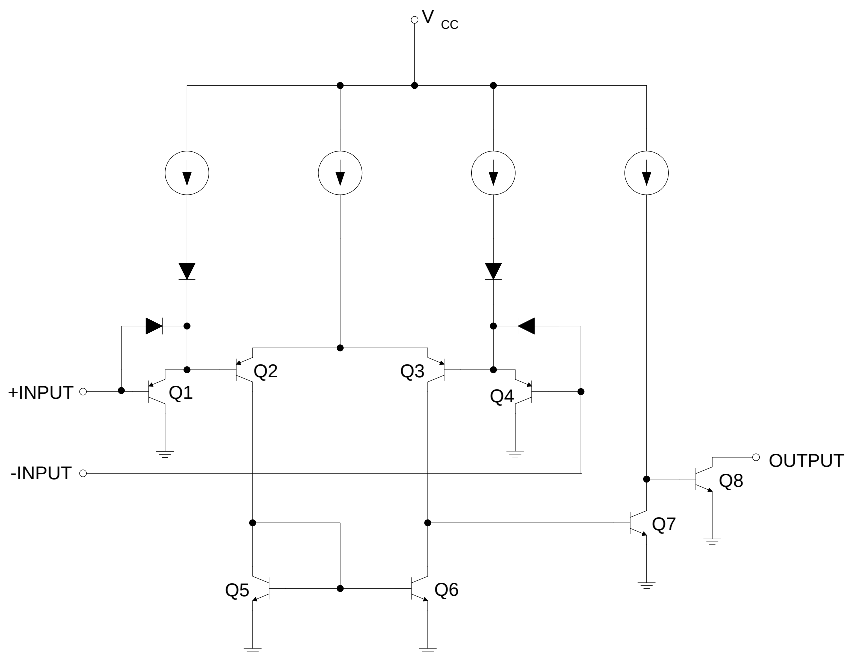
Schematic Diagram



Functional Block Diagram of LM2901/2901A/2903/2903A
(Each Comparator)

Pin Descriptions

LM2901, LM2901A		
Pin Name	**Pin #**	**Function**
1OUT	1	Channel 1 Output
2OUT	2	Channel 2 Output
V_{CC}	3	Chip Supply Voltage
2IN-	4	Channel 2 Inverting Input
2IN+	5	Channel 2 Non-Inverting Input
1IN-	6	Channel 1 Inverting Input
1IN+	7	Channel 1 Non-Inverting Input
3IN-	8	Channel 3 Inverting Input
3IN+	9	Channel 3 Non-Inverting Input
4IN-	10	Channel 4 Inverting Input
4IN+	11	Channel 4 Non-Inverting Input
GND	12	Ground
4OUT	13	Channel 4 Output
3OUT	14	Channel 3 Output
LM2903, LM2903A		
1OUT	1	Channel 1 Output
1IN-	2	Channel 1 Inverting Input
1IN+	3	Channel 1 Non-Inverting Input
GND	4	Ground
2IN+	5	Channel 2 Non-Inverting Input
2IN-	6	Channel 2 Inverting Input
2OUT	7	Channel 2 Output
V_{CC}	8	Chip Supply Voltage

Absolute Maximum Ratings (Note 4) (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter		Rating	Unit
V_{CC}	Supply Voltage		36	V
V_{ID}	Differential Input Voltage		36	V
V_{IN}	Input Voltage		-0.3 to +36	V
I_{IN}	Input Current (V_{IN} < -0.3V)		50	mA
V_O	Output Voltage		36	V
I_O	Output Current		20	mA
—	Duration of Output Short Circuit to Ground (Note 5)		Unlimited	—
θ_{JA}	Package Thermal Impedance (Note 6)	SO-8	110	°C/W
		MSOP-8	160	
		TSSOP-8	185	
		SO-14	100	
		TSSOP-14	129	
θ_{JC}	Package Thermal Impedance (Note 6)	SO-8	8.5	°C/W
		MSOP-8	25	
		TSSOP-8	17	
		SO-14	16	
		TSSOP-14	6.3	
T_A	Operating Temperature Range		-40 to +125	°C
T_J	Operating Junction Temperature		150	°C
T_{ST}	Storage Temperature Range		-65 to +150	°C
T_{LEAD}	Lead Temperature (Soldering, 10 seconds)		260	°C
ESD	Human Body Mode ESD Protection (Note 7)		500	V
	Machine Mode ESD Protection		100	

Notes:
4. Stresses beyond those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods can affect device reliability.
5. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.
6. Maximum power dissipation is a function of $T_{J(MAX)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
7. Human body model, 1.5kΩ in series with 100pF.

Electrical Characteristics (Notes 8 & 9) (@V_{CC} = 5.0V, GND = 0V, T_A = +25°C, unless otherwise specified.)

LM2901, LM2901A

Parameter		Conditions		T_A	Min	Typ	Max	Unit
V_{IO}	Input Offset Voltage	$V_{IC} = V_{CMR}$ Min, V_O = 1.4V, V_{CC} = 5V to 30V (Note 10)	Non-A Device	T_A = +25°C	—	2	7	mV
				Full Range	—	—	15	
			A-Suffix Device	T_A = +25°C	—	1	2	
				Full Range	—	—	4	
I_B	Input Bias Current	I_{IN+} or I_{IN-} with OUT in Linear Range, V_{CM} = 0V (Note 11)		T_A = +25°C	—	25	250	nA
				Full Range	—	—	500	
I_{IO}	Input Offset Current	$I_{IN+} - I_{IN-}$, V_{CM} = 0V		T_A = +25°C	—	5	50	nA
				Full Range	—	—	200	
V_{CMR}	Input Common-Mode Voltage Range	V_{CC} = 30V (Note 12)		T_A = +25°C	0 to V_{CC}-1.5	—	—	V
				Full Range	0 to V_{CC}-2	—	—	
I_{CC}	Supply Current (Four Comparators)	$R_L = \infty$ on Quad Channels	V_{CC} = 30V	T_A = +25°C	—	1.2	2.5	mA
				Full Range	—	—	3.5	
			V_{CC} = 5V	T_A = +25°C	—	0.9	2	
				Full Range	—	—	3.0	
A_V	Voltage Gain	V_{CC} = 15V, V_{OUT} = 1V to 11V, $R_L \geq 15k\Omega$,		T_A = +25°C	50	200	—	V/mV
—	Large Signal Response time	V_{IN} = TTL Logic Swing, V_{REF} = 1.4V, V_{RL} = 5V, R_L = 5.1kΩ		T_A = +25°C	—	300	—	ns
—	Response Time	V_{RL} = 5V, R_L = 5.1kΩ (Note 13)		T_A = +25°C	—	1.3	—	µs
$I_{O(SINK)}$	Output Sink Current	V_{IN-} = 1V, V_{IN+} = 0, $V_O \leq$ 1.5V		T_A = +25°C	6	16	—	mA
V_{SAT}	Saturation Voltage	V_{IN-} = 1V, V_{IN+} = 0, $I_{SINK} \leq$ 4mA		T_A = +25°C	—	100	400	mV
				Full Range	—	—	700	
$I_{O(LEAK)}$	Output Leakage Current	V_{IN-} = 0V, V_{IN+} = 1, V_O = 5V		T_A = +25°C	—	0.1	—	nA
		V_{IN-} = 0V, V_{IN+} = 1, V_O = 30V		Full Range	—	—	1	µA
V_{ID}	Differential Input Voltage	All $V_{IN} \geq$0V (or V- if used) (Note 14)		Full Range	—	—	36	V

Notes:
8. Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.
9. All limits are guaranteed by testing or statistical analysis. Limits over the full temperature are guaranteed by design, but not tested in production.
10. $V_O \cong$ 1.4V, R_S = 0Ω with V_{CC} from 5V to 30V;
11. 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 change exists on the input lines.
12. The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V (@ +25°C). The upper end of the common-mode voltage range is V_{CC} -1.5V (@ +25°C), but either or both inputs can go to +36V without damage, independent of the magnitude of V_{CC}.
13. The response time specified is for a 100mV step input with 5mV overdrive. For larger overdrive signals 300ns can be obtained, see typical performance characteristics.
14. Positive excursions of input voltage may exceed the power supply level. As long as other voltages remain within the common mode range, the comparator will provide a proper output stage. The low voltage state must not be less than -0.3V (or 0.3V below the magnitude of the negative power supply, if used).

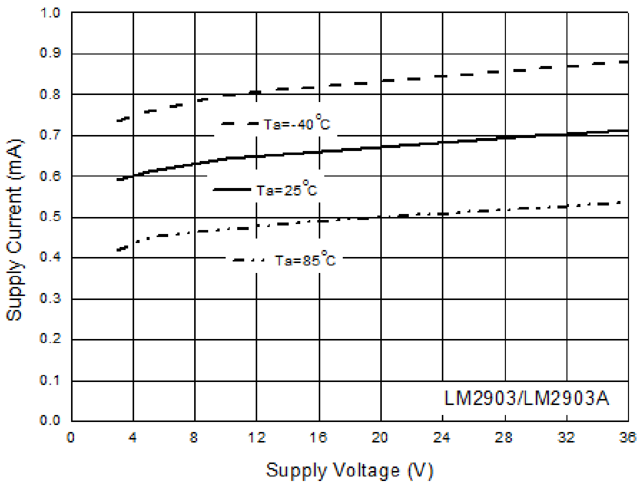
Electrical Characteristics (Notes 8 & 9) (@V_{CC} = 5.0V, GND = 0V, T_A = +25°C, unless otherwise specified.)

LM2903, LM2903A

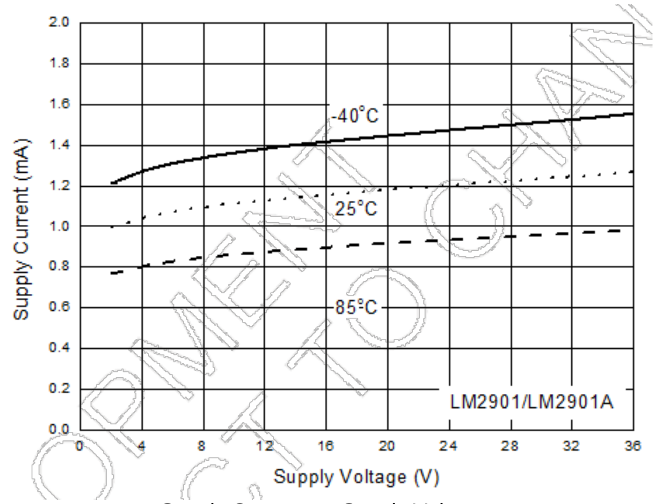
Parameter		Conditions		T_A	Min	Typ	Max	Unit
V_{IO}	Input Offset Voltage	V_{IC} = V_{CMR} Min, V_O = 1.4V, V_{CC} = 5V to =30V (Note 10)	Non-A Device	T_A = +25°C	—	2	7	mV
				Full Range	—	—	15	
			A-Suffix Device	T_A = +25°C	—	1	2	
				Full Range	—	—	4	
I_B	Input Bias Current	I_{IN+} or I_{IN-} with OUT in Linear Range, V_{CM} = 0V (Note 11)		T_A = +25°C	—	25	250	nA
				Full Range	—	—	500	
I_{IO}	Input Offset Current	I_{IN+} - I_{IN-}, V_{CM} = 0V		T_A = +25°C	—	5	50	nA
				Full Range	—	—	200	
V_{CMR}	Input Common-Mode Voltage Range	V_{CC} = 30V (Note 12)		T_A = +25°C	0 to V_{CC} -1.5	—	—	V
				Full Range	0 to V_{CC}-2	—	—	
I_{CC}	Supply Current	R_L = ∞ on Both Channels	V_{CC} = 30V	T_A = +25°C	—	0.7	1.7	mA
				Full Range	—	—	3.0	
			V_{CC} = 5V	T_A = +25°C	—	0.6	1	
				Full Range	—	—	2.0	
A_V	Voltage Gain	V_{CC} = 15V, V_{OUT} = 1V to 11V, R_L ≥ 15kΩ,		T_A = +25°C	50	200	—	V/mV
—	Large Signal Response Time	V_{IN} = TTL Logic Swing, V_{REF} = 1.4V, V_{RL} = 5V, R_L = 5.1kΩ		T_A = +25°C	—	300	—	ns
—	Response Time	V_{RL} = 5V, R_L = 5.1kΩ (Note 13)		T_A = +25°C	—	1.3	—	µs
$I_{O(SINK)}$	Output Sink Current	V_{IN-} = 1V, V_{IN+} = 0, V_O ≤ 1.5V		T_A = +25°C	6	16	—	mA
V_{SAT}	Saturation Voltage	V_{IN-} = 1V, V_{IN+} = 0, I_{SINK} ≤ 4mA		T_A = +25°C	—	200	400	mV
				Full Range	—	—	700	
$I_{O(LEAK)}$	Output Leakage Current	V_{IN-} = 0V, V_{IN+} = 1, V_O = 5V		T_A = +25°C	—	0.1	—	nA
		V_{IN-} = 0V, V_{IN+} = 1, V_O = 30V		Full Range	—	—	1	µA
V_{ID}	Differential Input Voltage	All V_{IN} ≥0V (or V- if used) (Note 14)		Full Range	—	—	36	V

Notes:
8. Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.
9. All limits are guaranteed by testing or statistical analysis. Limits over the full temperature are guaranteed by design, but not tested in production.
10. V_O ≅ 1.4V, R_S = 0Ω with V_{CC} from 5V to 30V;
11. 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 change exists on the input lines.
12. The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V (@ +25°C). The upper end of the common-mode voltage range is V_{CC} -1.5V (@ +25°C), but either or both inputs can go to +36V without damage, independent of the magnitude of V_{CC}.
13. The response time specified is for a 100mV step input with 5mV overdrive. For larger overdrive signals 300ns can be obtained, see typical performance characteristics.
14. Positive excursions of input voltage may exceed the power supply level. As long as other voltages remain within the common mode range, the comparator will provide a proper output stage. The low voltage state must not be less than -0.3V (or 0.3V below the magnitude of the negative power supply, if used).

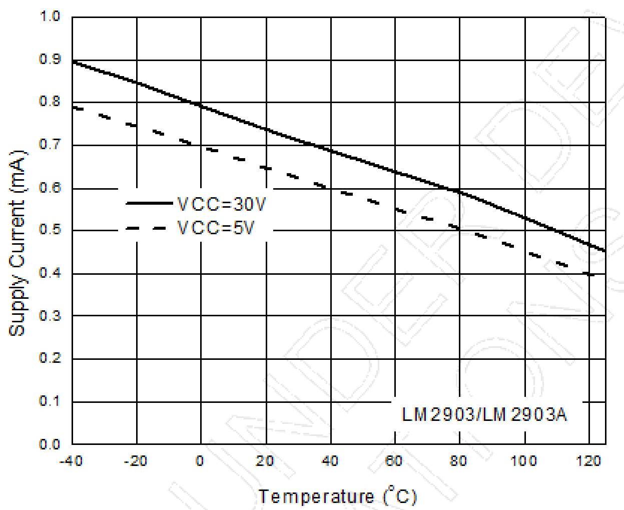
Performance Characteristics



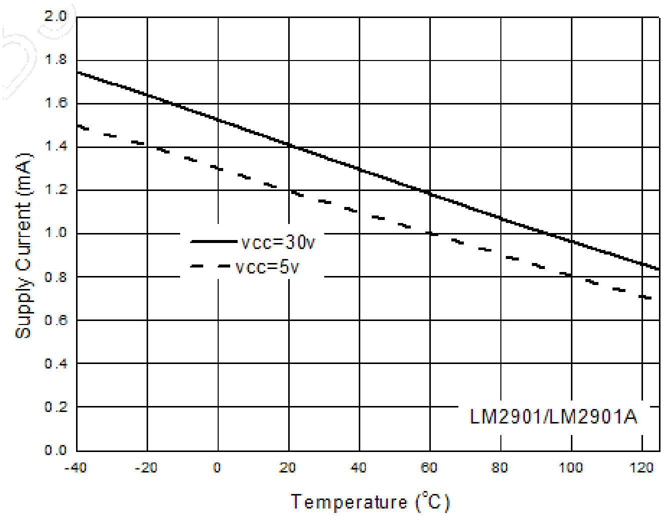
Supply Current vs. Supply Voltage



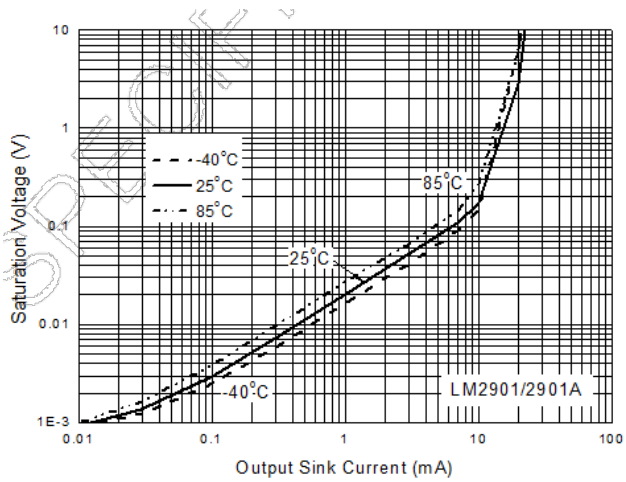
Supply Current vs. Supply Voltage



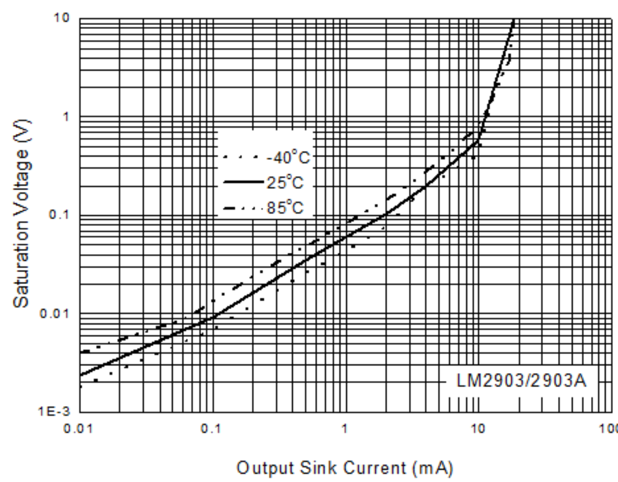
Supply Current vs. Temperature



Supply Current vs. Temperature

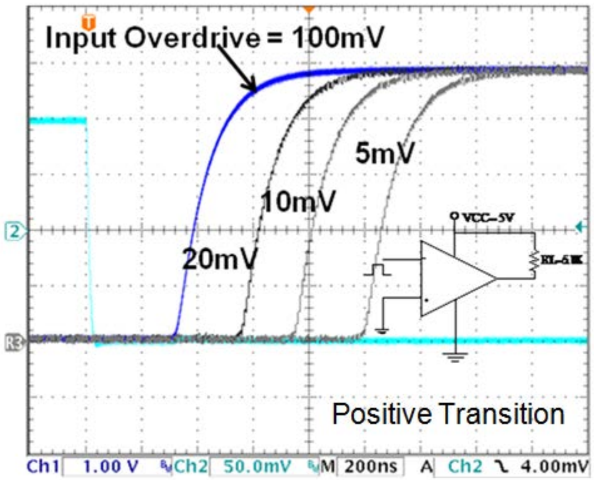


Output Saturation Voltage vs. Sink Current

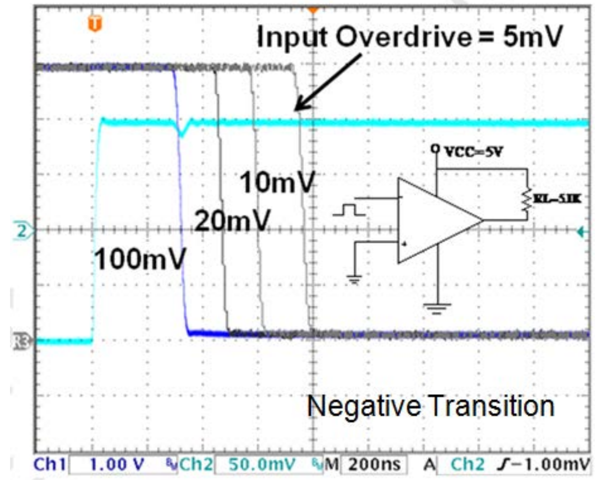


Output Saturation Voltage vs. Sink Current

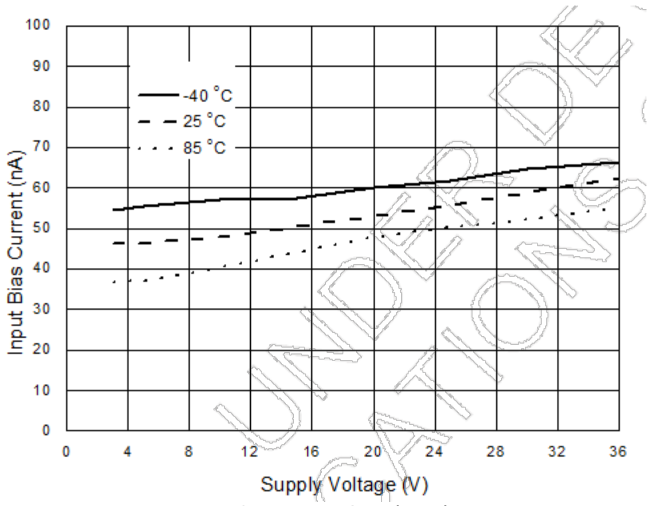
Performance Characteristics (continued)



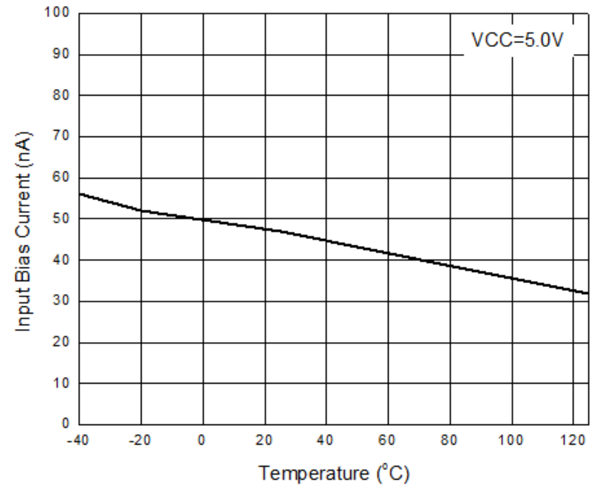
Response Time for Various Input Overdrive



Response Time for Various Input Overdrive



Input Current vs. Supply Voltage



Input Current vs. Temperature

Application Information

General Information

The LM2901/2903 series comparators are high-gain, wide bandwidth devices. Like most comparators, the series can easily oscillate if the output lead is inadvertently allowed to capacitive couple to the inputs via stray capacitance. This shows up only during the output voltage transition intervals as the comparators change states. Standard PC board layout is helpful as it reduces stray input-output coupling. Reducing the input resistors to <10kΩ reduces the feedback signal levels. Finally, adding even a small amount (1.0mV to 10mV) of positive feedback (hysteresis) causes such a rapid transition that oscillations, due to stray feedback, are not possible. Simply socketing the IC and attaching resistors to the pins will cause input-output oscillations during the small transition intervals unless hysteresis is used. If the input signal is a pulse waveform, with relatively fast rise and fall times, hysteresis is not required. All input pins of any unused comparators should be tied to the negative supply.

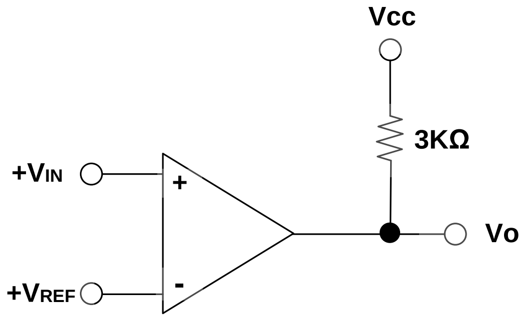
The bias network of the LM2901/2903 series comparators establishes a quiescent current independent of the magnitude of the power supply voltage over the range of from $2.0V_{DC}$ to $30V_{DC}$.

The differential input voltage may be larger than V_{CC} without damaging the device. Protection should be provided to prevent the input voltages from going negative more than $-0.3V_{DC}$ (@ +25°C). An input clamp diode can be used as shown in the applications section.

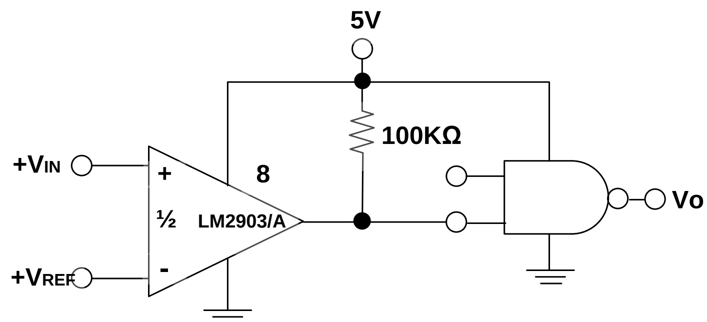
The output of the LM2901/2903 series comparators is the uncommitted collector of a grounded-emitter NPN output transistor. Many collectors can be tied together to provide an output ORing function. An output pull-up resistor can be connected to any available power supply voltage within the permitted supply voltage range and there is no restriction on this voltage due to the magnitude of the voltage applied to the V_{CC} terminal of LM2901/2903 series comparator package. The output can also be used as a simple SPST switch to ground (when a pull-up resistor is not used).

The amount of current the output device can sink is limited by the drive available (which is independent of V_{CC}) and the β of this device. When the maximum current limit is reached (approximately 16mA), the output transistor will come out of saturation and the output voltage will rise very rapidly. The output saturation voltage is limited by the approximately 60Ω R_{SAT} of the output transistor. The low offset voltage of the output transistor (1.0mV) allows the output to clamp essentially to ground level for small load currents.

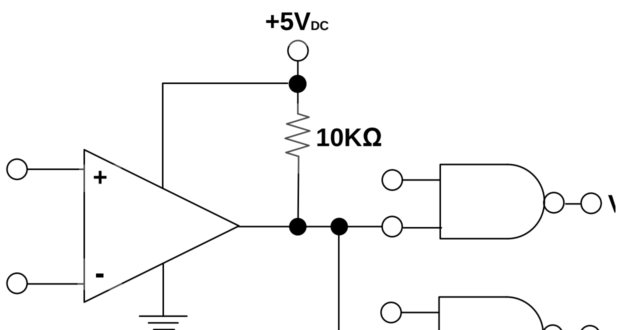
Typical Application Circuit (V_{CC} = 5.0V_{DC})



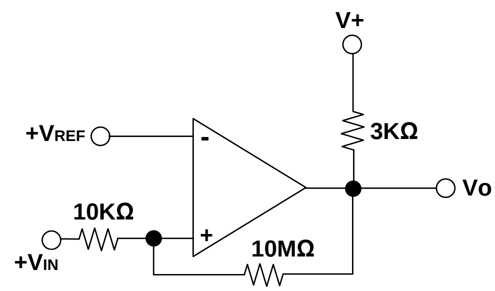
Basic Comparator



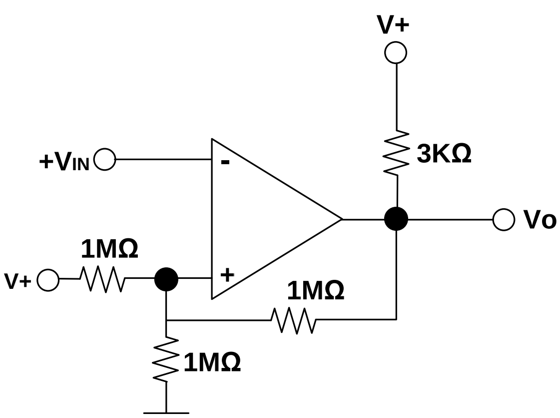
Driving CMOS



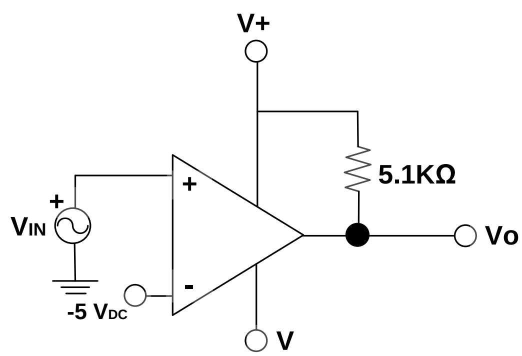
Driving TTL



Non-Inverting Comparator with Hysteresis

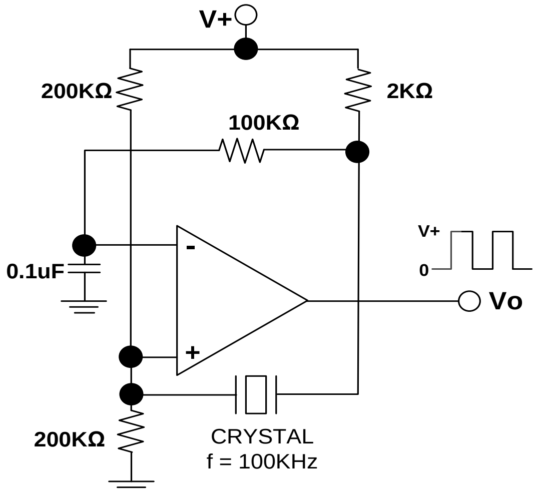


Inverting Comparator with Hysteresis

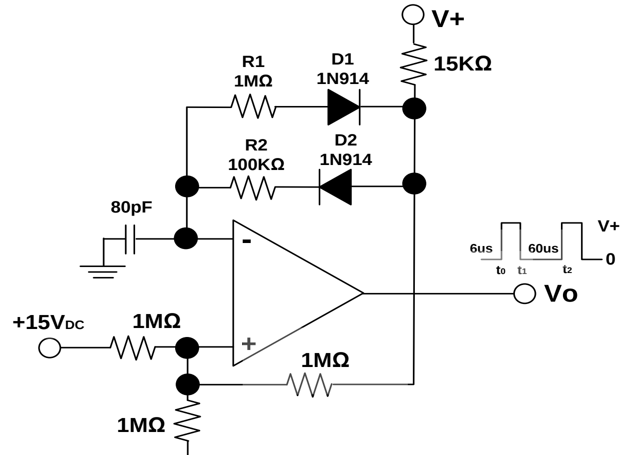


Comparator with a Negative Reference

Typical Application Circuit (V_{CC} = 5.0V_{DC}) (continued)

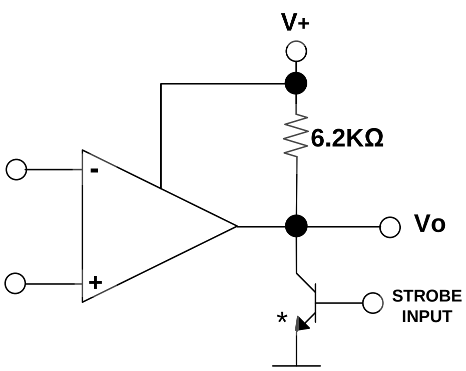


Crystal Controlled Oscillator



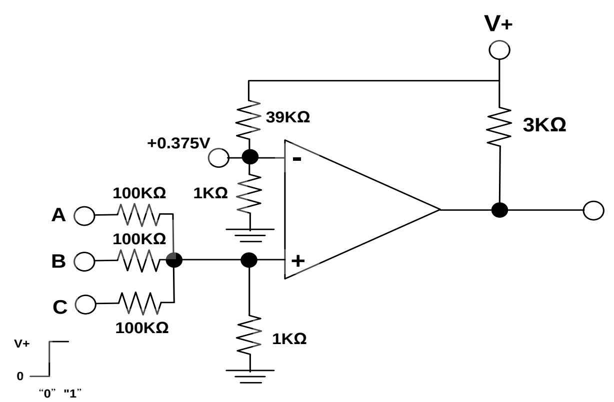
* For large ratios of R1/R2, D1 can be omitted.

Pulse Generator

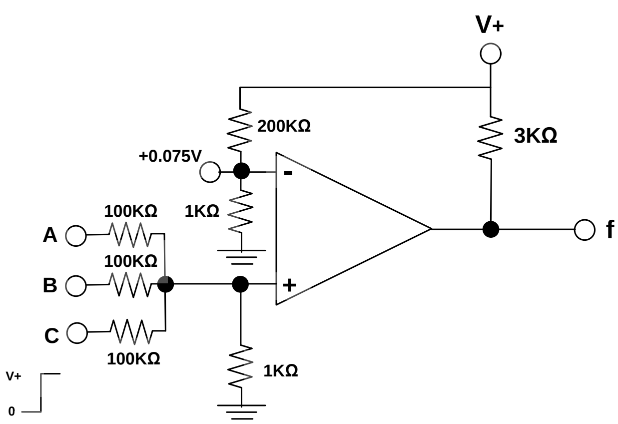


*Or logic gate without pull-up resistor

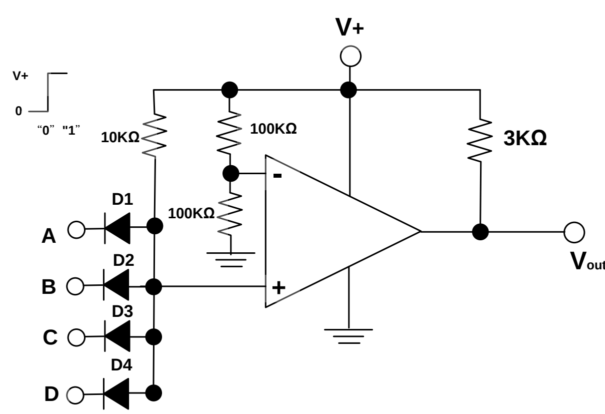
Output Strobing



AND Gate

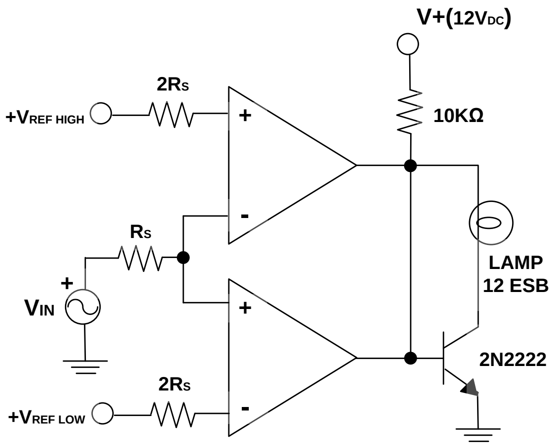


OR Gate

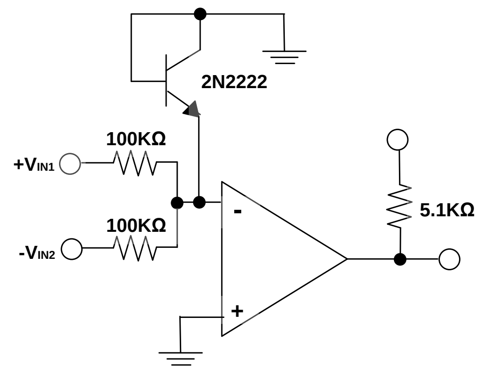


Large Fan-in AND Gate

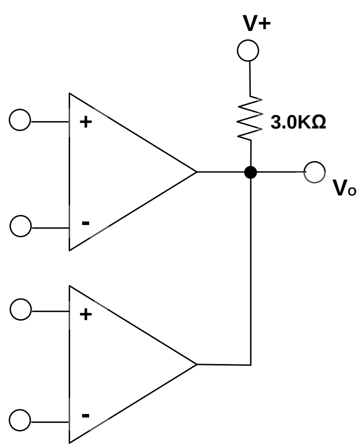
Typical Application Circuit (V_{CC} = 5.0V_{DC}) (continued)



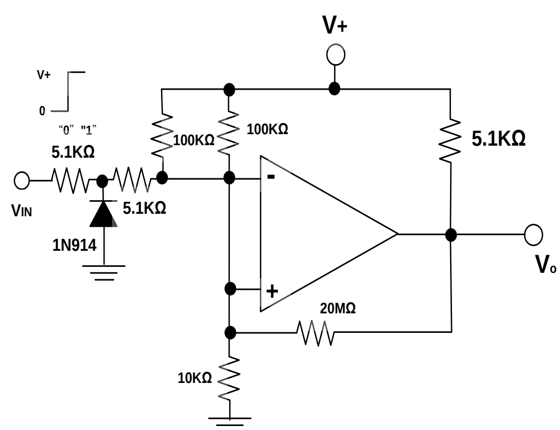
Limit Comparator



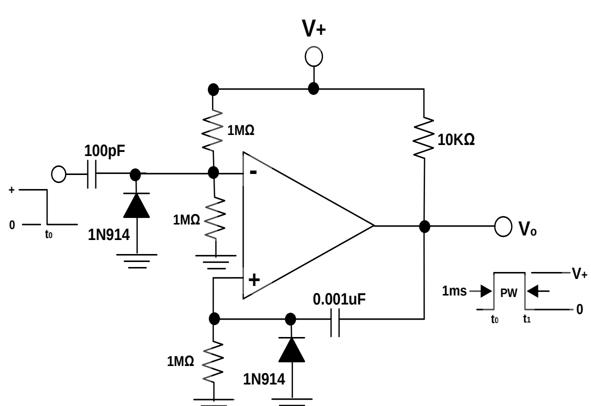
Comparing Input Voltage of Opposite Polarity



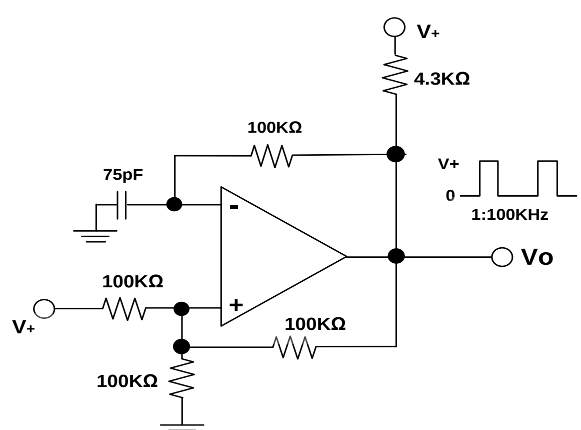
ORing the Outputs



Zero Crossing Detector (Single Power Supply)



One-Shot Multivibrator



Squarewave Oscillator

Ordering Information (Note 15)

LM290X X XXX - 13

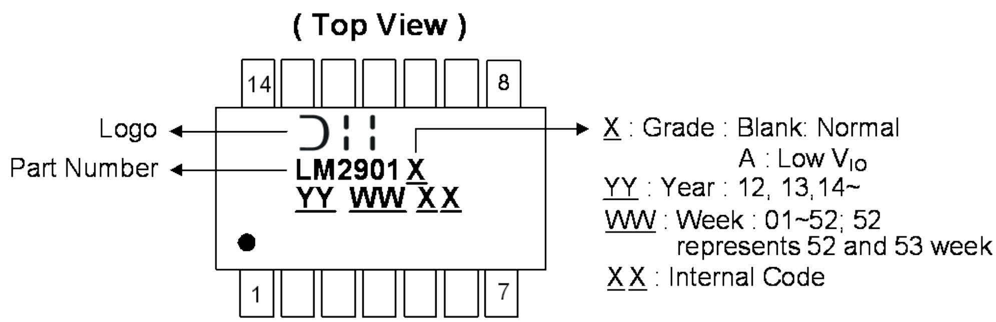
Channel	Grade	Package	Packing
1 : Quad 3 : Dual	Blank : Normal A : Low V_{IO}	T14 : TSSOP-14 S14 : SO-14 S : SO-8 M8: MSOP-8 TH: TSSOP-8	13 : Tape & Reel

Part Number	Package Code	Packaging	13" Tape and Reel	
			Quantity	Part Number Suffix
LM2901T14-13	T14	TSSOP-14	2500/Tape & Reel	-13
LM2901AT14-13	T14	TSSOP-14	2500/Tape & Reel	-13
LM2901S14-13	S14	SO-14	2500/Tape & Reel	-13
LM2901AS14-13	S14	SO-14	2500/Tape & Reel	-13
LM2903S-13	S	SO-8	2500/Tape & Reel	-13
LM2903AS-13	S	SO-8	2500/Tape & Reel	-13
LM2903AM8-13	M8	MSOP-8	2500/Tape & Reel	-13
LM2903M8-13	M8	MSOP-8	2500/Tape & Reel	-13
LM2903ATH-13	TH	TSSOP-8	2500/Tape & Reel	-13
LM2903TH-13	TH	TSSOP-8	2500/Tape & Reel	-13

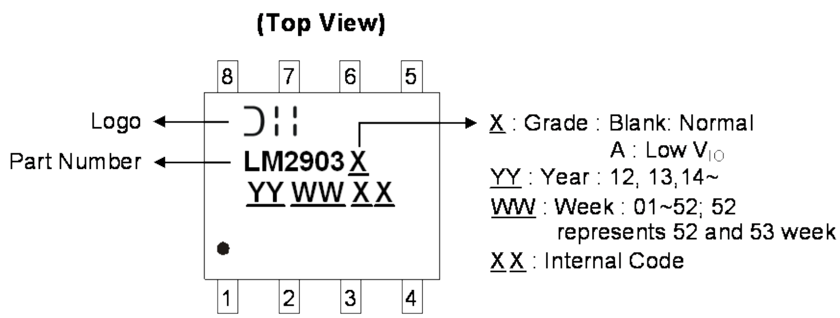
Note: 15. For packaging details, go to our website at http://www.diodes.com/products/packages.html.

Marking Information

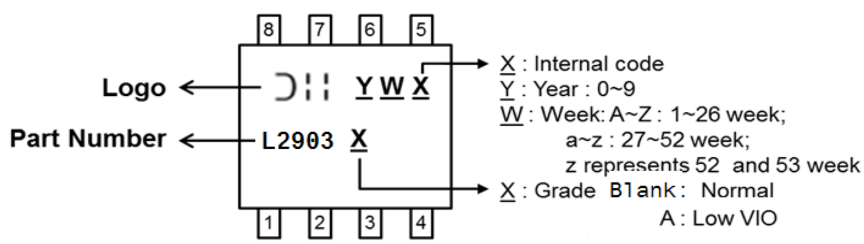
(1) TSSOP-14 and SO-14



(2) SO-8



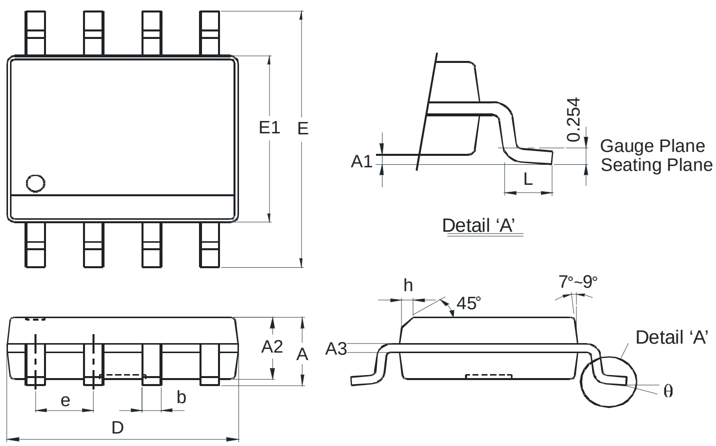
(3) MSOP-8 & TSSOP-8



Package Outline Dimensions

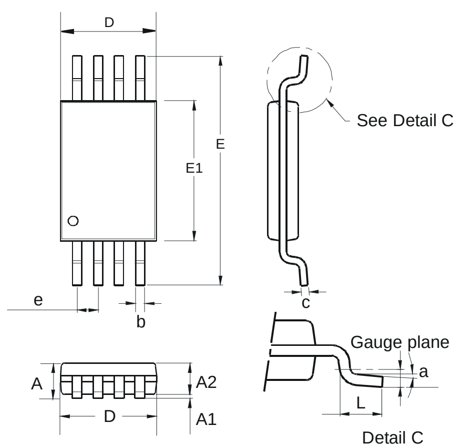
Please see http://www.diodes.com/package-outlines.html for the latest version.

SO-8



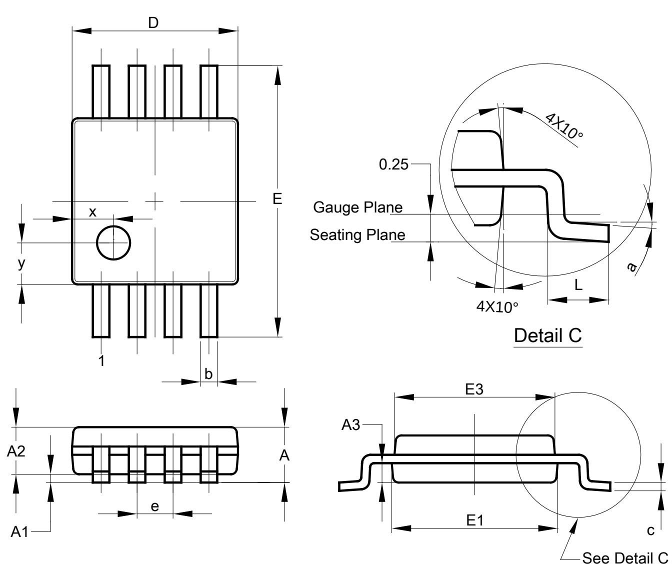
SO-8		
Dim	**Min**	**Max**
A	–	1.75
A1	0.10	0.20
A2	1.30	1.50
A3	0.15	0.25
b	0.3	0.5
D	4.85	4.95
E	5.90	6.10
E1	3.85	3.95
e	1.27 Typ	
h	–	0.35
L	0.62	0.82
θ	0°	8°
All Dimensions in mm		

TSSOP-8



TSSOP-8			
Dim	**Min**	**Max**	**Typ**
a	0.09	–	–
A	–	1.20	–
A1	0.05	0.15	–
A2	0.825	1.025	0.925
b	0.19	0.30	–
c	0.09	0.20	–
D	2.90	3.10	3.025
e	–	–	0.65
E	–	–	6.40
E1	4.30	4.50	4.425
L	0.45	0.75	0.60
All Dimensions in mm			

MSOP-8

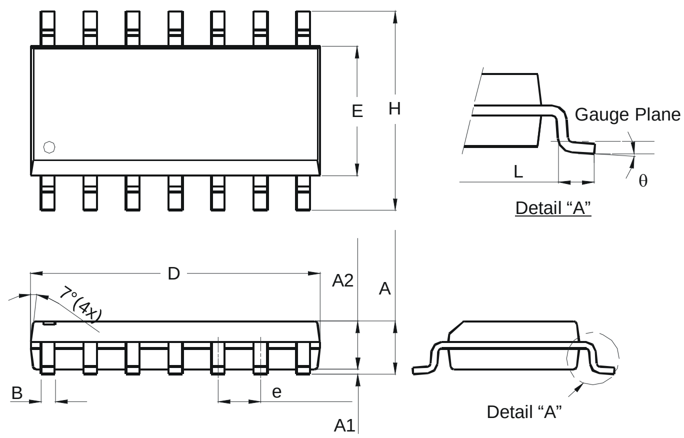


MSOP-8			
Dim	**Min**	**Max**	**Typ**
A	–	1.10	–
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E3	2.85	3.05	2.95
e	–	–	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	–	–	0.750
y	–	–	0.750
All Dimensions in mm			

Package Outline Dimensions (continued)

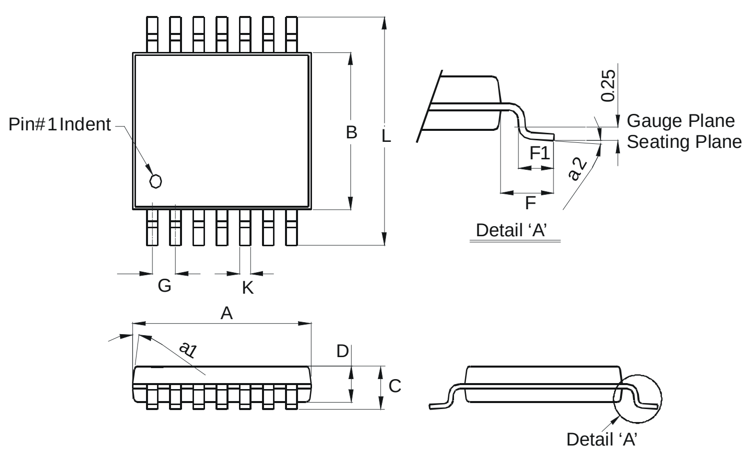
Please see http://www.diodes.com/package-outlines.html for the latest version.

SO-14



SO-14		
Dim	**Min**	**Max**
A	1.47	1.73
A1	0.10	0.25
A2	1.45 Typ	
B	0.33	0.51
D	8.53	8.74
E	3.80	3.99
e	1.27 Typ	
H	5.80	6.20
L	0.38	1.27
θ	0°	8°
All Dimensions in mm		

TSSOP-14

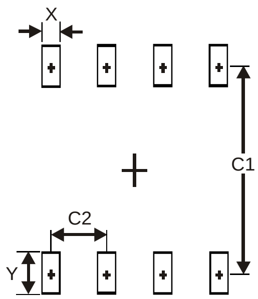


TSSOP-14		
Dim	**Min**	**Max**
a1	7° (4X)	
a2	0°	8°
A	4.9	5.10
B	4.30	4.50
C	–	1.2
D	0.8	1.05
F	1.00 Typ	
F1	0.45	0.75
G	0.65 Typ	
K	0.19	0.30
L	6.40 Typ	
All Dimensions in mm		

Suggested Pad Layout

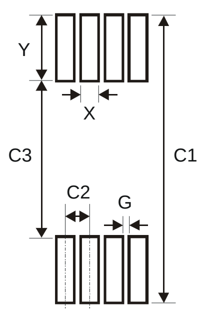
Please see http://www.diodes.com/package-outlines.html for the latest version.

SO-8



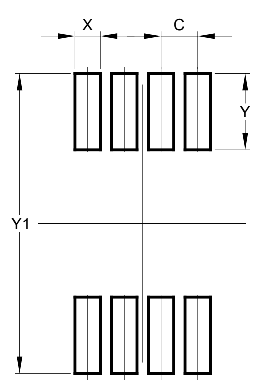
Dimensions	Value (in mm)
X	0.60
Y	1.55
C1	5.4
C2	1.27

TSSOP-8



Dimensions	Value (in mm)
X	0.45
Y	1.78
C1	7.72
C2	0.65
C3	4.16
G	0.20

MSOP-8

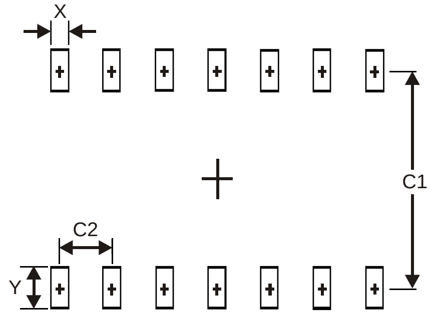


Dimensions	Value (in mm)
C	0.650
X	0.450
Y	1.350
Y1	5.300

Suggested Pad Layout (continued)

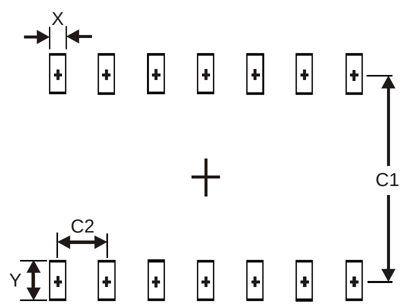
Please see http://www.diodes.com/package-outlines.html for the latest version.

SO-14



Dimensions	Value (in mm)
X	0.60
Y	1.50
C1	5.4
C2	1.27

TSSOP-14



Dimensions	Value (in mm)
X	0.45
Y	1.45
C1	5.9
C2	0.65

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