1.Features

- Wide Supply Ranges
  Single Supply: 3V to 32V (26 V for LM2902)
  Dual Supplies: +1.5V to +16V (+13V for LM2902)
- Low Supply-Current Drain independent of Supply Voltage: 0.8mA Typical
- Common-Mode Input Voltage Range includes Ground, Allowing Direct Sensing Near Ground
- Low Input Bias and Offset Parameters
  Input Offset Voltage: 3mV Typical
  Input Offset Current: 2nA Typical
  Input Bias Current: 20 nA Typical
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage: 32V(26V for LM2902)
- Open-Loop Differential Voltage Amplification: 100V/mV Typical
- Internal Frequency Compensation
- On Products Compliant to MIL-PRF-38535, All Parameters are Tested Unless Otherwise Noted. On All Other Products, Production Processing Does Not Necessarily Include Testingof All Parameters.

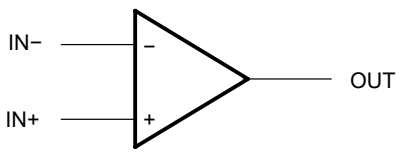
2.Description

These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply or split supply over a wide range of voltages.

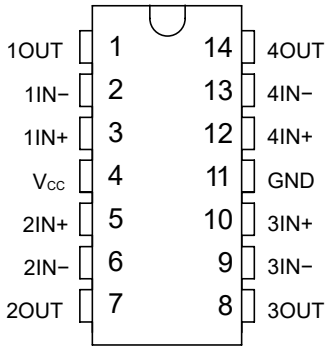
3.Applications

- Blu-ray Players and Home Theaters
- Chemical and Gas Sensors
- DVD Recorders and Players
- Digital Multimeter: Bench and Systems
- Digital Multimeter: Handhelds
- Field Transmitter: Temperature Sensors
- Motor Control: AC Induction, Brushed DC, Brushless DC, High-Voltage, Low-Voltage, Permanent Magnet, and Stepper Motor
- Oscilloscopes
- TV: LCD and Digital
- Temperature Sensors or Controllers Using Modbus
- Weigh Scales

4.Symbol (Each Amplifier)



5.Pinning Information



DR,PWR
14-Pin SOP, DIP,TSSOP

Pin Functions

Pin			I/O	Description
Name	LCCC NO.	SOP, DIP		
1IN-		2	I	Negative input
1IN+		3	I	Positive input
1OUT		1	O	Output
2IN-		6	I	Negative input
2IN+		5	I	Positive input
2OUT		7	O	Output
3IN-		9	I	Negative input
3IN+		10	I	Positive input
3OUT		8	O	Output
4IN-		13	I	Negative input
4IN+		12	I	Positive input
4OUT		14	O	Output
GND		11	-	Ground
V_{CC}	6	4	-	Power supply

6.Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

Parameter	Symbol	LM2902		LMX24		Units
		Min	Max	Min	Max	
Supply voltage (2)	V_{CC}		26		32	V
Differential input voltage (3)	V_{ID}		±26		±32	V
Input voltage (either input)	V_I	-0.3	26	-0.3	32	V
Duration of output short circuit (one amplifier) to ground at (or Unlimited Unlimited below) T_A=25°C, V_{CC}≤15V (4)		Unlimited		Unlimited		
Operating virtual junction temperature	T_J		150		150	°C
Storage temperature	T_{STG}	-65	150	-65	150	°C

(1) Stresses beyond those listed under Absolute Maximum Ratings may 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-rated conditions for extended periods may affect device reliability.

(2) All voltage values (except differential voltages and V_{CC} specified for the measurement of I_{OS}) are with respect to the network GND.

(3) Differential voltages are at IN+, with respect to IN-.

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

7.ESD Ratings

Parameter (LMX24, LM2902)		Symbol	Value	Units
Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	V_{ESD}	±500	V
	Charged-device model (CDM), per JEDEC specification JESD22-C101		±1000	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

8.Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)(1)

Parameter		Symbol	LM2902		LMX24		Units
			Min	Max	Min	Max	
Supply voltage		V_{CC}	3	26	3	30	V
Common-mode voltage		V_{CM}	0	V_{CC}-2	0	V_{CC}-2	V
Operating free air temperature	LM124	T_A			-40	105	°C
	LM2902		-40	105			°C
	LM224				-20	85	°C
	LM324				0	70	°C

9.Thermal Information

Thermal Metric (1)	Symbol	LMX24,LM2902		Units
		(SOP)	(DIP)	
		14Pins	14Pins	
Junction-to-ambient thermal resistance	$R_{\theta JA}$ (2) (3)	86	80	°C/W
Junction-to-case (top) thermal resistance	$R_{\theta JC}$ (4)	-	-	°C/W

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

(2) Maximum power dissipation is a function of $T_{J(max)}$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(max)} – T_A)/R_{\theta JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

(3) Maximum power dissipation is a function of $T_{J(max)}$, $R_{\theta JA}$, and T_C. The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_{J(max)} – T_C)/R_{\theta JC}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

10.Electrical Characteristics (LMx24)

at specified free-air temperature, V_{CC}=5V (unless otherwise noted)

Parameter	Symbol	Test Conditions(1)		T_A (2)	LMX24			LM2902			Units
					Min	Typ(3)	Max	Min	Typ(3)	Max	
Input offset voltage	V_{IO}	V_{CC}=5V to MAX		25°C		3	5		3	7	mV
		$V_{IC}=V_{ICR}$ min,V_O=1.4V		Full range			7			10	mV
Input offset current	I_{IO}	V_O=1.4V		25°C		2	30		2	50	nA
				Full range			100			300	nA
Input bias current	I_{IB}	V_O=1.4V		25°C		-20	-150		-20	-250	nA
				Full range			-300			-500	nA
Common-mode input voltage range	V_{ICR}	V_{CC}=5V to MAX		25°C			0 to V_{CC} - 1.5			0 to V_{CC} - 1.5	V
				Full range			0 to V_{CC} - 2			0 to V_{CC} - 2	V
High-level output voltage	V_{OH}	R_L=2kΩ		25°C	V_{CC} - 1.5			V_{CC} - 1.5			V
		V_{CC}=MAX	R_L=2kΩ	Full range	26			22			V
			R_L=10kΩ	Full range	27	28		23	24		V
Low-level output voltage	V_{OL}	R_L≤10kΩ		Full range		5	20		5	20	mV
Large-signal differential voltage amplification	A_{VD}	V_{CC}=15V, V_O=1V to 11V, R_L≥2kΩ		25°C	50	100					V/mV
				Full range	25			15	100		V/mV
Common-mode rejection ratio	CMRR	$V_{IC}=V_{ICR}$min		25°C	70	80		50	80		dB
Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	k_{SVR}			25°C	65	100		50	100		dB
Crosstalk attenuation	V_{O1}/V_{O2}	f=1kHz to 20kHz		25°C		120			120		dB

Parameter	Symbol	Test Conditions(1)	T_A (2)	LMX24			LM2902			Units
				Min	Typ(3)	Max	Min	Typ(3)	Max	
Output current	I_O	V_{CC}=15V, V_{ID}=1V	25°C	-20	-30	-60	-20	-30	-60	mA
		V_O=0 (Source)	Full range	-10			-10			mA
		V_{CC}=15V, V_{ID}=-1V	25°C	10	20		10	20		mA
		V_O=15V (Sink)	Full range	5			5			mA
		V_{ID}=-1V, V_O=200mV	25°C	12	30			30		μA
Short-circuit output current	I_{OS}	V_{CC} at 5V, V_O=0 GND at -5V	25°C		±40	±60		±40	±60	mA
Supply current (four amplifiers)	I_{CC}	V_O=2.5V, no load	Full range		0.7	1.2		0.7	1.2	mA
		V_{CC}=MAX, V_O=0.5V_{CC} no load	Full range		1.4	3		1.4	3	mA

(1) All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified. MAX V_{CC} for testing purposes is 26 V for LM2902 and 30 V for the others.

(2) Full range is -40°C to 125°C for LM124, –20°C to 85°C for LM224

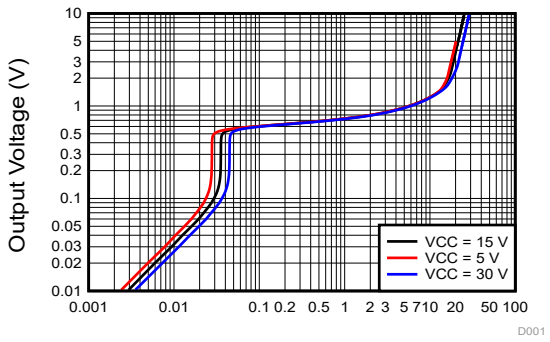
(3) All typical values are at T_A=25°C

11.Operating Conditions

V_{CC}=±15 V, T_A=25°C

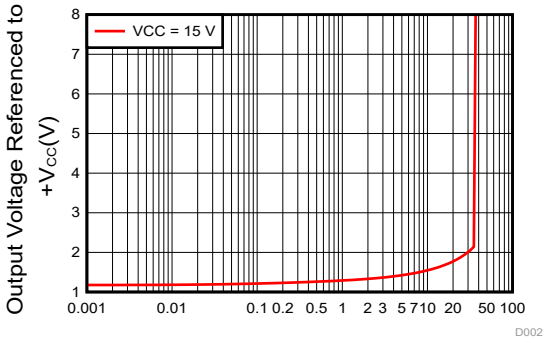
Parameter	Symbol	Test Conditions	Typ	Units
Slew rate at unity gain	SR	R_L=1MΩ, C_L=30pF, V_I=±10V (see Figure 7)	0.5	V/μs
Unity-gain bandwidth	B_1	R_L=1MΩ, C_L=20pF (see Figure 7)	1.2	MHz
Equivalent input noise voltage	V_n	R_S=100Ω, V_I=0V, f=1kHz (see Figure 8)	35	nV/√Hz

12.Typical Characterisitics



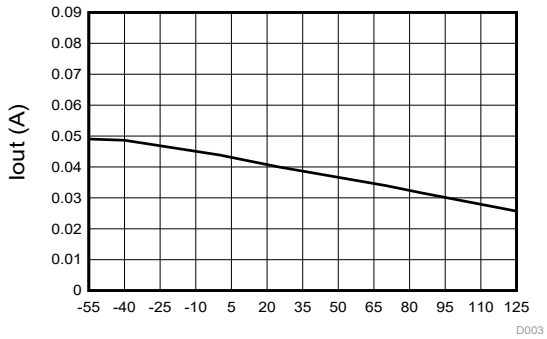
Output Sink Current (mA)

Figure 1: Output Sinking Characteristics



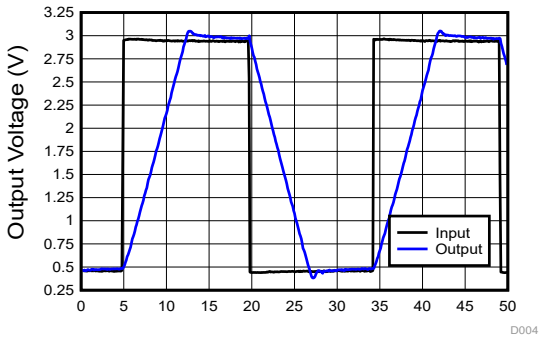
Output Source Current (mA)

Figure 2: Output Sourcing Characteristics



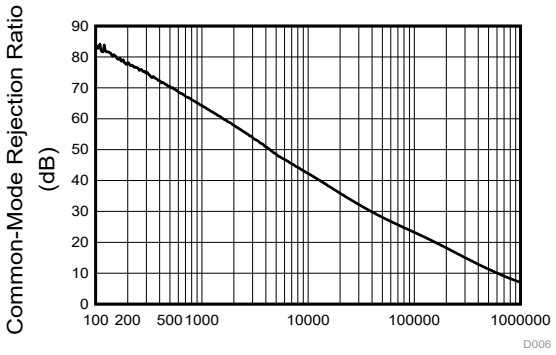
Temperature (°C)

Figure 3: Source Current Limiting



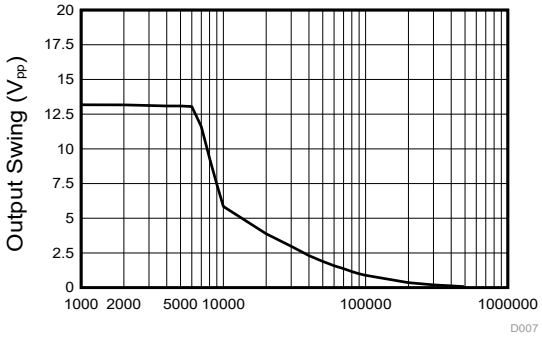
Time (µS)

Figure 4: Voltage Follower Large Signal Response (50 pF)



Frequency (Hz)

Figure 5: Common-Mode Rejection Ratio



Frequency (Hz)

Figure 6: Maximum Output Swing vs. Frequency (V_{CC} = 15 V)

13.Parameter Measurement Information

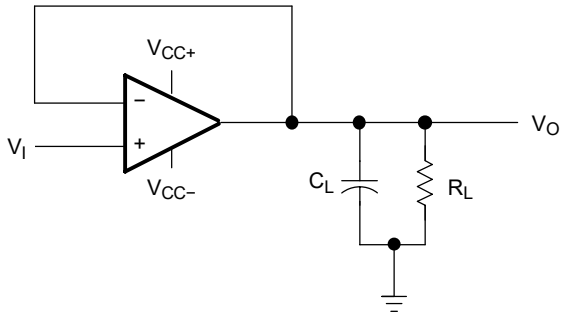


Figure 7: Unity-Gain Amplifier

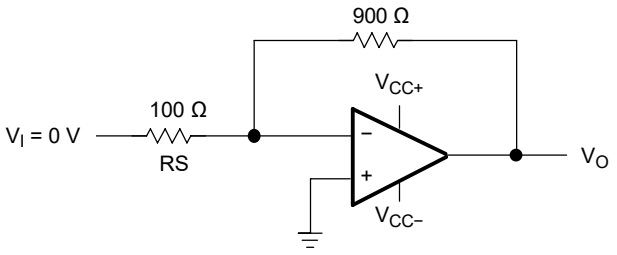


Figure 8: Noise-Test Circuit

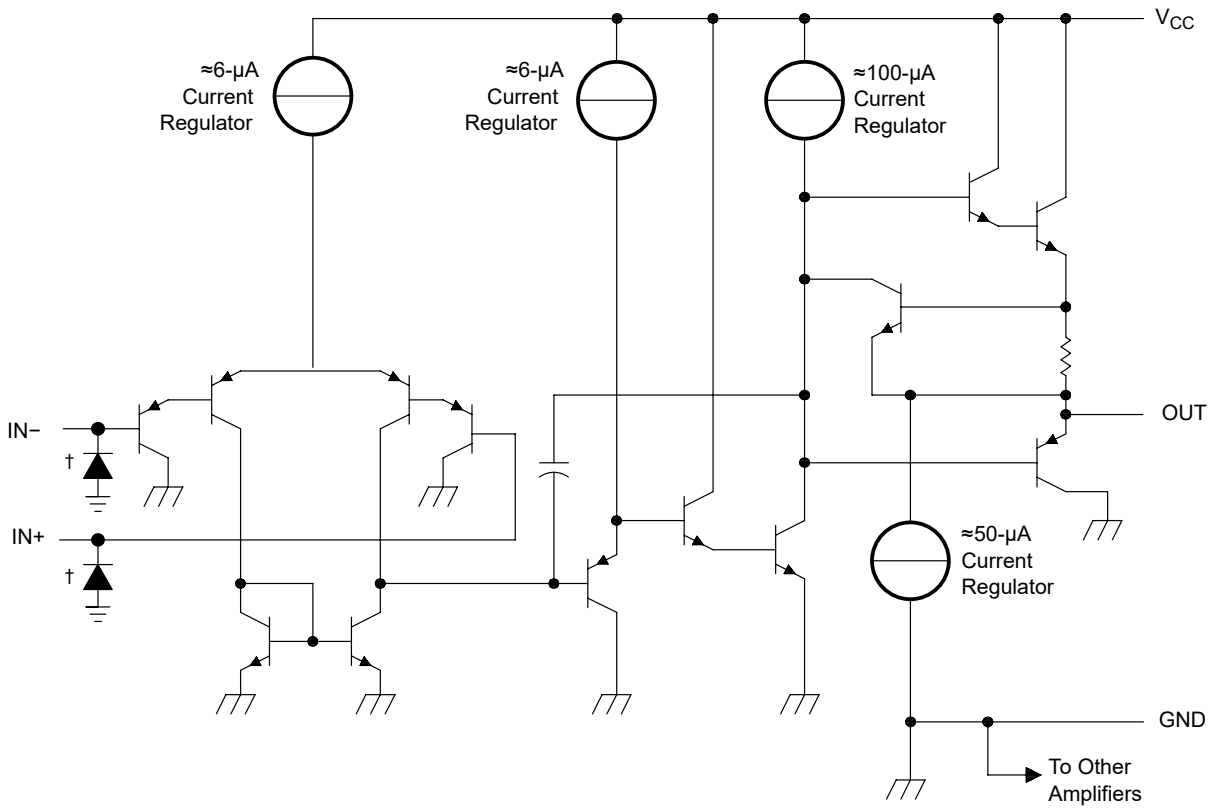
14.Detailed Description

14.1 Overview

These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3 V to 32 V (3 V to 26 V for the LM2902 device), and V_{CC} is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

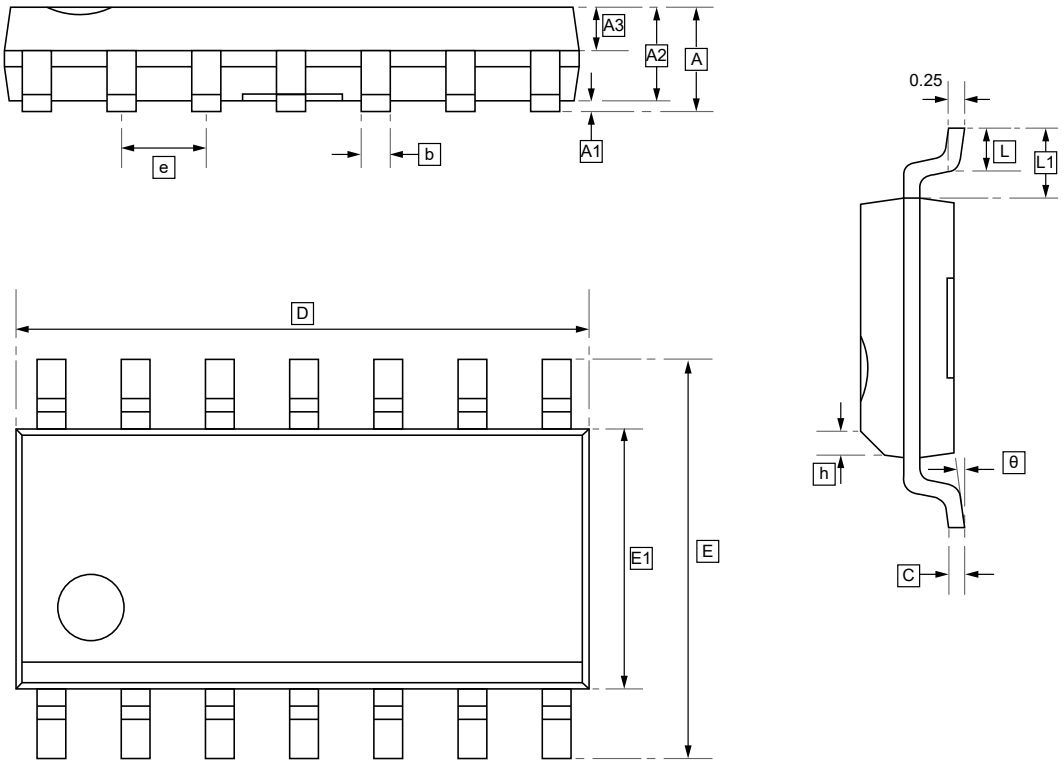
Applications include transducer amplifiers, DC amplification blocks, and all the conventional operational-amplifier circuits that now can be more easily implemented in single-supply-voltage systems. For example, the LM124 device can be operated directly from the standard 5-V supply that is used in digital systems and provides the required interface electronics, without requiring additional ±15-V supplies.

14.2 Functional Block Diagram



COMPONENT COUNT (total device)	
Epi-FET	1
Transistors	95
Diodes	4
Resistors	11
Capacitors	4

15.1 SOP-14 Package Outline Dimensions

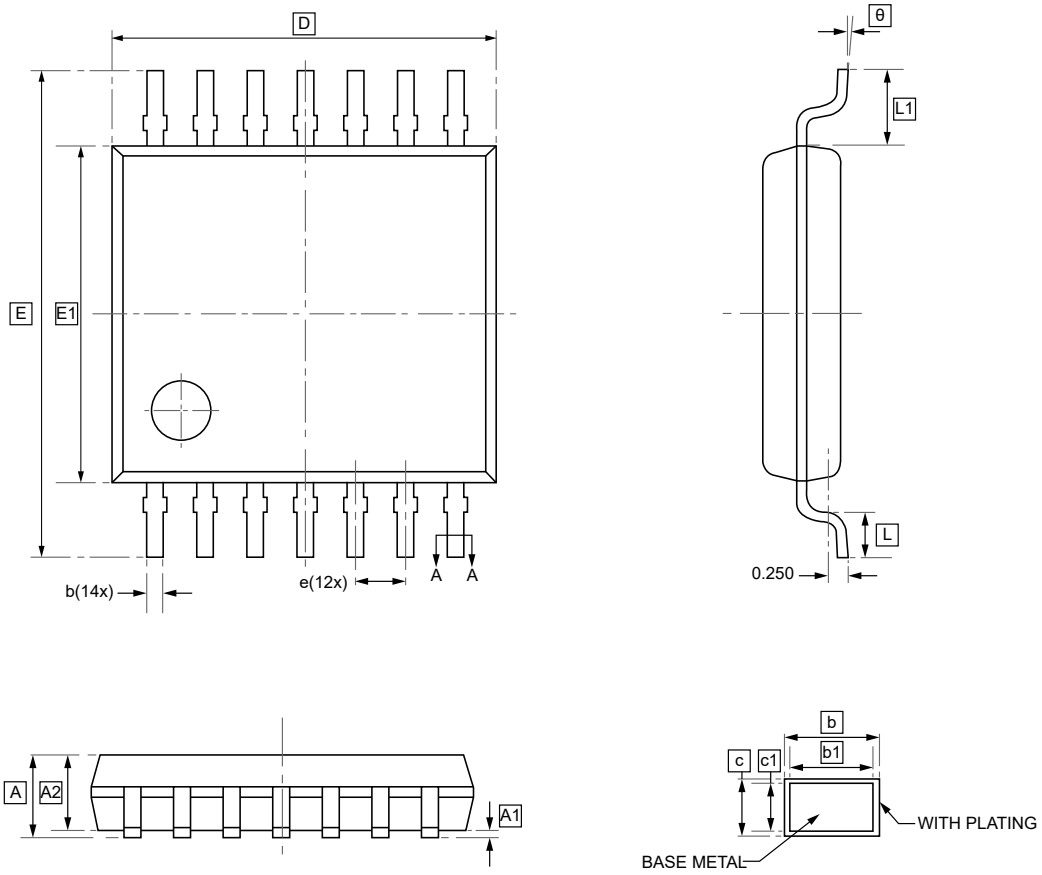


DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	A3	b	C	D	E	E1	e	h	L
Min	-	0.05	1.35	0.65	0.203	0.17	8.45	5.80	3.80	1.24	0.25	0.40
Max	1.75	0.25	1.55	0.75	0.305	0.25	8.85	6.20	4.00	1.30	0.50	0.80

Symbol	L1	θ
Min	1.00	0°
Max	1.10	8°

15.2 TSSOP-14 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	b	b1	c	c1	D	E	E1	e	L1
Min	-	0.05	0.90	0.20	0.19	0.13	0.120	4.90	6.20	4.30	0.65	0.85
Max	1.20	0.15	1.05	0.28	0.25	0.17	0.14	5.10	6.60	4.50	BSC	1.15

Symbol	L	θ
Min	0.45	0°
Max	0.75	8°

16.Ordering Information

SOP-14



TSSOP-14



yww: Batch Code

Order Code	Marking	Package	Base QTY	Delivery Mode
UMW LM124DR	LM124	SOP-14	2500	Tape and reel
UMW LM224DR	LM224	SOP-14	2500	Tape and reel
UMW LM2902DR	LM2902	SOP-14	2500	Tape and reel
UMW LM2902PWR	LM2902	TSSOP-14	4000	Tape and reel

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