

## Low-power dual voltage comparator

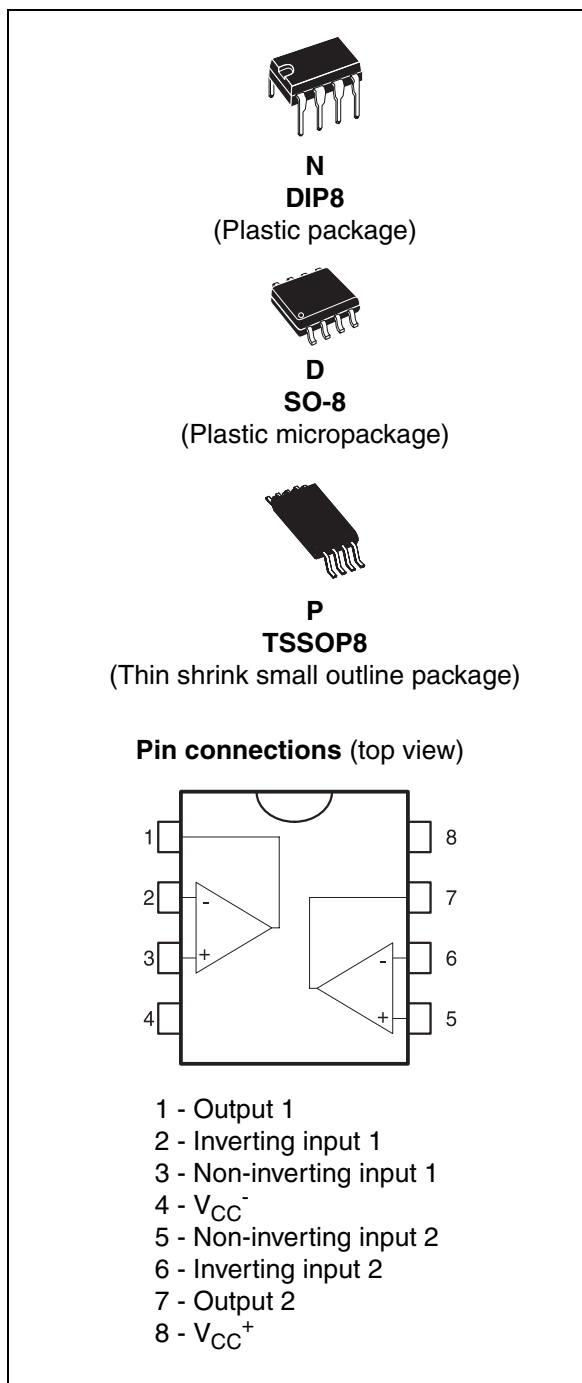
### Features

- Wide single supply voltage range or dual supplies +2 V to +36 V or  $\pm 1$  V to  $\pm 18$  V
- Very low supply current (0.4 mA) independent of supply voltage (1 mW/comparator at +5 V)
- Low input bias current: 25 nA typ.
- Low input offset current:  $\pm 5$  nA typ.
- Input common-mode voltage range includes negative rail
- Low output saturation voltage: 250 mV typ. ( $I_O = 4$  mA)
- Differential input voltage range equal to the supply voltage
- TTL, DTL, ECL, MOS, CMOS compatible outputs

### Description

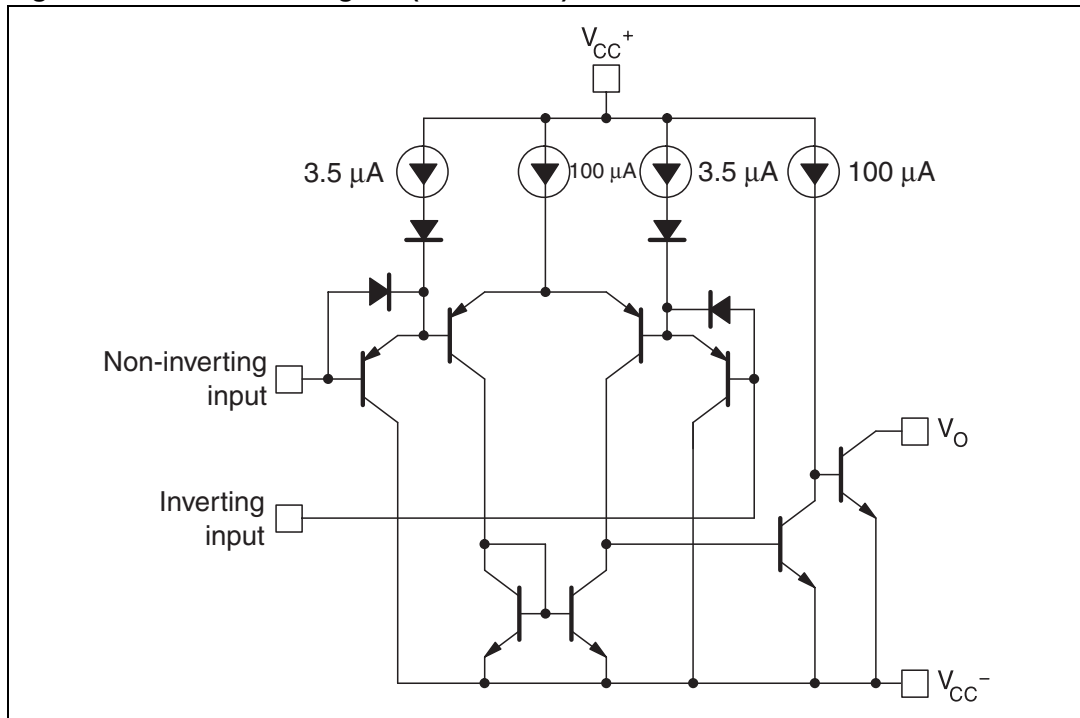
This device consists of two independent low-power voltage comparators designed specifically to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible.

The device also has a unique characteristic in that the input common-mode voltage range includes the negative rail even though operated from a single power supply voltage.



# 1 Schematic diagram

Figure 1. Schematic diagram (1/2 LM2903)



## 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage	$\pm 18$ to 36	V
$V_{id}$	Differential input voltage	$\pm 36$	V
$V_{in}$	Input voltage	-0.3 to +36	V
	Output short-circuit to ground <sup>(1)</sup>	Infinite	
$R_{thja}$	Thermal resistance junction to ambient <sup>(2)</sup>		$^{\circ}\text{C}/\text{W}$
	DIP8	85	
	SO-8	125	
	TSSOP8	120	
$R_{thjc}$	Thermal resistance junction to case <sup>(2)</sup>		$^{\circ}\text{C}/\text{W}$
	DIP8	41	
	SO-8	40	
	TSSOP8	37	
$T_j$	Maximum junction temperature	+150	$^{\circ}\text{C}$
$T_{stg}$	Storage temperature range	-65 to +150	$^{\circ}\text{C}$
ESD	Human body model (HBM) <sup>(3)</sup>	800	V
	Machine model (MM) <sup>(4)</sup>	200	V
	CDM: charged device model <sup>(5)</sup>	1.5	kV

- Short-circuits from the output to  $V_{CC}^+$  can cause excessive heating and possible destruction. The maximum output current is approximately 20 mA, independent of the magnitude of  $V_{CC}^+$ .
- Short-circuits can cause excessive heating and destructive dissipation. Values are typical.
- Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 k $\Omega$  resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5  $\Omega$ ). This is done for all couples of connected pin combinations while the other pins are floating.
- Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.

**Table 2. Operating conditions**

Symbol	Parameter	Value	Unit
$V_{icm}$	Common mode input voltage range	0 to $V_{CC}^+ - 1.5$	V
	$T_{min} \leq T_{amb} \leq T_{max}$	0 to $V_{CC}^+ - 2$	
$T_{oper}$	Operating free-air temperature range	-40 to +125	$^{\circ}\text{C}$

### 3 Electrical characteristics

**Table 3.**  $V_{CC}^+ = 5\text{ V}$ ,  $V_{CC}^- = \text{GND}$ ,  $T_{\text{amb}} = 25^\circ\text{C}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input offset voltage <sup>(1)</sup> $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		1	7 15	mV
$I_{io}$	Input offset current $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		5	50 150	nA
$I_{ib}$	Input bias current <sup>(2)</sup> $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		25	250 400	nA
$A_{vd}$	Large signal voltage gain $V_{CC} = 15\text{V}$ , $R_L = 15\text{k}\Omega$ , $V_o = 1$ to $11\text{V}$	25	200		V/mV
$I_{CC}$	Supply current (all comparators) $V_{CC} = 5\text{V}$ , no load $V_{CC} = 30\text{V}$ , no load		0.4 1	1 2.5	mA
$V_{id}$	Differential input voltage <sup>(3)</sup>			$V_{CC}^+$	V
$V_{OL}$	Low level output voltage ( $V_{id} = -1\text{V}$ , $I_{\text{sink}} = 4\text{mA}$ ) $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		250	400 700	mV
$I_{OH}$	High level output current ( $V_{CC} = V_o = 30\text{V}$ , $V_{id} = 1\text{V}$ ) $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$		0.1	1	nA $\mu\text{A}$
$I_{\text{sink}}$	Output sink current ( $V_{id} = -1\text{V}$ , $V_o = 1.5\text{V}$ )	6	16		mA
$t_{\text{res}}$	Small signal response time <sup>(4)</sup> ( $R_L = 5.1\text{k}\Omega$ to $V_{CC}^+$ )		1.3		$\mu\text{s}$
$t_{\text{rel}}$	Large signal response time <sup>(5)</sup> TTL input ( $V_{\text{ref}} = +1.4\text{ V}$ , $R_L = 5.1\text{k}\Omega$ to $V_{CC}^+$ ) Output signal at 50% of final value Output signal at 95% of final value			500 1	ns $\mu\text{s}$

1. At output switch point,  $V_o \approx 1.4\text{ V}$ ,  $R_S = 0\ \Omega$  with  $V_{CC}^+$  from  $5\text{ V}$  to  $30\text{ V}$ , and over the full input common-mode range ( $0\text{ V}$  to  $V_{CC}^+ - 1.5\text{ V}$ ).
2. The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so no loading charge exists on the reference of input lines.
3. Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than  $-0.3\text{ V}$  (or  $0.3\text{ V}$  below the negative power supply, if used).
4. The response time specified is for a  $100\text{ mV}$  input step with  $5\text{ mV}$  overdrive.
5. Maximum values are guaranteed by design and evaluation.

Figure 2. Supply current vs. supply voltage

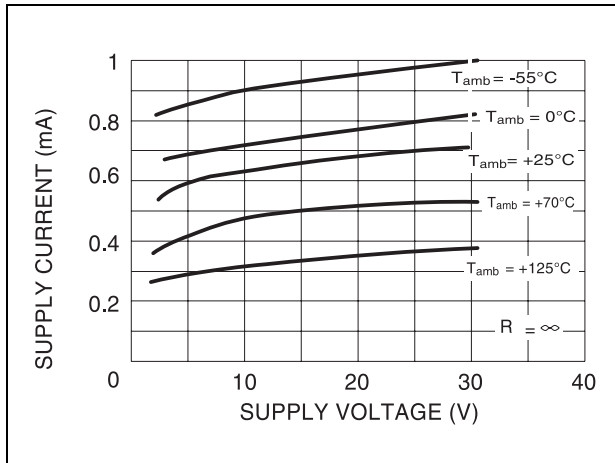


Figure 3. Input current vs. supply voltage

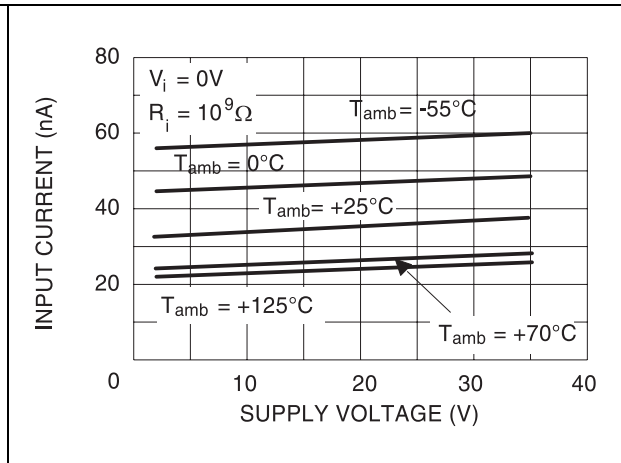


Figure 4. Output saturation voltage vs. output current

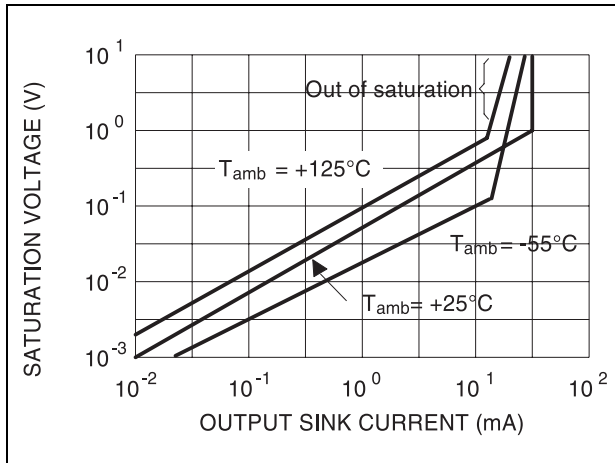


Figure 5. Response time for various input overdrives - negative transition

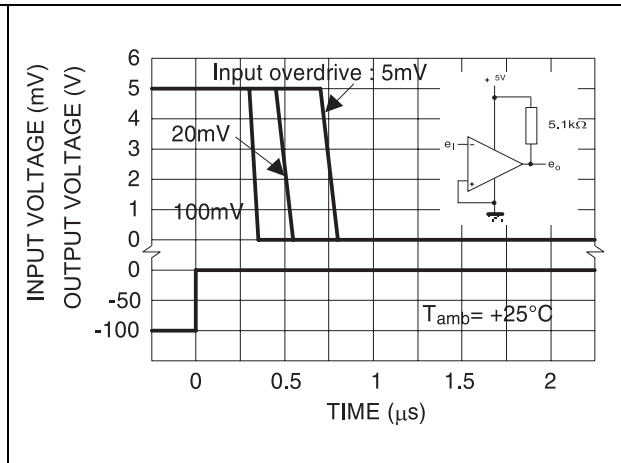
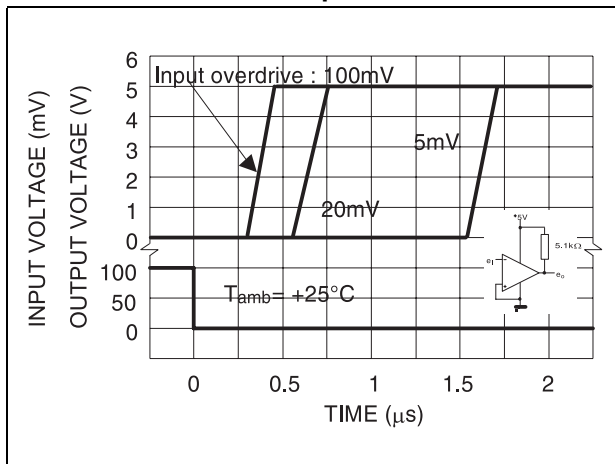


Figure 6. Response time for various input overdrives - positive transition



# 4 Typical application schematics

Figure 7. Basic comparator

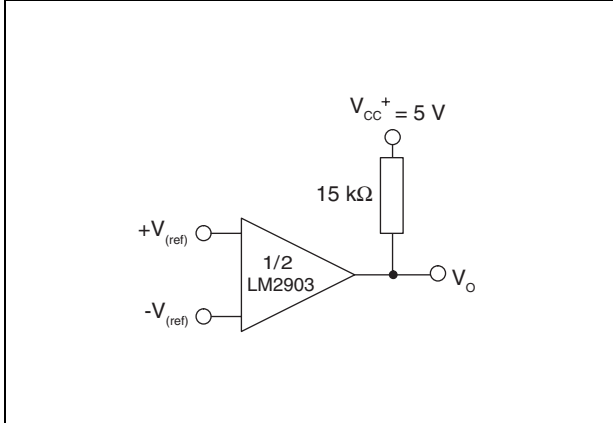


Figure 8. Driving CMOS

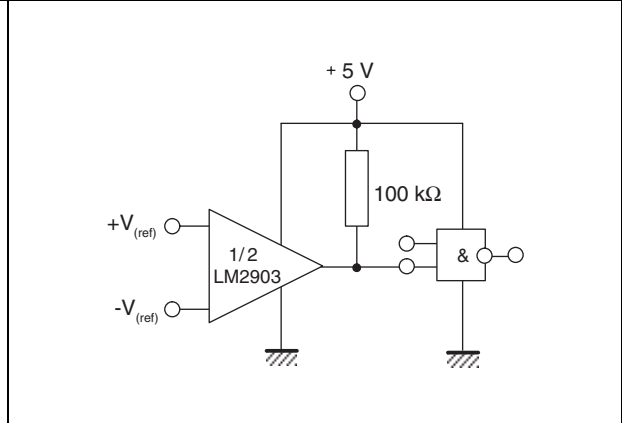


Figure 9. Driving TTL

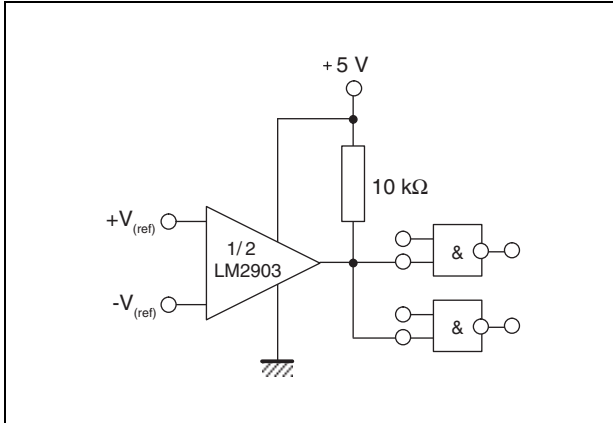


Figure 10. Low frequency op-amp

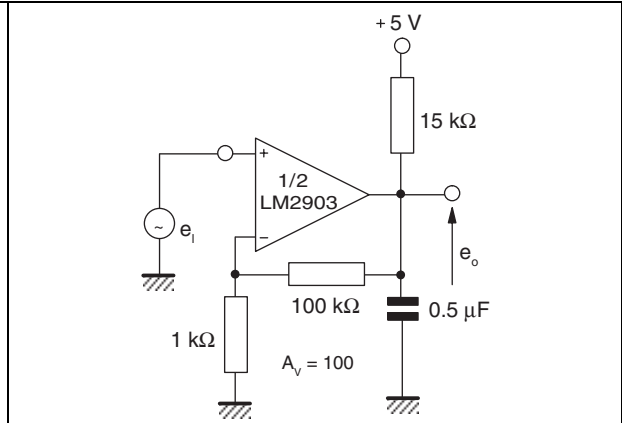


Figure 11. Low frequency op-amp with boost

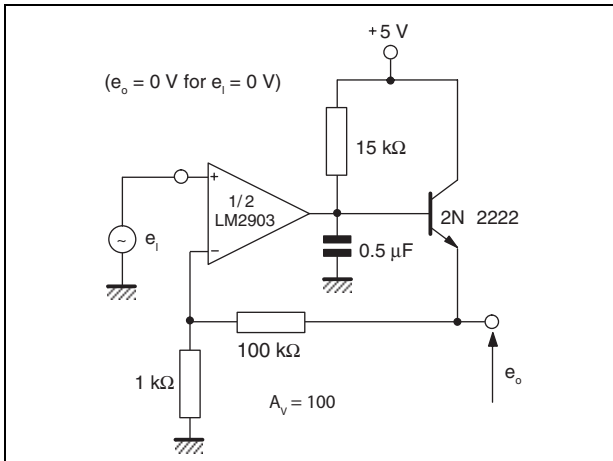


Figure 12. Transducer amplifier

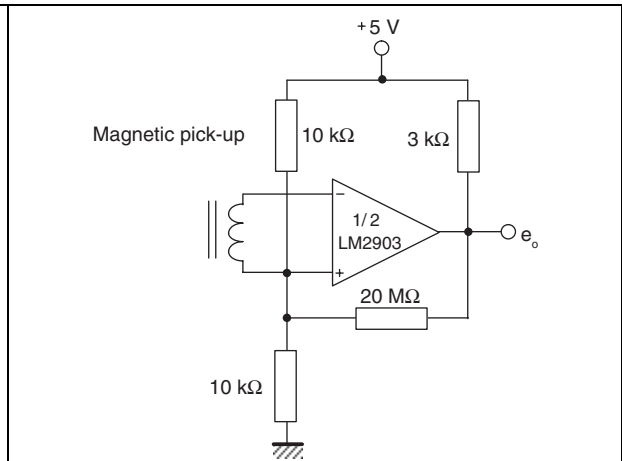


Figure 13. Low frequency op- amp with offset adjust

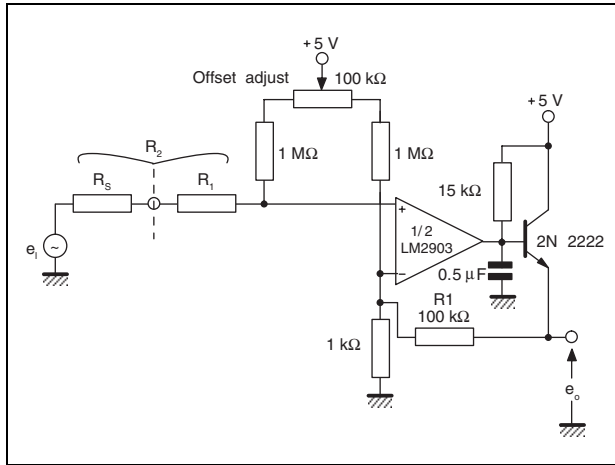


Figure 14. Zero crossing detector (single power supply)

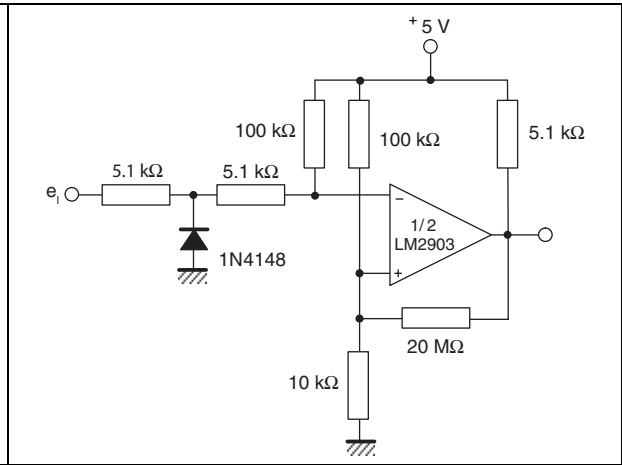


Figure 15. Limit comparator

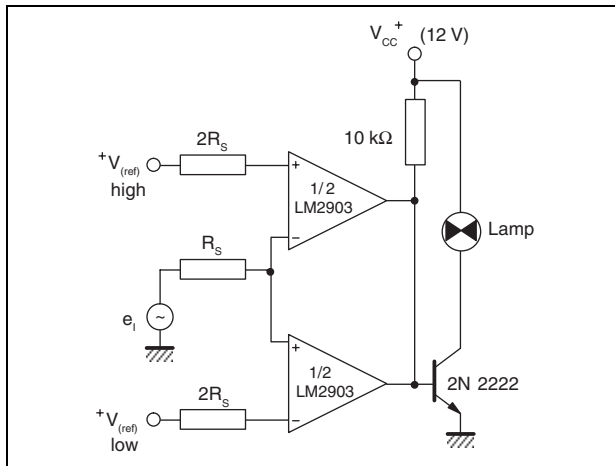


Figure 16. Split-supply applications - zero crossing detector

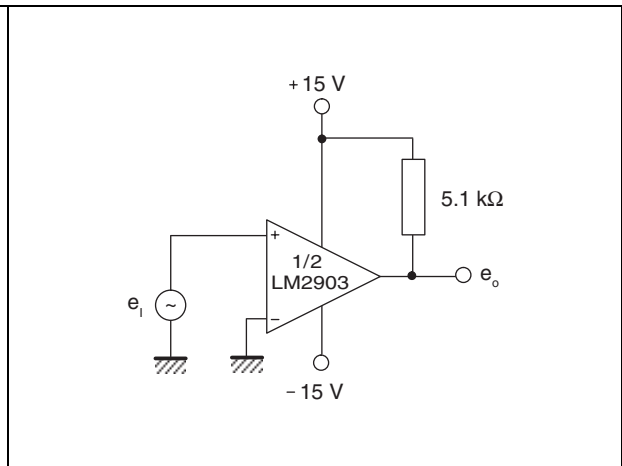


Figure 17. Crystal controlled oscillator

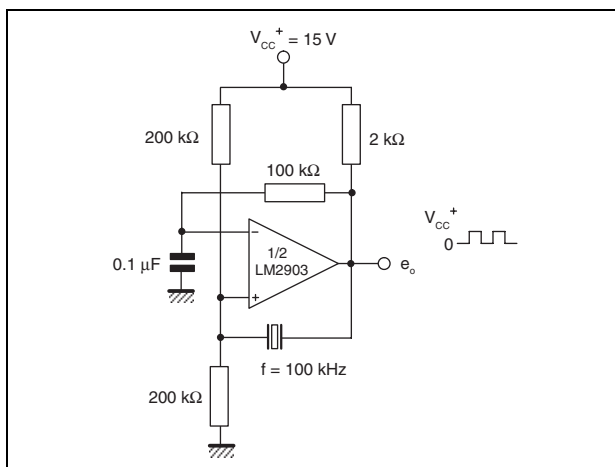


Figure 18. Comparator with a negative reference

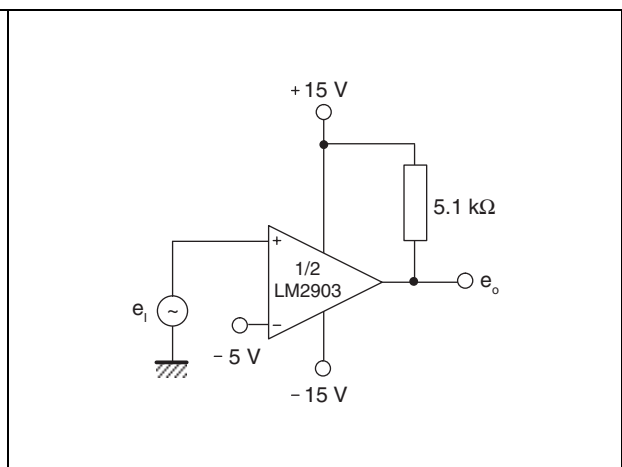


Figure 19. Time delay generator

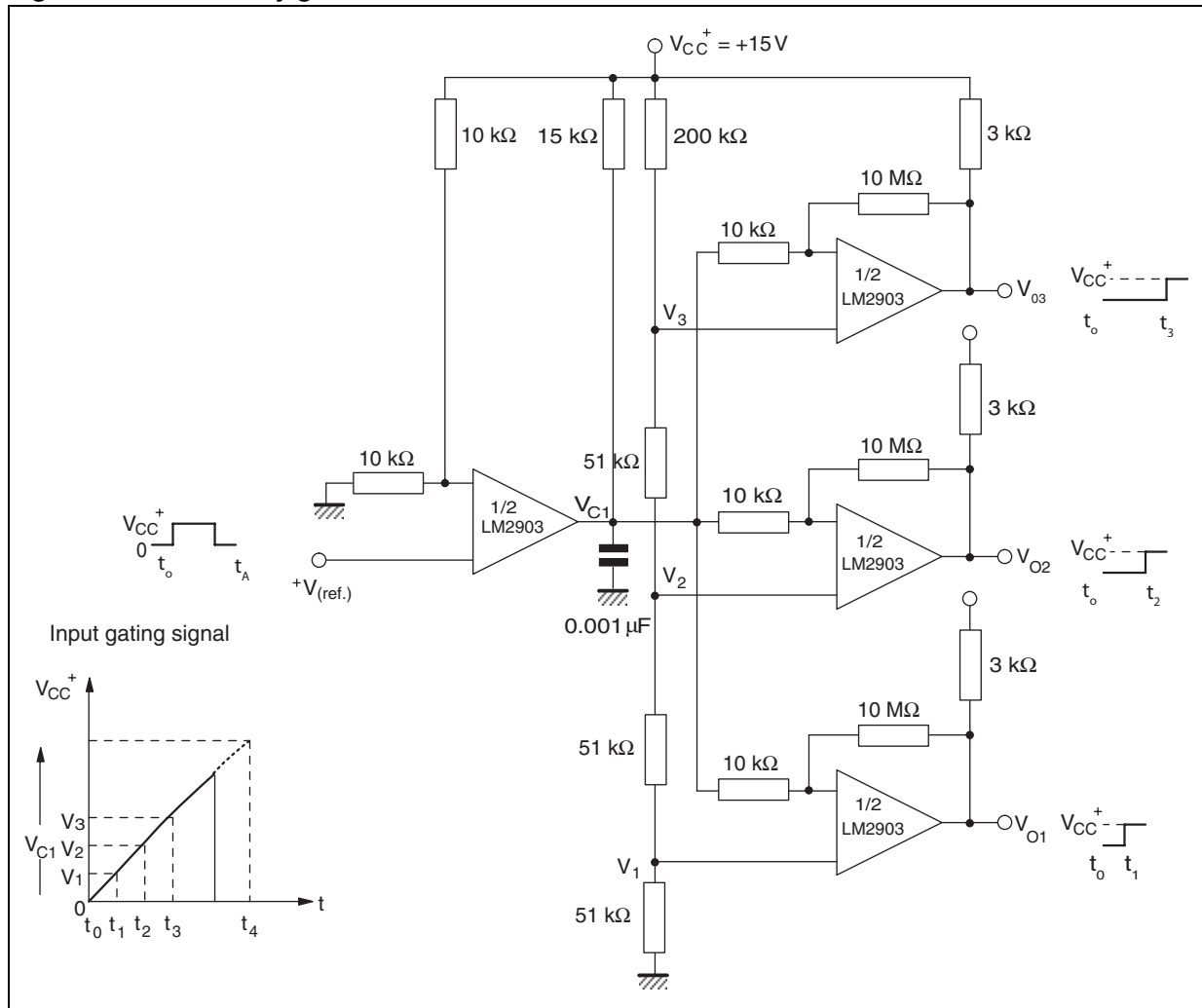
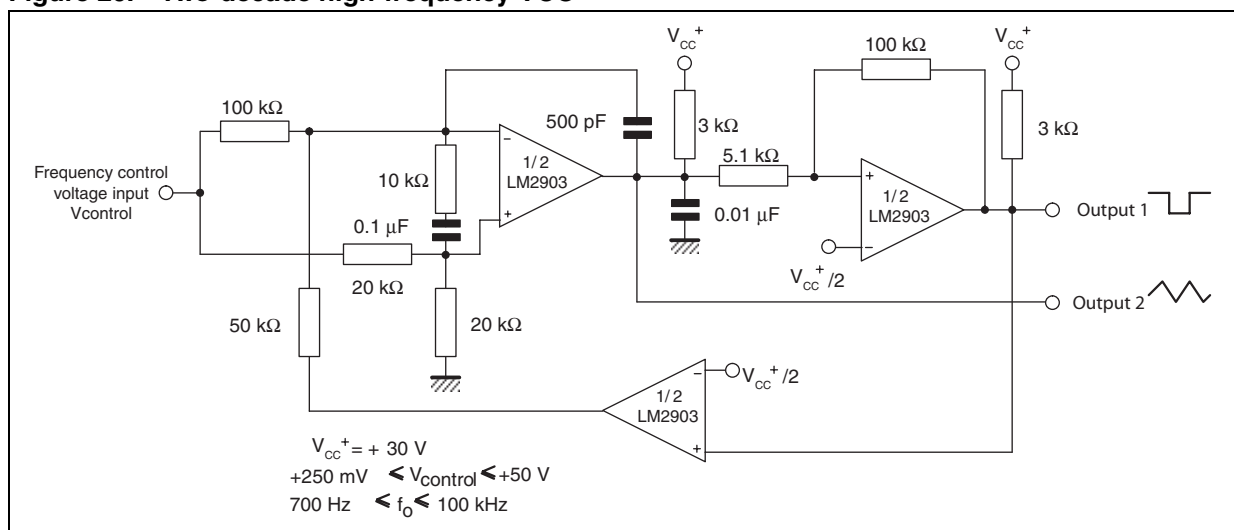


Figure 20. Two-decade high-frequency VCO





## 5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 5.1 DIP8 package information

Figure 21. DIP8 package mechanical drawing

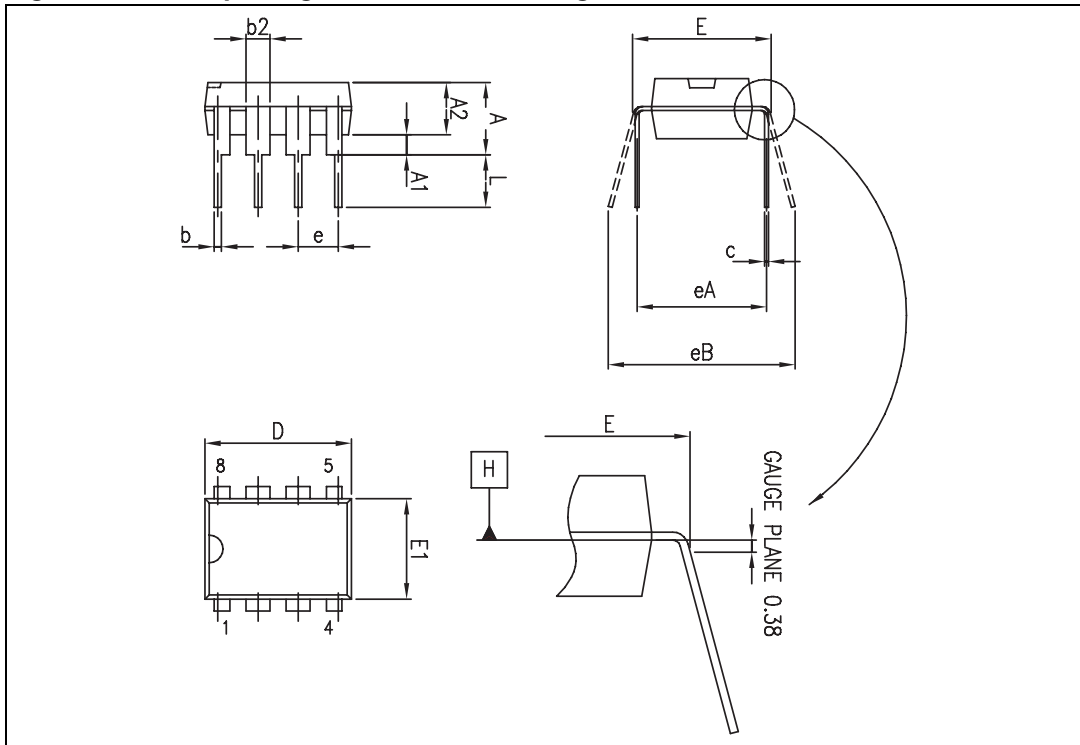


Table 4. DIP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
c	0.20	0.25	0.36	0.008	0.010	0.014
D	9.02	9.27	10.16	0.355	0.365	0.400
E	7.62	7.87	8.26	0.300	0.310	0.325
E1	6.10	6.35	7.11	0.240	0.250	0.280
e		2.54			0.100	
eA		7.62			0.300	
eB			10.92			0.430
L	2.92	3.30	3.81	0.115	0.130	0.150

## 5.2 SO-8 package information

Figure 22. SO-8 package mechanical drawing

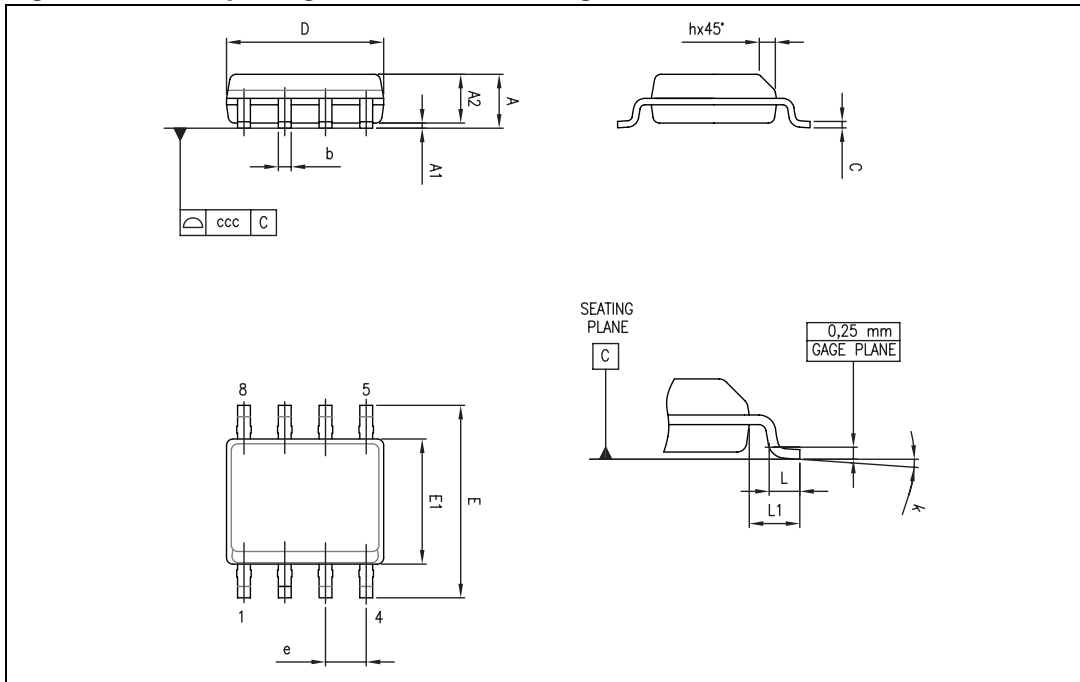


Table 5. SO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
L1		1.04			0.040	
k	1°		8°	1°		8°
ccc			0.10			0.004

### 5.3 TSSOP8 package information

Figure 23. TSSOP8 package mechanical drawing

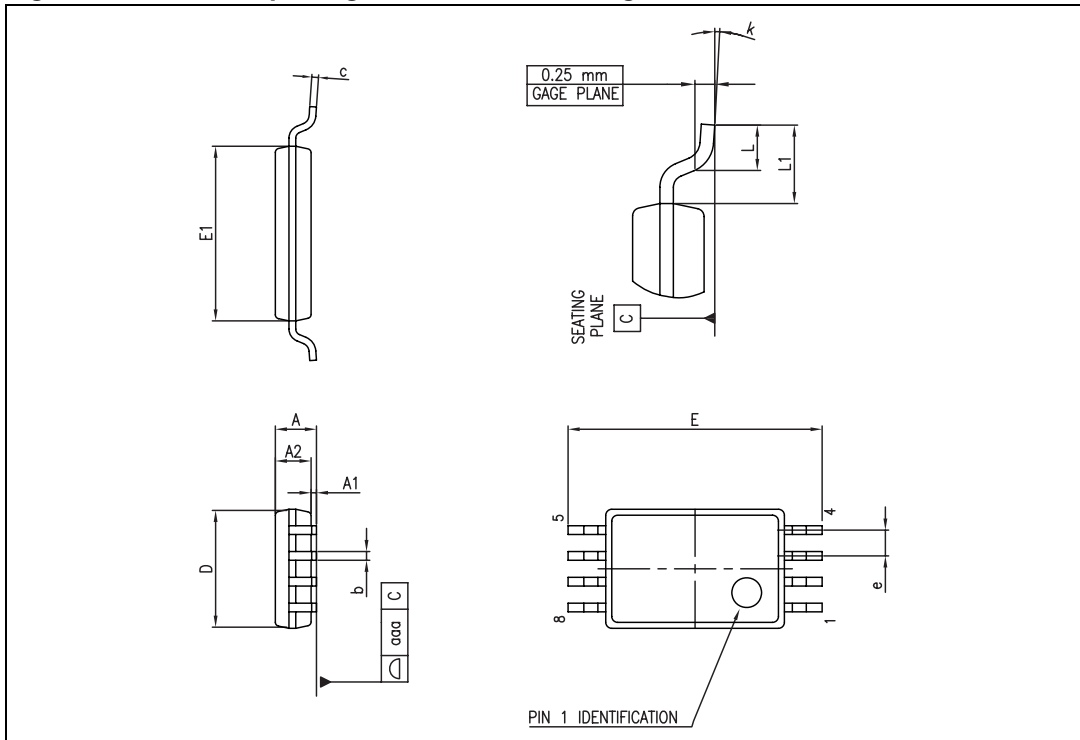


Table 6. TSSOP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.0256	
k	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	
aaa			0.10			0.004

## 6 Ordering information

**Table 7. Order codes**

Order code	Temperature range	Package	Packing	Marking
LM2903N	-40°C to +125°C	DIP8	Tube	LM2903N
LM2903D/DT		SO-8	Tube or tape & reel	2903
LM2903PT		TSSOP8	Tape & reel	
LM2903YDT <sup>(1)</sup>		SO-8 (Automotive grade)	Tape & reel	2903Y
LM2903YPT <sup>(2)</sup>		TSSOP8 (Automotive grade)	Tape & reel	

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.
2. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are on-going.

## 7 Revision history

**Table 8. Document revision history**

Date	Revision	Changes
15-Jun-2003	1	Initial release.
2-May-2005	2	PPAP references inserted in the datasheet see table order code p1.
8-Aug-2005	3	Electrical characteristics table corrected (see <a href="#">Table 3 on page 4</a> ). Pin connections diagram moved to cover page. Lead-free package information added.
27-Oct-2005	4	PPAP part number added in <a href="#">Table 7: Order codes</a> .
11-May-2007	5	ESD tolerance added in <a href="#">Table 1: Absolute maximum ratings on page 3</a> .
17-Jan-2008	6	Added $R_{thja}$ and $R_{thjc}$ , and ESD CDM parameters in <a href="#">Table 1: Absolute maximum ratings</a> . Removed $V_{icm}$ from electrical characteristics in <a href="#">Table 3</a> . Reformatted package information in <a href="#">Section 5</a> . Added footnotes for automotive grade parts in <a href="#">Table 7: Order codes</a> .
21-Feb-2008	7	Corrected SO-8 package mechanical data. Dimension E in drawing was marked H in table. Corrected revision history (revision 6 is of January 2008, not January 2007).
03-Dec-2009	8	Added pin description on cover page.
16-Feb-2012	9	Removed LM2903YD order code from <a href="#">Table 7</a> .

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