General-Purpose High-Voltage Open-Drain Output Dual Comparator

1 FEATURES

- **Supply Range: +3.8V to +36V**
- **Low Supply Current**
  55μA (TYP) per channel at V_S = 5V
- **Common-Mode Input Voltage Range Includes Ground**
- **Low Output Saturation Voltage**
- **Open-Drain Output for Maximum Flexibility**
- **SPECIFIED UP TO +125°C**
- **Micro SIZE PACKAGES: SOIC-8(SOP8)、MSOP-8**

2 APPLICATIONS

- **Hysteresis Comparators**
- **Factory Automation & Control**
- **Industrial Equipment**
- **Test and Measurement**
- **Cordless Power Tool**
- **Vacuum Robot**
- **Wireless Infrastructure**

3 DESCRIPTIONS

The LM2903H is the dual comparator version, and the outputs can be connected to other open-collector outputs to achieve wired-AND relationships. It can operate from 3.8V to 36V, and have low power consuming 55μA (TYP) per channel.

The LM2903H consist of two independent voltage comparators that are designed to operate from a single power supply over a wide range of voltages. Quiescent current is independent of the supply voltage. The device is the most cost-effective solutions for applications where low offset voltage, high supply voltage capability, low supply current, and space saving are the primary specifications in circuit design for portable consumer products.

The LM2903H is available in Green SOIC-8, MSOP-8 packages. It operates over an ambient temperature range of -40°C to +125°C.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
LM2903H	SOIC-8(SOP8)	4.90mm×3.90mm
	MSOP-8	3.00mm×3.00mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

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4 Revision History

Note: Page numbers for previous revisions may different from page numbers in the current version.

VERSION	Change Date	Change Item
E.1	2023/03/13	Initial version completed

5 PACKAGE/ORDERING INFORMATION [(1)]

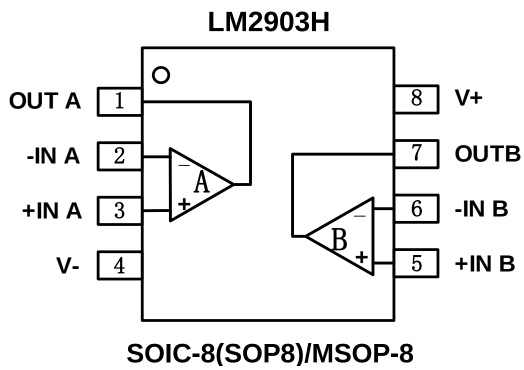
Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking [(2)]	Package Qty
LM2903HXK	SOIC-8(SOP8)	8	2	-40°C ~+125°C	LM2903	Tape and Reel,4000
LM2903HXM	MSOP-8	8	2	-40°C ~+125°C	LM2903	Tape and Reel,4000

NOTE:

(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(2) There may be additional marking, which relates to the lot trace code information(data code and vendor code)，the logo or the environmental category on the device.

6 Pin Configuration and Functions (Top View)



Pin Description

NAME	PIN	I/O (1)	DESCRIPTION
	SOIC-8(SOP8)/MSOP-8		
OUTA	1	O	Output, channel A
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
V-	4	P	Negative (lowest) power supply
+INB	5	I	Noninverting input, channel B
-INB	6	I	Inverting input, channel B
OUTB	7	O	Output, channel B
V+	8	P	Positive (highest) power supply

(1) I=Input, O=Output, P=Power.

7 SPECIFICATIONS

7.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) (1)

			MIN	MAX	UNIT
Voltage	Supply, V_S=(V+) - (V-)		-0.3	40	V
	Input pin (IN+, IN-) (2)		(V-)-0.3	(V+) +0.3	
	Signal output pin (3)		(V-)-0.3	(V+) +0.3	
Current	Signal input pin (IN+, IN-) (2)		-10	10	mA
	Signal output pin (3)		-20	20	mA
	Output short-circuits (4)		Continuous		
$θ_{JA}$	Package thermal impedance (5)	SOIC-8(SOP8)		110.88	°C/W
		MSOP-8		165.7	
Temperature	Operating range, T_A		-40	125	°C
	Junction, T_J (6)		-40	150	
	Storage, T_{stg}		-65	150	

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.3V beyond the supply rails should be current-limited to 10mA or less.
(3) Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.3V beyond the supply rails should be current-limited to ±20mA or less.
(4) Short-circuit from output to V_{CC} can cause excessive heating and eventual destruction.
(5) The package thermal impedance is calculated in accordance with JESD-51.
(6) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{θJA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{θJA}$. All numbers apply for packages soldered directly onto a PCB.

7.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-Body Model (HBM), per ANSI/ESDA/JEDEC JS-001 (1)	±2000	V
		Charged Device Model (CDM), per JEDEC specification JESD22-C101(2)	±1000	

(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.

ESD SENSITIVITY CAUTION

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

7.3 Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
Supply voltage，V_S= (V+) - (V-）	Single-supply	3.8		36	V
	Dual-supply	±1.9		±18	

7.4 ELECTRICAL CHARACTERISTICS

(At T_A = +25°C, V_{CM}=(V_S/2), V_S=5V, unless otherwise noted.) (1)

PARAMETER		CONDITIONS	LM2903H MIN(2)	LM2903H TYP(3)	LM2903H MAX(2)	UINT
V_S	Operating Voltage Range		3.8		36	V
I_Q	Quiescent Current	V_S=5V, no load		110	180	uA
		V_S=36V, no load, T_A=-40°C to +125°C			250	uA
V_{OS}	Input offset voltage	V_S=3.8V to 36V	-4.5	±0.8	4.5	mV
		V_S=3.8V to 36V T_A=-40°C to +125°C	-5		5	mV
IB	Input Bias Current (4) (5)	T_A=25°C		1	50	pA
		T_A=-40°C to +125°C			50	nA
I_{OS}	Input Offset Current (4)	T_A=25°C		1	50	pA
		T_A=-40°C to +125°C			50	nA
V_{CM}	Common-Mode Voltage Range (6)	V_S=3.8V to 36V	(V-)		(V+)-1.5	V
		V_S=3.8V to 36V T_A=-40°C to +125°C	(V-)		(V+)-2.0	V
A_{VD}	Large signal differential voltage amplification	V_S=15V, V_O=1.4V to 11.4V, R_L≥15k to (V+)	20	100		V/mV
V_{OL}	Low-Level output voltage	I_{sink}≤4mA, V_{ID}=-1V		250	350	mV
		I_{sink}≤4mA, V_{ID}=-1V T_A=-40°C to +125°C			550	mV
I_{OL}	Output Current(sinking)	V_O=1.5V; V_{ID}=-1V	10	20		mA
I_{OH-LKG}	High-Level Output Leakage Current	(V+) =V_O=5V; V_{ID}=1V		6	50	nA
		(V+) =V_O=36V; V_{ID}=1V		35	100	nA
Switching Characteristics						
T_{PHL}	Propagation Delay H To L(7)	V_S=5V, RPU=5.1KΩ Overdrive =10mV		0.65		us
		V_S=5V, RPU=5.1KΩ Overdrive =100mV		0.25		us
		V_S=36V, RPU=5.1KΩ Overdrive =10mV		0.55		us
		V_S=36V, RPU=5.1KΩ Overdrive =100mV		0.25		us
T_{PLH}	Propagation Delay L To H(7)	V_S=5V, RPU=5.1KΩ Overdrive =10mV		1.0		us
		V_S=5V, RPU=5.1KΩ Overdrive =100mV		0.6		us
		V_S=36V, RPU=5.1KΩ Overdrive =10mV		0.9		us
		V_S=36V, RPU=5.1KΩ Overdrive =100mV		0.55		us

NOTE:

(1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

(2) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.

(3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

(4) This parameter is ensured by design and/or characterization and is not tested in production.

(5) Positive current corresponds to current flowing into the device.

(6) The voltage at either the input or common mode should not be allowed to negative by more that 0.3 V. The upper end of the common-mode voltage range is (V+) – 1.5 V; however, one input can exceed Vs, and the comparator will provide a proper output state as long as the other input remains in the common-mode range. Either or both inputs can go to 36 V without damage.

(7) High-to-low and low-to-high refers to the transition at the input.

7.5 TYPICAL CHARACTERISTICS

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, V_S=5V, R_{PULLUP}=5.1k, V_{CM} = Vs/2, C_L=15pF, unless otherwise noted.

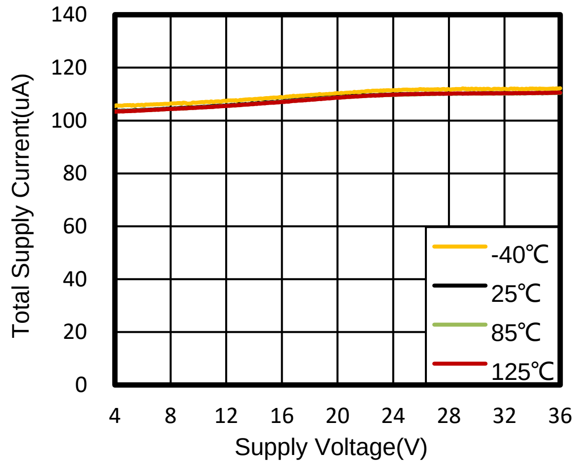


Figure 1. Total Supply Current vs Supply Voltage

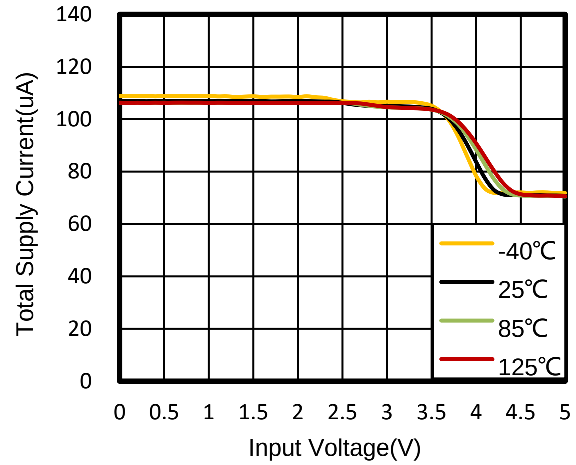


Figure 2. Total Supply Current vs Input Voltage at 5V

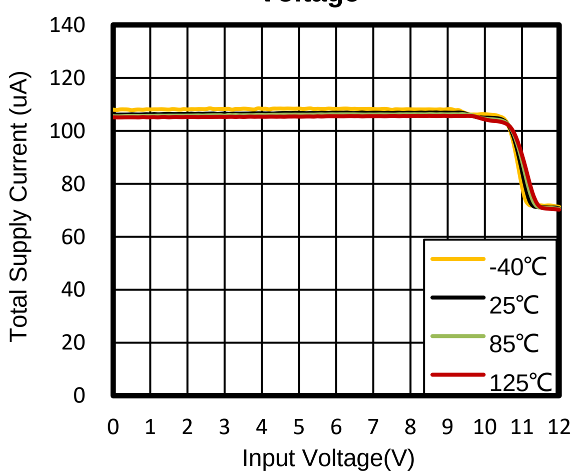


Figure 3. Total Supply Current vs Input Voltage at 12V

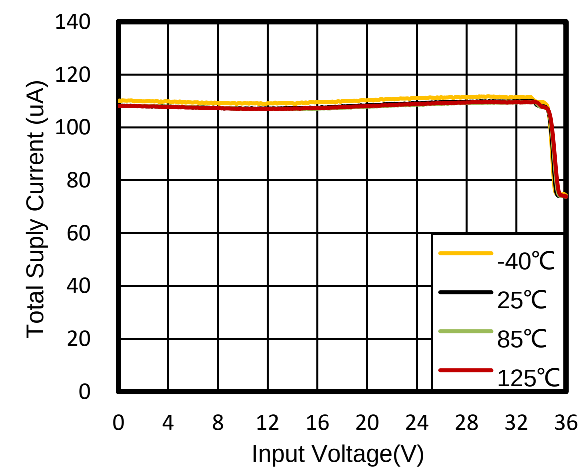


Figure 4. Total Supply Current vs Input Voltage at 36V

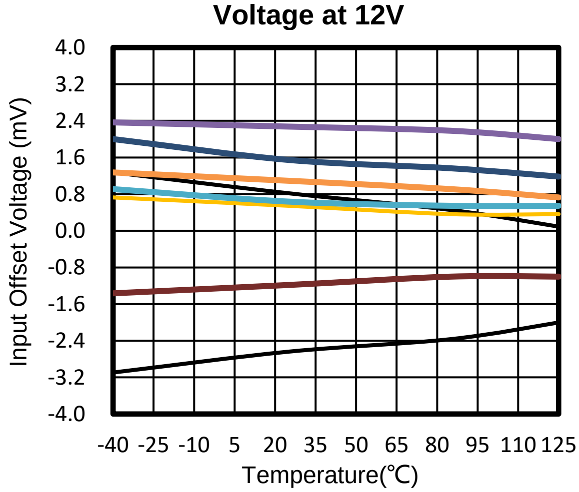


Figure 5. Input Offset Voltage vs Temperature at 5V

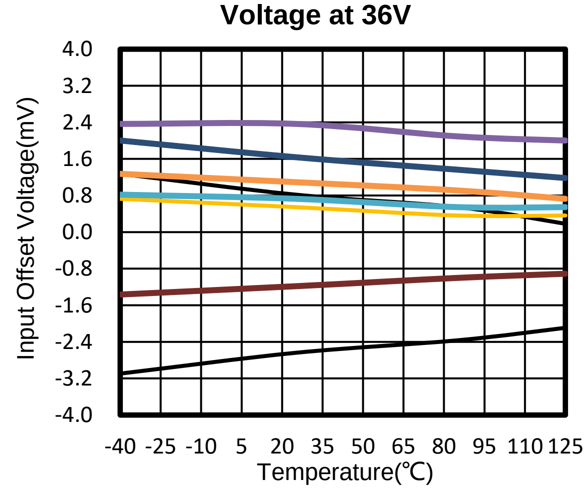


Figure 6. Input Offset Voltage vs Temperature at 12V

TYPICAL CHARACTERISTICS

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, V_S=5V, R_{PULLUP}=5.1k, V_{CM} = Vs/2, C_L=15pF, unless otherwise noted.

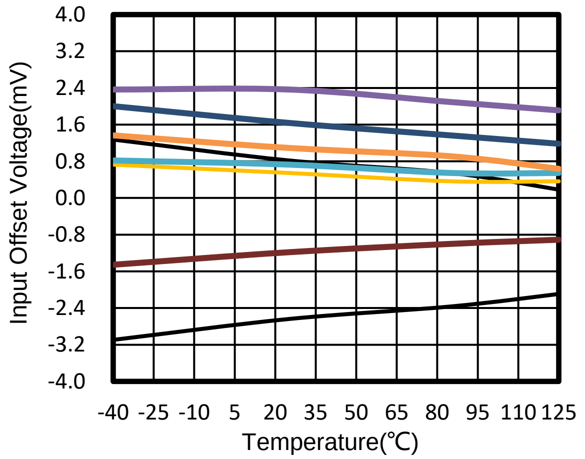


Figure 7. Input Offset Voltage vs Temperature at 36V

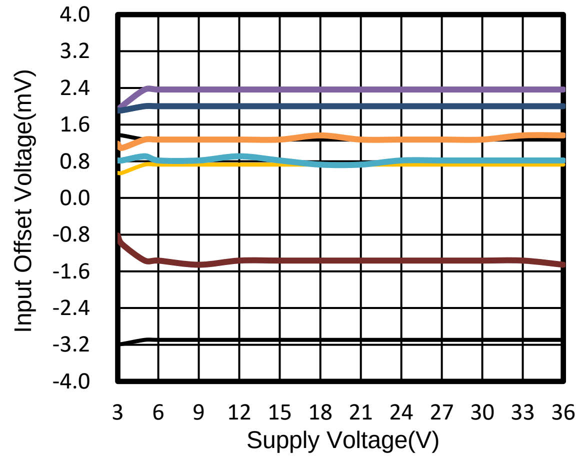


Figure 8. Input Offset Voltage vs Supply Voltage at -40°C

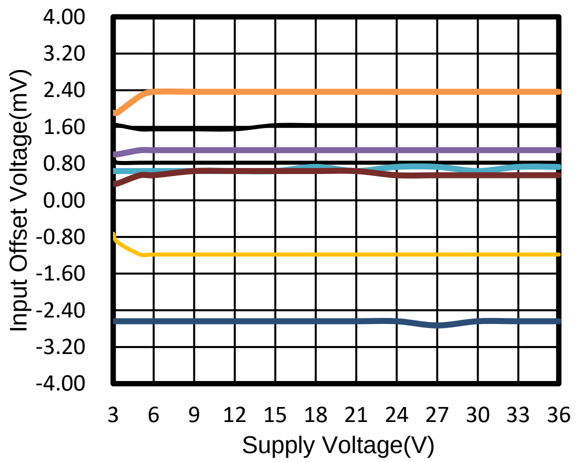


Figure 9. Input Offset Voltage vs Supply Voltage at 25°C

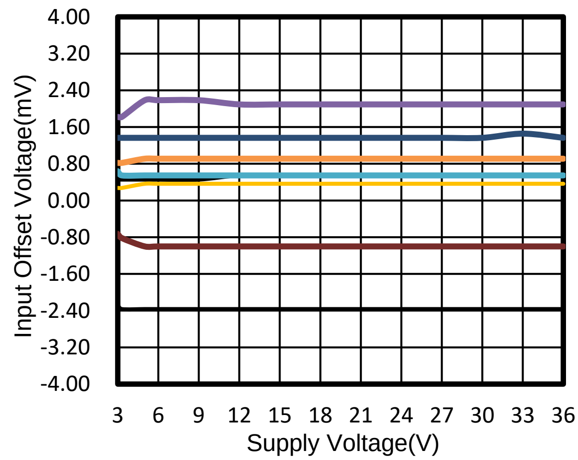


Figure 10. Input Offset Voltage vs Supply Voltage at 85°C

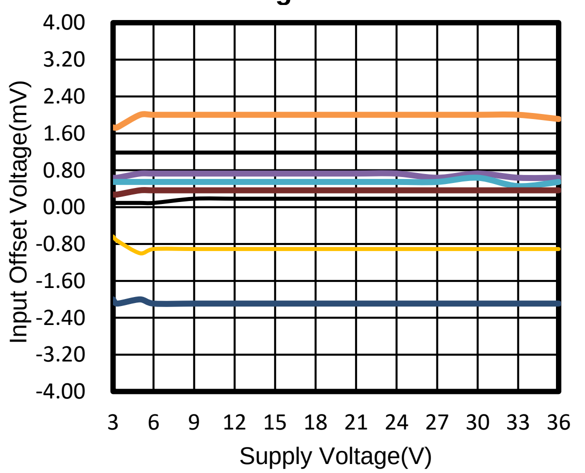


Figure 11. Input Offset Voltage vs Supply Voltage at 125°C

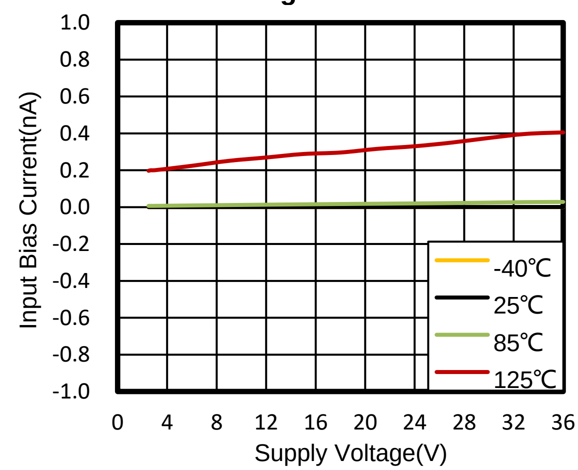


Figure 12. Input Bias Current vs Supply Voltage

TYPICAL CHARACTERISTICS

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, V_S=5V, R_{PULLUP}=5.1k, V_{CM} = Vs/2, C_L=15pF, unless otherwise noted.

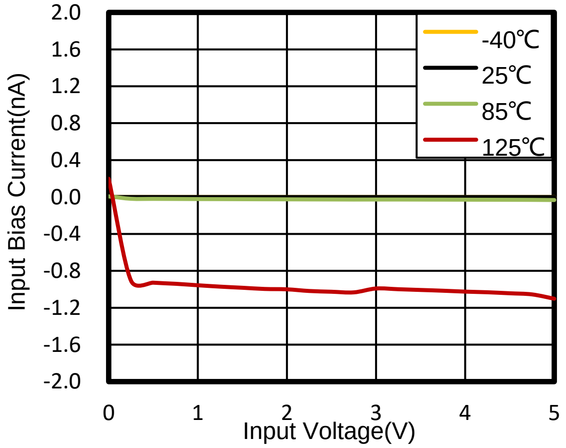


Figure 13. Input Bias Current vs Input Voltage at 5V

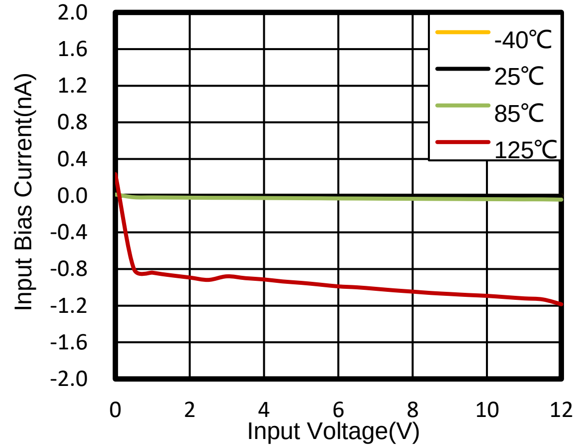


Figure 14. Input Bias Current vs Input Voltage at 12V

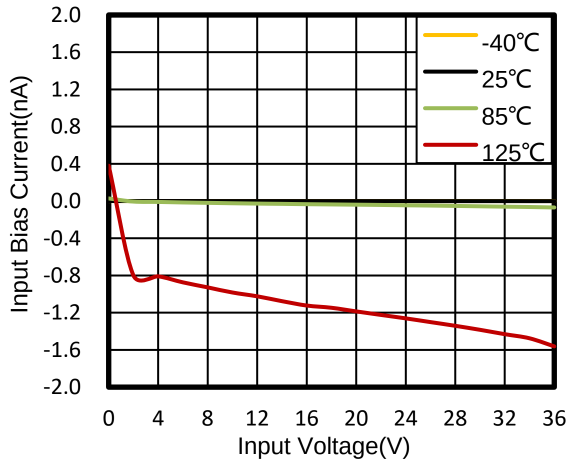


Figure 15. Input Bias Current vs Input Voltage at 36V

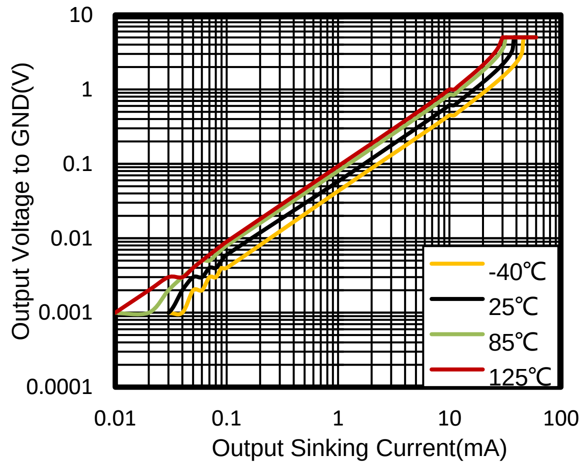


Figure 16. Output Low Voltage vs Output Sinking Current at 5V

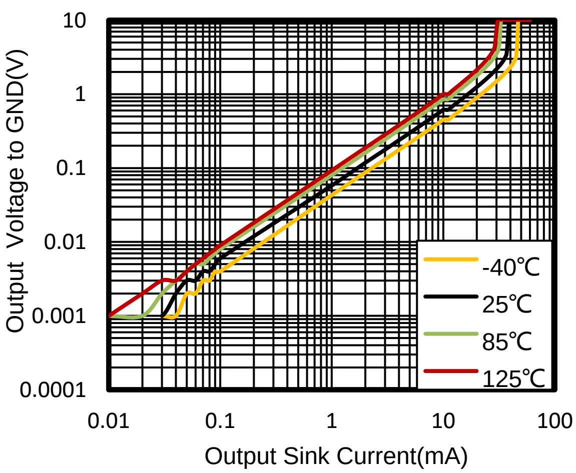


Figure 17. Output Low Voltage vs Output Sinking Current at 12V

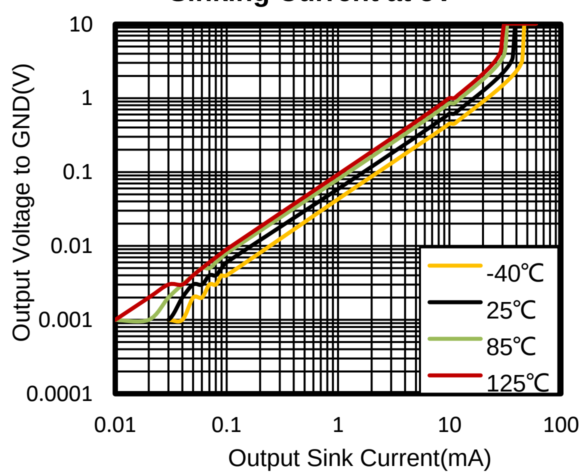


Figure 18. Output Low Voltage vs Output Sinking Current at 36V

TYPICAL CHARACTERISTICS

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, V_S=5V, R_{PULLUP}=5.1k, V_{CM} = Vs/2, C_L=15pF, unless otherwise noted.

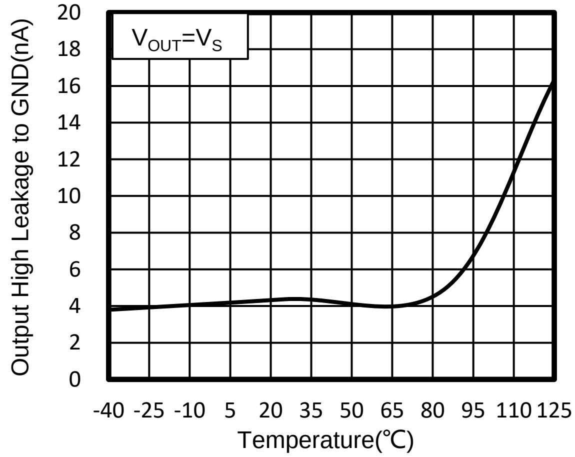


Figure 19. Output High Leakage Current vs Temperature at 5V

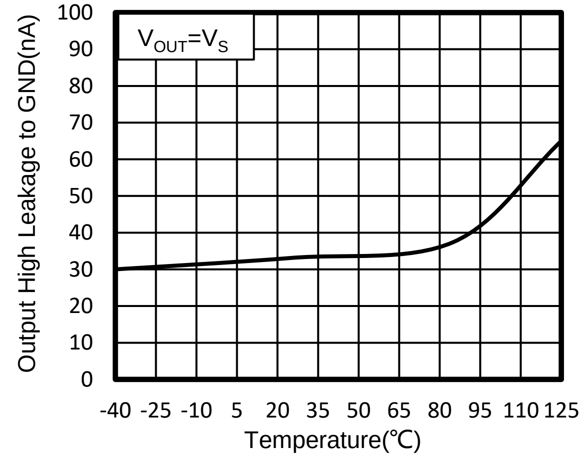


Figure 20. Output High Leakage Current vs Temperature at 36V

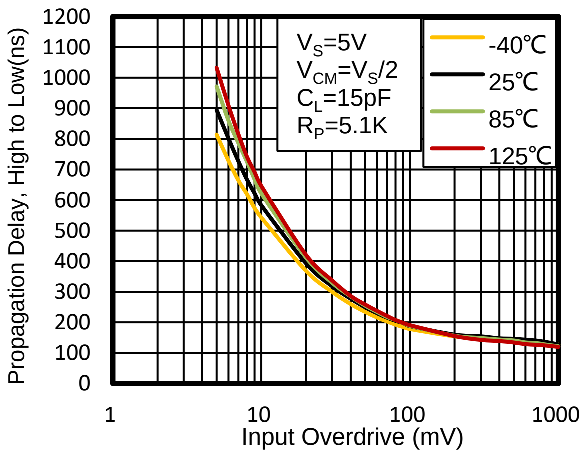


Figure 21. High to Low Propagation Delay vs Input Overdrive Voltage, 5V

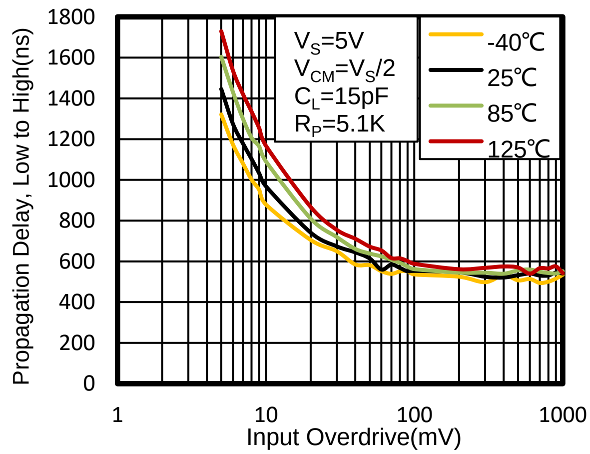


Figure 22. Low to High Propagation Delay vs Input Overdrive Voltage, 5V

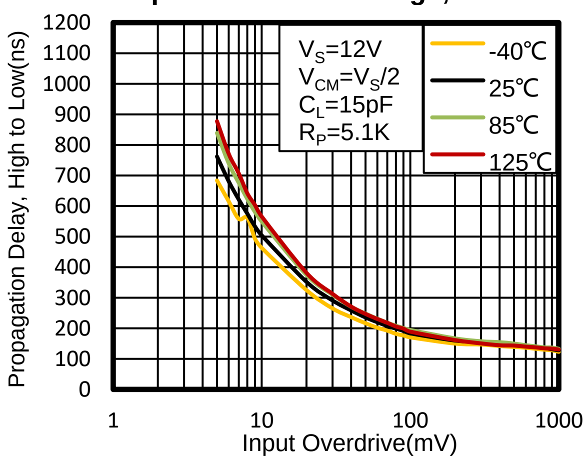


Figure 23. High to Low Propagation Delay vs Input Overdrive Voltage, 12V

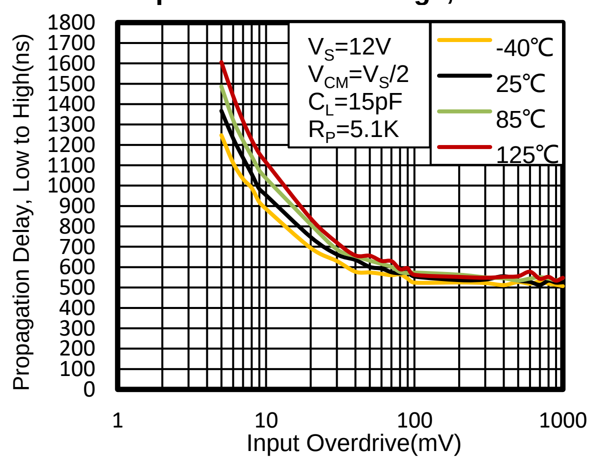


Figure 24. Low to High Propagation Delay vs Input Overdrive Voltage, 12V

TYPICAL CHARACTERISTICS

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, V_S=5V, R_{PULLUP}=5.1k, V_{CM} = Vs/2, C_L=15pF, unless otherwise noted.

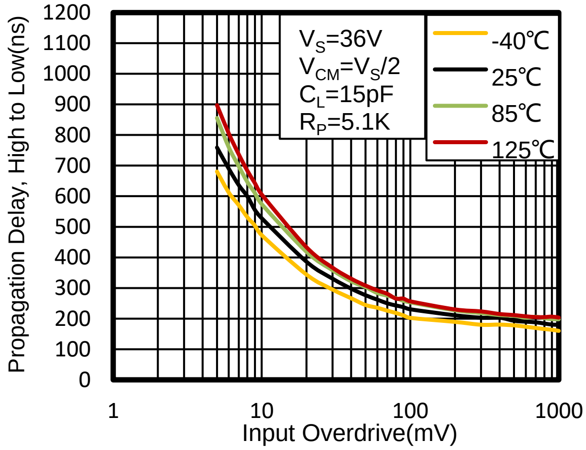


Figure 25. High to Low Propagation Delay vs Input Overdrive Voltage, 36V

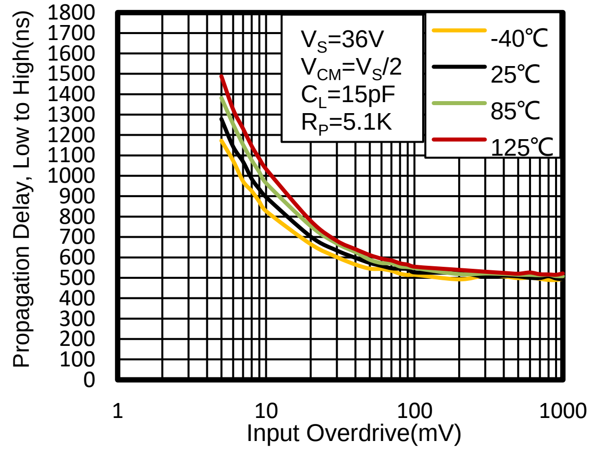


Figure 26. Low to High Propagation Delay vs Input Overdrive Voltage, 36V

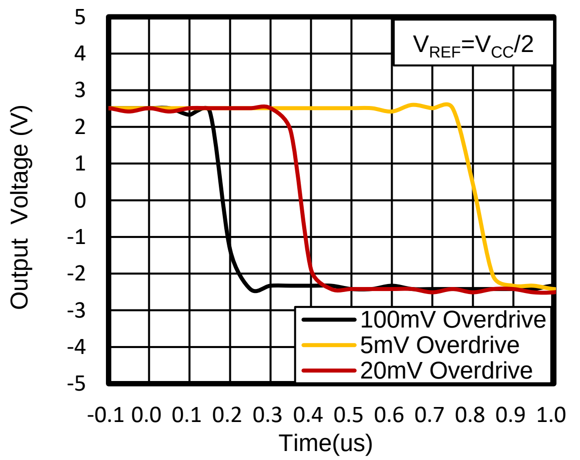


Figure 27. Response Time for Various Overdrives, High-to-Low Transition

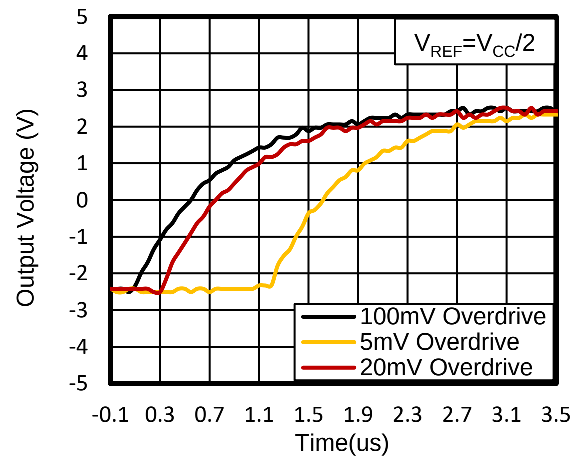


Figure 28. Response Time for Various Overdrives, Low-to-High Transition

8 Detailed Description

8.1 Overview

The LM2903H family of comparators can operate up to 36V on the supply pin. This standard device has proven ubiquity and versatility across a wide range of applications. This is due to its low power and high speed. The open-drain output allows the user to configure the output's logic low voltage (V_{OL}) and can be utilized to enable the comparator to be used in AND functionality.

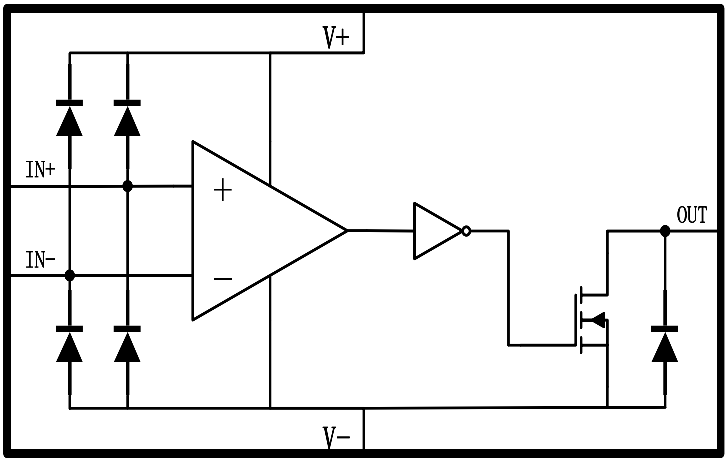


Figure 29. Functional Block Diagram

9 Application and Implementation

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

9.1 Application Information

LM2903H is typically used to compare a single signal to a reference or two signals against each other. Many users take advantage of the open drain output (logic high with pull-up) to drive the comparison logic output to a logic voltage level to an MCU or logic device. The wide supply range and high voltage capability makes this comparator optimal for level shifting to a higher or lower voltage.

9.2 Typical Application

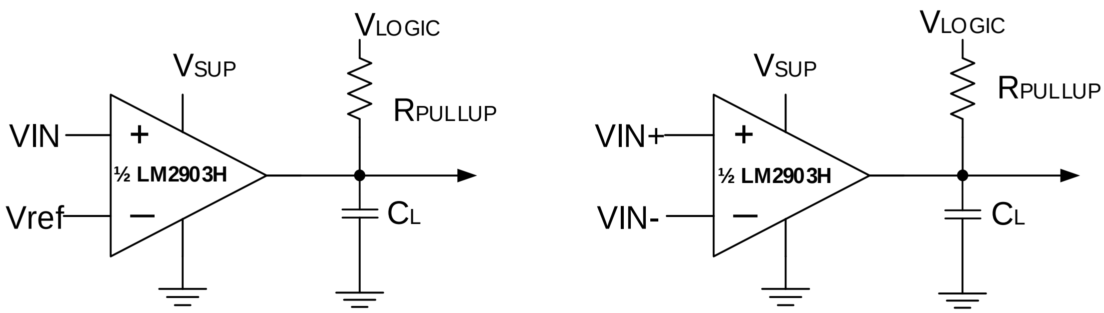


Figure 30. Single-Ended and Differential Comparator Configurations

9.3 Detailed Design Procedure

When using the device in a general comparator application, determine the following:

- Input Voltage Range
- Minimum Overdrive Voltage
- Output and Drive Current
- Response Time

9.4 Input Voltage Range

When choosing the input voltage range, the input common mode voltage range (V_{ICR}) must be taken in to account. If temperature operation is below 25°C the V_{ICR} can range from 0 V to V_{CC}– 2.0 V. This limits the input voltage range to as high as V_{CC}– 2.0 V and as low as 0 V. Operation outside of this range can yield incorrect comparisons.

10 Layout

10.1 Layout Guidelines

For accurate comparator applications without hysteresis, it is important maintain a stable power supply with minimized noise and glitches. To achieve this, it is best to add a bypass capacitor between the supply voltage and ground. This should be implemented on the positive power supply and negative supply (if available). If a negative supply is not being used, do not put a capacitor between the IC's GND pin and system ground. Minimize coupling between outputs and inverting inputs to prevent output oscillations. Do not run output and inverting input traces in parallel unless there is a V_{CC} or GND trace between output and inverting input traces to reduce coupling. When series resistance is added to inputs, place resistor close to the device.

10.2 Layout Example

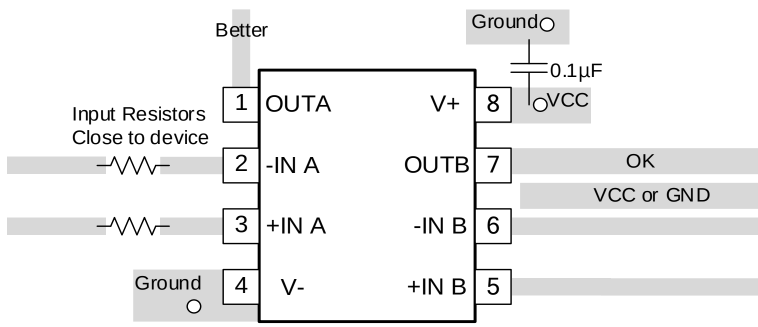
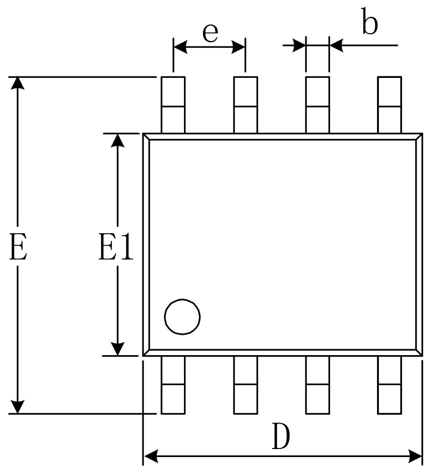
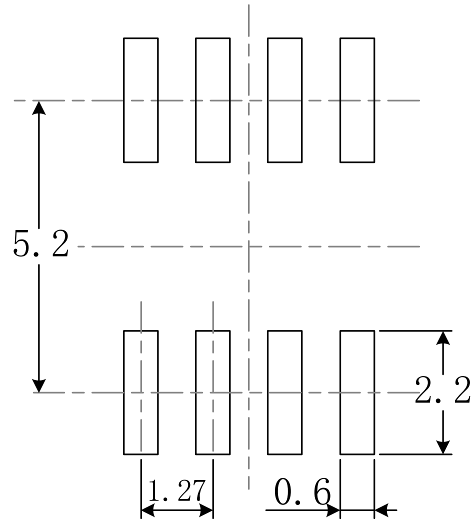


Figure 31. LM2903H Layout Example

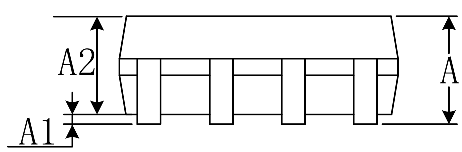
11 PACKAGE OUTLINE DIMENSIONS

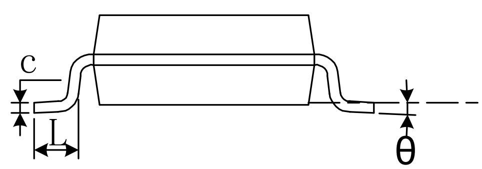
SOIC-8(SOP8)





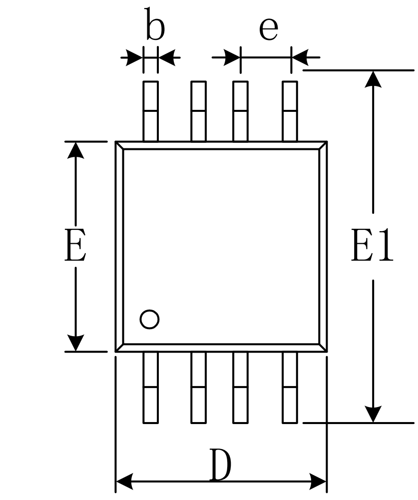
RECOMMENDED LAND PATTERN (Unit: mm)

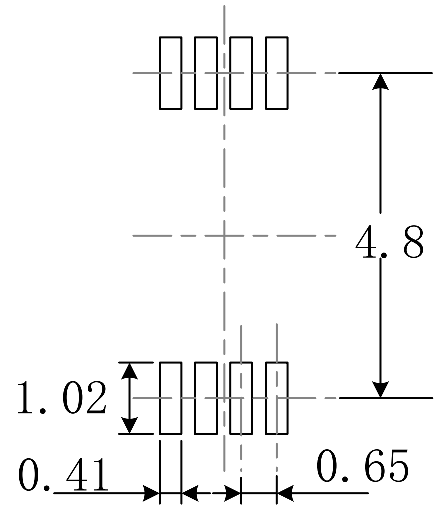




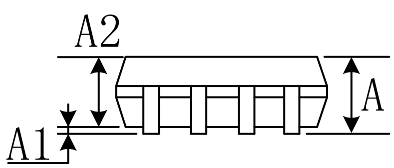
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

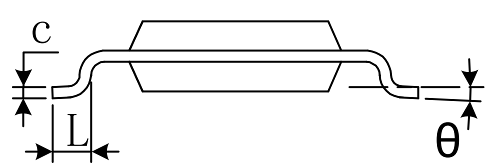
MSOP-8





RECOMMENDED LAND PATTERN (Unit: mm)





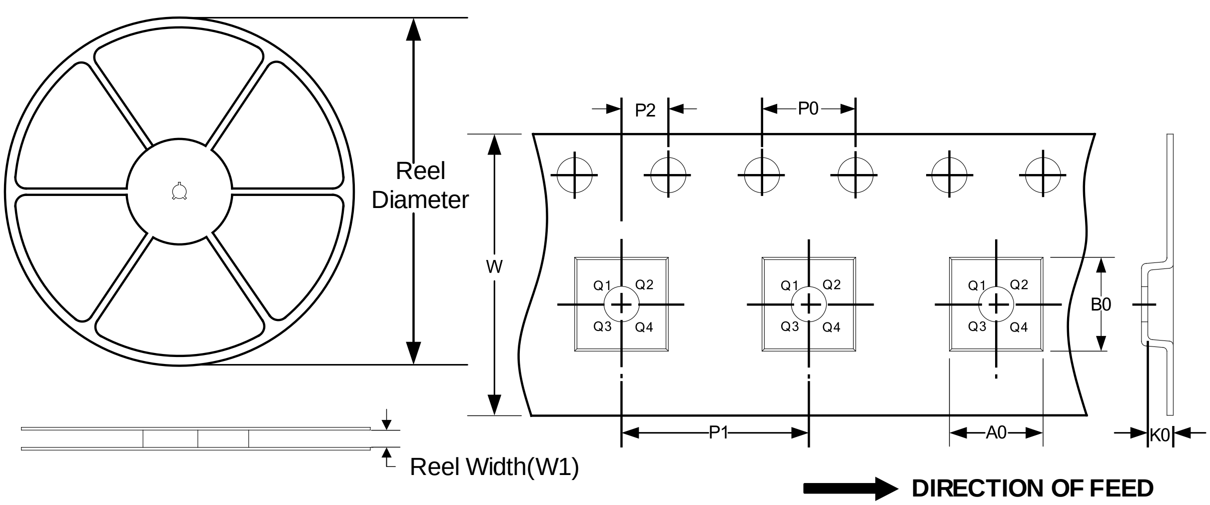
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

NOTE:

A. All linear dimension is in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

12 TAPE AND REEL INFORMATION

REEL DIMENSIONS **TAPE DIMENSION**



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOIC-8(SOP8)	13''	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP-8	13''	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

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