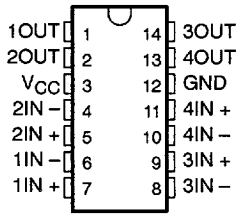
SLCS004A – D3044, OCTOBER 1987 – REVISED MAY 1988

- **Ultralow Power Supply Current Drain . . . 60 μA Typ**
- **Low Input Biasing Current . . . 3 nA**
- **Low Input Offset Current . . . ±0.5 nA**
- **Low Input Offset Voltage . . . ±2 mV**
- **Common-Mode Input Voltage Includes Ground**
- **Output Voltage Compatible With MOS and CMOS Logic**
- **High Output Sink-Current Capability (30 mA at V_O = 2V)**
- **Power Supply Input Reverse-Voltage Protected**
- **Single-Power-Supply Operation**
- **Pin-for-Pin Compatible With LM239, LM339, LM2901**

D, J, OR N PACKAGE
(TOP VIEW)



description

The LP239, LP339, LP2901 are low-power quadruple differential comparators. Each device consists of four independent voltage comparators designed specifically to operate from a single power supply and typically to draw 60-μA drain current over a wide range of voltages. Operation from split power supplies is also possible and the ultralow power supply drain current is independent of the power supply voltage.

Applications include limit comparators, simple analog-to-digital converters, pulse generators, squarewave generators, time delay generators, voltage controlled oscillators, multivibrators, and high-voltage logic gates. The LP239, LP339, LP2901 were specifically designed to interface with the CMOS logic family. The ultralow power supply current makes these products desirable in battery-powered applications.

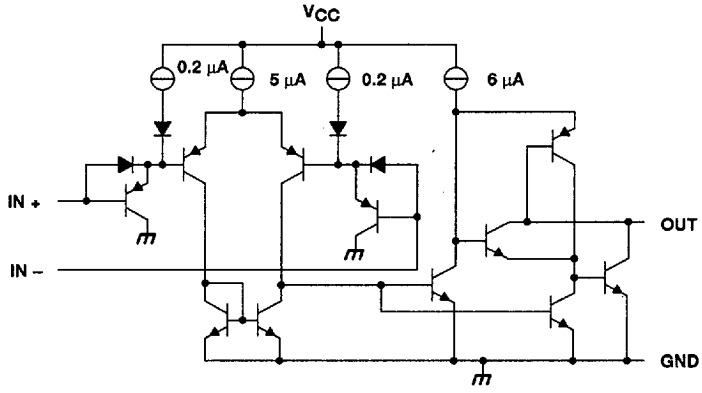
The LP239 is characterized for operation from – 25°C to 85°C. The LP339 is characterized for operation from 0°C to 70°C. The LP2901 is characterized for operation from – 40°C to 85°C.

AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGE		
		SMALL OUTLINE (D)	PLASTIC DIP (P)	CERAMIC DIP (JG)
0 °C to 70 °C	±5 mV	LP339D	LP339N	LP339J
– 25 °C to 85 °C	±5 mV	LP239D	LP239N	LP239J
– 40 °C to 85 °C	±5 mV	LP2901D	LP2901N	LP2901J

The D package is available taped-and-reeled. Add R suffix to device type when ordering (e.g., LP339DR).

schematic diagram (each comparator)



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

Supply voltage, V_{CC} (see Note 1) ..... 36 V
Differential input voltage, V_{ID} (see Note 2) ..... ±36 V
Input voltage range, V_I (either input) ..... – 0.3 V to 36 V
Input current, $V_I \leq -0.3$ V (see Note 3) ..... – 50 mA
Duration of output short-circuit to ground (see Note 4) ..... Unlimited
Continuous total dissipation (see Note 5) ..... See Dissipation Rating Table
Operating free-air temperature range, T_A: LP239 ..... – 25°C to 85°C
LP339 ..... 0°C to 70°C
LP2901 ..... – 40°C to 85°C
Storage temperature range ..... – 65°C to 150°C
Lead temperature range 1,6 mm (1/16 inch) from case for 10 seconds: D or N package ..... 260°C
Lead temperature range 1,6 mm (1/16 inch) from case for 60 seconds: J package ..... 300°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 in the recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltage values, except differential voltages, are with respect to the network ground.
2. Differential voltages are at IN+ with respect to IN –.
3. This input current only exists when the voltage at any of the inputs is driven negative. The current flows through the collector-base junction of the input clamping device. In addition to the clamping device action, there is lateral n-p-n parasitic transistor action. This action is not destructive and normal output states are re-established when the input voltage returns to a value more positive than – 0.3 V at T_A = 25°C.
4. Short circuits between outputs to V_{CC} can cause excessive heating and eventual destruction.
5. If the output transistors are allowed to saturate, the low bias dissipation and the on-off characteristics of the outputs keep the dissipation very small (usually less than 100 mW).

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25°C$ POWER RATING	DERATING FACTOR ABOVE T_A = 25°C	T_A = 70°C POWER RATING	T_A = 85°C POWER RATING
D	950 mW	7.6 mW/°C	608 mW	494 mW
J	1025 mW	8.2 mW/°C	656 mW	533 mW
N	1150 mW	9.2 mW/°C	736 mW	598 mW

recommended operating conditions

			LP239		LP339		LP2901		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		5	30	5	30	5	30	V
V_{IC}	Common-mode input voltage	V_{CC} = 5 V	0	3	0	3	0	3	V
		V_{CC} = 30 V	0	28	0	28	0	28	V
V_I	Input voltage	V_{CC} = 5 V	0	3	0	3	0	3	V
		V_{CC} = 30 V	0	28	0	28	0	28	V
T_A	Operating free-air temperature		– 25	85	0	70	– 40	85	°C

electrical characteristics, V_{CC} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	V_{CC} = 5 V to 30 V, RS = 0,	V_O = 2 V, See Note 6	25°C		±2	±5	mV
				Full range			±9	
I_{IO}	Input offset current			25°C		±0.5	±5	nA
				Full range		±1	±15	
I_{IB}	Input bias current	See Note 7		25°C		– 2.5	– 25	nA
				Full range		– 4	– 40	
V_{ICR}	Common-mode input voltage range	Single supply		25°C	0 to V_{CC} – 1.5			V
				Full range	0 to V_{CC} – 2			
A_{VD}	Large-signal differential voltage amplification	V_{CC} = 15 V,	RL = 15 kΩ			500		V/mV
	Output sink current	V_{I-} = 1 V, V_{I+} = 0	V_O = 2 V, See Note 8	25°C	20	30		mA
				Full range	15			
			V_O = 0.4 V	25°C	0.2	0.7		
	Output leakage current	V_{I+} = 1 V, V_{I-} = 0	V_O = 5 V	25°C		0.1		nA
			V_O = 30 V	Full range			1	µA
V_{ID}	Differential input voltage	V_I ≤ 0 (or V_{CC-} on split supplies)					36	V
I_{CC}	Supply current	R_L = ∞ all comparators				60	100	µA

† Full range is –25°C to 85°C for the LP239, 0°C to 70°C for the LP339, and –40°C to 85°C for the LP2901.

NOTES: 6. V_{IO} is measured over the full common-mode input voltage range.
7. Because of the p-n-p input stage, the direction of the current is out of the device. This current is essentially constant (i.e., independent of the output state). No loading change exists on the reference or input lines as long as the common-mode input voltage range is not exceeded.
8. The output sink current is a function of the output voltage. These devices have a bimodal output section that allows them to sink (via a Darlington connection) large currents at output voltages greater than 1.5 V, and smaller currents at output voltages less than 1.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C, R_L connected to 5 V through 5.1 kΩ

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Large-signal response time	TTL logic swing, V_{ref} = 1.4 V		1.3		µs
Response time			8		

APPLICATION INFORMATION

Figure 1 shows the basic configuration for using the LP239, LP339, or LP2901 comparator. Figure 2 shows the diagram for using one of these comparators as a CMOS driver.

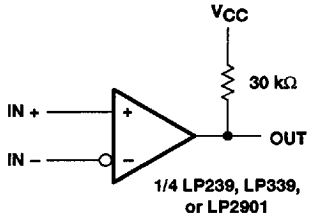


Figure 1. Basic Comparator

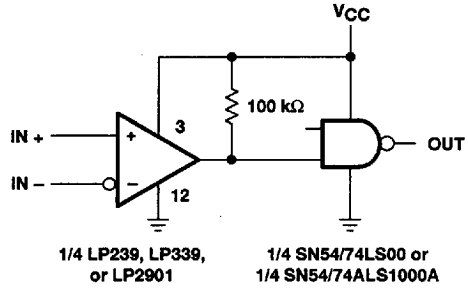


Figure 2. CMOS Driver

All pins of any unused comparators should be grounded. The bias network of the LP239, LP339, and LP2901 establishes a drain current that is independent of the magnitude of the power supply voltage over the range of 2 V to 30 V. It is usually necessary to use a bypass capacitor across the power supply line.

The differential input voltage may be larger than V_{CC} without damaging the device. Protection should be provided to prevent the input voltages from going negative by more than – 0.3 V. The output section has two distinct modes of operation: a Darlington mode and a ground-emitter mode. This unique drive circuit permits the device to sink 30 mA at V_O = 2 V in the Darlington mode and 700 μA at V_O = 0.4 V in the ground-emitter mode. Figure 3 is a simplified schematic diagram of the output section. The output section is configured in a Darlington connection (ignoring Q3). If the output voltage is held high enough (above 1 V), Q1 is not saturated and the output current is limited only by the product of the h_{FE} of Q1, the h_{FE} of Q2, and I1 and the 60-Ω saturation resistance of Q2. The devices are capable of driving LEDs, relays, etc. in this mode while maintaining an ultralow power supply current of 60 μA typically.

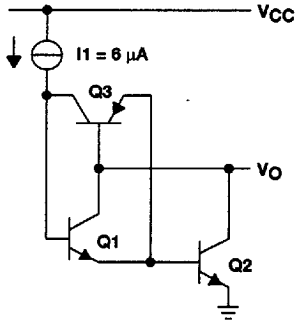


Figure 3. Output-Section Schematic Diagram

APPLICATION INFORMATION

Without transistor Q3, if the output voltage were allowed to drop below 0.8 V, transistor Q1 would saturate and the output current would drop to zero. The circuit would be unable to pull low current loads down to ground or the negative supply, if used. Transistor Q3 has been included to bypass transistor Q1 under these conditions and apply the current I1 directly to the base of Q2. The output sink current is now approximately I1 times the h_{FE} of Q2 (700 μA at V_O = 0.4 V). The output of the devices exhibit a bimodal characteristic with a smooth transition between modes.

In both cases, the output is an uncommitted collector. Several outputs can be tied together to provide a dot logic function. An output pullup resistor can be connected to any available power supply voltage within the permitted power supply range, and there is no restriction on this voltage based on the magnitude of the voltage that is supplied to V_{CC} of the package.