36-V Low-Power Comparators

Features

- Wide Single-Supply Voltage Range or Dual Supplies: +2.5 V to +36 V or ±1.25 V to ±18 V
- Very Low Supply Current (150 μA/ch)
- Low Input Bias Current: 1 nA (Max)
- Low Offset Voltage: ±6.0 mV (Max)
- Input Common-Mode Voltage Range Includes Ground
- Internal Differential Input Voltage Range Equal to the Supply Voltage
- Low Output Saturation
- Operating Temperature Range: −40°C to 125°C
- ESD Rating: 4-kV HBM, 2-kV CDM

Applications

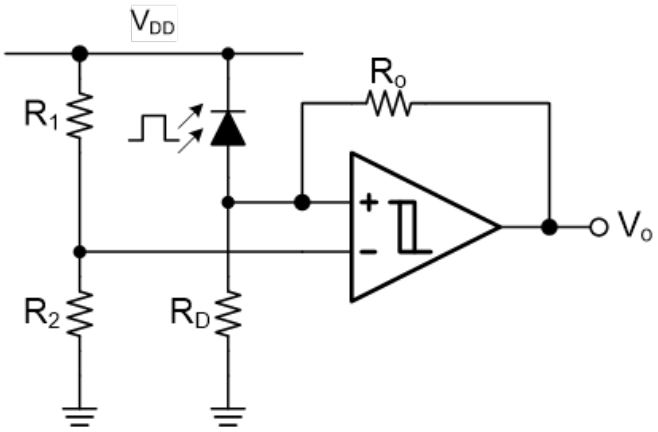
- High-Speed Line or Digital Line Receivers
- High-Speed Sampling Circuits
- Peak and Zero-Crossing Detectors
- Threshold Detectors/Discriminators
- Sensing at Ground or Supply Line

Description

The devices in this series consist of single/dual/quad independent single- or dual-supply voltage comparators on a single monolithic substrate. The common-mode input voltage range includes ground even when operated from a single supply, and the low power supply current drain makes these comparators suitable for battery operation. These types are designed to directly interface with TTL and CMOS. The current drain is independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationships.

All devices are specified for the temperature range from –40°C to 125°C.

Typical Application Circuit



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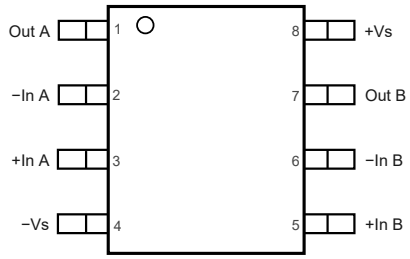
Revision History

Date	Revision	Notes
2022-05-05	Rev.A.0	Updated the document format. Updated the format of Package Outline Dimensions, with no change on the products. Combined LM2903A and LM2901A to one datasheet. Updated the Electrical Characteristics: • I_B: added the max value of 1 nA at 25 °C, and 10 nA at −40°C to 125°C; • I_{OS}: added the max value of 1 nA at 25 °C, and 10 nA at −40°C to 125°C; • I_{OS}: added the typical value of 50 nA at 25 °C.
2022-05-13	Rev.A.1	Corrected a typo in Order Information: • Corrected the MSL of LM2903AL1-SR: from "3" to "1", with no change on the product.
2023-05-29	Rev.A.2	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. • Updated the symbol of Figure 3 in Typical Performance Characteristics. • Updated the website address. • Updated Tape and Reel Information.
2024-12-18	Rev.A.3	The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged. • Updated to a new datasheet format. • Updated to a new format of Package Outline Dimensions. • Updated the Tape and Reel Information.

Pin Configuration and Functions

LM2903A
SOP8
Top View



LM2903A
MSOP8
Top View

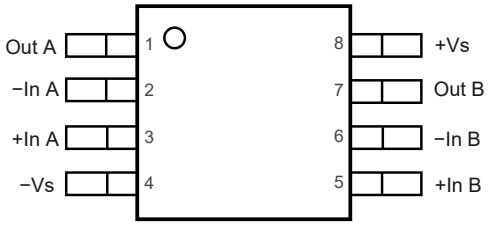
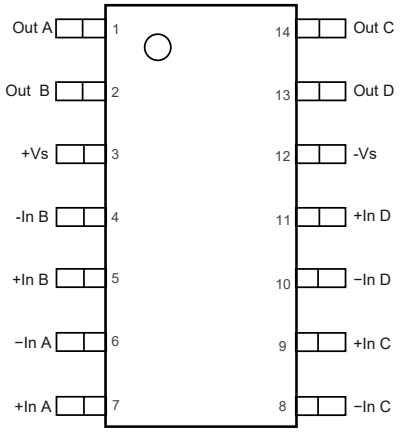


Table 1. Pin Functions: LM2903A

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	$-V_S$		Negative power supply
5	+In B	I	Non-inverting input
6	−In B	I	Inverting input
7	Out B	O	Output
8	$+V_S$		Positive power supply

LM2901A
SOP14
Top View



LM2901A
TSSOP14
Top View

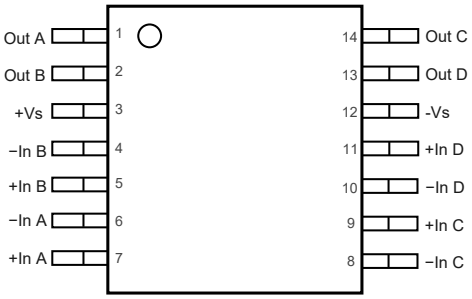


Table 2. Pin Functions: LM2901A

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

Specifications

Absolute Maximum Ratings (1)

Parameters		Min	Max	Unit
	Supply Voltage: $(+V_S) - (-V_S)$		42	V
	Voltage on Input and Output Pins	$(-V_S) - 0.3$	$(+V_S) + 0.3$	V
	Input Current: +IN, –IN (2)	−20	20	mA
	Output Current: OUT	−20	20	mA
	Output Short-Circuit Duration (3)		Infinite	
	Current at Supply Pins	−60	60	mA
T_J	Maximum Junction Temperature		150	°C
T_A	Operating Temperature Range	−40	125	°C
T_{STG}	Storage Temperature Range	−65	150	°C
T_L	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 500 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 (1)	4	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	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_{JA}	θ_{JC}	Unit
SOP8	158	43	°C/W
MSOP8	210	45	°C/W
SOP14	97	47	°C/W
TSSOP14	108	43	°C/W

Electrical Characteristics

All test conditions: V_{CC} = 5 V, R_{PU} = 10 kΩ, C_L = 15 pF, T_A = 25°C, unless otherwise noted.

Parameter		Conditions		Min	Typ	Max	Unit
V_{CC}	Supply Voltage	T_A = −40°C to 125°C		2.5		36	V
V_{OS}	Input Offset Voltage	V_{CC} = 5 V to 30 V, V_{CM} = 0 V, V_O = 1.4 V, T_A = −40°C to 125°C		−6	±0.6	6	mV
I_B	Input Bias Current (1)	V_{DM} = 0 V, V_{CM} = 0 V			0.1	1	nA
		V_{DM} = 0 V, V_{CM} = 0 V, T_A = −40°C to 125°C			1	10	nA
I_{OS}	Input Offset Current (1)	V_{DM} = 0 V, V_{CM} = 0 V			0.1	1	nA
		V_{DM} = 0 V, V_{CM} = 0 V, T_A = −40°C to 125°C			1	10	nA
I_{Diff}	Input Differential Current	V_{CC} = 36 V, V_{DM} = 36 V			50		nA
C_{IN}	Input Capacitance	T_A = 25°C	Differential mode		2.5		pF
			Common mode		5		
V_{CM}	Common-Mode Input Voltage Range			0		V_{CC} − 1.5	V
		T_A = −40°C to 125°C		0		V_{CC} − 2	V
A_{VD}	Large-Signal Differential-Voltage Amplification	V_{CC} = 15 V, V_O = 1.4 V to 11.4 V, R_L ≥ 15 kΩ to V_{CC}		50	400		V/mV
I_{OH}	High-Level Output Current	V_{OH} = 5 V, V_{ID} = 1 V			25	200	nA
		V_{CC} = 36 V, V_{OH} = 36 V, V_{ID} = 1 V, T_A = −40°C to 125°C				7	μA
V_{OL}	Low-Level Output Voltage	I_{OL} = 4 mA, V_{ID} = −1 V			250	400	mV
		I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to 125°C				500	mV
I_{OL}	Low-Level Output Current	V_{OL} = 1.5 V, V_{ID} = −1 V		10			mA
I_Q	Quiescent Current per Comparator	V_{CC} = 5 V			150	300	μA
		V_{CC} = 36 V			150	300	μA
t_{RT}	Response Time	R_L connected to 5 V through 5.1 kΩ, C_L = 15 pF	100-mV input step with 5-mV overdrive		2		μs
			TTL-level input step		0.5		

(1) Provided by bench tests and design simulation.

Typical Performance Characteristics

All test conditions: V_S = 5 V, V_{CM} = 0 V, R_L = Open, unless otherwise noted.

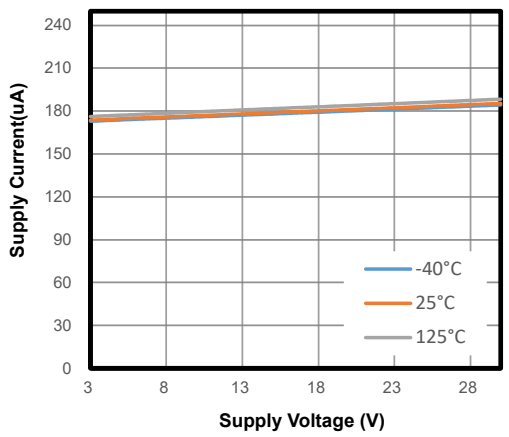


Figure 1. Supply Current vs. Supply Voltage (Dual Channel)

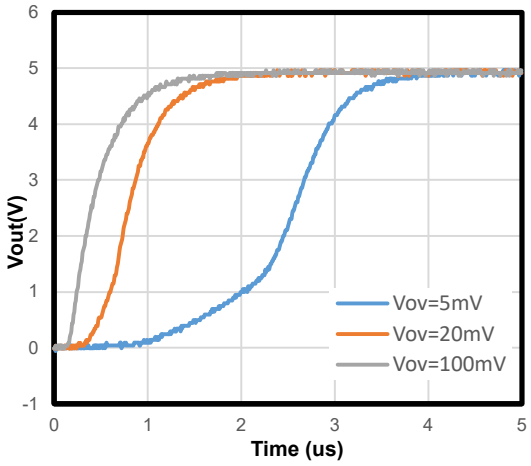


Figure 2. Response Time for Various Input Overdrives: Positive Transition

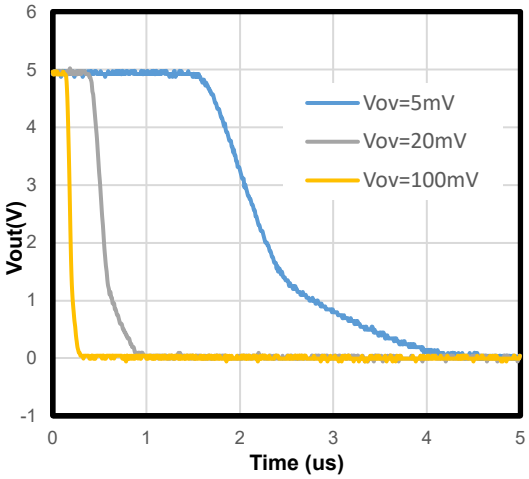


Figure 3. Response Time for Various Input Overdrives: Negative Transition

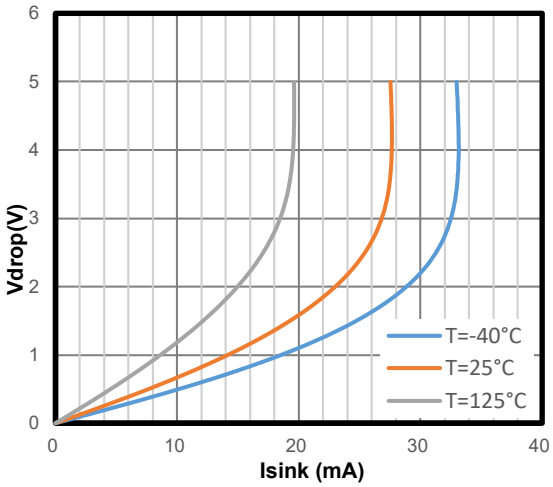


Figure 4. Negative Output Swing vs. Sink Current

Detailed Description

Overview

The devices in this series consist of single/dual/quad independent single- or dual-supply voltage comparators on a single monolithic substrate. The common-mode input voltage range includes ground even when operated from a single supply, and the low power supply current drain makes these comparators suitable for battery operation. These types were designed to directly interface with TTL and CMOS. The current drain is independent of the supply voltage. The outputs can be connected to other open-collector outputs to achieve wired-AND relationships.

Application and Implementation

> Note
>
> Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Application Information

Power Supply Layout and Bypass

The power supply pins of the LM2903A/2901A series should have a local bypass capacitor (i.e., 0.01 μF to 0.1 μF) within 2 mm for high-frequency performance. It can also use a bulk capacitor (i.e., 1 μF or larger) within 100 mm to provide large, slow currents. This bulk capacitor can be shared with other analog parts.

A good ground layout improves performance by decreasing the amount of stray capacitance and noise at the inputs and outputs of the comparator. To decrease stray capacitance, minimize PCB lengths and resistor leads, and place external components to the pins of the comparator as close as possible.

Inputs

The electrostatic discharge (ESD) protection input structure of two back-to-back diodes and 1-kΩ series resistors are used to limit the differential input voltage applied to the precision input of the comparator by clamping input voltages that exceed supply voltages, as shown in Figure 5. Large voltage exceeding the supply voltage should be avoided to prevent damage to the input stage.

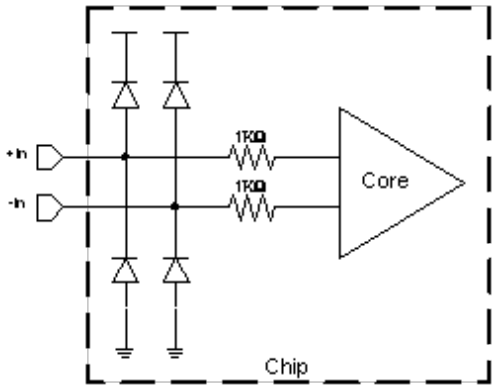


Figure 5. Equivalent Input Structure

Operation Outside of the Common Input Voltage Range

A list of input voltage situation and their outcomes are as follows:

1. When both −IN and +IN are both within the common-mode range:
   a. If −IN is higher than +IN and the offset voltage, the output is low, and the output MOSFET is sinking current.
   b. If −IN is lower than +IN and the offset voltage, the output is high impedance.
2. When −IN is higher than the common mode and +IN is within the common mode, the output is low, and the output MOSFET is sinking current.
3. When +IN is higher than the common mode and −IN is within the common mode, the output is high impedance.
4. When −IN and +IN are both higher than common mode, the output is in uncertain state.

Typical Application

IR Receiver

The device is an ideal candidate to be used as an infrared receiver shown in Figure 6. The infrared photo diode creates a current relative to the amount of infrared light present. The current creates a voltage across R_D. When this voltage level crosses the voltage applied by the voltage divider to the inverting input, the output transitions. Optional R_O provides additional hysteresis for noise immunity.

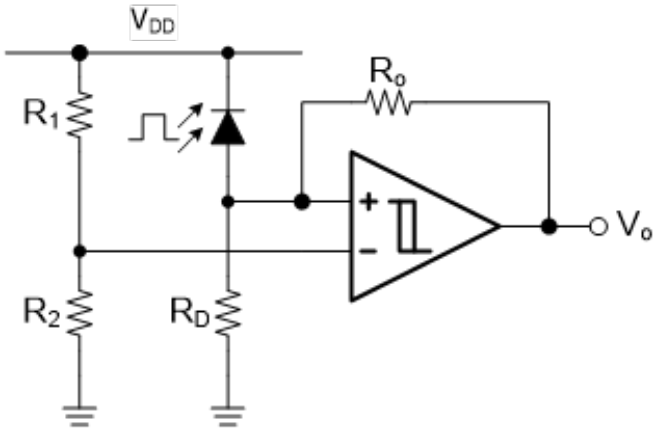
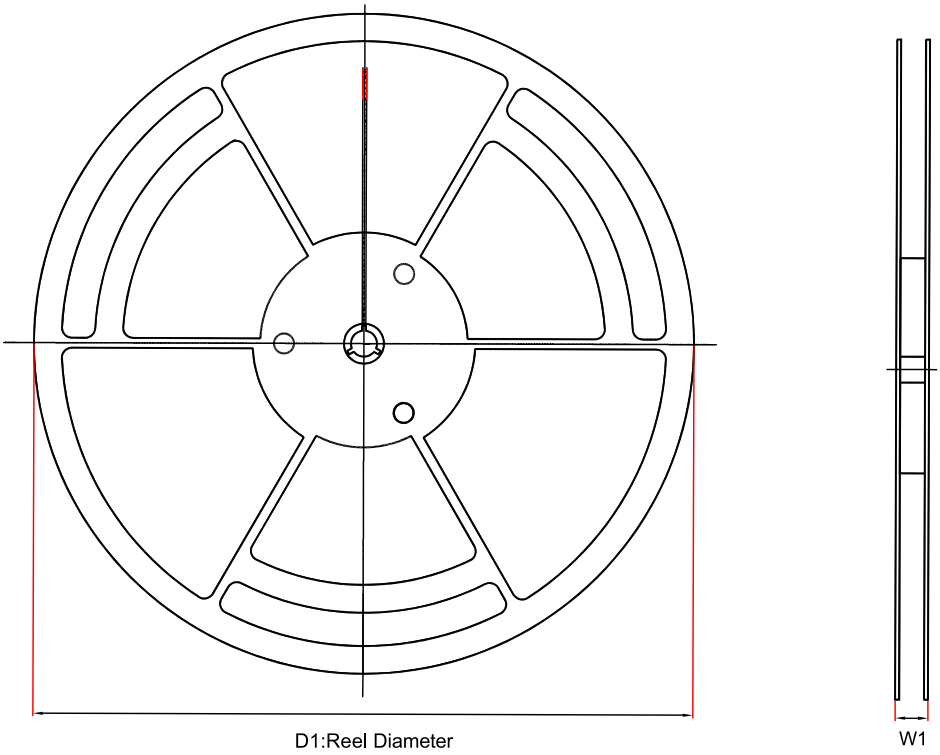
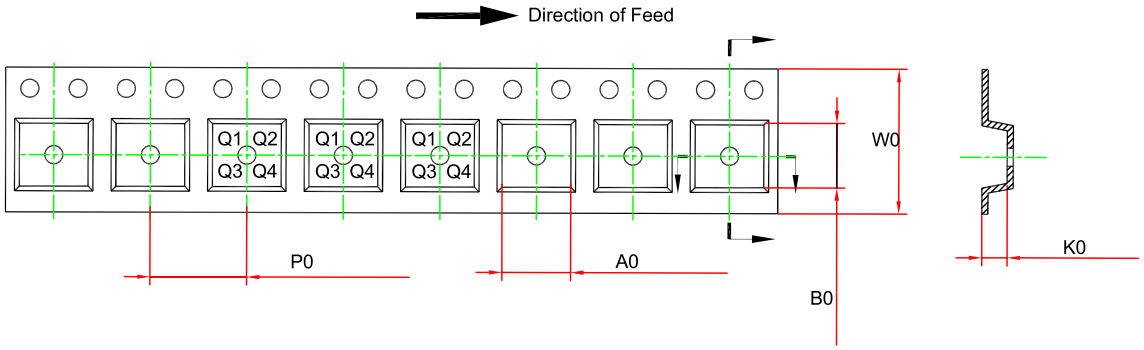


Figure 6. IR Receiver

Tape and Reel Information





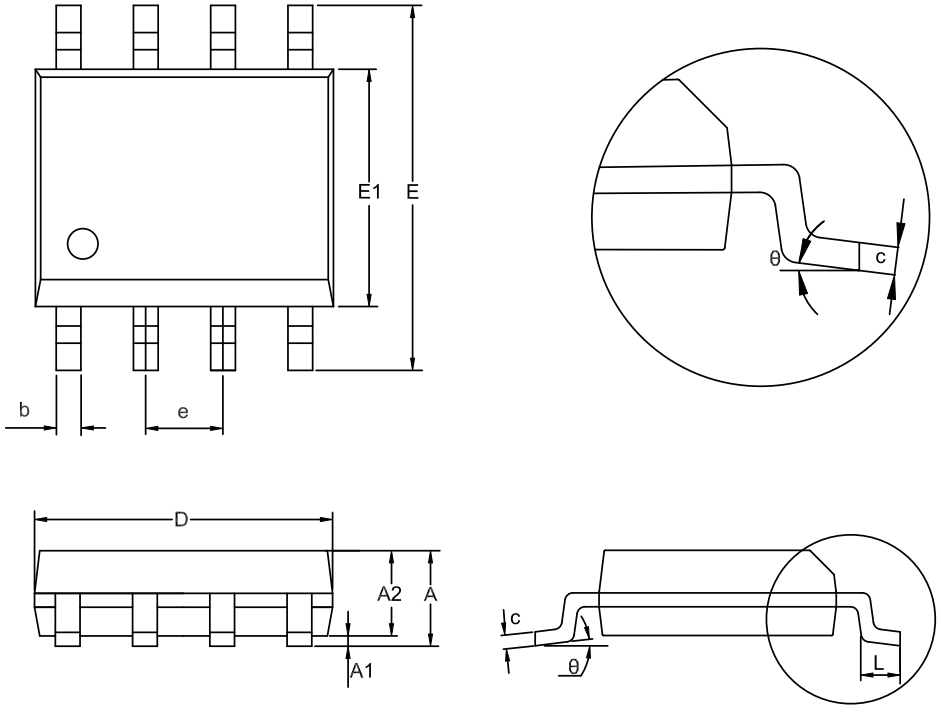
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
LM2903A-SR	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
LM2903AL1-SR	SOP8	330.0	17.6	6.5	5.4	2.0	8.0	12.0	Q1
LM2903A-VR	MSOP8	330.0	17.6	5.2	3.3	1.5	8.0	12.0	Q1
LM2901A-SR	SOP14	330.0	21.6	6.5	9.2	2.0	8.0	16.0	Q1
LM2901A-TR	TSSOP14	330.0	17.6	6.8	5.4	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

Package Outline Dimensions SO1(SOP-8-A)



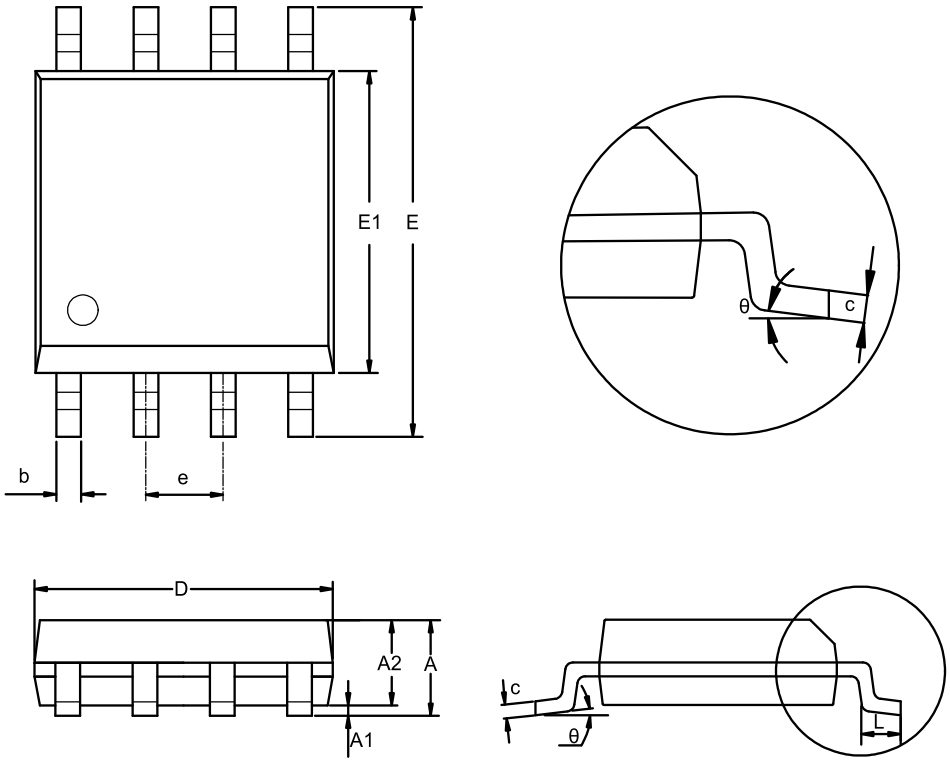
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.000	0.016	0.039
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)



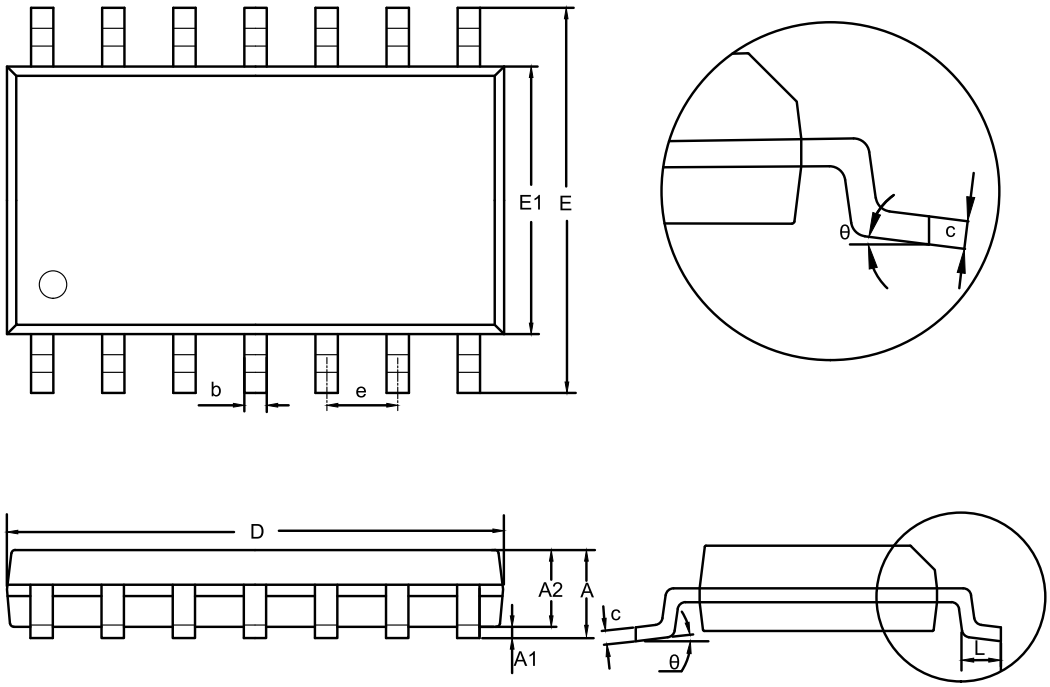
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	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)



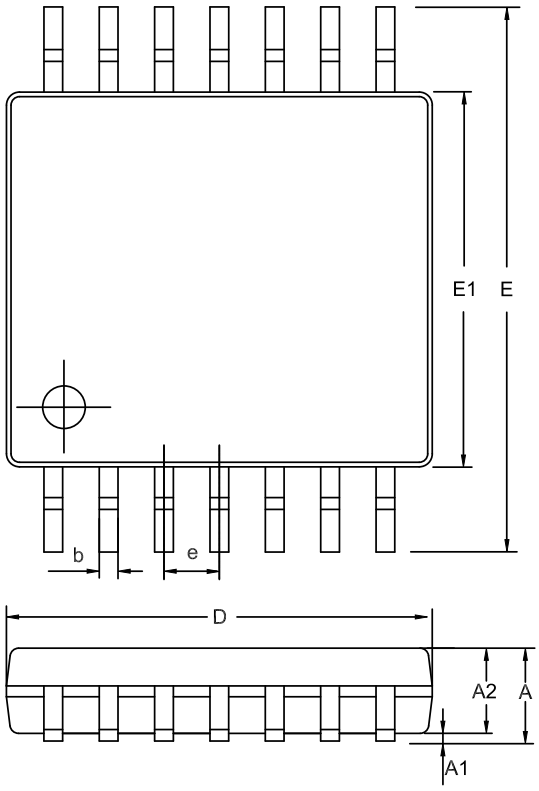
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050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

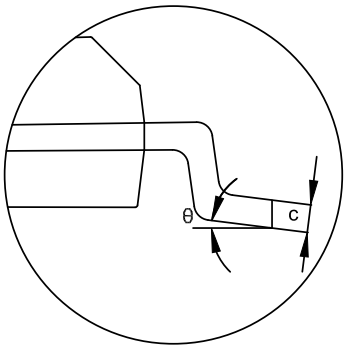
NOTES

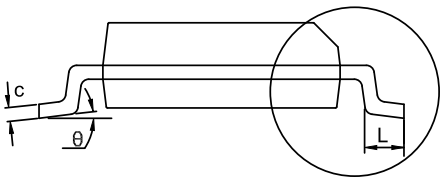
1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

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
LM2903AL1-SR	−40 to 125°C	SOP8	2903A	1	Tape and Reel, 4000	Green
LM2903A-SR	−40 to 125°C	SOP8	LM393	3	Tape and Reel, 4000	Green
LM2903A-VR	−40 to 125°C	MSOP8	2903A	3	Tape and Reel, 3000	Green
LM2901A-SR	−40 to 125°C	SOP14	2901A	3	Tape and Reel, 2500	Green
LM2901A-TR (1)	−40 to 125°C	TSSOP14	2901A	3	Tape and Reel, 3000	Green

(1) For future products, contact the 3PEAK factory for more information and samples.

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

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