AUTOMOTIVE COMPLIANT DUAL AND QUAD OPERATIONAL AMPLIFIERS

Description

The LM2902Q/LM2902AQ/LM2904Q/LM2904AQ series consist of two or four independent high-gain operational amplifiers 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 LM2904Q/LM2904AQ dual devices are available in SO-8, TSSOP-8 and MSOP-8 packages; the LM2902Q/LM2902AQ quad devices are available in SO-14 and TSSOP-14 packages. All of them are in industry-standard pin outs, and use “green” mold compound as standard.

The LM2902Q/LM2902AQ/LM2904Q/LM2904AQ are characterized for operation from -40°C to +125°C, qualified to AEC-Q100 Grade 1 and are automotive compliant, supporting PPAPs.

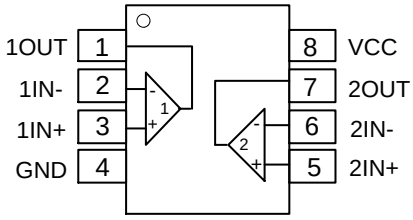
Features

- Wide Power Supply Voltage Range
  - Single Supply: 3V to 36V
  - Dual Supplies: ±1.5V to ±18V
- Very Low Supply Current Drain – Independent of Supply Voltage
  - LM2904Q: 500µA
  - LM2902Q: 700µA
- Low Input Bias Current: 20nA
- Low Input Offset Voltage
  - A Versions: 1mV (typ)
  - Non-A Version: 2mV (typ)
- Large DC Voltage Gain: 100dB
- Wide Bandwidth (Unity Gain): 700kHz (Temperature Compensated)
- Internally Compensated with Unity Gain
- Input Common-Mode Voltage Range Includes Ground
- Differential Input Voltage Range Equal to Power Supply Voltage
- Large Output Voltage Swing: 0V to V_{CC} -1.5V
- Qualified to AEC-Q100 Grade 1
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. “Green” Device (Note 3)**
- **The LM2902Q/LM2902AQ/LM2904Q/LM2904AQ is suitable for automotive applications requiring specific change control; this part is AEC-Q100 qualified, PPAP capable, and manufactured in IATF16949 certified facilities.**
  https://www.diodes.com/quality/product-definitions/

Pin Assignments

LM2904Q/LM2904AQ

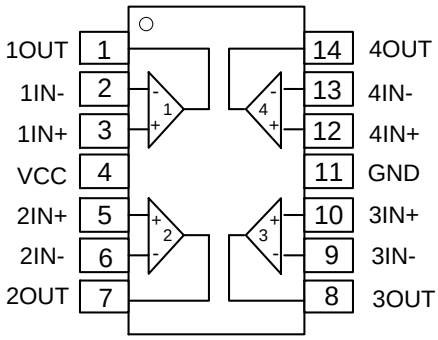
(Top View)



SO-8/TSSOP-8/MSOP-8

LM2902Q/LM2902AQ

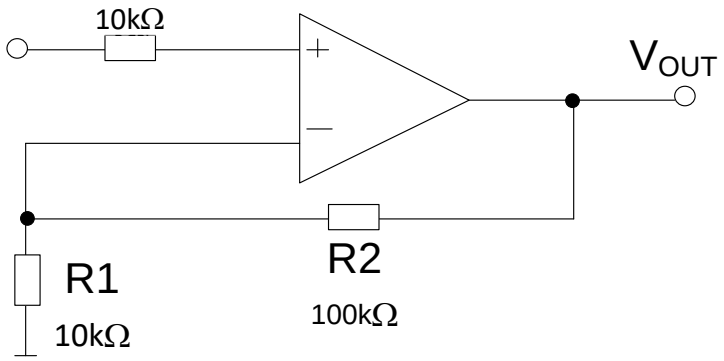
(Top View)



SO-14/TSSOP-14

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ 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.

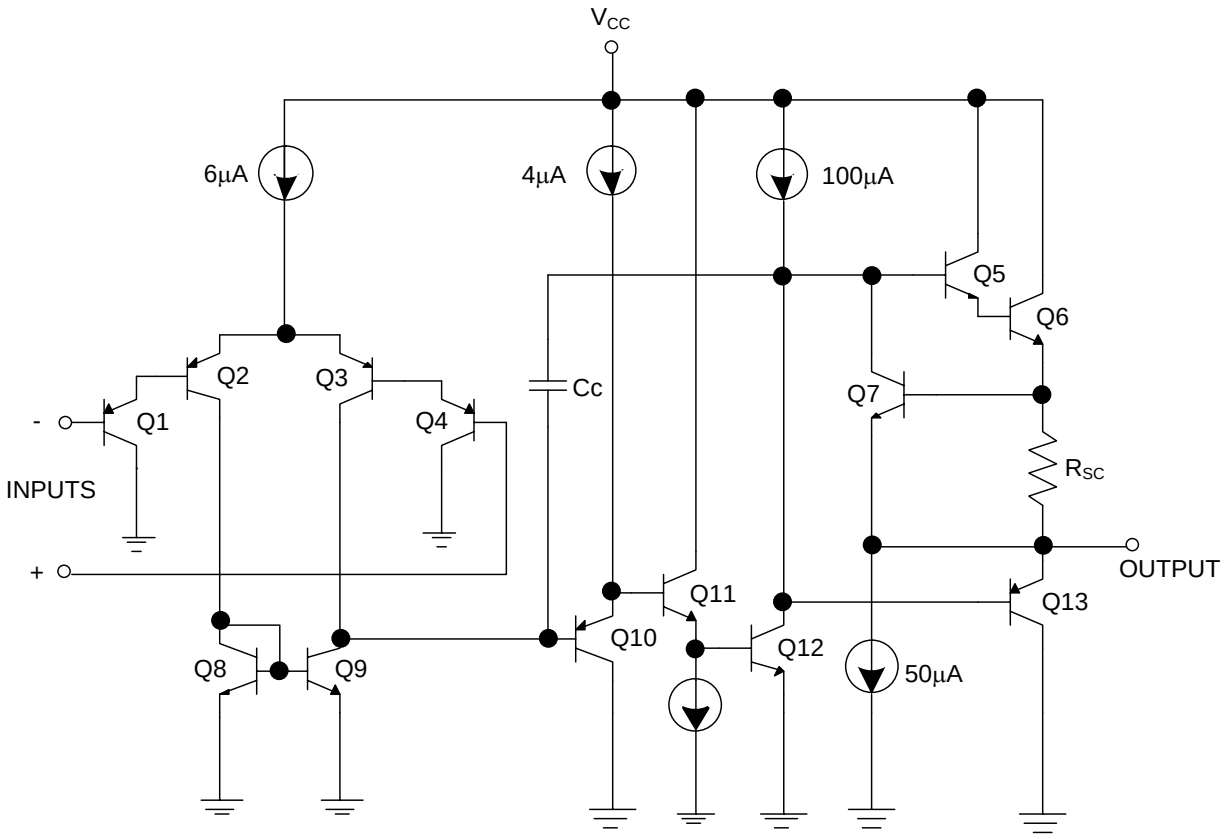
Typical Applications Circuit



Pin Descriptions

Pin Number	Pin Name	Function
LM2902Q/LM2902AQ		
1	1OUT	Channel 1 Output
2	1IN-	Channel 1 Inverting Input
3	1IN+	Channel 1 Non-Inverting Input
4	VCC	Chip Supply Voltage
5	2IN+	Channel 2 Non-Inverting Input
6	2IN-	Channel 2 Inverting Input
7	2OUT	Channel 2 Output
8	3OUT	Channel 3 Output
9	3IN-	Channel 3 Inverting Input
10	3IN+	Channel 3 Non-Inverting Input
11	GND	Ground
12	4IN+	Channel 4 Non-Inverting Input
13	4IN-	Channel 4 Inverting Input
14	4OUT	Channel 4 Output
LM2904Q/LM2904AQ		
1	1OUT	Channel 1 Output
2	1IN-	Channel 1 Inverting Input
3	1IN+	Channel 1 Non-Inverting Input
4	GND	Ground
5	2IN+	Channel 2 Non-Inverting Input
6	2IN-	Channel 2 Inverting Input
7	2OUT	Channel 2 Output
8	VCC	Chip Supply Voltage

Functional Block Diagram



Functional Block Diagram of LM2902Q/LM2902AQ/LM2904Q/LM2904AQ (Each Amplifier)

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

Symbol	Parameter		Rating	Unit
V_{CC}	Supply Voltage		±18 or 36	V
V_{ID}	Differential Input Voltage		36	V
V_{IN}	Input Voltage		-0.3 to +36	V
θ_{JA}	Package Thermal Impedance (Note 5)	SO-8	150	°C/W
		TSSOP-8	175	
		MSOP-8	200	
		SO-14	89	
		TSSOP-14	100	
—	Output Short-Circuit to GND (One Amplifier) (Note 6)	V_{CC} ≤ 15V and T_A = +25°C	Continuous	—
T_A	Operating Temperature Range		-40 to +125	°C
T_J	Operating Junction Temperature		+150	°C
T_{STG}	Storage Temperature Range		-65 to +150	°C

Notes: 4. Stresses greater than those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and 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 Ratings* for extended periods can affect device reliability.

5. 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.

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

ESD Ratings

Parameter		Rating	Unit
Human Body Mode ESD Protection (Note 7)	SO-14	500	V
	TSSOP-14	500	
	SO-8	500	
	TSSOP-8	500	
	MSOP-8	< 500	
Charge Device Mode ESD Protection	SO-14	1,000	
	TSSOP-14		
	SO-8		
	TSSOP-8		
	MSOP-8		

Note: 7. Human body model, 1.5kΩ in series with 100pF.

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

Parameter		Min	Max	Unit
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 8 and 9) (@ V_{CC} = +5.0V, T_A = +25°C, unless otherwise specified.)

LM2902Q/LM2902AQ

Symbol	Parameter	Conditions		T_A	Min	Typ	Max	Unit
V_{IO}	Input Offset Voltage	V_{IC} = V_{CMR} Minimum V_O = 1.4V V_{CC} = 5V to Maximum R_S = 0Ω	Non-A Device	T_A = +25°C	—	2	7	mV
				Full Range	—	—	10	
			A-Suffix Device	T_A = +25°C	—	1	2	
				Full Range	—	—	4	
$\Delta V_{IO}/\Delta T$	Input Offset Voltage Temperature Drift	R_S = 0Ω		Full Range	—	7	—	µV/°C
I_B	Input Bias Current	I_{IN+} or I_{IN-} with OUT in Linear Range V_{CMR} = 0V (Note 10)		T_A = +25°C	—	-20	-200	nA
				Full Range	—	—	-500	
I_{IO}	Input Offset Current	I_{IN+} - I_{IN-}, V_{CM} = 0V		T_A = +25°C	—	2	50	nA
				Full Range	—	—	150	
$\Delta I_{IO}/\Delta T$	Input Offset Current Temperature Drift	—		Full Range	—	10	—	pA/°C
V_{CMR}	Input Common-Mode Voltage Range	V_{CC} = 30V (Note 11)		T_A = +25°C	0 to V_{CC} -1.5	—	—	V
				Full Range	0 to V_{CC} -2.0	—	—	
I_{CC}	Supply Current (Four Amplifiers)	V_O = 0.5 V_{CC}, No Load	V_{CC} = 30V	Full Range	—	1.0	3.0	mA
		V_O = 0.5 V_{CC}, No Load	V_{CC} = 5V	Full Range	—	0.7	1.2	
A_V	Voltage Gain	V_{CC} = 15V, V_{OUT} = 1V to 11V R_L ≥ 2kΩ		T_A = +25°C	25	100	—	V/mV
				Full Range	15	—	—	
CMRR	Common Mode Rejection Ratio	DC, V_{CMR} = 0V to V_{CC}-1.5V		T_A = +25°C	60	70	—	dB
PSRR	Power Supply Rejection Ratio	V_{CC} = 5V to 30V		T_A = +25°C	70	100	—	dB
—	Amplifier to Amplifier Coupling	f = 1kHz to 20kHz (Input Referred) (Note 12)		T_A = +25°C	—	-120	—	dB
I_{SINK}	Output Current	Sink	V_{IN-} = 1V, V_{IN+} = 0V, V_{CC} = 15V V_O = 200mV	T_A = +25°C	12	50	—	µA
			V_{IN-} = 1V, V_{IN+} = 0V, V_{CC} = 15V V_O = 15V	T_A = +25°C	10	20	—	mA
				Full Range	5	—	—	
I_{SOURCE}		Source	V_{IN+} = 1V, V_{IN-} = 0V, V_{CC} = 15V V_O = 0V	T_A = +25°C	-20	-40	-60	
				Full Range	-10	—	—	
I_{SC}	Short-Circuit to Ground	V_{CC} = 5V, GND = -5V, V_O = 0V		T_A = +25°C	—	±40	±60	mA
V_{OH}	High-Level Output Voltage Swing	R_L = 10kΩ		T_A = +25°C	—	V_{CC} -1.5	—	V
		V_{CC} = 30V	R_L = 2kΩ	Full Range	26	—	—	
			R_L ≥ 10kΩ		27	28	—	
V_{OL}	Low-Level Output Voltage Swing	R_L ≤ 10kΩ		Full Range	—	5	20	mV

Notes:
8. Typical values are all at T_A = +25°C conditions and 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 (-40 ≤ T_A ≤ +125°C) are guaranteed by design, but not tested in production.
10. 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 that no loading change exists on the input lines.
11. The input common-mode voltage of either input signal voltage should not be allowed to become 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}.
12. Due to proximity of external components, ensure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.

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

LM2904Q/LM2904AQ

Symbol	Parameter	Conditions		T_A	Min	Typ	Max	Unit
V_{IO}	Input Offset Voltage	V_{IC} = V_{CMR} Minimum V_O = 1.4V V_{CC} = 5V to Maximum R_S = 0Ω	Non-A Device	T_A = +25°C	—	2	7	mV
				Full Range	—	—	10	
			A-Suffix Device	T_A = +25°C	—	1	2	
				Full Range	—	—	4	
$\Delta V_{IO}/\Delta T$	Input Offset Voltage Temperature Drift	R_S = 0Ω		Full Range	—	7	—	µV/°C
I_B	Input Bias Current	I_{IN+} or I_{IN-} with OUT in Linear Range V_{CMR} = 0V (Note 10)		T_A = +25°C	—	-20	-250	nA
				Full Range	—	—	-500	
I_{IO}	Input Offset Current	I_{IN+} - I_{IN-}, V_{CM} = 0V		T_A = +25°C	—	2	50	nA
				Full Range	—	—	150	
$\Delta I_{IO}/\Delta T$	Input Offset Current Temperature Drift	—		Full Range	—	10	—	pA/°C
V_{CMR}	Input Common-Mode Voltage Range	V_{CC} = 30V (Note 11)		T_A = +25°C	0 to V_{CC} -1.5	—	—	V
				Full Range	0 to V_{CC} -2.0	—	—	
I_{CC}	Supply Current (Two Amplifiers)	V_O = 0.5 V_{CC}, No Load	V_{CC} = 30V	Full Range	—	0.7	2.0	mA
		V_O = 0.5 V_{CC}, No Load	V_{CC} = 5V	Full Range	—	0.5	1.2	
A_V	Voltage Gain	V_{CC} = 15V, V_{OUT} = 1V to 11V R_L ≥ 2kΩ		T_A = +25°C	25	100	—	V/mV
				Full Range	15	—	—	
CMRR	Common Mode Rejection Ratio	DC, V_{CMR} = 0V to V_{CC}-1.5V		T_A = +25°C	60	70	—	dB
PSRR	Power Supply Rejection Ratio	V_{CC} = 5V to 30V		T_A = +25°C	70	100	—	dB
—	Amplifier to Amplifier Coupling	f = 1kHz to 20kHz (Note 12)		T_A = +25°C	—	120	—	dB
I_{SINK}	Output Current	V_{IN-} = 1V, V_{IN+} = 0V, V_{CC} = 15V V_O = 200mV	Sink	T_A = +25°C	12	50	—	µA
		V_{IN-} = 1V, V_{IN+} = 0V, V_{CC} = 15V V_O = 15V		T_A = +25°C	10	20	—	mA
				Full Range	5	—	—	
I_{SOURCE}		V_{IN+} = 1V, V_{IN-} = 0V, V_{CC} = 15V V_O = 0V	Source	T_A = +25°C	-20	-40	-60	
				Full Range	-10	—	—	
I_{SC}	Short-Circuit to Ground	V_{CC} = 5V, GND = -5V, V_O = 0V		T_A = +25°C	—	±40	±60	mA
V_{OH}	High-Level Output Voltage Swing	R_L = 10kΩ		T_A = +25°C	V_{CC} -1.5	—	—	V
		V_{CC} = 30V	R_L = 2kΩ	Full Range	26	—	—	
			R_L ≥ 10kΩ		27	28	—	
V_{OL}	Low-Level Output Voltage Swing	R_L ≤ 10kΩ		Full Range	—	5	20	mV

Notes:
8. Typical values are all at T_A = +25°C conditions and 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 (-40 ≤ T_A ≤ +125°C) are guaranteed by design, but not tested in production.
10. 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 that no loading change exists on the input lines.
11. The input common-mode voltage of either input signal voltage should not be allowed to become 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}.
12. Due to proximity of external components, ensure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.

AC Electrical Characteristics (Notes 8 and 9) (@ V_{CC} = ±15.0V, T_A = +25°C, unless otherwise specified.)

LM2902Q/LM2902AQ

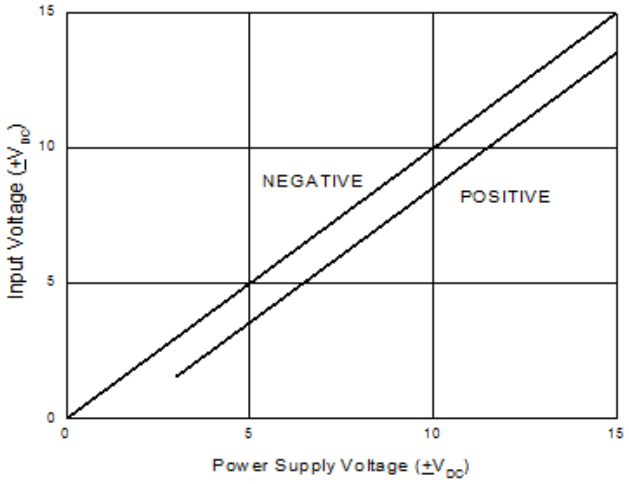
Symbol	Parameter	Conditions	Typ	Unit
SR	Slew Rate at Unity Gain	R_L = 1MΩ, C_L = 30pF, V_I = ±10V	0.3	V/μs
B1	Unity Gain Bandwidth	R_L = 1MΩ, C_L = 20pF	0.7	MHz
Vn	Equivalent Input Noise Voltage	R_S = 100Ω, V_I = 0V, f = 1kHz	40	nV/√Hz

LM2904Q/LM2904AQ

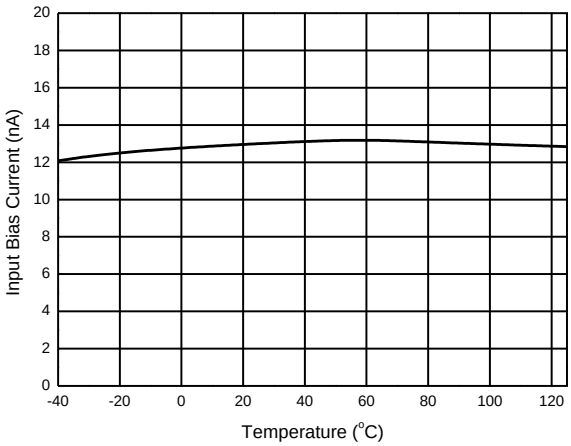
Symbol	Parameter	Conditions	Typ	Unit
SR	Slew Rate at Unity Gain	R_L = 1MΩ, C_L = 30pF, V_I = ±10V	0.3	V/μs
B1	Unity Gain Bandwidth	R_L = 1MΩ, C_L = 20pF	0.7	MHz
Vn	Equivalent Input Noise Voltage	R_S = 100Ω, V_I = 0V, f = 1kHz	40	nV/√Hz

Notes:
8. Typical values are all at T_A = +25°C conditions and 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 (-40 ≤ T_A ≤ +125°C) are guaranteed by design, but not tested in production.

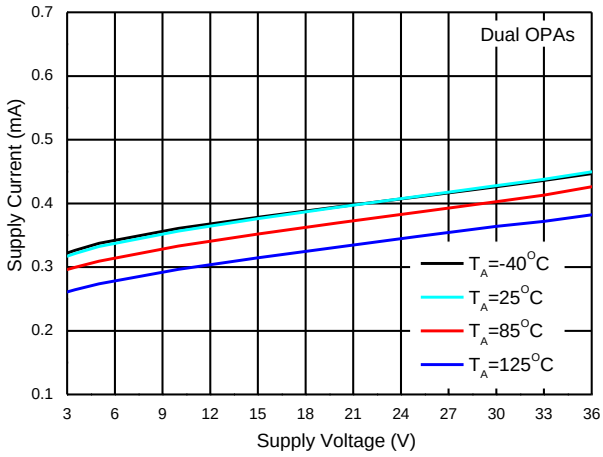
Performance Characteristics



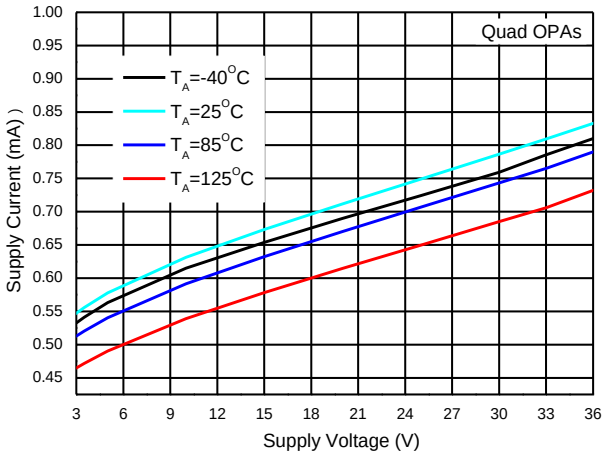
Input Voltage Range



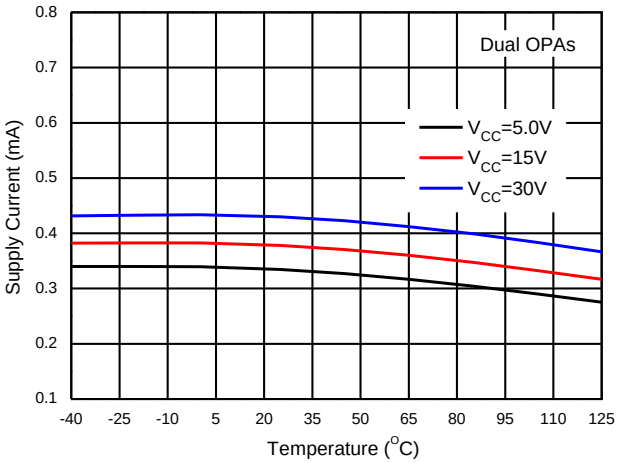
Input Current



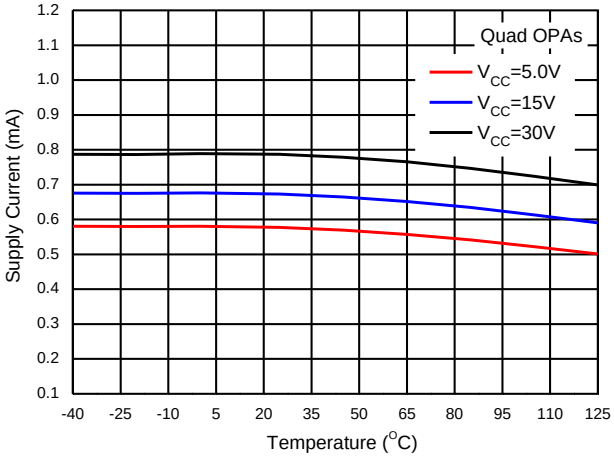
Supply Current vs. Supply Voltage (LM2904Q/LM2904AQ)



Supply Current vs. Supply Voltage (LM2902Q/LM2902AQ)

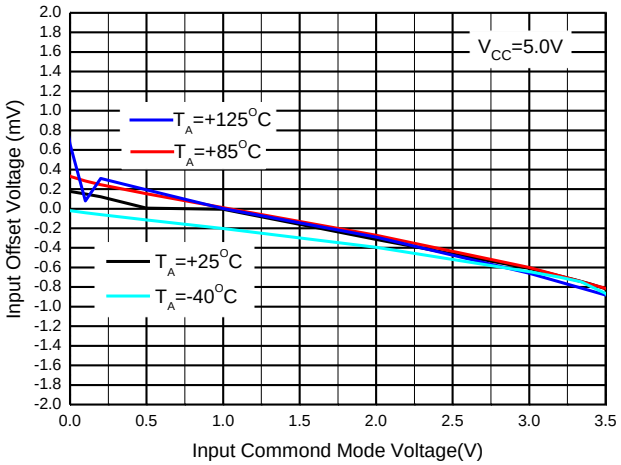


Supply Current vs. Temperature (LM2904Q/LM2904AQ)

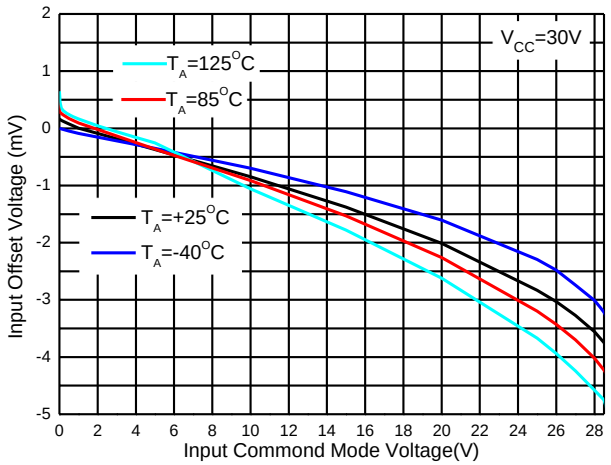


Supply Current vs. Temperature (LM2902Q/LM2902AQ)

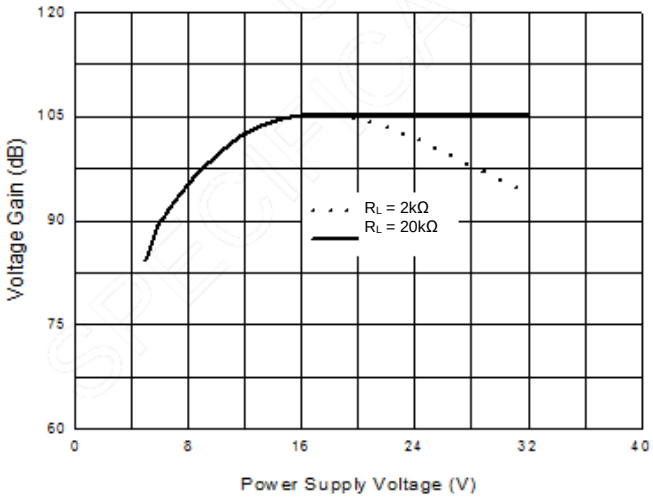
Performance Characteristics (continued)



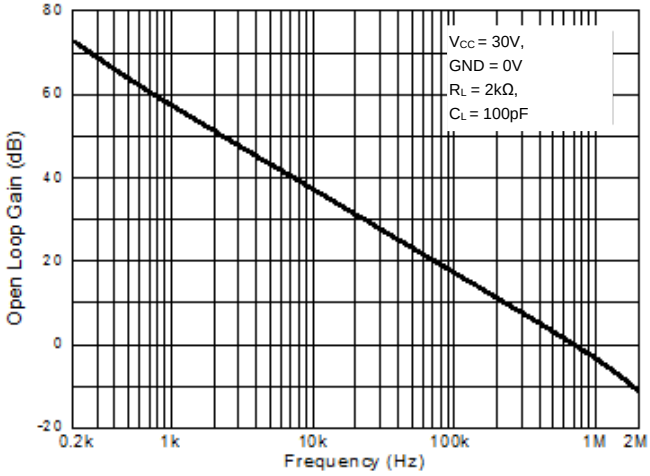
Input Offset Voltage vs. Common Mode Voltage



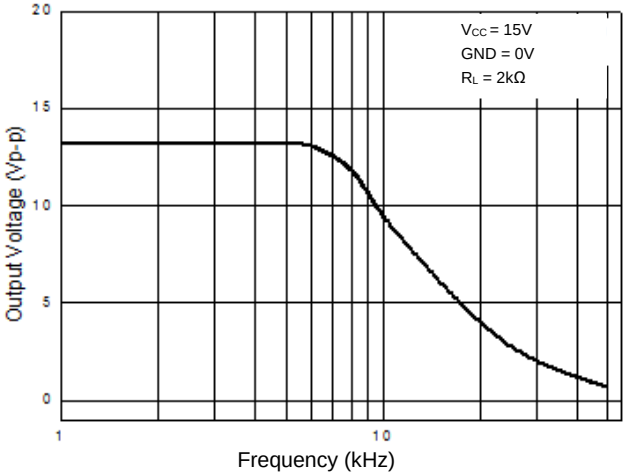
Input Offset Voltage vs. Common Mode Voltage



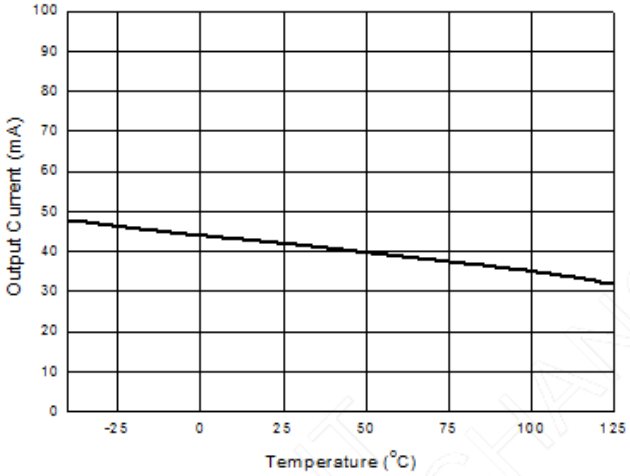
Voltage Gain



Open Loop Frequency Response

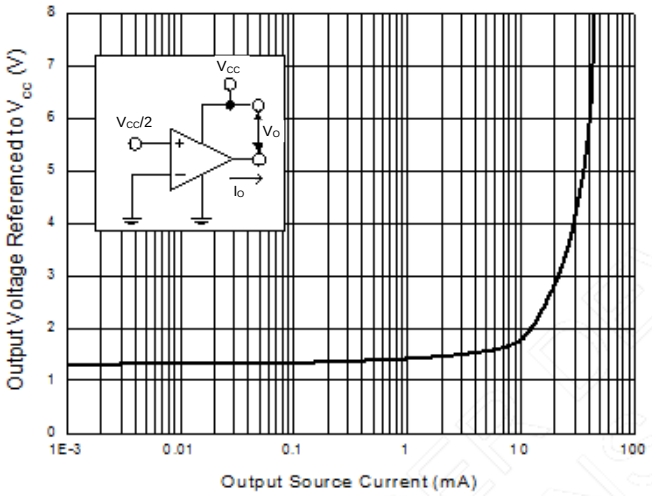


Large Signal Frequency Response

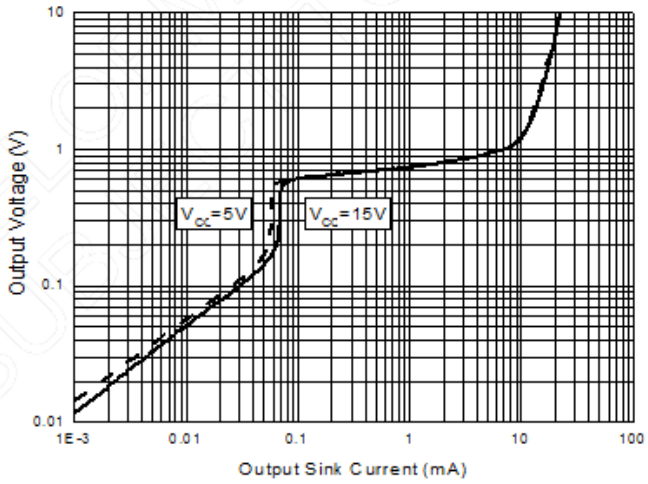


Current Limit

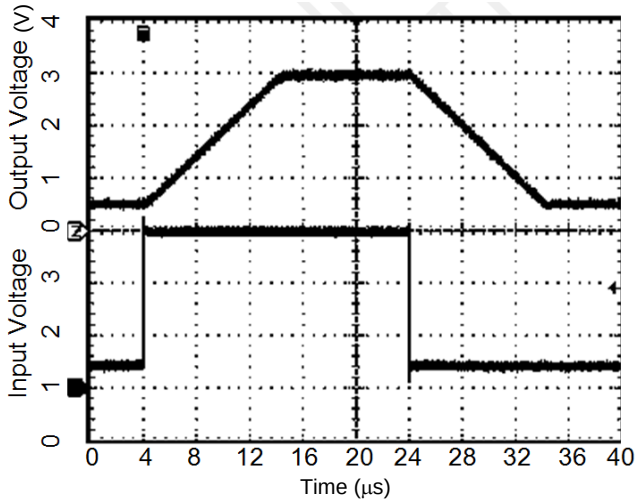
Performance Characteristics (continued)



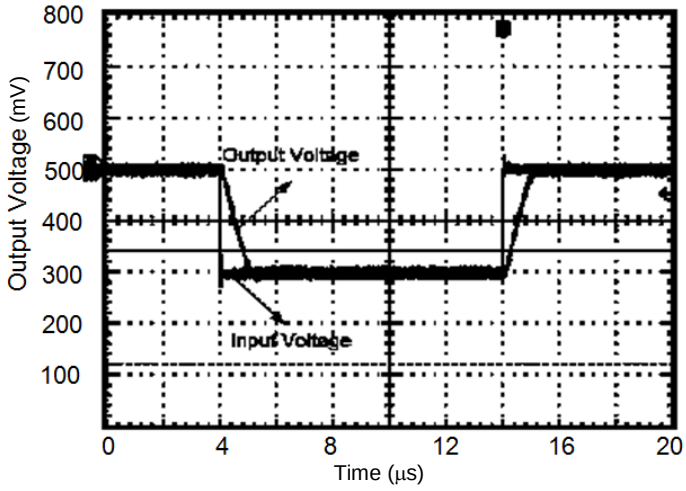
Output Characteristics: Current Sourcing



Output Characteristics: Current Sinking



Voltage Follower Pulse Response



Voltage Follower Pulse Response (Small Signal)

Application Information

General Information

The LM2902Q/LM2902AQ/LM2904Q/LM2904AQ series op amps which operate with only a single power supply voltage, have true-differential inputs and remain in the linear mode with an input common-mode voltage of 0V. These amplifiers operate over a wide range of power supply voltage with little change in performance characteristics. At +25°C, amplifier operation is possible down to a minimum supply voltage of 2.3V.

Precautions should be taken to ensure that the power supply for the integrated circuit never becomes reversed in polarity, or that the unit is not inadvertently installed backwards in a test socket. If precaution is not taken, an unlimited current surge through the resulting forward diode within the IC may occur and could cause fusing of the internal conductors, destroying the unit.

Large differential input voltages can be easily accommodated and, as input differential voltage protection diodes are not needed, no large input currents result from large differential input voltages. The differential input voltage may be larger than V+ without damaging the device. Protection should be provided to prevent the input voltages from becoming negative more than -0.3V (@ +25°C). An input clamp diode with a resistor to the IC input terminal can be used.

To reduce the power supply current drain, the amplifiers have a class A output stage for small signal levels which converts to class B in a large signal mode. This allows the amplifiers to achieve both source and sink large output currents. Therefore both NPN and PNP external current boost transistors can be used to extend the power capability of the basic amplifiers. The output voltage needs to raise approximately 1 diode drop above ground to bias the on-chip vertical PNP transistor for output current sinking applications.

For AC applications where the load is capacitive coupled to the output of the amplifier, a resistor should be used from the output of the amplifier to ground to increase the class A bias current, and prevent crossover distortion. Where the load is directly coupled, as in DC applications, there is no crossover distortion.

Capacitive loads which are applied directly to the output of the amplifier reduce the loop stability margin. Values of 50pF can be accommodated using the worst-case non-inverting unity gain connection. Large closed loop gains or resistive isolation should be used if larger load capacitance must be driven by the amplifier.

The bias network of the LM2902Q/LM2902AQ/LM2904Q/LM2904AQ series establishes a quiescent current which is independent of the magnitude of the power supply voltage over the range of 3V to 30V.

Output short circuits either to ground or to the positive power supply should be of short time duration. Units can be destroyed, not as a result of the short-circuit current causing metal fusing, but rather due to the large increase in IC chip dissipation which will cause eventual failure due to excessive function temperatures. Putting direct short-circuits on more than one amplifier at a time will increase the total IC power dissipation to destructive levels, if not properly protected with external dissipation limiting resistors in series with the output leads of the amplifiers. The larger value of output source current which is available at +25°C provides a larger output current capability at elevated temperatures (see *Typical Performance Characteristics*) than a standard IC op amp.

The circuits presented in *Typical Applications Circuit* section emphasize operation on a single power supply voltage. If complementary power supplies are available, all of the standard op amp circuits can be used. In general, introducing a pseudo-ground (a bias voltage reference of $V_{CC}/2$) will allow operation above and below this value in single power supply systems. Many application circuits are shown which take advantage of the wide input common-mode voltage range which includes ground. In most cases, input biasing is not required and input voltages which range to ground can easily be accommodated.

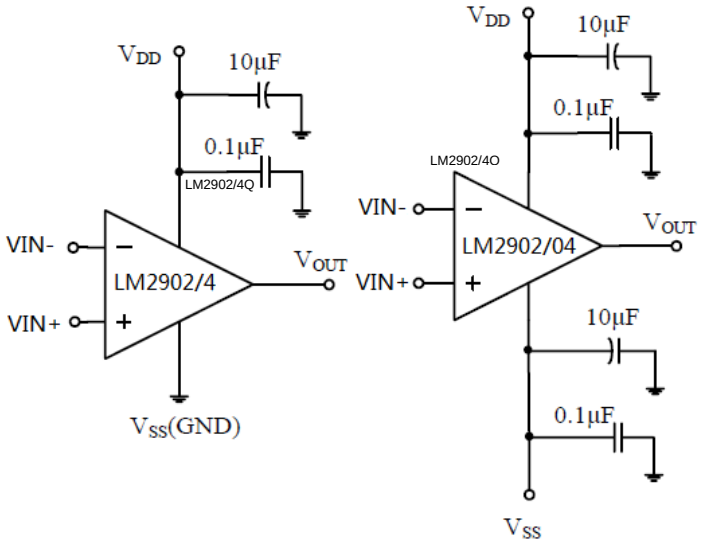
Application Information (continued)

Power Supply Bypassing and Layout

The LM2902Q/LM2902AQ/LM2904Q/LM2904AQ family operates from both single supply voltage ranging 3V to 36V, or dual supply voltage ±1.5V to ±18V.

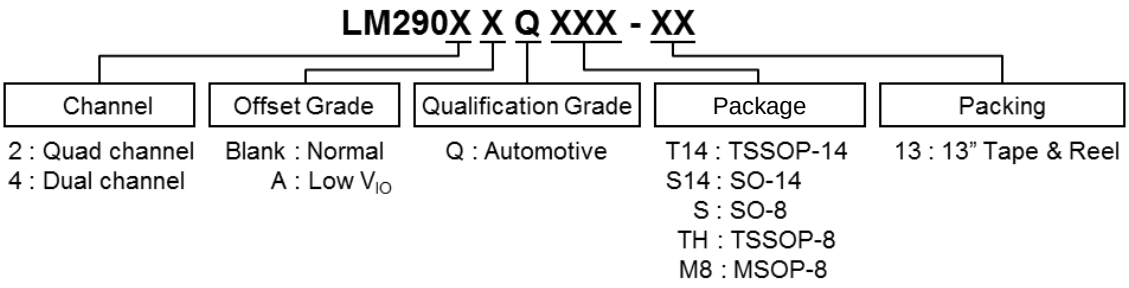
As with any operation amplifier, proper supply bypassing is critical for low-noise performance and high power supply rejection. For single-supply operation system, a minimum 0.1µF bypass capacitor should be recommended to place as close as possible between V_{CC} pin and GND. For dual-supply operation, both the positive supply pin and negative supply pin should be bypassed to ground with a separate 0.1µF ceramic capacitor.

2.2µF tantalum capacitor can be added for better performance. Keep the length of leads and traces that connect capacitors between LM2902Q/LM2902AQ/LM2904Q/LM2904AQ power supply pin and ground as short as possible.



Amplifier with Bypass Capacitors

Ordering Information

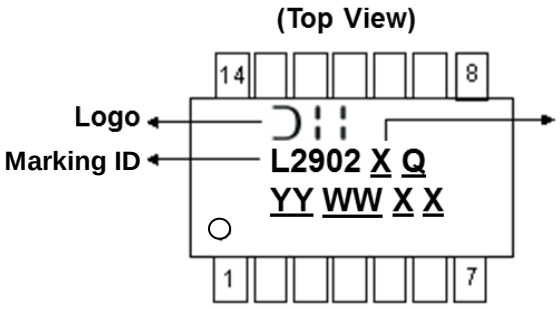


Part Number	Part Number Suffix	Package Code	Package (Note 13)	Packing	
				Qty.	Carrier
LM2902QT14-13	-13	T14	TSSOP-14	2,500	Tape & Reel
LM2902AQT14-13	-13	T14	TSSOP-14	2,500	Tape & Reel
LM2902QS14-13	-13	S14	SO-14	2,500	Tape & Reel
LM2902AQS14-13	-13	S14	SO-14	2,500	Tape & Reel
LM2904QS-13	-13	S	SO-8	2,500	Tape & Reel
LM2904AQS-13	-13	S	SO-8	2,500	Tape & Reel
LM2904QTH-13	-13	TH	TSSOP-8	2,500	Tape & Reel
LM2904AQTH-13	-13	TH	TSSOP-8	2,500	Tape & Reel
LM2904QM8-13	-13	M8	MSOP-8	2,500	Tape & Reel
LM2904AQM8-13	-13	M8	MSOP-8	2,500	Tape & Reel

Note: 13. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

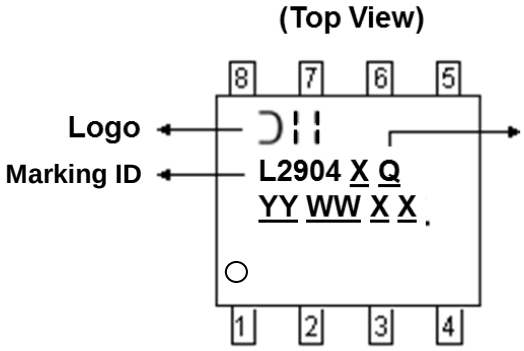
Marking Information

(1) TSSOP-14 and SO-14



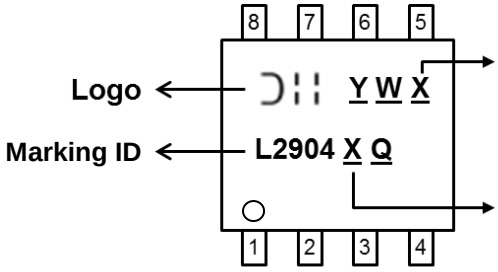
X : Grade : - : Normal
A : Low V_{IO}
Q : Automotive Grade
YY : Year (ex: 23 = 2023)
WW : Week : 01 to 52; 52 represents week 52 and 53
X X : Internal Code

(2) SO-8



X : Grade : - : Normal
A : Low V_{IO}
Q : Automotive Grade
YY : Year (ex: 23 = 2023)
WW : Week : 01 to 52; 52 represents week 52 and 53
X X : Internal Code

(3) MSOP-8 and TSSOP-8

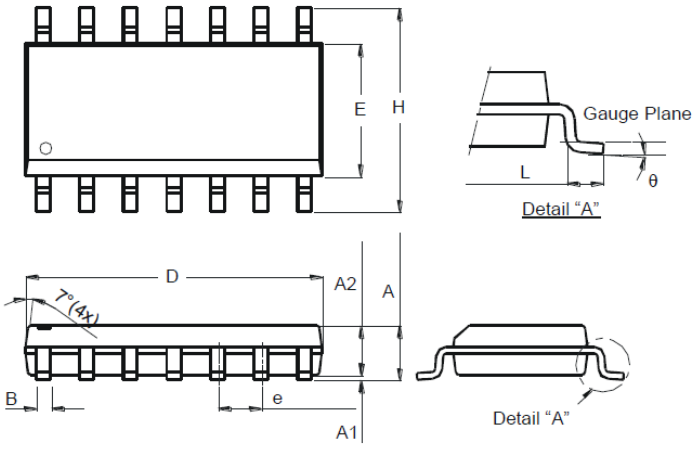


X : Internal Code
Y : Year : 0 to 9 (ex: 3 = 2023)
W : Week : A to Z : week 1 to 26; a to z : week 27 to 52;
z represents week 52 and 53
X : Grade : - : Normal
A : Low V_{IO}
Q : Automotive Grade

Package Outline Dimensions

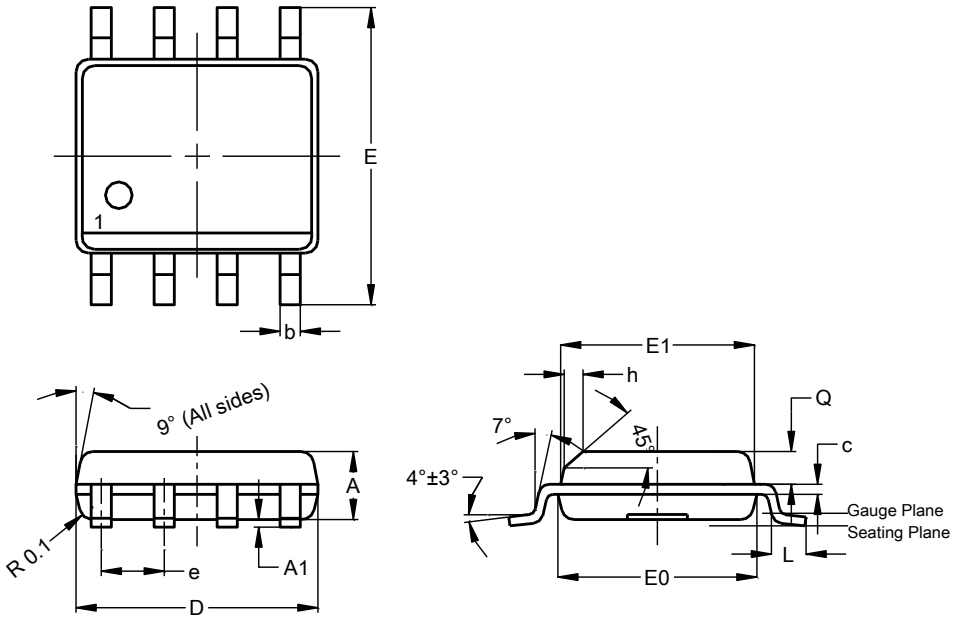
Please see http://www.diodes.com/package-outlines.html for the latest version.

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

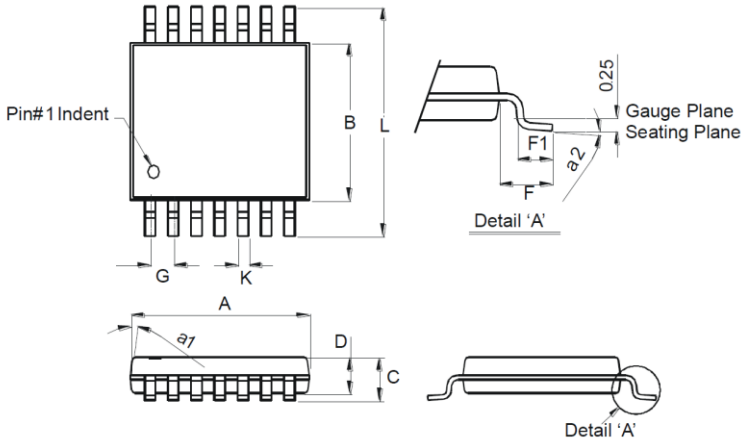


SO-8			
Dim	**Min**	**Max**	**Typ**
A	1.40	1.50	1.45
A1	0.10	0.20	0.15
b	0.30	0.50	0.40
c	0.15	0.25	0.20
D	4.85	4.95	4.90
E	5.90	6.10	6.00
E1	3.80	3.90	3.85
E0	3.85	3.95	3.90
e	--	--	1.27
h	-	--	0.35
L	0.62	0.82	0.72
Q	0.60	0.70	0.65
All Dimensions in mm			

Package Outline Dimensions (continued)

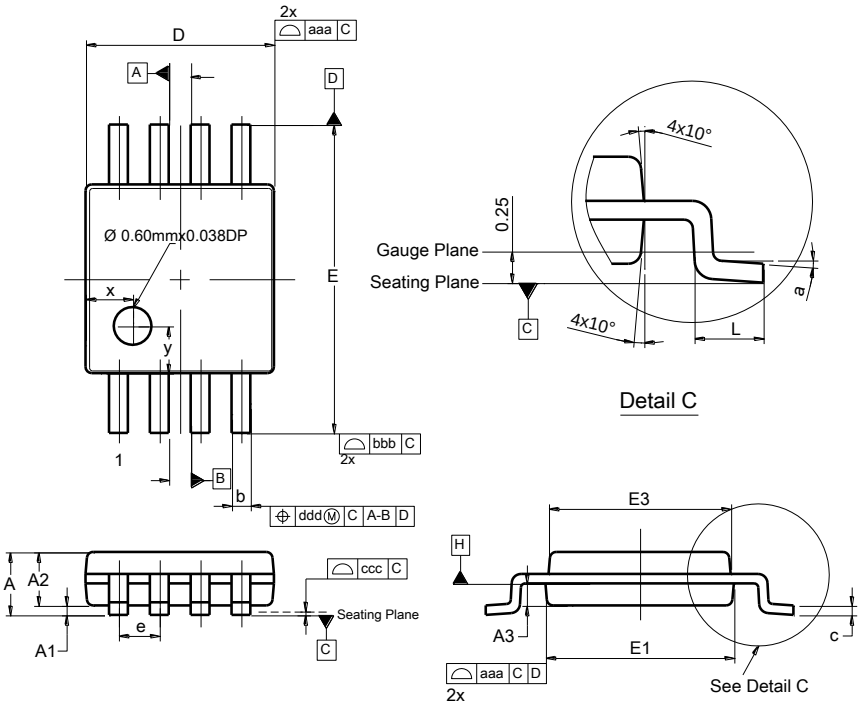
Please see http://www.diodes.com/package-outlines.html for the latest version.

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

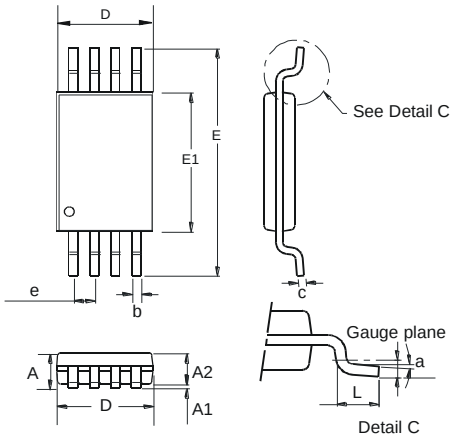


MSOP-8			
Dim	**Min**	**Max**	**Typ**
A	--	1.10	--
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E3	2.85	3.05	2.95
e	--	--	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	--	--	0.750
y	--	--	0.750
aaa	0.20		
bbb	0.25		
ccc	0.10		
ddd	0.13		
All Dimensions in mm			

Package Outline Dimensions (continued)

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

TSSOP-8

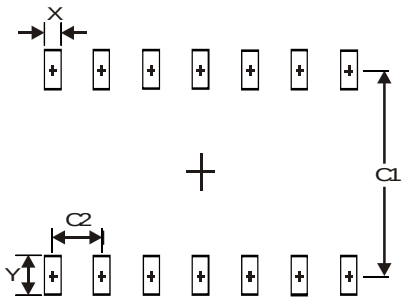


TSSOP-8			
Dim	**Min**	**Max**	**Typ**
a	0.09	–	–
A	–	1.20	–
A1	0.05	0.15	–
A2	0.825	1.025	0.925
b	0.19	0.30	–
c	0.09	0.20	–
D	2.90	3.10	3.025
e	—	—	0.65
E	—	—	6.40
E1	4.30	4.50	4.425
L	0.45	0.75	0.60
All Dimensions in mm			

Suggested Pad Layout

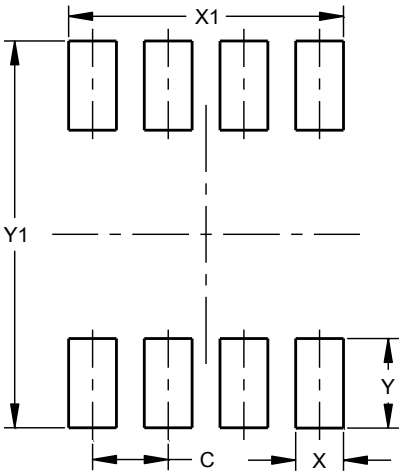
Please see http://www.diodes.com/package-outlines.html for the latest version.

SO-14



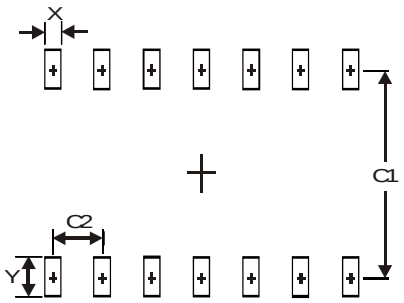
Dimensions	Value (in mm)
X	0.60
Y	1.50
C1	5.4
C2	1.27

SO-8



Dimensions	Value (in mm)
C	1.27
X	0.802
X1	4.612
Y	1.505
Y1	6.50

TSSOP-14

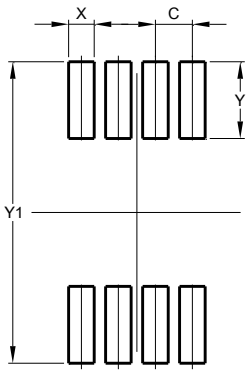


Dimensions	Value (in mm)
X	0.45
Y	1.45
C1	5.9
C2	0.65

Suggested Pad Layout (continued)

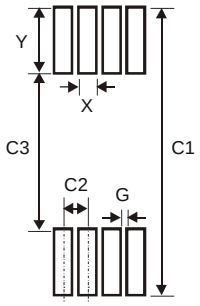
Please see http://www.diodes.com/package-outlines.html for the latest version.

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

Mechanical Data

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 e3
- Weight: SO-8 – 0.074 grams (Approximate)
  SO-14 – 0.14 grams (Approximate)
  TSSOP-8 – 0.041 grams (Approximate)
  MSOP-8 – 0.027 grams (Approximate)
  TSSOP-14 – 0.052 grams (Approximate)

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