

### Features

- Supply Voltage: 3 V to 36 V or  $\pm 1.5$  V to  $\pm 18$  V
- Low Supply Current: 100  $\mu$ A per channel
- Input Common-Mode Voltage Range Includes Ground
- Can Work as Comparators
- Rail-to-Rail Output
- Bandwidth: 0.9 MHz
- Slew Rate: 0.5 V/ $\mu$ s
- Excellent EMI Suppress Performance: 71 dB at 1 GHz
- Offset Voltage:  $\pm 3$  mV Maximum
- $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  Operation Temperature Range
- Qualified for Automotive Applications with AEC-Q100 Reliability Test

### Applications

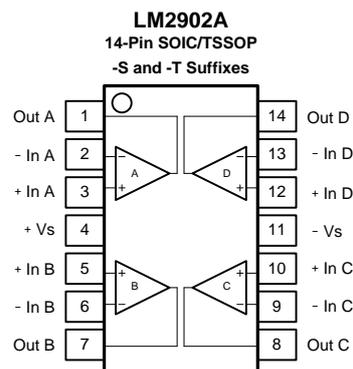
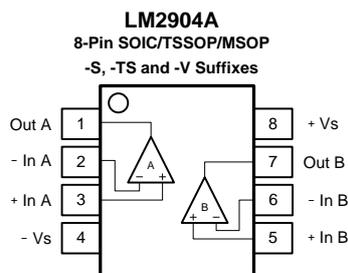
- Automotive
- Sensor Interface
- Motor Control

### Description

The LM2904A/2902A series of amplifiers are the newest high-supply voltage amplifiers with low offset, low power, and stable frequency response. They incorporate 3PEAK’s proprietary and patented design techniques to achieve very good AC performance with 0.9-MHz bandwidth and 0.5-V/ $\mu$ s slew rate. The input common-mode voltage range extends to  $V_{-}$ , and the outputs swing rail-to-rail. The LM2904A/2902A family can be used as plug-in replacements for many commercially available op-amps to reduce power and improve input/output range and performance.

The combination of features makes the LM2904A/2902A ideal choices for the power module, industrial control, motor control, and audio applications.

### Pin Configuration



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## Revision History

Date	Revision	Notes
2022-12-25	Rev.A.0	Initial version.
2023-06-01	Rev.A.1.	The following updates are all about the new datasheet formats or typo, the actual product remains unchanged. Updated address of web site. Updated tape and reel information. Updated status of LM2902A-TS2R-S and LM2902A-SO2R-S, the Q100 test is finished.

## Absolute Maximum Ratings <sup>(1)</sup>

Parameters	Rating
Supply Voltage, (+V <sub>S</sub> )– (–V <sub>S</sub> )	40 V
Voltage on Input Pin and Output Pin	(–V <sub>S</sub> ) – 0.3 to (+V <sub>S</sub> ) + 0.3
Differential Input Voltage	(–V <sub>S</sub> ) – (+V <sub>S</sub> ) to (+V <sub>S</sub> ) – (–V <sub>S</sub> )
Input Current: +I <sub>N</sub> , –I <sub>N</sub> <sup>Note 2</sup>	±10mA
Output Short-Circuit Duration <sup>Note 3</sup>	Infinite
Maximum Junction Temperature	150°C
Operating Temperature Range	–40 to 125°C
Storage Temperature Range	–65 to 150°C
Lead Temperature (Soldering, 10 sec)	260°C

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 300 mV beyond the power supply, the input current should be limited to less than 10 mA.

Note 3: A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

## ESD Rating

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	AEC-Q100-002	3	kV
CDM	Charged Device Model ESD	AEC-Q100-011	1	kV

## Thermal Information

Package Type	$\theta_{JA}$	$\theta_{JC}$	Unit
SOP8	158	43	°C/W
TSSOP8	191	44	°C/W
MSOP8	210	45	°C/W
SOP14	120	36	°C/W
TSSOP14	180	35	°C/W

## Electrical Characteristics

All test conditions:  $V_S = 30\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 10\text{ k}\Omega$ ,  $C_L = 100\text{ pF}$ , unless otherwise noted.

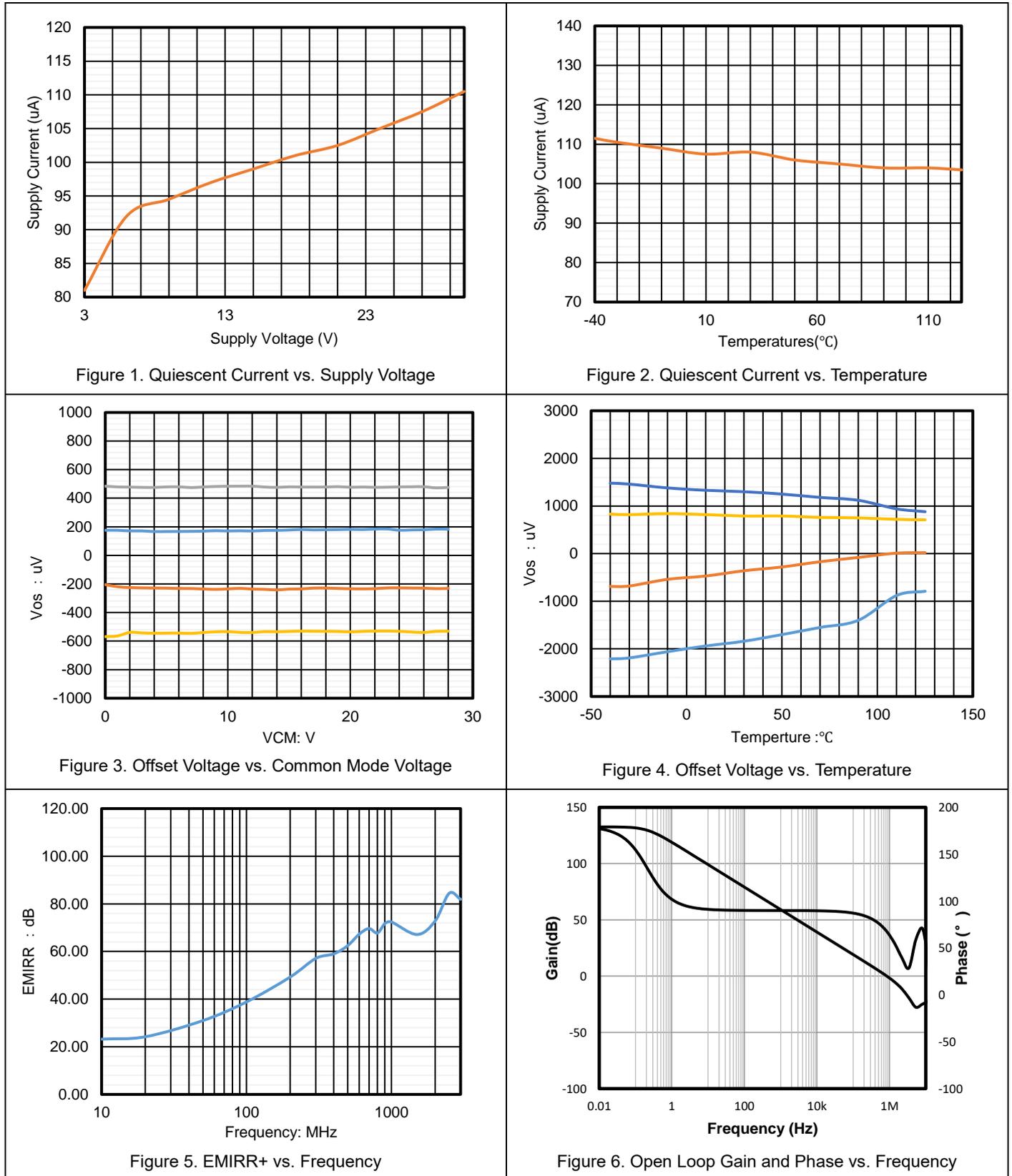
Symbol	Parameter	Conditions	$T_A$	Min	Typ	Max	Unit
<b>Power Supply</b>							
$V_S$	Supply Voltage Range			3		36	V
$I_Q$	Quiescent Current per Amplifier	$V_S = 30\text{ V}$			120	300	$\mu\text{A}$
			Operating Range			500	$\mu\text{A}$
PSRR	Power Supply Rejection Ratio	$V_S = 5\text{ V to } 36\text{ V}$		80	120		dB
			Operating Range	70			dB
<b>Input Characteristics</b>							
$V_{OS}$	Input Offset Voltage	$V_S = 30\text{ V}, V_{CM} = 0\text{ V to } 28\text{ V}$		-4	1	4	mV
			Operating Range	-7		7	mV
		$V_S = 5\text{ V}, V_{CM} = 0\text{ V to } 3\text{ V}$		-4	1	4	mV
			Operating Range	-7		7	mV
$V_{OS\ TC}$	Input Offset Voltage Drift		Operating Range		7		$\mu\text{V}/^\circ\text{C}$
$I_B$	Input Bias Current <sup>(1)</sup>				60	1000	pA
			Operating Range		600	2000	pA
$I_{OS}$	Input Offset Current <sup>(1)</sup>				60	1000	pA
			Operating Range		600	2000	pA
$R_{IN}$	Input Impedence				$10^{10}$		$\Omega$
$C_{IN}$	Input Capacitance	Differential Mode			5		pF
		Common Mode			5		pF
$A_V$	Open-loop Voltage Gain			90	110		dB
			Operating Range	85			dB
$V_{CMR}$	Common-Mode Input Voltage Range		Operating Range	(V-)		(V+) - 2	V
CMRR	Common Mode Rejection Ratio	$V_{CM} = 0\text{ V to } 28\text{ V}$		65	120		dB
			Operating Range	60	90		dB
<b>Output Characteristics</b>							
	Output Voltage Swing from Positive and Negative Rail	$R_{LOAD} = 10\text{ k}\Omega\text{ to } V_S/2$			200	500	mV
			Operating Range			1000	mV
		$R_{LOAD} = 2\text{ k}\Omega\text{ to } V_S/2$			1.1	1.5	V
			Operating Range			3	V
	Output Voltage Swing from Negative Rail	$V_S = 5\text{ V}, R_{LOAD} = 10\text{ k}\Omega\text{ to } 0\text{ V}$			5	20	mV
$I_{SC}$	Output Short-Circuit Current			10	25		mA
			Operating Range	5			mA

(1) Provided by bench test and design simulation

AC Specifications							
GBW	Gain-Bandwidth Product				0.9		MHz
SR	Slew Rate	G = 1, 2 V step			0.5		V/ $\mu$ s
$t_s$	Settling Time, 0.1%	G = 1, 2 V step			4		$\mu$ s
	Settling Time, 0.01%				5		$\mu$ s
PM	Phase Margin	$V_s = 30$ V, $R_L = 1$ K, $C_L = 100$ pF			60		°
GM	Gain Margin	$V_s = 30$ V, $R_L = 1$ K, $C_L = 100$ pF			15		dB
	Channel Separation	f = 1 kHz to 20 kHz			120		dB
Noise Performance							
$E_N$	Input Voltage Noise	f = 0.1 Hz to 10 Hz			3		$\mu$ V <sub>RMS</sub>
$e_N$	Input Voltage Noise Density	f = 1 kHz			70		nV/ $\sqrt$ Hz
$i_N$	Input Current Noise	f = 1 kHz			3		fA/ $\sqrt$ Hz

## Typical Performance Characteristics

All test conditions:  $V_s = \pm 15\text{ V}$ ,  $V_{CM} = 0\text{ V}$ ,  $R_L = 10\text{ k}\Omega$ , unless otherwise specified.



All test conditions:  $V_S = \pm 15\text{ V}$ ,  $V_{CM} = 0\text{ V}$ ,  $R_L = 10\text{ k}\Omega$ , unless otherwise specified.

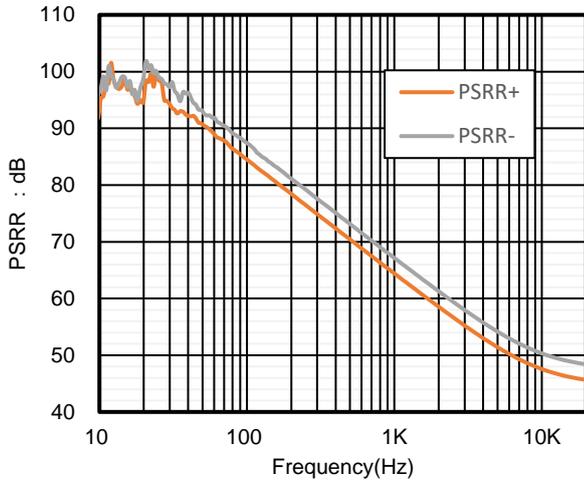


Figure 7. PSRR vs. Frequency

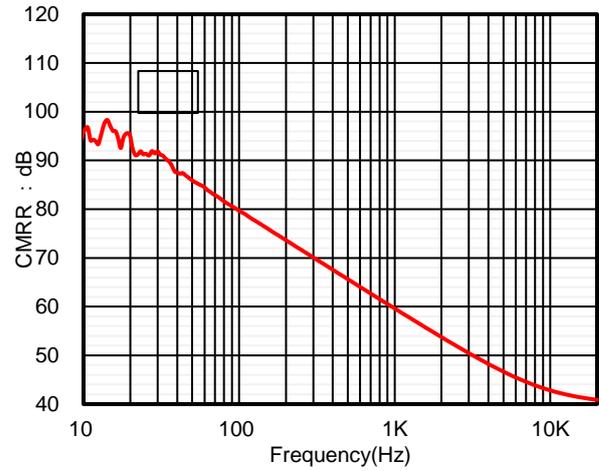


Figure 8. CMRR vs. Frequency

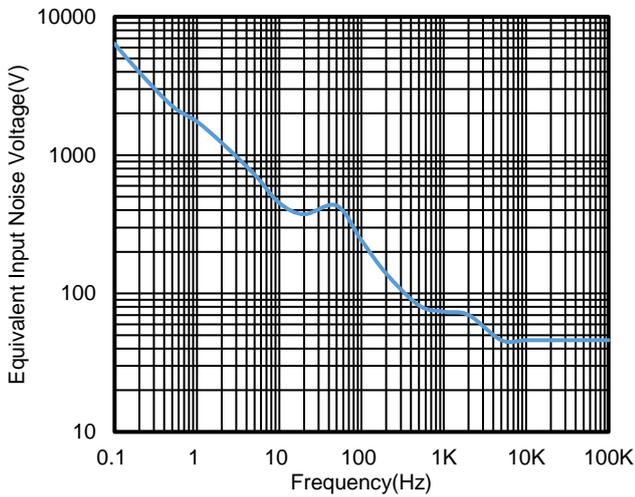


Figure 9. Voltage Noise Spectral Density vs. Frequency

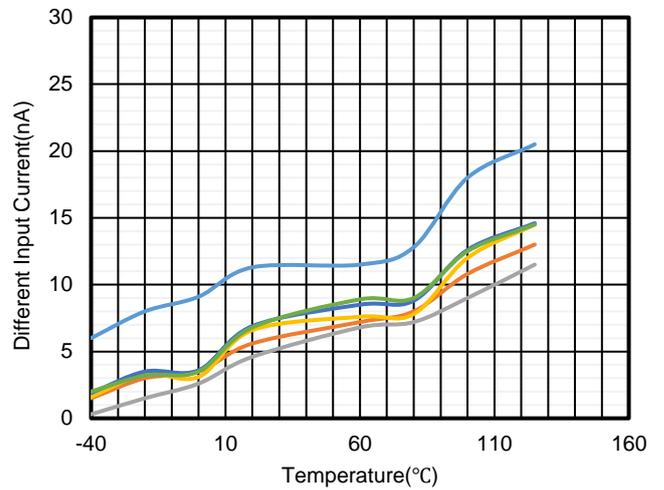
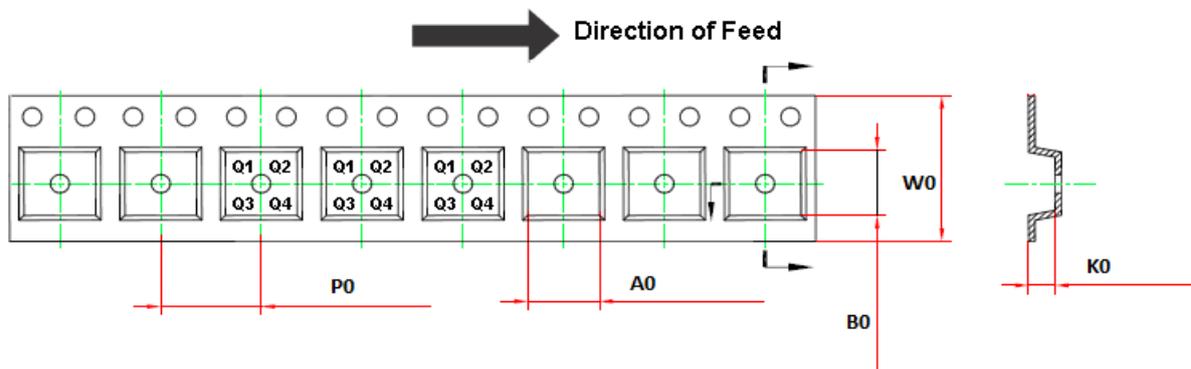
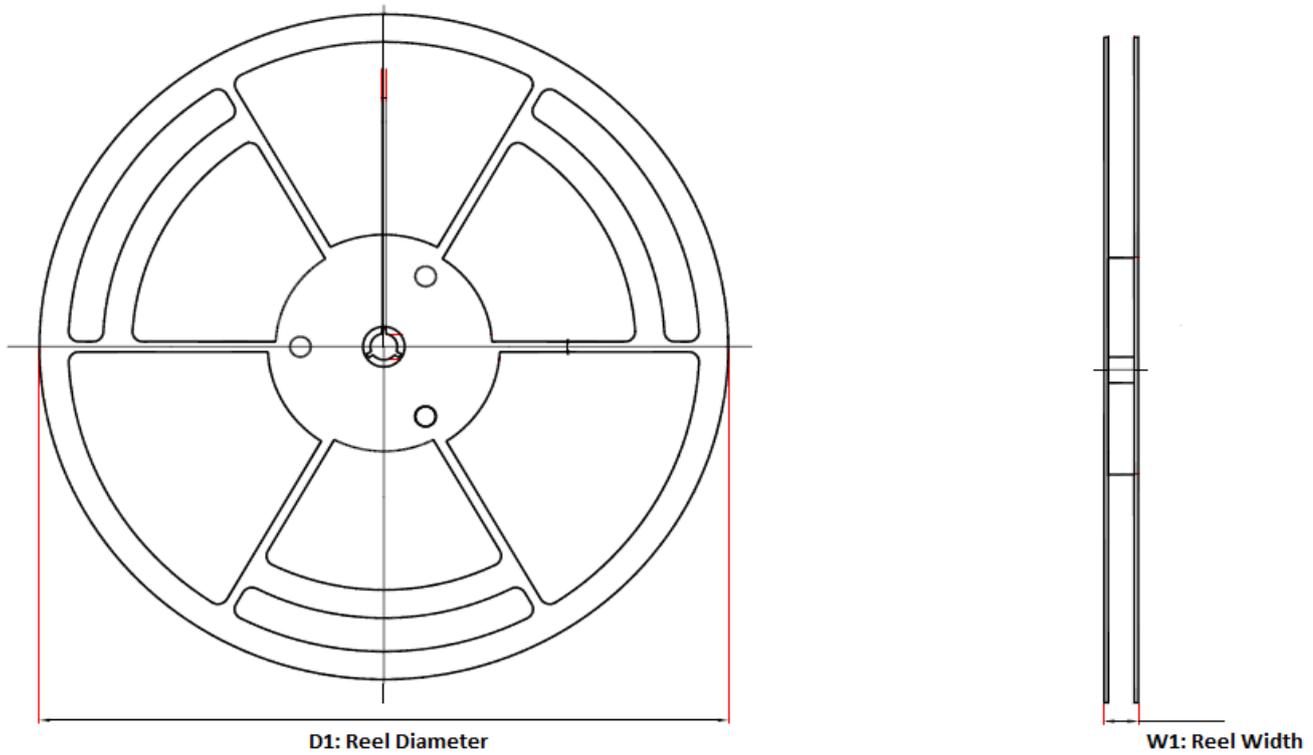


Figure 10. Different Input Current vs. Temperature

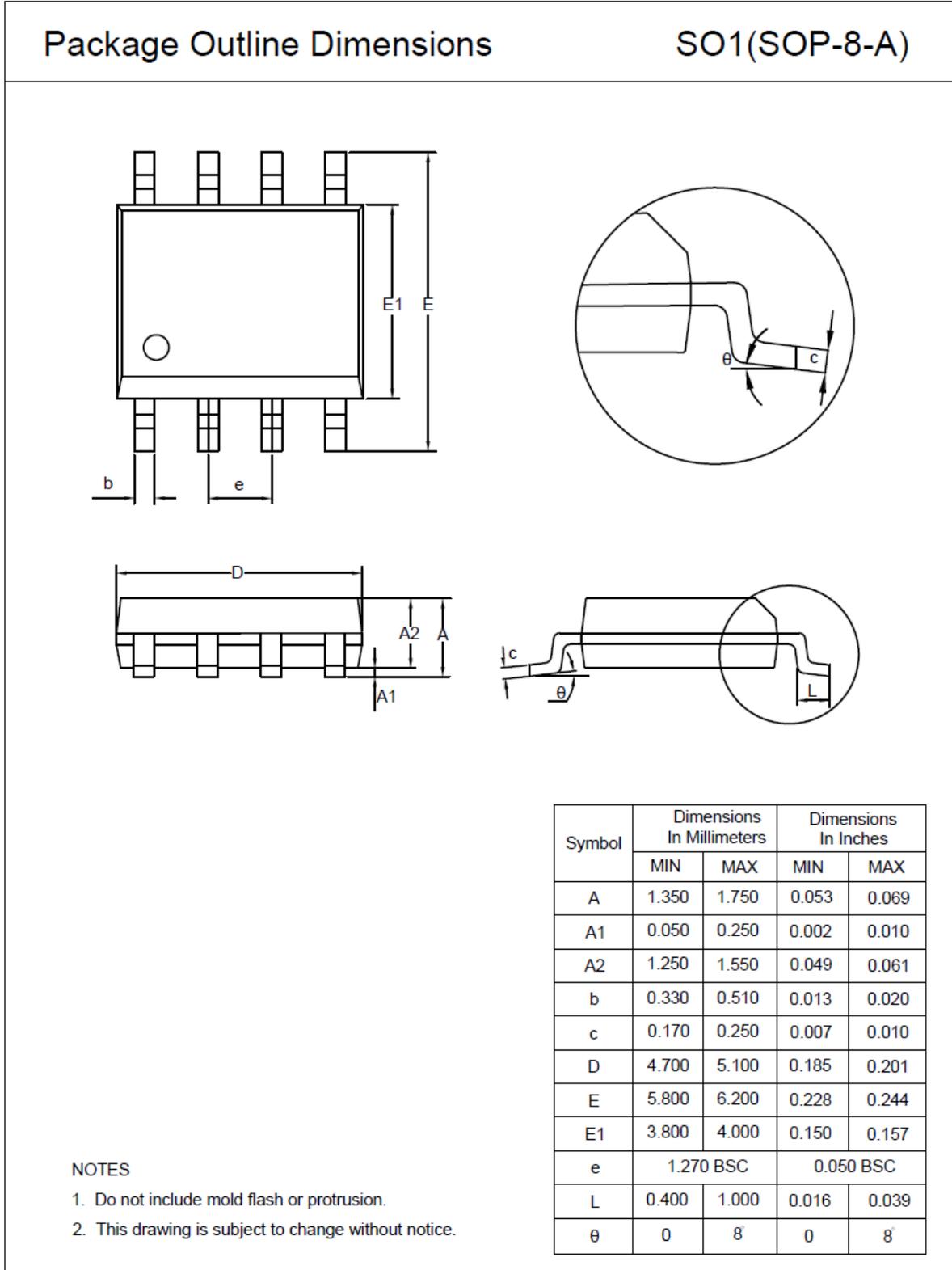
### Tape and Reel Information



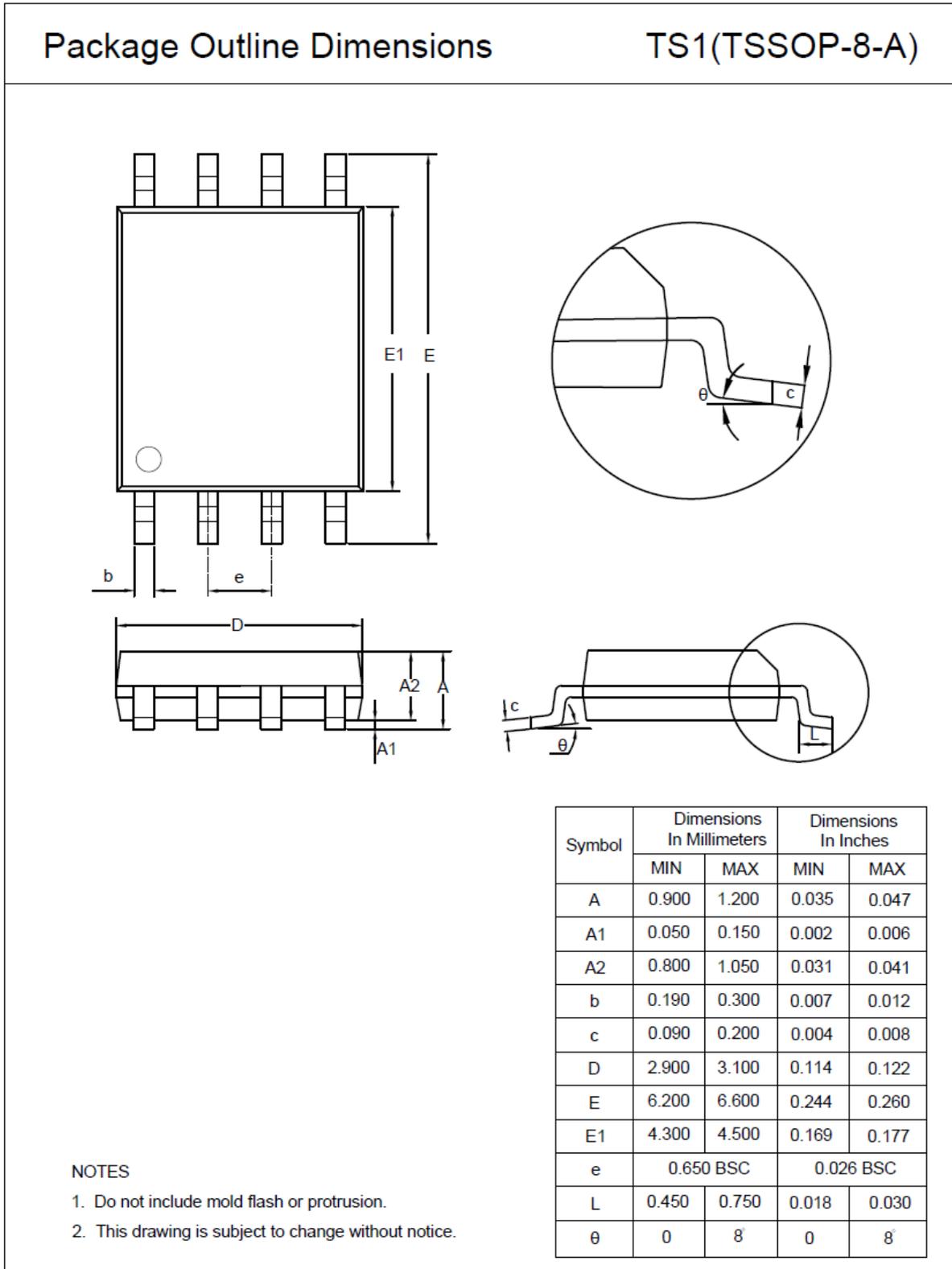
Order Number	Package	D1	W1	A0	B0	K0	P0	W0	Pin1 Quadrant
LM2904A-SO1R-S	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
LM2904A-VS1R-S	MSOP8	330.0	17.6	5.2	3.3	1.5	8.0	12.0	Q1
LM2904A-TS1R-S	TSSOP8	330.0	17.6	6.8	3.3	1.7	8.0	12.0	Q1
LM2902A-SO2R-S	SOP14	330.0	21.6	6.5	9.2	1.8	8.0	16.0	Q1
LM2902A-TS2R-S	TSSOP14	330.0	17.6	6.8	5.5	1.7	8.0	12.0	Q1

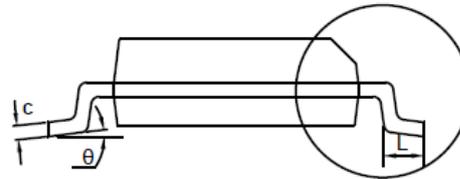
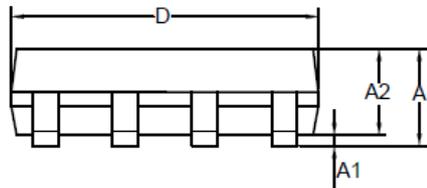
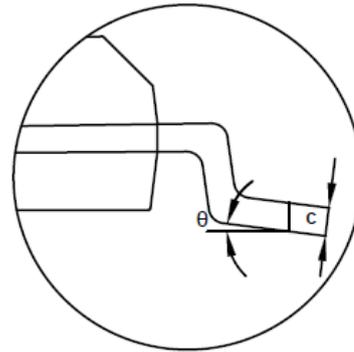
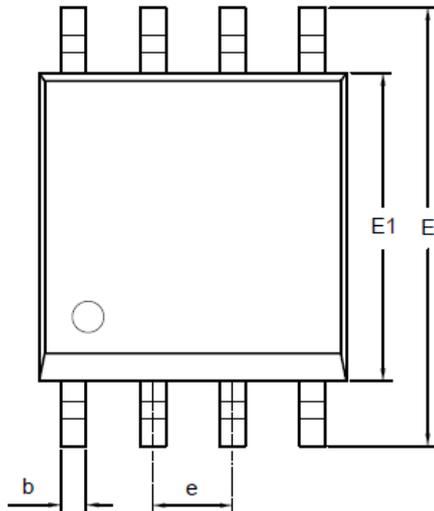
Package Outline Dimensions

SOP8



TSSOP8



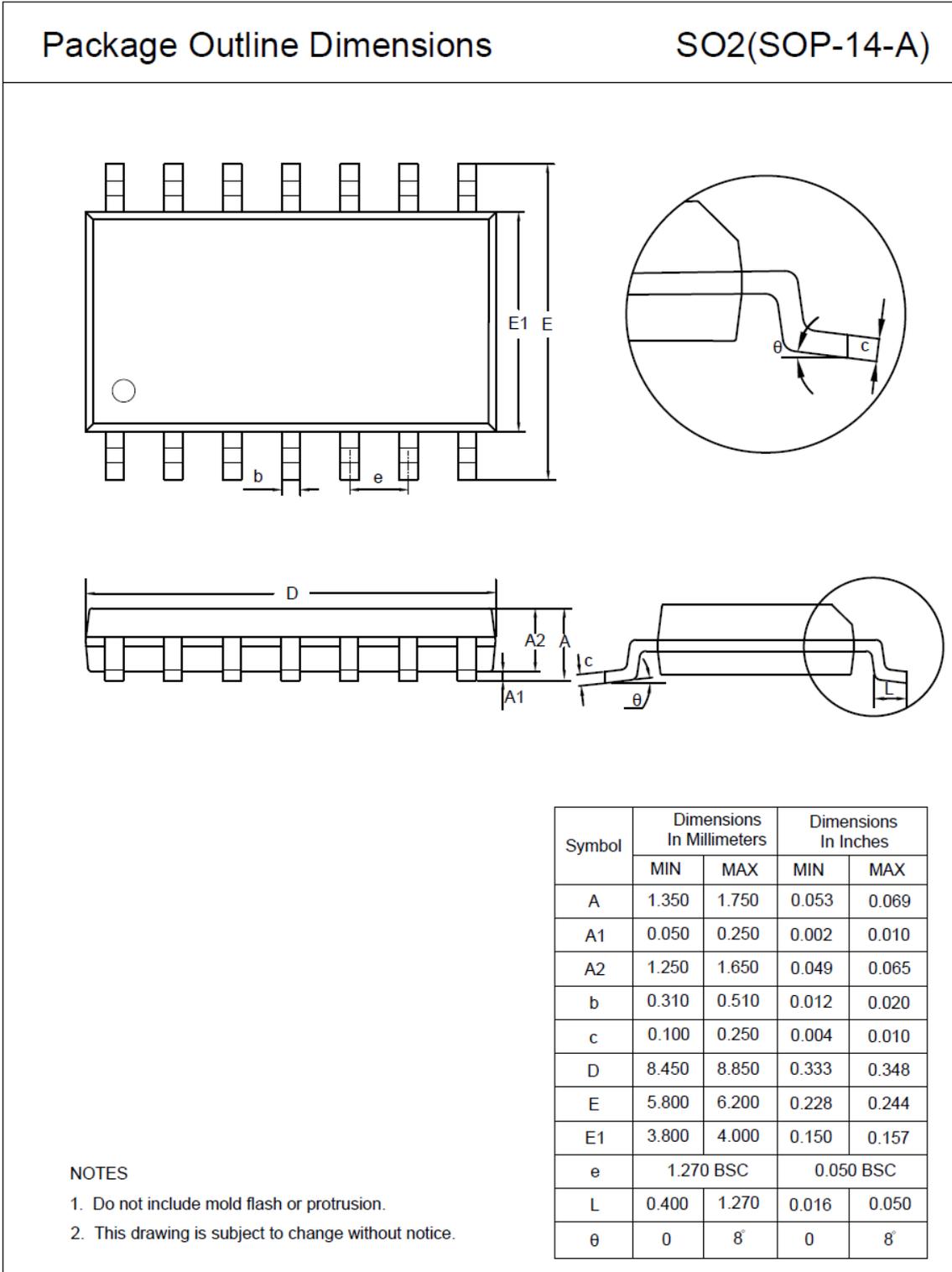
**MSOP8**
**Package Outline Dimensions**
**VS1(MSOP-8-A)**


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.050	0.150	0.002	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
$\theta$	0	8°	0	8°

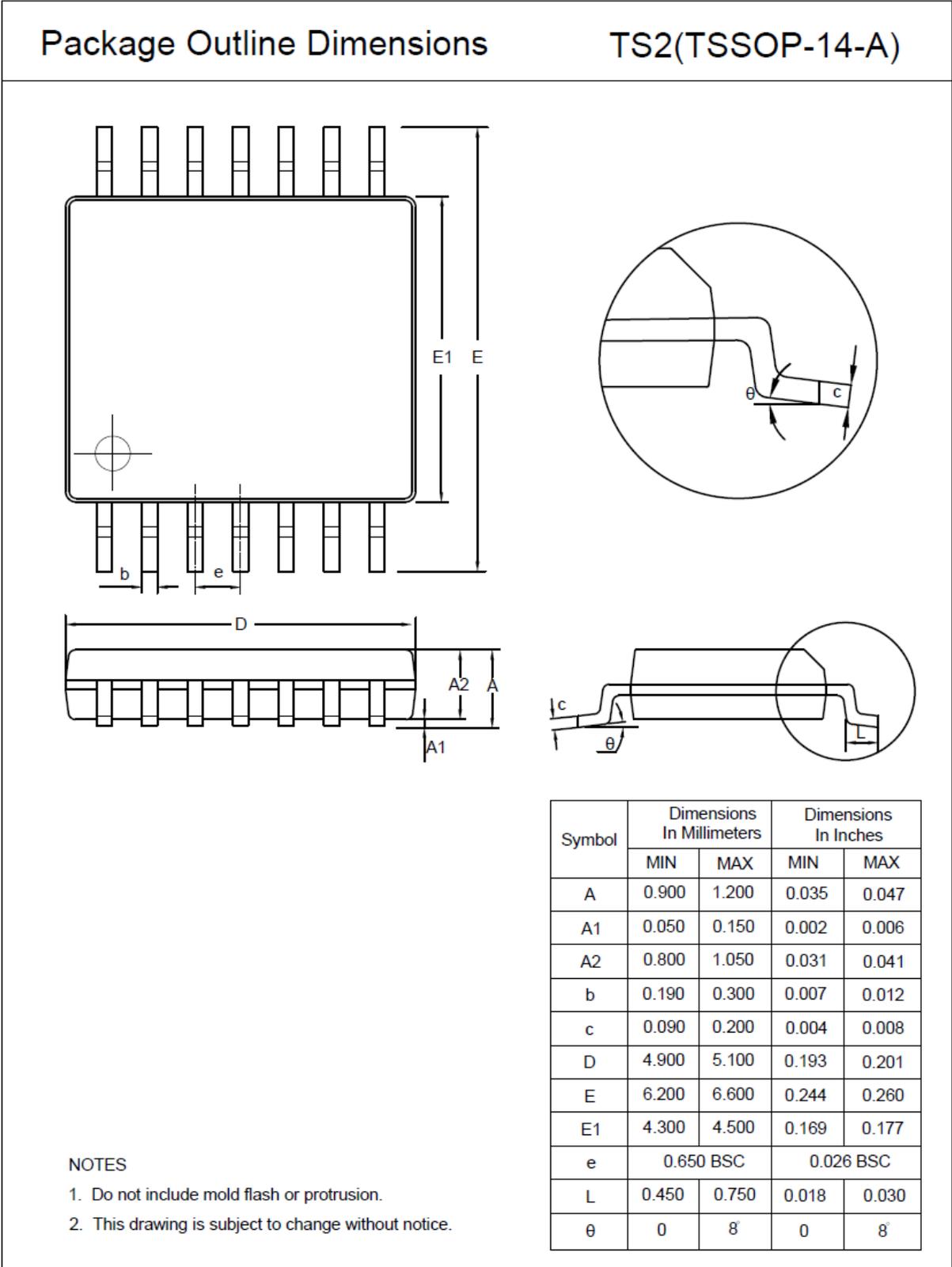
**NOTES**

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

SOP14



TSSOP14



**Order Information**

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity
LM2904A-SO1R-S	-40 to 125°C	SOP8	2904S	3	Tape and Reel, 4000
LM2904A-TS1R-S	-40 to 125°C	TSSOP8	2904S	3	Tape and Reel, 3000
LM2904A-VS1R-S	-40 to 125°C	MSOP8	2904S	3	Tape and Reel, 3000
LM2902A-SO2R-S	-40 to 125°C	SOP14	2902S	3	Tape and Reel, 2500
LM2902A-TS2R-S	-40 to 125°C	TSSOP14	2902S	3	Tape and Reel, 3000

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