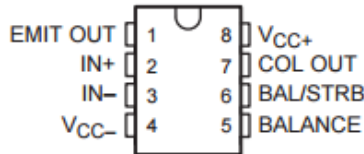


# LM111, LM211, LM311 DIFFERENTIAL COMPARATORS WITH STROBES

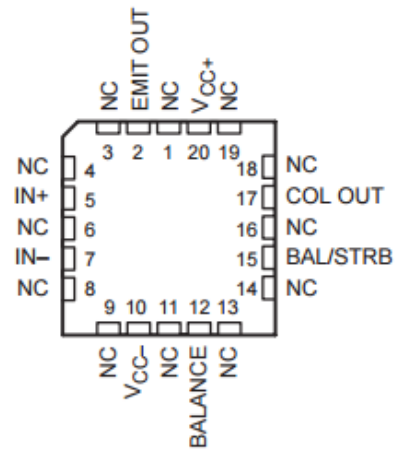
SLCS007H – SEPTEMBER 1973 – REVISED AUGUST 2003

- 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  $\pm 15$ -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.

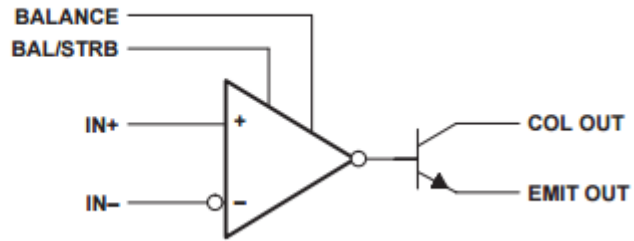
## description/ordering information

### ORDERING INFORMATION

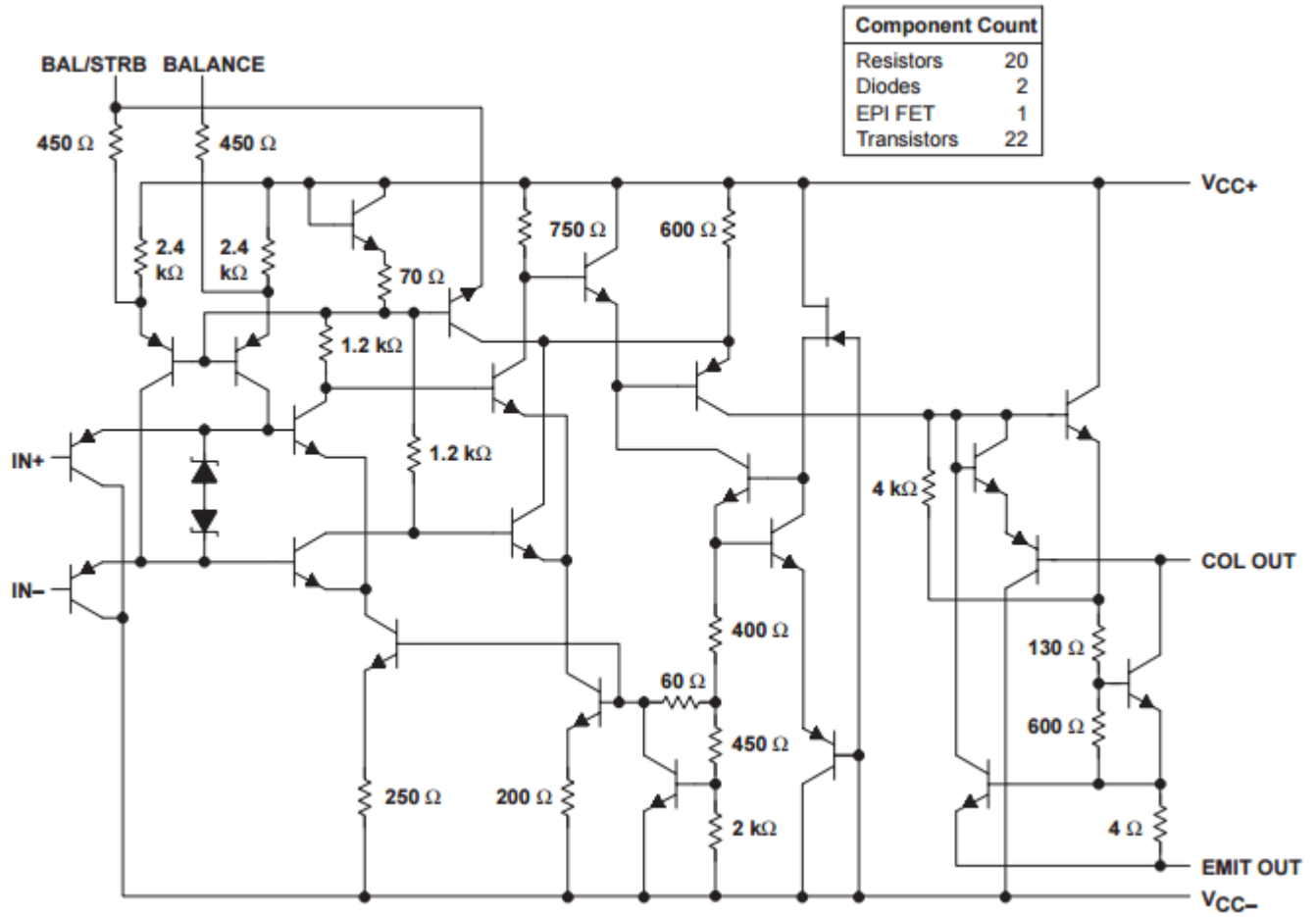
$T_A$	$V_{IO}$ max AT 25°C	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–0°C to 70°C	7.5 mV	PDIP (P)	Tube of 50	LM311P	LM311P
		SOIC (D)	Tube of 75	LM311D	LM311
			Reel of 2500	LM311DR	
		SOP (PS)	Reel of 2000	LM311PSR	L311
TSSOP (PW)	Reel of 150	LM311PW	L311		
	Tube of 2000	LM311PWR			
–40°C to 85°C	3 mV	PDIP (P)	Tube of 50	LM211P	LM211P
		SOIC (D)	Tube of 75	LM211D	LM211
			Reel of 2500	LM211DR	
		TSSOP (PW)	Reel of 150	LM211PW	L211
Reel of 2000	LM211PWR				
–40°C to 125°C	3 mV	SOIC (D)	Tube of 75	LM211QD	LM211Q
			Reel of 2500	LM211QDR	
–55°C to 125°C	3 mV	CDIP (JG)	Tube of 50	LM111JG	LM111JG
		LCCC (FK)	Tube of 55	LM111FK	LM111FK

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

## functional block diagram



## schematic



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)	$\pm 30$ 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 $V_{CC-}$ :	
LM111	50 V
LM211	50 V
LM211Q	50 V
LM311	40 V
Duration of output short circuit (see Note 4)	10 s
Package thermal impedance, $\theta_{JA}$ (see Notes 5 and 6):	
D package	97°C/W
P package	85°C/W
PS package	95°C/W
PW package	149°C/W
Package thermal impedance, $\theta_{JC}$ (see Notes 7 and 8):	
FK package	5.61°C/W
JG package	14.5°C/W
Operating virtual junction temperature, $T_J$	150°C
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:
- All voltage values, unless otherwise noted, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .
  - Differential voltages are at  $IN+$  with respect to  $IN-$ .
  - The magnitude of the input voltage must never exceed the magnitude of the supply voltage or  $\pm 15$  V, whichever is less.
  - The output may be shorted to ground or either power supply.
  - 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.
  - The package thermal impedance is calculated in accordance with JESD 51-7.
  - Maximum power dissipation is a function of  $T_{J(max)}$ ,  $\theta_{JC}$ , and  $T_C$ . The maximum allowable power dissipation at any allowable case temperature is  $P_D = (T_{J(max)} - T_C)/\theta_{JC}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  - The package thermal impedance is calculated in accordance with MIL-STD-883.

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

**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$  (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	$V_O = 1\text{ V to } 14\text{ V}$	25°C	75 100			100 250			nA	
		Full range	150			300				
$I_{IL(S)}$ Low-level strobe current (see Note 7)	$V_{(strobe)} = 0.3\text{ V}, V_{ID} \leq -10\text{ mV}$	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	$V_O = 5\text{ V to } 35\text{ V}, R_L = 1\text{ k}\Omega$	25°C	40 200			40 200			V/mV	
$I_{OH}$ High-level (collector) output leakage current	$I_{(strobe)} = -3\text{ mA}, V_{OH} = 35\text{ V}, V_{ID} = 5\text{ mV}$	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				0.2 50			nA
$V_{OL}$ Low-level (collector-to-emitter) output voltage	$I_{OL} = 50\text{ mA}, V_{CC+} = 4.5\text{ V}, V_{CC-} = 0, I_{OL} = 8\text{ mA}$	$V_{ID} = -5\text{ mV}$	25°C	0.75 1.5						V
		$V_{ID} = -10\text{ mV}$	25°C				0.75 1.5			
		$V_{ID} = -6\text{ mV}$	Full range	0.23 0.4						
		$V_{ID} = -10\text{ mV}$	Full range				0.23 0.4			
$I_{CC+}$ Supply current from $V_{CC+}$ , output low	$V_{ID} = -10\text{ mV},$ No load	25°C	5.1 6			5.1 7.5			mA	
$I_{CC-}$ Supply current from $V_{CC-}$ , output high	$V_{ID} = 10\text{ mV},$ 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  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ , for LM211 is  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ , for LM211Q is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ , and for LM311 is  $0^\circ\text{C}$  to  $70^\circ\text{C}$ .

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

NOTES: 9. 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  $7.5\text{ k}\Omega$  to  $V_{CC+}$ . These parameters actually define an error band and take into account the worst-case effects of voltage gain and input impedance.

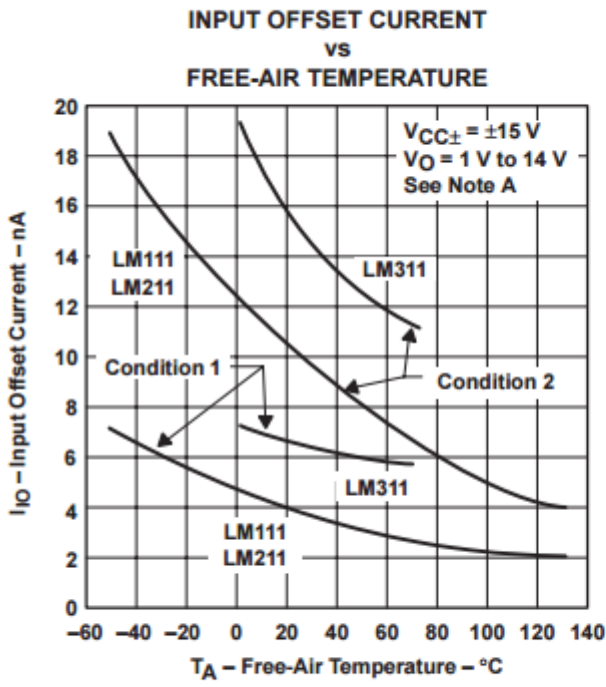
10. The strobe should not be shorted to ground; it should be current driven at  $-3\text{ mA}$  to  $-5\text{ mA}$  (see Figures 13 and 27).

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

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

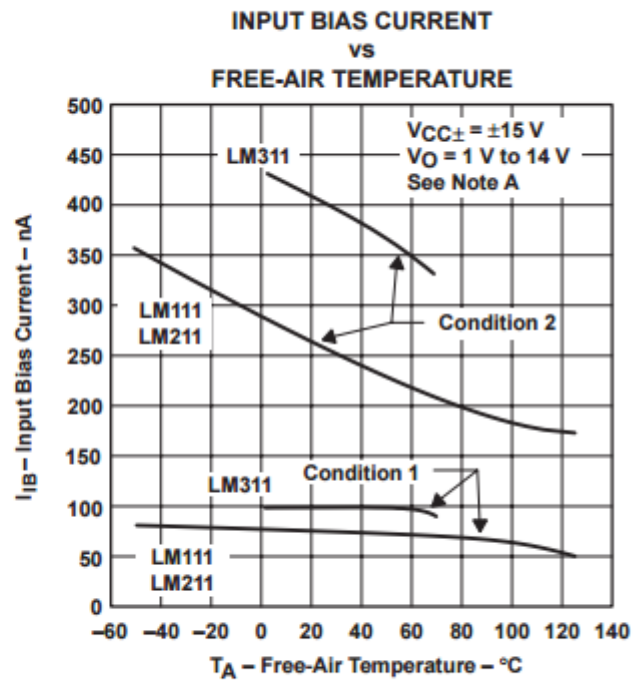
NOTE 11: The response time specified is for a 100-mV input step with 5-mV overdrive and is the interval between the input step function and the instant when the output crosses 1.4 V.

# TYPICAL CHARACTERISTICS†



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

**Figure 1**



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

OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

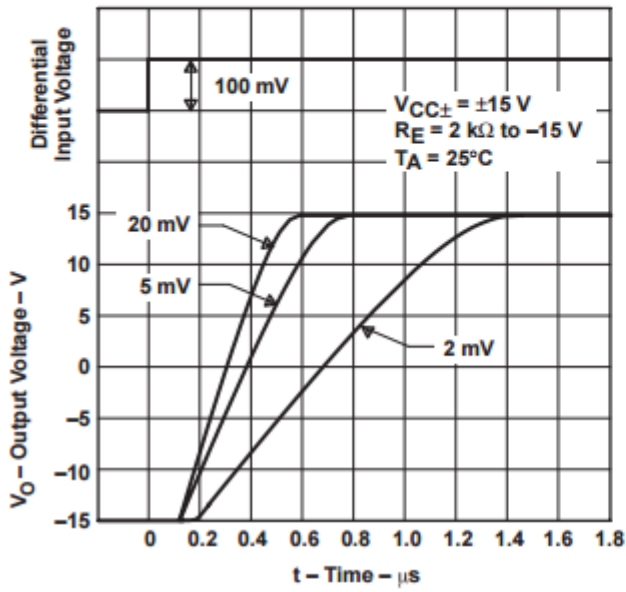


Figure 6

OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

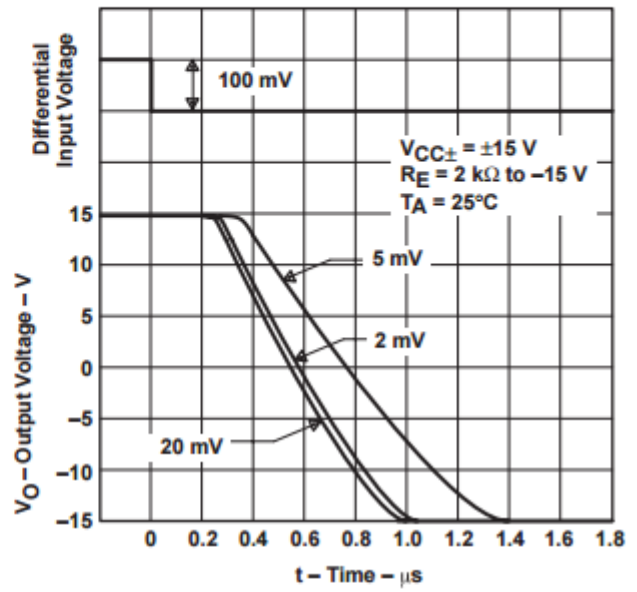
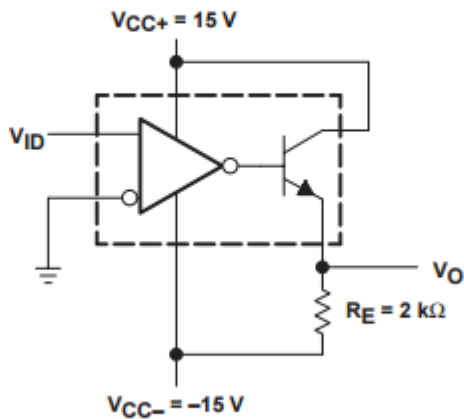


Figure 7



TEST CIRCUIT FOR FIGURES 6 AND 7

## TYPICAL CHARACTERISTICS

**OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES**

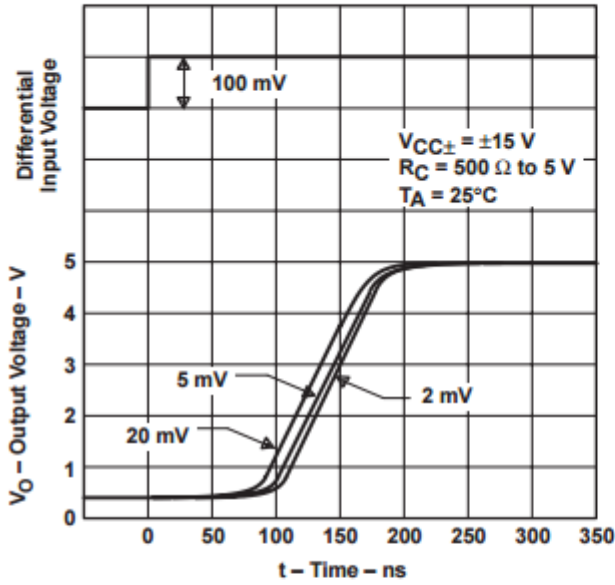


Figure 4

**OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES**

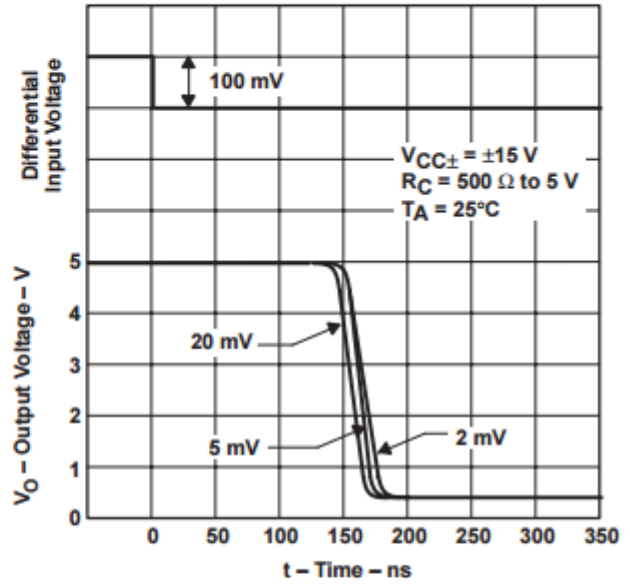
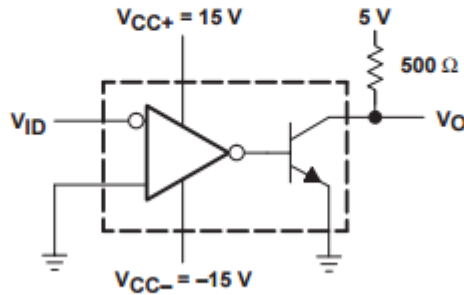


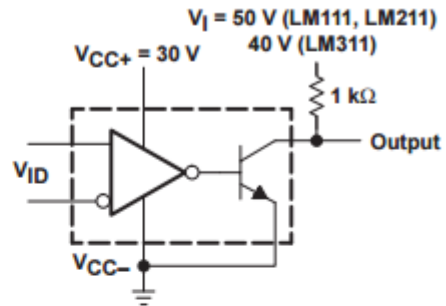
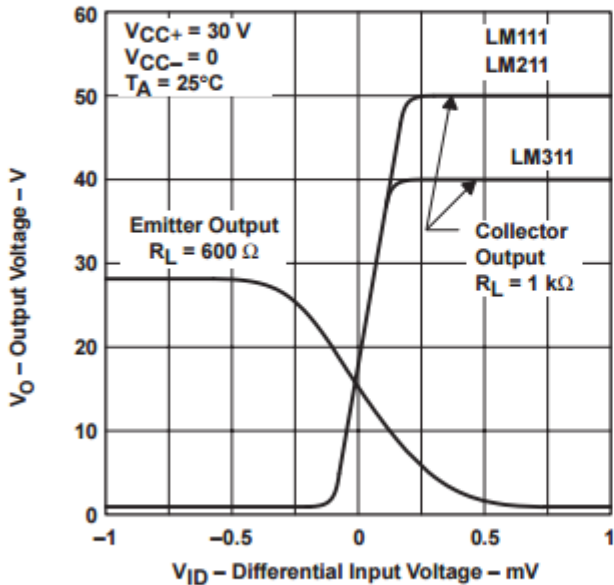
Figure 5



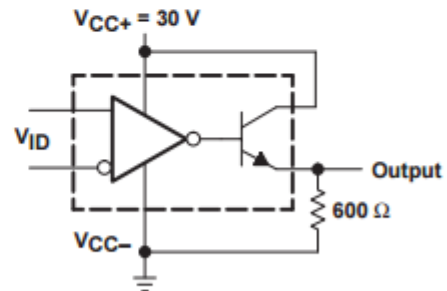
TEST CIRCUIT FOR FIGURES 4 AND 5

## TYPICAL CHARACTERISTICS†

**VOLTAGE TRANSFER CHARACTERISTICS**



COLLECTOR OUTPUT TRANSFER CHARACTERISTIC TEST CIRCUIT FOR FIGURE 3



EMITTER OUTPUT TRANSFER CHARACTERISTIC TEST CIRCUIT FOR FIGURE 3

Figure 3