36-V Dual Comparators

Features

- Wide Single-Supply Voltage Range or Dual Supplies: +3 V to +36 V or ±1.5 V to ±18 V
- Low Supply Current: 1 mA
- Low Input Bias Current: 75 nA (Typ)
- Low Offset Voltage: ±7 mV (Max)
- Input Common-Mode Voltage Range Includes Ground
- Internal Differential Input Voltage Range Equal to the Supply Voltage
- Operating Temperature Range: −40°C to 125°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°C to +125°C.

Typical Application Circuit

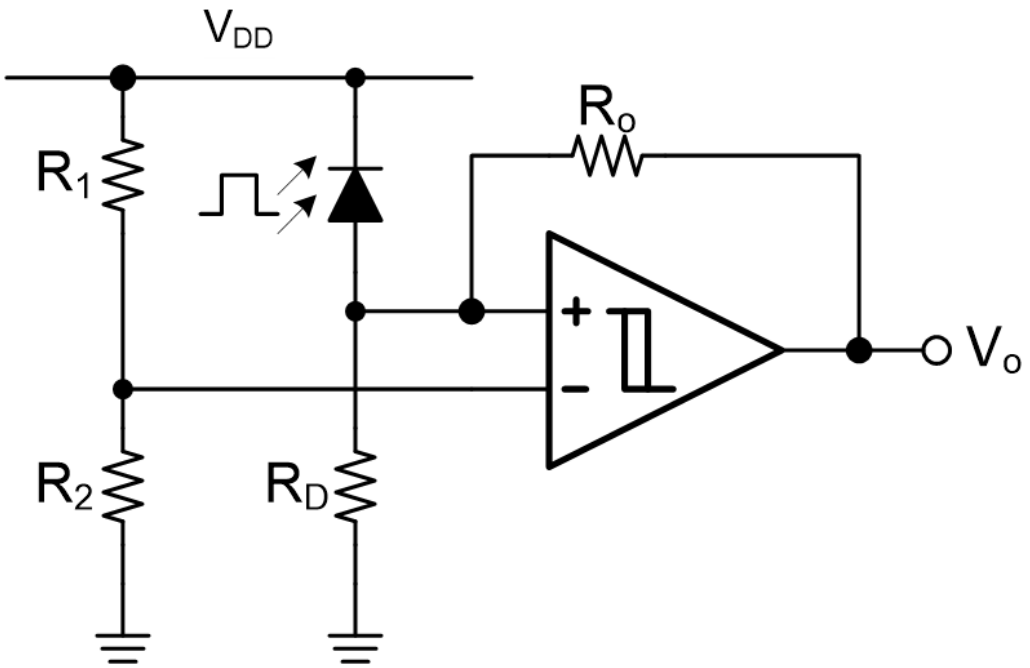


Table of Contents

Features **1**
Applications **1**
Description **1**
Typical Application Circuit **1**
Revision History **3**
Pin Configuration and Functions **4**
Specifications **5**
Absolute Maximum Ratings (1) 5
ESD, Electrostatic Discharge Protection 5
Recommended Operating Conditions 6
Thermal Information 6
Electrical Characteristics 7
Typical Performance Characteristics 9
Detailed Description **10**
Overview 10
Functional Block Diagram 10
Application and Implementation **11**
Application Information 11
Typical Application 12
Tape and Reel Information **13**
Package Outline Dimensions **14**
SOP8 14
MSOP8 15
TSSOP8 16
Order Information **17**
IMPORTANT NOTICE AND DISCLAIMER **18**

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	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.
2025-02-18	Rev.A.4	Removed part number: LM2903D-TS1R. Added part number: LM2903DA-TS1R. Updated Electrical Characteristics: • Input bias current: from Typ 25 to Typ 75. • Supply Current, 2ch comparator, VCC = 5 V: from Typ 0.7, Max 1 to Typ 0.9, Max 1.2. • Supply Current, 2ch comparator, VCC = 36 V, TA = −40°C to +125°C: from Typ 0.8, Max 1.2 to Typ 1.2, Max 1.6.

Pin Configuration and Functions

LM2903D
SOP8/MSOP8/TSSOP8
Top View

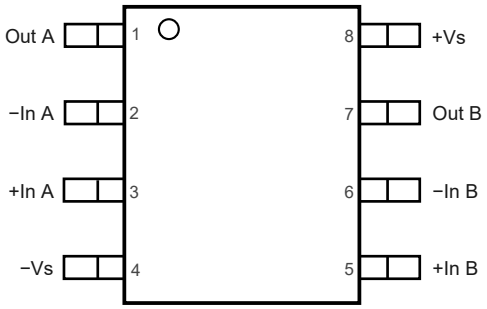


Table 1. Pin Functions: LM2903D

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	$-V_S$	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	$+V_S$	I	Positive power supply.

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
	Supply Voltage: $(+V_S) – (−V_S)$		40	V
	Input Voltage	$(−V_S) − 0.3$	40	V
	Input Current: +IN, −IN (2)	−10	10	mA
	Output Current: OUT (2)	−10	10	mA
	Output Sink Current (3)		50	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 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 (1)	2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	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_S	Supply Voltage, $(+V_S) – (-V_S)$	3		36	V
	Input Voltage Range	0		$(+V_S) - 2$	V
T_A	Operating Temperature Range	−40		125	°C

Thermal Information

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

Electrical Characteristics

All test conditions: T_A = 25°C, V_S = 5 V, V_{CM} = 0 V, unless otherwise noted.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_S	Supply Voltage			3		36	V
V_{OS}	Input Offset Voltage (1)	V_S = 5 V to 36 V, V_{CM} = 0 V to ($+V_S$) – 2 V		−7	1	7	mV
		V_S = 5 V to 36 V, V_{CM} = 0 V to ($+V_S$) – 2 V, T_A = −40 to 125°C		−10		10	mV
		V_S = 5 V, V_{CM} = 0 V, LM2903DA Only		−4	1	4	mV
I_B	Input Bias Current				75	250	nA
		T_A = −40 to 125°C				400	nA
I_{OS}	Input Offset Current				10	50	nA
		T_A = −40 to 125°C				150	nA
V_{CM}	Common-Mode Input Voltage Range			0		($+V_S$) − 1.5	V
		T_A = −40°C to +125°C		0		($+V_S$) − 2	V
A_{VD}	Large-Signal Voltage Gain	V_{CC} = 15 V, R_L ≥ 15 kΩ to V_{CC}			200		V/mV
I_{OH}	High-Level Output Current	V_{OH} = 5 V, V_{ID} = 1 V			25	50	nA
		V_{OH} = 36 V, V_{ID} = 1 V, T_A = −40°C to +125°C				200	nA
V_{OL}	Low-Level Output Voltage	I_{OL} = 4 mA, V_{ID} = −1 V			150	350	mV
		I_{OL} = 4 mA, V_{ID} = −1 V, T_A = −40°C to +125°C				400	mV
I_{OL}	Low-Level Output Current	V_{OL} = 1.5 V, V_{ID} = −1 V		25	40		mA
		V_{OL} = 1.5 V, V_{ID} = −1 V, T_A = −40°C to +125°C		10			
I_Q	Quiescent Current, 2-Channel Comparator	V_{CC} = 5 V			0.9	1.2	mA
		V_{CC} = 36 V, T_A = −40°C to +125°C			1.2	1.6	mA
t_{RT}	Response Time	R_L connected to 5 V through 5.1 kΩ, C_L = 15 pF (2)(3)	100-mV input step with 5-mV overdrive		1.6		µs
			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 V, V_{CM} = 0 V, R_L = Open, unless otherwise noted.

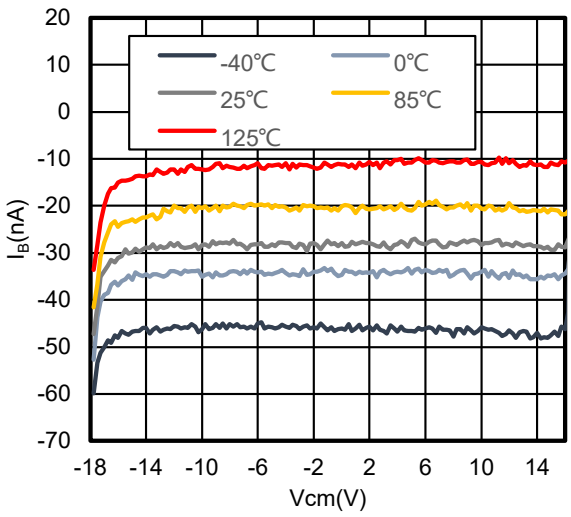


Figure 1. I_B vs. V_{CM}, (+V_S) = 18 V, (−V_S) = −18 V

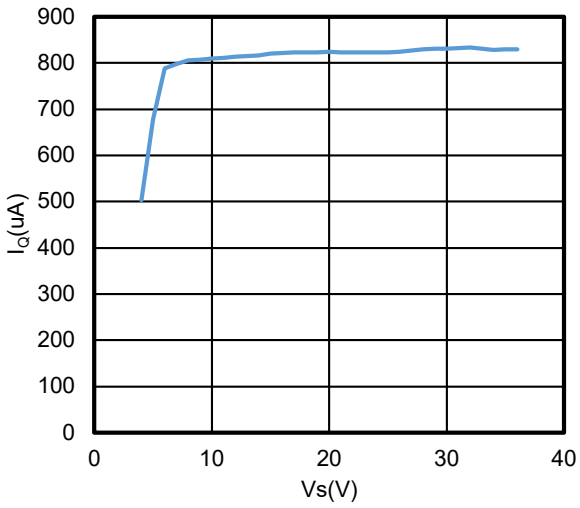


Figure 2. Supply Current vs. Supply Voltage

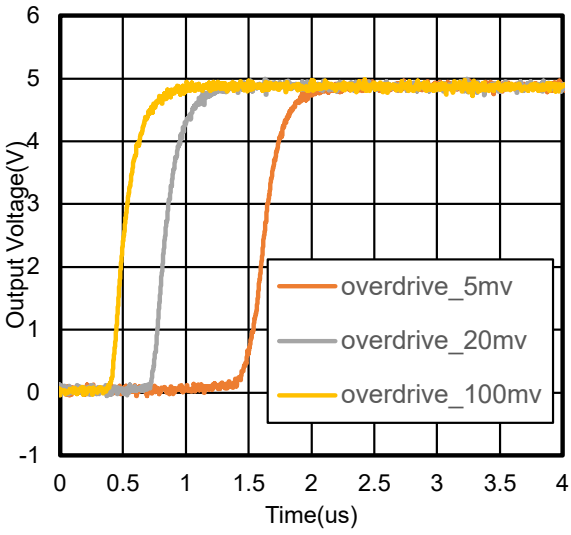


Figure 3. Response Time for Various Input Overdrives, Positive Transition

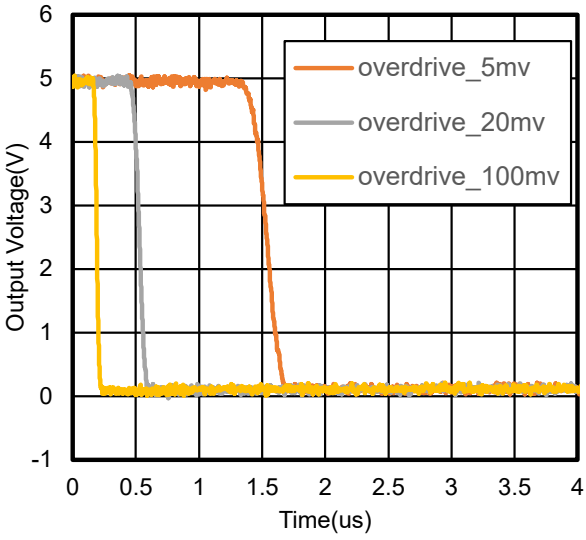


Figure 4. Response Time for Various Input Overdrives, Negative Transition

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

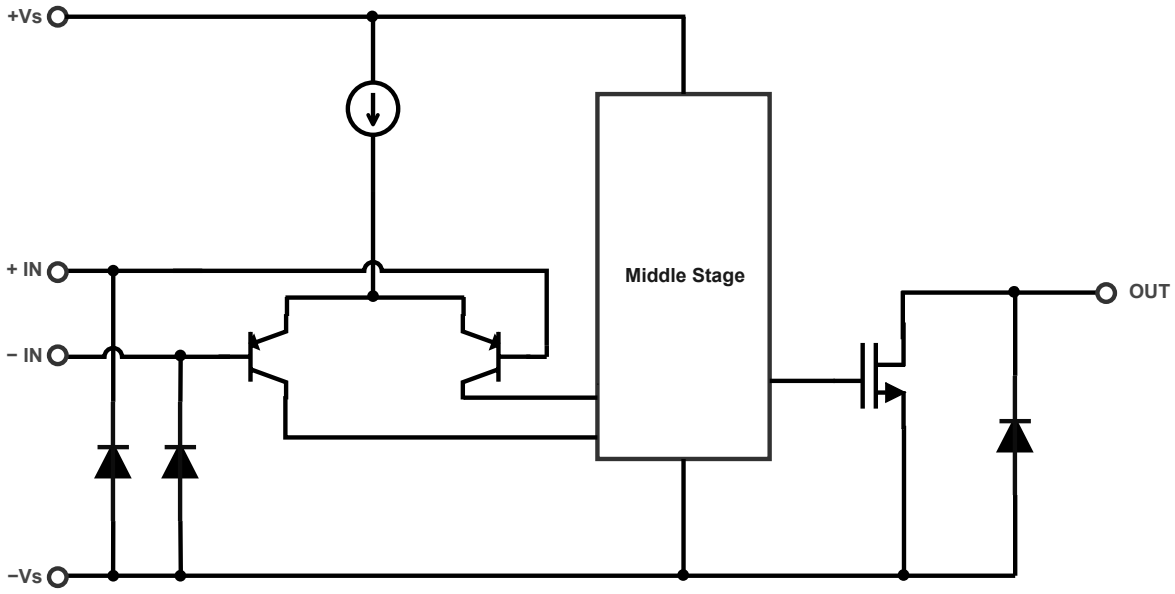


Figure 5. Functional Block Diagram

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 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 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.

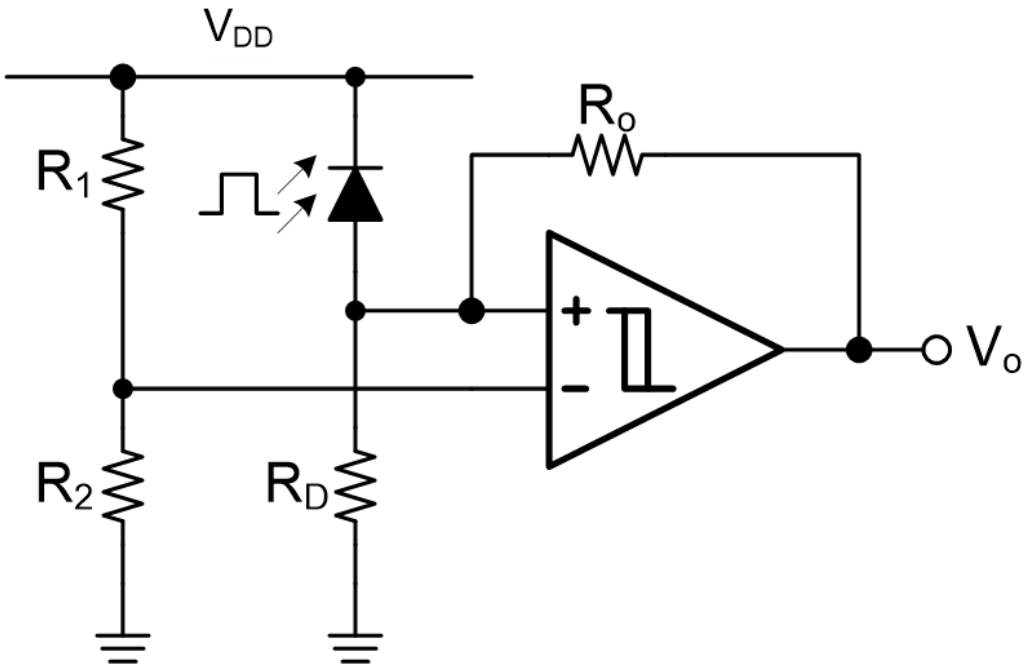
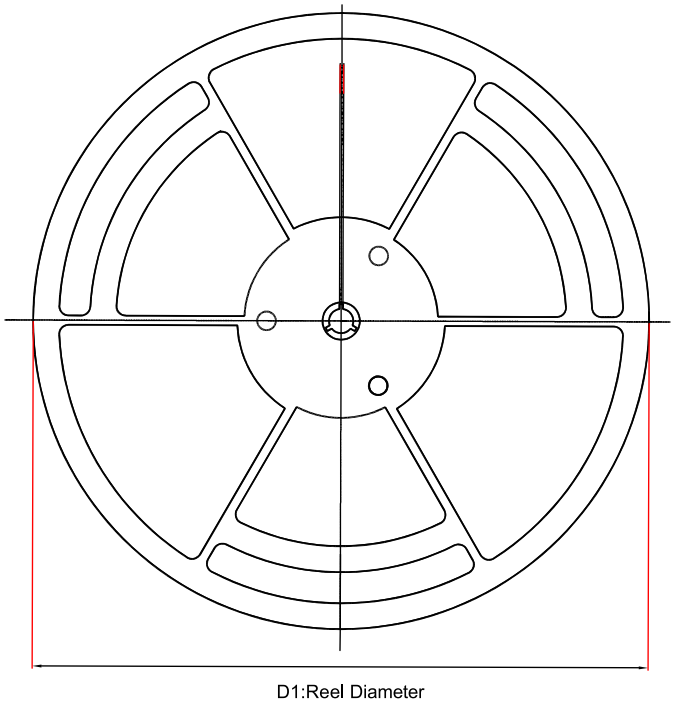
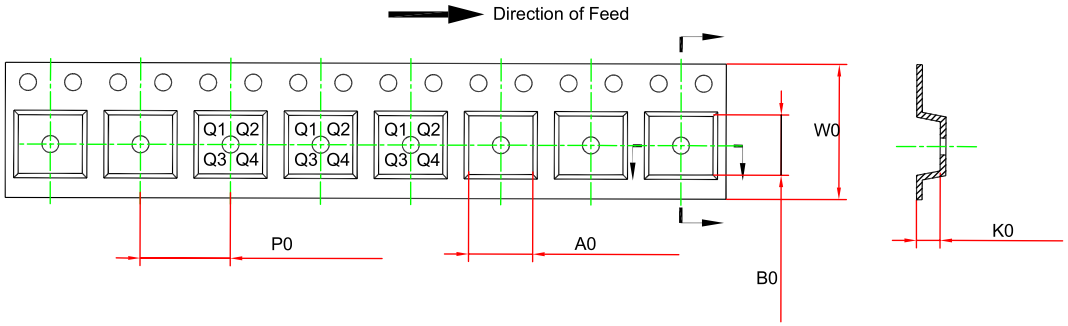


Figure 6. Typical Application Circuit

Tape and Reel Information





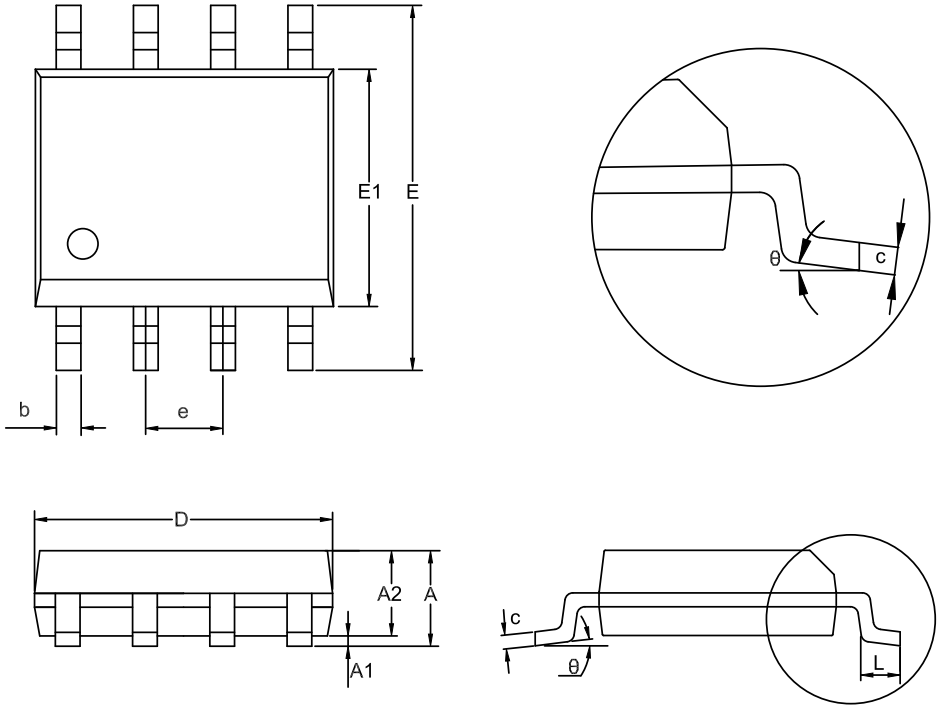
Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm) (1)	B0 (mm) (1)	K0 (mm) (1)	P0 (mm)	W0 (mm)	Pin1 Quadrant
LM2903D-SO1R	SOP8	330.0	17.6	6.4	5.4	2.1	8.0	12.0	Q1
LM2903D-VS1R	MSOP8	330.0	17.6	5.2	3.3	1.5	8.0	12.0	Q1
LM2903DA-TS1R	TSSOP8	330.0	17.6	6.8	3.3	1.2	8.0	12.0	Q1

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

Package Outline Dimensions

SOP8

Package Outline Dimensions SO1(SOP-8-A)



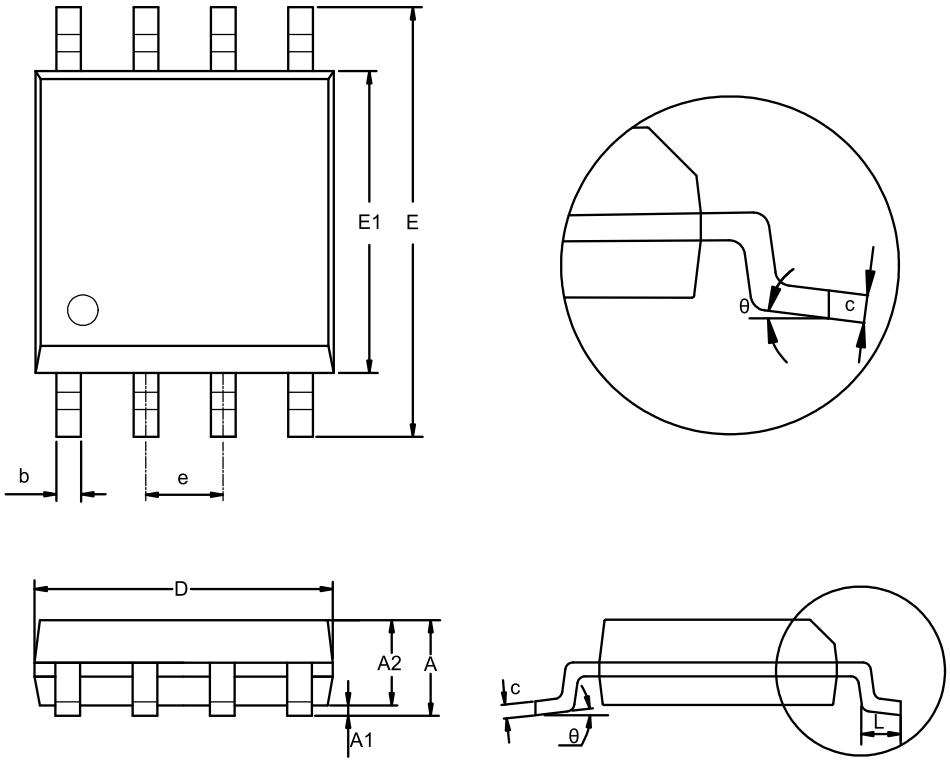
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.550	0.049	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050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



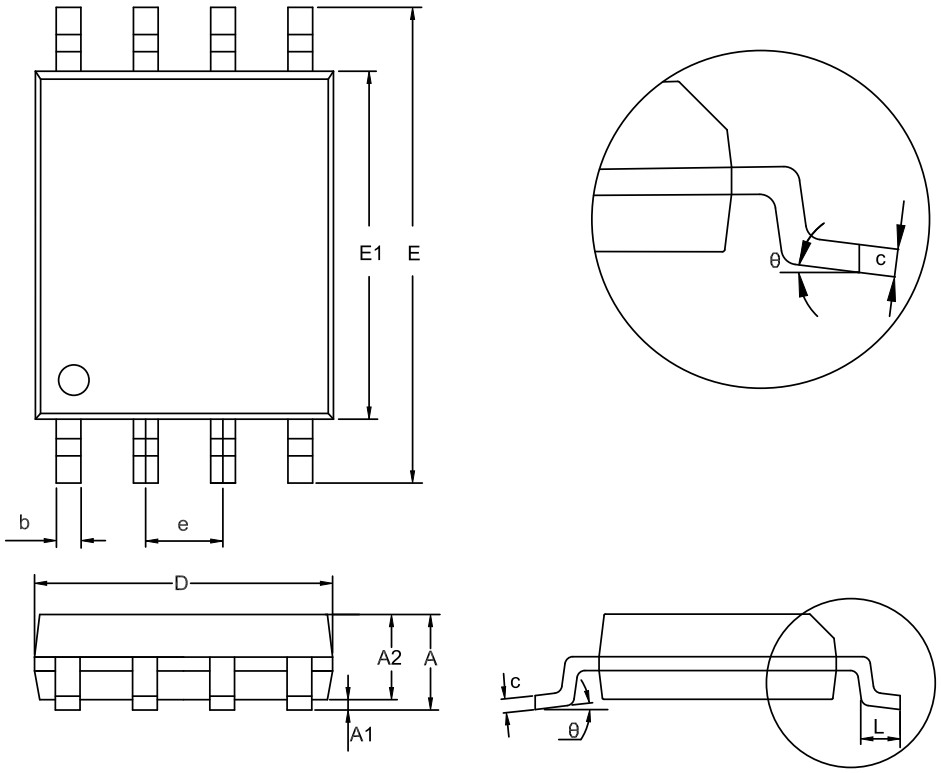
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.800	1.100	0.031	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	4.700	5.100	0.185	0.201
E1	2.900	3.100	0.114	0.122
e	0.650 BSC		0.026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

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.

IMPORTANT NOTICE AND DISCLAIMER

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.