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Description

The LM2901Q/2903Q series comparators consist of four and two independent precision voltage comparators with very low input offset voltage specification. They are designed to operate from a single power supply over a wide range of voltages; however operation from split power supplies is also possible. They offer low power supply current independent of the magnitude of the power supply voltage.

The LM2901Q/2903Q series comparators are designed to directly interface with TTL and CMOS.

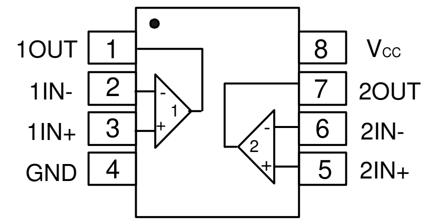
The LM2903Q dual devices are available in SO-8, MSOP-8 and TSSOP-8; and the LM2901Q quad devices are available in SO-14 and TSSOP-14 - all are in industry-standard pinouts.

All use "green" mold compound and are qualified to AEC-Q100 Grade 1 and are Automotive Compliant supporting PPAPs.

Pin Assignments

LM2903Q/ LM2903AQ

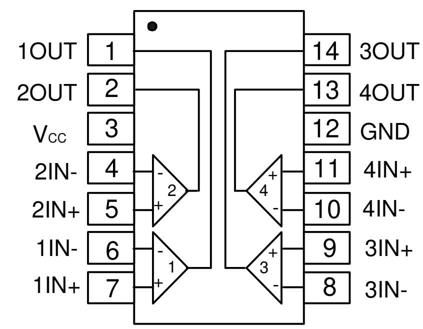
(Top View)



SO-8/TSSOP-8/MSOP-8

LM2901Q/ LM2901AQ

(Top View)



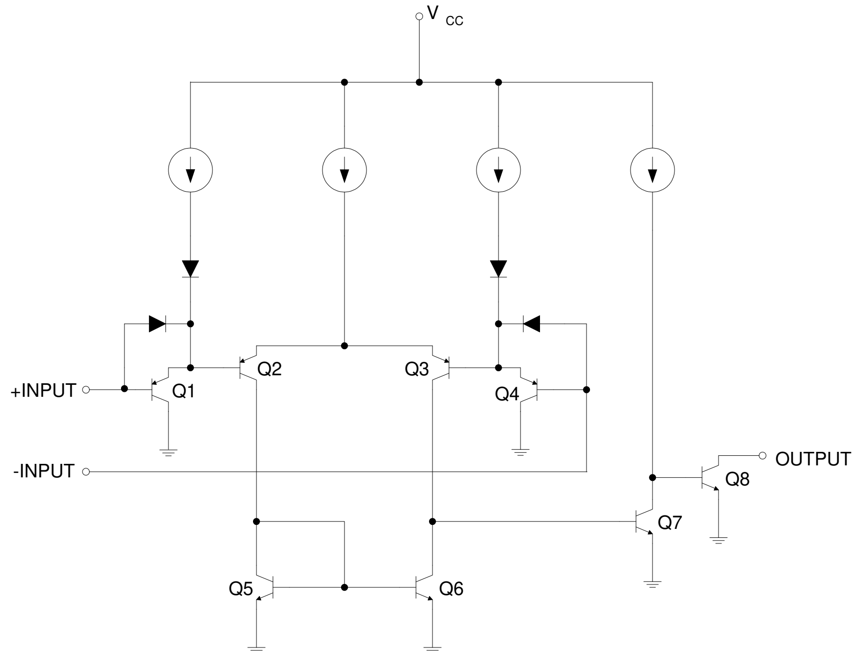
SO-14/TSSOP-14

Features

- Wide Power Supply Range:
  - Single Supply: 2V to 36V
  - Dual Supplies: ±1.0V to ±18V
- Very Low Supply Current Drain – Independent of Supply Voltage
  - LM2903Q: 0.6mA
  - LM2901Q: 0.9mA
- Low Input Bias Current: 25nA
- Low Input Offset Current: ±5nA
- Typical Offset Voltage:
  - Non-A Device: 2mV
  - A Device: 1mV
- Common-Mode Input Voltage Range Includes Ground
- Differential Input Voltage Range Equal to the Power Supply Voltage
- Low Output Saturation Voltage:
  - LM2903Q: 200mV at 4mA
  - LM2901Q: 100mV at 4mA
- Output Voltage Compatible with TTL, MOS and CMOS
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **Qualified to AEC-Q100 Grade 1**
- **PPAP Capable (Note 4)**

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. Automotive products are AEC-Q100 qualified and are PPAP capable. Refer http://www.diodes.com/quality/product_compliance_definitions/.

Schematic Diagram



Functional Block Diagram of LM2901Q/2901AQ/2903Q/2903AQ
(Each Comparator)

Pin Descriptions

LM2901Q, LM2901AQ		
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
LM2903Q, LM2903AQ		
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 5) (@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 6)		Unlimited	—
$θ_{JA}$	Package Thermal Impedance (Note 7)	LM2903_QS-13	150	°C/W
		LM2903_QTH-13	175	
		LM2903_QM8-13	200	
		LM2901_QS14	89	
		LM2901_QT14	100	
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

Notes: 5. Stresses beyond those listed under absolute maximum ratings may 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 may affect device reliability.

6. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

7. 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 $P_D = (T_{J(MAX)} − T_A)/θ_{JA}$. Operating at the absolute maximum T_J of +150°C can affect reliability.

ESD Ratings

Human Body Mode ESD Protection (Note 8)	LM2901_QS14	500	V
	LM2901_QT14	500	
	LM2903_QS-13	500	
	LM2903_QTH-13	500	
	LM2903_QM8-13	<500	
Charge Device Mode ESD Protection	LM2901_QS14	1,000	
	LM2901_QT14		
	LM2903_QS-13		
	LM2903_QTH-13		
	LM2903_QM8-13		

Note: 8. Human body model, 1.5kΩ in series with 100pF.

Recommended Operating Conditions (Over Operating Free-Air Temperature Range, unless otherwise noted.)

Parameter		Min	Max	Units
Supply Voltage	Single Supply	2	36	V
	Dual Supply	±1	±18	
Ambient Temperature Range		-40	+125	°C
Junction Temperature Range		-40	+125	

Electrical Characteristics (Notes 9 & 10) (@V_{CC} = 5.0V, GND = 0V, T_A = +25°C, unless otherwise specified.)

LM2901Q, LM2901AQ

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 11)	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 12)		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 13)		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 14)		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 15)		Full Range	—	—	36	V

Notes:
9. 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.
10. All limits are guaranteed by testing or statistical analysis. Limits over the full temperature (-40 ≤ T_A ≤ +125°C) are guaranteed by design, but not tested in production.
11. $V_O \cong$ 1.4V, R_S = 0Ω with V_{CC} from 5V to 30V.
12. 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.
13. 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}.
14. 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.
15. 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).

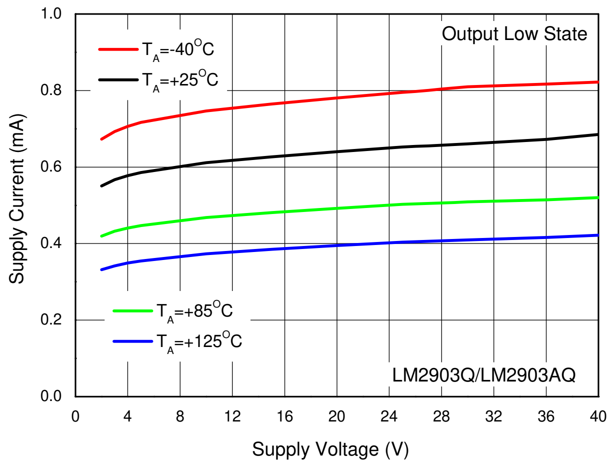
Electrical Characteristics (continued) (Notes 9 & 10) (@V_{CC} = 5.0V, GND = 0V, T_A = +25°C, unless otherwise specified.)

LM2903Q, LM2903AQ

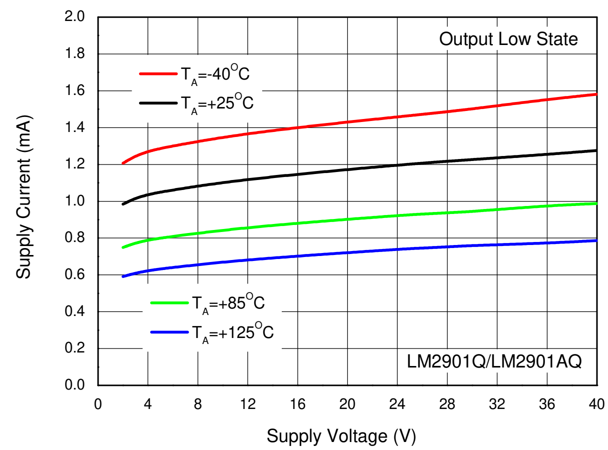
Parameter		Conditions		T_A	Min	Typ	Max	Unit
V_{IO}	Input Offset Voltage	V_{IC} = V_{CMR} Min, V_O = 1.4V, V_{CC} = 5V to =30V (Note 11)	Non-A Device	T_A = +25°C	—	2	7	mV
				Full Range	—	—	15	
			A-Suffix Device	T_A = +25°C	—	1	2	
				Full Range	—	—	4	
I_B	Input Bias Current	I_{IN+} or I_{IN-} with OUT in Linear Range, V_{CM} = 0V (Note 12)		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 13)		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 14)		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 15)		Full Range	—	—	36	V

Notes:
9. 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
10. All limits are guaranteed by testing or statistical analysis. Limits over the full temperature (-40 ≤ T_A ≤ +125°C) are guaranteed by design, but not tested in production.
11. V_O ≅ 1.4V, R_S = 0Ω with V_{CC} from 5V to 30V.
12. 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.
13. 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}.
14. 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.
15. 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).

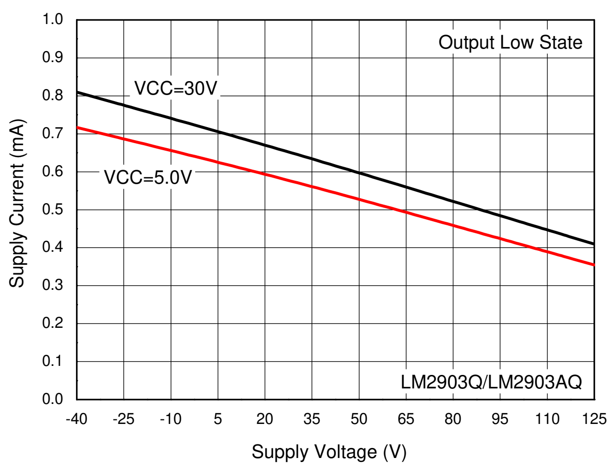
Performance Characteristics



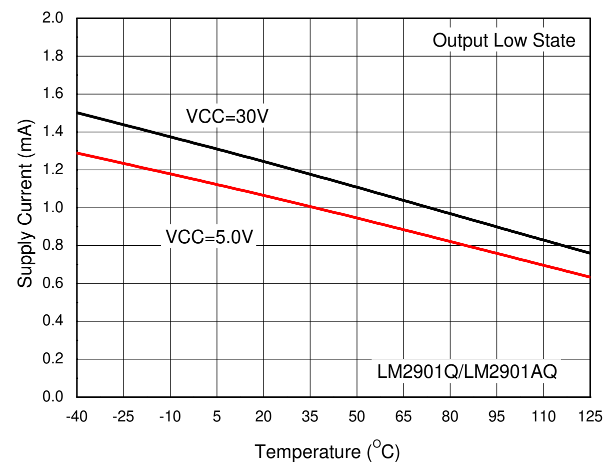
Supply Current vs. Supply Voltage



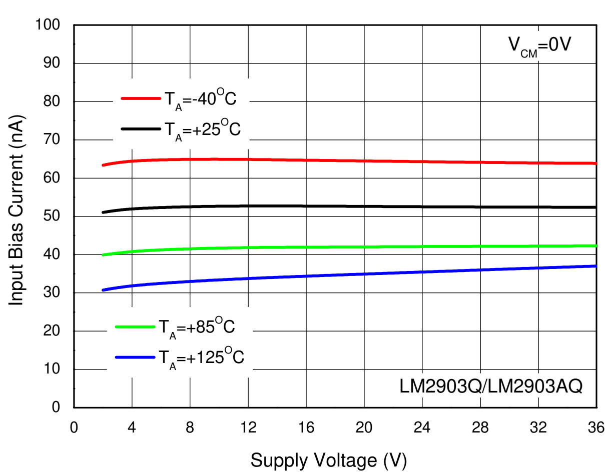
Supply Current vs. Supply Voltage



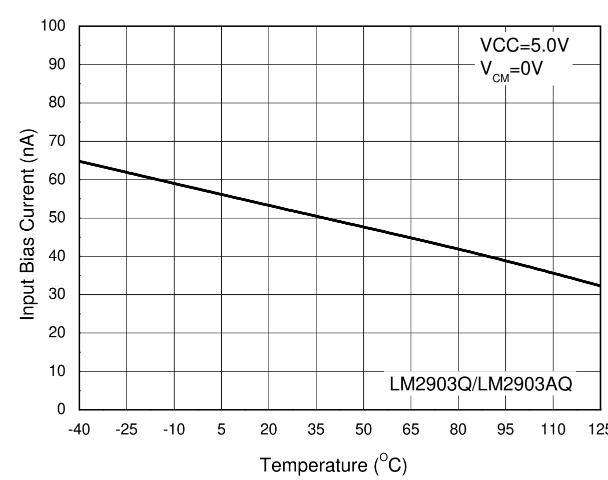
Supply Current vs. Temperature



Supply Current vs. Temperature

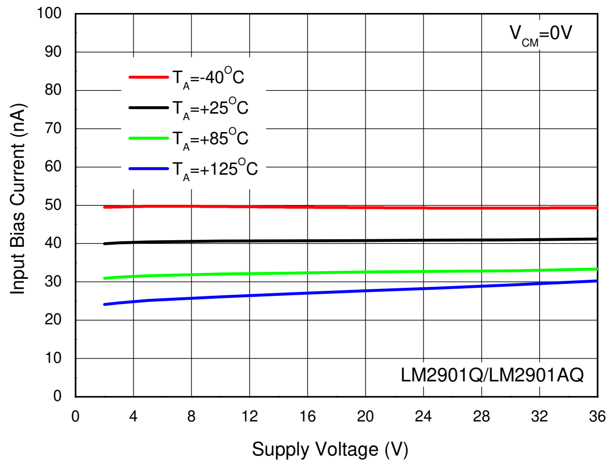


Input Bias Current vs. Supply Voltage

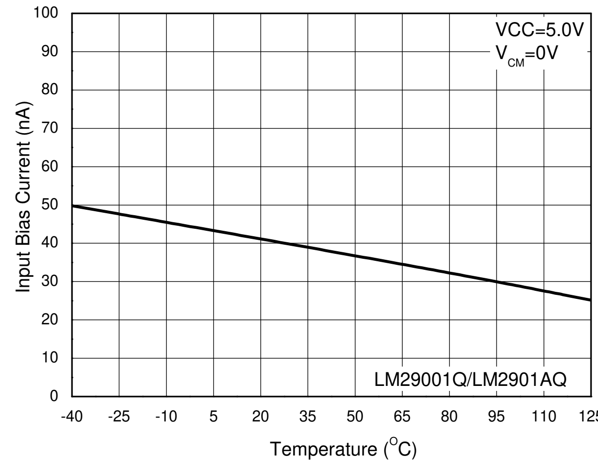


Input Bias Current vs. Temperature

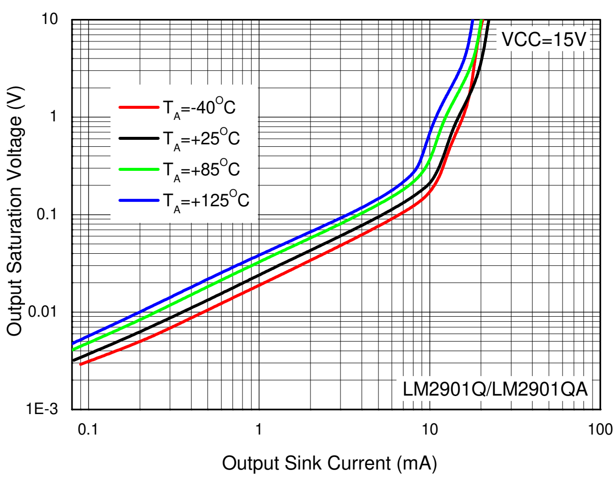
Performance Characteristics (continued)



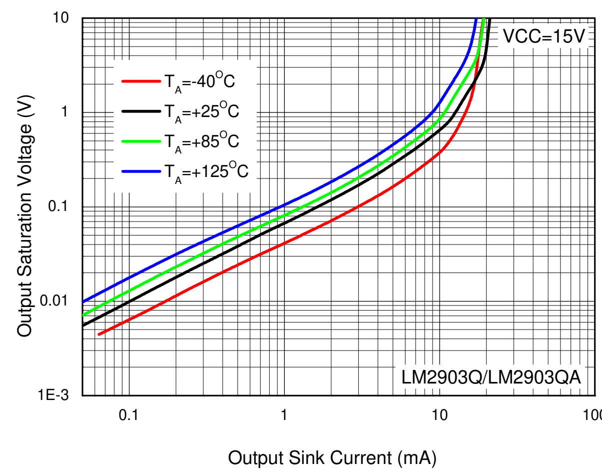
Input Bias Current vs. Supply Voltage



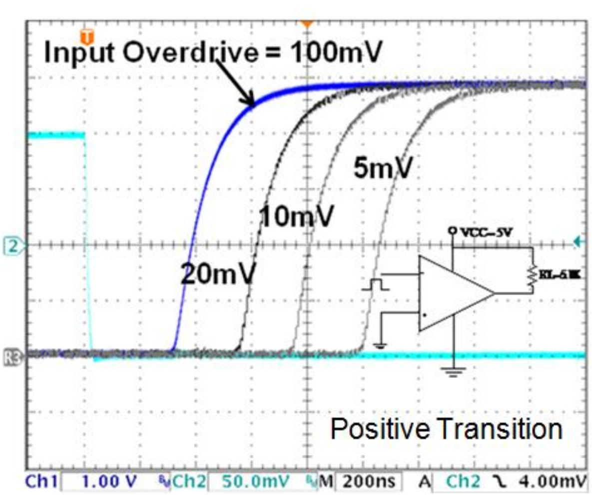
Input Bias Current vs. Temperature



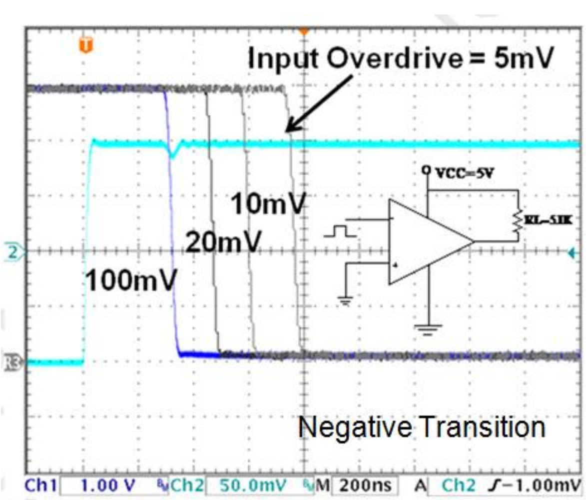
Output Saturation Voltage vs. Sink Current



Output Saturation Voltage vs. Sink Current

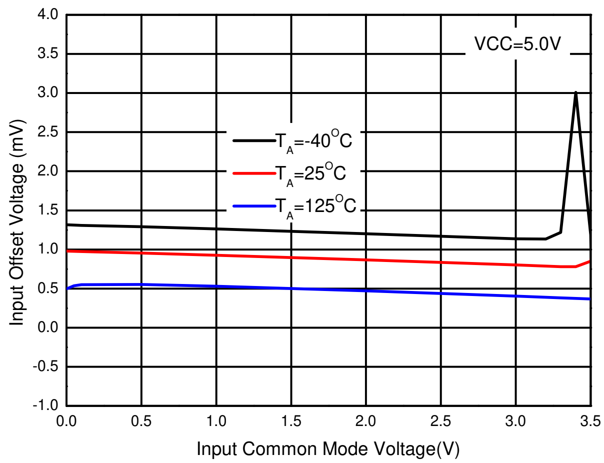


Response Time for Various Input Overdrive

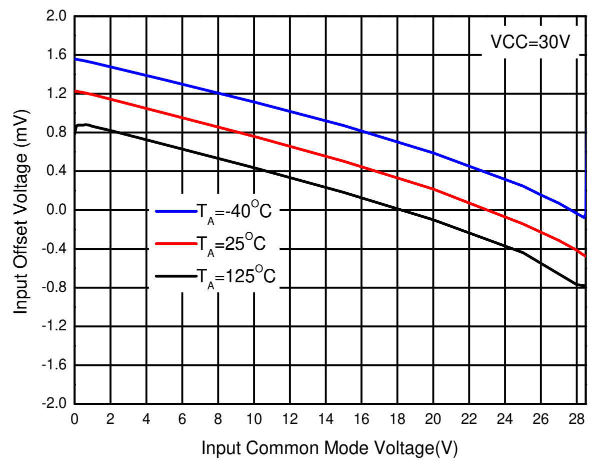


Response Time for Various Input Overdrive

Performance Characteristics (continued)



Input Offset Voltage vs. Input Common-Mode Voltage



Input Offset Voltage vs. Input Common-Mode Voltage

Application Information

General Information

The LM2901Q/2903Q series comparators are high-gain, wide-bandwidth devices, and like most comparators, 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 comparator changes 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 and finally, adding even a small amount (1.0 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.

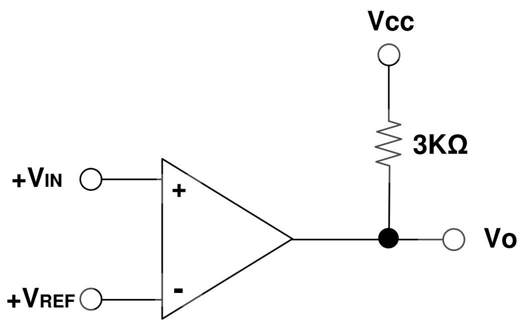
The bias network of the LM2901Q/2903Q series comparators establishes a quiescent current independent of the magnitude of the power supply voltage over the range of from 2.0 V_{DC} to 30 V_{DC}.

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

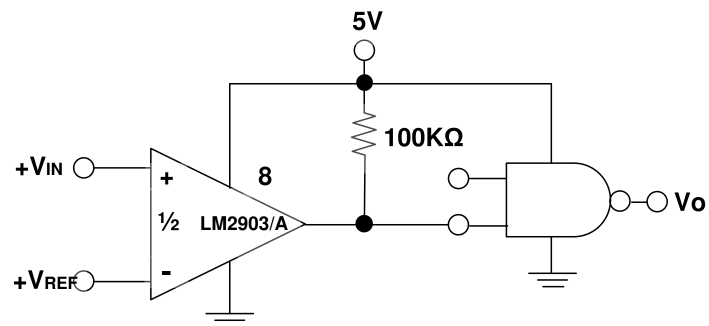
The output of the LM2901Q/2903Q series comparators is the uncommitted collector of a grounded-emitter NPN output transistor. Many collectors can be tied together to provide an output OR'ing function. An output pull-up resistor can be connected to any available power supply voltage within the permitted 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.

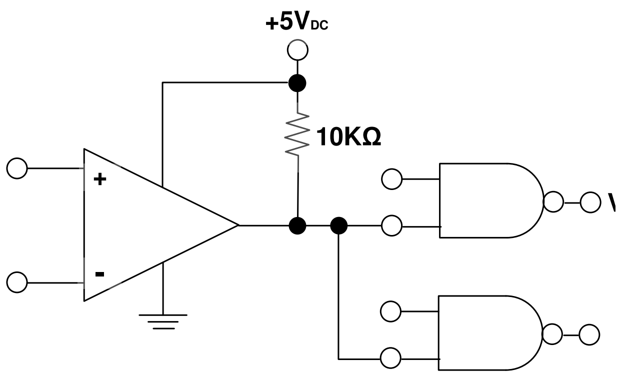
Typical Application Circuit (V_{CC} = 5.0 V_{DC})



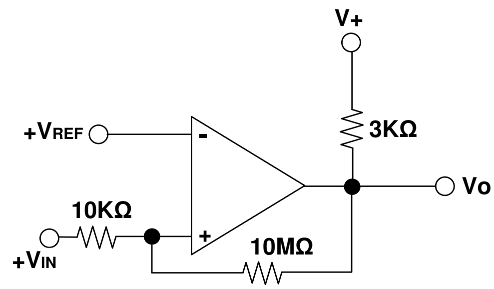
Basic Comparator



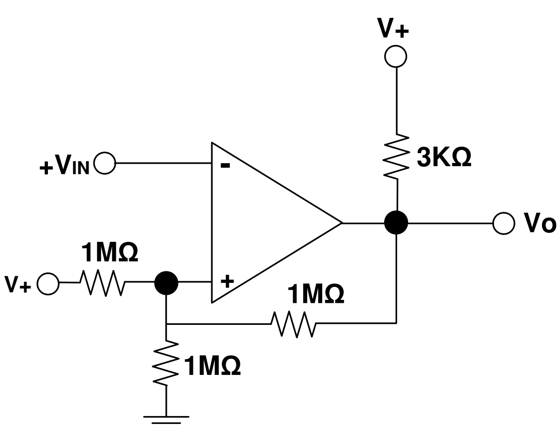
Driving CMOS



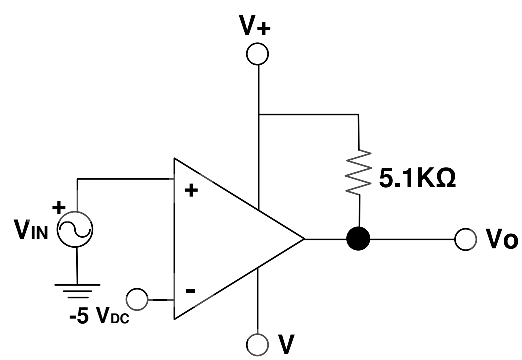
Driving TTL



Non-Inverting Comparator with Hysteresis

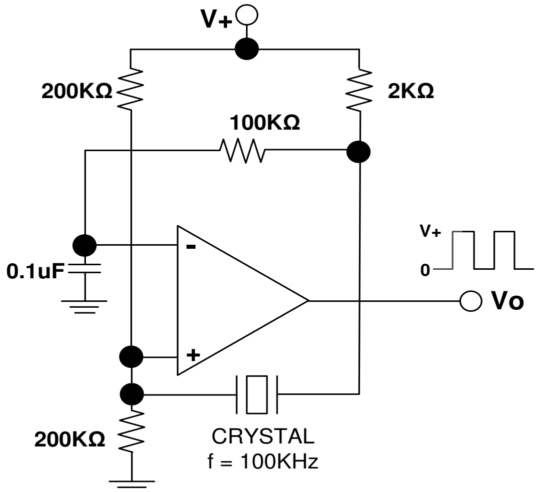


Inverting Comparator with Hysteresis

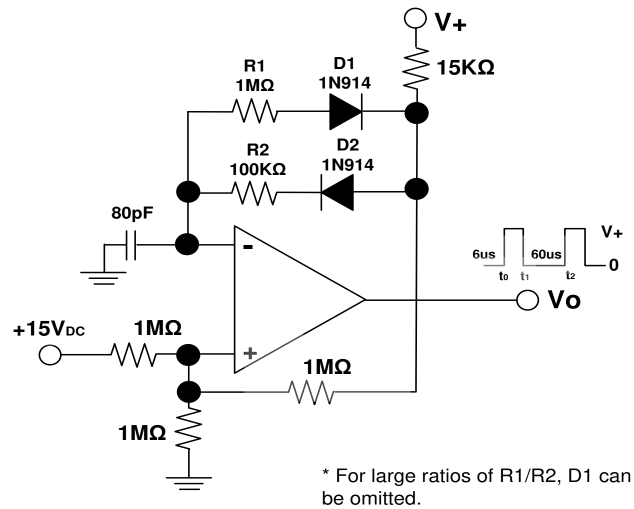


Comparator with a Negative Reference

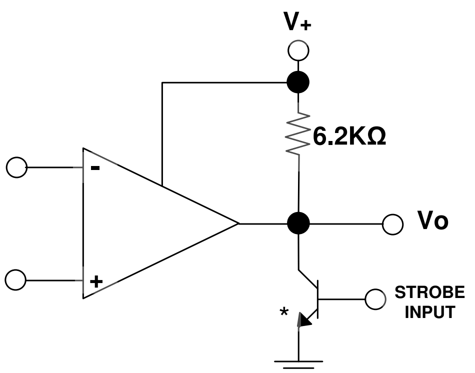
Typical Application Circuit (continued) (V_{CC} = 5.0 V_{DC})



Crystal Controlled Oscillator

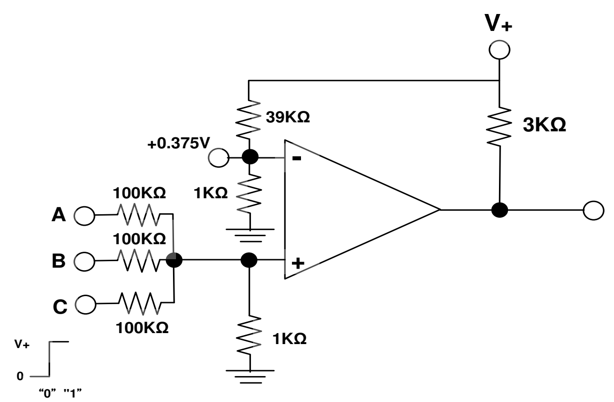


Pulse Generator

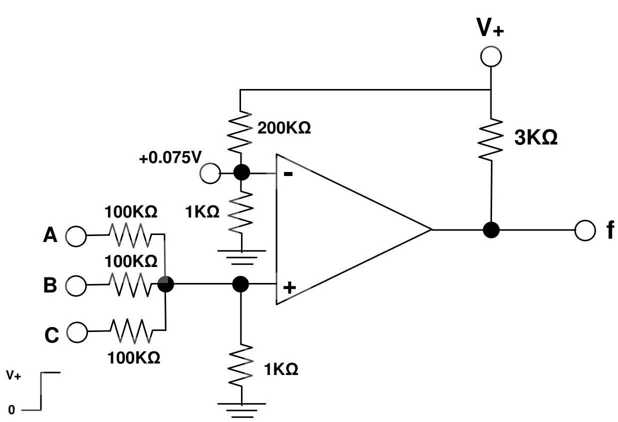


*Or logic gate without pull-up resistor

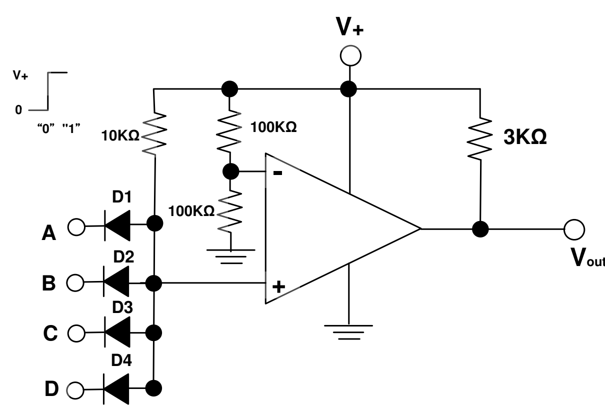
Output Strobing



AND Gate

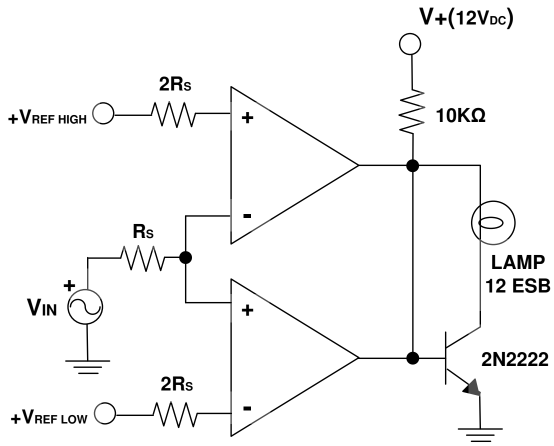


OR Gate

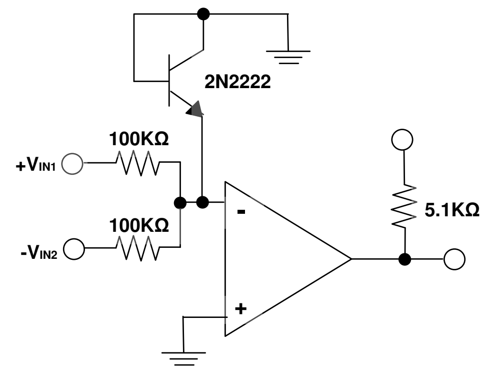


Large Fan-in AND Gate

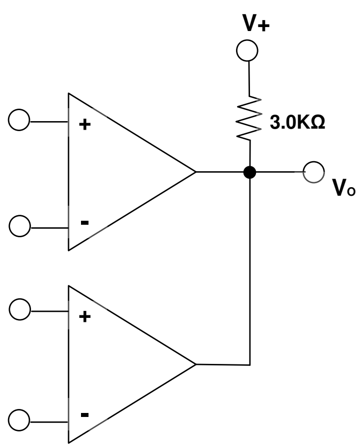
Typical Application Circuit (cont.) (V_{CC} = 5.0 V_{DC})



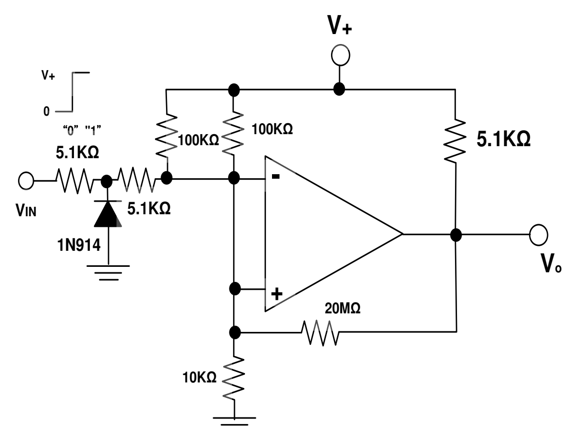
Limit Comparator



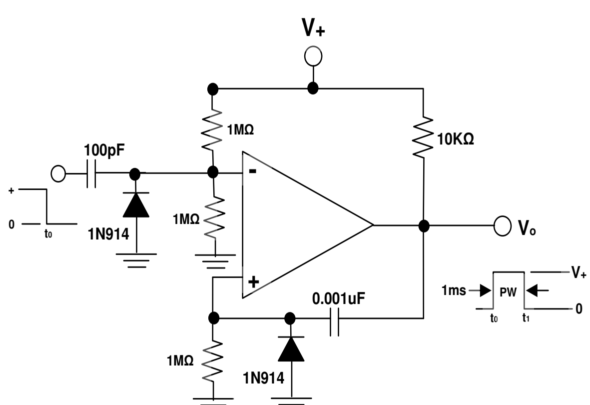
Comparing Input Voltage of Opposite Polarity



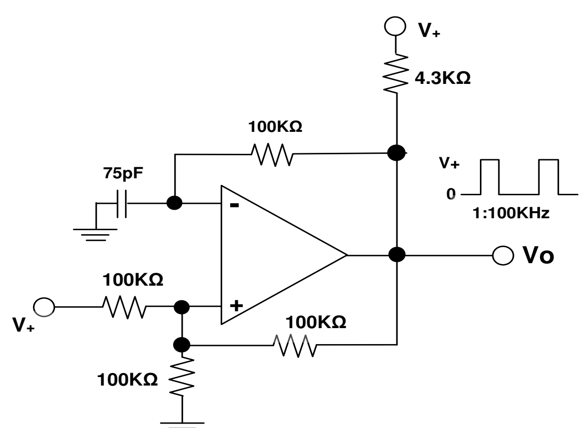
ORing the Outputs



Zero Crossing Detector
(Single Power Supply)

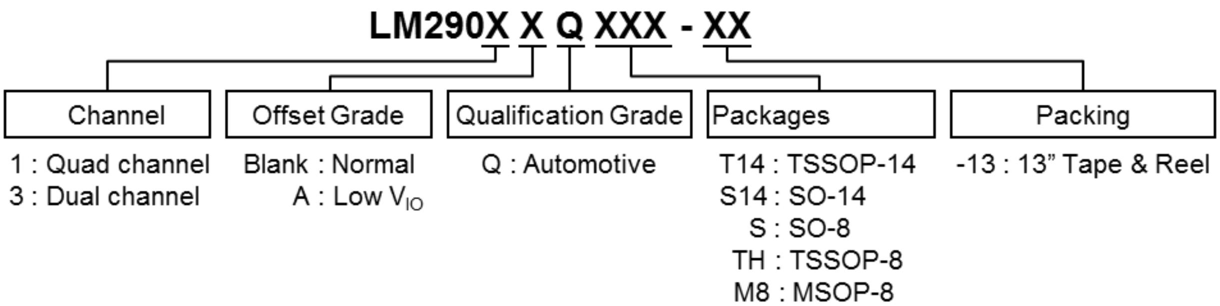


One-Shot Multivibrator



Squarewave Oscillator

Ordering Information

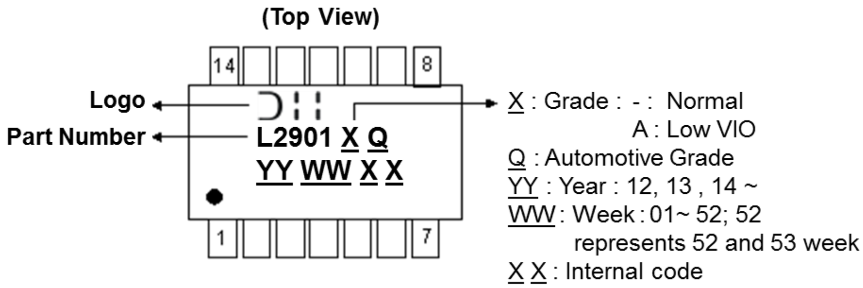


Part Number	Package Code	Packaging (Note 16)	13" Tape and Reel		Qualification Grade (Note 17)
			Quantity	Part Number Suffix	
LM2901QT14-13	T14	TSSOP-14	2,500/Tape & Reel	-13	Automotive Compliant
LM2901AQT14-13	T14	TSSOP-14	2,500/Tape & Reel	-13	Automotive Compliant
LM2901QS14-13	S14	SO-14	2,500/Tape & Reel	-13	Automotive Compliant
LM2901AQS14-13	S14	SO-14	2,500/Tape & Reel	-13	Automotive Compliant
LM2903QS-13	S	SO-8	2,500/Tape & Reel	-13	Automotive Compliant
LM2903AQS-13	S	SO-8	2,500/Tape & Reel	-13	Automotive Compliant
LM2903QTH-13	TH	TSSOP-8	2,500/Tape & Reel	-13	Automotive Compliant
LM2903AQTH-13	TH	TSSOP-8	2,500/Tape & Reel	-13	Automotive Compliant
LM2903QM8-13	M8	MSOP-8	2,500/Tape & Reel	-13	Automotive Compliant
LM2903AQM8-13	M8	MSOP-8	2,500/Tape & Reel	-13	Automotive Compliant

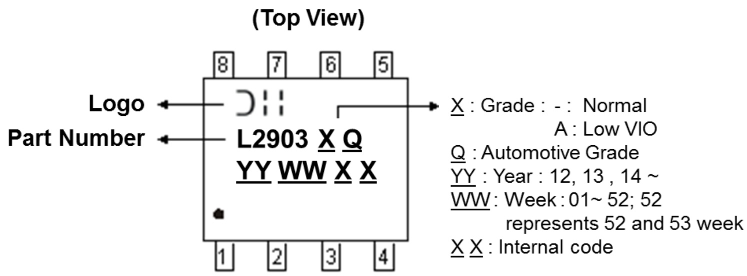
Notes: 16. For packaging details, go to our website at http://www.diodes.com/products/packages.html.
17. LM2901Q/2903Q have been qualified to AEC-Q100 grade 1 and are classified as "Automotive Compliant" which supports PPAP documentation. See LM2901/2903 datasheet for commercial qualified versions.

Marking Information

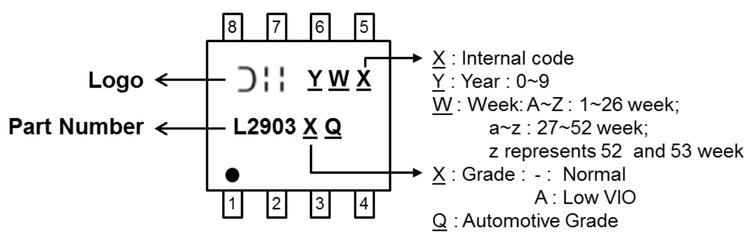
(1) TSSOP-14 and SO-14



(2) SO-8



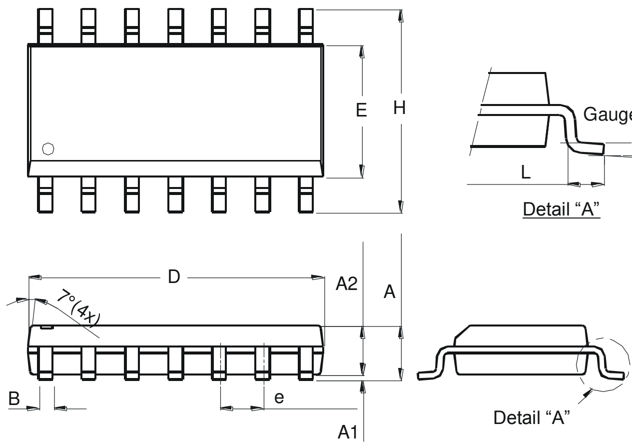
(3) MSOP-8 and TSSOP-8



Package Outline Dimensions

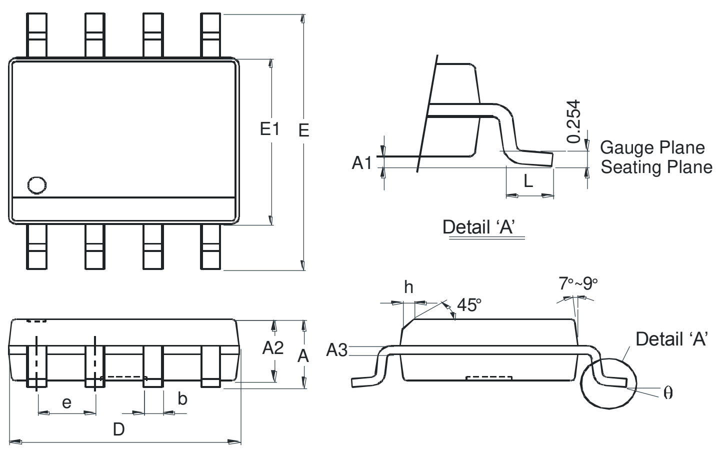
Please see http://www.diodes.com/package-outlines.html for the latest version.

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		

SO-8

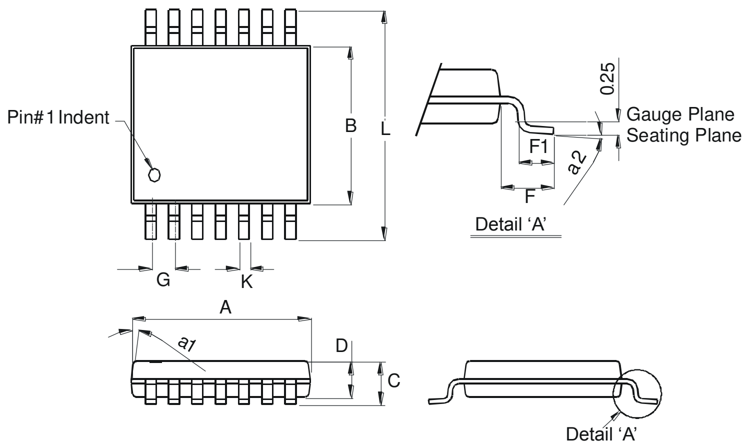


SO-8		
Dim	**Min**	**Max**
A	—	1.75
A1	0.10	0.20
A2	1.30	1.50
A3	0.15	0.25
b	0.3	0.5
D	4.85	4.95
E	5.90	6.10
E1	3.85	3.95
e	1.27 Typ	
h	—	0.35
L	0.62	0.82
θ	0°	8°
All Dimensions in mm		

Package Outline Dimensions (Continued)

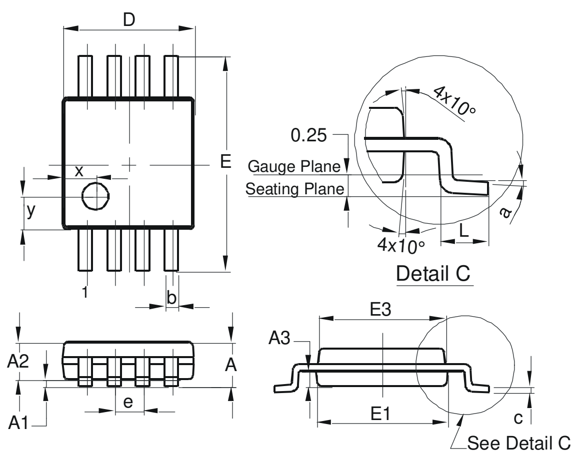
Please see http://www.diodes.com/package-outlines.html for the latest version.

TSSOP-14



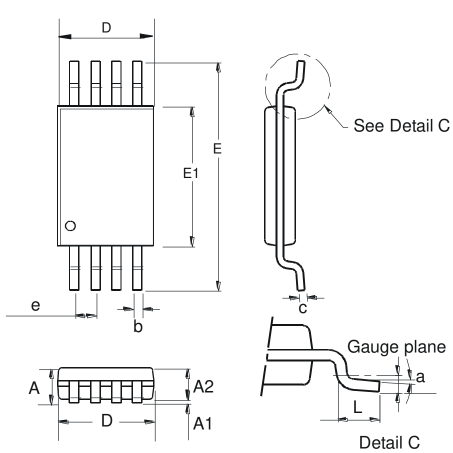
TSSOP-14		
Dim	Min	Max
a1	7° (4X)	
a2	0°	8°
A	4.9	5.10
B	4.30	4.50
C	—	1.2
D	0.8	1.05
F	1.00 Typ	
F1	0.45	0.75
G	0.65 Typ	
K	0.19	0.30
L	6.40 Typ	
All Dimensions in mm		

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			

TSSOP-8

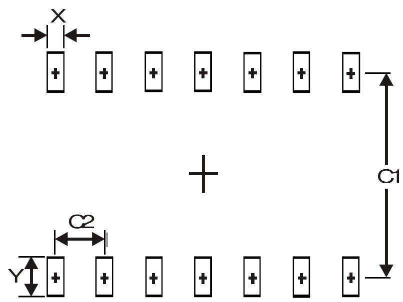


TSSOP-8			
Dim	Min	Max	Typ
a	0.09	—	—
A	—	1.20	—
A1	0.05	0.15	—
A2	0.825	1.025	0.925
b	0.19	0.30	—
c	0.09	0.20	—
D	2.90	3.10	3.025
e	—	—	0.65
E	—	—	6.40
E1	4.30	4.50	4.425
L	0.45	0.75	0.60
All Dimensions in mm			

Suggested Pad Layout

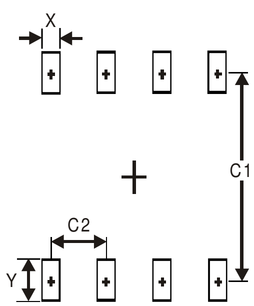
Please see http://www.diodes.com/package-outlines.html for the latest version.

SO-14



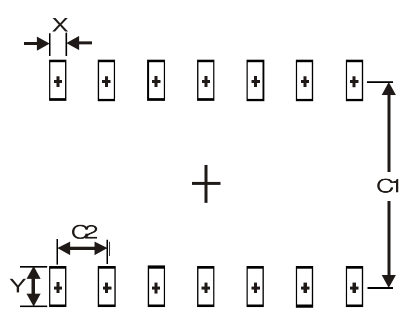
Dimensions	Value (in mm)
X	0.60
Y	1.50
C1	5.4
C2	1.27

SO-8



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

TSSOP-14

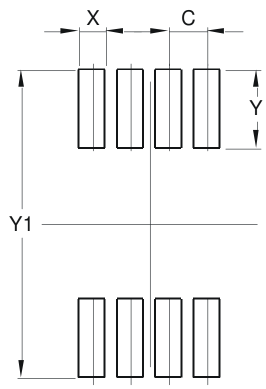


Dimensions	Value (in mm)
X	0.45
Y	1.45
C1	5.9
C2	0.65

Suggested Pad Layout (Continued)

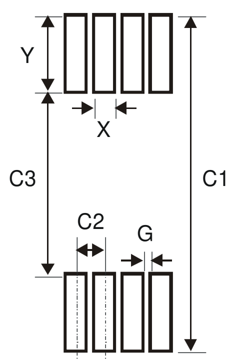
Please see http://www.diodes.com/package-outlines.html for the latest version.

MSOP-8



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

TSSOP-8



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