

## LM2903-Q1 和 LM2903B-Q1 汽车类双路比较器

### 特性

- 符合汽车应用要求
- 具有符合 AEC-Q100 标准的下列特性：
  - 器件温度等级 0：-40°C 至 150°C 的环境工作温度范围 (LM2903E-Q1)
  - 器件温度等级 1：-40°C 至 125°C 环境工作温度范围
  - 器件 HBM ESD 分类等级 H1C
  - 器件 CDM ESD 分类等级 C4B
- 改进了“B”器件的 2kV HBM ESD
- 可用于“B”器件的 Tri-Temp 测试
- 单电源或双电源
- 独立于电源电压的  
低电源电流：  
每个比较器 200uA (典型值) (“B”版本)
- 低输入偏置电流：3.5nA (典型值) (“B”器件)
- 低输入偏置电流：0.5nA (典型值) (“B”器件)
- 低输入偏移电压：±0.37mV (典型值) (“B”器件)
- 共模输入电压范围包括接地
- 差动输入电压范围等于最大额定电源电压：±36V
- 输出与 TTL、MOS 和 CMOS 兼容
- 功能安全型
  - 可提供用于功能安全系统设计的文档

### 应用

- 汽车
  - HEV/EV 和动力总成
  - 信息娱乐系统与仪表组
  - 车身控制模块
- 工业
- 电器

### 说明

LM2903B-Q1 器件是业界通用 LM2903-Q1 比较器系列的下一代版本。该下一代系列为成本敏感型应用提供了卓越的价值，其特性包括更低的失调电压、更高的电源电压能力、更低的电源电流、更低的输入偏置电流、更低的传播延迟以及更高的 2kV ESD 性能，并提供了直接替代的便利性。

所有器件都包含两个独立的电压比较器，这些比较器可在广泛的电压范围内运行。如果两个电源的电压差处于 2V 至 36V 范围内且 VCC 比输入共模电压至少高 1.5V，那么也可以使用双电源。输出可以连接到其他集电极开路输出。

LM2903-Q1 和 LM2903B-Q1 符合 -40°C 至 +125°C 的 AEC-Q100 1 级温度范围。LM2903E-Q1 符合 -40°C 至 +150°C 的 0 级工作温度范围。

#### 器件信息

器件型号	封装 (1)	封装尺寸 (标称值)
LM2903B-Q1	SOIC (8)	4.90mm × 3.91mm
	TSSOP (8)	3.00mm × 4.40mm
	VSSOP(8)	3.00mm × 3.00mm
	WSON (8)	2.00mm × 2.00mm
	SOT-23 (8)	1.60mm × 2.90mm
LM2903-Q1	SOIC (8)	4.90mm × 3.91mm
	TSSOP (8)	3.00mm × 4.40mm
	VSSOP(8)	3.00mm × 3.00mm
LM2903E-Q1	TSSOP (8)	3.00mm × 4.40mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。

#### 系列比较表

规格	LM2903B-Q1	LM2903-Q1	LM2903-Q1 “A” 器件	LM2903-Q1 “AV” 器件	LM2903E-Q1	单位
指定电源电压	2 至 36	2 至 30	2 至 30	2 至 32	2 至 30	V
总电源电流 (5V 至 V <sub>S</sub> max)	0.6 至 0.8	1 至 2.5	1 至 2.5	1 至 2.5	1 至 2.5	mA
温度范围	-40 至 125	-40 至 125	-40 至 125	-40 至 125	-40 至 150	°C
ESD (HBM/CDM)	2k/1k	1k / 750	1k / 750	1k / 750	1k / 750	V
失调电压 (整个温度范围内的最大值)	±4	±15	±4	±4	±15	mV
输入偏置电流 (典型值/最大值)	3.5/25	25/250	25/250	25/250	25/250	nA
响应时间 (典型值)	1	1.3	1.3	1.3	1.3	µsec



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## 1 Pin Configuration and Functions

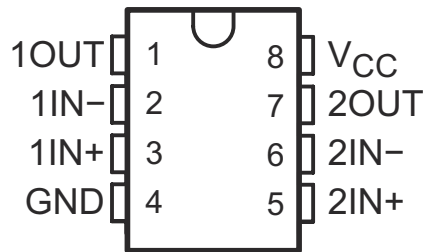
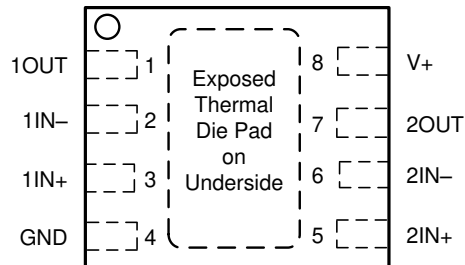


图 1-1. D, DGK, DDF OR PW PACKAGE  
Top View



Connect thermal pad directly to GND pin.

图 1-2. DSG Package  
8-Pin WSON With Exposed Pad  
Top View

### 1.1 Pin Functions

NAME	PIN		I/O	DESCRIPTION
	SOIC, VSSOP, PDIP, SO, DDF and TSSOP	DSG		
1OUT	1	1	Output	Output pin of comparator 1
1IN -	2	2	Input	Negative input pin of comparator 1
1IN+	3	3	Input	Positive input pin of comparator 1
GND	4	4	—	Ground
2IN+	5	5	Input	Positive input pin of comparator 2
2IN-	6	6	Input	Negative input pin of comparator 2
2OUT	7	7	Output	Output pin of comparator 2
V <sub>CC</sub>	8	8	—	Positive Supply
Thermal Pad	—	PAD	—	Connect directly to GND pin

## 2 Specifications

### 2.1 Absolute Maximum Ratings, LM2903-Q1 and LM2903E-Q1

over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage <sup>(2)</sup>		36	V
V <sub>CC</sub>	Supply voltage, LM2903E-Q1 Only <sup>(2)</sup>		32	V
V <sub>ID</sub>	Differential input voltage <sup>(3)</sup>	-36	36	V
V <sub>I</sub>	Input voltage range (either input)	-0.3	36	V
V <sub>O</sub>	Output voltage		36	V
I <sub>O</sub>	Output current		20	mA
T <sub>J</sub>	Operating virtual-junction temperature		150	°C
T <sub>SCG</sub>	Duration of output short-circuit to ground		Unlimited	s

(1) Stresses beyond those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods can affect device reliability.

(2) All voltage values, except differential voltages, are with respect to GND.

(3) Differential voltages are at IN+ with respect to IN-.

### 2.2 Absolute Maximum Ratings, LM2903B-Q1

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
Supply voltage: V <sub>S</sub> = (V+) - (V-)		-0.3	38	V
Differential input voltage : V <sub>ID</sub> <sup>(2)</sup>			±38	V
Input pins (IN+, IN-)		-0.3	38	V
Current into input pins (IN+, IN-)			-50	mA
Output pin (OUT)		-0.3	38	V
Output sink current			25	mA
Operating virtual-junction temperature			150	°C
Output short-circuit duration <sup>(3)</sup>			Unlimited	s

(1) Stresses beyond those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods can affect device reliability.

(2) Differential voltages are at IN+ with respect to IN-.

(3) Short circuits from outputs to V+ can cause excessive heating and eventual destruction.

### 2.3 ESD Ratings, LM2903-Q1 and LM2903E-Q1

			MIN	MAX	UNIT
T <sub>stg</sub>	Storage temperature range	LM2903-Q1 Only	-65	150	°C
V <sub>(ESD)</sub>	Electrostatic discharge	Human body model (HBM), per AEC Q100-002 <sup>(1)</sup>	-1000	1000	V
		Charged device model (CDM), per AEC Q100-011	All pins	-750	

(1) AEC Q100-002 indicates HBM stressing is done in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

### 2.4 ESD Ratings, LM2903B-Q1

			MIN	MAX	UNIT
T <sub>stg</sub>	Storage temperature range		-65	150	°C
V <sub>(ESD)</sub>	Electrostatic discharge	Human body model (HBM), per AEC Q100-002 <sup>(1)</sup>	-2000	2000	V
		Charged device model (CDM), per AEC Q100-011	All pins	-1000	

(1) AEC Q100-002 indicates HBM stressing is done in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

## 2.5 Recommended Operating Conditions, LM2903B-Q1

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

	MIN	MAX	UNIT
Supply voltage: $V_S = (V+) - (V-)$	2	36	V
Ambient temperature, $T_A$ , LM2903B	-40	125	°C
Input voltage range, $V_{IVR}$	-0.1	(V+) - 2	V

## 2.6 Recommended Operating Conditions, LM2903-Q1

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

	MIN	MAX	UNIT
$V_{CC}$ (non-V devices)	2	30	V
$V_{CC}$ (V devices)	2	32	V
$T_J$ Junction Temperature	-40	125	°C

## 2.7 Recommended Operating Conditions, LM2903E-Q1

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

	MIN	MAX	UNIT
$V_{CC}$	2	30	V
$T_J$ Junction Temperature	-40	150	°C

## 2.8 Thermal Information

THERMAL METRIC <sup>(1)</sup>	LM2903x-Q1					UNIT
	D (SOIC)	DGK (VSSOP)	PW (TSSOP)	DSG (WSON)	DDF (SOT-23)	
	8 PINS	8 PINS	8 PINS	8 PINS	8 PINS	
$R_{\theta JA}$ Junction-to-ambient thermal resistance	154.1	176.5	182.9	102.1	197.9	°C/W
$R_{\theta JC(top)}$ Junction-to-case (top) thermal resistance	96.5	85.5	87.1	126.0	119.2	
$R_{\theta JB}$ Junction-to-board thermal resistance	97.7	112.4	123.2	68.6	115.4	
$\psi_{JT}$ Junction-to-top characterization parameter	45.7	17.3	16.7	15.9	19.4	
$\psi_{JB}$ Junction-to-board characterization parameter	96.9	110.1	120.4	68.4	113.7	
$R_{\theta JC(bot)}$ Junction-to-case (bottom) thermal resistance	-	-	-	43.9	-	

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

## 2.9 Electrical Characteristics LM2903B - Q1

$V_S = 5V$ ,  $V_{CM} = (V^-)$ ;  $T_A = 25^\circ C$  (unless otherwise noted).

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
$V_{IO}$	Input offset voltage, DGK package only	Input offset voltage, DGK package only	$V_S = 5$ to 36V	- 3.5	$\pm 0.37$	3.5	mV
$V_{IO}$	Input offset voltage, DGK package only	Input offset voltage, DGK package only	$V_S = 5$ to 36V, $T_A = -40^\circ C$ to $+125^\circ C$	- 5		5	mV
$V_{IO}$	Input offset voltage		$V_S = 5$ to 36V	- 2.5	$\pm 0.37$	2.5	mV
			$V_S = 5$ to 36V, $T_A = -40^\circ C$ to $+125^\circ C$	- 4		4	mV
$I_B$	Input bias current			-25	- 3.5		nA
			$T_A = -40^\circ C$ to $+125^\circ C$	-50			nA
$I_{OS}$	Input offset current			- 10	$\pm 0.5$	10	nA
			$T_A = -40^\circ C$ to $+125^\circ C$	- 25		25	nA
$V_{CM}$	Common mode range <sup>(1)</sup>		$V_S = 3$ to 36V	( $V^-$ )		( $V^+$ ) - 1.5	V
			$V_S = 3$ to 36V, $T_A = -40^\circ C$ to $+125^\circ C$	( $V^-$ )		( $V^+$ ) - 2.0	V
$A_{VD}$	Large signal differential voltage amplification		$V_S = 15V$ , $V_O = 1.4V$ to 11.4V; $R_L \geq 15k$ to ( $V^+$ )	50	200		V/mV
$V_{OL}$	Low level output Voltage {swing from ( $V^-$ )}		$I_{SINK} \leq 4mA$ , $V_{ID} = -1V$		110	400	mV
			$I_{SINK} \leq 4mA$ , $V_{ID} = -1V$ $T_A = -40^\circ C$ to $+125^\circ C$				550
$I_{OH-LKG}$	High-level output leakage current		( $V^+$ ) = $V_O = 5V$ ; $V_{ID} = 1V$		0.1	20	nA
			( $V^+$ ) = $V_O = 36V$ ; $V_{ID} = 1V$		0.3	50	nA
$I_{OL}$	Low level output current		$V_{OL} = 1.5V$ ; $V_{ID} = -1V$ ; $V_S = 5V$	6	21		mA
$I_Q$	Quiescent current (all comparators)		$V_S = 5V$ , no load		400	600	$\mu A$
			$V_S = 36V$ , no load, $T_A = -40^\circ C$ to $+125^\circ C$		550	800	$\mu A$

- (1) The voltage at any input should not be allowed to go negative by more than 0.3V. The upper end of the input voltage range is  $V_{CC} - 1.5V$  for one input, and the other input can exceed the  $V_{CC}$  level; the comparator provides a proper output state. Either or both inputs can go to 36V without damage.

## 2.10 Switching Characteristics LM2903B - Q1

$V_S = 5V$ ,  $V_O$  PULLUP = 5V,  $V_{CM} = V_S/2$ ,  $C_L = 15pF$ ,  $R_L = 5.1k\Omega$ ,  $T_A = 25^\circ C$  (unless otherwise noted).

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
$t_{response}$	Propagation delay time, high-to-low; TTL input signal <sup>(1)</sup>		TTL input with $V_{ref} = 1.4V$		300		ns
$t_{response}$	Propagation delay time, high-to-low; Small scale input signal <sup>(1)</sup>		Input overdrive = 5mV, Input step = 100mV		1000		ns

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

## 2.11 LM2903B-Q1 "T", "R" and "H" Temperature Test Options

The following table describes the production temperature testing for the LM2903B-Q1 "H", "R" and "T" options. Specifications are the same as the LM2903B-Q1 above.

Test	LM2903B-Q1	LM2903BR-Q1	LM2903BH-Q1	LM2903BT-Q1
Probe (Wafer)	-	25°C	125°C	-40°C and 125°C
Final (Packaged)	25°C	25°C	25°C	25°C

## 2.12 Electrical Characteristics, LM2903-Q1 and LM2903E-Q1

at specified free-air temperature,  $V_{CC} = 5V$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS		$T_A$ (1)	MIN	TYP	MAX	UNIT	
$V_{IO}$ Input offset voltage	$V_O = 1.4V$ , $V_{IC} = V_{IC(min)}$ , $V_{CC} = 5V$ to MAX(2)	Non-A devices	25°C	2	7		mV	
			Full range			15		
		A-suffix devices	25°C		1	2		
			Full range					4
$I_{IO}$ Input offset current	$V_O = 1.4V$		25°C		5	50	nA	
			Full range			200		
$I_{IB}$ Input bias current	$V_O = 1.4V$		25°C	-25	-250		nA	
			Full range			-500		
$V_{ICR}$ Common-mode input voltage range(3)			25°C	0 to $V_{CC}-1.5$			V	
			Full range	0 to $V_{CC}-2$				
$A_{VD}$ Large-signal differential-voltage amplification	$V_{CC} = 15V$ , $V_O = 1.4V$ to 11.4V, $R_L \geq 15k\Omega$ to $V_{CC}$		25°C	25	100		V/mV	
$I_{OH}$ High-level output current	$V_{OH} = 5V$ $V_{OH} = V_{CC} \text{ MAX}(2)$	$V_{ID} = 1V$	25°C		0.1	50	nA	
			Full range				1	$\mu A$
$V_{OL}$ Low-level output voltage	$I_{OL} = 4mA$	$V_{ID} = -1V$	25°C		150	400	mV	
			Full range			700		
$I_{OL}$ Low-level output current	$V_{OL} = 1.5V$	$V_{ID} = -1V$	25°C	6			mA	
$I_{CC}$ Supply current	$R_L = \infty$		25°C		0.8	1	mA	
			Full range			2.5		

- (1) Full range (MIN or MAX) for LM2903-Q1 is  $-40^\circ C$  to  $125^\circ C$  and  $-40^\circ C$  to  $150^\circ C$  for the LM2903E-Q1. All characteristics are measured with zero common-mode input voltage, unless otherwise specified.
- (2)  $V_{CC} \text{ MAX} = 30V$  for non-V devices and 32V for V-suffix devices.
- (3) The voltage at either input or common-mode can not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is  $V_{CC} + -1.5V$  for the inverting input (-), and the non-inverting input (+) can exceed the  $V_{CC}$  level; the comparator provides a proper output state. Either or both inputs can go to 30V (32V for V-suffix devices) without damage.

## 2.13 Switching Characteristics, LM2903-Q1 and LM2903E-Q1

$V_{CC} = 5V$ ,  $T_A = 25^\circ C$

PARAMETER	TEST CONDITIONS		TYP	UNIT
Response time	$R_L$ connected to 5V through 5.1k $\Omega$ ,	100m input step with 5mV overdrive	1.3	$\mu s$
	$C_L = 15pF$ (1) (2)	TTL-level input step	0.3	

- (1)  $C_L$  includes probe and jig capacitance.
- (2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4V.

## 2.14 Typical Characteristics

$T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_{\text{PULLUP}} = 5.1\text{k}$ ,  $C_L = 15\text{pF}$ ,  $V_{\text{CM}} = 0\text{V}$ ,  $V_{\text{UNDERDRIVE}} = 100\text{mV}$ ,  $V_{\text{OVERDRIVE}} = 100\text{mV}$  unless otherwise noted.

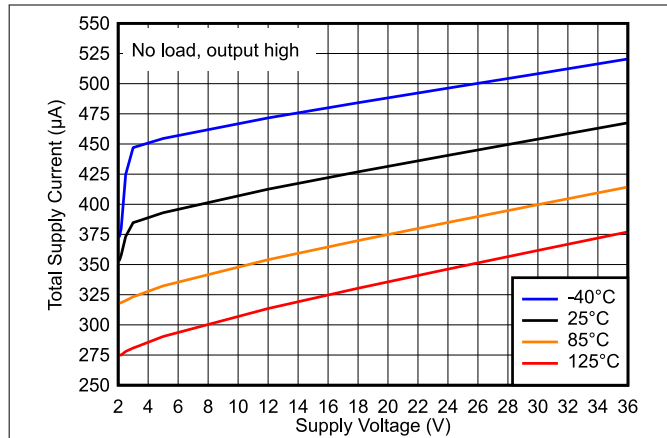


图 2-1. Total Supply Current vs. Supply Voltage

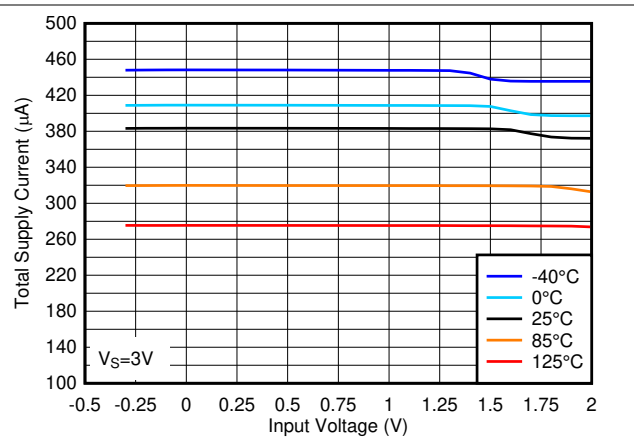


图 2-2. Total Supply Current vs. Input Voltage at 3V

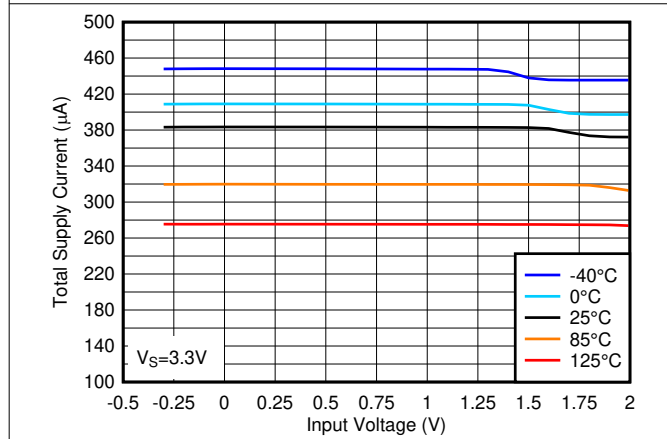


图 2-3. Total Supply Current vs. Input Voltage at 3.3V

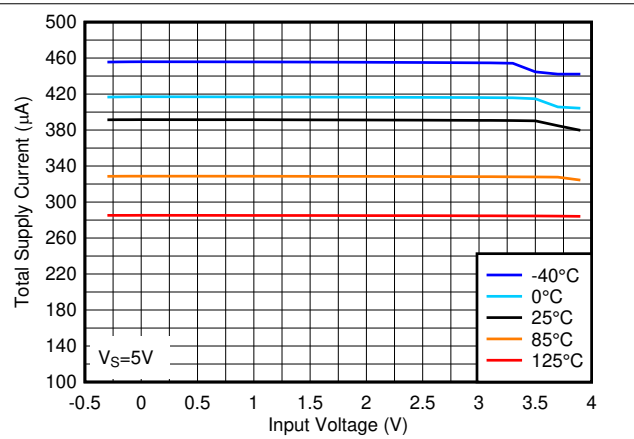


图 2-4. Total Supply Current vs. Input Voltage at 5V

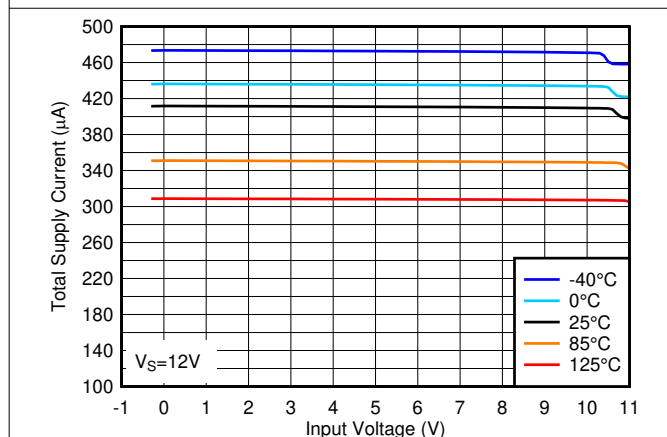


图 2-5. Total Supply Current vs. Input Voltage at 12V

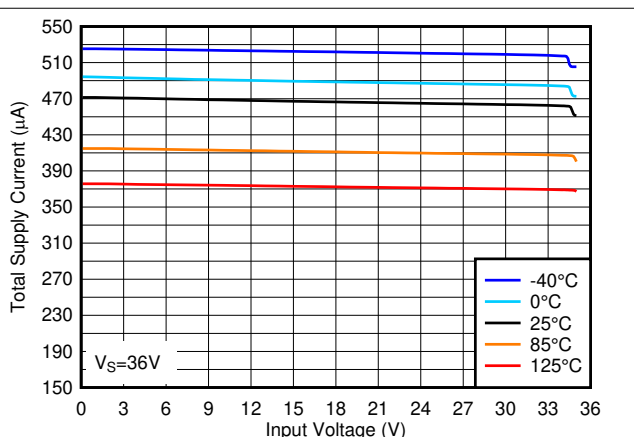


图 2-6. Total Supply Current vs. Input Voltage at 36V



## 2.14 Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_{\text{PULLUP}} = 5.1\text{k}$ ,  $C_L = 15\text{pF}$ ,  $V_{\text{CM}} = 0\text{V}$ ,  $V_{\text{UNDERDRIVE}} = 100\text{mV}$ ,  $V_{\text{OVERDRIVE}} = 100\text{mV}$  unless otherwise noted.

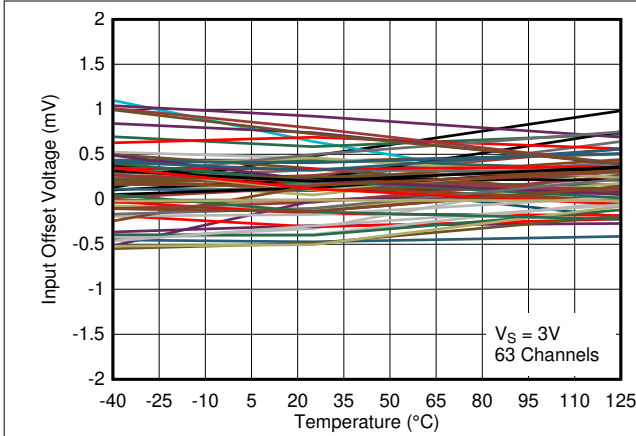


图 2-7. Input Offset Voltage vs. Temperature at 3V

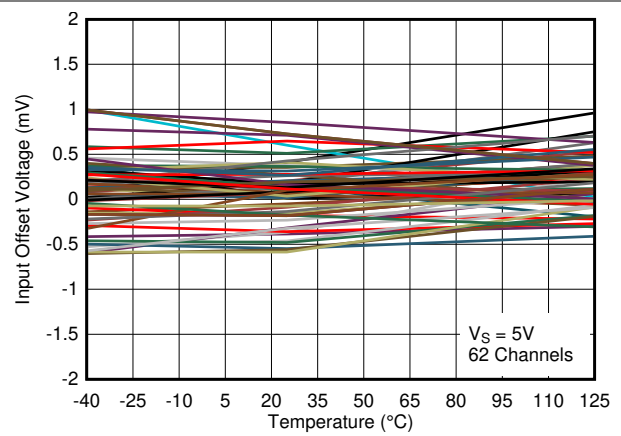


图 2-8. Input Offset Voltage vs. Temperature at 5V

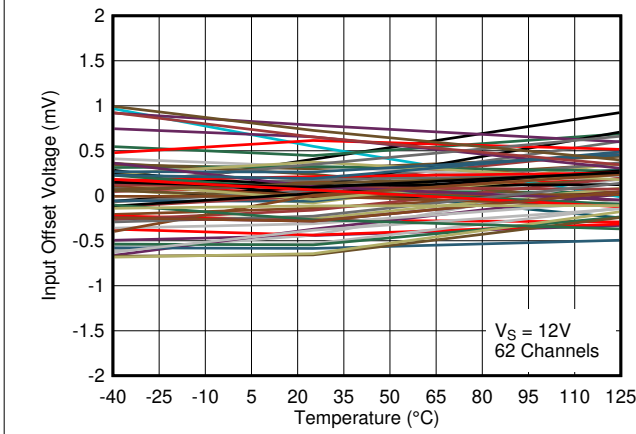


图 2-9. Input Offset Voltage vs. Temperature at 12V

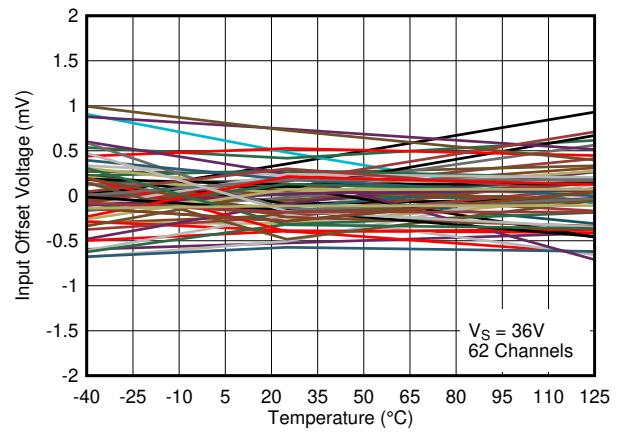


图 2-10. Input Offset Voltage vs. Temperature at 36V

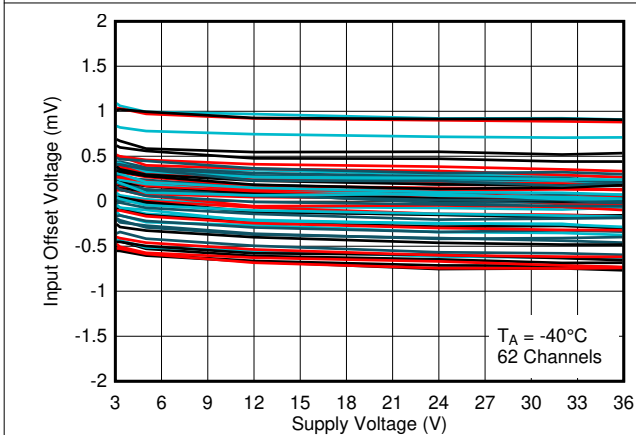


图 2-11. Input Offset Voltage vs. Supply Voltage at  $-40^\circ\text{C}$

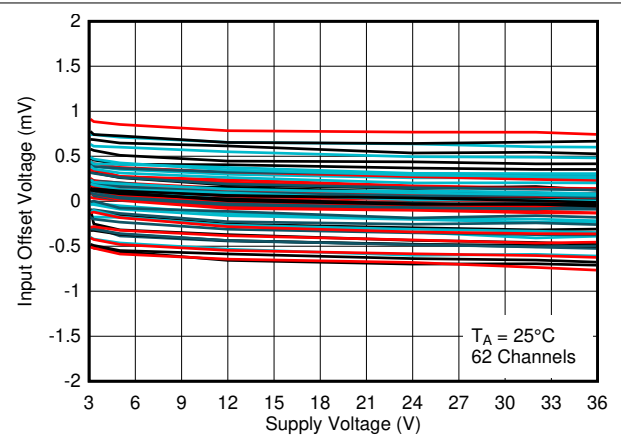


图 2-12. Input Offset Voltage vs. Supply Voltage at  $25^\circ\text{C}$

## 2.14 Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_{\text{PULLUP}} = 5.1\text{k}$ ,  $C_L = 15\text{pF}$ ,  $V_{\text{CM}} = 0\text{V}$ ,  $V_{\text{UNDERDRIVE}} = 100\text{mV}$ ,  $V_{\text{OVERDRIVE}} = 100\text{mV}$  unless otherwise noted.

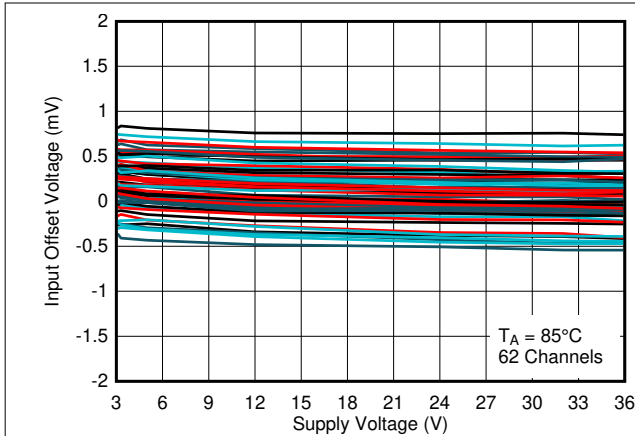


图 2-13. Input Offset Voltage vs. Supply Voltage at 85°C

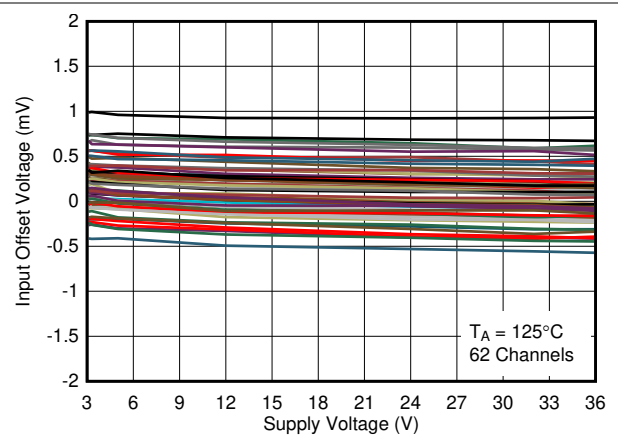


图 2-14. Input Offset Voltage vs. Supply Voltage at 125°C

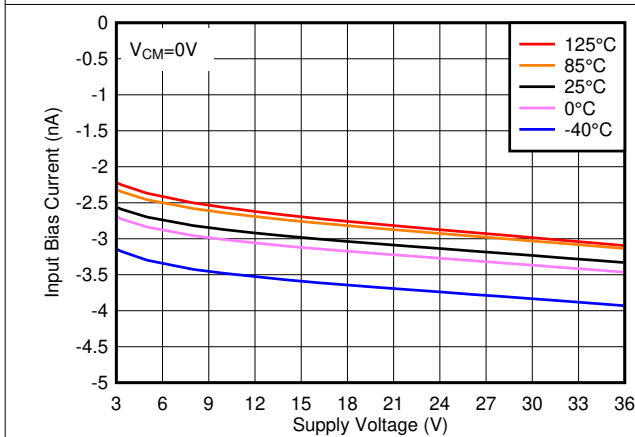


图 2-15. Input Bias Current vs. Supply Voltage

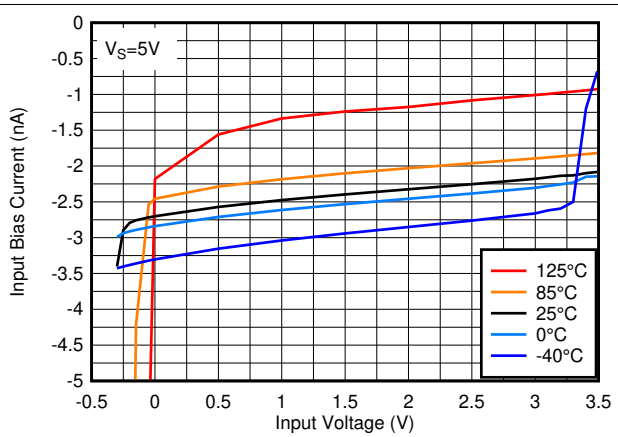


图 2-16. Input Bias Current vs. Input Voltage at 5V

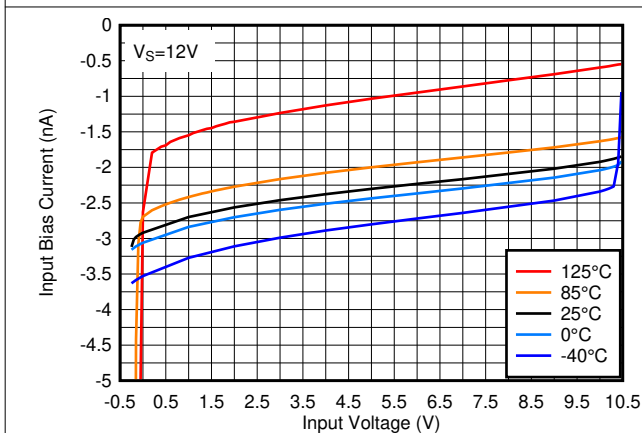


图 2-17. Input Bias Current vs. Input Voltage at 12V

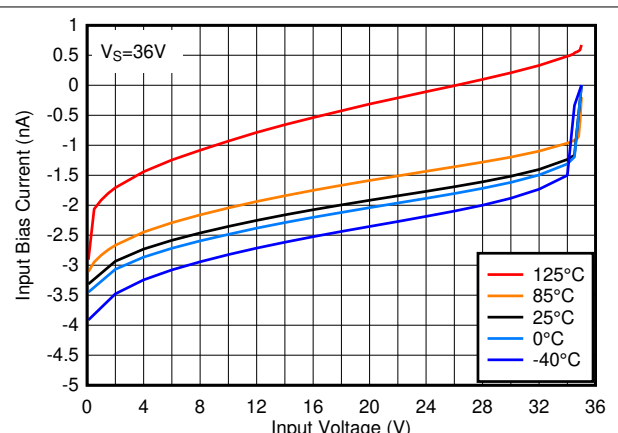


图 2-18. Input Bias Current vs. Input Voltage at 36V

## 2.14 Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_{\text{PULLUP}} = 5.1\text{k}$ ,  $C_L = 15\text{pF}$ ,  $V_{\text{CM}} = 0\text{V}$ ,  $V_{\text{UNDERDRIVE}} = 100\text{mV}$ ,  $V_{\text{OVERDRIVE}} = 100\text{mV}$  unless otherwise noted.

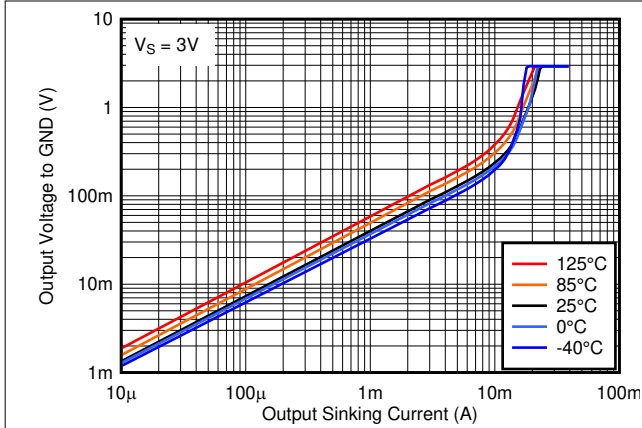


图 2-19. Output Low Voltage vs. Output Sinking Current at 3V

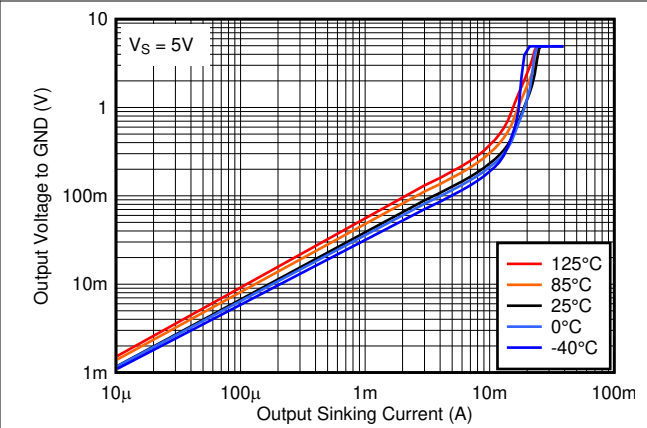


图 2-20. Output Low Voltage vs. Output Sinking Current at 5V

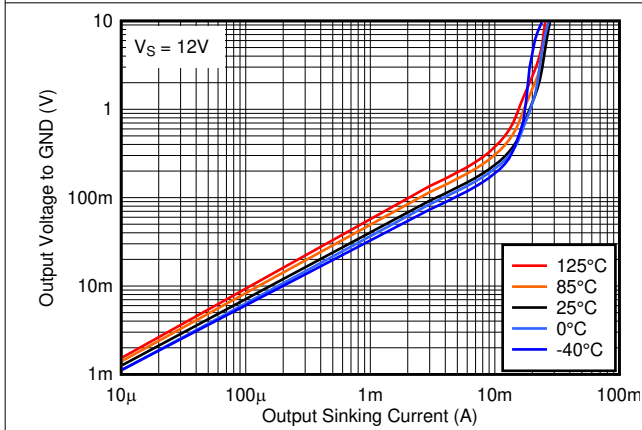


图 2-21. Output Low Voltage vs. Output Sinking Current at 12V

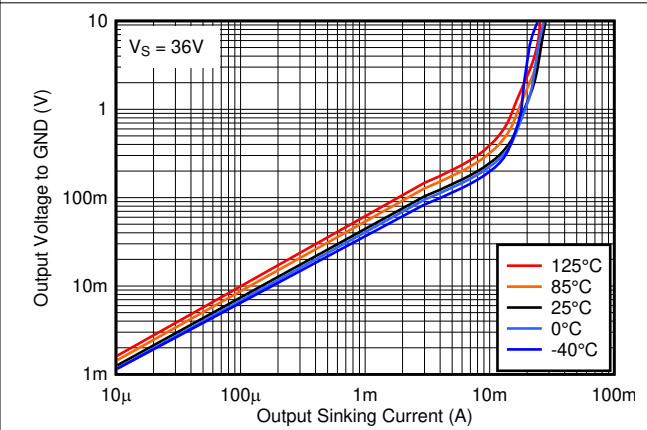


图 2-22. Output Low Voltage vs. Output Sinking Current at 36V

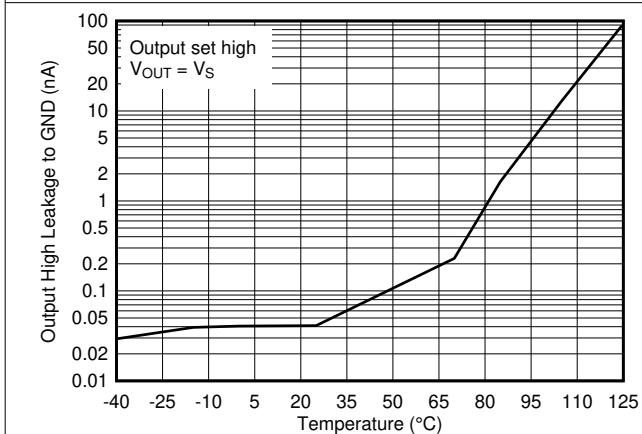


图 2-23. Output High Leakage Current vs. Temperature at 5V

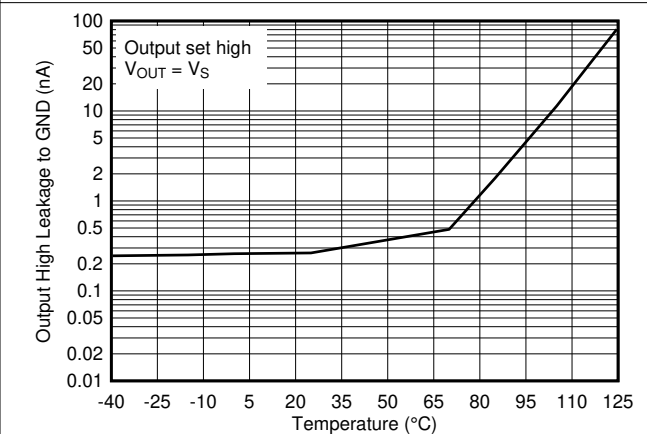


图 2-24. Output High Leakage Current vs. Temperature at 36V

## 2.14 Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_{\text{PULLUP}} = 5.1\text{k}$ ,  $C_L = 15\text{pF}$ ,  $V_{\text{CM}} = 0\text{V}$ ,  $V_{\text{UNDERDRIVE}} = 100\text{mV}$ ,  $V_{\text{OVERDRIVE}} = 100\text{mV}$  unless otherwise noted.

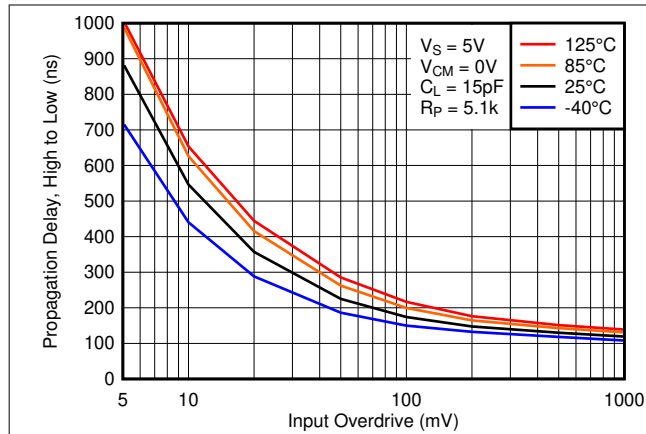


图 2-25. High to Low Propagation Delay vs. Input Overdrive Voltage, 5V

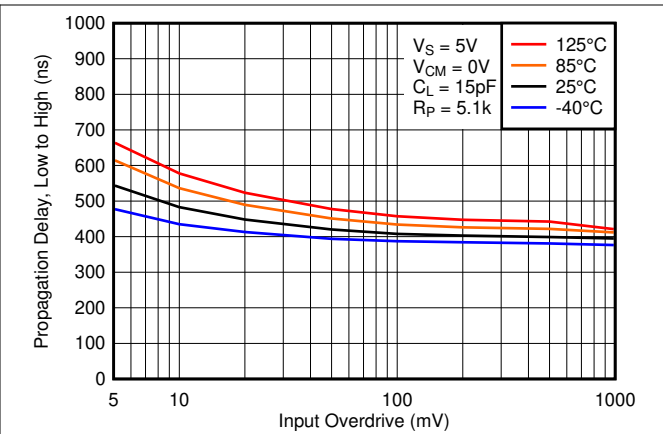


图 2-26. Low to High Propagation Delay vs. Input Overdrive Voltage, 5V

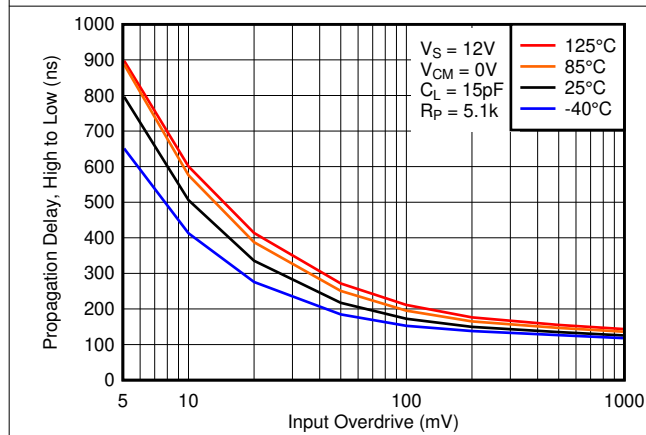


图 2-27. High to Low Propagation Delay vs. Input Overdrive Voltage, 12V

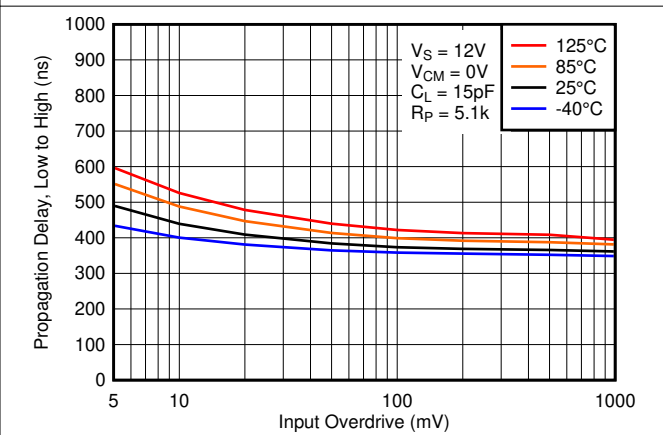


图 2-28. Low to High Propagation Delay vs. Input Overdrive Voltage, 12V

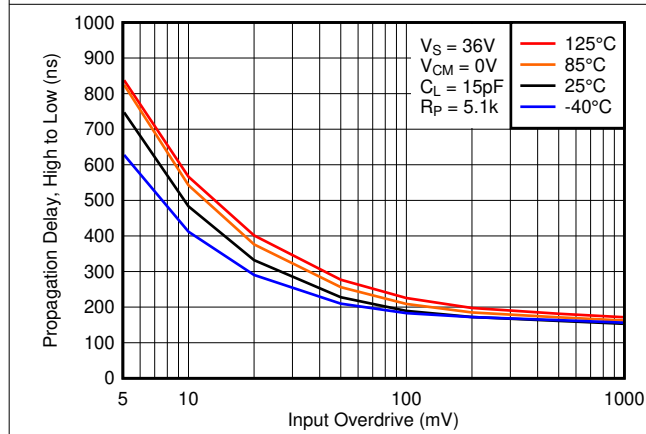


图 2-29. High to Low Propagation Delay vs. Input Overdrive Voltage, 36V

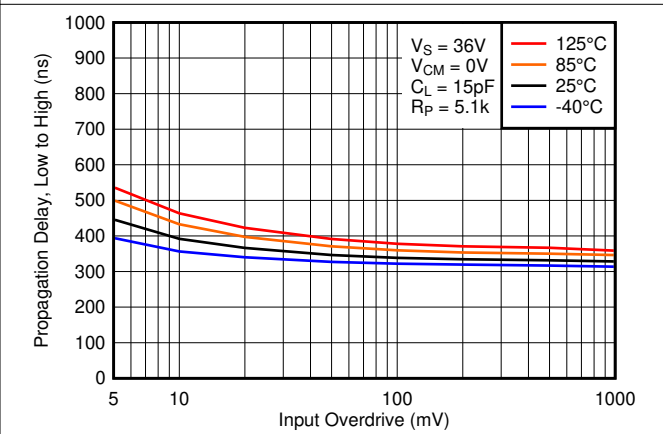
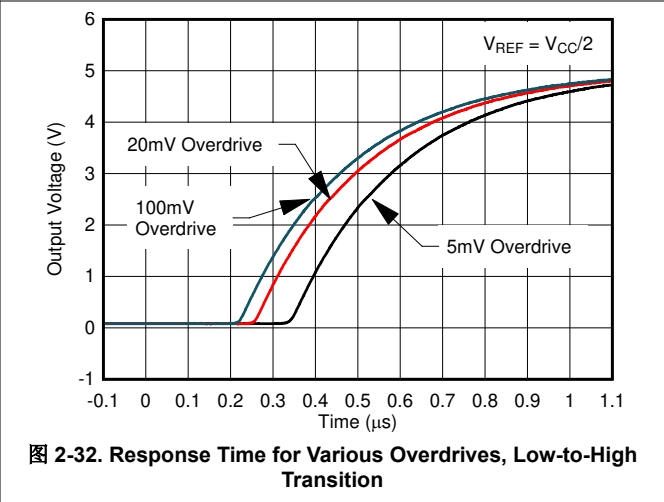
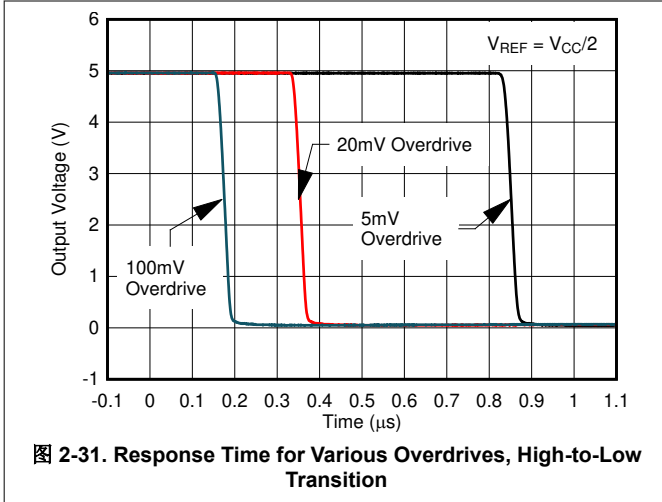


图 2-30. Low to High Propagation Delay vs. Input Overdrive Voltage, 36V

## 2.14 Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_{\text{PULLUP}} = 5.1\text{k}$ ,  $C_L = 15\text{pF}$ ,  $V_{\text{CM}} = 0\text{V}$ ,  $V_{\text{UNDERDRIVE}} = 100\text{mV}$ ,  $V_{\text{OVERDRIVE}} = 100\text{mV}$  unless otherwise noted.



## 3 Detailed Description

### 3.1 Overview

The LM2903-Q1 family is a dual comparator with the ability to 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 very wide supply voltages range (2V to 36V), low  $I_q$  and fast response.

This device is AEC-Q100 qualified and can operate over a wide temperature range of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  (LM2903-Q1 and LM2903B-Q1) or  $-40^{\circ}\text{C}$  to  $150^{\circ}\text{C}$  (LM2903E-Q1).

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.

The "B" versions add dedicated ESD protections on all the pins for improved ESD performance as well as improved negative input voltage handling. Please see Application Note [SNOAA35](#) for more information

### 3.2 Functional Block Diagram

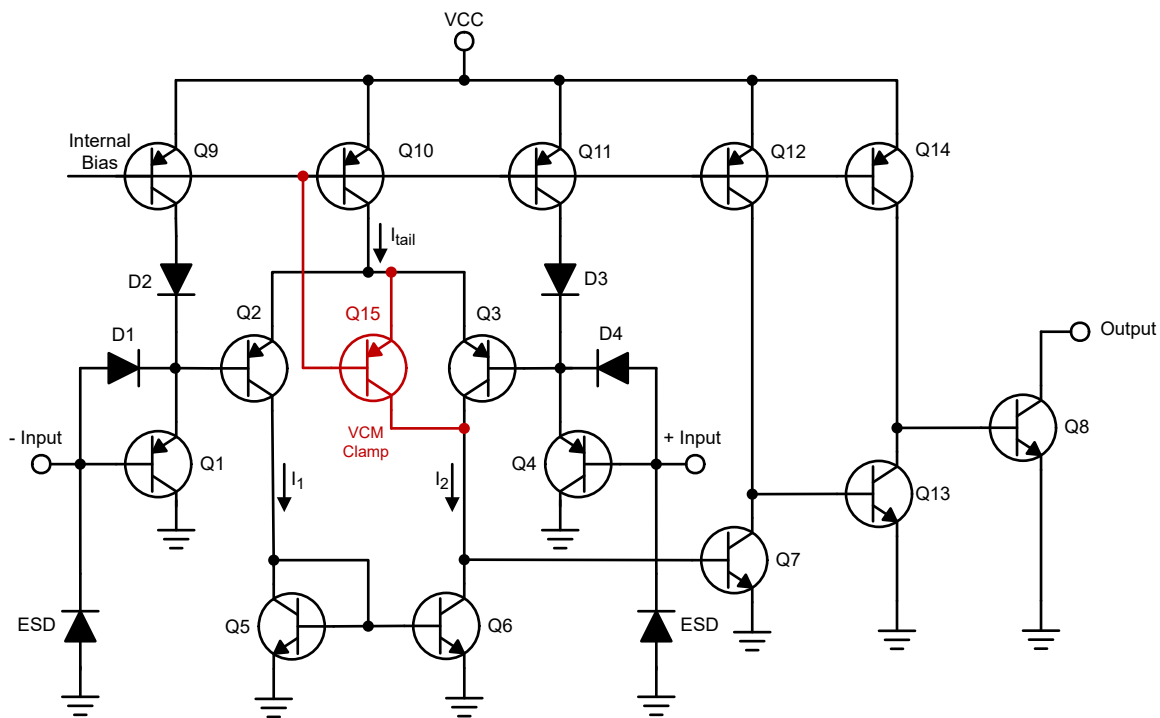


图 3-1. Schematic (Each Comparator)

### 3.3 Feature Description

LM2903-Q1 family consists of a PNP darlington pair input, allowing the device to operate with very high gain and fast response with minimal input bias current. The input Darlington pair creates a limit on the input common mode voltage capability, allowing LM2903-Q1 to accurately function from ground to  $V_{CC} - 1.5\text{V}$  differential input. This enables much head room for modern day supplies of 3.3V and 5.0V. A clamp (Q15) was added around Q3 to force the output low when both inputs are taken above the VCM range.

The output consists of an open drain NPN (pull-down or low side) transistor. The output NPN sinks current when the negative input voltage is higher than the positive input voltage and the offset voltage. The  $V_{OL}$  is resistive and scales with the output current. Please see [Output Low Voltage vs. Output Sinking Current at 5V](#) in the [Typical Characteristics](#) section for  $V_{OL}$  values with respect to the output current.

## 3.4 Device Functional Modes

### 3.4.1 Voltage Comparison

The LM2903-Q1 family operates solely as a voltage comparator, comparing the differential voltage between the positive and negative pins and outputting a logic low or high impedance (logic high with pull-up) based on the input differential polarity.

## 4 Application and Implementation

### 备注

以下应用部分中的信息不属于 TI 器件规格的范围，TI 不担保其准确性和完整性。TI 的客户应负责确定器件是否适用于其应用。客户应验证并测试其设计，以确保系统功能。

### 4.1 Application Information

LM2903-Q1 will typically be used to compare a single signal to a reference or two signals against each other. Many users take advantage of the open drain output 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 LM2903Q1 optimal for level shifting to a higher or lower voltage.

### 4.2 Typical Application

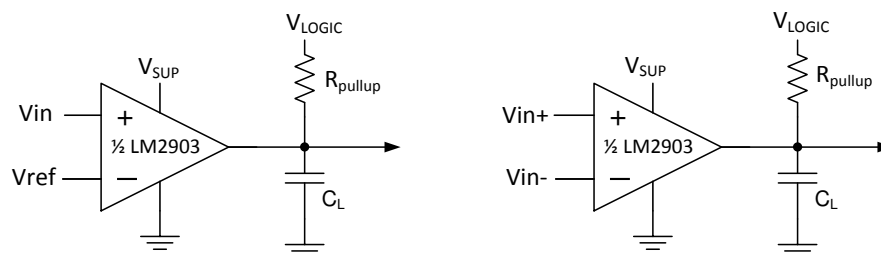


图 4-1. Single-ended and Differential Comparator Configurations

#### 4.2.1 Design Requirements

For this design example, use the parameters listed in 表 4-1 as the input parameters.

表 4-1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Input Voltage Range	0V to Vsup-1.5V
Supply Voltage	2V to 36V
Logic Supply Voltage	2V to 36V
Output Current (R <sub>PULLUP</sub> )	1μA to 20mA
Input Overdrive Voltage	100mV
Reference Voltage	2.5V
Load Capacitance (C <sub>L</sub> )	15pF

#### 4.2.2 Detailed Design Procedure

When using LM2903-Q1 family in a general comparator application, determine the following:

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

##### 4.2.2.1 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 above or below 25°C the  $V_{ICR}$  can range from 0V to  $V_{CC} - 2V$ . This limits the input voltage range to as high as  $V_{CC} - 2.0V$  and as low as 0V. Operation outside of this range can yield incorrect comparisons.



Below is a list of input voltage situation and the outcomes:

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 transistor is sinking current
  - b. If IN- is lower than IN+ and the offset voltage, the output is high impedance and the output transistor is not conducting
2. When IN- is higher than common mode and IN+ is within common mode, the output is low and the output transistor is sinking current
3. When IN+ is higher than common mode and IN- is within common mode, the output is high impedance and the output transistor is not conducting
4. When IN- and IN+ are both higher than common mode, see Section 2 of [Application Design Guidelines for LM339, LM393, TL331 Family Comparators Including the New B-versions](#)

#### 4.2.2.2 Minimum Overdrive Voltage

Overdrive Voltage is the differential voltage produced between the positive and negative inputs of the comparator over the offset voltage ( $V_{IO}$ ). To make an accurate comparison the Overdrive Voltage ( $V_{OD}$ ) must be higher than the input offset voltage ( $V_{IO}$ ). Overdrive voltage can also determine the response time of the comparator, with the response time decreasing with increasing overdrive. [图 4-2](#) and [图 4-3](#) show positive and negative response times with respect to overdrive voltage.

#### 4.2.2.3 Output and Drive Current

Output current is determined by the load/pull-up resistance and logic/pull-up voltage. The output current produces a output low voltage ( $V_{OL}$ ) from the comparator. In which  $V_{OL}$  is proportional to the output current. Use [图 2-21](#) to determine  $V_{OL}$  based on the output current.

The output current can also effect the transient response. More explanation is in the next section.

#### 4.2.2.4 Response Time

The transient response can be determined by the load capacitance ( $C_L$ ), load/pull-up resistance ( $R_{PULLUP}$ ) and equivalent collector-emitter resistance ( $R_{CE}$ ).

- The positive response time ( $\tau_P$ ) is approximately  $\tau_P = R_{PULLUP} \times C_L$
- The negative response time ( $\tau_N$ ) is approximately  $\tau_N = R_{CE} \times C_L$ 
  - $R_{CE}$  can be determine by taking the slope of [图 2-21](#) in it's linear region at the desired temperature, or by dividing the  $V_{OL}$  by  $I_{out}$

#### 4.2.3 Application Curves

The following curves were generated with 5V on  $V_{CC}$  and  $V_{Logic}$ ,  $R_{PULLUP} = 5.1k\Omega$ , and 50pF scope probe.

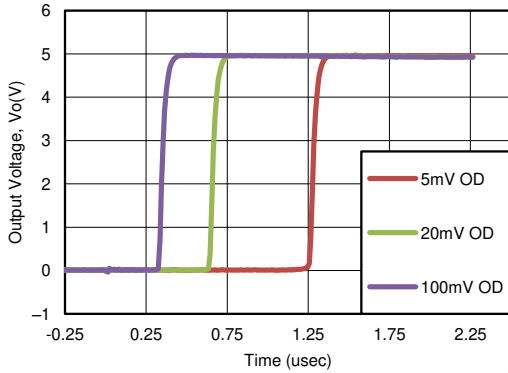


图 4-2. Response Time for Various Overdrives (Positive Transition)

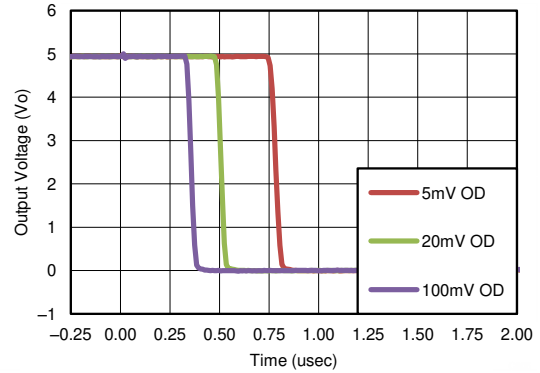


图 4-3. Response Time for Various Overdrives (Negative Transition)

### 4.3 Power Supply Recommendations

A bypass capacitor is recommended on the supply pin to reject any variation on the supply voltage. This variation can eat into the comparator's input common mode range and create an inaccurate comparison.

### 4.4 Layout

#### 4.4.1 Layout Guidelines

For accurate comparator applications without hysteresis, a stable power supply with minimal noise must be maintained. To achieve this, the best practice is to add a bypass capacitor between the supply voltage and ground. This can 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.

#### 4.4.2 Layout Example

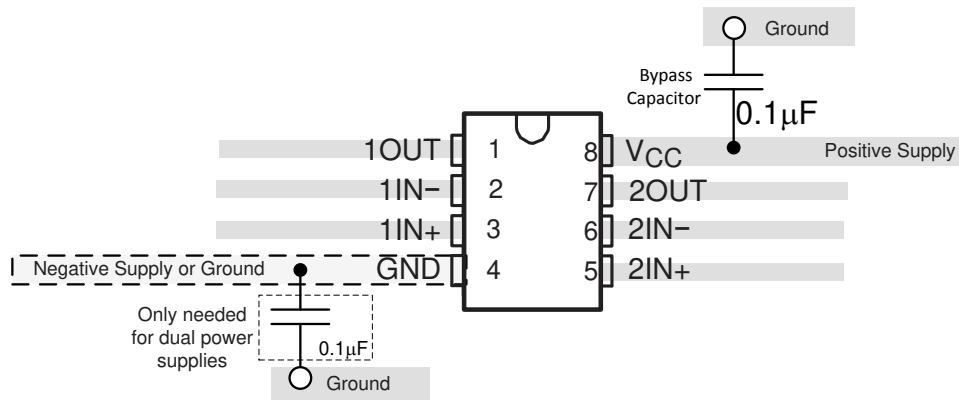


图 4-4. LM2903Q1 Layout Example

## 5 Device and Documentation Support

### 5.1 Documentation Support

#### 5.1.1 Related Documentation

[LM2903B-Q1 Functional Safety FIT Rate, FMD and Pin FMA - SLCA005](#)

[Application Design Guidelines for LM339, LM393, TL331 Family Comparators - SNOAA35](#)

[Analog Engineers Circuit Cookbook: Amplifiers \(See Comparators section\) - SLYY137](#)

## 5.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

## 5.3 支持资源

[TI E2E™ 中文支持论坛](#)是工程师的重要参考资料，可直接从专家处获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题，获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的[使用条款](#)。

## 5.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.  
所有商标均为其各自所有者的财产。

## 5.5 静电放电警告



静电放电 (ESD) 会损坏这个集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

## 5.6 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

## 6 Revision History

注：以前版本的页码可能与当前版本的页码不同

<b>Changes from Revision L (August 2023) to Revision M (December 2024)</b>	<b>Page</b>
• Updated thermal table .....	5
• Updated Typical Characteristics.....	8
• Updated Functional Block Diagram.....	14

<b>Changes from Revision K (August 2022) to Revision L (August 2023)</b>	<b>Page</b>
• Added reference to Application Note.....	16

<b>Changes from Revision J (November 2020) to Revision K (August 2022)</b>	<b>Page</b>
• Added T, R and H Temp Test Options table.....	6

<b>Changes from Revision I (June 2020) to Revision J (November 2020)</b>	<b>Page</b>
• 在整个数据表中将 LM2903B-Q1 最小建议电源电压更改为 2V.....	1
• Added Operating Virtual Temp to Abs Max Table for both versions.....	4
• Updated Supply Voltage vs Supply Current graph for 2V.....	4

<b>Changes from Revision G (November 2018) to Revision H (January 2020)</b>	<b>Page</b>
• 向数据表添加了 LM2903B-Q1.....	1
• 添加了“器件信息”表.....	1
• Added "B" device graphs .....	8
• Changed incorrect input text in Feature Description in Apps Section.....	14

<b>Changes from Revision F (May 2018) to Revision G (November 2018)</b>	<b>Page</b>
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<b>Changes from Revision H (January 2020) to Revision I (June 2020)</b>	<b>Page</b>
• 添加了“功能安全”文本和链接.....	1
• 将 VSSOP 封装添加到“B”器件信息列表中.....	1
• Added DGK to "B" Thermal Table.....	5
• Added text to Apps Overview section for ESD.....	14

## 7 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. 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 left-hand navigation.

**PACKAGING INFORMATION**

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">LM2903AVQDRG4Q1</a>	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903AVQ
LM2903AVQDRG4Q1.A	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903AVQ
LM2903AVQDRG4Q1.B	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903AVQ
<a href="#">LM2903AVQDRQ1</a>	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(2903AVQ, 903AVQ)
LM2903AVQDRQ1.A	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(2903AVQ, 903AVQ)
LM2903AVQDRQ1.B	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	(2903AVQ, 903AVQ)
<a href="#">LM2903AVQPWRG4Q1</a>	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903AVQ
LM2903AVQPWRG4Q1.A	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903AVQ
<a href="#">LM2903AVQPWRQ1</a>	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903AVQ
LM2903AVQPWRQ1.A	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903AVQ
<a href="#">LM2903BHQDGKRQ1</a>	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3BHQ
LM2903BHQDGKRQ1.A	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3BHQ
LM2903BHQDGKRQ1.B	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3BHQ
<a href="#">LM2903BHQDRQ1</a>	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BHQ
LM2903BHQDRQ1.A	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BHQ
LM2903BHQDRQ1.B	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BHQ
<a href="#">LM2903BHQPWRQ1</a>	Active	Production	TSSOP (PW)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BH
LM2903BHQPWRQ1.A	Active	Production	TSSOP (PW)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BH
LM2903BHQPWRQ1.B	Active	Production	TSSOP (PW)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BH
<a href="#">LM2903BQDDFRQ1</a>	Active	Production	SOT-23-THIN (DDF)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BQ
LM2903BQDDFRQ1.B	Active	Production	SOT-23-THIN (DDF)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BQ
<a href="#">LM2903BQDGKRQ1</a>	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	03BQ
LM2903BQDGKRQ1.A	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	03BQ
LM2903BQDGKRQ1.B	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	03BQ
<a href="#">LM2903BQDRQ1</a>	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BQ
LM2903BQDRQ1.A	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BQ
LM2903BQDRQ1.B	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BQ
<a href="#">LM2903BQPWRQ1</a>	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BQ
LM2903BQPWRQ1.A	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BQ

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM2903BQPWRQ1.B	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BQ
<a href="#">LM2903BRQDGKRQ1</a>	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3BRQ
LM2903BRQDGKRQ1.A	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3BRQ
LM2903BRQDGKRQ1.B	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3BRQ
<a href="#">LM2903BRQDRQ1</a>	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BRQ
LM2903BRQDRQ1.A	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BRQ
LM2903BRQDRQ1.B	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BRQ
<a href="#">LM2903BRQPWRQ1</a>	Active	Production	TSSOP (PW)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BR
LM2903BRQPWRQ1.A	Active	Production	TSSOP (PW)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BR
LM2903BRQPWRQ1.B	Active	Production	TSSOP (PW)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BR
<a href="#">LM2903BTQDGKRQ1</a>	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3BTQ
LM2903BTQDGKRQ1.A	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3BTQ
LM2903BTQDGKRQ1.B	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3BTQ
<a href="#">LM2903BTQDRQ1</a>	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BTQ
LM2903BTQDRQ1.A	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BTQ
LM2903BTQDRQ1.B	Active	Production	SOIC (D)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	903BTQ
<a href="#">LM2903BTQPWRQ1</a>	Active	Production	TSSOP (PW)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BT
LM2903BTQPWRQ1.A	Active	Production	TSSOP (PW)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BT
LM2903BTQPWRQ1.B	Active	Production	TSSOP (PW)   8	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903BT
<a href="#">LM2903BWDSGRQ1</a>	Active	Production	WSON (DSG)   8	3000   LARGE T&R	Yes	Call TI   Sn	Level-2-260C-1 YEAR	-40 to 125	3BWQ
LM2903BWDSGRQ1.A	Active	Production	WSON (DSG)   8	3000   LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	3BWQ
LM2903BWDSGRQ1.B	Active	Production	WSON (DSG)   8	3000   LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	3BWQ
<a href="#">LM2903EPWRQ1</a>	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 150	2903Q0
LM2903EPWRQ1.A	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 150	2903Q0
<a href="#">LM2903QDGKRQ1</a>	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	KACQ
LM2903QDGKRQ1.A	Active	Production	VSSOP (DGK)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	KACQ
<a href="#">LM2903QDRG4Q1</a>	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903Q1
LM2903QDRG4Q1.A	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903Q1
<a href="#">LM2903QDRQ1</a>	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903Q1
LM2903QDRQ1.A	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903Q1
LM2903QDRQ1.B	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903Q1

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM2903QPWRG4Q1	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903Q1
LM2903QPWRG4Q1.A	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903Q1
LM2903QPWRQ1	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903Q1
LM2903QPWRQ1.A	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903Q1
LM2903VQDRG4Q1	Obsolete	Production	SOIC (D)   8	-	-	Call TI	Call TI	-40 to 125	2903VQ1
LM2903VQDRQ1	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903VQ1
LM2903VQDRQ1.A	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903VQ1
LM2903VQDRQ1.B	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903VQ1
LM2903VQPWRG4Q1	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903VQ
LM2903VQPWRG4Q1.A	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903VQ
LM2903VQPWRG4Q1.B	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903VQ
LM2903VQPWRQ1	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903VQ
LM2903VQPWRQ1.A	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903VQ
LM2903VQPWRQ1.B	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	2903VQ

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.



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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF LM2903-Q1, LM2903B-Q1 :**

- Catalog : [LM2903](#), [LM2903B](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM2903AVQDRG4Q1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM2903AVQDRG4Q1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM2903AVQDRQ1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM2903AVQDRQ1	SOIC	D	8	2500	330.0	12.5	6.4	5.2	2.1	8.0	12.0	Q1
LM2903AVQPWRG4Q1	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM2903AVQPWRQ1	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM2903BHQDGKRQ1	VSSOP	DGK	8	2500	330.0	12.4	5.25	3.35	1.25	8.0	12.0	Q1
LM2903BHQDRQ1	SOIC	D	8	3000	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM2903BHQPWRQ1	TSSOP	PW	8	3000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM2903BQDDFRQ1	SOT-23-THIN	DDF	8	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM2903BQDGKRQ1	VSSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LM2903BQDRQ1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM2903BQPWRQ1	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM2903BRQDGKRQ1	VSSOP	DGK	8	2500	330.0	12.4	5.25	3.35	1.25	8.0	12.0	Q1
LM2903BRQDRQ1	SOIC	D	8	3000	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM2903BRQPWRQ1	TSSOP	PW	8	3000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM2903BTQDGKRQ1	VSSOP	DGK	8	2500	330.0	12.4	5.25	3.35	1.25	8.0	12.0	Q1
LM2903BTQDRQ1	SOIC	D	8	3000	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM2903BTQPWRQ1	TSSOP	PW	8	3000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM2903BWDSGRQ1	WSON	DSG	8	3000	180.0	8.4	2.2	2.2	1.2	4.0	8.0	Q2
LM2903EPWRQ1	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM2903QDGKRQ1	VSSOP	DGK	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM2903QDRG4Q1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM2903QDRQ1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM2903QPWRG4Q1	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM2903QPWRQ1	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM2903VQDRQ1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
LM2903VQPWRG4Q1	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1
LM2903VQPWRQ1	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2903AVQDRG4Q1	SOIC	D	8	2500	353.0	353.0	32.0
LM2903AVQDRG4Q1	SOIC	D	8	2500	340.5	338.1	20.6
LM2903AVQDRQ1	SOIC	D	8	2500	340.5	338.1	20.6
LM2903AVQDRQ1	SOIC	D	8	2500	353.0	353.0	32.0
LM2903AVQPWRG4Q1	TSSOP	PW	8	2000	353.0	353.0	32.0
LM2903AVQPWRQ1	TSSOP	PW	8	2000	353.0	353.0	32.0
LM2903BHQDGKRQ1	VSSOP	DGK	8	2500	366.0	364.0	50.0
LM2903BHQDRQ1	SOIC	D	8	3000	340.5	338.1	20.6
LM2903BHPWRQ1	TSSOP	PW	8	3000	353.0	353.0	32.0
LM2903BQDDFRQ1	SOT-23-THIN	DDF	8	3000	210.0	185.0	35.0
LM2903BQDGKRQ1	VSSOP	DGK	8	2500	353.0	353.0	32.0
LM2903BQDRQ1	SOIC	D	8	2500	353.0	353.0	32.0
LM2903BQPWRQ1	TSSOP	PW	8	2000	353.0	353.0	32.0
LM2903BRQDGKRQ1	VSSOP	DGK	8	2500	366.0	364.0	50.0
LM2903BRQDRQ1	SOIC	D	8	3000	340.5	338.1	20.6
LM2903BRQPWRQ1	TSSOP	PW	8	3000	353.0	353.0	32.0
LM2903BTQDGKRQ1	VSSOP	DGK	8	2500	366.0	364.0	50.0
LM2903BTQDRQ1	SOIC	D	8	3000	340.5	338.1	20.6

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2903BTQPWRQ1	TSSOP	PW	8	3000	353.0	353.0	32.0
LM2903BWDSGRQ1	WSON	DSG	8	3000	213.0	191.0	35.0
LM2903EPWRQ1	TSSOP	PW	8	2000	353.0	353.0	32.0
LM2903QDGKRQ1	VSSOP	DGK	8	2500	353.0	353.0	32.0
LM2903QDRG4Q1	SOIC	D	8	2500	353.0	353.0	32.0
LM2903QDRQ1	SOIC	D	8	2500	353.0	353.0	32.0
LM2903QPWRG4Q1	TSSOP	PW	8	2000	353.0	353.0	32.0
LM2903QPWRQ1	TSSOP	PW	8	2000	353.0	353.0	32.0
LM2903VQDRQ1	SOIC	D	8	2500	353.0	353.0	32.0
LM2903VQPWRG4Q1	TSSOP	PW	8	2000	353.0	353.0	32.0
LM2903VQPWRQ1	TSSOP	PW	8	2000	353.0	353.0	32.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
LM2903BQDGKRQ1	DGK	VSSOP	8	2500	328	7.98	550	NA
LM2903BQDGKRQ1.A	DGK	VSSOP	8	2500	328	7.98	550	NA
LM2903BQDGKRQ1.B	DGK	VSSOP	8	2500	328	7.98	550	NA

# DGK0008A



# PACKAGE OUTLINE

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



4214862/A 04/2023

**NOTES:**

PowerPAD is a trademark of Texas Instruments.

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187.

# EXAMPLE BOARD LAYOUT

DGK0008A

™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 15X



SOLDER MASK DETAILS

4214862/A 04/2023

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
9. Size of metal pad may vary due to creepage requirement.



# EXAMPLE STENCIL DESIGN

DGK0008A

<sup>TM</sup> VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
SCALE: 15X

4214862/A 04/2023

NOTES: (continued)

11. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
12. Board assembly site may have different recommendations for stencil design.



# EXAMPLE BOARD LAYOUT

DDF0008A

SOT-23-THIN - 1.1 mm max height

PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4222047/E 07/2024

NOTES: (continued)

- 4. Publication IPC-7351 may have alternate designs.
- 5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DDF0008A

SOT-23-THIN - 1.1 mm max height

PLASTIC SMALL OUTLINE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

4222047/E 07/2024

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
7. Board assembly site may have different recommendations for stencil design.



D0008A

# PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

### NOTES:

- Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
- This drawing is subject to change without notice.
- This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
- This dimension does not include interlead flash.
- Reference JEDEC registration MS-012, variation AA.

# EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE  
 EXPOSED METAL SHOWN  
 SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.125 MM] THICK STENCIL  
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

## GENERIC PACKAGE VIEW

**DSG 8**

**WSON - 0.8 mm max height**

2 x 2, 0.5 mm pitch

PLASTIC SMALL OUTLINE - NO LEAD

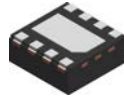
This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



4224783/A



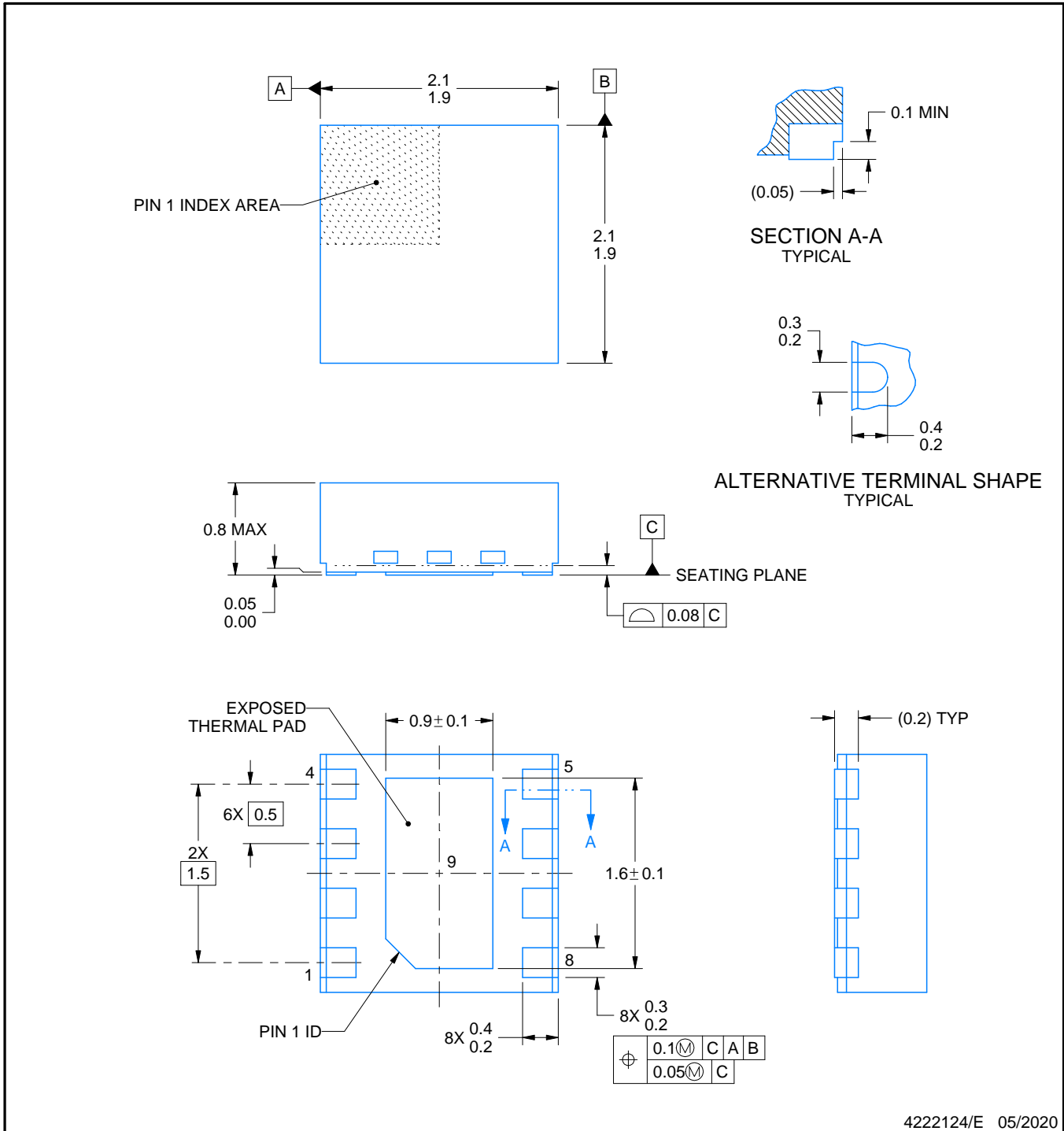
# DSG0008B



# PACKAGE OUTLINE

## WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



**NOTES:**

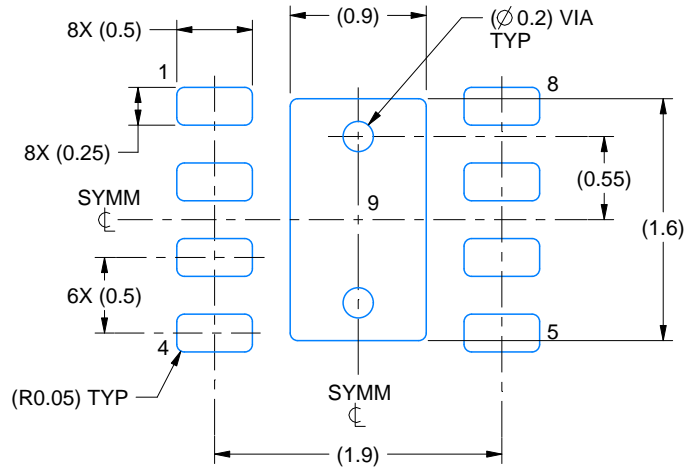
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

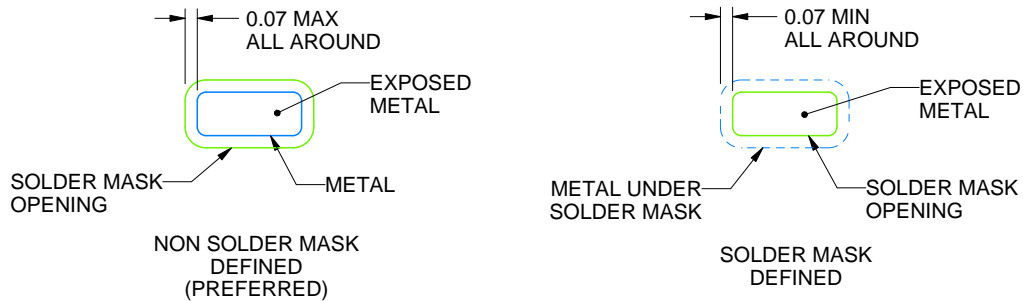
DSG0008B

WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:20X



SOLDER MASK DETAILS

4222124/E 05/2020

NOTES: (continued)

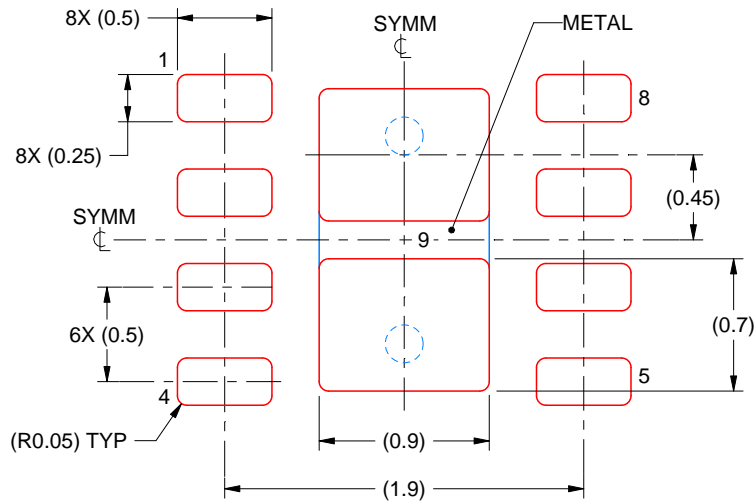
- This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slue271](http://www.ti.com/lit/slue271)).
- Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

DSG0008B

WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 9:  
87% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:25X

4222124/E 05/2020

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

PW0008A



PACKAGE OUTLINE  
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4221848/A 02/2015

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153, variation AA.

# EXAMPLE BOARD LAYOUT

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

4221848/A 02/2015

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:10X

4221848/A 02/2015

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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