

# LM193, LM293, LM393, LM293A, LM393A, LM2903 DUAL DIFFERENTIAL COMPARATORS

D2232, JUNE 1976—REVISED NOVEMBER 1988

- Single Supply or Dual Supplies
- Wide Range of Supply Voltage . . . 2 to 36 V
- Low Supply Current Drain Independent of Supply Voltage . . . 0.5 mA Typ
- Low Input Bias Current . . . 25 nA Typ
- Low Input Offset Current . . . 3 nA Typ (LM139)
- Low Input Offset Voltage . . . 2 mV Typ
- Common-Mode Input Voltage Range Includes Ground
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage . . .  $\pm 36$  V
- Low Output Saturation Voltage
- Output Compatible with TTL, MOS, and CMOS

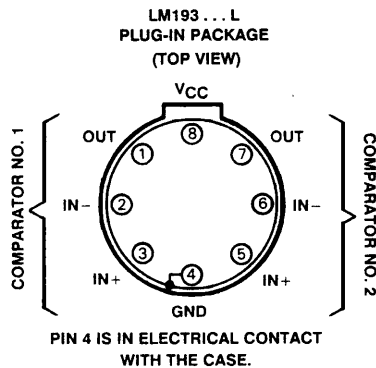
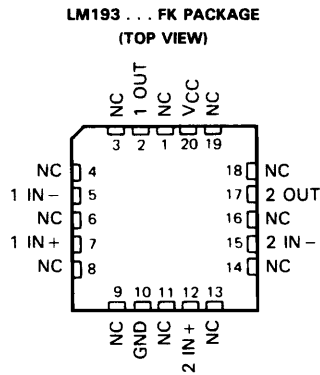
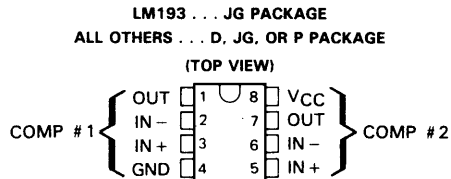
## description

These devices consist of two independent voltage comparators that are designed to operate from a single power supply over a wide range of voltages. Operation from dual supplies is also possible as long as the difference between the two supplies is 2 V to 36 V and pin 8 is at least 1.5 V more positive than the input common-mode voltage. Current drain is independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationships.

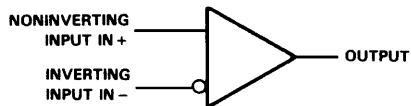
### AVAILABLE OPTIONS

SYMBOLIZATION		OPERATING TEMPERATURE RANGE	V <sub>IO</sub> MAX AT T <sub>A</sub> = 25°C
DEVICE	PACKAGE SUFFIX		
LM193	L, FK, JG	-55°C to 125°C	5 mV
LM293	D, JG, P	-25°C to 85°C	5 mV
LM293A	D, JG, P	-25°C to 85°C	2 mV
LM393	D, JG, P	0°C to 70°C	5 mV
LM393A	D, JG, P	0°C to 70°C	2 mV
LM2903	D, JG, P	-40°C to 125°C	7 mV

The D package is available in tape and reel. Add an R suffix when ordering. (e.g., LM393DR)

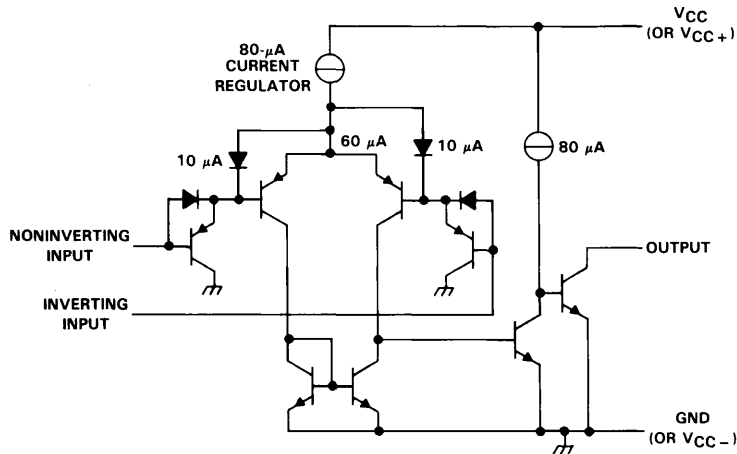


## symbol (each comparator)



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schematic (each comparator)



Current values shown are nominal.

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

Supply voltage, $V_{CC}$ (see Note 1)	36 V
Differential input voltage (see Note 2)	$\pm 36$ V
Input voltage range (either input)	-0.3 V to 36 V
Output voltage	36 V
Output current	20 mA
Duration of output short-circuit to ground (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range:	
LM193	-55°C to 125°C
LM293, LM293A	-25°C to 85°C
LM393, LM393A	0°C to 70°C
LM2903	-40°C to 125°C
Storage temperature range	-65°C to 150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or P package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package	300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: L package	300°C

- NOTES: 1. All voltage values, except differential voltages, are with respect to the network ground terminal.  
 2. Differential voltages are at the noninverting input terminal with respect to the inverting input.  
 3. Short circuits from outputs to  $V_{CC}$  can cause excessive heating and eventual destruction.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$	DERATING	DERATE	$T_A = 70^\circ\text{C}$	$T_A = 85^\circ\text{C}$	$T_A = 125^\circ\text{C}$
	POWER RATING	FACTOR	ABOVE $T_A$	POWER RATING	POWER RATING	POWER RATING
D	725 mW	5.8 mW/°C	25°C	464 mW	377 mW	—
FK	900 mW	11.0 mW/°C	68°C	880 mW	715 mW	275 mW
JG (LM193)	900 mW	8.4 mW/°C	43°C	672 mW	546 mW	210 mW
JG (All others)	825 mW	6.6 mW/°C	25°C	528 mW	429 mW	—
L	825 mW	6.6 mW/°C	25°C	528 mW	429 mW	165 mW
P	900 mW	8.0 mW/°C	37°C	640 mW	520 mW	—

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electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	LM193			LM293, LM393			LM293A, LM393A			LM2903			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{CC} = 5\text{ V to }30\text{ V}$ , $V_{IC} = V_{ICR}$ , $V_O = 1.4\text{ V}$ Full range	2	5	9	2	5	9	1	2	4	2	7	mV	
$I_{IO}$ Input offset current	$V_O = 1.4\text{ V}$ Full range	3	25	100	5	50	150	5	50	150	5	50	nA	
$I_{IB}$ Input bias current	$V_O = 1.4\text{ V}$ Full range	25	100	300	25	250	400	25	250	400	25	250	nA	
$V_{ICR}$ Common-mode input voltage range‡	25°C Full range	0 to $V_{CC}-1.5$	0 to $V_{CC}-1.5$	0 to $V_{CC}-1.5$	0 to $V_{CC}-1.5$	0 to $V_{CC}-1.5$	0 to $V_{CC}-1.5$	0 to $V_{CC}-1.5$	0 to $V_{CC}-1.5$	0 to $V_{CC}-1.5$	0 to $V_{CC}-1.5$	0 to $V_{CC}-1.5$	V	
$A_{VD}$ Large-signal differential voltage amplification	$V_{CC} = 15\text{ V}$ , $V_O = 1.4\text{ V to }11.4\text{ V}$ , $R_L \geq 15\text{ k}\Omega$ to $V_{CC}$	50	200	50	50	200	50	200	50	200	25	100	V/mV	
$I_{OH}$ High-level output current	$V_{OH} = 5\text{ V}$ , $V_{ID} = 1\text{ V}$ $V_{OH} = 30\text{ V}$ , $V_{ID} = 1\text{ V}$ Full range	0.1	0.1	50	0.1	50	1	1	1	50	0.1	50	mA	
$V_{OL}$ Low-level output voltage	$I_{OL} = 4\text{ mA}$ , $V_{ID} = -1\text{ V}$ , Full range	150	400	700	150	400	700	150	400	700	150	400	mV	
$I_{OL}$ Low-level output current	$V_{OL} = 1.5\text{ V}$ , $V_{ID} = -1\text{ V}$ Full range	6	6	6	6	6	6	6	6	6	6	6	mA	
$I_{CC}$ Supply current	$R_L = \infty$ $V_{CC} = 5\text{ V}$ $V_{CC} = 30\text{ V}$ Full range	0.8	1	2.5	0.8	1	2.5	0.8	1	2.5	0.8	1	mA	

† Full range (MIN to MAX) for LM193 is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ , for LM293 and LM293A is  $25^\circ\text{C}$  to  $85^\circ\text{C}$ , for the LM393 and LM393A is  $0^\circ\text{C}$  to  $70^\circ\text{C}$ , and for LM2903 is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ . All characteristics are measured with zero common-mode input voltage unless otherwise specified.

‡ The voltage at either input or common-mode should not be allowed to go negative by more than  $0.3\text{ V}$ . The upper end of the common-mode voltage range is  $V_{CC} + -1.5\text{ V}$ , but either or both inputs can go to  $30\text{ V}$  without damage.

## switching characteristics, $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT

NOTE 4: The response time specified is the interval between the input step function and the instant when the output crosses  $1.4\text{ V}$ .

