

SLCS005K – JUNE 1976 – REVISED JUNE 2002

- **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

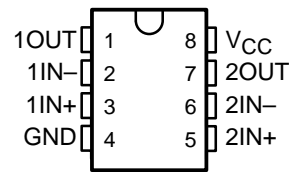
LM293 . . . D OR P PACKAGE

LM293A . . . D PACKAGE

LM393, LM393A . . . D, P, PS, OR PW PACKAGE**LM2903 . . . D, P, PS, OR PW PACKAGE**

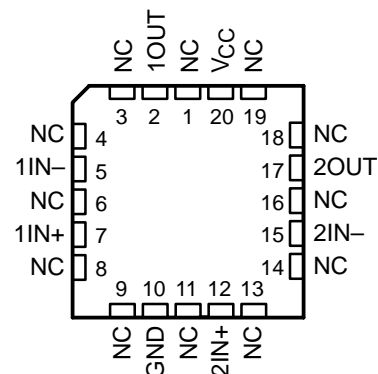
LM2903Q . . . D OR P PACKAGE

(TOP VIEW)



LM193 . . . FK PACKAGE

(TOP VIEW)



NC – No internal connection

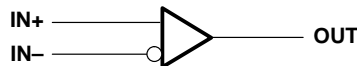
description

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)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



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On products compliant to MIL-PRF-38535, all parameters are tested
unless otherwise noted. On all other products, production
processing does not necessarily include testing of all parameters.

LM193, LM293, LM293A, LM393
 LM393A, LM2903, LM2903Q
 DUAL DIFFERENTIAL COMPARATORS

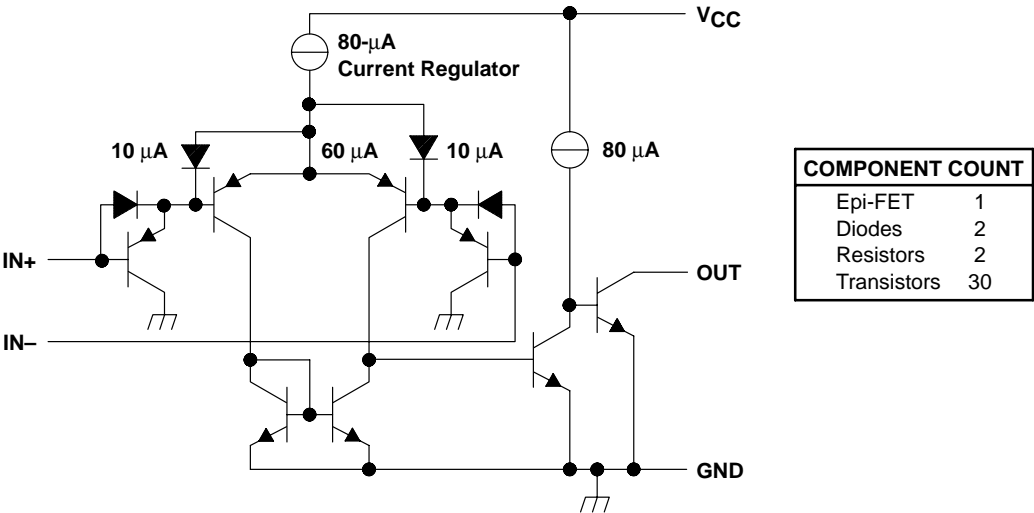
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AVAILABLE OPTIONS

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 LM393PS	— —	— —	LM393P —	LM393PW —
	2 mV	LM393AD LM393APS	— —	— —	LM393AP —	LM393APW —
–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)



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	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR	DERATE ABOVE T_A	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ 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

LM193, LM293, LM293A, LM393
LM393A, LM2903, LM2903Q
DUAL DIFFERENTIAL COMPARATORS

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electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (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 ≥ 15 kΩ 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		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 $V_{CC+} - 1.5\text{ V}$, but either or both inputs can go to 30 V without damage.

electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (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 ≥ 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 $V_{CC+} - 1.5\text{ V}$, but either or both inputs can go to 30 V without damage.

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

PARAMETER	TEST CONDITIONS		LM193 LM293, LM293A LM393, LM393A LM2903, LM2903Q	UNIT
			TYP	
Response time	R_L connected to 5 V through 5.1 k Ω , $C_L = 15\text{ pF}$ §, 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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