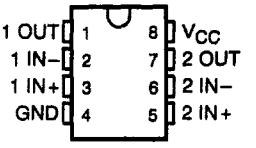
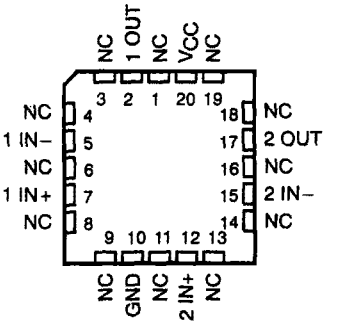
- **Single Supply or Dual Supplies**
- **Wide Range of Supply Voltage . . . 2 to 36 V**
- **Low Supply Current Drain Independent of Supply Voltage . . . 0.5 mA Typ**
- **Low Input Bias Current . . . 25 nA Typ**
- **Low Input Offset Current . . . 3 nA Typ (LM193)**
- **Low Input Offset Voltage . . . 2 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**

D, DB, JG, P, OR PW PACKAGE
(TOP VIEW)



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 is also 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 LM2903Q is manufactured to demanding automotive requirements.

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 and LM2903Q are characterized for operation from −40°C to 125°C.

symbol (each comparator)

AVAILABLE OPTIONS

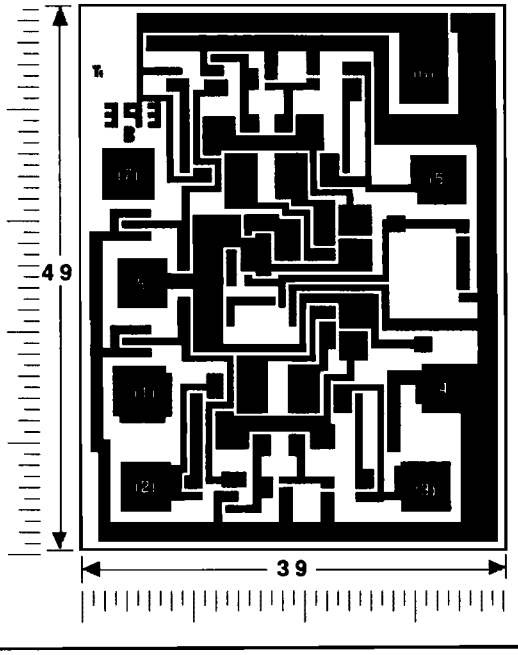
T_A	V_{IO} max at 25°C	PACKAGE						CHIP FORM (Y)§
		SMALL OUTLINE (D)†	SSOP (DB)‡	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	TSSOP (PW)‡	
0°C to 70°C	5 mV	LM393D	LM393DB			LM393P	LM393PW	LM393Y
	2 mV	LM393AD				LM393AP		
−25°C to 85°C	5 mV	LM293D				LM293P		
	2 mV	LM293AD				LM293AP		
−40°C to 125°C	7 mV	LM2903D	LM2903DB			LM2903P	LM2903PW	
	7 mV	LM2903QD				LM2903QP		
−55°C to 125°C	5 mV	LM193D		LM193FK	LM193JG	LM193P		

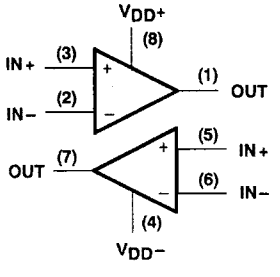
† The D package is available taped and reeled. Add the suffix R (e.g., LM393DR).
‡ The DB and PW packages are only available left-end taped and reeled. Add suffix LE (e.g., LM393DBLE).
§ Chips are tested at 25°C. See LM393Y for electrical characteristics.

LM393Y chip information

These chips, properly assembled, display characteristics similar to the LM393 (see electrical table on LM393Y). Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 3.6 × 3.6 MINIMUM

T_J max = 150°C

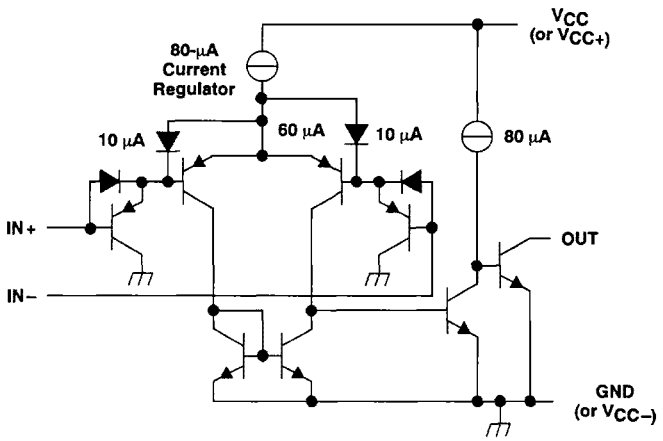
TOLERANCES ARE ±10%

ALL DIMENSIONS ARE IN MILS

NO BACKSIDE METALLIZATION

PIN (4) INTERNALLY CONNECTED TO BACKSIDE OF CHIP

schematic (each comparator)



Component Count:
Epi-SET 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 (see Note 2) ..... ±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, LM2903Q ..... −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, DB, P, or PW package ..... 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG 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	$T_A \le 25°C$ 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
D	725 mW	5.8 mW/°C	25°C	464 mW	377 mW	145 mW
DB	525 mW	4.2 mW/°C	25°C	336 mW	273 mW	N/A
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
P	900 mW	8.0 mW/°C	37°C	640 mW	520 mW	200 mW
PW	525 mW	4.2 mW/°C	25°C	336 mW	273 mW	N/A

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

PARAMETER		TEST CONDITIONS†			LM193			LM293, LM393			LM293A, LM393A			LM2903, LM2903Q			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{CC} = 5 V to 30 V, $V_{IC} = V_{IC}$ min, V_O = 1.4 V		25°C		2	5		2	5		1	2		2	7	mV
				Full range			9			9			4			15	
I_{IO}	Input offset current	V_O = 1.4 V		25°C		3	25		5	50		5	50		5	50	nA
				Full range			100			100			150			200	
I_{IB}	Input bias current	V_O = 1.4 V		25°C		−25	−100		−25	−250		−25	−250		−25	−250	nA
				Full range			−300			−400			−400			−500	
V_{ICR}	Common-mode input voltage range‡			25°C	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
				Full range	0 to V_{CC}−2			0 to V_{CC}−2			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		50	200		25	100		V/mV
I_{OH}	High-level output current	V_{OH} = 5 V, V_{ID} = 1 V		25°C		0.1			0.1	50		0.1	50		0.1	50	nA
		V_{OH} = 30 V, V_{ID} = 1 V		Full range			1			1			1			1	µA
V_{OL}	Low-level output voltage	I_{OL} = 4 mA, V_{ID} = −1 V		25°C		150	400		150	400		150	400		150	400	mV
				Full range			700			700			700			700	
I_{OL}	Low-level output current	V_{OL} = 1.5 V, V_{ID} = 1 V		25°C	6			6			6			6			mA
I_{CC}	Supply current	R_L = ∞	V_{CC} = 5 V	25°C		0.8	1		0.8	1		0.8	1		0.8	1	mA
			V_{CC} = 30 V	Full range			2.5			2.5			2.5			2.5	

† Full range (MIN or MAX) for LM193 is −55°C to 125°C, for LM293 and LM293A is 25°C to 85°C, for the LM393 and 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		MIN	TYP	MAX	UNIT
Response time	R_L connected to 5 V through 5.1 kΩ, C_L = 15 pF§, See Note 4	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 4: 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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electrical characteristics at V_{CC} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V_{IO}	Input offset voltage	V_{CC} = 5 V to 30 V, V_O = 1.4 V	$V_{IC} = V_{ICR}$min,		2	5	mV
I_{IO}	Input offset current				5	50	nA
I_{IB}	Input bias current				−25	−250	nA
V_{ICR}	Common-mode input voltage range	V_{CC} = 5 V to 30 V		0 to V_{CC}−1.5			V
A_{VD}	Large-signal differential voltage amplification	V_{CC} = 15 V, $R_L \geq 15\ k\Omega$ to V_{CC}	V_O = 1.4 V to 11.4 V,	25	200		V/mV
I_{OH}	High-level output current	V_{OH} = 5 V,	V_{ID} = 1 V		0.1	50	nA
V_{OL}	Low-level output voltage	I_{OL} = 4 mA,	V_{ID} = −1 V		150	400	mV
I_{OL}	Low-level output current	V_{OL} = 1.5 V,	V_{ID} = −1 V	6			mA
I_{CC}	Supply current	$R_L = \infty$,	V_{CC} = 5 V		0.8	1	mA

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified.