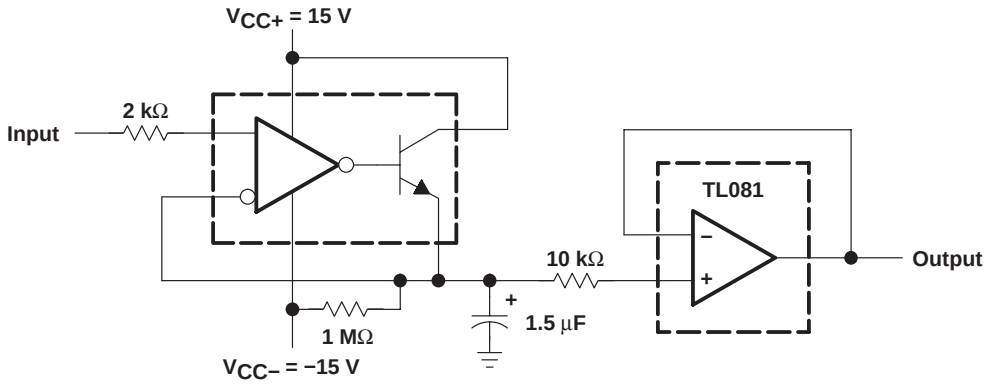


Figure 24. Positive-Peak Detector

APPLICATION INFORMATION

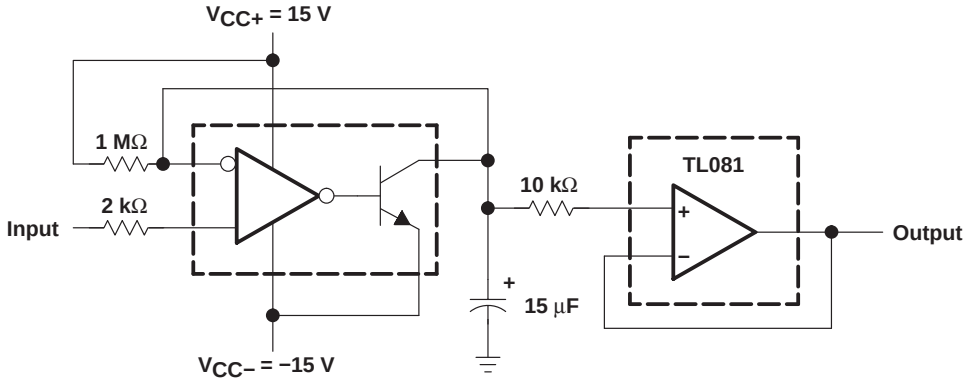
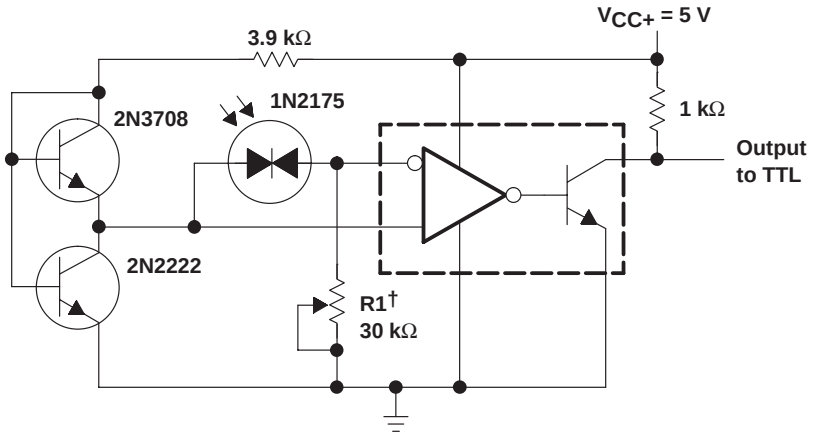
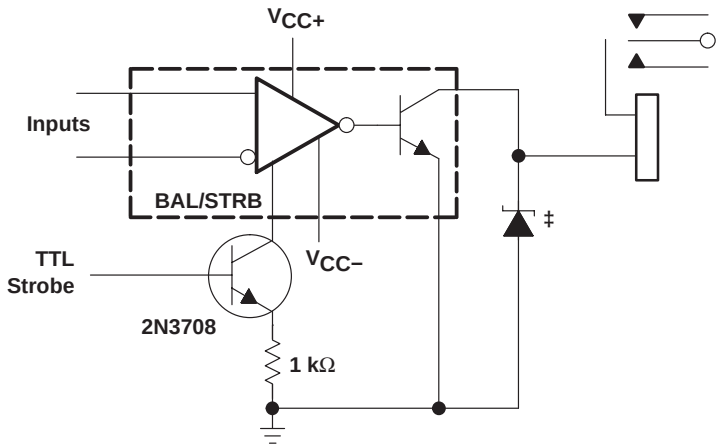


Figure 25. Negative-Peak Detector



† 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

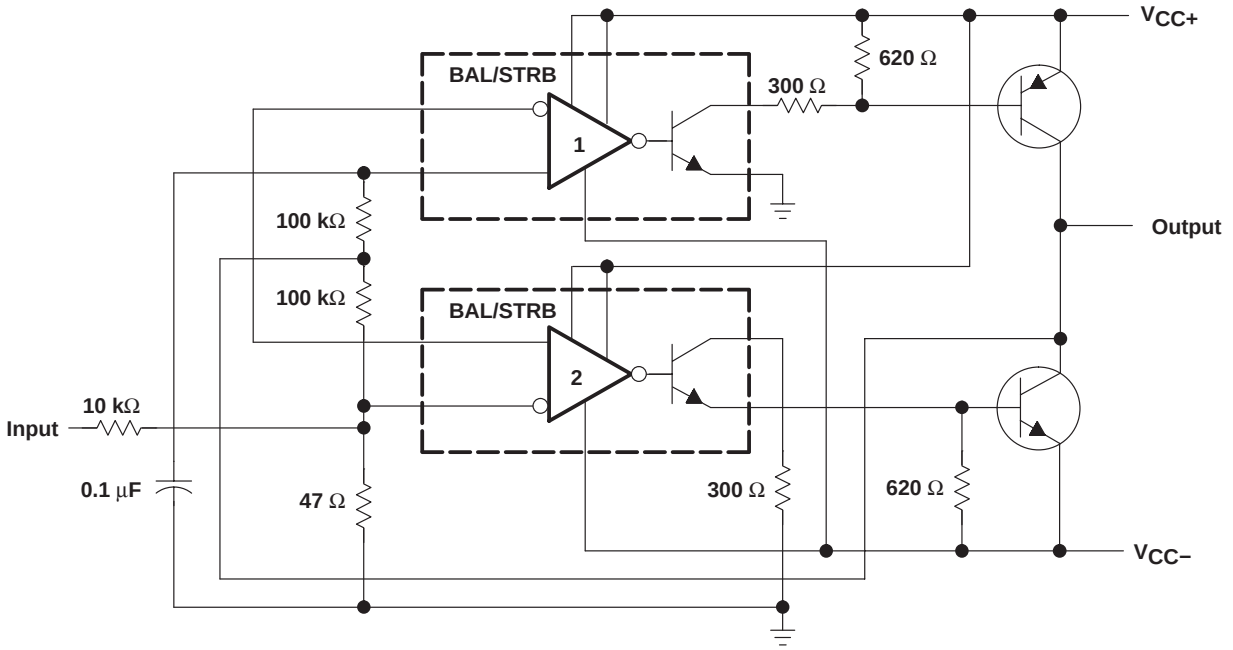


Figure 28. Switching Power Amplifier

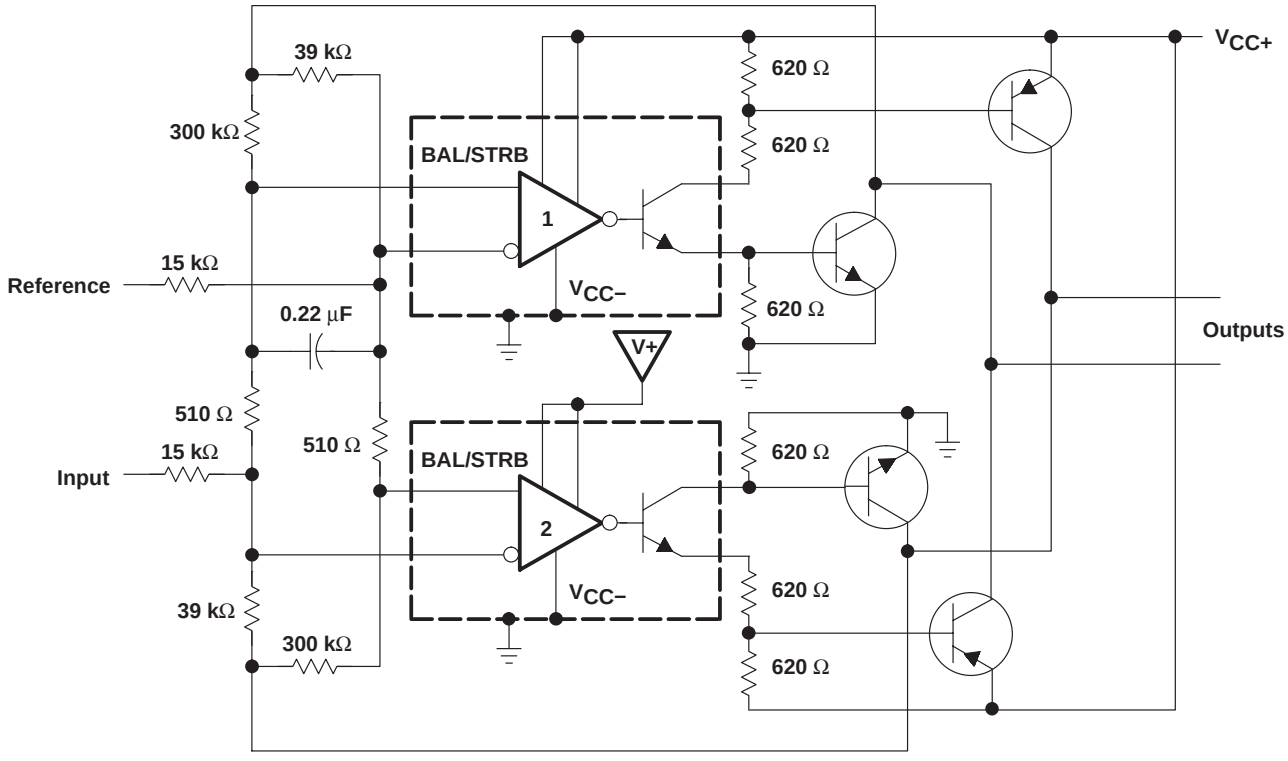


Figure 29. Switching Power Amplifiers

PACKAGING INFORMATION

Orderable 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	Samples
LM211QDRQ1	ACTIVE	SOIC	D	8	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	LM211Q	Samples

(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.

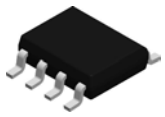
(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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

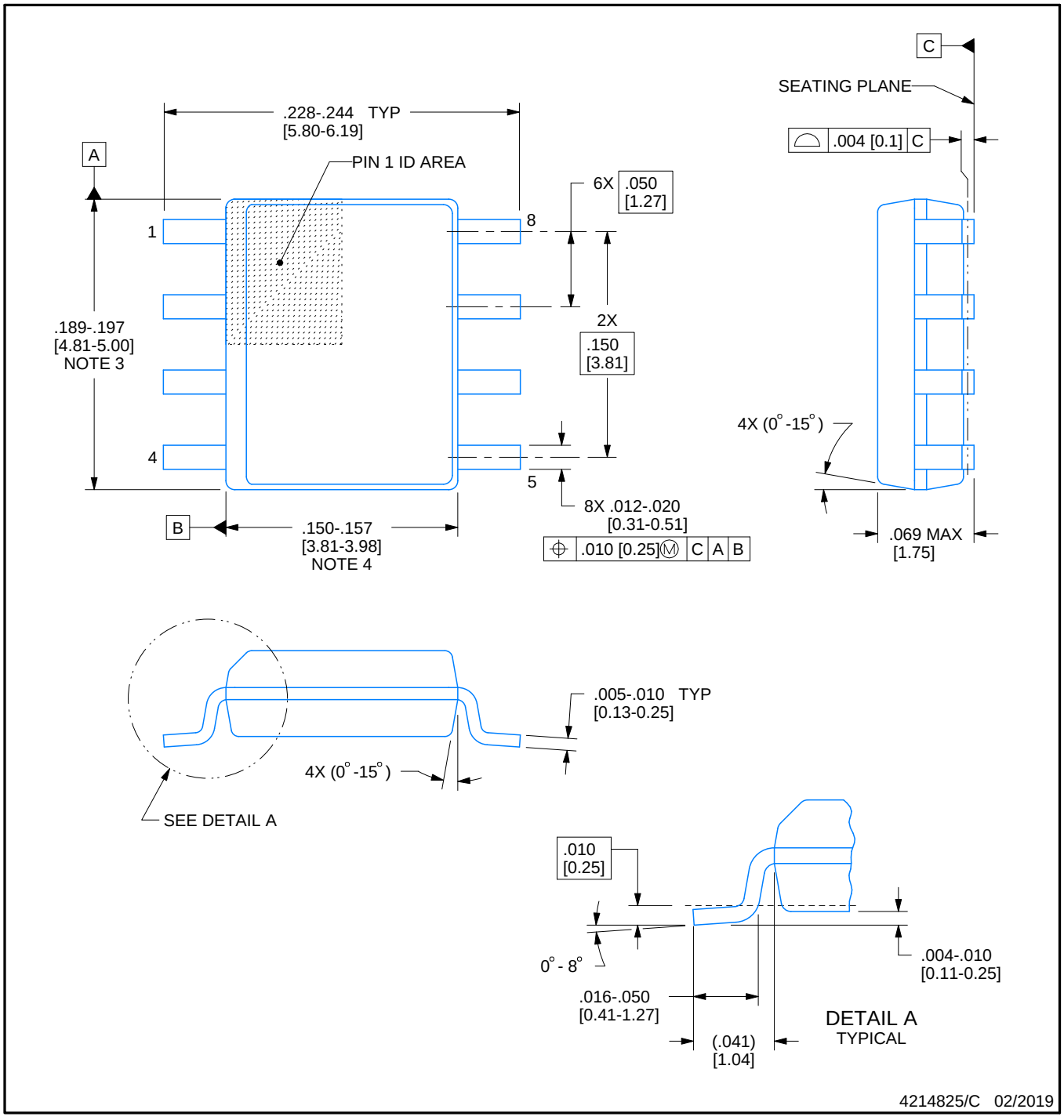


PACKAGE OUTLINE

D0008A

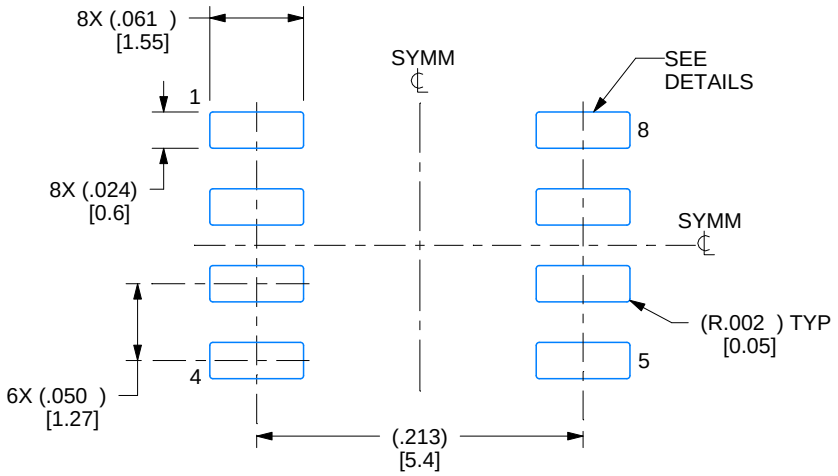
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

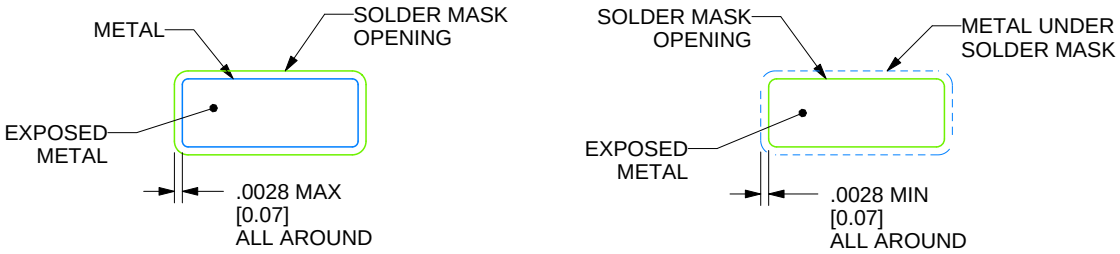


NOTES:

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)

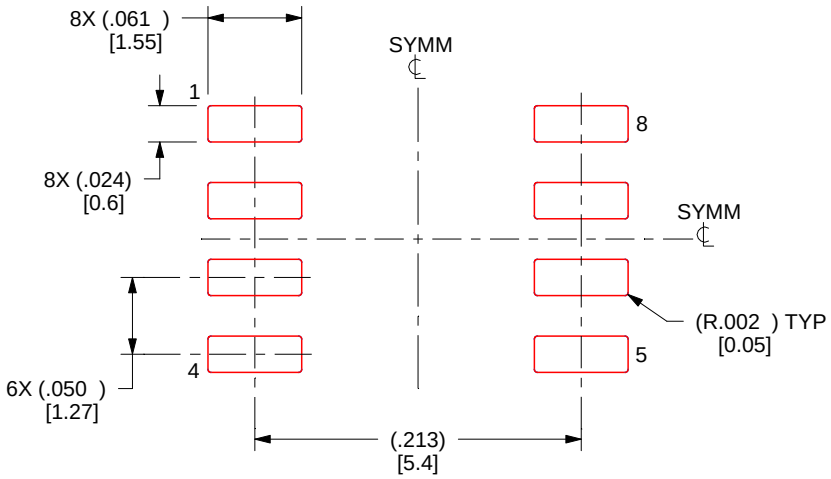
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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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