



# TS2903

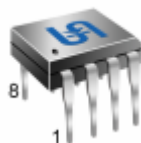
## Dual Voltage Comparator

Preliminary

SOP-8



DIP-8



Pin assignment:

1. Output
2. Input A (-)
3. Input A (+)
4. Gnd
5. Input B (+)
6. Input B (-)
7. Output B
8. Vcc

**Supply Voltage Range 2V to 36V**  
**Dual Channel Comparator**

### General Description

The TS2903 is dual independent precision voltage comparators capable of single-supply or split-supply operation. The specifications as low as 2.0 mV make this device an excellent ground level with single-supply operation. Input offset-voltage selection for many applications in consumer automotive, and It is designed to permit a common mode range-to- industrial electronics.

The TS2903 is offered in 8 pin SOP-8 and DIP-8 package.

### Features

- ◇ Output voltage compatible with DTL, ECL, TTL, MOS and CMOS Logic Levels
- ◇ Low input bias current -25nA
- ◇ Low input offset current  $\pm 5\text{nA}$
- ◇ Low input offset voltage  $\pm 3\text{mV}(\text{max})$
- ◇ Input common mode range to ground level
- ◇ Differential Input voltage range equal to power supply voltage
- ◇ Very low current drain independent of supply voltage - 0.4mA
- ◇ Wide single-supply range 2V to 36V
- ◇ Split-supply range  $\pm 1\text{V}$  to  $\pm 18\text{V}$

### Block Diagram

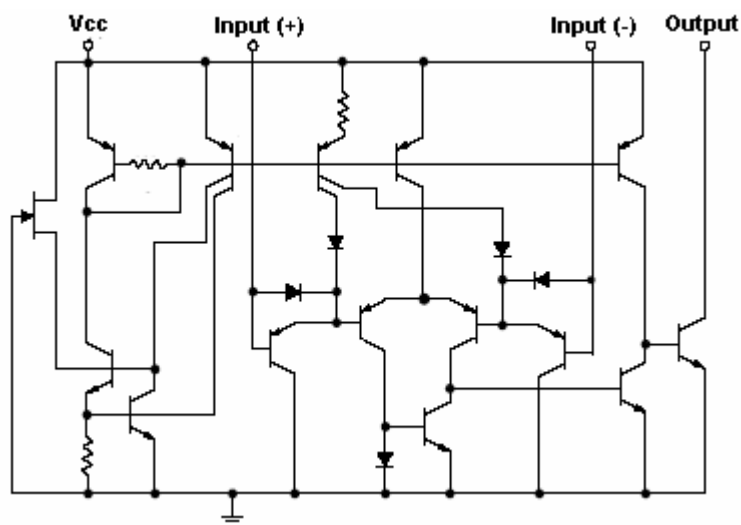


Pin 4 = Gnd Pin 8 = Vcc

### Ordering Information

Part No.	Operating Temp.	Package
TS2903CD	-40 ~ +105 °C	DIP-8
TS2903CS		SOP-8

### Schematic (each comparator)



Absolute Maximum Rating						
Supply Voltage	V <sub>CC</sub>	+36 or ±18	V			
Differential Input Voltage	V <sub>IDR</sub>	36	V			
Input Common Mode Voltage Range	V <sub>ICR</sub>	-0.3 to 36	V			
Input Current (note 2)	I <sub>in</sub>	50	mA			
Output Short Circuit to Ground	I <sub>sc</sub>	Continuous				
Output Sink Current (note 1)	I <sub>sink</sub>	20	mA			
Power Dissipation @ Ta=25 °C		570	mW			
Derate above 25 °C	1/Rθja	5.7	mW/°C			
Operating Junction Temperature Range	T <sub>J</sub>	0 ~ +125	°C			
Storage Temperature Range	T <sub>STG</sub>	-65 ~ +150	°C			
Lead Temperature 1.6mm(1/16") from case for 10Sec.	T <sub>LEAD</sub>	260	°C			
Electrical Characteristics						
(V <sub>CC</sub> = 5V, T <sub>LOW</sub> ≤ Ta ≤ T <sub>HIGH</sub> ; unless otherwise specified.)						
Characteristics	Symbol	Test condition	Min	Typ	Max	Unit
Input Offset Voltage (note 3)	V <sub>io</sub>	Ta =25 °C T <sub>LOW</sub> ≤ Ta ≤ T <sub>HIGH</sub>	-- --	2.0 9.0	7.0 15	mV
Input Offset Current	I <sub>io</sub>	Ta =25 °C T <sub>LOW</sub> ≤ Ta ≤ T <sub>HIGH</sub>	-- --	±5.0 ±5.0	±50 ±200	nA
Input Offset Current (note 4)	I <sub>IB</sub>	Ta =25 °C T <sub>LOW</sub> ≤ Ta ≤ T <sub>HIGH</sub>	-- --	25 200	250 500	nA
Input Common Mode Voltage Range (note 5)	V <sub>ICR</sub>	Ta =25 °C T <sub>LOW</sub> ≤ Ta ≤ T <sub>HIGH</sub>	0 0	-- --	V <sub>CC</sub> -1.5 V <sub>CC</sub> -2.0	V
Voltage Gain	A <sub>VOL</sub>	R <sub>L</sub> ≥15K, V <sub>CC</sub> = 15Vdc. Ta =25 °C	25	200	--	V/mV
Large Signal Response Time	--	V <sub>in</sub> = TTL Logic Swing. V <sub>ref</sub> = 1.4Vdc, V <sub>RL</sub> = 5Vdc. R <sub>L</sub> 5.1KΩ, Ta =25 °C	--	300	--	nS
Response Time (note 6)	t <sub>TLH</sub>	V <sub>RL</sub> = 5Vdc, R <sub>K</sub> = 5.1KΩ Ta =25 °C	--	1.5	--	uS
Input Differential Voltage (note 7)	V <sub>ID</sub>	All V <sub>in</sub> ≥ Gnd or V-Supply (if used)	--	--	V <sub>CC</sub>	V
Output Sink Current	I <sub>SINK</sub>	V <sub>in</sub> ≥1Vdc, V <sub>in+</sub> =0Vdc, V <sub>O</sub> ≤1 Vdc, Ta =25 °C	6.0	16	--	mA
Output Saturation Voltage	V <sub>OL</sub>	V <sub>in</sub> ≥1Vdc, V <sub>in+</sub> =0, I <sub>SINK</sub> ≤4mA, Ta =25 °C T <sub>LOW</sub> ≤ Ta ≤ T <sub>HIGH</sub>	-- --	-- 200	400 700	mV
Output Leakage Current	I <sub>OL</sub>	V <sub>in</sub> =0V, V <sub>in+</sub> ≥1Vdc, P=5Vdc. Ta =25 °C V <sub>in</sub> =0V, V <sub>in+</sub> ≥1V, V <sub>O</sub> =30Vdc T <sub>LOW</sub> ≤ Ta ≤ T <sub>HIGH</sub>	-- --	0.1 --	-- 1000	nA
Supply Current	I <sub>CC</sub>	R <sub>L</sub> = ∞, Ta =25 °C R <sub>L</sub> = ∞, V <sub>CC</sub> =30 V	-- --	0.4 --	1.0 2.5	mA



## Electrical Characteristics (Continues)

Note 1. The max. Output current may be as high as 20mA, independent of the magnitude of  $V_{CC}$ , output short circuits to  $V_{CC}$  can cause excessive heating and eventual destruction.

Note 2. This magnitude of input current will only occur if the input leads are driven more negative than ground or the negative supply voltage. This is due to the input PNP collector base junction becoming forward biased acting as an input clamp diode. There is also a lateral PNP parasitic transistor action on the IC chip. This phenomena can cause the output voltage of the comparators to go to the  $V_{CC}$  voltage level (or ground if overdrive is large) during the time the input is driven negative. This will not destroy the device and normal output states will recover when the inputs become -0.3V of ground or negative supply.

Note 3. At output switch point,  $V_O=1.4V_{dc}$ ,  $R_S=0\Omega$  with  $V_{CC}$  from 5Vdc to 30Vdc, and over the full input common-mode

Note 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.

Note 5. Input common mode of either input should not be permitted to go more than 0.3V negative of ground or minus supply. The upper limit of common mode range is  $V_{CC} - 1.5V$  but either or both inputs can betaken to as high as 30volts without damage.

Note 6. Response time is specified with a 100mV step and 5.0mV of overdrive. With larger magnitudes of overdrive faster response times are obtainable.

Note 7. The comparator will inhibit proper output state if one of the inputs is become greater than  $V_{CC}$ , the other input must remain within the common mode range. The low input state must not be less than -0.3volts of ground of minus supply.

## Applications Information

This dual comparator feature high gain, wide bandwidth characteristics. This gives the device oscillation tendencies if the outputs are capacitive 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  $<10K\Omega$  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  $-0.3V$  should not be used.

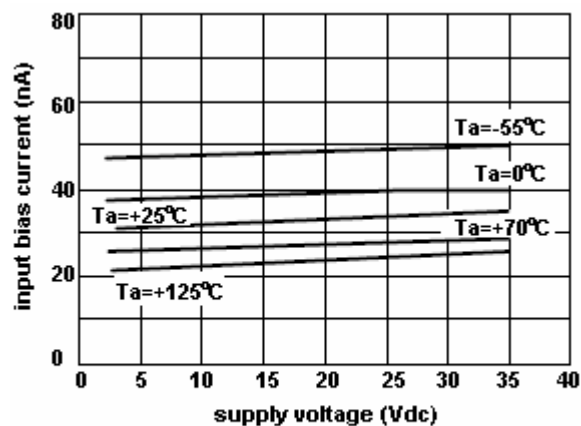


Figure 1. input bias current vs power supply voltage

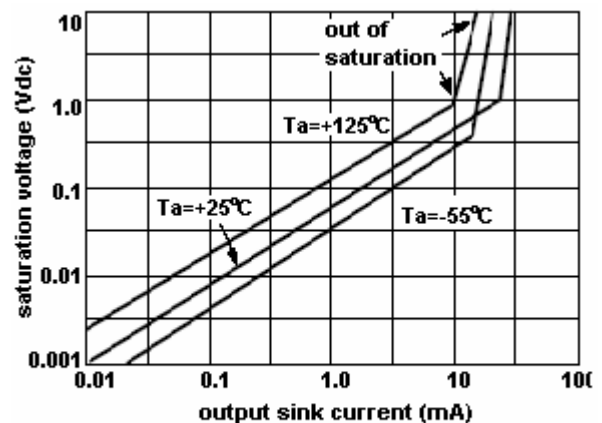


Figure 2. output saturation voltage vs output sink current

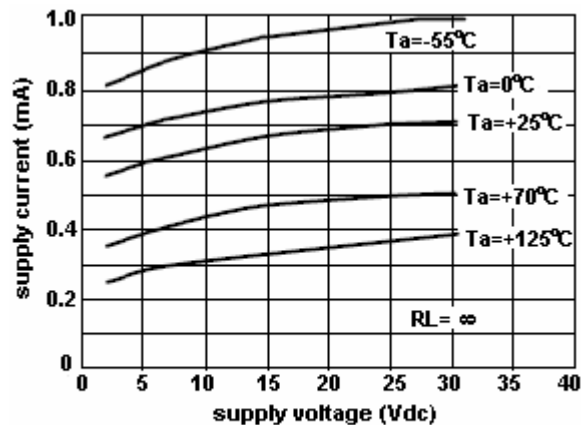
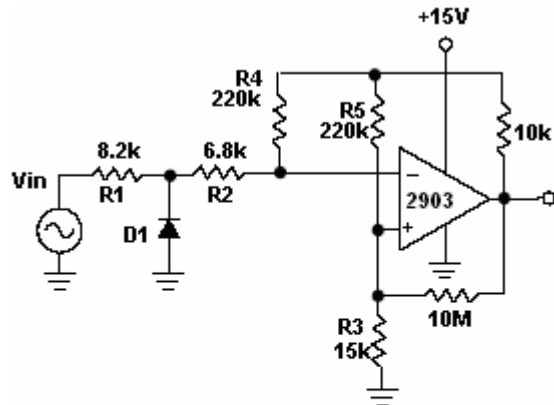


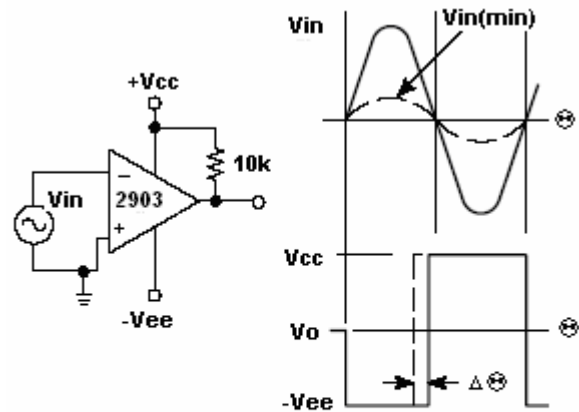
Figure 3. power supply current vs power supply voltage

## Electrical Characteristics Curve



D1 prevents input from going negative by more than 0.6V,  $R1 + R2 = R3$   
 $R3 \leq R5 / 10$  for small error in zero crossing

Figure 4. zero crossing detector (single supply)



$V_{in(min)} = 0.4V$  peak for 1% phase distortion ( $\Delta \phi$ )

Figure 5. zero crossing detector (split supply)

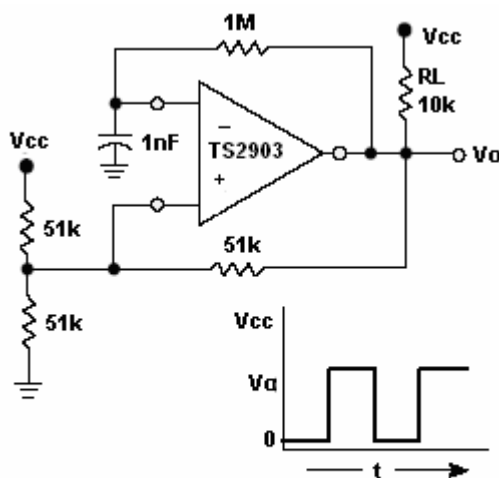
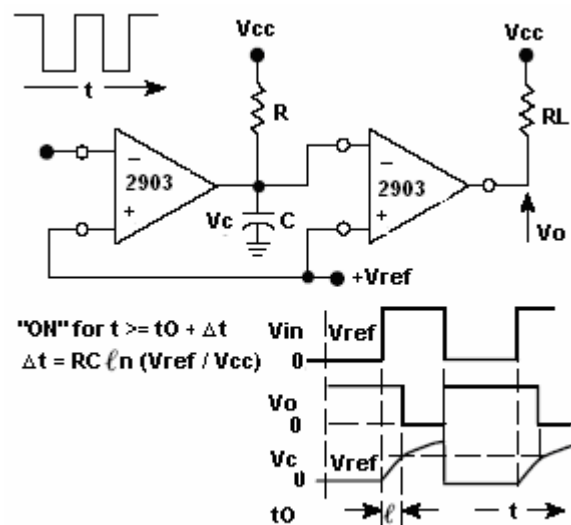
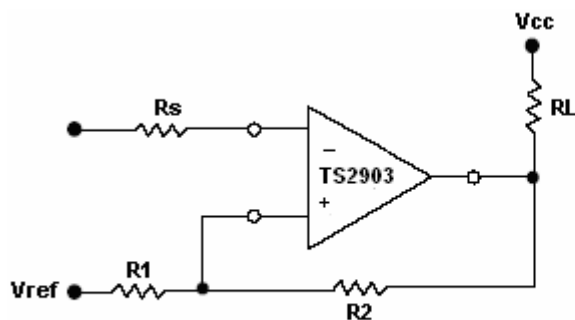


Figure 6. free-running square-wave oscillator



"ON" for  $t \geq t_0 + \Delta t$   
 $\Delta t = RC \ln(V_{ref} / V_{cc})$

Figure 7. time delay generator



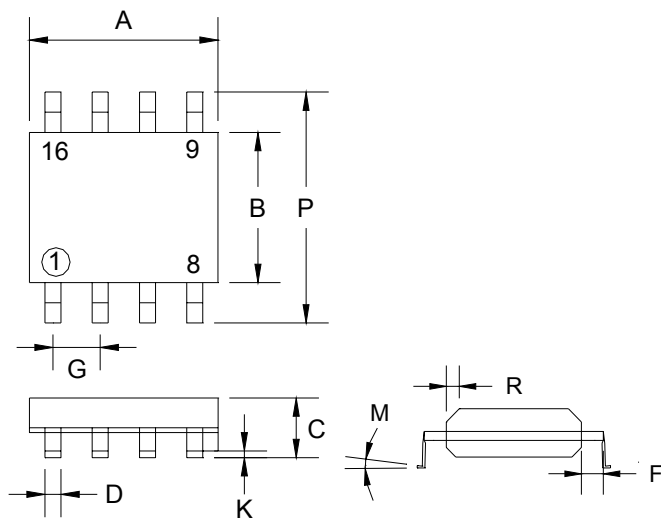
$$R_s = R1 \parallel R2$$

$$V_{th1} = V_{ref} + \frac{(V_{cc} - V_{ref}) \cdot R1}{R1 + R2 + RL}$$

$$V_{th2} = V_{ref} - \frac{(V_{ref} - V_{o \text{ low}}) \cdot R1}{R1 + R2}$$

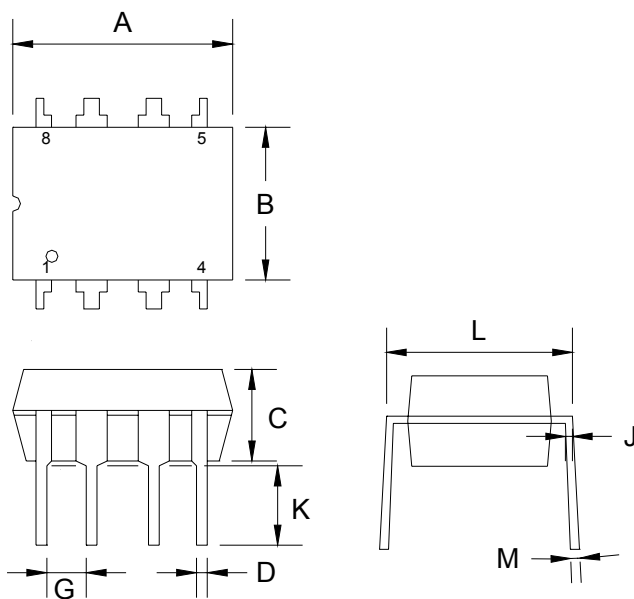
Figure 8. comparator with hysteresis

## SOP-8 Mechanical Drawing



SOP-8 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 (typ)		0.05 (typ)	
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

## DIP-8 Mechanical Drawing



SOP-8 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.07	9.32	0.357	0.367
B	6.22	6.48	0.245	0.255
C	3.18	4.45	0.125	0.135
D	0.35	0.55	0.019	0.020
G	2.54 (typ)		0.10 (typ)	
J	0.29	0.31	0.011	0.012
K	3.25	3.35	0.128	0.132
L	7.75	8.00	0.305	0.315
M	-	10°	-	10°