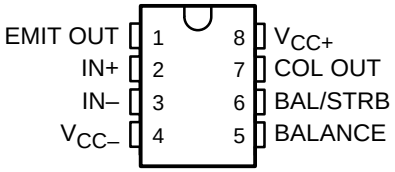
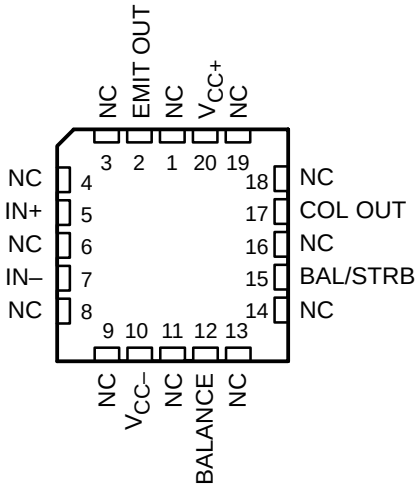
- **Fast Response Times**
- **Strobe Capability**
- **Maximum Input Bias Current . . . 300 nA**
- **Maximum Input Offset Current . . . 70 nA**
- **Can Operate From Single 5-V Supply**
- **Available in Q-Temp Automotive**
  - **High-Reliability Automotive Applications**
  - **Configuration Control/Print Support**
  - **Qualification to Automotive Standards**

LM111 . . . JG PACKAGE
LM211 . . . D, P, OR PW PACKAGE
LM311 . . . D, P, PS, OR PW PACKAGE
(TOP VIEW)



LM111 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

description/ordering information

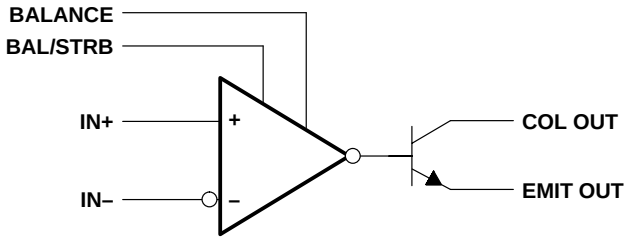
The LM111, LM211, and LM311 are single high-speed voltage comparators. These devices are designed to operate from a wide range of power-supply voltages, including ±15-V supplies for operational amplifiers and 5-V supplies for logic systems. The output levels are compatible with most TTL and MOS circuits. 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.

ORDERING INFORMATION

T_A	V_{IO} max AT 25°C	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–0°C to 70°C	7.5 mV	PDIP – P	Tube	LM311P	LM311P
		SOIC – D	Tube	LM311D	LM311
			Tape and reel	LM311DR	
		SOP – PS	Tape and reel	LM311PSR	L311
		TSSOP – PW	Tape and reel	LM311PWR	L311
–40°C to 85°C	3 mV	PDIP – P	Tube	LM211P	LM211P
		SOIC – D	Tube	LM211D	LM211
			Tape and reel	LM211DR	
		TSSOP – PW	Tape and reel	LM211PWR	L211
–40°C to 125°C	3 mV	SOIC – D	Tube	LM211QD	LM211Q
			Tape and reel	LM211QDR	
–55°C to 125°C	3 mV	CDIP – JG	Tube	LM111JG	LM111JG
		LCCC – FK	Tube	LM111FK	LM111FK

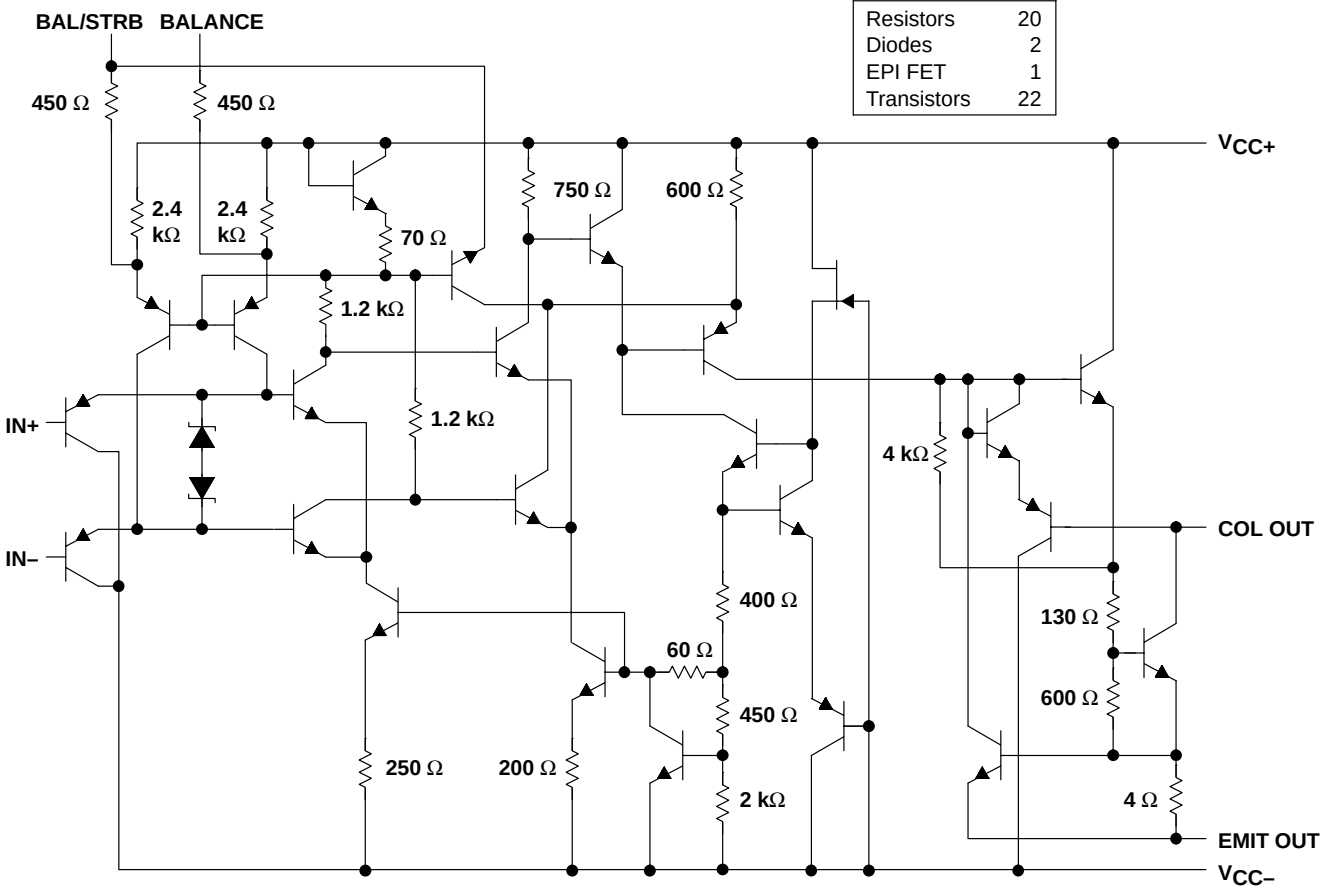
† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

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-}: LM111 . . . . . 50 V
LM211 . . . . . 50 V
LM211Q . . . . . 50 V
LM311 . . . . . 40 V
Duration of output short circuit (see Note 4) . . . . . 10 s
Continuous total dissipation . . . . . See Dissipation Rating Table
Package thermal impedance, θ_{JA} (see Note 5): D package . . . . . 97°C/W
P package . . . . . 85°C/W
PS package . . . . . 95°C/W
PW package . . . . . 149°C/W
Case temperature for 60 seconds: FK package . . . . . 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: J or JG package . . . . . 300°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: D, P, PS, or PW package . . . . . 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. The package thermal impedance is calculated in accordance with JESD 51-7.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR	DERATE ABOVE T_A	$T_A = 70°C$ POWER RATING	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
FK	500 mW	11.0 mW/°C	105°C	500 mW	500 mW	275 mW
JG	500 mW	8.4 mW/°C	90°C	500 mW	500 mW	210 mW

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	LM111	–55	125	°C
		LM211	–40	85	
		LM211Q	–40	125	
		LM311	0	70	

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

PARAMETER		TEST CONDITIONS		T_A†	LM111, LM211, LM211Q			LM311			UNIT
					MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IO}	Input offset voltage	See Note 6		25°C		0.7	3		2	7.5	mV
				Full range			4			10	
I_{IO}	Input offset current	See Note 6		25°C		4	10		6	50	nA
				Full range			20			70	
I_{IB}	Input bias current	V_O = 1 V to 14 V		25°C		75	100		100	250	nA
				Full range			150			300	
$I_{IL(S)}$	Low-level strobe current (see Note 7)	$V_{(strobe)}$ = 0.3 V,	$V_{ID} \le$ –10 mV	25°C		–3			–3		mA
V_{ICR}	Common-mode input voltage range			Full range	13 to –14.5	13.8 to –14.7		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		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					0.2	50	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					0.75	1.5	
		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					0.23	0.4	
I_{CC+}	Supply current from V_{CC+}, output low	V_{ID} = –10 mV,	No load	25°C		5.1	6		5.1	7.5	mA
I_{CC-}	Supply current from V_{CC-}, output high	V_{ID} = 10 mV,	No load	25°C		–4.1	–5		–4.1	–5	mA

† 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.

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

NOTES: 6. 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.

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

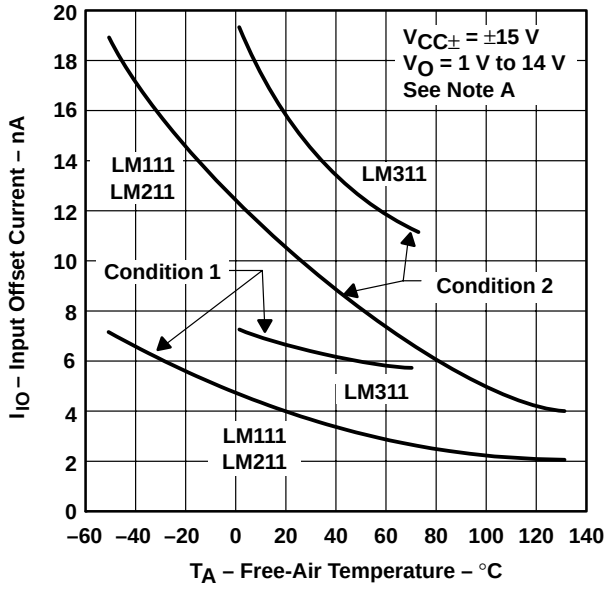
switching characteristics, $V_{CC\pm}$ = ±15 V, T_A = 25°C

PARAMETER	TEST CONDITIONS			LM111, LM211, LM211Q, LM311	UNIT
				TYP	
Response time, low-to-high-level output	R_C = 500 Ω to 5 V,	C_L = 5 pF,	See Note 8	115	ns
Response time, high-to-low-level output				165	ns

NOTE 8: 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†

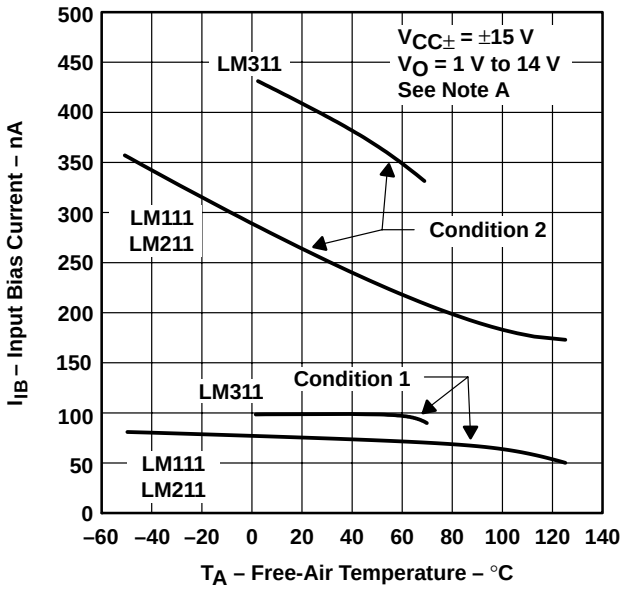
INPUT OFFSET CURRENT vs FREE-AIR TEMPERATURE



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

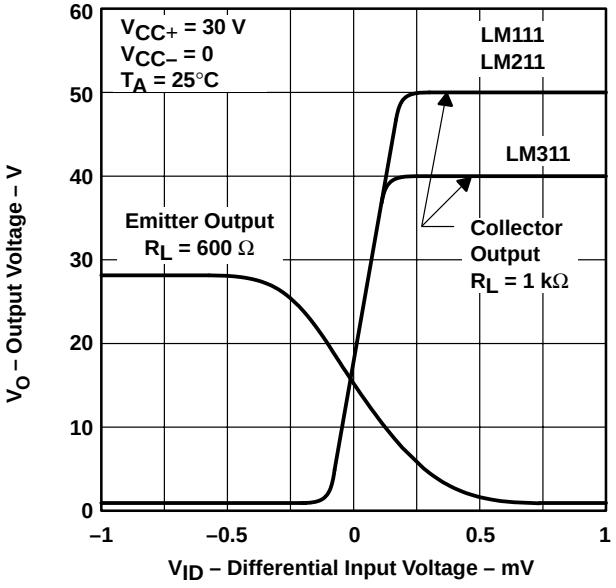


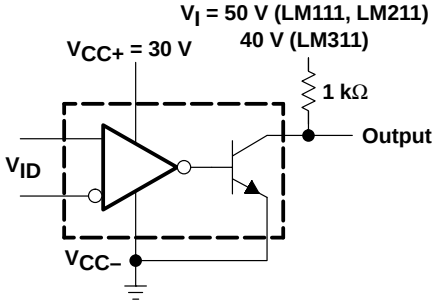
NOTE A: Condition 1 is with BALANCE and BAL/STRB open. Condition 2 is with BALANCE and BAL/STRB connected to V_{CC+}.

Figure 2

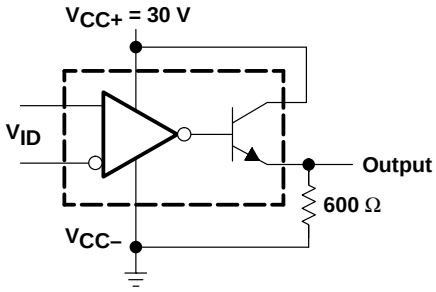
† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†





COLLECTOR OUTPUT TRANSFER CHARACTERISTIC
TEST CIRCUIT FOR FIGURE 3



EMITTER OUTPUT TRANSFER CHARACTERISTIC
TEST CIRCUIT FOR FIGURE 3

Figure 3

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

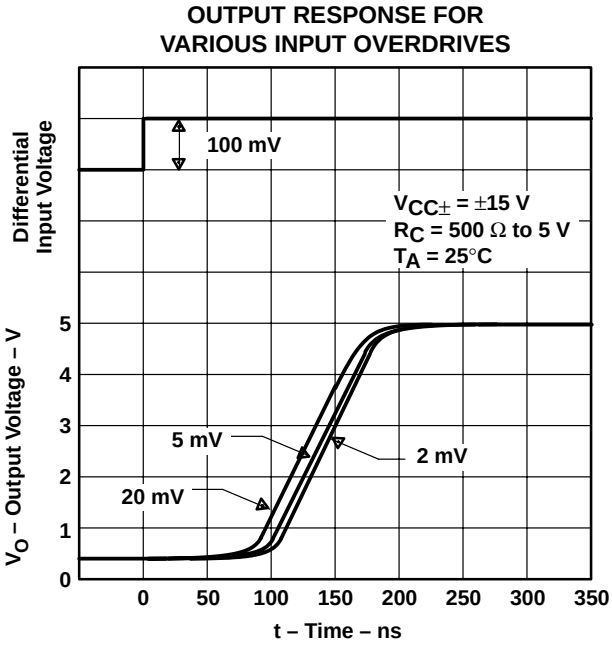


Figure 4

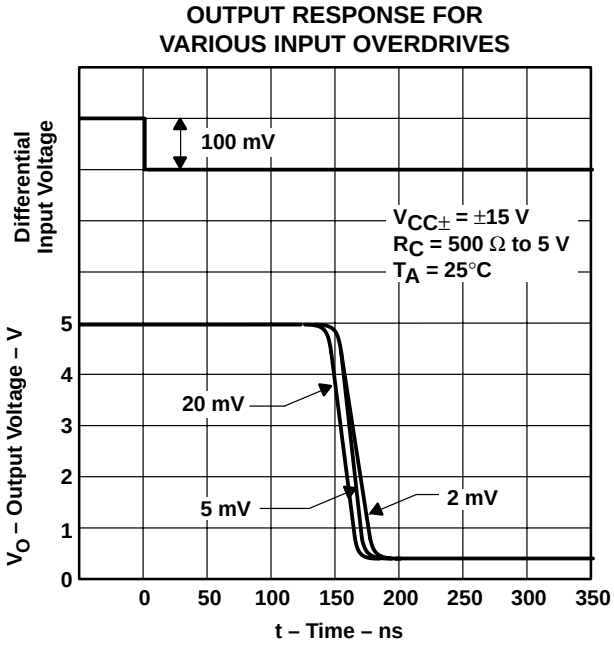
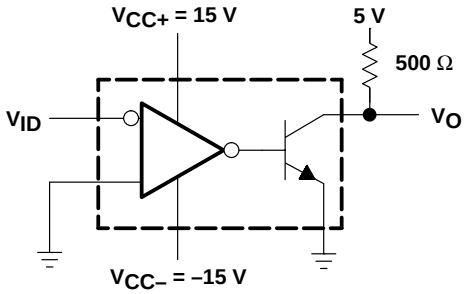


Figure 5



TEST CIRCUIT FOR FIGURES 4 AND 5

TYPICAL CHARACTERISTICS

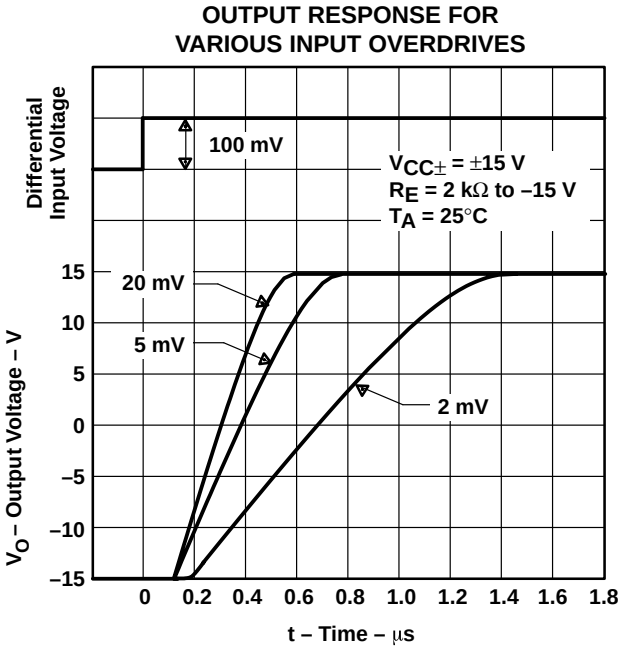


Figure 6

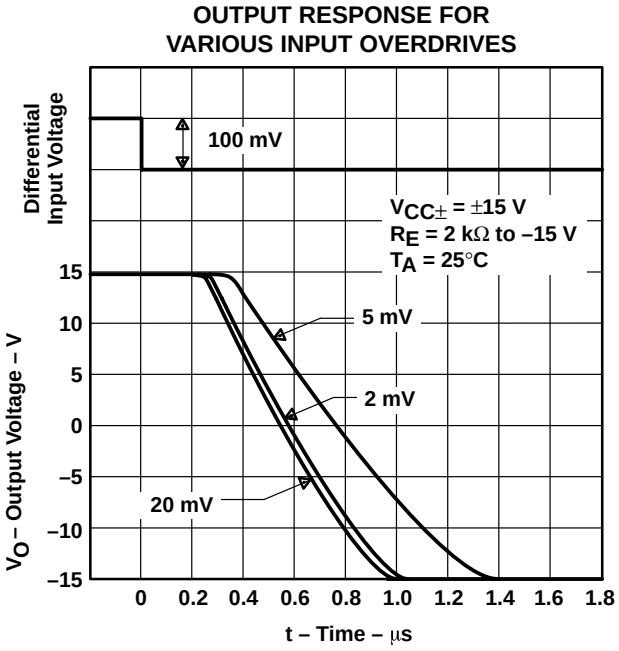
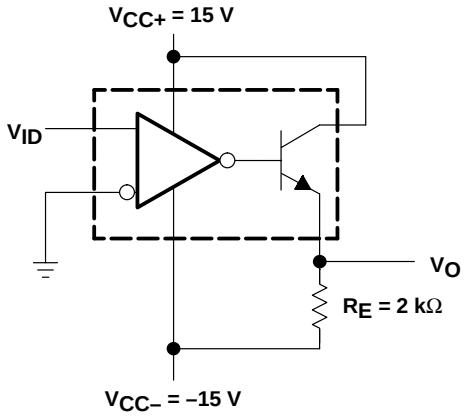


Figure 7



TEST CIRCUIT FOR FIGURES 6 AND 7

TYPICAL CHARACTERISTICS

OUTPUT CURRENT AND DISSIPATION vs OUTPUT VOLTAGE

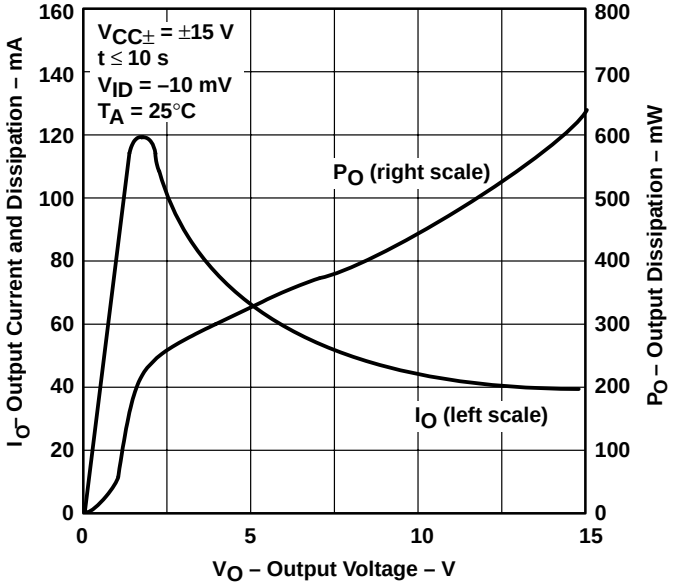


Figure 8

POSITIVE SUPPLY CURRENT vs POSITIVE SUPPLY VOLTAGE

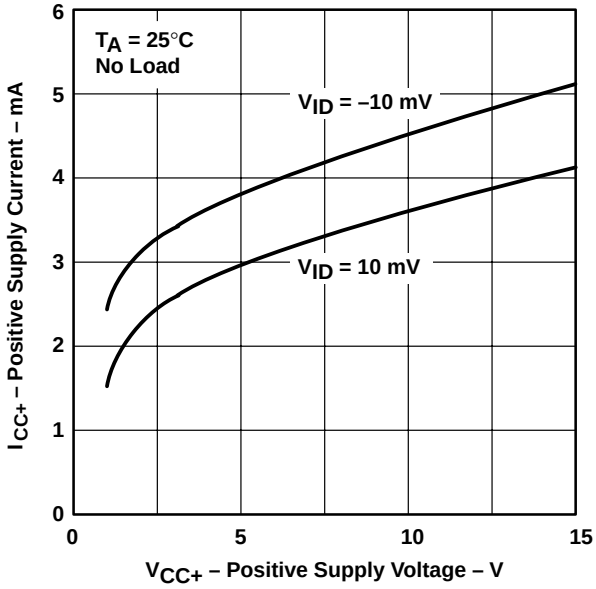


Figure 9

NEGATIVE SUPPLY CURRENT vs NEGATIVE SUPPLY VOLTAGE

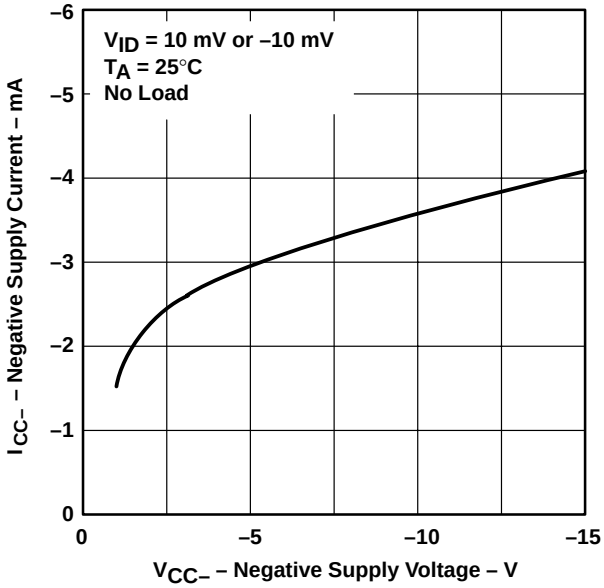


Figure 10

APPLICATION INFORMATION

Figure 11 through Figure 29 show various applications for the LM111, LM211, and LM311 comparators.

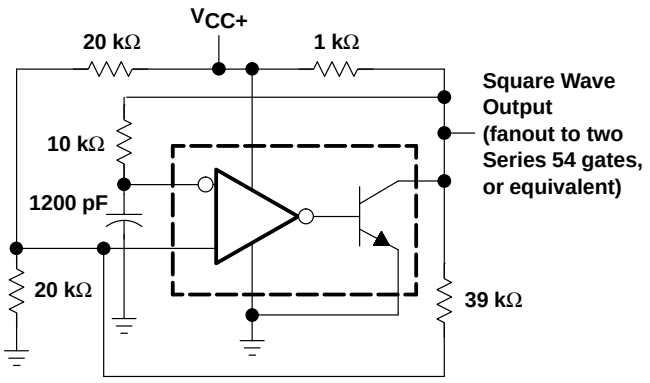
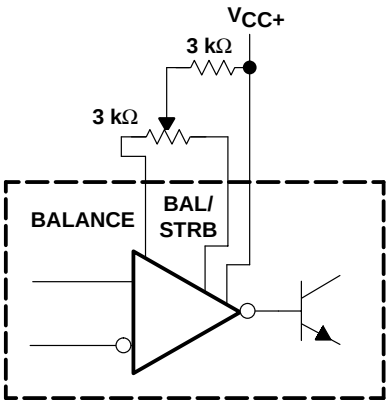


Figure 11. 100-kHz Free-Running Multivibrator



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

Figure 12. Offset Balancing

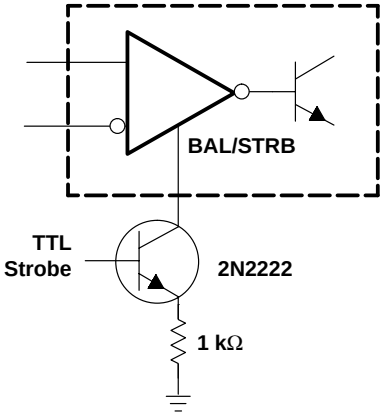


Figure 13. Strobing

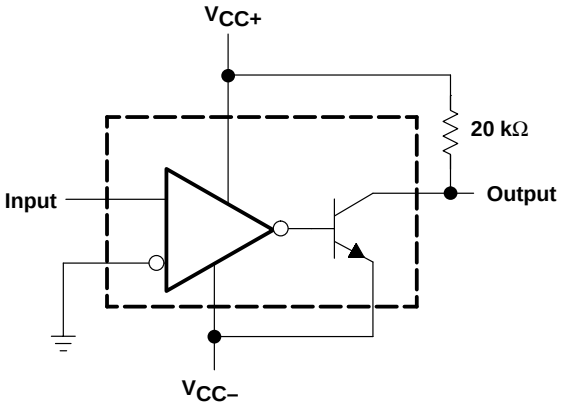
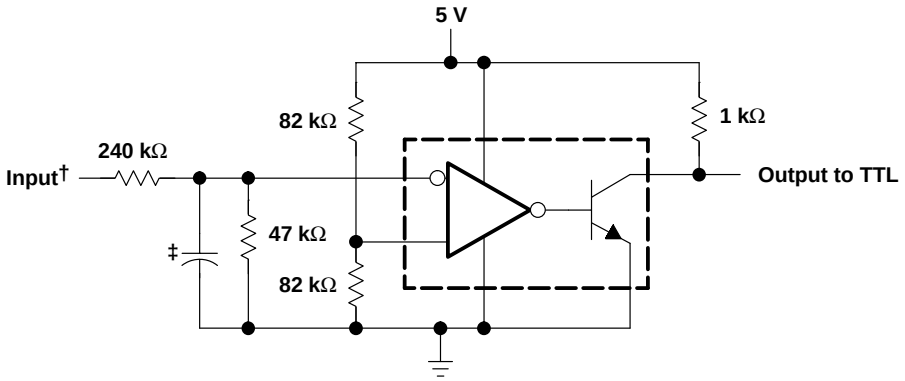


Figure 14. Zero-Crossing Detector

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

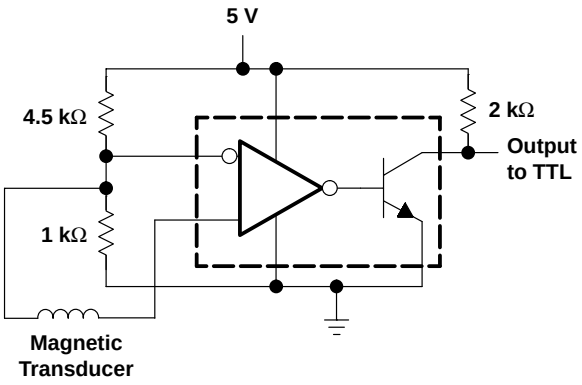


Figure 16. Detector for Magnetic Transducer

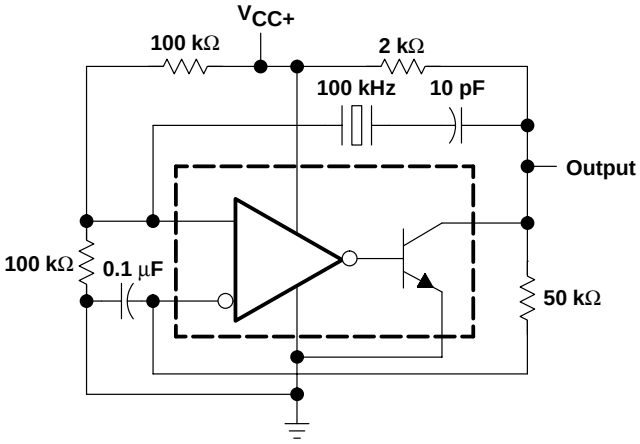


Figure 17. 100-kHz Crystal Oscillator

APPLICATION INFORMATION

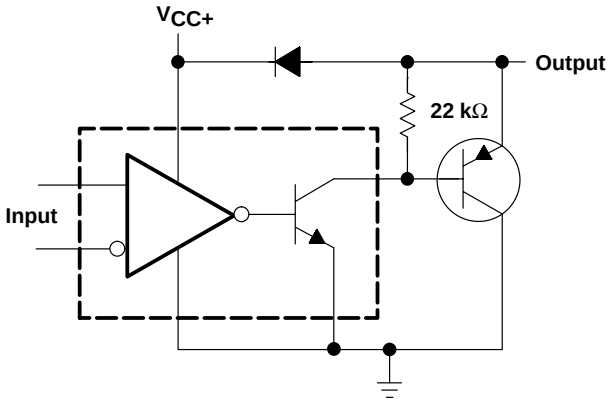
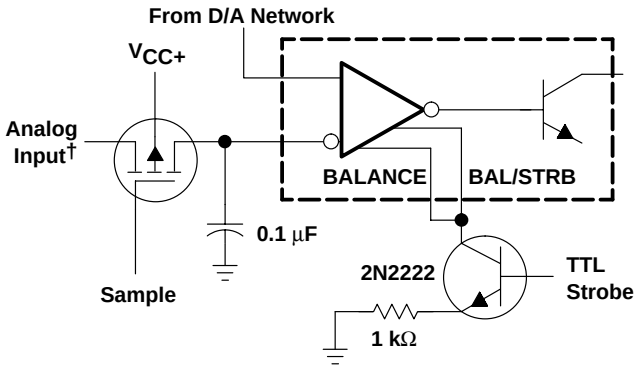


Figure 18. Comparator and Solenoid Driver



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

Figure 19. Strobing Both Input and Output Stages Simultaneously

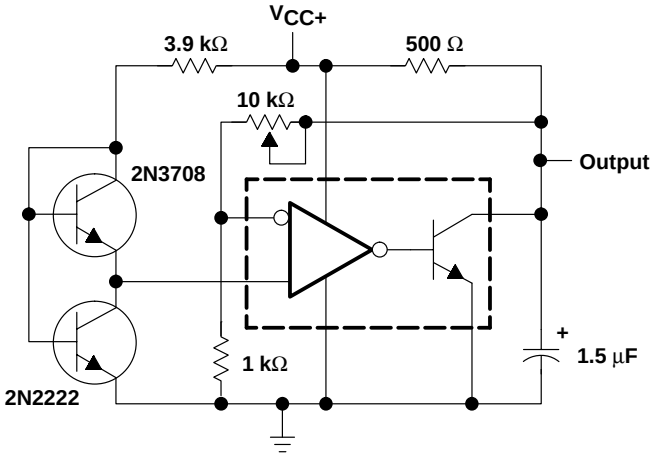


Figure 20. Low-Voltage Adjustable Reference Supply

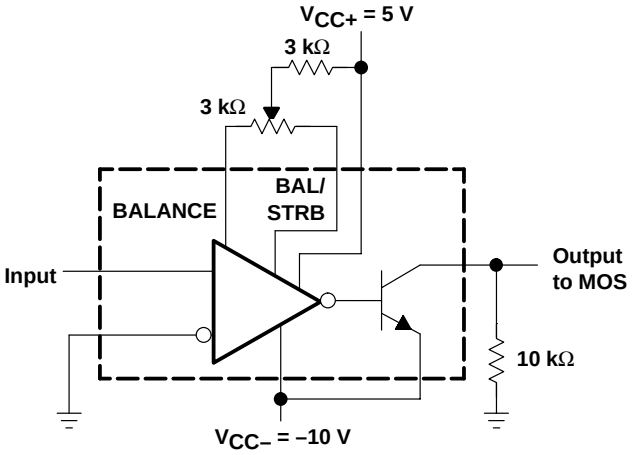
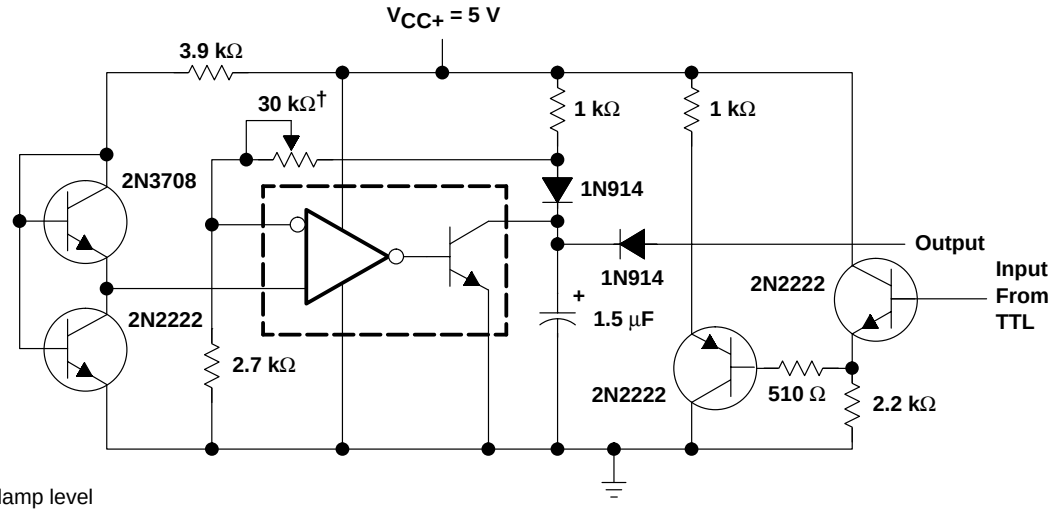


Figure 21. Zero-Crossing Detector Driving MOS Logic

APPLICATION INFORMATION



† Adjust to set clamp level

Figure 22. Precision Squarer

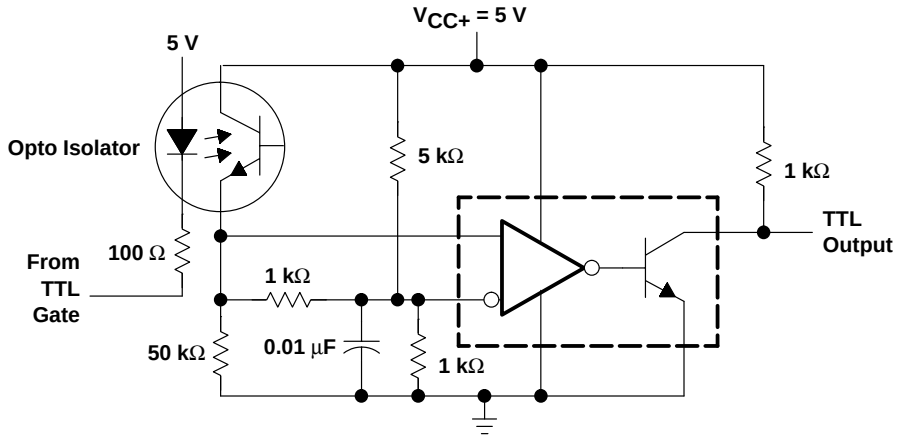


Figure 23. Digital Transmission Isolator

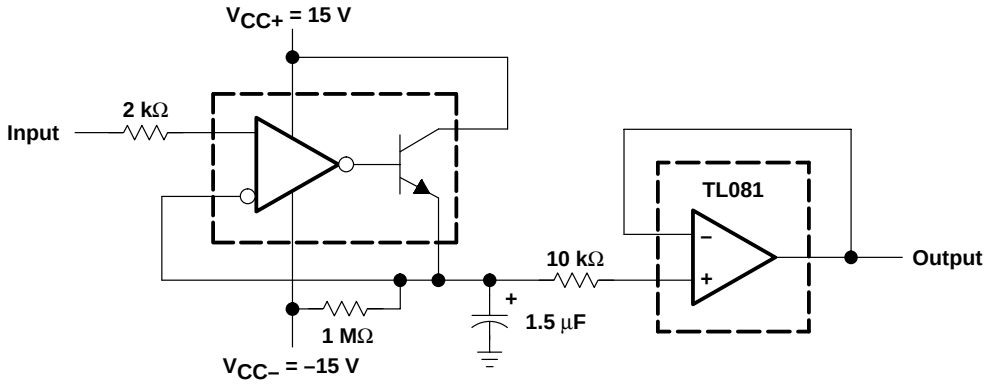


Figure 24. Positive-Peak Detector

APPLICATION INFORMATION

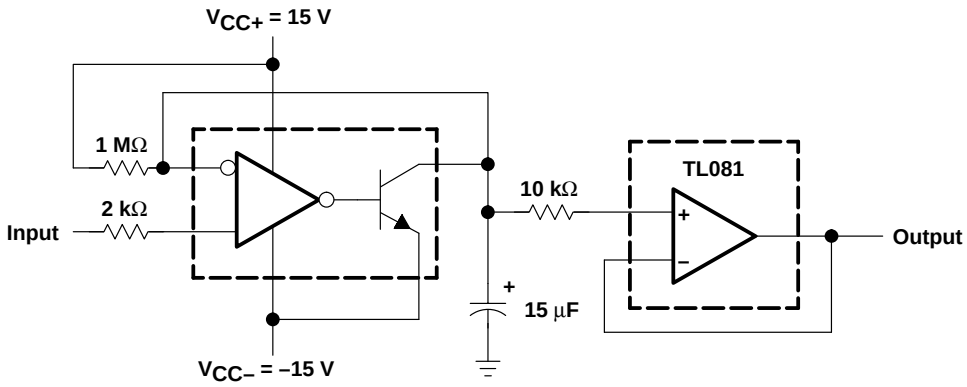
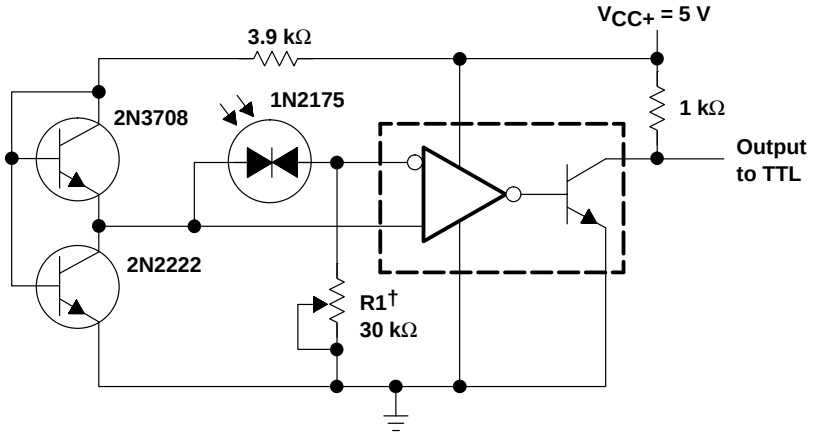
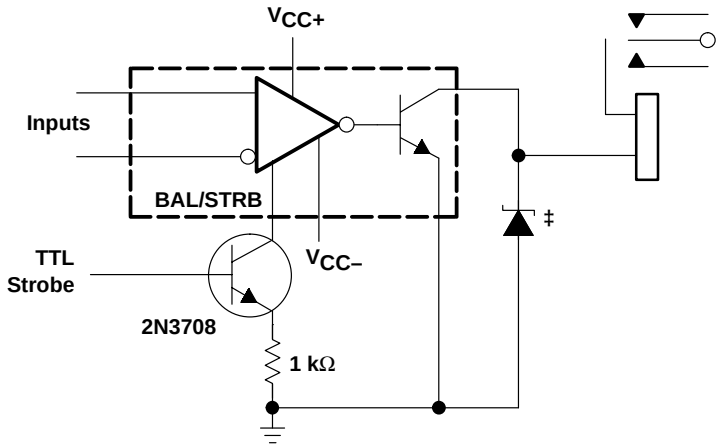


Figure 25. Negative-Peak Detector



† 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

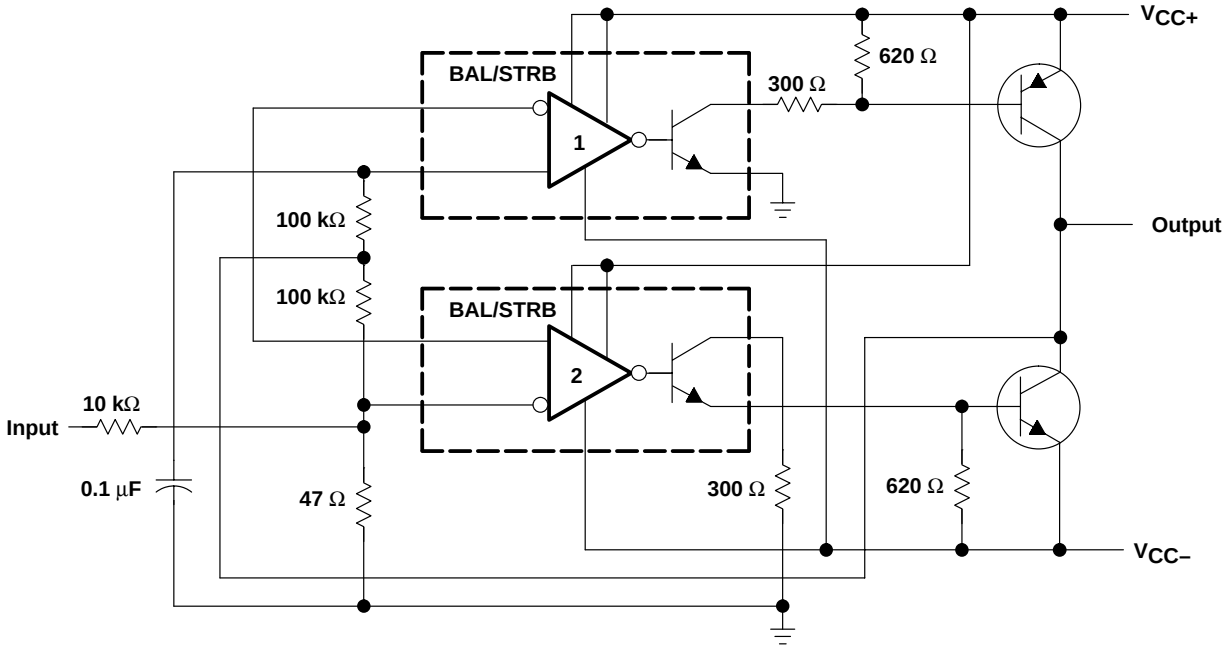


Figure 28. Switching Power Amplifier

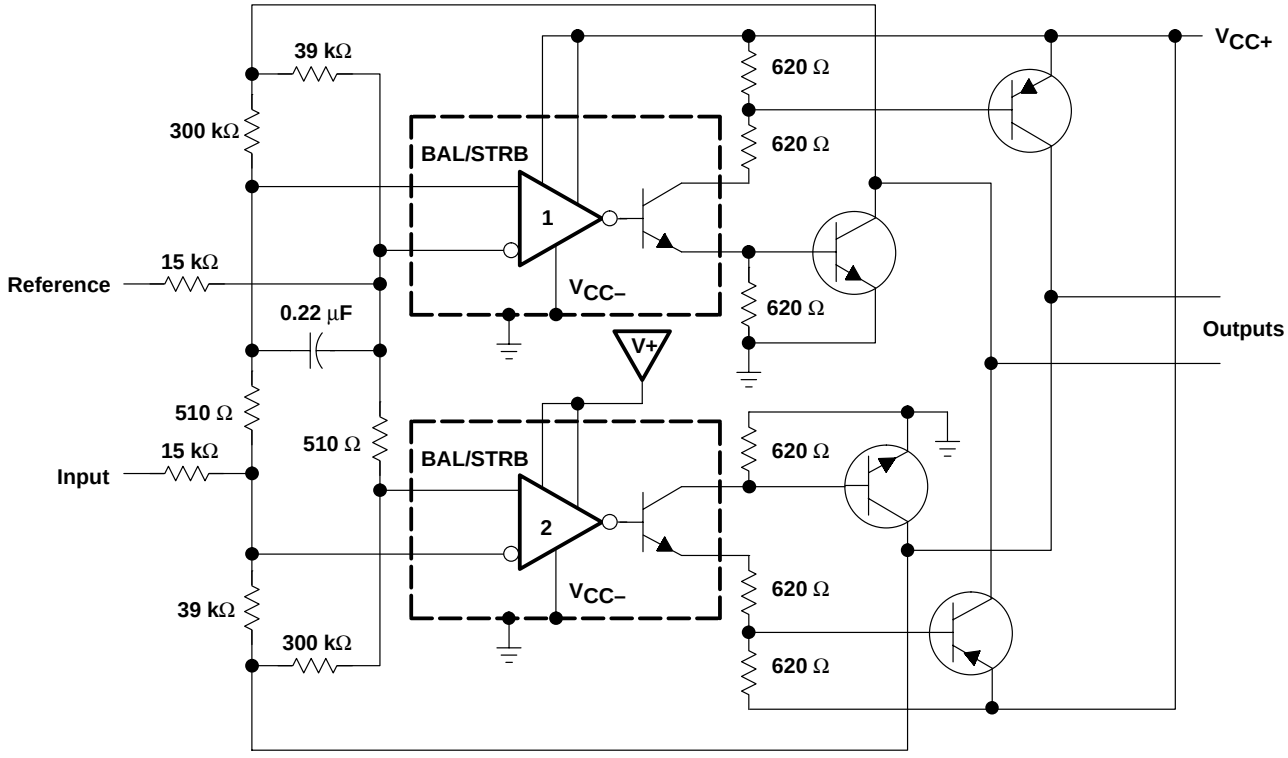


Figure 29. Switching Power Amplifiers

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