

# LM393, LM293, LM2903, LM2903V, NCV2903



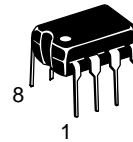
ON Semiconductor®

## Low Offset Voltage Dual Comparators

The LM393 series are dual independent precision voltage comparators capable of single or split supply operation. These devices are designed to permit a common mode range-to-ground level with single supply operation. Input offset voltage specifications as low as 2.0 mV make this device an excellent selection for many applications in consumer, automotive, and industrial electronics.

### Features

- Wide Single-Supply Range: 2.0 Vdc to 36 Vdc
- Split-Supply Range:  $\pm 1.0$  Vdc to  $\pm 18$  Vdc
- Very Low Current Drain Independent of Supply Voltage: 0.4 mA
- Low Input Bias Current: 25 nA
- Low Input Offset Current: 5.0 nA
- Low Input Offset Voltage: 5.0 mV (max) LM293/393
- Input Common Mode Range to Ground Level
- Differential Input Voltage Range Equal to Power Supply Voltage
- Output Voltage Compatible with DTL, ECL, TTL, MOS, and CMOS Logic Levels
- ESD Clamps on the Inputs Increase the Ruggedness of the Device without Affecting Performance
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes
- Pb-Free Packages are Available



PDIP-8  
N SUFFIX  
CASE 626

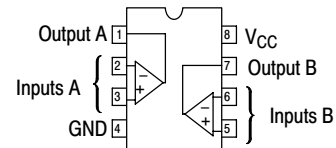


SOIC-8  
D SUFFIX  
CASE 751



Micro8™  
DM SUFFIX  
CASE 846A

### PIN CONNECTIONS



(Top View)

### DEVICE MARKING AND ORDERING INFORMATION

See detailed marking information and ordering and shipping information on pages 6 and 7 of this data sheet.

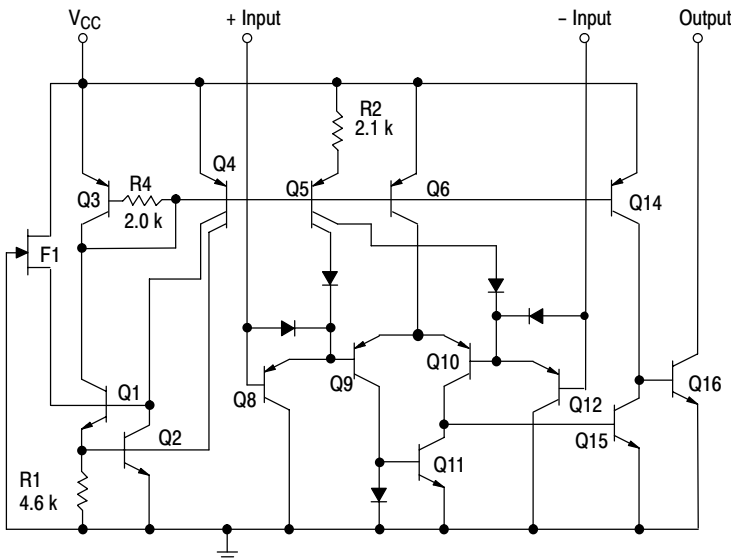


Figure 1. Representative Schematic Diagram  
(Diagram shown is for 1 comparator)

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## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage	$V_{CC}$	+36 or $\pm 18$	Vdc
Input Differential Voltage Range	$V_{IDR}$	36	Vdc
Input Common Mode Voltage Range	$V_{ICR}$	-0.3 to +36	Vdc
Output Short Circuit-to-Ground Output Sink Current (Note 1)	$I_{SC}$ $I_{Sink}$	Continuous 20	mA
Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$ $1/R_{\theta JA}$	570 5.7	mW mW/ $^\circ\text{C}$
Operating Ambient Temperature Range LM293 LM393 LM2903 LM2903V, NCV2903 (Note 2)	$T_A$	-25 to +85 0 to +70 -40 to +105 -40 to +125	$^\circ\text{C}$
Maximum Operating Junction Temperature LM393, 2903, LM2903V LM293, NCV2903	$T_{J(max)}$	150 150	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$
ESD Protection at any Pin (Note 3) - Human Body Model - Machine Model	$V_{ESD}$	1500 150	V

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. The maximum output current may be as high as 20 mA, independent of the magnitude of  $V_{CC}$ , output short circuits to  $V_{CC}$  can cause excessive heating and eventual destruction.
2. *NCV2903 is qualified for automotive use.*
3.  $V_{ESD}$  rating for NCV/SC devices is: Human Body Model – 2000 V; Machine Model – 200 V.

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## ELECTRICAL CHARACTERISTICS ( $V_{CC} = 5.0$ Vdc, $T_{low} \leq T_A \leq T_{high}$ , unless otherwise noted.)

Characteristic	Symbol	LM293, LM393			LM2903, LM2903V, NCV2903			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (Note 5) $T_A = 25^\circ\text{C}$ $T_{low} \leq T_A \leq T_{high}$	$V_{IO}$	–	$\pm 1.0$	$\pm 5.0$ 9.0	–	$\pm 2.0$ 9.0	$\pm 7.0$ 15	mV
Input Offset Current $T_A = 25^\circ\text{C}$ $T_{low} \leq T_A \leq T_{high}$	$I_{IO}$	–	$\pm 5.0$	$\pm 50$ $\pm 150$	–	$\pm 5.0$ $\pm 50$	$\pm 50$ $\pm 200$	nA
Input Bias Current (Note 6) $T_A = 25^\circ\text{C}$ $T_{low} \leq T_A \leq T_{high}$	$I_{IB}$	–	25	250 400	–	25 200	250 500	nA
Input Common Mode Voltage Range (Note 6) $T_A = 25^\circ\text{C}$ $T_{low} \leq T_A \leq T_{high}$	$V_{ICR}$	0 0	– –	$V_{CC} - 1.5$ $V_{CC} - 2.0$	0 0	– –	$V_{CC} - 1.5$ $V_{CC} - 2.0$	V
Voltage Gain $R_L \geq 15$ k $\Omega$ , $V_{CC} = 15$ Vdc, $T_A = 25^\circ\text{C}$	$A_{VOL}$	50	200	–	25	200	–	V/mV
Large Signal Response Time $V_{in} =$ TTL Logic Swing, $V_{ref} = 1.4$ Vdc $V_{RL} = 5.0$ Vdc, $R_L = 5.1$ k $\Omega$ , $T_A = 25^\circ\text{C}$	–	–	300	–	–	300	–	ns
Response Time (Note 8) $V_{RL} = 5.0$ Vdc, $R_L = 5.1$ k $\Omega$ , $T_A = 25^\circ\text{C}$	$t_{TLH}$	–	1.3	–	–	1.5	–	$\mu\text{s}$
Input Differential Voltage (Note 9) All $V_{in} \geq$ GND or V– Supply (if used)	$V_{ID}$	–	–	$V_{CC}$	–	–	$V_{CC}$	V
Output Sink Current $V_{in} \geq 1.0$ Vdc, $V_{in+} = 0$ Vdc, $V_O \leq 1.5$ Vdc, $T_A = 25^\circ\text{C}$	$I_{Sink}$	6.0	16	–	6.0	16	–	mA
Output Saturation Voltage $V_{in} \geq 1.0$ Vdc, $V_{in+} = 0$ , $I_{Sink} \leq 4.0$ mA, $T_A = 25^\circ\text{C}$ $T_{low} \leq T_A \leq T_{high}$	$V_{OL}$	– –	150 –	400 700	– –	– 200	400 700	mV
Output Leakage Current $V_{in-} = 0$ V, $V_{in+} \geq 1.0$ Vdc, $V_O = 5.0$ Vdc, $T_A = 25^\circ\text{C}$ $V_{in-} = 0$ V, $V_{in+} \geq 1.0$ Vdc, $V_O = 30$ Vdc, $T_{low} \leq T_A \leq T_{high}$	$I_{OL}$	– –	0.1 –	– 1000	– –	0.1 –	– 1000	nA
Supply Current $R_L = \infty$ Both Comparators, $T_A = 25^\circ\text{C}$ $R_L = \infty$ Both Comparators, $V_{CC} = 30$ V	$I_{CC}$	– –	0.4 –	1.0 2.5	– –	0.4 –	1.0 2.5	mA

LM293  $T_{low} = -25^\circ\text{C}$ ,  $T_{high} = +85^\circ\text{C}$

LM393  $T_{low} = 0^\circ\text{C}$ ,  $T_{high} = +70^\circ\text{C}$

LM2903  $T_{low} = -40^\circ\text{C}$ ,  $T_{high} = +105^\circ\text{C}$

LM2903V & NCV2903  $T_{low} = -40^\circ\text{C}$ ,  $T_{high} = +125^\circ\text{C}$

NCV2903 is qualified for automotive use.

4. The maximum output current may be as high as 20 mA, independent of the magnitude of  $V_{CC}$ , output short circuits to  $V_{CC}$  can cause excessive heating and eventual destruction.
5. At output switch point,  $V_O \approx 1.4$  Vdc,  $R_S = 0$   $\Omega$  with  $V_{CC}$  from 5.0 Vdc to 30 Vdc, and over the full input common mode range (0 V to  $V_{CC} = -1.5$  V).
6. Due to the PNP transistor inputs, bias current will flow out of the inputs. This current is essentially constant, independent of the output state, therefore, no loading changes will exist on the input lines.
7. Input common mode of either input should not be permitted to go more than 0.3 V negative of ground or minus supply. The upper limit of common mode range is  $V_{CC} - 1.5$  V.
8. Response time is specified with a 100 mV step and 5.0 mV of overdrive. With larger magnitudes of overdrive faster response times are obtainable.
9. The comparator will exhibit proper output state if one of the inputs becomes greater than  $V_{CC}$ , the other input must remain within the common mode range. The low input state must not be less than  $-0.3$  V of ground or minus supply.

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## ORDERING INFORMATION

Device	Package	Shipping†
LM293D	SOIC-8	98 Units / Rail
LM293DG	SOIC-8 (Pb-Free)	98 Units / Rail
LM293DR2	SOIC-8	2500 / Tape & Reel
LM293DR2G	SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM293DMR2	Micro8	4000 / Tape and Reel
LM293DMR2G	Micro8 (Pb-Free)	4000 / Tape and Reel
LM393D	SOIC-8	98 Units / Rail
LM393DG	SOIC-8 (Pb-Free)	98 Units / Rail
LM393DR2	SOIC-8	2500 / Tape & Reel
LM393DR2G	SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM393N	PDIP-8	50 Units / Rail
LM393NG	PDIP-8 (Pb-Free)	50 Units / Rail
LM393DMR2	Micro8	4000 / Tape and Reel
LM393DMR2G	Micro8 (Pb-Free)	4000 / Tape and Reel
LM2903D	SOIC-8	98 Units / Rail
LM2903DG	SOIC-8 (Pb-Free)	98 Units / Rail
LM2903DR2	SOIC-8	2500 / Tape & Reel
LM2903DR2G	SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM2903N	PDIP-8	50 Units / Rail
LM2903NG	PDIP-8 (Pb-Free)	50 Units / Rail
LM2903DMR2	Micro8	4000 / Tape and Reel
LM2903DMR2G	Micro8 (Pb-Free)	4000 / Tape and Reel
LM2903VD	SOIC-8	98 Units / Rail
LM2903VDG	SOIC-8 (Pb-Free)	98 Units / Rail
LM2903VDR2	SOIC-8	2500 / Tape & Reel
LM2903VDR2G	SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM2903VN	PDIP-8	50 Units / Rail
LM2903VNG	PDIP-8 (Pb-Free)	50 Units / Rail
NCV2903DR2 (Note 10)	SOIC-8	2500 / Tape & Reel
NCV2903DR2G (Note 10)	SOIC-8 (Pb-Free)	2500 / Tape & Reel
NCV2903DMR2 (Note 10)	Micro8	4000 / Tape & Reel
NCV2903DMR2G (Note 10)	Micro8 (Pb-Free)	4000 / Tape & Reel

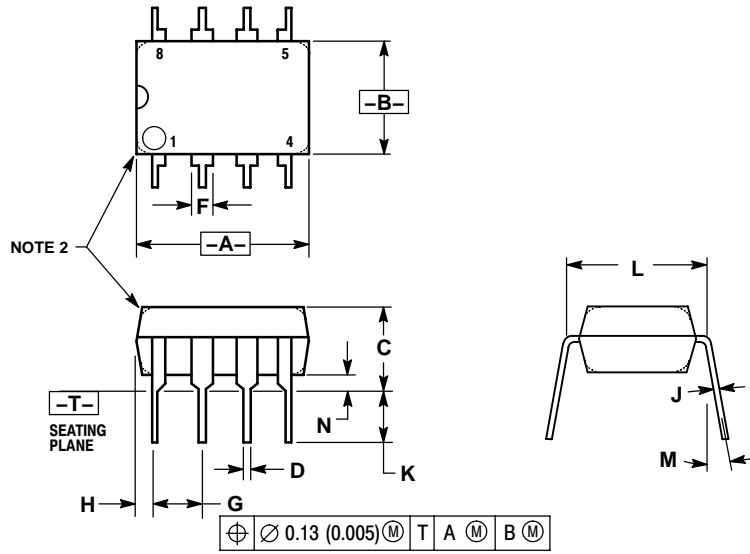
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

10. NCV2903 is qualified for automotive use.

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## PACKAGE DIMENSIONS

PDIP-8  
N SUFFIX  
CASE 626-05  
ISSUE L



### NOTES:

1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	10.16	0.370	0.400
B	6.10	6.60	0.240	0.260
C	3.94	4.45	0.155	0.175
D	0.38	0.51	0.015	0.020
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	0.76	1.27	0.030	0.050
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	---	10°	---	10°
N	0.76	1.01	0.030	0.040