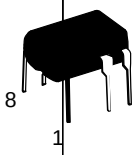
Low Offset Voltage Dual Comparators

LM393, LM393E, LM293, LM2903, LM2903E, LM2903V, NCV2903



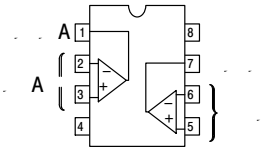
PDIP−8
N SUFFIX
CASE 626

Micro8™
DM SUFFIX
CASE 846A

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.

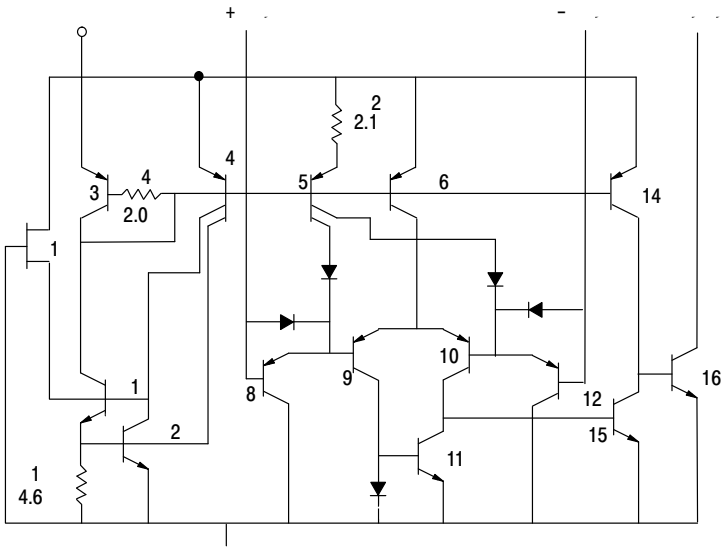
Features

- Wide Single−Supply Range: 2.0 Vdc to 36 Vdc
- Split−Supply Range: ±1.0 Vdc to ±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 Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant



DEVICE MARKING AND ORDERING INFORMATION

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


+
-
2
2.1
4
3
4
2.0
5
6
14
1
10
9
16
1
8
12
2
15
11
1
4.6

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

Characteristic	Symbol	LM293, LM393, LM393E			LM2903/E/V, NCV2903			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (Note 4)	V_{IO}							mV
T_A = 25°C		–	±1.0	±5.0	–	±2.0	±7.0	
$T_{low} \le T_A \le T_{high}$		–	–	±9.0	–	±9.0	±15	
Input Offset Current	I_{IO}							nA
T_A = 25°C		–	±5.0	±50	–	±5.0	±50	
$T_{low} \le T_A \le T_{high}$		–	–	±150	–	±50	±200	
Input Bias Current (Note 5)	I_{IB}							nA
T_A = 25°C		–	20	250	–	20	250	
$T_{low} \le T_A \le T_{high}$		–	–	400	–	20	500	
Input Common Mode Voltage Range (Note 6)	V_{ICR}							V
T_A = 25°C		0	–	V_{CC} −1.5	0	–	V_{CC} −1.5	
$T_{low} \le T_A \le T_{high}$		0	–	V_{CC} −2.0	0	–	V_{CC} −2.0	
Voltage Gain $R_L \ge 15$ kΩ, V_{CC} = 15 Vdc, T_A = 25°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 kΩ, T_A = 25°C	–	–	300	–	–	300	–	ns
Response Time (Note 7) V_{RL} = 5.0 Vdc, R_L = 5.1 kΩ, T_A = 25°C	t_{TLH}	–	1.3	–	–	1.5	–	μs
Input Differential Voltage (Note 8) All $V_{in} \ge$ GND or V− Supply (if used)	V_{ID}	–	–	V_{CC}	–	–	V_{CC}	V
Output Sink Current $V_{in} \ge 1.0$ Vdc, V_{in+} = 0 Vdc, $V_O \le 1.5$ Vdc T_A = 25°C	I_{Sink}	6.0	16	–	6.0	16	–	mA
Output Saturation Voltage	V_{OL}							mV
$V_{in} \ge 1.0$ Vdc, V_{in+} = 0, $I_{Sink} \le 4.0$ mA, T_A = 25°C		–	150	400	–	–	400	
$T_{low} \le T_A \le T_{high}$		–	–	700	–	200	700	
Output Leakage Current	I_{OL}							nA
V_{in-} = 0 V, $V_{in+} \ge 1.0$ Vdc, V_O = 5.0 Vdc, T_A = 25°C		–	0.1	–	–	0.1	–	
V_{in-} = 0 V, $V_{in+} \ge 1.0$ Vdc, V_O = 30 Vdc, $T_{low} \le T_A \le T_{high}$		–	–	1000	–	–	1000	
Supply Current	I_{CC}							mA
R_L = ∞ Both Comparators, T_A = 25°C		–	0.4	1.0	–	0.4	1.0	
R_L = ∞ Both Comparators, V_{CC} = 30 V		–	–	2.5	–	–	2.5	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

LM293 T_{low} = −25°C, T_{high} = +85°C
LM393, LM393E T_{low} = 0°C, T_{high} = +70°C
LM2903, LM2903E T_{low} = −40°C, T_{high} = +105°C
LM2903V & NCV2903 T_{low} = −40°C, T_{high} = +125°C
NCV2903 is qualified for automotive use.

3. 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.
4. At output switch point, V_O □1.4 Vdc, R_S = 0 Ω 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).
5. 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.
6. 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.
7. 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.
8. The comparator will exhibit proper output state if one of the inputs becomes greater than V_{CC}C C ï

LM293/393

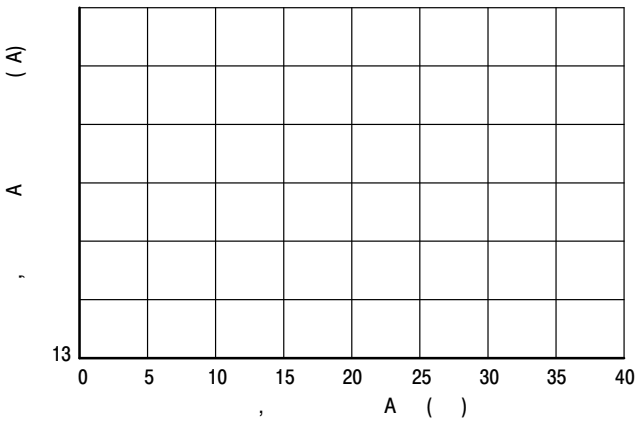


Figure 2. Input Bias Current versus Power Supply Voltage

LM2903

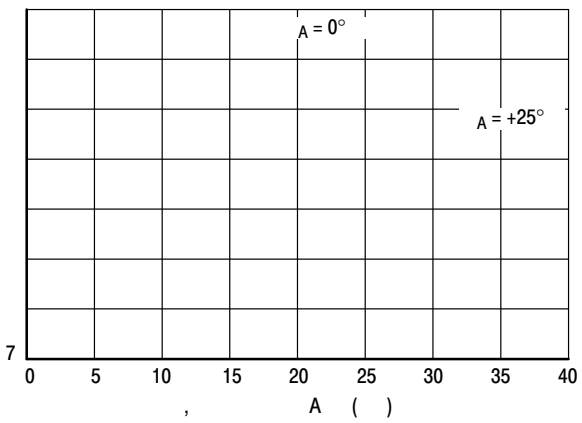


Figure 3. Input Bias Current versus Power Supply Voltage

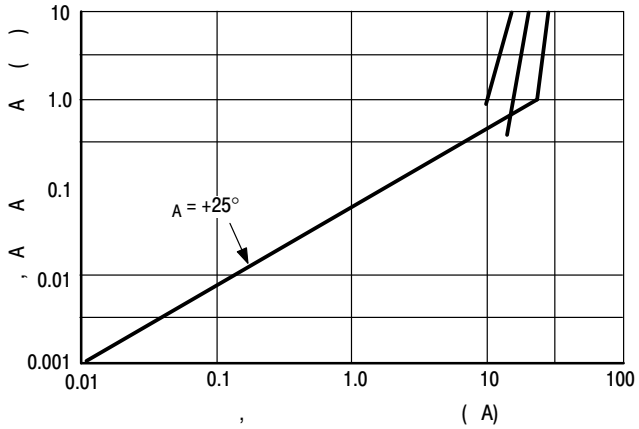


Figure 4. Output Saturation Voltage versus Output Sink Current

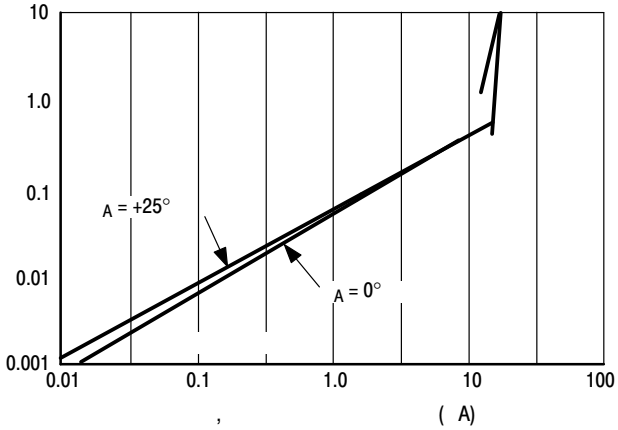


Figure 5. Output Saturation Voltage versus Output Sink Current

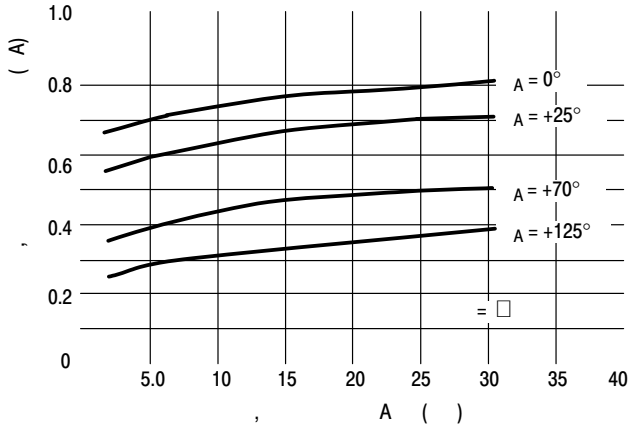


Figure 6. Power Supply Current versus Power Supply Voltage

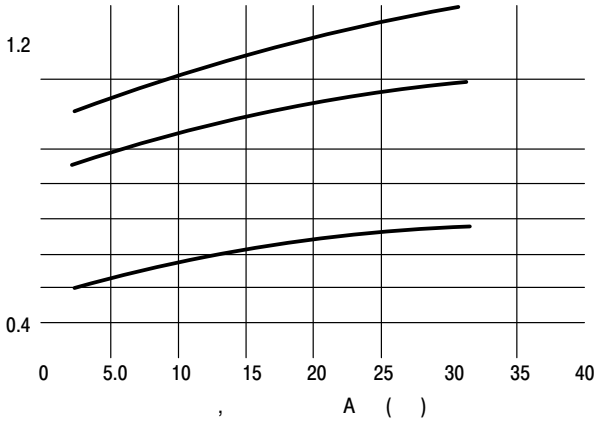


Figure 7. Power Supply Current versus Power Supply Voltage

APPLICATIONS INFORMATION

These dual comparators feature high gain, wide bandwidth characteristics. This gives the device oscillation tendencies if the outputs are capacitively coupled to the inputs via stray capacitance. This oscillation manifests itself during output transitions (V_{OL} to V_{OH}). To alleviate this situation, input resistors < 10 kΩ should be used.

The addition of positive feedback (< 10 mV) is also recommended. It is good design practice to ground all unused pins.

Differential input voltages may be larger than supply voltage without damaging the comparator's inputs. Voltages more negative than −0.3 V should not be used.

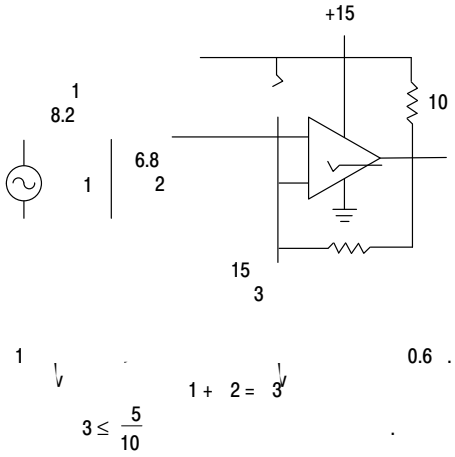


Figure 8. Zero Crossing Detector (Single Supply)

Figure 9. Zero Crossing Detector (Split Supply)

Figure 10. Free−Running Square−Wave Oscillator

Figure 11. Time Delay Generator

Figure 12. Comparator with Hysteresis

MARKING DIAGRAMS

PDIP−8
CASE 626

Micro8
CASE 846A

SOIC−8
CASE 751

x	= 2 or 3
A	= Assembly Location
WL, L	= Wafer Lot
YY, Y	= Year
WW, W	= Work Week
▪, G	= Pb−Free Package

*This marking diagram also applies to NCV2903DR2G

ORDERING INFORMATION

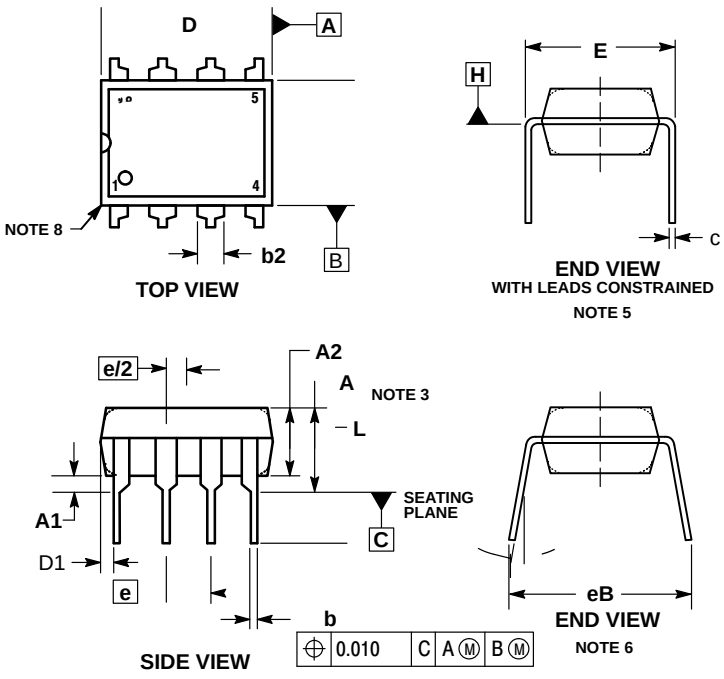
Device	Operating Temperature Range	Package	Shipping†
LM293DG	−25°C to +85°C	SOIC−8 (Pb−Free)	98 Units / Rail
LM293DR2G			2500 / Tape & Reel
LM293DMR2G		Micro8 (Pb−Free)	4000 / Tape and Reel
LM393DG	0°C to +70°C	SOIC−8 (Pb−Free)	98 Units / Rail
LM393DR2G			2500 / Tape & Reel
LM393EDR2G		SOIC−8 (Pb−Free)	2500 / Tape & Reel
LM393NG		PDIP−8 (Pb−Free)	50 Units / Rail
LM393DMR2G		Micro8 (Pb−Free)	4000 / Tape and Reel
LM2903DG	−40°C to +105°C	SOIC−8 (Pb−Free)	98 Units / Rail
LM2903DR2G			2500 / Tape & Reel
LM2903EDR2G		SOIC−8 (Pb−Free)	2500 / Tape & Reel
LM2903DMR2G		Micro8 (Pb−Free)	4000 / Tape and Reel
LM2903NG		PDIP−8 (Pb−Free)	50 Units / Rail
LM2903VDG	−40°C to +125°C	SOIC−8 (Pb−Free)	98 Units / Rail
LM2903VDR2G			2500 / Tape & Reel
LM2903VNG		PDIP−8 (Pb−Free)	50 Units / Rail
NCV2903DR2G*		SOIC−8 (Pb−Free)	2500 / Tape & Reel
NCV2903DMR2G*		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.

Packaging

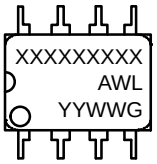
PDIP−8
CASE 626−05
ISSUE P

DATE 22 APR 2015



DIM	INCHES MIN	INCHES MAX		
A	----	0.210		
A1	0.015	----		
A2	0.115	0.195	2.92	4.95
b	0.014	0.022		
C	0.008	0.014		
D	0.355	0.400		
D1	0.005	----		
E	0.300	0.325		
e	0.100 BSC			
L	0.115	0.150	2.92	3.81

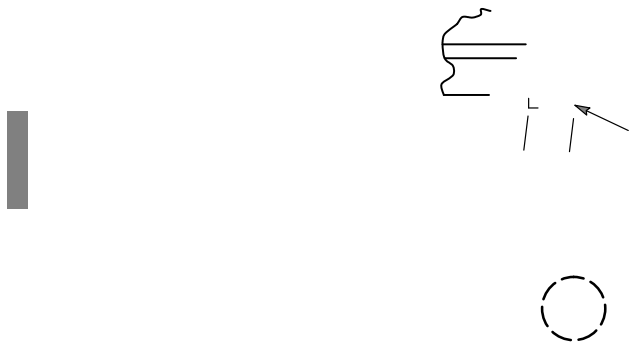
GENERIC
MARKING DIAGRAM*

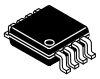


XXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
YY = Year
WW = Work Week
G = Pb−Free Package

SOIC 8 NB
CASE 751−07
ISSUE AK

DATE 16 FEB 2011





SCALE 2:1

Micro8
CASE 846A–02
ISSUE K

DATE 16 JUL 2020