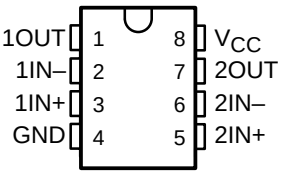
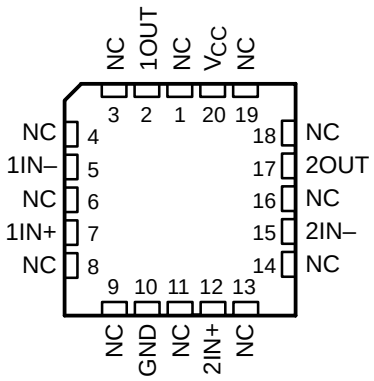
- **Single Supply or Dual Supplies**
- **Wide Range of Supply Voltage . . . 2 V to 36 V**
- **Low Supply-Current Drain Independent of Supply Voltage . . . 0.4 mA Typ Per Comparator**
- **Low Input Bias Current . . . 25 nA Typ**
- **Low Input Offset Current . . . 3 nA Typ (LM193)**
- **Low Input Offset Voltage . . . 2 mV Typ**
- **Common-Mode Input Voltage Range Includes Ground**
- **Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage . . . ±36 V**
- **Low Output Saturation Voltage**
- **Output Compatible With TTL, MOS, and CMOS**
- **LM2903Q Available in Q-Temp Automotive**
  - **High-Reliability Automotive Applications**
  - **Configuration Control/Print Support**
  - **Qualification to Automotive Standards**

LM193 . . . D OR JG PACKAGE
LM293 . . . D OR P PACKAGE
LM293A . . . D PACKAGE
LM393, LM393A . . . D, P, PS, OR PW PACKAGE
LM2903 . . . D, P, PS, OR PW PACKAGE
LM2903Q . . . D OR P PACKAGE
(TOP VIEW)



LM193 . . . FK PACKAGE
(TOP VIEW)



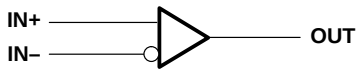
NC – No internal connection

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 also is possible as long as the difference between the two supplies is 2 V to 36 V, and V_{CC} 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.

The LM193 is characterized for operation from –55°C to 125°C. The LM293 and LM293A are characterized for operation from –25°C to 85°C. The LM393 and LM393A are characterized for operation from 0°C to 70°C. The LM2903 is characterized for operation from –40°C to 125°C. The LM2903Q is tested from –40°C to 125°C and is manufactured to demanding automotive requirements.

symbol (each comparator)

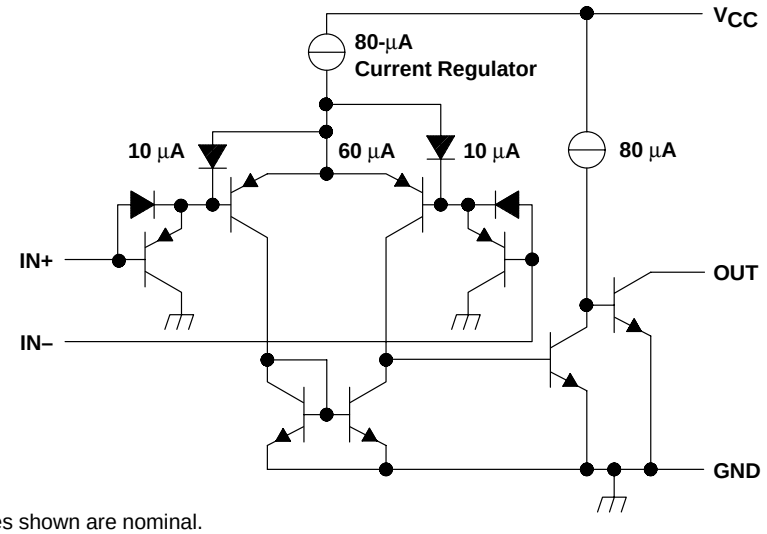


AVAILABLE OPTIONS

T_A	$V_{IO(max)}$ AT 25°C	PACKAGE				
		SMALL OUTLINE (D, PS)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	PLASTIC THIN SHRINK SMALL OUTLINE (PW)
0°C to 70°C	5 mV	LM393D	—	—	LM393P	LM393PW
		LM393PS	—	—	—	—
	2 mV	LM393AD	—	—	LM393AP	LM393APW
		LM393APS	—	—	—	—
–25°C to 85°C	5 mV	LM293D	—	—	LM293P	—
	2 mV	LM293AD	—	—	—	—
–40°C to 125°C	7 mV	LM2903D	—	—	LM2903P	LM2903PW
		LM2903PS	—	—	—	—
		LM2903QD	—	—	LM2903QP	—
–55°C to 125°C	5 mV	LM193D	LM193FK	LM193JG	—	—

The D package also is available taped and reeled. Add the suffix R (e.g., LM393DR). The PS and PW packages are only available taped and reeled.

schematic (each comparator)



COMPONENT COUNT	
Epi-FET	1
Diodes	2
Resistors	2
Transistors	30

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, V_{ID} (see Note 2) . . . . . ±36 V
Input voltage range, V_I (either input) . . . . . –0.3 V to 36 V
Output voltage, V_O . . . . . 36 V
Output current, I_O . . . . . 20 mA
Duration of output short-circuit to ground (see Note 3) . . . . . Unlimited
Continuous total power dissipation . . . . . See Dissipation Rating Table
Package thermal impedance, θ_{JA} (see Note 4): 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: D, P, PS, or PW package . . . . . 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package . . . . . 300°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, except differential voltages, are with respect to GND.
2. Differential voltages are at IN+ with respect to IN–.
3. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.
4. 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	900 mW	11.0 mW/°C	68°C	880 mW	715 mW	275 mW
JG	900 mW	8.4 mW/°C	43°C	672 mW	546 mW	210 mW

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

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

† Full range (MIN or MAX) for LM193 is –55°C to 125°C, for LM293 is 25°C to 85°C, and for LM393 is 0°C to 70°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 V. The upper end of the common-mode voltage range is V_{CC+} – 1.5 V, but either or both inputs can go to 30 V without damage.

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

PARAMETER		TEST CONDITIONS		T_A†	LM293A LM393A			LM2903 LM2903Q			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{CC} = 5 V to 30 V, V_O = 1.4 V, $V_{IC} = V_{IC(min)}$		25°C		1	2		2	7	mV
				Full range			4			15	
I_{IO}	Input offset current	V_O = 1.4 V		25°C		5	50		5	50	nA
				Full range			150			200	
I_{IB}	Input bias current	V_O = 1.4 V		25°C		–25	–250		–25	–250	nA
				Full range			–400			–500	
V_{ICR}	Common-mode input voltage range‡			25°C	0 to V_{CC}–1.5			0 to V_{CC}–1.5			V
				Full range	0 to V_{CC}–2			0 to V_{CC}–2			
A_{VD}	Large-signal differential-voltage amplification	V_{CC} = 15 V, V_O = 1.4 V to 11.4 V, $R_L \geq 15$ kΩ to V_{CC}		25°C	50	200		25	100		V/mV
I_{OH}	High-level output current	V_{OH} = 5 V,	V_{ID} = 1 V	25°C		0.1	50		0.1	50	nA
		V_{OH} = 30 V,	V_{ID} = 1 V	Full range			1			1	μA
V_{OL}	Low-level output voltage	I_{OL} = 4 mA,	V_{ID} = –1 V	25°C		150	400		150	400	mV
				Full range			700			700	
I_{OL}	Low-level output current	V_{OL} = 1.5 V,	V_{ID} = –1 V	25°C	6			6			mA
I_{CC}	Supply current	R_L = ∞	V_{CC} = 5 V	25°C		0.8	1		0.8	1	mA
			V_{CC} = 30 V	Full range			2.5			2.5	

† Full range (MIN or MAX) for LM293A is 25°C to 85°C, for LM393A is 0°C to 70°C, and for LM2903 and LM2903Q is –40°C to 125°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 V. The upper end of the common-mode voltage range is V_{CC+} – 1.5 V, but either or both inputs can go to 30 V without damage.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER	TEST CONDITIONS		LM193 LM293, LM293A LM393, LM393A LM2903, LM2903Q	UNIT
			TYP	
Response time	R_L connected to 5 V through 5.1 kΩ, C_L = 15 pF§, See Note 5	100-mV input step with 5-mV overdrive	1.3	μs
		TTL-level input step	0.3	

§ C_L includes probe and jig capacitance.

NOTE 5: The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.

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