

## Features

- Wide Single-Supply Voltage Range or Dual Supplies: +3 V to +36 V or  $\pm 1.5$  V to  $\pm 18$  V
- Low Supply Current: 1 mA
- Low Input Bias Current: 75 nA (Typ)
- Low Offset Voltage:  $\pm 7$  mV (Max)
- Input Common-Mode Voltage Range Includes Ground
- Internal Differential Input Voltage Range Equal to the Supply Voltage
- Operating Temperature Range:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$

## Applications

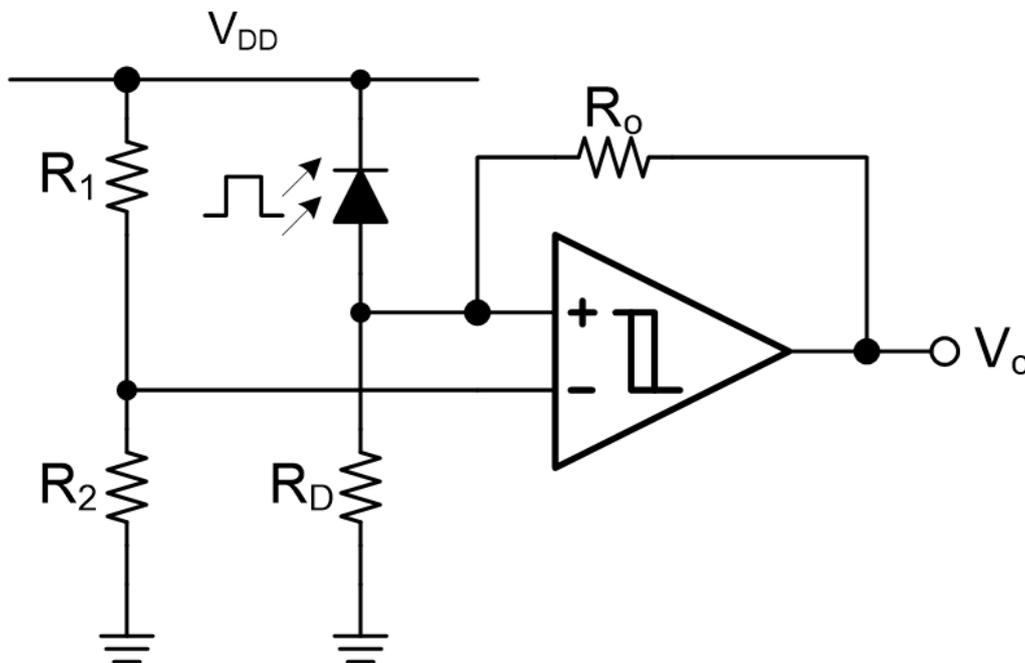
- High-Speed Sampling Circuits
- Peak and Zero-Crossing Detectors
- Threshold Detectors/Discriminators
- Sensing at Ground or Supply Line

## Description

The devices in this series consist of dual comparators on a single monolithic substrate. The common-mode input voltage range includes ground even when the LM2903D is operated from a single supply. 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.

The LM2903D is a dual-channel version available in the SOP8 and MSOP8 packages. All devices are specified for the temperature range from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

## Typical Application Circuit



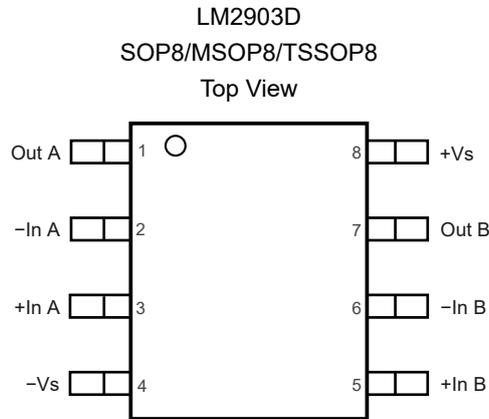
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## Revision History

Date	Revision	Notes
2022-06-15	Rev.A.0	Initial version
2022-06-27	Rev.A.1	Removed the minimum specification of $A_{VD}$ in Electrical Characteristics
2023-02-22	Rev.A.2	Added a new part number: LM2903D-TS1R.
2024-12-18	Rev.A.3	<p>The following updates are all about the new datasheet formats or typos, and the actual product remains unchanged.</p> <ul style="list-style-type: none"><li>• Updated to a new datasheet format.</li><li>• Updated to a new format of Package Outline Dimensions.</li><li>• Updated the Tape and Reel Information.</li></ul>
2025-02-18	Rev.A.4	<p>Removed part number: LM2903D-TS1R. Added part number: LM2903DA-TS1R. Updated Electrical Characteristics:</p> <ul style="list-style-type: none"><li>• Input bias current: from Typ 25 to Typ 75.</li><li>• Supply Current, 2ch comparator, <math>V_{CC} = 5\text{ V}</math>: from Typ 0.7, Max 1 to Typ 0.9, Max 1.2.</li><li>• Supply Current, 2ch comparator, <math>V_{CC} = 36\text{ V}</math>, <math>T_A = -40^\circ\text{C}</math> to <math>+125^\circ\text{C}</math>: from Typ 0.8, Max 1.2 to Typ 1.2, Max 1.6.</li></ul>

## Pin Configuration and Functions



**Table 1. Pin Functions: LM2903D**

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

## 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	40	V
	Input Current: +I <sub>N</sub> , –I <sub>N</sub> <sup>(2)</sup>	–10	10	mA
	Output Current: O <sub>UT</sub> <sup>(2)</sup>	–10	10	mA
	Output Sink Current <sup>(3)</sup>		50	mA
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 and outputs are protected by ESD protection diodes to the negative power supply. If the input or output extends more than 300 mV beyond the negative power supply, the 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 comparators 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>	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup>	1	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.

### Recommended Operating Conditions

Parameter		Min	Typ	Max	Unit
V <sub>S</sub>	Supply Voltage, (+V <sub>S</sub> ) – (–V <sub>S</sub> )	3		36	V
	Input Voltage Range	0		(+V <sub>S</sub> ) – 2	V
T <sub>A</sub>	Operating Temperature Range	–40		125	°C

### Thermal Information

Package Type	$\theta_{JA}$	$\theta_{JC}$	Unit
SOP8	158	43	°C/W
MSOP8	210	45	°C/W

**Electrical Characteristics**

 All test conditions:  $T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{ V}$ ,  $V_{CM} = 0\text{ V}$ , unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$V_S$	Supply Voltage		3		36	V	
$V_{OS}$	Input Offset Voltage <sup>(1)</sup>	$V_S = 5\text{ V to } 36\text{ V}$ , $V_{CM} = 0\text{ V to } (+V_S) - 2\text{ V}$	-7	1	7	mV	
		$V_S = 5\text{ V to } 36\text{ V}$ , $V_{CM} = 0\text{ V to } (+V_S) - 2\text{ V}$ , $T_A = -40\text{ to } 125^\circ\text{C}$	-10		10	mV	
		$V_S = 5\text{ V}$ , $V_{CM} = 0\text{ V}$ , LM2903DA Only	-4	1	4	mV	
$I_B$	Input Bias Current			75	250	nA	
		$T_A = -40\text{ to } 125^\circ\text{C}$			400	nA	
$I_{OS}$	Input Offset Current			10	50	nA	
		$T_A = -40\text{ to } 125^\circ\text{C}$			150	nA	
$V_{CM}$	Common-Mode Input Voltage Range		0		$(+V_S) - 1.5$	V	
		$T_A = -40^\circ\text{C to } +125^\circ\text{C}$	0		$(+V_S) - 2$	V	
$A_{VD}$	Large-Signal Voltage Gain	$V_{CC} = 15\text{ V}$ , $R_L \geq 15\text{ k}\Omega\text{ to } V_{CC}$		200		V/mV	
$I_{OH}$	High-Level Output Current	$V_{OH} = 5\text{ V}$ , $V_{ID} = 1\text{ V}$		25	50	nA	
		$V_{OH} = 36\text{ V}$ , $V_{ID} = 1\text{ V}$ , $T_A = -40^\circ\text{C to } +125^\circ\text{C}$			200	nA	
$V_{OL}$	Low-Level Output Voltage	$I_{OL} = 4\text{ mA}$ , $V_{ID} = -1\text{ V}$		150	350	mV	
		$I_{OL} = 4\text{ mA}$ , $V_{ID} = -1\text{ V}$ , $T_A = -40^\circ\text{C to } +125^\circ\text{C}$			400	mV	
$I_{OL}$	Low-Level Output Current	$V_{OL} = 1.5\text{ V}$ , $V_{ID} = -1\text{ V}$	25	40		mA	
		$V_{OL} = 1.5\text{ V}$ , $V_{ID} = -1\text{ V}$ , $T_A = -40^\circ\text{C to } +125^\circ\text{C}$	10				
$I_Q$	Quiescent Current, 2-Channel Comparator	$V_{CC} = 5\text{ V}$		0.9	1.2	mA	
		$V_{CC} = 36\text{ V}$ , $T_A = -40^\circ\text{C to } +125^\circ\text{C}$		1.2	1.6	mA	
$t_{RT}$	Response Time	$R_L$ connected to 5 V through 5.1 k $\Omega$ , $C_L = 15\text{ pF}$ <sup>(2)(3)</sup>	100-mV input step with 5-mV overdrive		1.6		$\mu\text{s}$
			TTL-level input step, low to high		0.6	1	
			TTL-level input step, high to low		0.3	0.5	

(1) The input offset voltage is the average of the input-referred trip points.

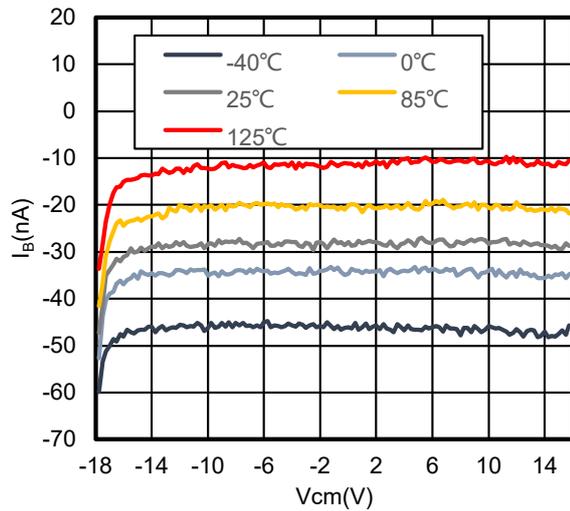
(2)  $C_L$  includes probe and jig capacitance.

(3) The response time specified is the interval between the input step function and the instant of output:

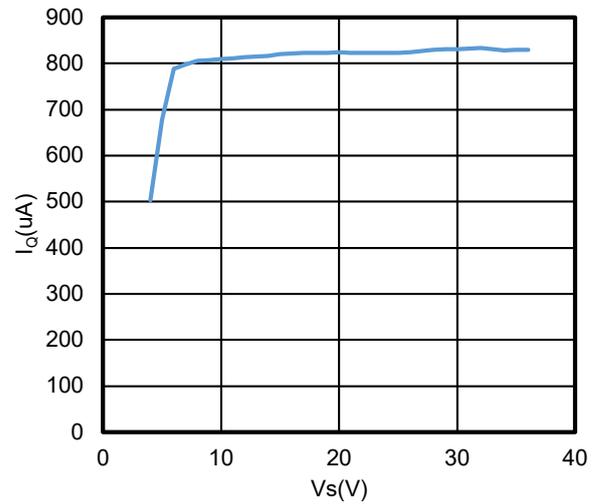
- Output low-to-high transition: when the output crosses 10% of the high-level output voltage.
- Output high-to-low transition: when the output crosses 90% of the high-level output voltage.

**Typical Performance Characteristics**

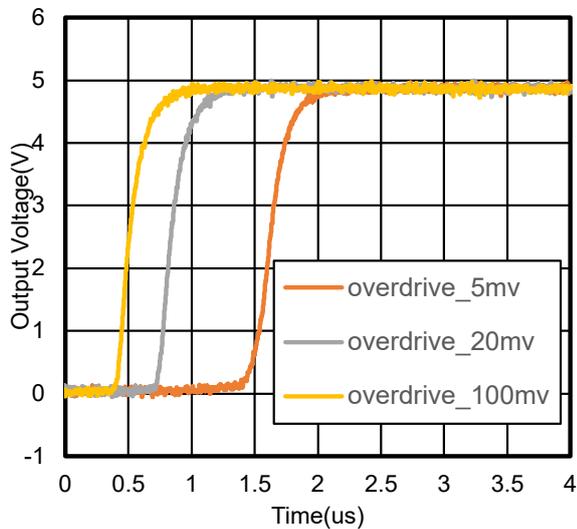
All test conditions:  $V_S = +5\text{ V}$ ,  $V_{CM} = 0\text{ V}$ ,  $R_L = \text{Open}$ , unless otherwise noted.



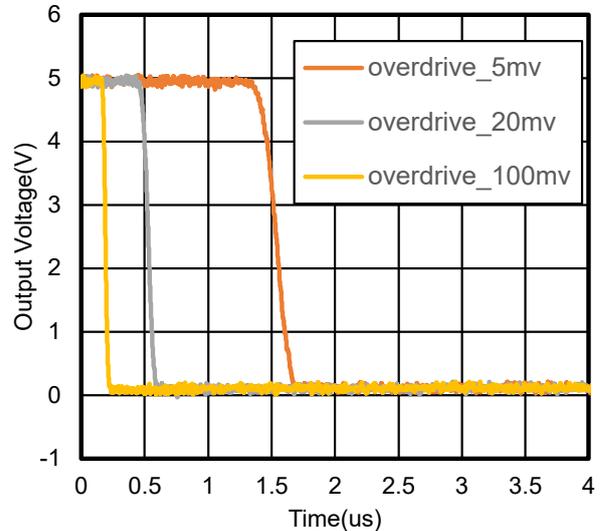
**Figure 1.  $I_B$  vs.  $V_{CM}$ , ( $+V_S$ ) = 18 V, ( $-V_S$ ) = -18 V**



**Figure 2. Supply Current vs. Supply Voltage**



**Figure 3. Response Time for Various Input Overdrives, Positive Transition**



**Figure 4. Response Time for Various Input Overdrives, Negative Transition**

## Detailed Description

### Overview

The LM2903D comparator can operate from 3 V to 36 V on the supply pin and also has a very low  $I_Q$  and fast response. The open-drain output allows the logic-high voltage of the output to be configured or used in the AND functionality.

### Functional Block Diagram

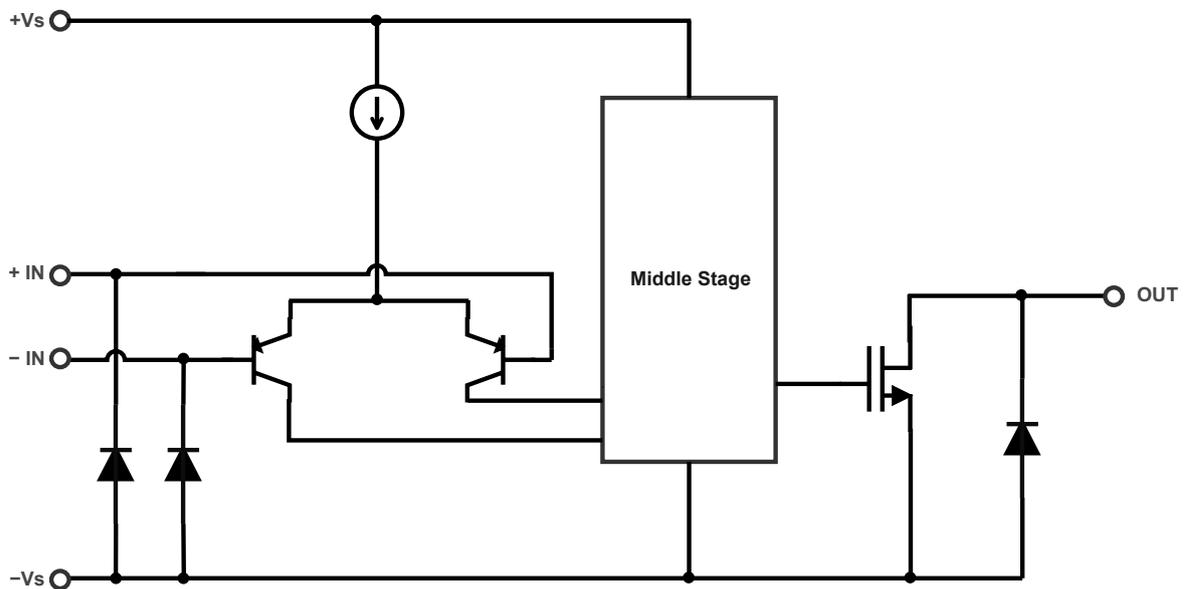


Figure 5. Functional Block Diagram

## 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 pin of the LM2903D should have a local bypass capacitor (i.e. 0.01  $\mu\text{F}$  to 0.1  $\mu\text{F}$ ) within 2 mm for high-frequency performance. It can also use a bulk capacitor (i.e. 1  $\mu\text{F}$  or larger) within 100 mm to provide large and 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 comparator pins as close as possible.

### Operation Outside of the Common Input Voltage Range

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

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

## Typical Application

### IR Receiver

The LM2903D is an ideal candidate to be used as an infrared receiver, as 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.

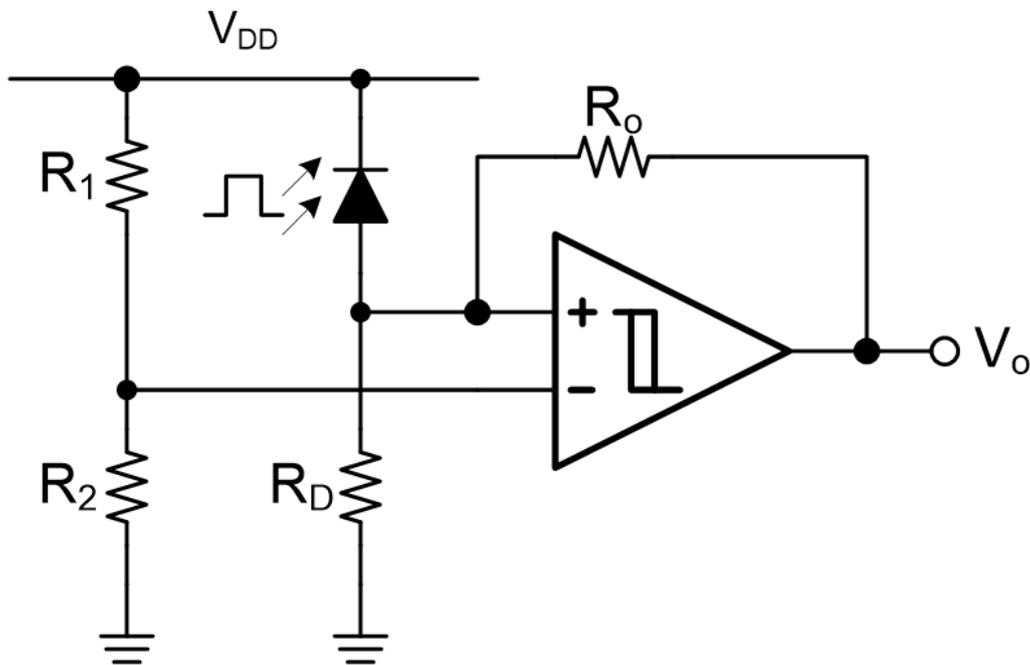
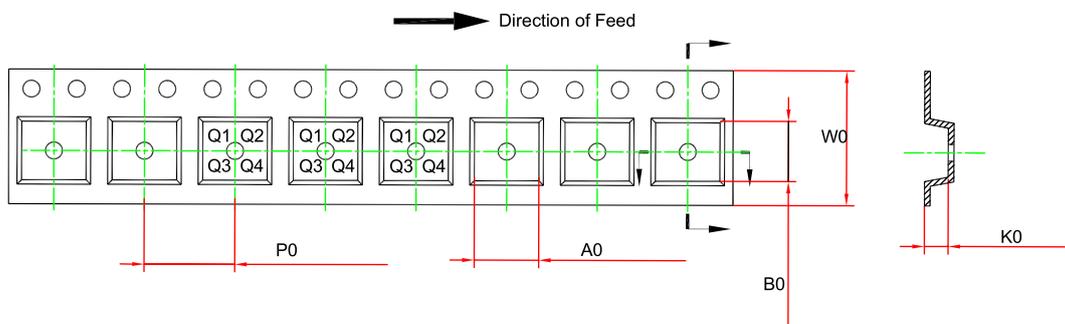
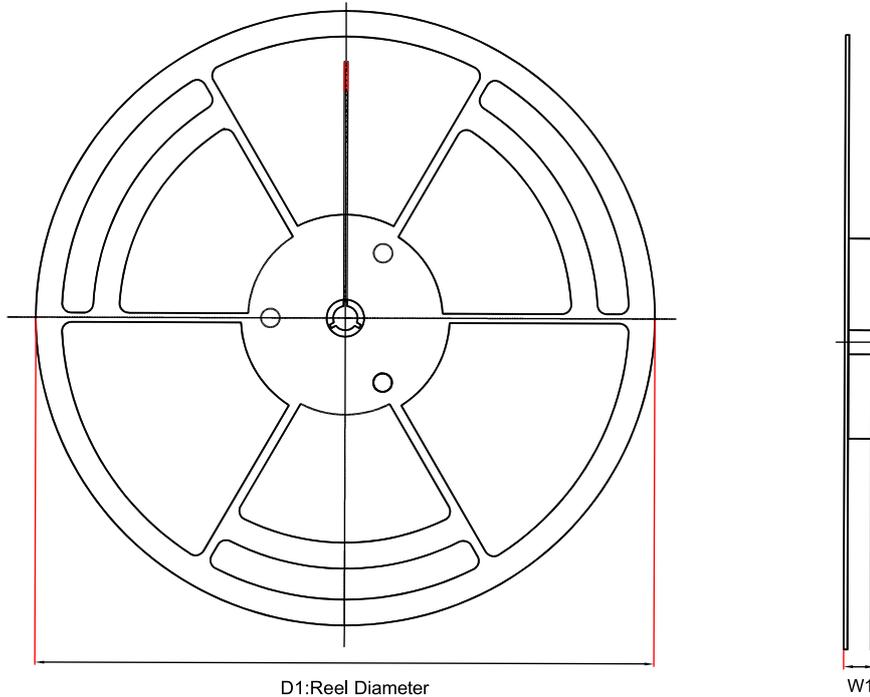


Figure 6. Typical Application Circuit

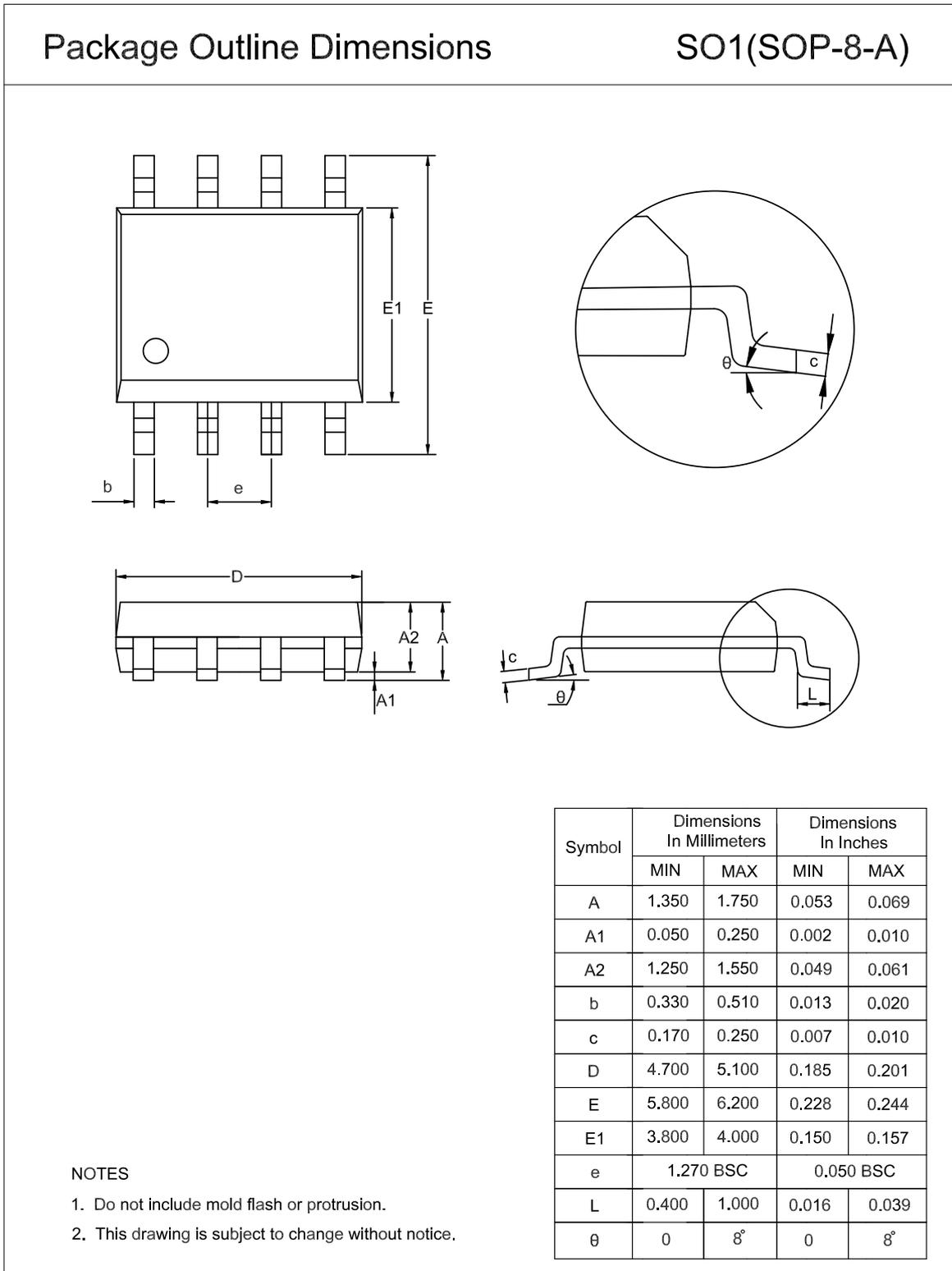
**Tape and Reel Information**


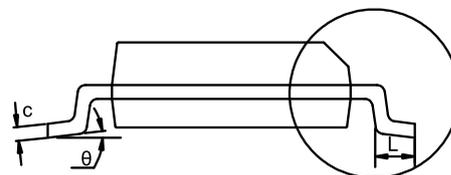
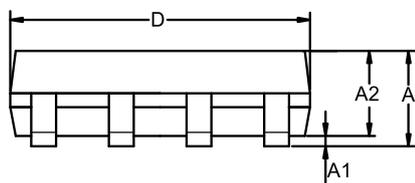
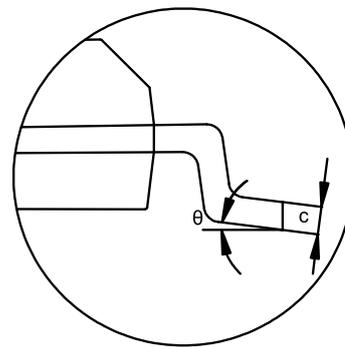
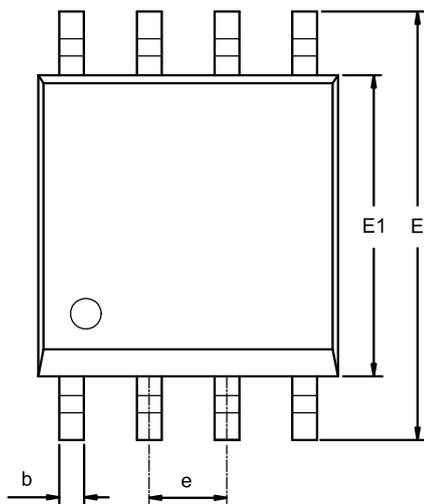
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) <sup>(1)</sup>	B0 (mm) <sup>(1)</sup>	K0 (mm) <sup>(1)</sup>	P0 (mm)	W0 (mm)	Pin1 Quadrant
LM2903D-SO1R	SOP8	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
LM2903D-VS1R	MSOP8	330.0	17.6	5.2	3.3	1.5	8.0	12.0	Q1
LM2903DA-TS1R	TSSOP8	330.0	17.6	6.8	3.3	1.2	8.0	12.0	Q1

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

Package Outline Dimensions

SOP8

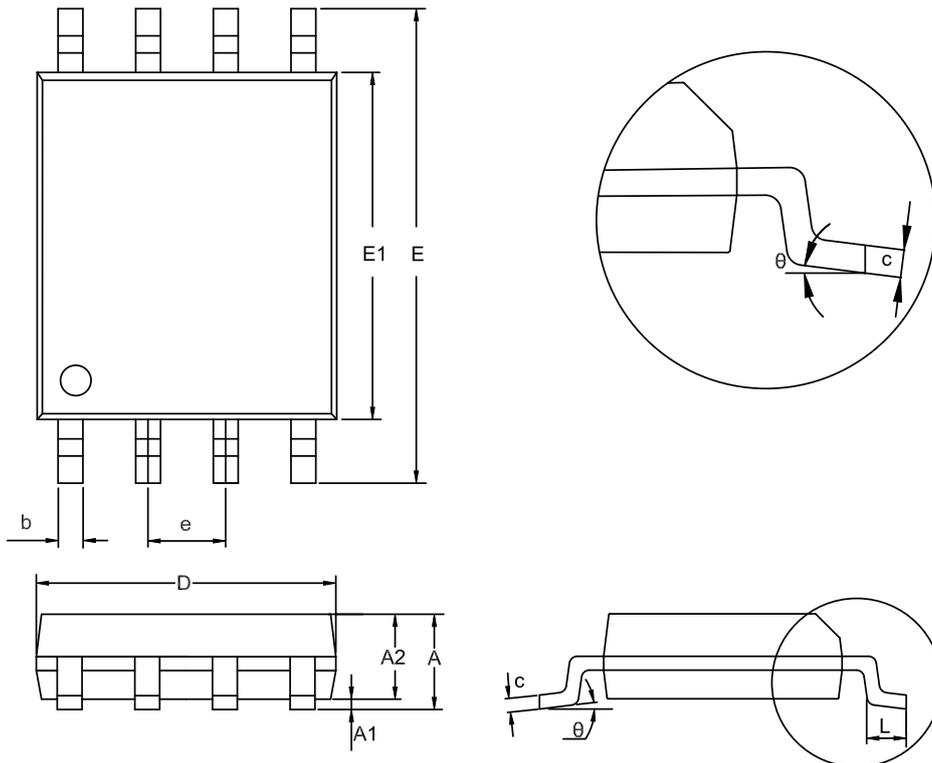


**MSOP8**
**Package Outline Dimensions**
**VS1(MSOP-8-A)**


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.

**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.

## Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
LM2903D-SO1R	-40 to 125°C	SOP8	LM2903	3	Tape and Reel, 4000	Green
LM2903D-VS1R	-40 to 125°C	MSOP8	LM2903	3	Tape and Reel, 3000	Green
LM2903DA-TS1R	-40 to 125°C	TSSOP8	2903D	1	Tape and Reel, 3000	Green

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

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