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Jameco Part Number 886534

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: ±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 Site and Control Changes
- Pb-Free Packages are Available

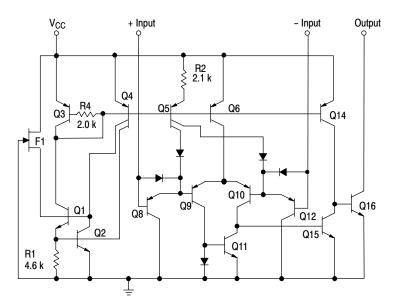


Figure 1. Representative Schematic Diagram

(Diagram shown is for 1 comparator)



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PDIP-8 N SUFFIX CASE 626

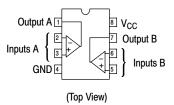


SOIC-8 D SUFFIX CASE 751



Micro8™ DM SUFFIX CASE 846A

PIN CONNECTIONS



DEVICE MARKING AND ORDERING INFORMATION

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

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage	V _{CC}	+36 or ±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°C Derate above 25°C	P _D 1/R _{θJA}	570 5.7	mW mW/°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	°C
Maximum Operating Junction Temperature LM393, 2903, LM2903V LM293, NCV2903	$T_{J(max)}$	150 150	°C
Storage Temperature Range	T _{stg}	-65 to +150	°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.

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.
 NCV2903 is qualified for automotive use.
 V_{ESD} rating for NCV/SC devices is: Human Body Model – 2000 V; Machine Model – 200 V.

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

		LM293, LM393		LM2903, LM2903V, NCV2903				
Characteristic	Symbol	Min	Тур	Max	Min	Тур	Max	Unit
Input Offset Voltage (Note 5)	V _{IO}							mV
$T_A = 25^{\circ}C$		_	±1.0	±5.0	_	±2.0	±7.0	
$T_{low} \le T_A \le T_{high}$		_	_	9.0	_	9.0	15	
Input Offset Current T _A = 25°C	I _{IO}		±5.0	±50	_	±5.0	±50	nA
$T_A = 25 \text{ G}$ $T_{low} \le T_A \le T_{high}$		_	±5.0	±30 ±150	_	±5.0 ±50	±200	
Input Bias Current (Note 6)	I _{IB}							nA
$T_A = 25^{\circ}C$, ID	_	25	250	_	25	250	117 (
$T_{low} \le T_A \le T_{high}$		-	_	400	-	200	500	
Input Common Mode Voltage Range (Note 6)	V _{ICR}							V
$T_A = 25^{\circ}C$		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	A_{VOL}	50	200	-	25	200	_	V/mV
$R_L \ge 15 \text{ k}\Omega, V_{CC} = 15 \text{ Vdc}, T_A = 25^{\circ}\text{C}$								
Large Signal Response Time	-	-	300	-	_	300	_	ns
V _{in} = TTL Logic Swing, V _{ref} = 1.4 Vdc								
$V_{RL} = 5.0 \text{ Vdc}, R_L = 5.1 \text{ k}\Omega, T_A = 25^{\circ}\text{C}$			4.0			4.5		
Response Time (Note 8) $V_{RL} = 5.0 \text{ Vdc}, R_L = 5.1 \text{ k}\Omega, T_A = 25^{\circ}\text{C}$	t _{TLH}	-	1.3	_	_	1.5	_	μS
Input Differential Voltage (Note 9) All V _{in} ≥ GND or V– Supply (if used)	V_{ID}	_	_	V _{CC}	_	_	V _{CC}	V
Output Sink Current	1	6.0	16	_	6.0	16	_	mA
$V_{in} \ge 1.0 \text{ Vdc}, V_{in+} = 0 \text{ Vdc}, V_O \le 1.5 \text{ Vdc } T_A = 25^{\circ}\text{C}$	I _{Sink}	6.0	16	_	6.0	16	_	IIIA
Output Saturation Voltage	V _{OL}							mV
$V_{in} \ge 1.0 \text{ Vdc}, V_{in+} = 0, I_{Sink} \le 4.0 \text{ mA}, T_A = 25^{\circ}\text{C}$	OL OL	_	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+} \geq 1.0 Vdc, V_O = 5.0 Vdc, T_A = 25°C		_	0.1	_	-	0.1	_	
$V_{in-} = 0 \text{ V, } V_{in+} \ge 1.0 \text{ Vdc, } V_O = 30 \text{ Vdc,}$								
$T_{low} \le T_A \le T_{high}$		-	_	1000	_	_	1000	
Supply Current	Icc						4.5	mA
$R_L = \infty$ Both Comparators, $T_A = 25^{\circ}$ C		_	0.4	1.0 2.5	_	0.4	1.0 2.5	
$R_L = \infty$ Both Comparators, $V_{CC} = 30 \text{ V}$	<u> </u>	_	_	2.5	_	_	2.5	

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

LM393 T_{low} = 0°C, T_{high} = +70°C LM2903 T_{low} = -40°C, T_{high} = +105°C

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

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=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 $V_{CC} = -1.5 \text{ V}$).
- 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.

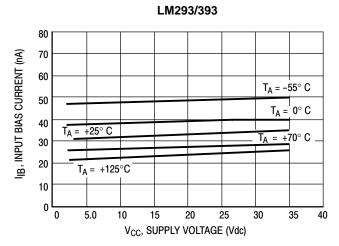


Figure 2. Input Bias Current versus Power Supply Voltage

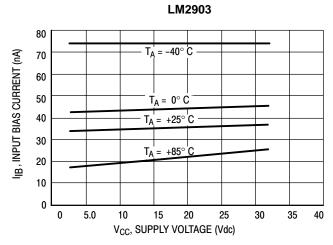


Figure 3. Input Bias Current versus Power Supply Voltage

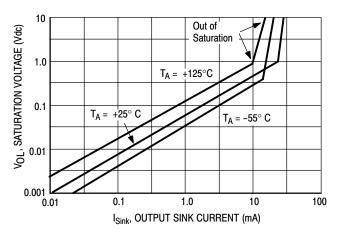


Figure 4. Output Saturation Voltage versus Output Sink Current

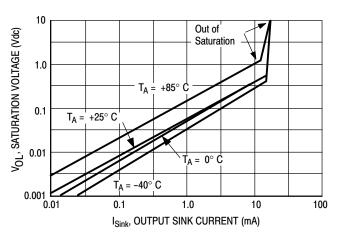


Figure 5. Output Saturation Voltage versus Output Sink Current

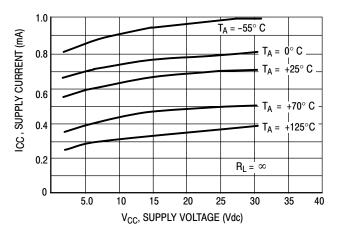


Figure 6. Power Supply Current versus Power Supply Voltage

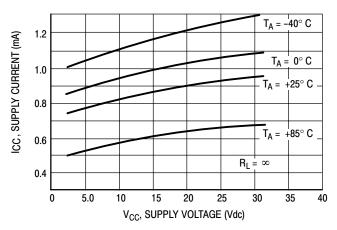


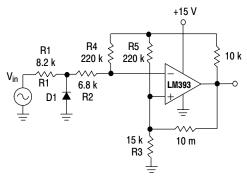
Figure 7. Power Supply Current versus Power Supply Voltage

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 k Ω should be used.

The addition of positive feedback ($<10\,\mathrm{mV}$) 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.



D1 prevents input from going negative by more than $\,$ 0.6 V.

$$R1 + R2 = R3$$

$$R3 \leq \frac{R5}{10} \ \ \text{for small error in zero crossing}.$$

Figure 8. Zero Crossing Detector (Single Supply)

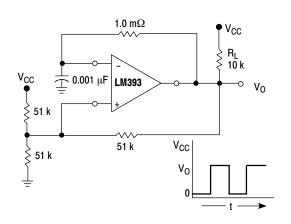
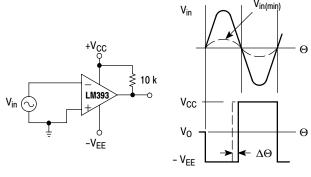


Figure 10. Free-Running Square-Wave Oscillator



 $V_{\text{in(min)}}\approx$ 0.4 V peak for 1% phase distortion ($\Delta\Theta).$

Figure 9. Zero Crossing Detector (Split Supply)

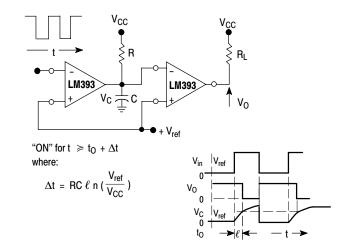


Figure 11. Time Delay Generator

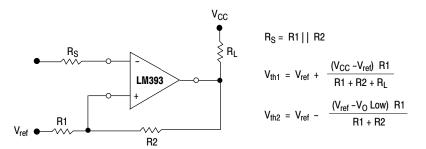
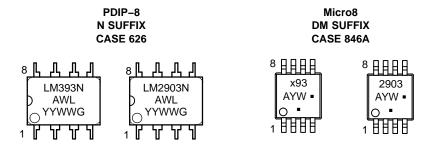
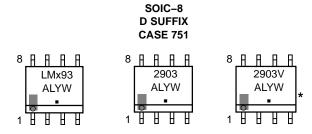


Figure 12. Comparator with Hysteresis

MARKING DIAGRAMS





x = 2 or 3

A = Assembly Location

WL, L = Wafer Lot YY, Y = Year WW, W = Work Week , G = Pb-Free Package

(Note: Microdot may be in either location)

*This marking diagram also applies to NCV2903DR2.

ORDERING INFORMATION

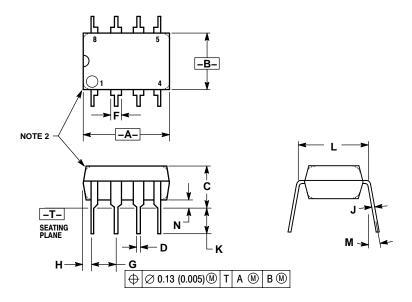
Device	Package	Shipping [†]
LM293D	SOIC-8	98 Units / Rail
LM293DG	SOIC-8 (Pb-Free)	98 Units / Rail
LM293DR2	SOIC-8	2500 / Tape & Reel
LM293DR2G	SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM293DMR2	Micro8	4000 / Tape and Reel
LM293DMR2G	Micro8 (Pb-Free)	4000 / Tape and Reel
LM393D	SOIC-8	98 Units / Rail
LM393DG	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.

PACKAGE DIMENSIONS

PDIP-8 **N SUFFIX** CASE 626-05 ISSUE L

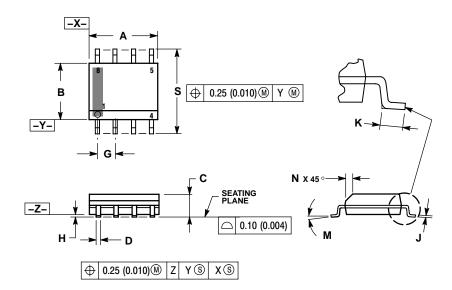


NOTES:

- (OLES: 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.

	MILLIN	IETERS	INCHES		
DIM	MIN	MAX	MIN	MAX	
Α	9.40	10.16	0.370	0.400	
В	6.10	6.60	0.240	0.260	
С	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		
Н	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	

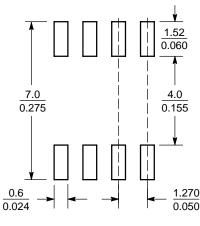
SOIC-8 **D SUFFIX** CASE 751-07 **ISSUE AG**



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER
- ANSI Y14.5M, 1982.
 CONTROLLING DIMENSION: MILLIMETER.
 DIMENSION A AND B DO NOT INCLUDE
 MOLD PROTRUSION.
- MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
- PER SIDE.
 DIMENSION D DOES NOT INCLUDE DAMBAR
 PROTRUSION. ALLOWABLE DAMBAR
 PROTRUSION SHALL BE 0.127 (0.005) TOTAL
 IN EXCESS OF THE D DIMENSION AT
 MAXIMUM MATERIAL CONDITION.
 751-01 THRU 751-06 ARE OBSOLETE. NEW
 STANDARD IS 751-07.

	MILLIN	IETERS	INCHES		
DIM	MIN	MAX	MIN	MAX	
Α	4.80	5.00	0.189	0.197	
В	3.80	4.00	0.150	0.157	
С	1.35	1.75	0.053	0.069	
D	0.33	0.51	0.013	0.020	
G	1.27	7 BSC	0.050 BSC		
Н	0.10	0.25	0.004	0.010	
J	0.19	0.25	0.007	0.010	
K	0.40	1.27	0.016	0.050	
M	0 °	8 °	0 °	8 °	
N	0.25	0.50	0.010	0.020	
S	5.80	6.20	0.228	0.244	

SOLDERING FOOTPRINT*

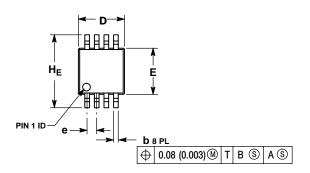


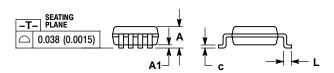
(mm inches) SCALE 6:1

^{*}For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

Micro8 **DM SUFFIX** CASE 846A-02 **ISSUE G**



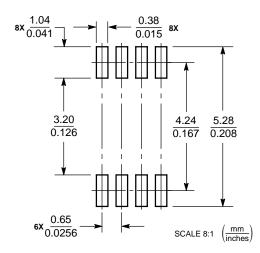


NOTES:

- EO.
 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 CONTROLLING DIMENSION: MILLIMETER.
 DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
- DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
- 5. 846A-01 OBSOLETE, NEW STANDARD 846A-02.

	MILLIMETERS			INCHES		
DIM	MIN	NOM	MAX	MIN	MOM	MAX
Α			1.10			0.043
A1	0.05	0.08	0.15	0.002	0.003	0.006
b	0.25	0.33	0.40	0.010	0.013	0.016
С	0.13	0.18	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	2.90	3.00	3.10	0.114	0.118	0.122
е		0.65 BSC)	
L	0.40	0.55	0.70	0.016	0.021	0.028
HE	4.75	4.90	5.05	0.187	0.193	0.199

SOLDERING FOOTPRINT*



*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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