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LM393S, LM2903S

Low Offset Voltage Dual Comparators

The LM393S and LM2903S 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) with LM393S
- 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
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

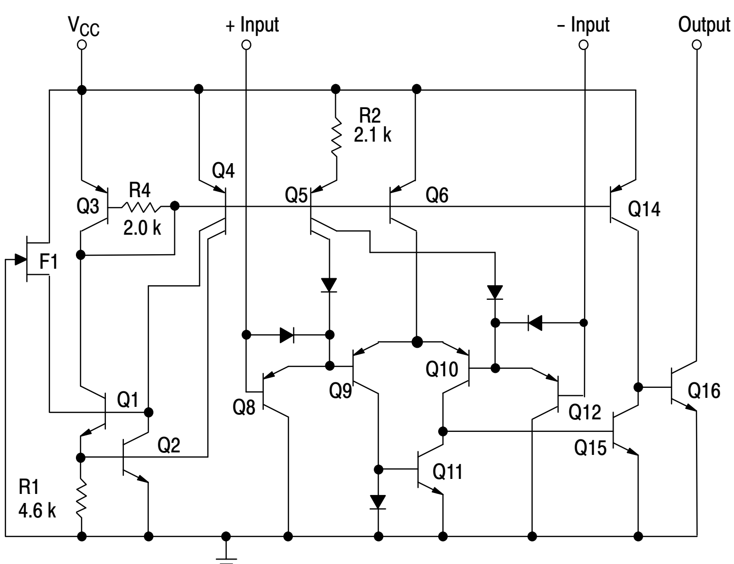

Figure 1. Representative Schematic Diagram
(Diagram shown is for 1 comparator)

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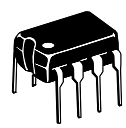
MARKING DIAGRAMS



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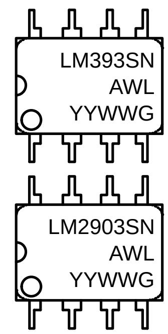
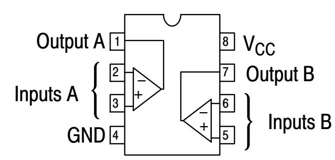


LMxxxx = Specific Device Code
A, AL = Assembly Location
WL = Wafer Lot
Y, YY = Year
W, WW = Work Week
G or ▪ = Pb−Free Package

PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

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

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC}	+36 or ±18	V
Input Differential Voltage	V_{IDR}	36	V
Input Common Mode Voltage Range (Note 1)	V_{ICR}	−0.3 to +36	V
Output Voltage	V_O	36	V
Output Short Circuit−to−Ground Output Sink Current (Note 2)	I_{SC} I_{Sink}	Continuous 20	mA
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D $1/R_{\theta JA}$	570 5.7	MW mW/°C
Operating Ambient Temperature Range LM393S LM2903S	T_A	 0 to +70 −40 to +105	°C
Maximum Operating Junction Temperature	$T_{J(max)}$	150	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. For supply voltages less than 36 V, the absolute maximum input voltage is equal to the supply voltage.
2. 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.

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

Characteristic	Symbol	LM393S			LM2903S			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage (Note 3)	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 4)	I_{IB}							nA
T_A = 25°C		–	25	250	–	25	250	
$T_{low} \le T_A \le T_{high}$		–	–	400	–	200	500	
Input Common Mode Voltage Range (Note 5)	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	–	–	200	–	–	200	–	ns
Response Time (Note 6) V_{RL} = 5.0 Vdc, R_L = 5.1 kΩ, T_A = 25°C	t_{TLH}	–	1.0	–	–	1.0	–	μs
Input Differential Voltage (Note 7) 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		–	0.6	1.0	–	0.6	1.0	
R_L = ∞ Both Comparators, V_{CC} = 30 V		–	0.75	2.5	–	0.75	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.

LM393S T_{low} = 0°C, T_{high} = +70°C
LM2903S T_{low} = −40°C, T_{high} = +105°C

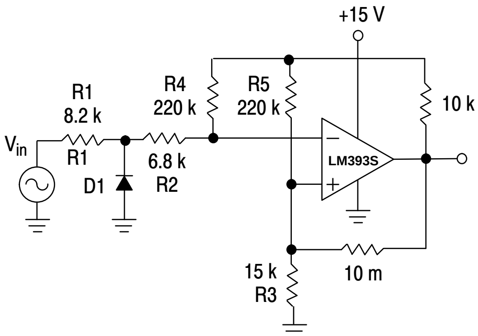
3. At output switch point, $V_O \simeq$ 1.4 Vdc, R_S = 0 Ω with V_{CC} from 5.0 Vdc to 30 Vdc, and over the full input common mode range (0 V to V_{CC} = −1.5 V).
4. Due to the PNP transistor inputs, bias current will flow out of the inputs. This current is essentially constant, independent of the output state, therefore, no loading changes will exist on the input lines.
5. 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.
6. 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.
7. 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.

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.

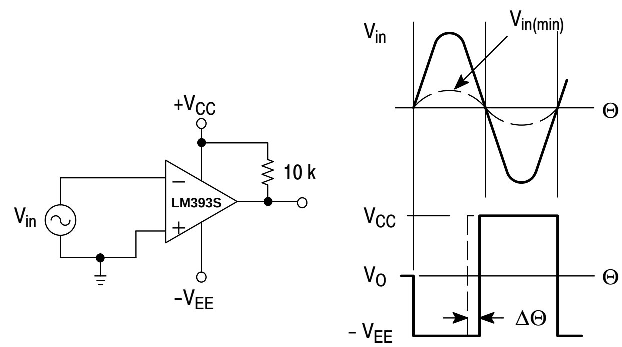


D1 prevents input from going negative by more than 0.6 V.

$R1 + R2 = R3$

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

Figure 2. Zero Crossing Detector (Single Supply)



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

Figure 3. Zero Crossing Detector (Split Supply)

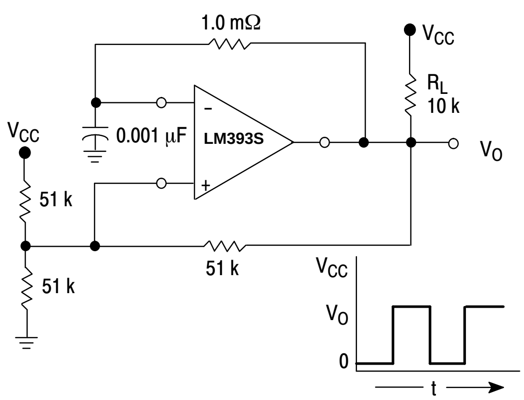


Figure 4. Free−Running Square−Wave Oscillator

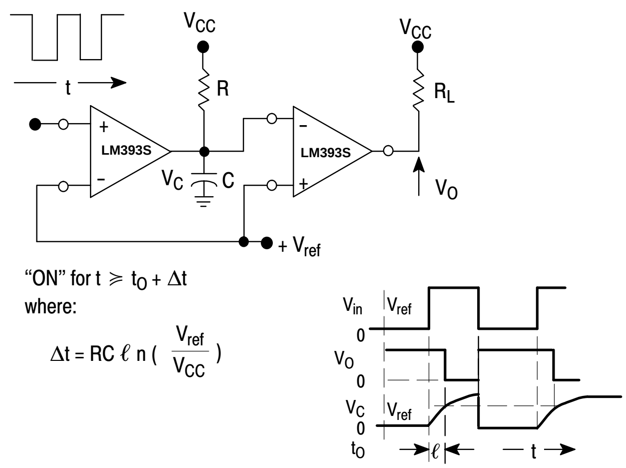
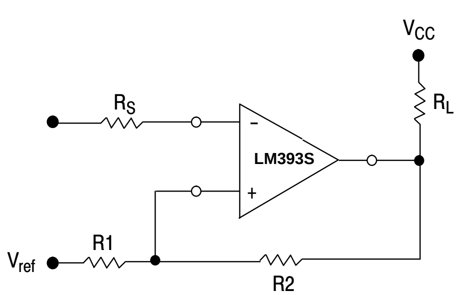


Figure 5. Time Delay Generator



$R_S = R1 \,||\, R2$

$$V_{th1} = V_{ref} + \frac{(V_{CC} - V_{ref})\,R1}{R1 + R2 + R_L}$$

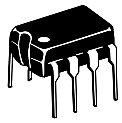
$$V_{th2} = V_{ref} - \frac{(V_{ref} - V_O\ \text{Low})\,R1}{R1 + R2}$$

Figure 6. Comparator with Hysteresis

ORDERING INFORMATION

Device	Operating Temperature Range	Package	Shipping†
LM393SNG	0°C to +70°C	PDIP−8 (Pb−Free)	50 Units / Rail
LM2903SNG	−40°C to +105°C	PDIP−8 (Pb−Free)	50 Units / Rail

†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.



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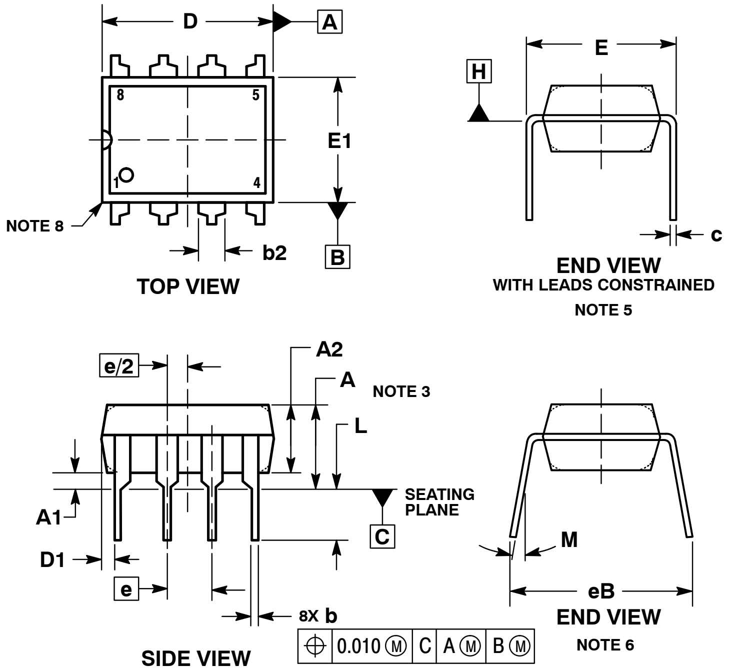
CASE 626−05
ISSUE P

DATE 22 APR 2015

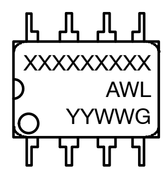


NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSIONS A, A1 AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS−3.
4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 0.10 INCH.
5. DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
6. DIMENSION eB IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
7. DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.
8. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	----	0.210	---	5.33
A1	0.015	----	0.38	---
A2	0.115	0.195	2.92	4.95
b	0.014	0.022	0.35	0.56
b2	0.060 TYP		1.52 TYP	
C	0.008	0.014	0.20	0.36
D	0.355	0.400	9.02	10.16
D1	0.005	----	0.13	---
E	0.300	0.325	7.62	8.26
E1	0.240	0.280	6.10	7.11
e	0.100 BSC		2.54 BSC	
eB	----	0.430	---	10.92
L	0.115	0.150	2.92	3.81
M	----	10°	---	10°

STYLE 1:
PIN 1. AC IN
2. DC + IN
3. DC − IN
4. AC IN
5. GROUND
6. OUTPUT
7. AUXILIARY
8. V_{CC}

GENERIC MARKING DIAGRAM*



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

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present.

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