

## 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 (Max)
- Offset Voltage Temperature Drift: 7  $\mu$ V/ $^{\circ}$ C
- Operating Temperature Range:  $-40^{\circ}$ C to  $125^{\circ}$ C

## Applications

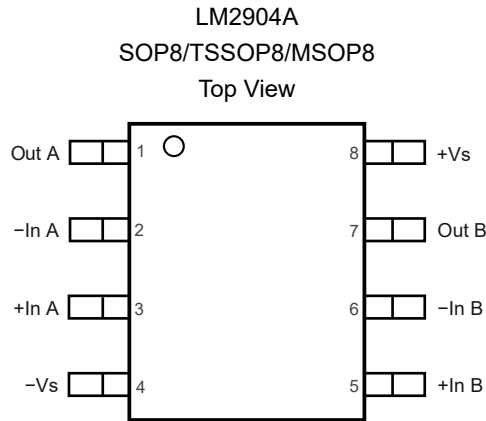
- Power Module
- Sensor Interface
- Motor Control
- Audio

## Description

The LM2904A/2902A is a series of the newest high-supply voltage amplifiers with low offset, low power, and stable frequency response. The series incorporates 3PEAK's proprietary and patented design techniques to achieve excellent AC performance with 0.9-MHz bandwidth, 0.5-V/ $\mu$ s slew rate, and maximum 3-mV offset while drawing only 100  $\mu$ A of quiescent current per amplifier. The input common-mode voltage range extends to  $-V_s$ , and the outputs swing rail-to-rail. The LM2904A/2902A series can be used as plug-in replacements for commercially available op amps to reduce power and improve input/output range and performance.

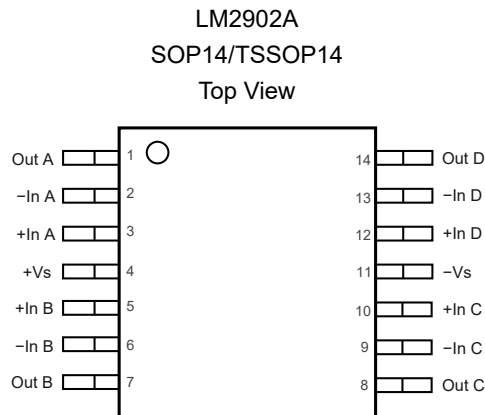
The combination of features makes the LM2904A/2902A ideal choices for the power module, industrial control, motor control, and audio applications.

## Pin Configuration and Functions



**Table 1. Pin Functions: LM2904A**

Pin No.	Name	I/O	Description
1	Out A	O	Output
2	-In A	I	Inverting input
3	+In A	I	Non-inverting input
4	-Vs	-	Negative power supply
5	+In B	I	Non-inverting input
6	-In B	I	Inverting input
7	Out B	O	Output
8	+Vs	-	Positive power supply

**36-V General Purpose Operational Amplifiers**

**Table 2. Pin Functions: LM2902A**

Pin No.	Name	I/O	Description
1	Out A	O	Output
2	-In A	I	Inverting input
3	+In A	I	Non-inverting input
4	+Vs	-	Positive power supply
5	+In B	I	Non-inverting input
6	-In B	I	Inverting input
7	Out B	O	Output power supply
8	Out C	O	Output power supply
9	-In C	I	Inverting input
10	+In C	I	Non-inverting input
11	-Vs	-	Negative power supply
12	+In D	I	Non-inverting input
13	-In D	I	Inverting input
14	Out D	O	Output

## Specifications

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

Parameter		Min	Max	Unit
	Supply Voltage, (+V <sub>S</sub> ) – (–V <sub>S</sub> )		40	V
	Input Voltage	(–V <sub>S</sub> ) – 0.3	(+V <sub>S</sub> ) + 0.3	V
	Differential Input Voltage		(+V <sub>S</sub> ) – (–V <sub>S</sub> )	V
	Input Current: +I <sub>N</sub> , –I <sub>N</sub> <sup>(2)</sup>	–10	10	mA
	Output Short-Circuit Duration <sup>(3)</sup>		Infinite	
T <sub>J</sub>	Maximum Junction Temperature		150	°C
T <sub>A</sub>	Operating Temperature Range	–40	125	°C
T <sub>STG</sub>	Storage Temperature Range	–65	150	°C
T <sub>L</sub>	Lead Temperature (Soldering 10 sec)		260	°C

(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.

(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.

(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, Electrostatic Discharge Protection

Symbol	Parameter	Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	3	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup>	2	kV

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

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### Thermal Information

Package Type	θ <sub>JA</sub>	θ <sub>JC</sub>	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

**36-V General Purpose Operational Amplifiers**
**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	$(+V_S) - (-V_S)$		3		36	V
$I_Q$	Quiescent Current per Amplifier	$V_S = 30\text{ V}$			110	200	$\mu\text{A}$
			$-40\text{ to }125^\circ\text{C}$			250	$\mu\text{A}$
		$V_S = 5\text{ V}$			100	150	$\mu\text{A}$
PSRR	Power Supply Rejection Ratio	$V_S = 5\text{ V to }36\text{ V}$		85	120		dB
			$-40\text{ to }125^\circ\text{C}$	80			dB
<b>Input Characteristics</b>							
$V_{OS}$	Input Offset Voltage	$V_S = 30\text{ V}, V_{CM} = 0\text{ V to }28\text{ V}$		-3	0.1	3	mV
			$-40\text{ to }85^\circ\text{C}$	-5		5	mV
			$-40\text{ to }125^\circ\text{C}$	-6		6	mV
		$V_S = 5\text{ V}, V_{CM} = 0\text{ V to }3\text{ V}$		-3	0.1	3	mV
			$-40\text{ to }85^\circ\text{C}$	-5		5	mV
			$-40\text{ to }125^\circ\text{C}$	-6		6	mV
$V_{OS\ TC}$	Input Offset Voltage Drift		$-40\text{ to }125^\circ\text{C}$		7		$\mu\text{V}/^\circ\text{C}$
$I_B$	Input Bias Current				60	500	pA
		$-40\text{ to }125^\circ\text{C}$			600	1000	pA
$I_{OS}$	Input Offset Current <sup>(1)</sup>				60	500	pA
		$-40\text{ to }125^\circ\text{C}$			600	1000	pA
$I_{IN}$	Different Input Current	$V_S = 36\text{ V}, V_{ID} = 36\text{ V}$			5	150	nA
		$V_S = 36\text{ V}, V_{ID} = 36\text{ V}$	$-40\text{ to }125^\circ\text{C}$		20	1000	nA
$C_{IN}$	Input Capacitance	Differential mode			5		pF
		Common mode			5		pF
$A_V$	Open-Loop Voltage Gain			95	110		dB
		$-40\text{ to }125^\circ\text{C}$		90			dB
$V_{CMR}$	Common-Mode Input Voltage Range			$(-V_S)$		$(+V_S) - 1.5$	V
		$-40\text{ to }125^\circ\text{C}$		$(-V_S)$		$(+V_S) - 2$	V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = 0\text{ V to }28\text{ V}$		75	120		dB
			$-40\text{ to }125^\circ\text{C}$	70	90		dB
<b>Output Characteristics</b>							

**36-V General Purpose Operational Amplifiers**

Symbol	Parameter	Conditions	T <sub>A</sub>	Min	Typ	Max	Unit
	Output Voltage Swing from Positive and Negative Rail	R <sub>LOAD</sub> = 10 kΩ to V <sub>S</sub> / 2			200	300	mV
			-40 to 125°C			700	mV
		R <sub>LOAD</sub> = 2 kΩ to V <sub>S</sub> / 2			1.1	1.3	V
			-40 to 125°C			2	V
	Output Voltage Swing from Negative Rail	V <sub>S</sub> = 5 V, R <sub>LOAD</sub> = 10 kΩ to 0 V			5	10	mV
			-40 to 125°C <sup>(1)</sup>			20	mV
I <sub>SC</sub>	Output Short-Circuit Current			25	30		mA
			-40 to 125°C	15			mA
<b>AC Specifications</b>							
GBW	Gain-Bandwidth Product				0.9		MHz
SR	Slew Rate	G = 1, 2-V step			0.5		V/μs
t <sub>s</sub>	Settling Time, 0.1%	G = 1, 2-V step			4		μs
	Settling Time, 0.01%				5		μs
PM	Phase Margin	V <sub>S</sub> = 30 V, R <sub>L</sub> = 1 kΩ, C <sub>L</sub> = 100 pF			60		°
GM	Gain Margin	V <sub>S</sub> = 30 V, R <sub>L</sub> = 1 kΩ, C <sub>L</sub> = 100 pF			15		dB
	Channel Separation	f = 1 kHz to 20 kHz			120		dB
<b>Noise Performance</b>							
E <sub>N</sub>	Input Voltage Noise	f = 0.1 Hz to 10 Hz			3		μV <sub>RMS</sub>
e <sub>N</sub>	Input Voltage Noise Density	f = 1 kHz			70		nV/√Hz
i <sub>N</sub>	Input Current Noise	f = 1 kHz			3		fA/√Hz
THD+N	Total Harmonic Distortion and Noise	f = 1 kHz, G = 1, R <sub>L</sub> = 10 kΩ, V <sub>OUT</sub> = 6 V <sub>RMS</sub>			0.001		%

(1) Provided by bench tests and design simulation.

Typical Performance Characteristics

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

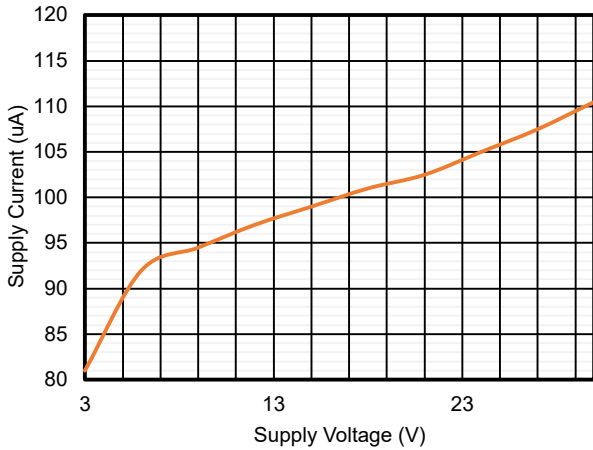


Figure 1. Quiescent Current vs. Supply Voltage

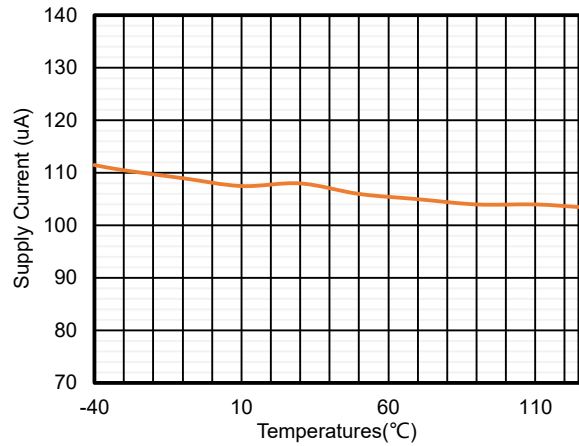


Figure 2. Quiescent Current vs. Temperature

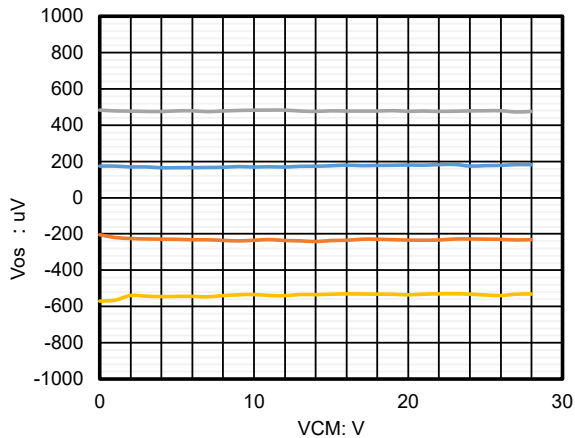


Figure 3. Offset Voltage vs. Common-Mode Voltage

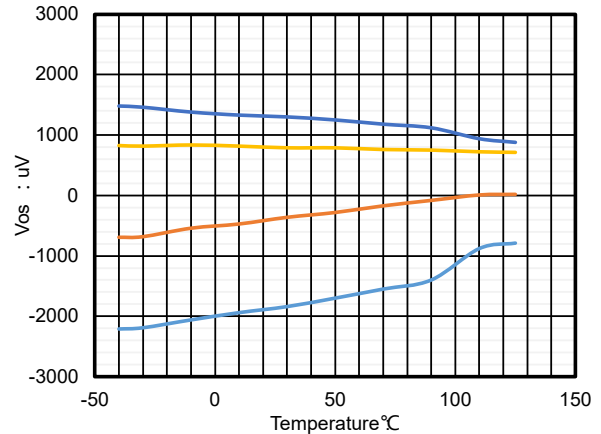


Figure 4. Offset Voltage vs. Temperature

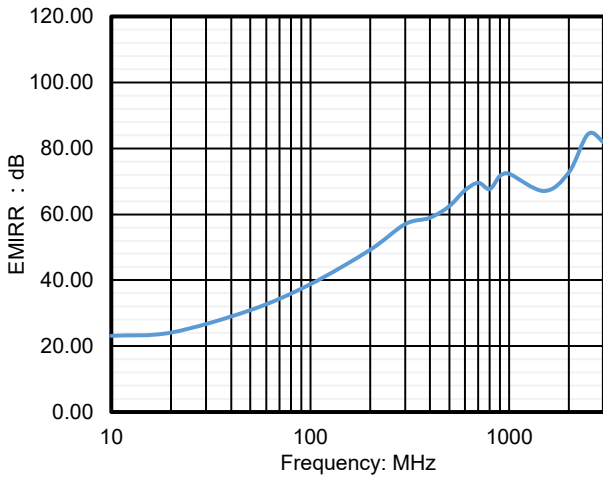


Figure 5. EMIRR+ vs. Frequency

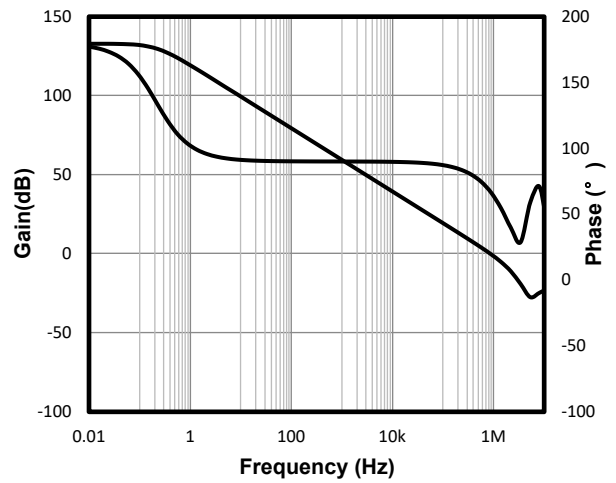


Figure 6. Open-Loop Gain and Phase vs. Frequency

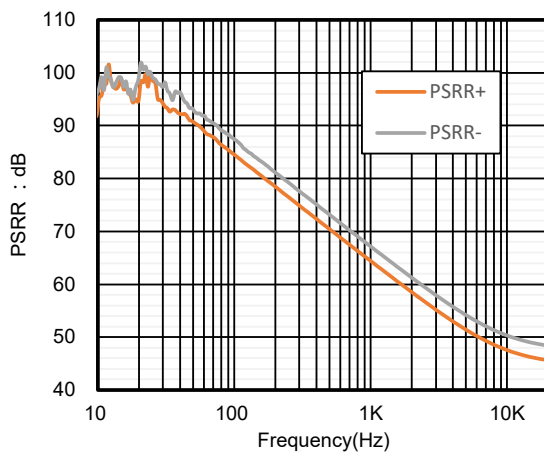


Figure 7. PSRR vs. Frequency

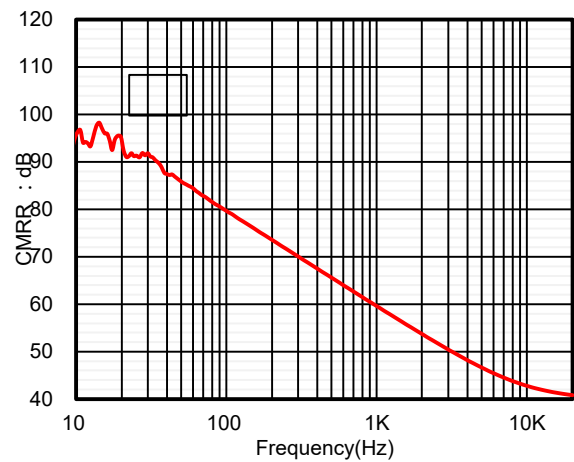


Figure 8. CMRR vs. Frequency

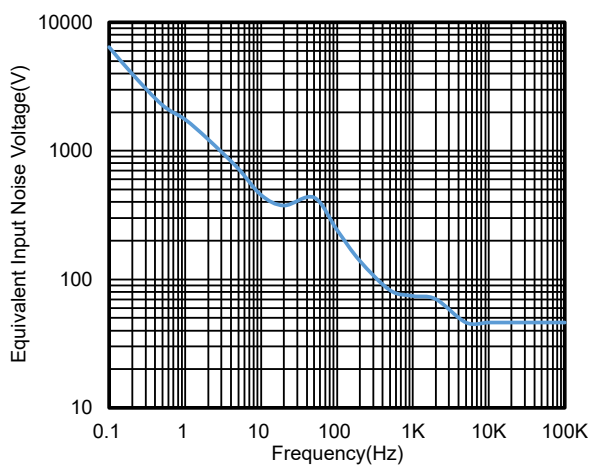


Figure 9. Voltage Noise Spectral Density vs. Frequency

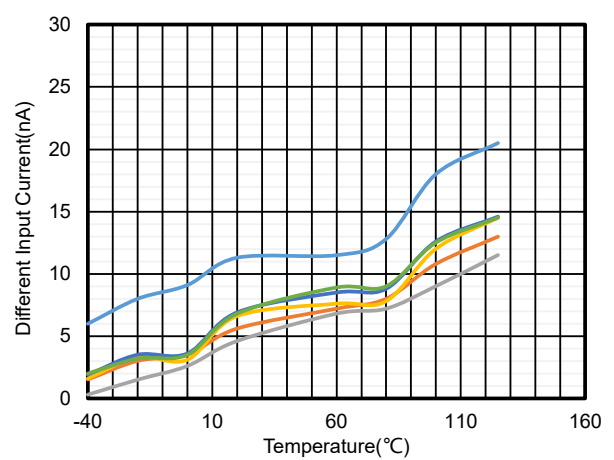
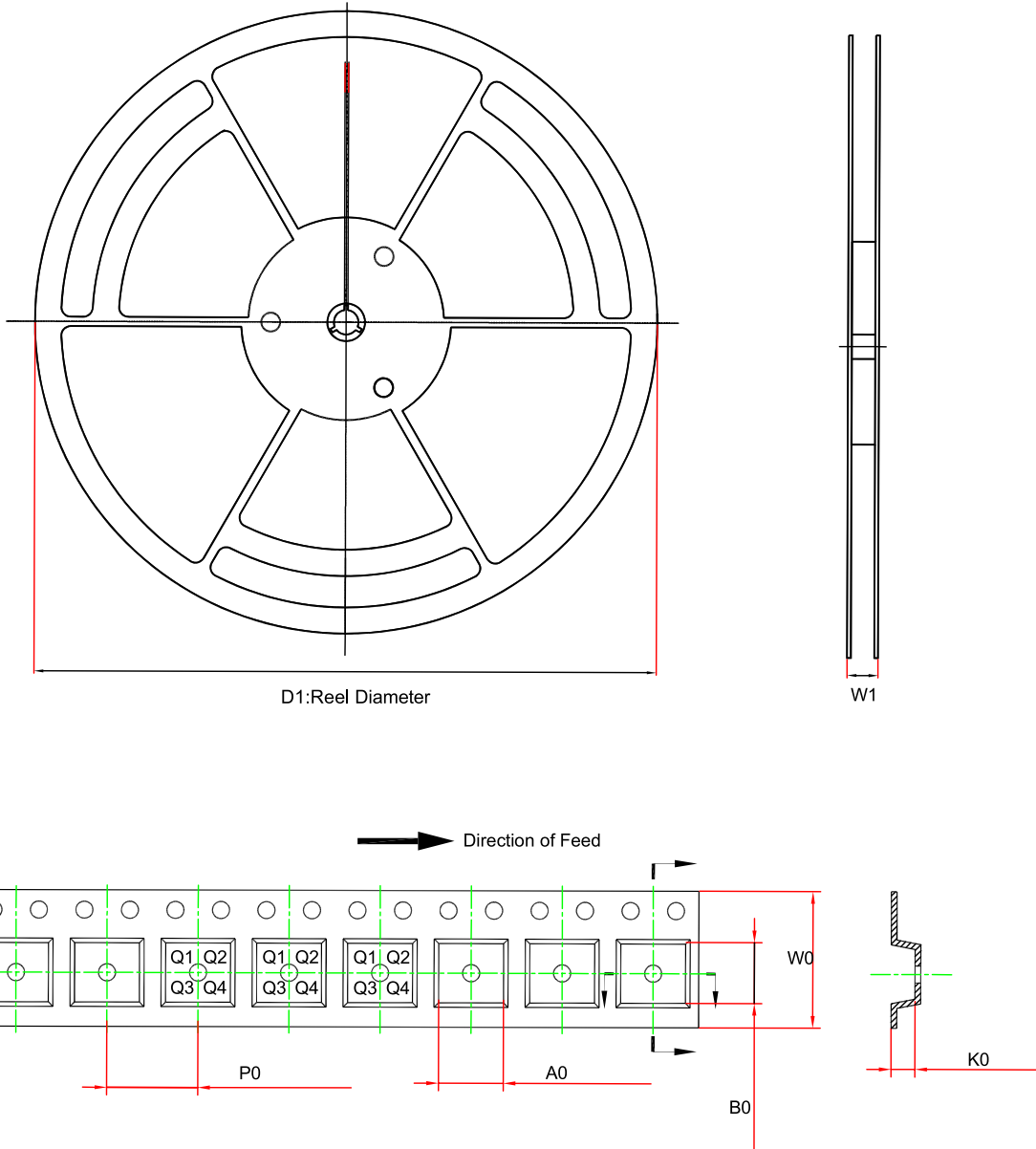
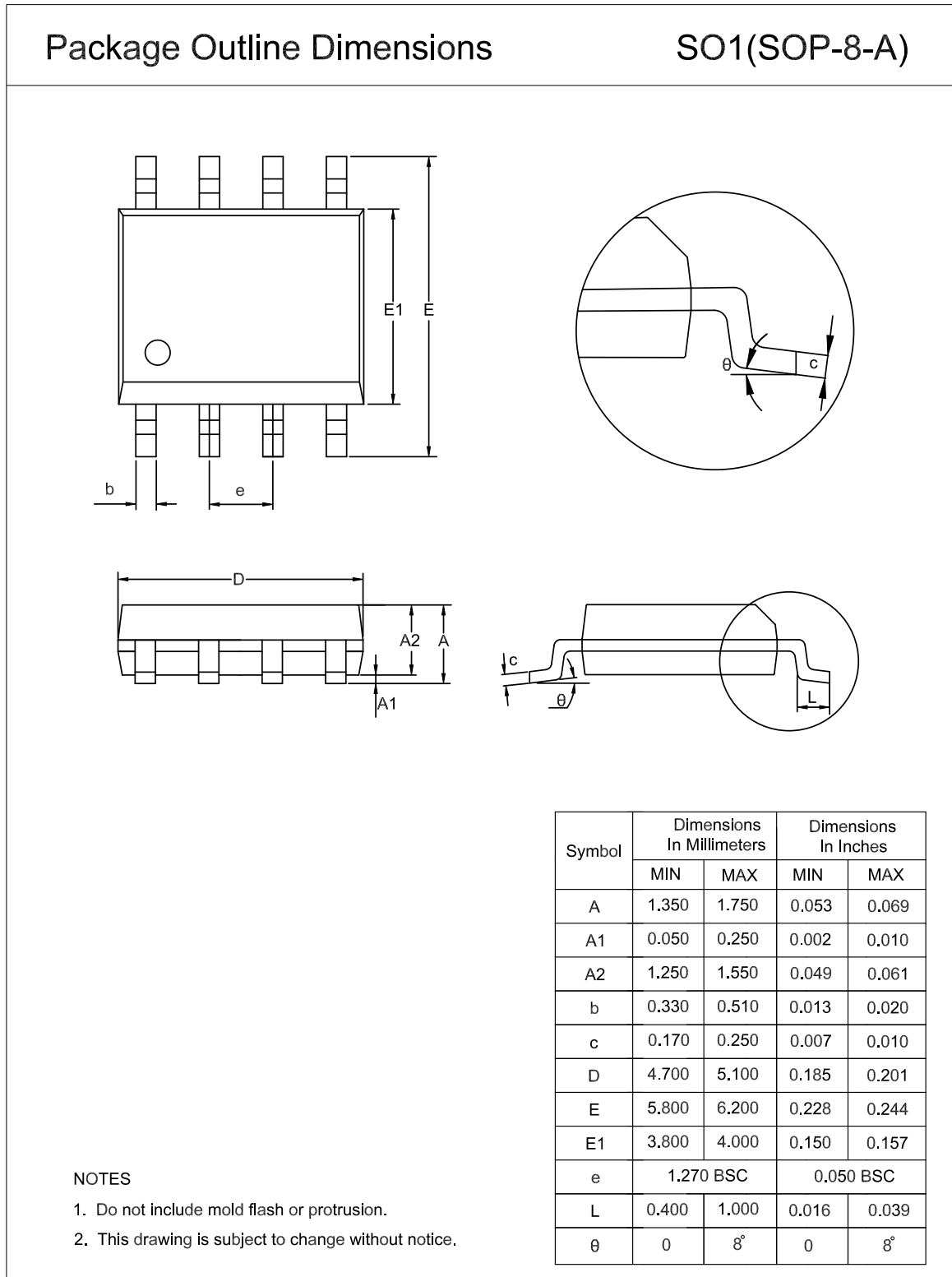


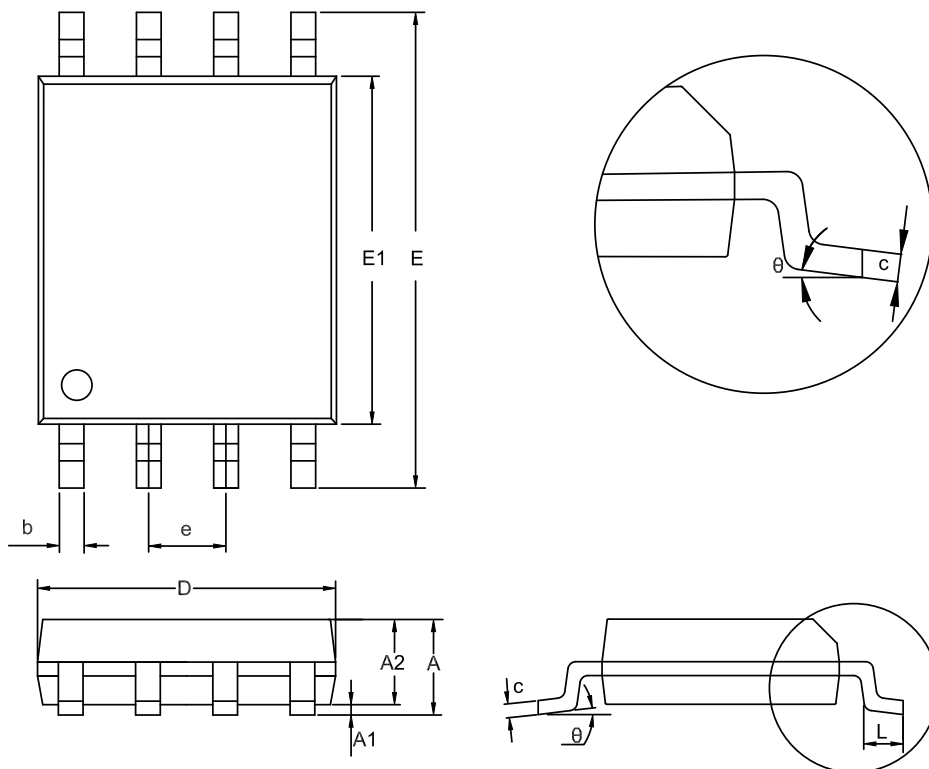
Figure 10. Different Input Current vs. Temperature

**Tape and Reel Information**


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) <sup>(1)</sup>	B0 (mm) <sup>(1)</sup>	K0 (mm) <sup>(1)</sup>	P0 (mm)	W0 (mm)	Pin1 Quadrant
LM2904A-SR	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
LM2904AL1-SR	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
LM2904A-VR	MSOP8	330.0	17.6	5.3	3.3	1.4	8.0	12.0	Q1
LM2904A-TSR	TSSOP8	330.0	17.6	6.8	3.4	1.7	8.0	12.0	Q1
LM2902A-SR	SOP14	330.0	21.6	6.5	9.15	1.8	8.0	16.0	Q1
LM2902A-TR	TSSOP14	330.0	17.6	6.8	5.5	1.7	8.0	12.0	Q1

(1) The value is for reference only. Contact the 3PEAK factory for more information.

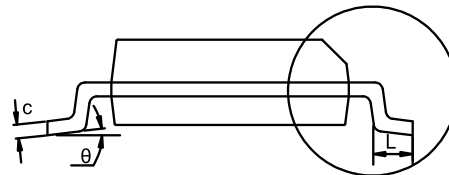
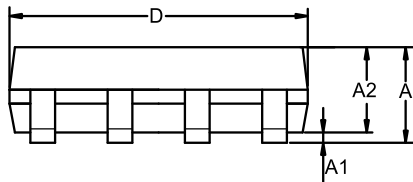
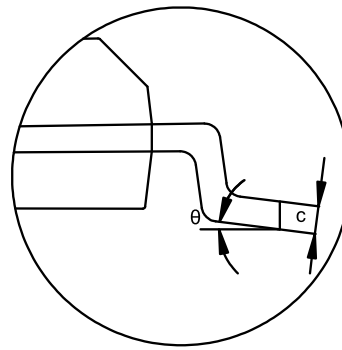
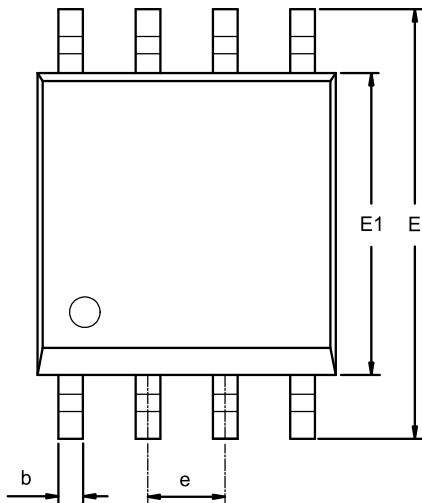
**Package Outline Dimensions**
**SOP8**


**TSSOP8**
**Package Outline Dimensions**
**TS1(TSSOP-8-A)**


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026 BSC	
L	0.450	0.750	0.018	0.030
θ	0	8°	0	8°

**NOTES**

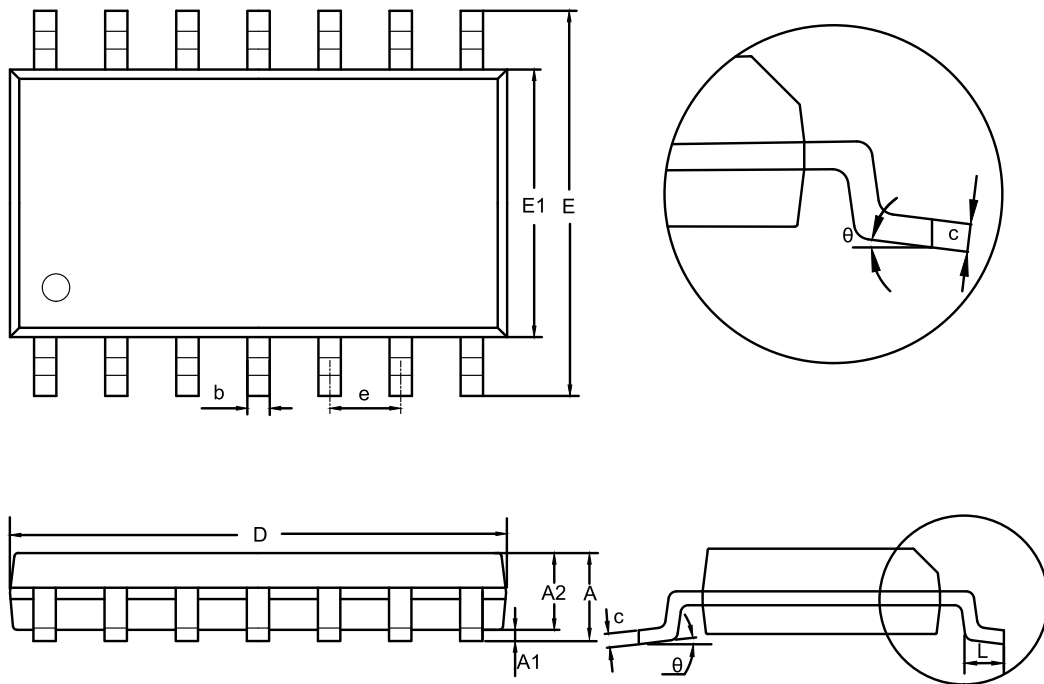
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

**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	0.020	0.150	0.001	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**

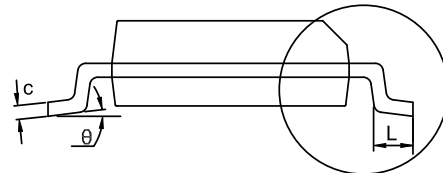
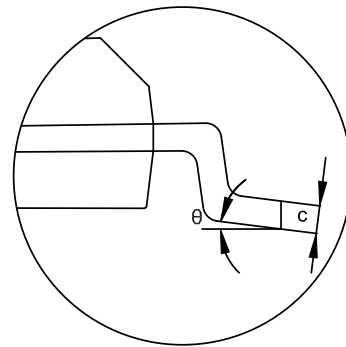
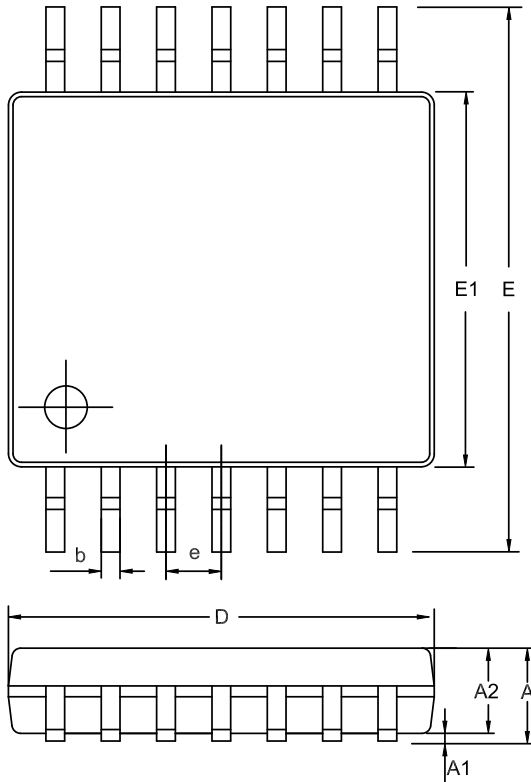
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

**SOP14**
**Package Outline Dimensions**
**SO2(SOP-14-A)**


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0	8°	0	8°

**NOTES**

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

**TSSOP14**
**Package Outline Dimensions**
**TS2(TSSOP-14-A)**


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026 BSC	
L	0.450	0.750	0.018	0.030
θ	0	8°	0	8°

**NOTES**

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

## Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
LM2904A-SR	-40 to 125°C	SOP8	2904A	3	Tape and Reel, 4000	Green
LM2904A-TSR	-40 to 125°C	TSSOP8	2904A	3	Tape and Reel, 3000	Green
LM2904A-VR	-40 to 125°C	MSOP8	2904A	3	Tape and Reel, 3000	Green
LM2902A-SR	-40 to 125°C	SOP14	2902A	3	Tape and Reel, 2500	Green
LM2902A-TR	-40 to 125°C	TSSOP14	2902A	3	Tape and Reel, 3000	Green

**Green:** 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.

## IMPORTANT NOTICE AND DISCLAIMER

**Copyright**© 3PEAK 2012-2025. All rights reserved.

**Trademarks.** Any of the 思瑞浦 or 3PEAK trade names, trademarks, graphic marks, and domain names contained in this document /material are the property of 3PEAK. You may NOT reproduce, modify, publish, transmit or distribute any Trademark without the prior written consent of 3PEAK.

**Performance Information.** Performance tests or performance range contained in this document/material are either results of design simulation or actual tests conducted under designated testing environment. Any variation in testing environment or simulation environment, including but not limited to testing method, testing process or testing temperature, may affect actual performance of the product.

**Disclaimer.** 3PEAK provides technical and reliability data (including data sheets), design resources (including reference designs), application or other design recommendations, networking tools, security information and other resources "As Is". 3PEAK makes no warranty as to the absence of defects, and makes no warranties of any kind, express or implied, including without limitation, implied warranties as to merchantability, fitness for a particular purpose or non-infringement of any third-party's intellectual property rights. Unless otherwise specified in writing, products supplied by 3PEAK are not designed to be used in any life-threatening scenarios, including critical medical applications, automotive safety-critical systems, aviation, aerospace, or any situations where failure could result in bodily harm, loss of life, or significant property damage. 3PEAK disclaims all liability for any such unauthorized use.