Dual And Quad Operational Amplifiers

1. Description

The LM2902/LM2904 series amplifiers consist of four and two independent high-gain operational amplifiers with very low input offset voltage specification. They have been 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.

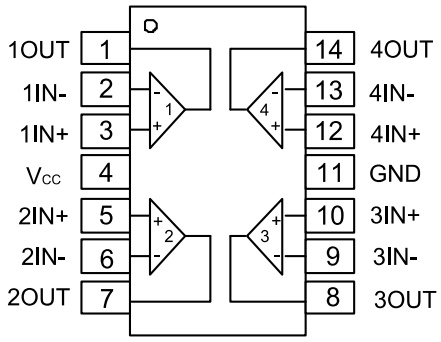
The LM2902/LM2904 series are characterized for operation from -40˚C to +125˚C and the dual devices are available in SOIC-8, MSOP-8, TSSOP-8 and the quad devices available in SOIC-14 and TSSOP-14 with industry standard pin-outs. Both use green mold compound as standard.

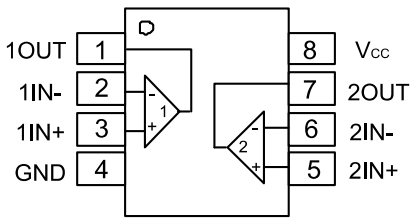
2. Features

- Wide Power Supply Voltage Range:
  - Single Supply: 3V to 36V
  - Dual Supplies: ±1.5V to ±18V
- Very Low Supply Current Drain
  - LM2904 500μA – Independent of Supply Voltage
  - LM2902 700μA – Independent of Supply Voltage
- Low Input Bias Current: 20nA
- Low Input Offset Voltage:
  - A Version: 1mV Typ
  - Non-A Version: 2mV Typ
- Large DC Voltage Gain: 100dB
- WideBandwidth (Unity Gain): 700kHz (Temperature Compensated)
- Internally Compensated with Unity Gain
- Input Common-Mode Voltage Range Includes Ground
- Differential Input Voltage Range Equal to the Power Supply Voltage
- Large Output Voltage Swing: 0V to V_{CC} -1.5V
- SOIC-8, MSOP-8, TSSOP-8 (Duals) and SOIC-14, TSSOP-14 (Quads) Packages Available

3. Pin Configuration

LM2902/LM2902A	LM2904/LM2904A
(TOP VIEW)	(TOP VIEW)





4. Pin Description

LM2902, LM2902A		
Pin Name	**Pin Number**	**Function**
1OUT	1	Channel 1 Output
1IN-	2	Channel 1 Inverting Input
1IN+	3	Channel 1 Non-Inverting Input
V_{CC}	4	Chip Supply Voltage
2IN+	5	Channel 2 Non-Inverting Input
2IN-	6	Channel 2 Inverting Input
2OUT	7	Channel 2 Output
3OUT	8	Channel 3 Output
3IN-	9	Channel 3 Inverting Input
3IN+	10	Channel 3 Non-Inverting Input
GND	11	Ground
4IN+	12	Channel 4 Non-Inverting Input
4IN-	13	Channel 4 Inverting Input
4OUT	14	Channel 4 Output
LM2904, LM2904A		
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

5. Ordering Information

DEVICE	Package Type	Packing	Packing Qty
LM2902M	SOIC-14	Tape & Reel	
LM2902AM	SOIC-14	Tape & Reel	
LM2902MT	TSSOP-14	Tape & Reel	
LM2902AMT	TSSOP-14	Tape & Reel	
LM2904M	SOIC-8	Tape & Reel	
LM2904AM	SOIC-8	Tape & Reel	
LM2904MT	TSSOP-8	Tape & Reel	
LM2904AMT	TSSOP-8	Tape & Reel	
LM2904MM	MSOP-8	Tape & Reel	
LM2904AMM	MSOP-8	Tape & Reel	

Note: If the physical information is inconsistent with the ordering information, please refer to the actual product.

6. 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)	SOIC-8	TBD	°C/W
		MSOP-8	TBD	
		TSSOP-8	TBD	
		SOIC-14	TBD	
		TSSOP-14	TBD	
θ_{JC}	Package Thermal Impedance (Note 6)	SOIC-8	TBD	°C/W
		MSOP-8	TBD	
		TSSOP-8	TBD	
		SOIC-14	TBD	
		TSSOP-14	TBD	
—	Output Short-Circuit to GND (One Amplifier) (Note 7)	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_{ST}	Storage Temperature Range		-65 to +150	°C
ESD	Human Body Mode ESD Protection (Note 8)		300	V
	Machine Mode ESD Protection		150	

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. 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. Maximum power dissipation is a function of $T_{J(max)}$, θ_{JC}, 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. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

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

7. Electrical Characteristics

(Notes 12 & 13) (@V_{CC} = +5.0V, T_A = +25°C, unless otherwise specified.)

LM2902, LM2902A

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 Max, R_S = 0Ω	Non-A Device	T_A=+25°C	—	2	7	mV
					Full Range	—	—	10	
				A-Suffix Device	TA=+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 9)		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 10)		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 = 0.5V_{CC}, No Load	V_{CC} = 30V	Full Range	—	1.0	3.0	mA
			V_O = 0.5V_{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 11)		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

LM2904, LM2904A

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 Max 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 9)		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 10)		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 = 0.5V_{CC}, No Load	V_{CC} = 30V	Full Range	—	0.7	2.0	mA
		V_O = 0.5V_{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 11)		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	—	—	
			V_{CC} = 30V, R_L ≥ 10kΩ		27	28	—	
V_{OL}	Low-Lever Output Voltage Swing		R_L ≦ 10kΩ	Full Range	—	5	20	mV

8. AC Electrical Characteristics

(Notes 12 & 13) (@ V_{CC} = ±15.0V, T_A = +25°C, unless otherwise specified.)

LM2902, LM2902A

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, VI = 0V, f = 1kHz	40	nV/√Hz

LM2904, LM2904A

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:

9. 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.

10.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}.

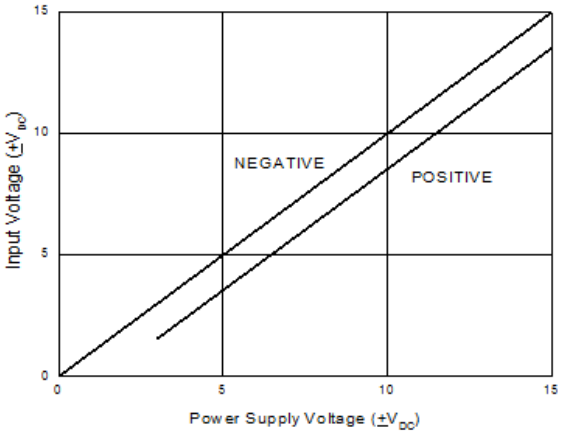
11. Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.

12. 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.

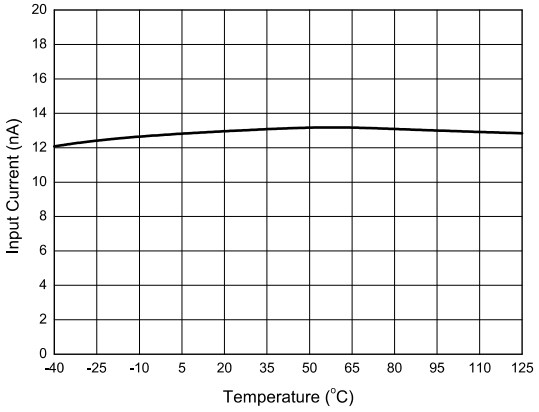
13. All limits are guaranteed by testing or statistical analysis. Limits over the full temperature are guaranteed by design, but not tested in production.

9. Typical Characteristics

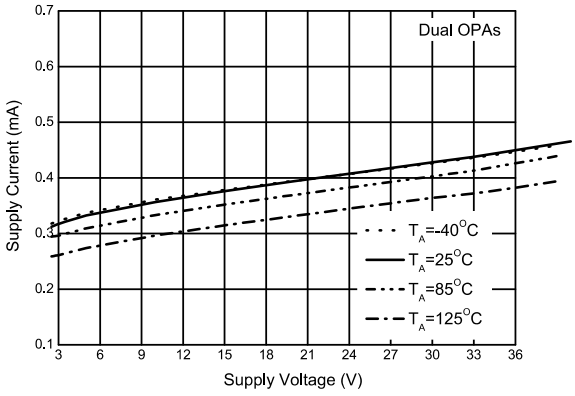
Input Voltage Range



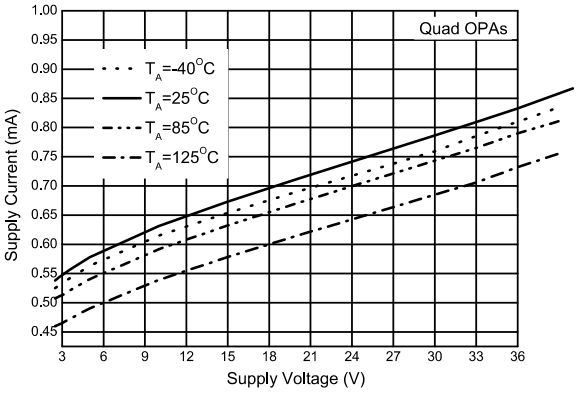
Input Current



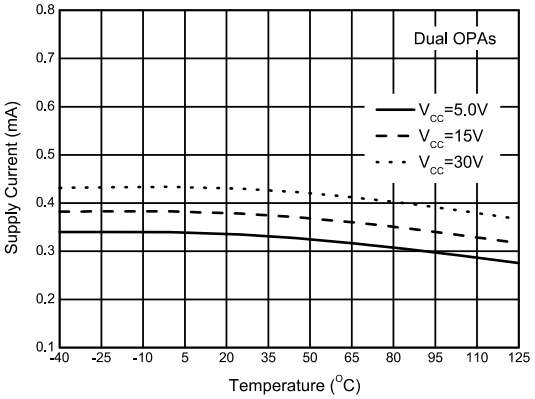
Supply Current vs. Supply Voltage (LM2904/LM2904A)



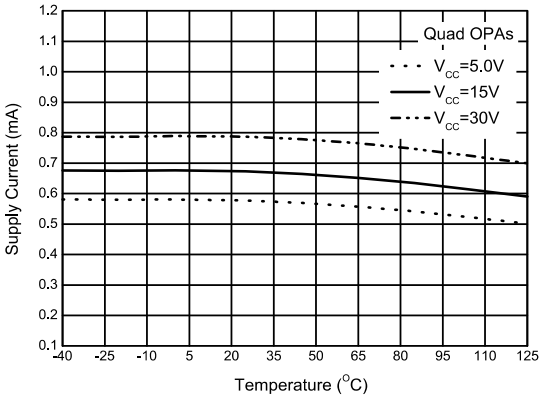
Supply Current vs. Supply Voltage (LM2902/LM2902A)



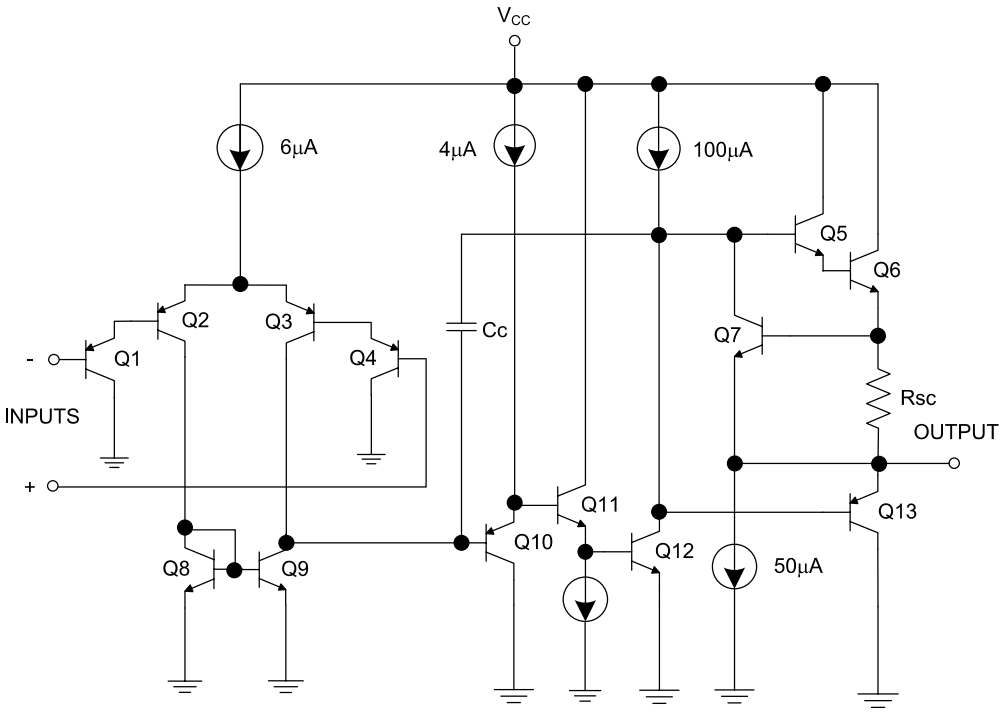
Supply Current vs. Temperature (LM2904/LM2904A)



Supply Current vs. Temperature (LM2902/LM2902A)



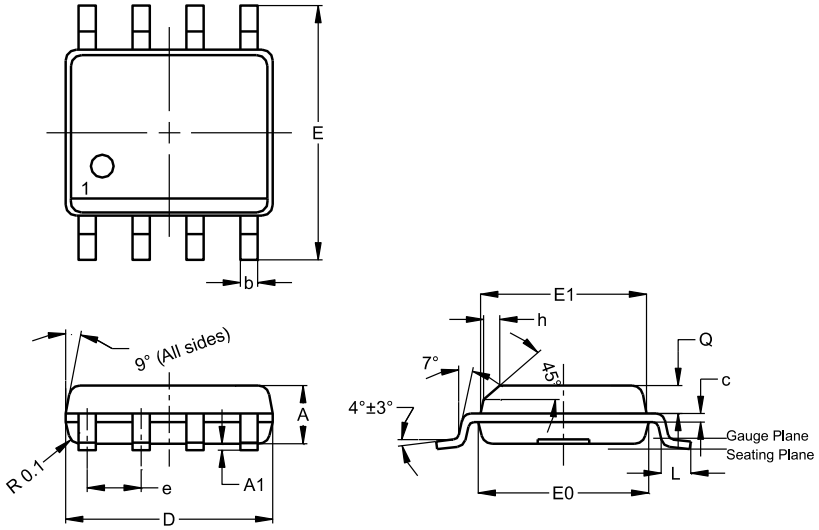
10. Functional Block Diagram



Each Amplifier

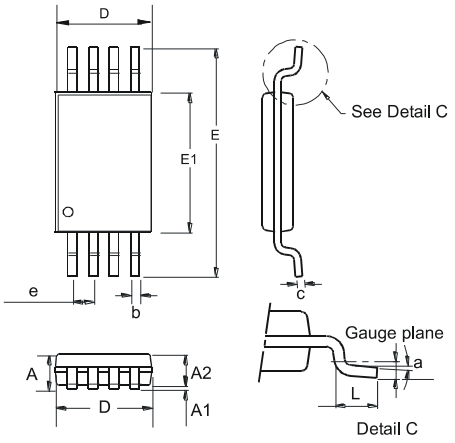
11. Package Outlines

SOIC-8



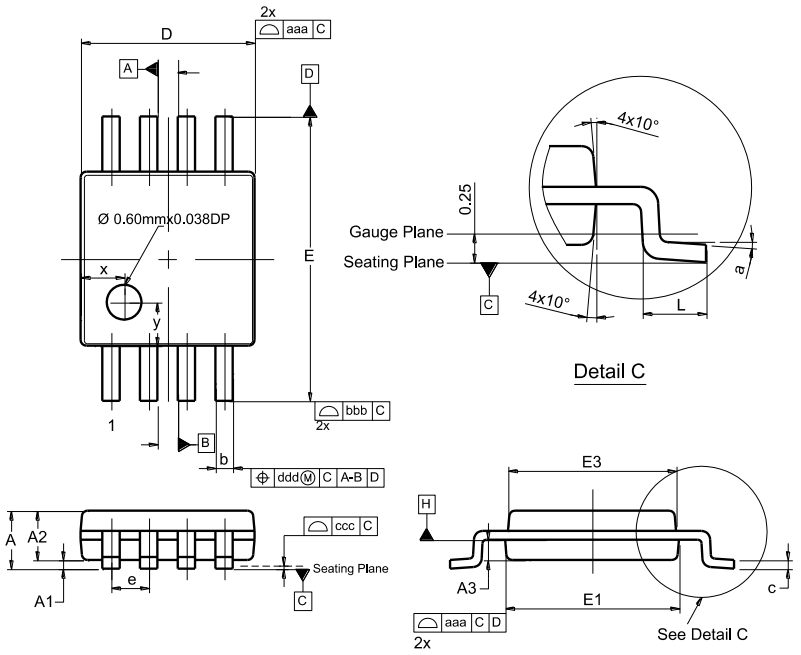
SOIC-8			
Dim	Min	Max	Typ
A	1.40	1.50	1.45
A1	0.10	0.20	0.15
b	0.30	0.50	0.40
c	0.15	0.25	0.20
D	4.85	4.95	4.90
E	5.90	6.10	6.00
E1	3.80	3.90	3.85
E0	3.85	3.95	3.90
e	--	--	1.27
h	-	--	0.35
L	0.62	0.82	0.72
Q	0.60	0.70	0.65
All Dimensions in mm			

TSSOP-8



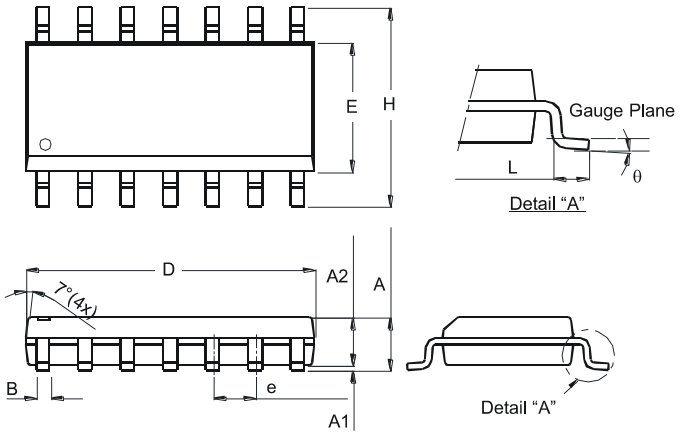
TSSOP-8			
Dim	Min	Max	Typ
a	0.09	–	–
A	–	1.20	–
A1	0.05	0.15	–
A2	0.825	1.025	0.925
b	0.19	0.30	–
c	0.09	0.20	–
D	2.90	3.10	3.025
e	–	–	0.65
E	–	–	6.40
E1	4.30	4.50	4.425
L	0.45	0.75	0.60
All Dimensions in mm			

MSOP-8



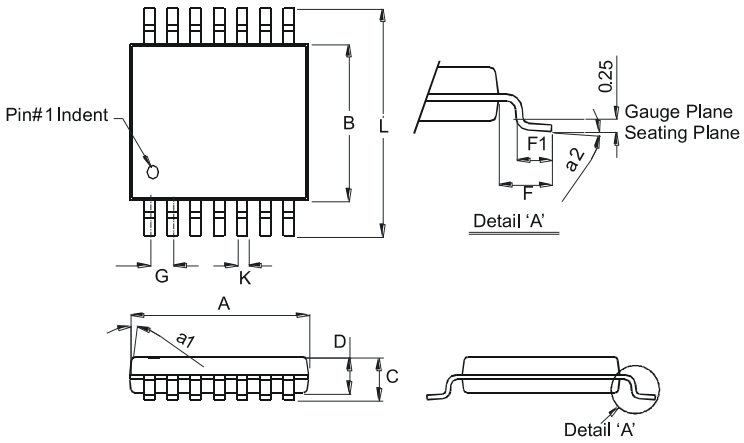
MSOP-8			
Dim	**Min**	**Max**	**Typ**
A	--	1.10	--
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E3	2.85	3.05	2.95
e	--	--	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	--	--	0.750
y	--	--	0.750
aaa	0.20		
bbb	0.25		
ccc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

SOIC-14



SOIC-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		

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