TEXAS INSTRUMENTS
LM193-N, LM2903-N, LM293-N, LM393-N
JAJSB74G – OCTOBER 1999 – REVISED OCTOBER 2018

LMx93-N、LM2903-N 低消費電力、低オフセット電圧のデュアル・コンパレータ

1 特長

- 広い電源範囲
  - 電圧範囲:2.0V～36V
  - シングルまたはデュアル電源:±1.0V～±18V
- 非常に低い消費電流 (0.4mA) - 電源電圧に非依存
- 低い入力バイアス電流: 25nA
- 低い入力オフセット電流: ±5nA
- 最大オフセット電圧：±3mV
- 入力同相電圧範囲にグランドを含む
- 差動入力電圧範囲は電源電圧に等しい
- 低い出力飽和電圧: 4mAで250mV
- 出力電圧はTTL、DTL、ECL、MOS、CMOS ロジック・システムと互換
- 8 バンプ (12 mil) DSBGA パッケージで供給
- DSBGAの考慮事項については、AN-1112 (SNVA009)を参照してください。
- 利点
  - 高精度のコンパレータ
  - 温度範囲全体にわたって低減された V_{OS} ドリフト
  - デュアル電源が不要
  - グランド付近のセンシングが可能
  - すべての形式のロジックと互換
  - バッテリ動作に適した消費電力

2 アプリケーション

- バッテリ駆動のアプリケーション
- 産業用アプリケーション

3 概要

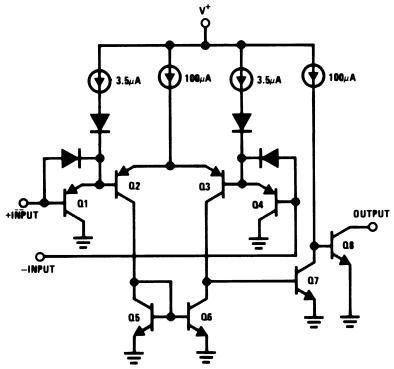
LM193-N シリーズは 2 つの独立した高精度電圧コンパレータで構成され、2 つのコンパレータのオフセット電圧仕様が最大約 2.0mV と低く、広範な電圧範囲の単一電源で動作するよう特化して設計されています。分割電源からも動作でき、低消費電力で、電源からの消費電流は電源電圧の大きさに依存しません。また、これらのコンパレータには、単一電源電圧で動作していても、入力同相電圧範囲にグランドが含まれるという独自の特性があります。

製品情報(1)

型番	パッケージ	本体サイズ(公称)
LM193-N	TO-99 (8)	9.08mm×9.08mm
LM293-N		
LM393-N	SOIC (8)	4.90mm×3.91mm
	DSBGA (8)	1.54mm×1.54mm
LM2903-N	SOIC (8)	4.90mm×3.91mm
	DSBGA (8)	1.54mm×1.54mm

(1) 利用可能なすべてのパッケージについては、このデータシートの末尾にある注文情報を参照してください。

概略回路図



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4 改訂履歴

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Revision F (December 2014) から **Revision G** に変更 **Page**

- フォーマット変換時に「製品情報」表から意図せず消去された DSBGA パッケージを 追加 ... 1

Revision E (March 2013) から **Revision F** に変更 **Page**

- 「*ピン構成および機能* 」セクション、「*ESD定格*」表、「*機能説明*」セクション、「*デバイスの機能モード*」セクション、「*アプリケーションと実装*」セクション、「*電源に関する推奨事項*」セクション、「*レイアウト*」セクション、「*デバイスおよびドキュメントのサポート*」セクション、「*メカニカル、パッケージ、および注文情報*」セクション 追加 ... 1

Revision D (March 2013) から **Revision E** に変更 **Page**

- ナショナル セミコンダクターのデータシートのレイアウトを TI フォーマットに 変更 ... 1

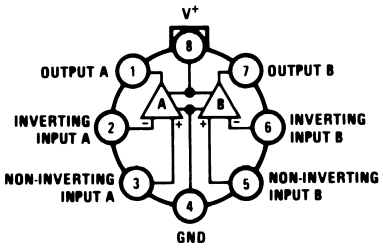
5 概要（続き）

アプリケーション分野には、制限コンパレータ、単純な A/D コンバータ、パルス、方形波および時間遅延ジェネレータ、広帯域 VCO、MOS クロック・タイマ、マルチバイブレータ、高電圧デジタル・ロジック・ゲートなどが含まれます。LM193-N シリーズは、TTL および CMOS と直接接続できるように設計されています。正負両方の電源で動作する場合、LM193-N シリーズは MOS ロジックと直接接続できます。MOS ロジックと接続する場合、本デバイスが低消費電力であることは標準的なコンパレータに対して明らかな利点です。

LM393 および LM2903 は、TI の革新的な 8 つの大型バンプ (12 mil) 付きの薄型 DSBGA パッケージで供給されます。

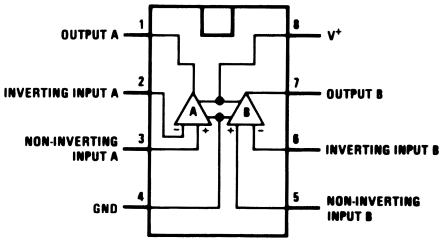
6 Pin Configuration and Functions

LMC Package
8-Pin TO-99
Top View



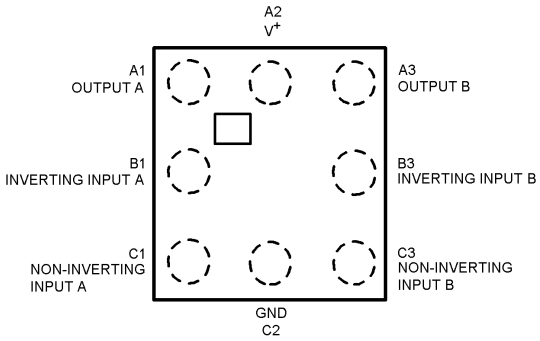
TOP VIEW

P and D Package
8-Pin CDIP, PDIP, SOIC
Top View



TOP VIEW

YZR Package
8-Pin DSBGA
Top View



Pin Functions

PIN			I/O	DESCRIPTION
NAME	NO.			
	PDIP/SOIC/ TO-99	DSBGA		
OUTA	1	A1	O	Output, Channel A
-INA	2	B1	I	Inverting Input, Channel A
+INA	3	C1	I	Noninverting Input, Channel A
GND	4	C2	P	Ground
+INB	5	C3	I	Noninverting Input, Channel B
-INB	6	B3	I	Inverting Input, Channel B
OUTB	7	A3	O	Output, Channel B
V+	8	A2	P	Positive power supply

7 Specifications

7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)(2)(3)

			MIN	MAX	UNIT
Differential Input Voltage (4)				36	V
Input Voltage			−0.3	36	V
Input Current (V_{IN}<−0.3 V) (5)				50	mA
Power Dissipation (6)	PDIP			780	mW
	TO-99			660	mW
	SOIC			510	mW
	DSBGA			568	mW
Output Short-Circuit to Ground (7)				Continuous	
Lead Temperature (Soldering, 10 seconds)				260	°C
Soldering Information	PDIP Package Soldering (10 seconds)			260	°C
	SOIC Package	Vapor Phase (60 seconds)		215	°C
		Infrared (15 seconds)		220	°C
Storage temperature, T_{stg}			-65	150	°C

(1) *Absolute Maximum Ratings* indicate limits beyond which damage may occur. *Recommended Operating Conditions* indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and test conditions, see the Electrical Characteristics.
(2) Refer to RETS193AX for LM193AH military specifications and to RETS193X for LM193H military specifications.
(3) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.
(4) Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than −0.3V (or 0.3V below the magnitude of the negative power supply, if used).
(5) This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the comparators to go to the V^+ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than −0.3V.
(6) For operating at high temperatures, the LM393 and LM2903 must be derated based on a 125°C maximum junction temperature and a thermal resistance of 170°C/W which applies for the device soldered in a printed circuit board, operating in a still air ambient. The LM193/LM193A/LM293 must be derated based on a 150°C maximum junction temperature. The low bias dissipation and the “ON-OFF” characteristic of the outputs keeps the chip dissipation very small (P_D≤100 mW), provided the output transistors are allowed to saturate.
(7) Short circuits from the output to V^+ can cause excessive heating and eventual destruction. When considering short circuits to ground, the maximum output current is approximately 20 mA independent of the magnitude of V^+.

7.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±1300	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

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

	MIN	NOM	MAX	UNIT
Supply Voltage (V+) - Single Supply	2.0		36	V
Supply Voltage (V+) - Dual Supply	±1.0		±18	V
Operating Input Voltage on (VIN pin)	0		(V+) -1.5V	V
Operating junction temperature, T_J : LM193/LM193A	-55		125	°C
Operating junction temperature, T_J : LM2903	-40		85	°C
Operating junction temperature, T_J : LM293	-25		85	°C
Operating junction temperature, T_J : LM393	0		70	°C

7.4 Thermal Information

THERMAL METRIC[1]		LMx93 TO-99 8 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	170	°C/W

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

7.5 Electrical Characteristics: LM193A V^+= 5 V, T_A = 25°C

Unless otherwise stated.

PARAMETER	TEST CONDITIONS		LM193A MIN	LM193A TYP	LM193A MAX	UNIT
Input Offset Voltage	See (1).			1.0	2.0	mV
Input Bias Current	I_{IN}(+) or I_{IN}(−) with Output In Linear Range, V_{CM} = 0 V (2)			25	100	nA
Input Offset Current	I_{IN}(+)−I_{IN}(−) V_{CM} = 0 V			3.0	25	nA
Input Common Mode Voltage Range	V+ = 30 V (3)		0		V^+−1.5	V
Supply Current	R_L=∞	V^+=5 V		0.4	1	mA
		V^+=36 V		1	2.5	mA
Voltage Gain	R_L≥15 kΩ, V^+=15 V V_O = 1 V to 11 V		50	200		V/mV
Large Signal Response Time	V_{IN}=TTL Logic Swing, V_{REF}=1.4 V V_{RL}=5V, R_L=5.1 kΩ			300		ns
Response Time	V_{RL}=5V, R_L=5.1 kΩ (4)			1.3		µs
Output Sink Current	V_{IN}(−)=1V, V_{IN}(+)=0, V_O≈1.5 V		6.0	16		mA
Saturation Voltage	V_{IN}(−)=1V, V_{IN}(+)=0, I_{SINK}≤4 mA			250	400	mV
Output Leakage Current	V_{IN}(−)=0, V_{IN}(+)=1V, V_O=5 V			0.1		nA

(1) At output switch point, V_O≈1.4V, R_S= 0 Ω with V^+ from 5V to 30V; and over the full input common-mode range (0V to V^+−1.5V), at 25°C.
(2) The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.
(3) The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is V^+−1.5 V at 25°C, but either or both inputs can go to 36 V without damage, independent of the magnitude of V^+.
(4) The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals 300 ns can be obtained, see *LMx93 and LM193A Typical Characteristics* .

7.6 Electrical Characteristics: LM193A (V+ = 5 V)(1)

PARAMETER	TEST CONDITIONS	LM193A MIN	LM193A TYP	LM193A MAX	UNIT
Input Offset Voltage	See (2)			4.0	mV
Input Offset Current	$I_{IN(+)}$−$I_{IN(-)}$, V_{CM}=0 V			100	nA
Input Bias Current	I_{IN}(+) or I_{IN}(−) with Output in Linear Range, V_{CM}=0 V (3)			300	nA
Input Common Mode Voltage Range	V^+=30 V (4)	0		V^+−2.0	V
Saturation Voltage	V_{IN}(−)=1V, V_{IN}(+)=0, I_{SINK}≤4 mA			700	mV
Output Leakage Current	V_{IN}(−)=0, $V_{IN(+)}$=1V, V_O=30 V			1.0	µA
Differential Input Voltage	Keep All V_{IN}'s≥0 V (or V^-, if Used), (5)			36	V

(1) These specifications are limited to −55°C≤T_A≤+125°C, for the LM193/LM193A. With the LM293 all temperature specifications are limited to −25°C≤T_A≤+85°C and the LM393 temperature specifications are limited to 0°C≤T_A≤+70°C. The LM2903 is limited to −40°C≤T_A≤+85°C.
(2) At output switch point, V_O≈1.4V, R_S= 0 Ω with V^+ from 5V to 30V; and over the full input common-mode range (0V to V^+−1.5V), at 25°C.
(3) The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.
(4) The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is V^+−1.5 V at 25°C, but either or both inputs can go to 36 V without damage, independent of the magnitude of V^+.
(5) Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than −0.3V (or 0.3V below the magnitude of the negative power supply, if used).

7.7 Electrical Characteristics: LMx93 and LM2903 V^+= 5 V, T_A = 25°C

Unless otherwise stated.

PARAMETER	TEST CONDITIONS		LM193-N			LM293-N, LM393-N			LM2903-N			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	See (1)			1.0	5.0		1.0	5.0		2.0	7.0	mV
Input Bias Current	$I_{IN}(+)$ or $I_{IN}(-)$ with Output In Linear Range, V_{CM} = 0 V (2)			25	100		25	250		25	250	nA
Input Offset Current	$I_{IN}(+)-I_{IN}(-)$ V_{CM} = 0 V			3.0	25		5.0	50		5.0	50	nA
Input Common Mode Voltage Range	V+ = 30 V (3)		0		V+−1.5	0		V+−1.5	0		V+−1.5	V
Supply Current	R_L=∞	V^+=5 V		0.4	1		0.4	1		0.4	1.0	mA
		V^+=36 V		1	2.5		1	2.5		1	2.5	mA
Voltage Gain	R_L≥15 kΩ, V^+=15 V V_O = 1 V to 11 V		50	200		50	200		25	100		V/mV
Large Signal Response Time	V_{IN}=TTL Logic Swing, V_{REF}=1.4 V V_{RL}=5 V, R_L=5.1 kΩ			300			300			300		ns
Response Time	V_{RL}=5 V, R_L=5.1 kΩ (4)			1.3			1.3			1.5		µs
Output Sink Current	$V_{IN}(-)$=1 V, $V_{IN}(+)$=0, V_O≤1.5 V		6.0	16		6.0	16		6.0	16		mA
Saturation Voltage	$V_{IN}(-)$=1 V, $V_{IN}(+)$=0, I_{SINK}≤4 mA			250	400		250	400		250	400	mV
Output Leakage Current	$V_{IN}(-)$=0, $V_{IN}(+)$=1V, V_O=5 V			0.1			0.1			0.1		nA

(1) At output switch point, V_O≈1.4V, R_S= 0 Ω with V^+ from 5V to 30V; and over the full input common-mode range (0V to V^+−1.5V), at 25°C.
(2) The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.
(3) The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is V^+−1.5 V at 25°C, but either or both inputs can go to 36 V without damage, independent of the magnitude of V^+.
(4) The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals 300 ns can be obtained, see *LMx93 and LM193A Typical Characteristics* .

7.8 Electrical Characteristics: LMx93 and LM2903 (V+ = 5 V)(1)

PARAMETER	TEST CONDITIONS	LM193-N			LM293-N, LM393-N			LM290-N			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	See (2)			9			9		9	15	mV
Input Offset Current	$I_{IN(+)}-I_{IN(-)}$, V_{CM}=0 V			100			150		50	200	nA
Input Bias Current	$I_{IN}(+)$ or $I_{IN}(-)$ with Output in Linear Range, V_{CM}=0 V (3)			300			400		200	500	nA
Input Common Mode Voltage Range	V^+=30V (4)	0		$V^+-2.0$	0		$V^+-2.0$	0		$V^+-2.0$	V
Saturation Voltage	$V_{IN}(-)$=1V, $V_{IN}(+)$=0, $I_{SINK}\leq$4 mA			700			700		400	700	mV
Output Leakage Current	$V_{IN}(-)$=0, $V_{IN(+)}$=1V, V_O=30 V			1.0			1.0			1.0	µA
Differential Input Voltage	Keep All V_{IN}'s≥0 V (or V^-, if Used), (5)			36			36			36	V

(1) These specifications are limited to −55°C≤T_A≤+125°C, for the LM193/LM193A. With the LM293 all temperature specifications are limited to −25°C≤T_A≤+85°C and the LM393 temperature specifications are limited to 0°C≤T_A≤+70°C. The LM2903 is limited to −40°C≤T_A≤+85°C.
(2) At output switch point, V_O≈1.4V, R_S= 0 Ω with V^+ from 5V to 30V; and over the full input common-mode range (0V to V^+−1.5V), at 25°C.
(3) The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the reference or input lines.
(4) The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is V^+−1.5 V at 25°C, but either or both inputs can go to 36 V without damage, independent of the magnitude of V^+.
(5) Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than −0.3V (or 0.3V below the magnitude of the negative power supply, if used).

7.9 Typical Characteristics: LMx93 and LM193A

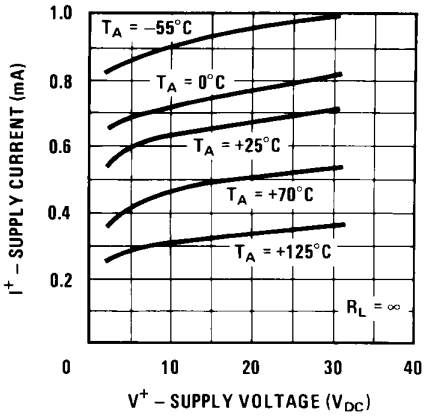


Figure 1. Supply Current

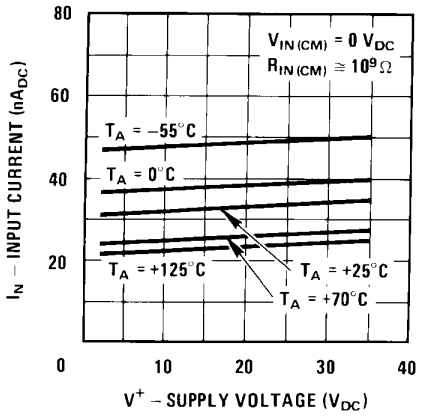


Figure 2. Input Current

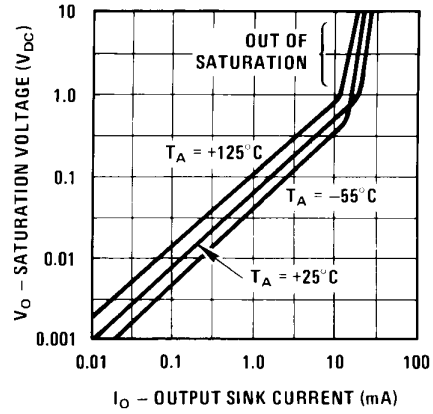


Figure 3. Output Saturation Voltage

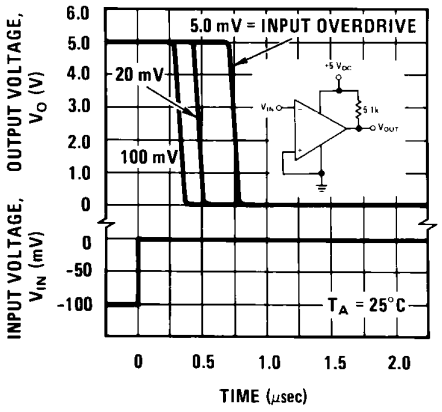


Figure 4. Response Time for Various Input Overdrives—Negative Transition

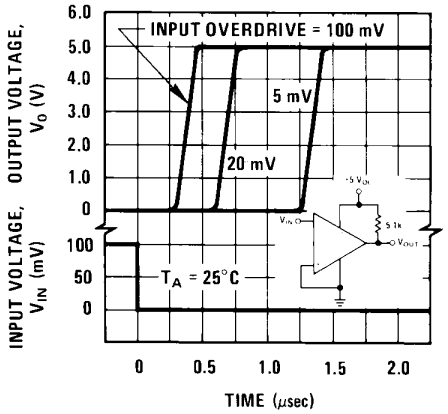


Figure 5. Response Time for Various Input Overdrives—Positive Transition

7.10 Typical Characteristics: LM2903

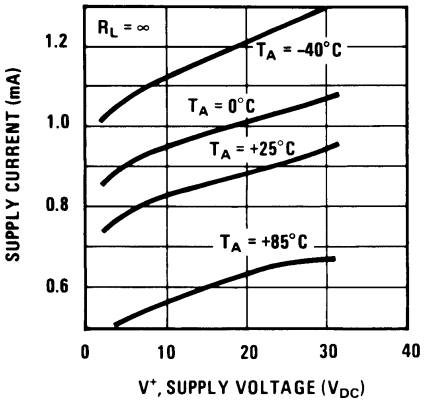


Figure 6. Supply Current

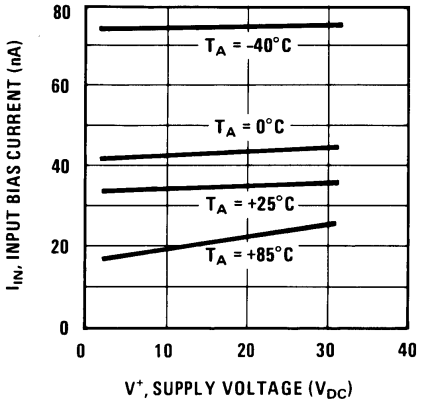


Figure 7. Input Current

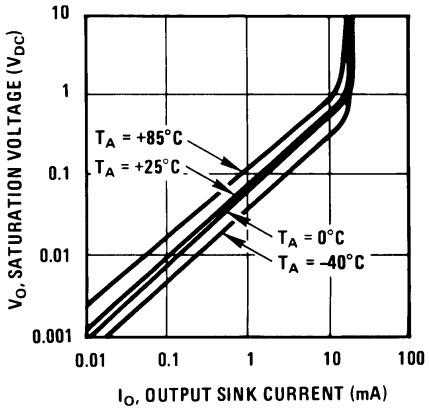


Figure 8. Output Saturation Voltage

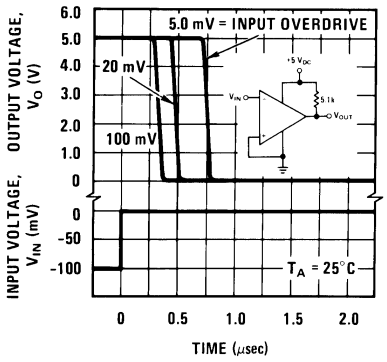


Figure 9. Response Time for Various Input Overdrives—Negative Transition

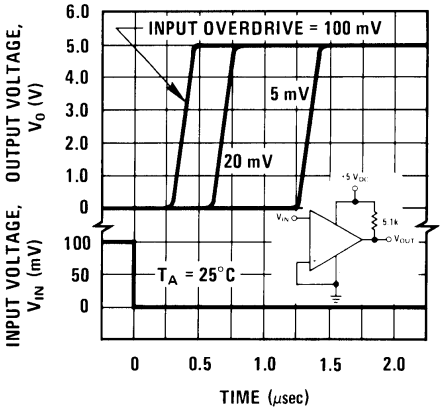


Figure 10. Response Time for Various Input Overdrives—Positive Transition

8 Detailed Description

8.1 Overview

The LM139 provides two independently functioning, high-precision, low V_{OS} drift, low input bias current comparators in a single package. The low power consumption of 0.4 mA at 5 V and the 2.0 V supply operation makes the LM139 suitable for battery powered applications.

8.2 Functional Block Diagram

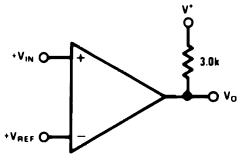


Figure 11. Basic Comparator

8.3 Feature Description

The input bias current of 25 nA enables the LM193 to use even very high impedance nodes as inputs. The differential voltage input range equals the supply voltage range.

The LM193 can be operated with a single supply, where V+ can be from 2.0 V to 36 V, or in a dual supply voltage configuration, where GND pin is used as a V– supply. The supply current draws only 0.4 mA for both comparators.

The output of each comparator in the LM193 is the open collector of a grounded-emitter NPN output transistor which can typically draw up to 16 mA.

8.4 Device Functional Modes

A basic comparator circuit is used for converting analog signals to a digital output. The output is HIGH when the voltage on the non-inverting (+IN) input is greater than the inverting (-IN) input. The output is LOW when the voltage on the non-inverting (+IN) input is less than the inverting (-IN) input. The inverting input (-IN) is also commonly referred to as the "reference" or "VREF" input. All pins of any unused comparators should be tied to the negative supply.

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI'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

The LM193 series are high gain, wide bandwidth devices which, like most comparators, can easily oscillate if the output lead is inadvertently allowed to capacitively couple to the inputs via stray capacitance. This shows up only during the output voltage transition intervals as the comparator change states. Power supply bypassing is not required to solve this problem. Standard PC board layout is helpful as it reduces stray input-output coupling. Reducing the input resistors to < 10 kΩ reduces the feedback signal levels and finally, adding even a small amount (1.0 to 10 mV) of positive feedback (hysteresis) causes such a rapid transition that oscillations due to stray feedback are not possible. Simply socketing the IC and attaching resistors to the pins will cause input-output oscillations during the small transition intervals unless hysteresis is used. If the input signal is a pulse waveform, with relatively fast rise and fall times, hysteresis is not required.

All input pins of any unused comparators should be tied to the negative supply.

The bias network of the LM193 series establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from 2.0 V_{DC} to 30 V_{DC}.

The differential input voltage may be larger than V^+ without damaging the device*Typical Applications* . Protection should be provided to prevent the input voltages from going negative more than −0.3 V_{DC} (at 25°C). An input clamp diode can be used as shown in *Typical Applications* .

The output of the LM193 series is the uncommitted collector of a grounded-emitter NPN output transistor. Many collectors can be tied together to provide an output OR'ing function. An output pullup resistor can be connected to any available power supply voltage within the permitted supply voltage range and there is no restriction on this voltage due to the magnitude of the voltage which is applied to the V^+ terminal of the LM193 package. The output can also be used as a simple SPST switch to ground (when a pullup resistor is not used). The amount of current which the output device can sink is limited by the drive available (which is independent of V^+) and the β of this device. When the maximum current limit is reached (approximately 16 mA), the output transistor will come out of saturation and the output voltage will rise very rapidly. The output saturation voltage is limited by the approximately 60 Ω r_{SAT} of the output transistor. The low offset voltage of the output transistor (1.0 mV) allows the output to clamp essentially to ground level for small load currents.

9.2 Typical Applications

9.2.1 Basic Comparator

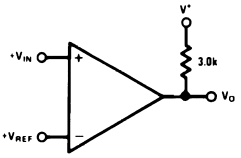


Figure 12. Basic Comparator

9.2.1.1 Design Requirements

The basic usage of a comparator is to indicate when a specific analog signal has exceeded some predefined threshold. In this application, the negative input (IN–) is tied to a reference voltage, and the positive input (IN+) is connected to the input signal. The output is pulled up with a resistor to the logic supply voltage, V+ with a pullup resistor.

For an example application, the supply voltage is 5V. The input signal varies between 1 V and 3 V, and we want to know when the input exceeds 2.5 V±1%. The supply current draw should not exceed 1 mA.

Typical Applications (continued)

9.2.1.2 Detailed Design Procedure

First, we determine the biasing for the 2.5-V reference. With the 5-V supply voltage, we would use a voltage divider consisting of one resistor from the supply to IN- and an second resistor from IN–. The 25 nA of input current bias should be < 1% of the bias current for Vref. With a 100-kΩ resistor from IN– to V+ and an additional 100-KΩ resistor from IN– to ground, there would be 25 µA of current through the two resistors. The 3-kΩ pullup shown will need 5 V/3 kΩ → 1.67 mA, which exceeds our current budget.

With the 400-µA supply current and 25 µA of VREF bias current, there is 575 µA remaining for output pullup resistor; with 5-V supply, we need a pullup larger than 8.7 kΩ. A 10-kΩ pullup is a value that is commonly available and can be used here.

9.2.1.3 Application Curve

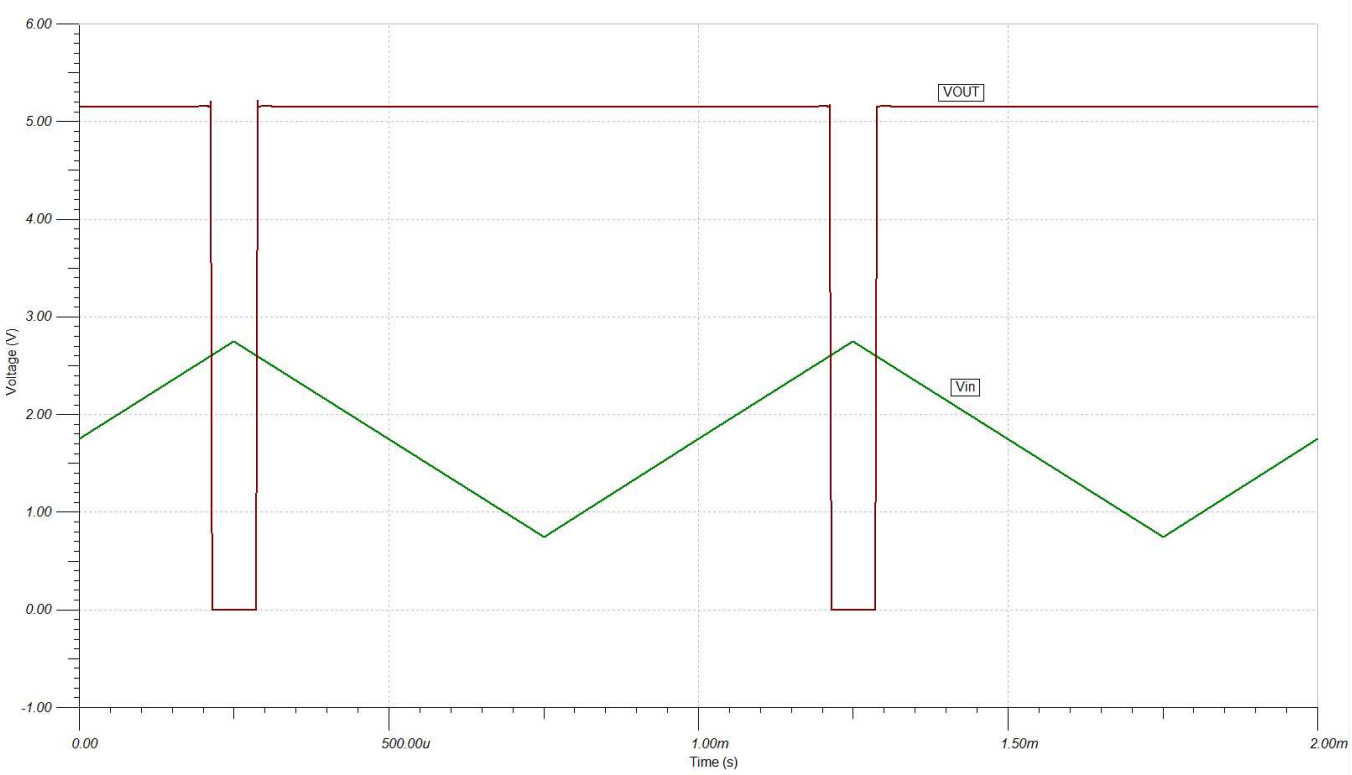
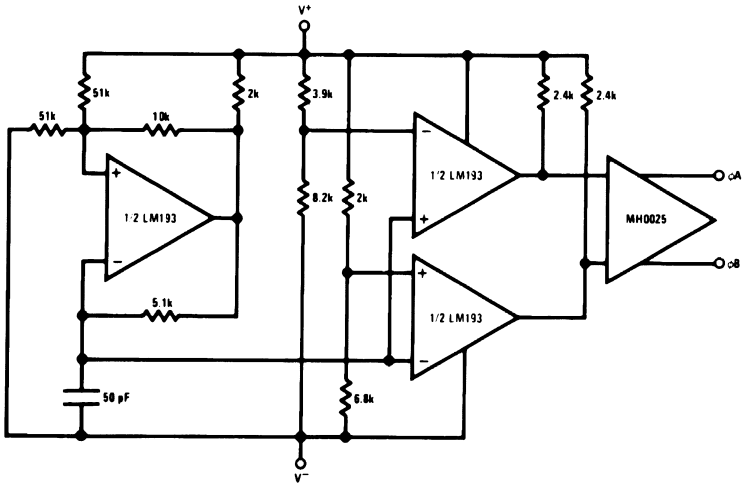


Figure 13. Basic Comparator Response

Typical Applications (continued)

9.2.2 System Examples

9.2.2.1 Split-Supply Application



(V+=-15 V_{DC} and V-=-15 V_{DC})

Figure 14. MOS Clock Driver

9.2.2.2 V+ = 5.0 V_{DC} Application Circuits

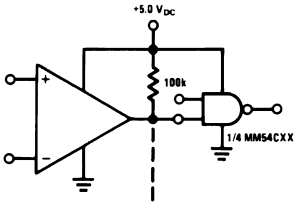


Figure 15. Driving CMOS

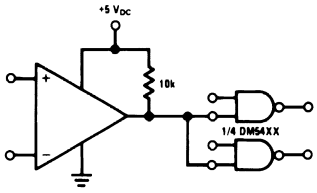


Figure 16. Driving TTL

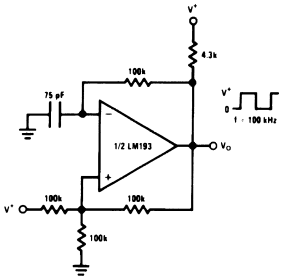
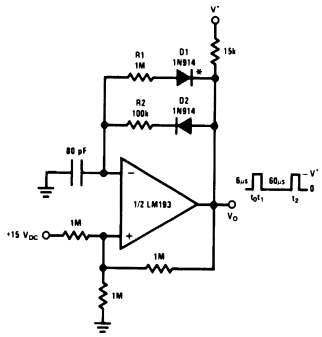


Figure 17. Squarewave Oscillator



* For large ratios of R1/R2,
D1 can be omitted.

Figure 18. Pulse Generator

Typical Applications (continued)

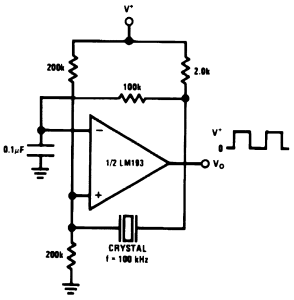
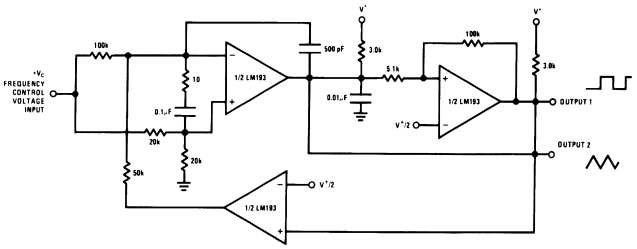


Figure 19. Crystal Controlled Oscillator



V* = +30 V_{DC}

+250 mV_{DC} ≤ V_C ≤ +50 V_{DC}

700Hz ≤ f_o ≤ 100kHz

Figure 20. Two-Decade High Frequency VCO

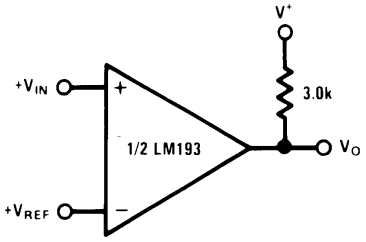


Figure 21. Basic Comparator

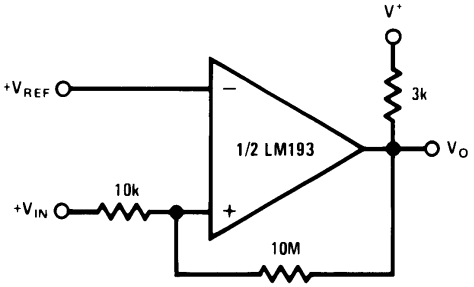


Figure 22. Non-Inverting Comparator With Hysteresis

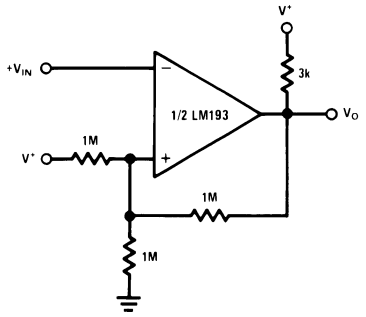


Figure 23. Inverting Comparator With Hysteresis

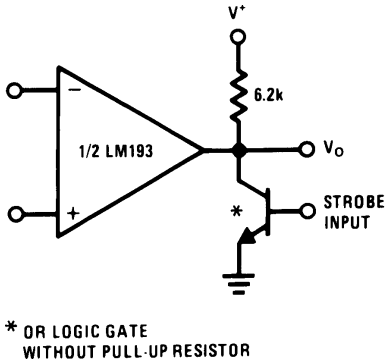


Figure 24. Output Strobing

Typical Applications (continued)

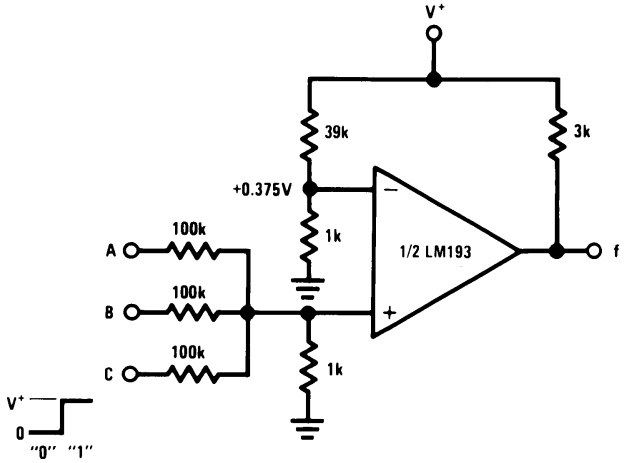


Figure 25. And Gate

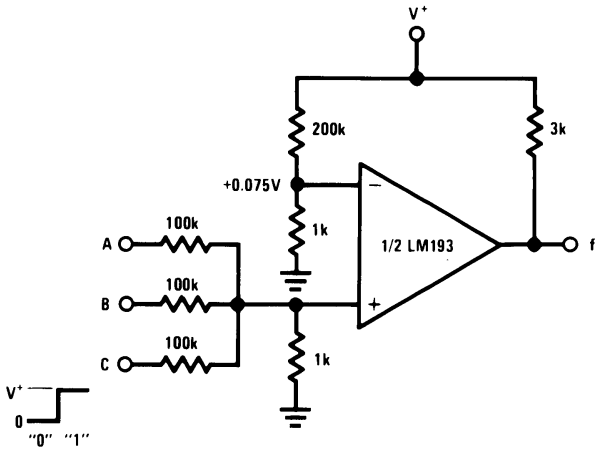


Figure 26. Or Gate

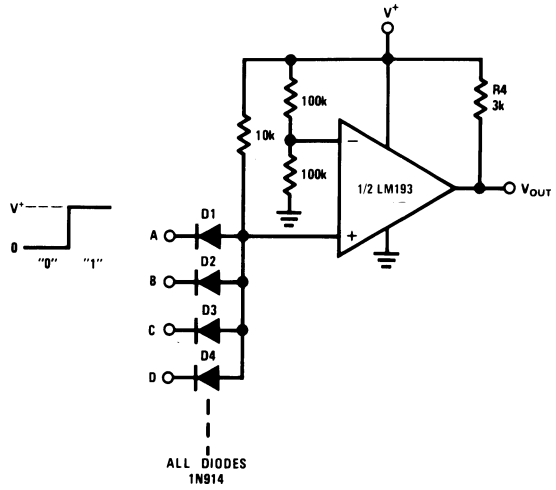


Figure 27. Large Fan-In and Gate

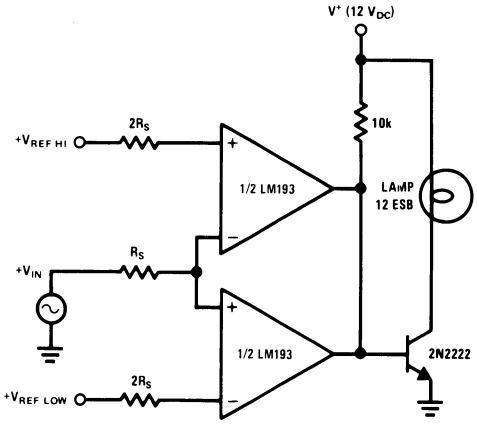


Figure 28. Limit Comparator

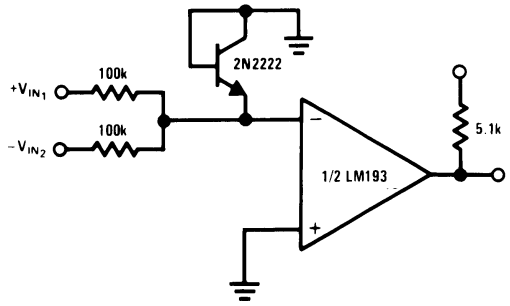


Figure 29. Comparing Input Voltages of Opposite Polarity

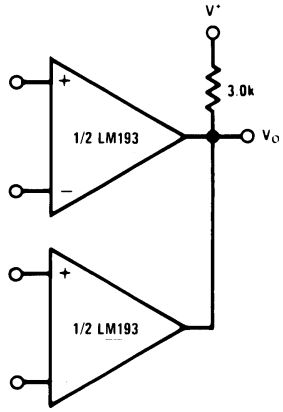


Figure 30. Oring the Outputs

Typical Applications (continued)

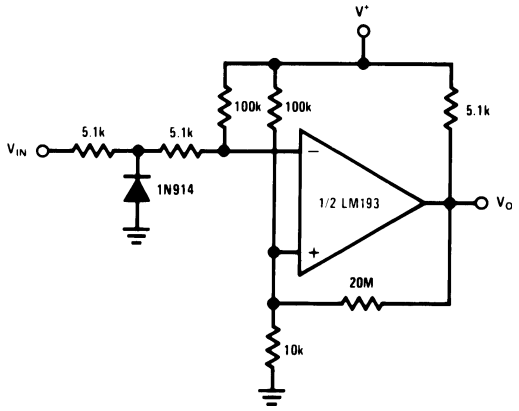


Figure 31. Zero Crossing Detector (Single Power Supply)

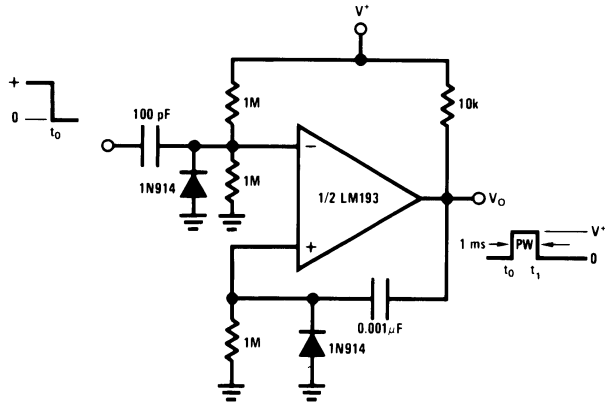


Figure 32. One-Shot Multivibrator

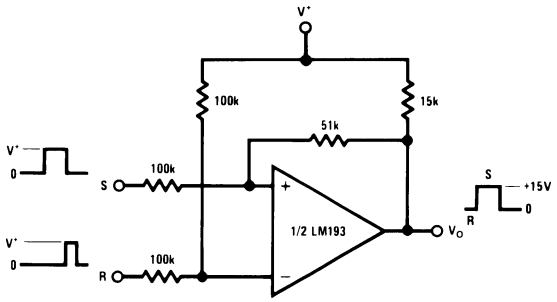


Figure 33. Bi-Stable Multivibrator

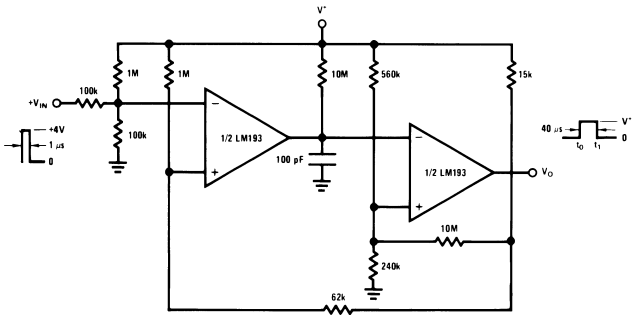


Figure 34. One-Shot Multivibrator With Input Lock Out

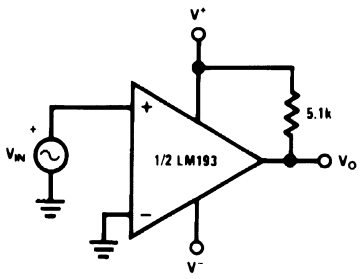


Figure 35. Zero Crossing Detector

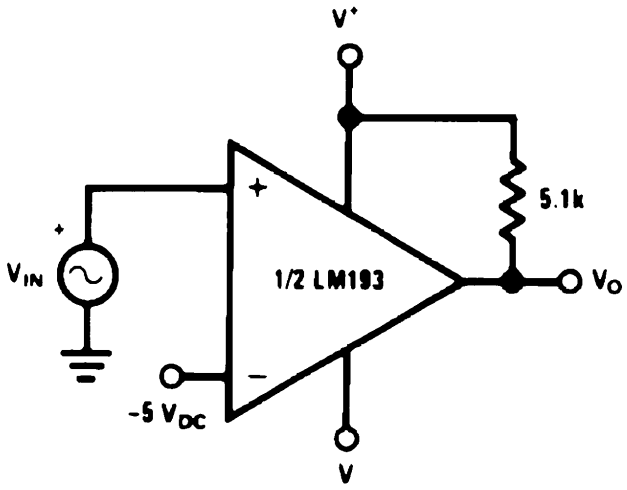


Figure 36. Comparator With a Negative Reference

Typical Applications (continued)

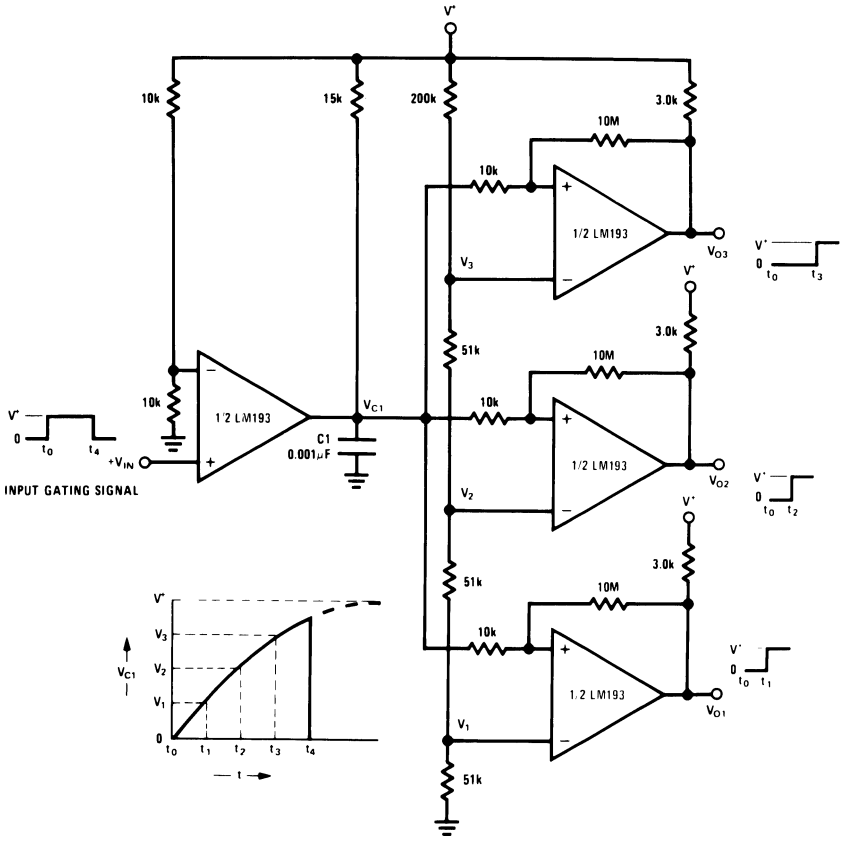


Figure 37. Time Delay Generator

10 Power Supply Recommendations

Even in low frequency applications, the LM139-N can have internal transients which are extremely quick. For this reason, bypassing the power supply with 1.0 μF to ground will provide improved performance; the supply bypass capacitor should be placed as close as possible to the supply pin and have a solid connection to ground. The bypass capacitor should have a low ESR and also a SRF greater than 50MHz.

11 Layout

11.1 Layout Guidelines

Try to minimize parasitic impedances on the inputs to avoid oscillation. Any positive feedback used as hysteresis should place the feedback components as close as possible to the input pins. Care should be taken to ensure that the output pins do not couple to the inputs. This can occur through capacitive coupling if the traces are too close and lead to oscillations on the output. The optimum placement for the bypass capacitor is closest to the V+ and ground pins. Take care to minimize the loop area formed by the bypass capacitor connection between V+ and ground. The ground pin should be connected to the PCB ground plane at the pin of the device. The feedback components should be placed as close to the device as possible minimizing strays.

11.2 Layout Example

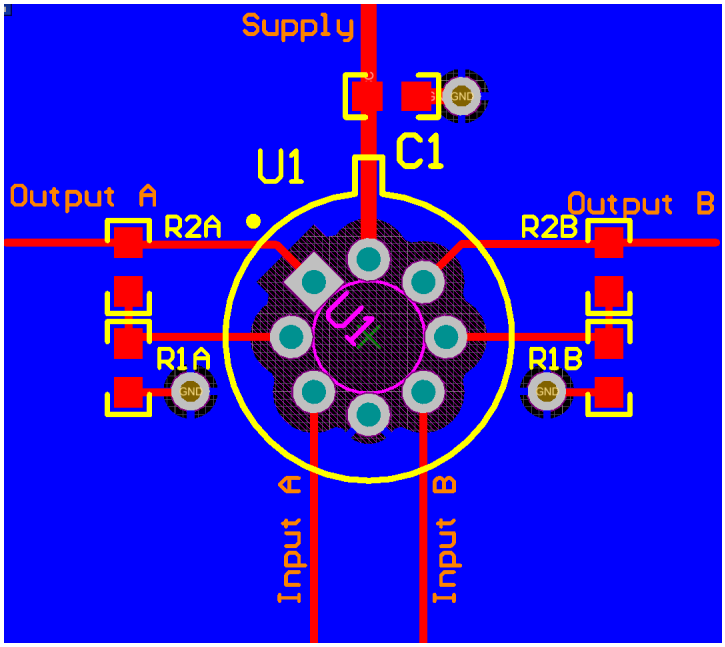


Figure 38. Layout Example

12 デバイスおよびドキュメントのサポート

12.1 関連リンク

次の表に、クイック・アクセス・リンクを示します。カテゴリには、技術資料、サポートおよびコミュニティ・リソース、ツールとソフトウェア、およびご注文へのクイック・アクセスが含まれます。

表 1. 関連リンク

製品	プロダクト・フォルダ	ご注文はこちら	技術資料	ツールとソフトウェア	サポートとコミュニティ
LM193-N	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック
LM2903-N	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック
LM293-N	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック
LM393-N	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック

12.2 ドキュメントの更新通知を受け取る方法

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12.3 商標

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12.4 静電気放電に関する注意事項

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12.5 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

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)
LM193AH	Active	Production	TO-99 (LMC) | 8	500 | OTHER	No	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM193AH, LM193AH)
LM193AH/NOPB	Active	Production	TO-99 (LMC) | 8	500 | OTHER	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM193AH, LM193AH)
LM193H	Active	Production	TO-99 (LMC) | 8	500 | OTHER	No	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM193H, LM193H)
LM193H/NOPB	Active	Production	TO-99 (LMC) | 8	500 | OTHER	Yes	Call TI	Level-1-NA-UNLIM	-55 to 125	(LM193H, LM193H)
LM2903ITL/NOPB	Active	Production	DSBGA (YZR) | 8	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	C 03
LM2903ITL/NOPB.B	Active	Production	DSBGA (YZR) | 8	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	C 03
LM2903ITLX/NOPB	Active	Production	DSBGA (YZR) | 8	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	C 03
LM2903ITLX/NOPB.B	Active	Production	DSBGA (YZR) | 8	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 85	C 03
LM2903M	Obsolete	Production	SOIC (D) | 8	-	-	Call TI	Call TI	-40 to 85	LM 2903M
LM2903M/NOPB	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM 2903M
LM2903M/NOPB.B	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM 2903M
LM2903MX/NOPB	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM 2903M
LM2903MX/NOPB.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	LM 2903M
LM2903N/NOPB	Active	Production	PDIP (P) | 8	40 | TUBE	Yes	NIPDAU	Level-1-NA-UNLIM	-40 to 85	LM 2903N
LM2903N/NOPB.B	Active	Production	PDIP (P) | 8	40 | TUBE	Yes	NIPDAU	Level-1-NA-UNLIM	-40 to 85	LM 2903N
LM293H	Active	Production	TO-99 (LMC) | 8	500 | TRAY NON-STD	No	Call TI	Level-1-NA-UNLIM	-25 to 85	(LM293H, LM293H)
LM293H/NOPB	Active	Production	TO-99 (LMC) | 8	500 | OTHER	Yes	Call TI	Level-1-NA-UNLIM	-25 to 85	(LM293H, LM293H)
LM393M	Obsolete	Production	SOIC (D) | 8	-	-	Call TI	Call TI	0 to 70	LM 393M

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)
LM393M/NOPB	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM 393M
LM393M/NOPB.B	Active	Production	SOIC (D) | 8	95 | TUBE	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM 393M
LM393MX	Obsolete	Production	SOIC (D) | 8	-	-	Call TI	Call TI	0 to 70	LM 393M
LM393MX/NOPB	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM 393M
LM393MX/NOPB.B	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	0 to 70	LM 393M
LM393N/NOPB	Active	Production	PDIP (P) | 8	40 | TUBE	Yes	NIPDAU	Level-1-NA-UNLIM	0 to 70	LM 393N
LM393N/NOPB.B	Active	Production	PDIP (P) | 8	40 | TUBE	Yes	NIPDAU	Level-1-NA-UNLIM	0 to 70	LM 393N
LM393TL/NOPB	Active	Production	DSBGA (YZR) | 8	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	0 to 70	C 02
LM393TL/NOPB.B	Active	Production	DSBGA (YZR) | 8	250 | SMALL T&R	Yes	SNAGCU	Level-1-260C-UNLIM	0 to 70	C 02
LM393TLX/NOPB	Active	Production	DSBGA (YZR) | 8	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	0 to 70	C 02
LM393TLX/NOPB.B	Active	Production	DSBGA (YZR) | 8	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	0 to 70	C 02

(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-N, LM293-N :

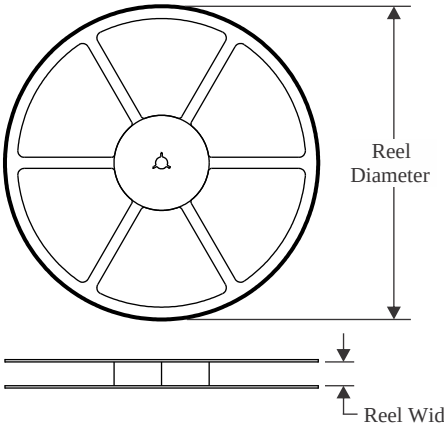
- Automotive : LM2903-Q1
- Enhanced Product : LM293-EP

NOTE: Qualified Version Definitions:

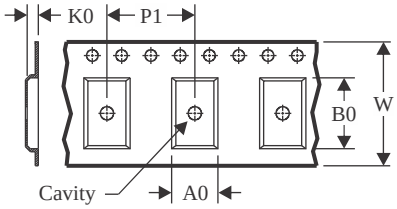
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

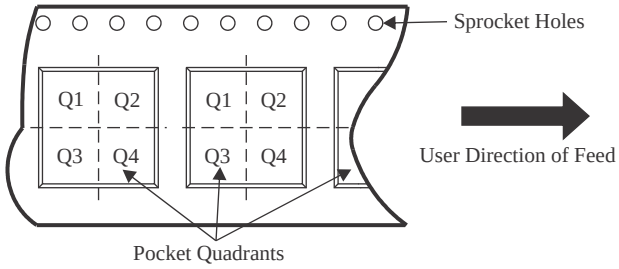


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

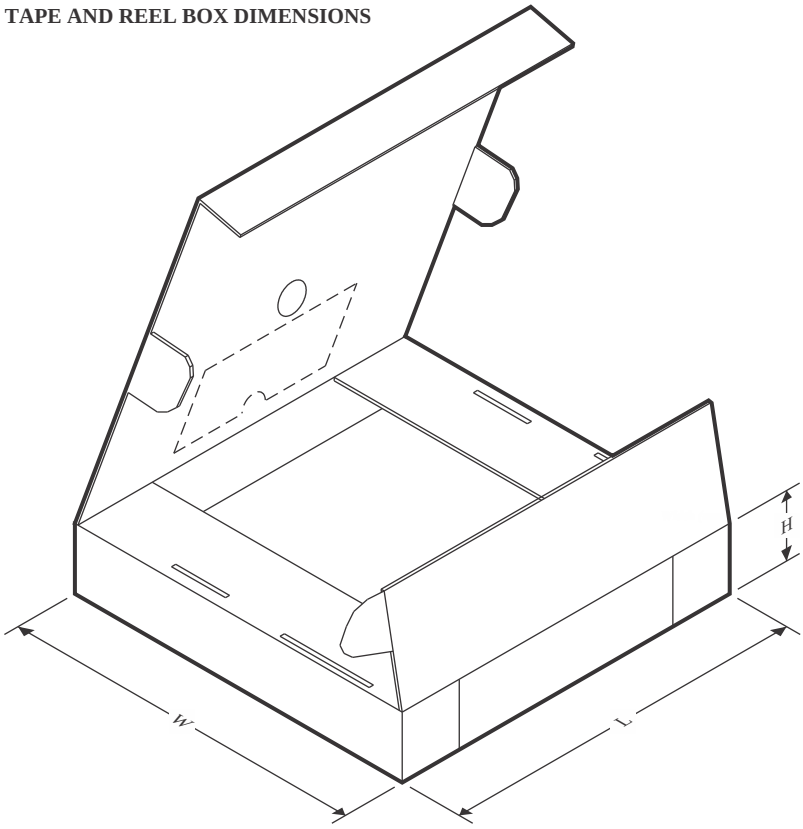
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LM2903ITL/NOPB	DSBGA	YZR	8	250	178.0	8.4	1.7	1.7	0.76	4.0	8.0	Q1
LM2903ITLX/NOPB	DSBGA	YZR	8	3000	178.0	8.4	1.7	1.7	0.76	4.0	8.0	Q1
LM2903MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM393MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LM393TL/NOPB	DSBGA	YZR	8	250	178.0	8.4	1.7	1.7	0.76	4.0	8.0	Q1
LM393TLX/NOPB	DSBGA	YZR	8	3000	178.0	8.4	1.7	1.7	0.76	4.0	8.0	Q1

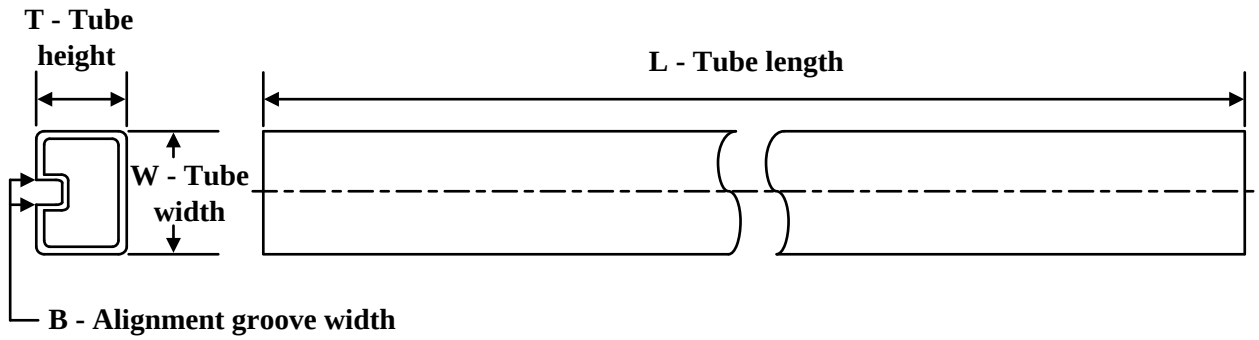
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

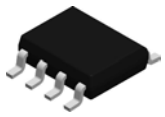
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM2903ITL/NOPB	DSBGA	YZR	8	250	208.0	191.0	35.0
LM2903ITLX/NOPB	DSBGA	YZR	8	3000	208.0	191.0	35.0
LM2903MX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LM393MX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0
LM393TL/NOPB	DSBGA	YZR	8	250	208.0	191.0	35.0
LM393TLX/NOPB	DSBGA	YZR	8	3000	208.0	191.0	35.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
LM2903M/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM2903M/NOPB.B	D	SOIC	8	95	495	8	4064	3.05
LM2903N/NOPB	P	PDIP	8	40	502	14	11938	4.32
LM2903N/NOPB.B	P	PDIP	8	40	502	14	11938	4.32
LM393M/NOPB	D	SOIC	8	95	495	8	4064	3.05
LM393M/NOPB.B	D	SOIC	8	95	495	8	4064	3.05
LM393N/NOPB	P	PDIP	8	40	502	14	11938	4.32
LM393N/NOPB.B	P	PDIP	8	40	502	14	11938	4.32

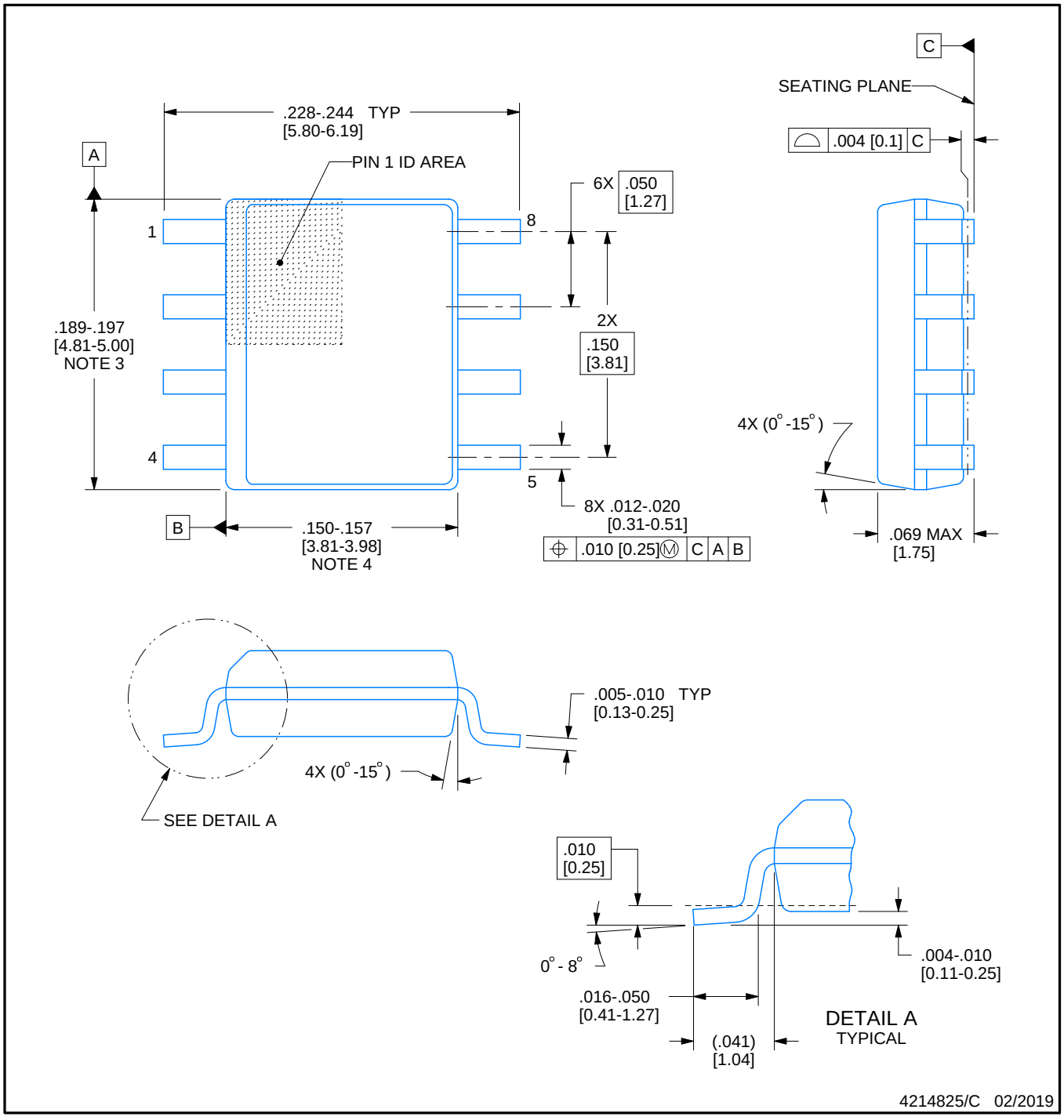


PACKAGE OUTLINE

D0008A

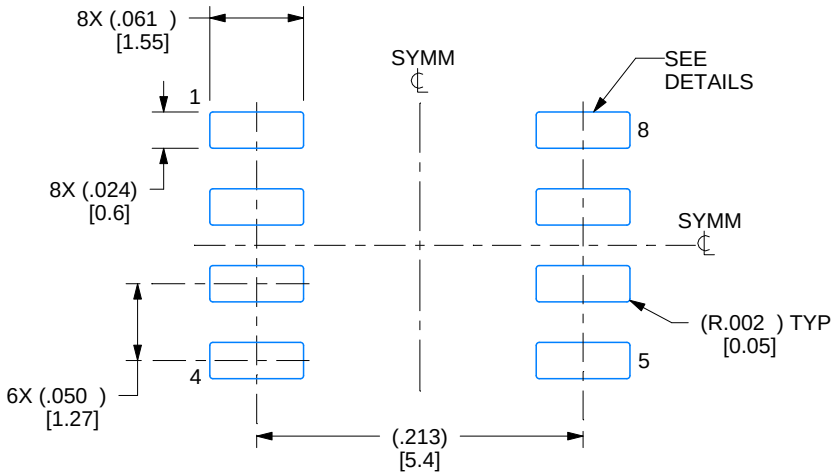
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

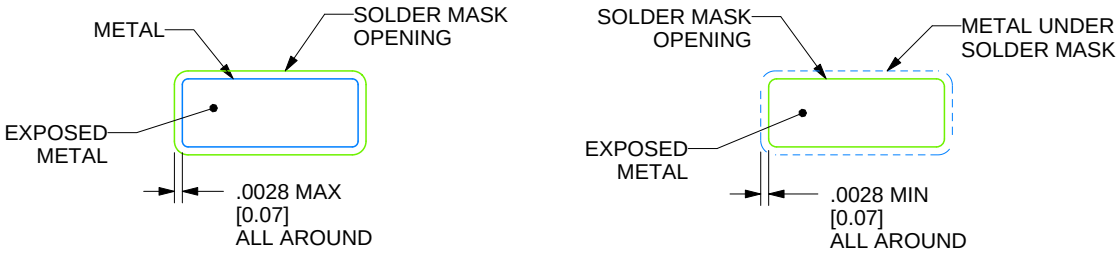


NOTES:

1. 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.
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 .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

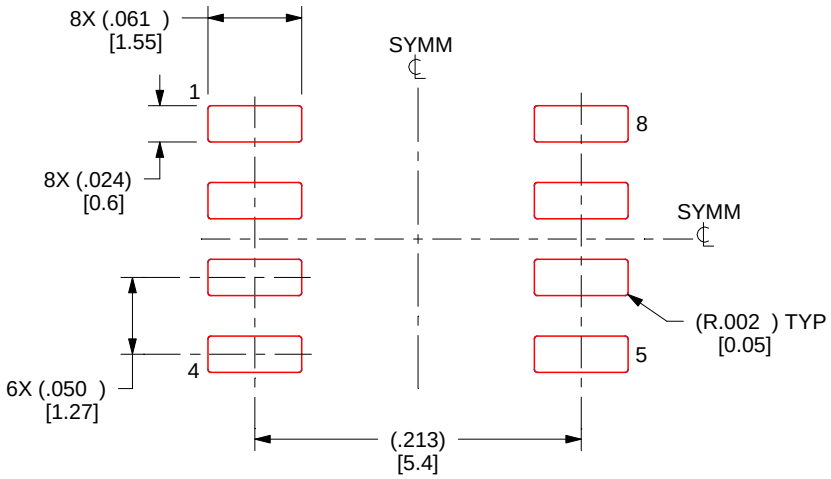
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



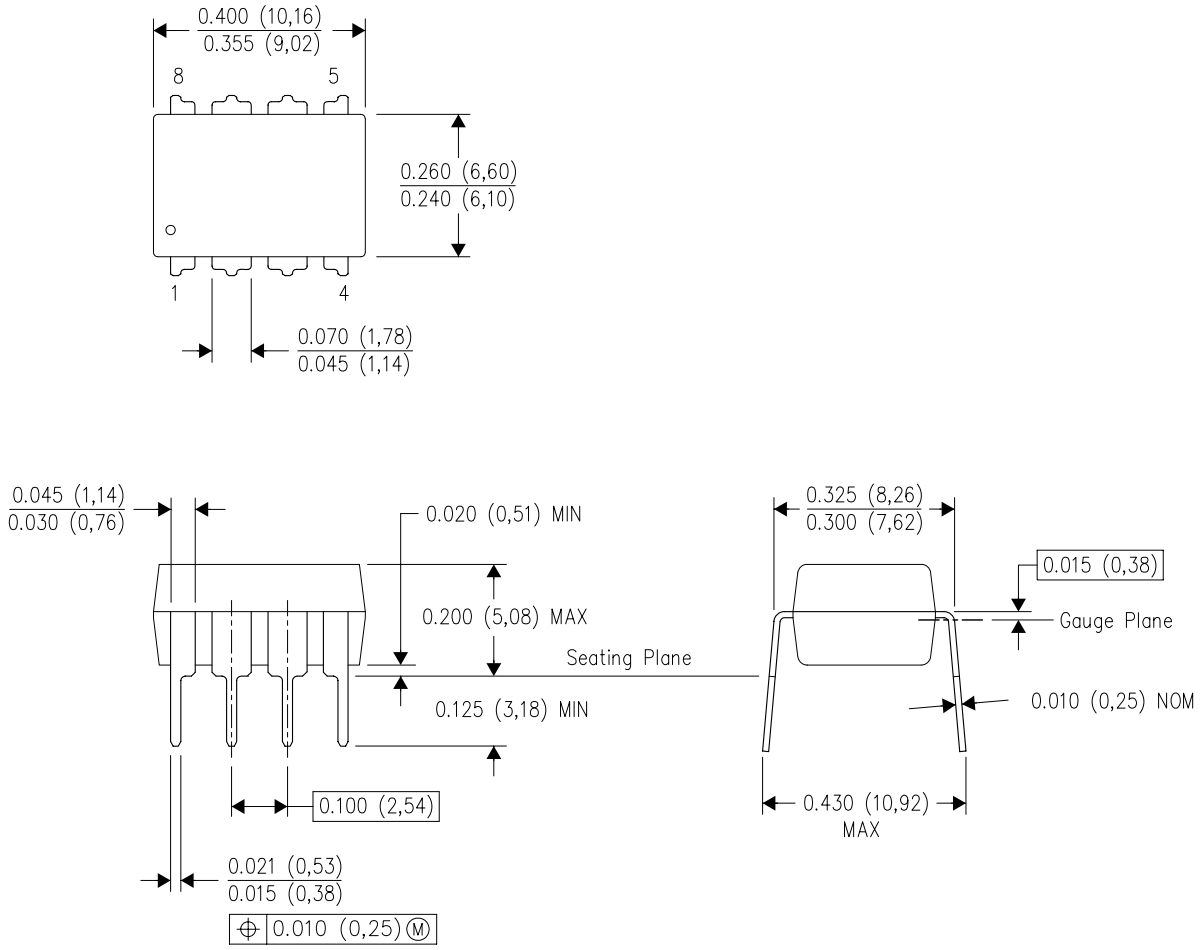
SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

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.

P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE



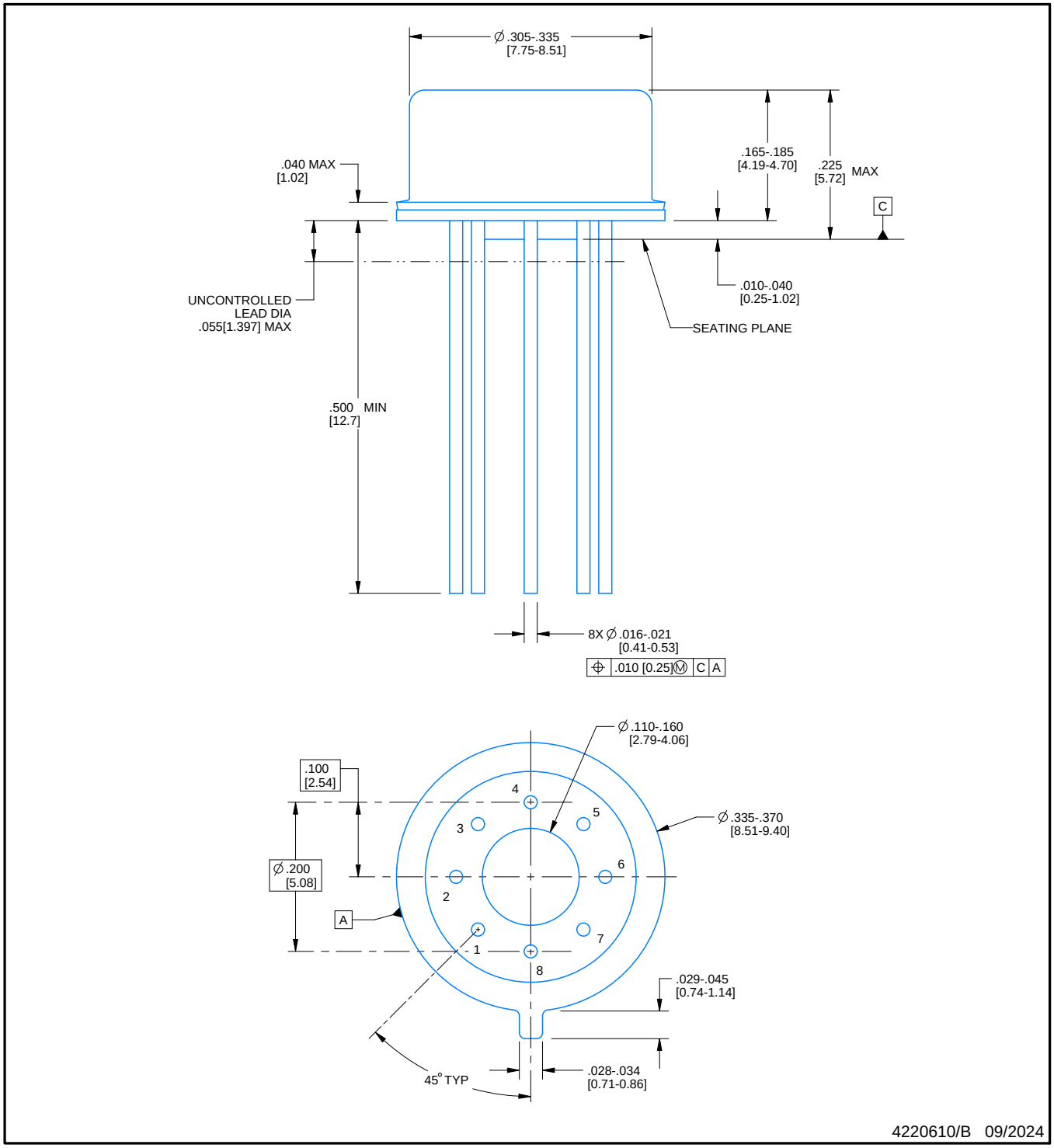
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001 variation BA.

PACKAGE OUTLINE

LMC0008A

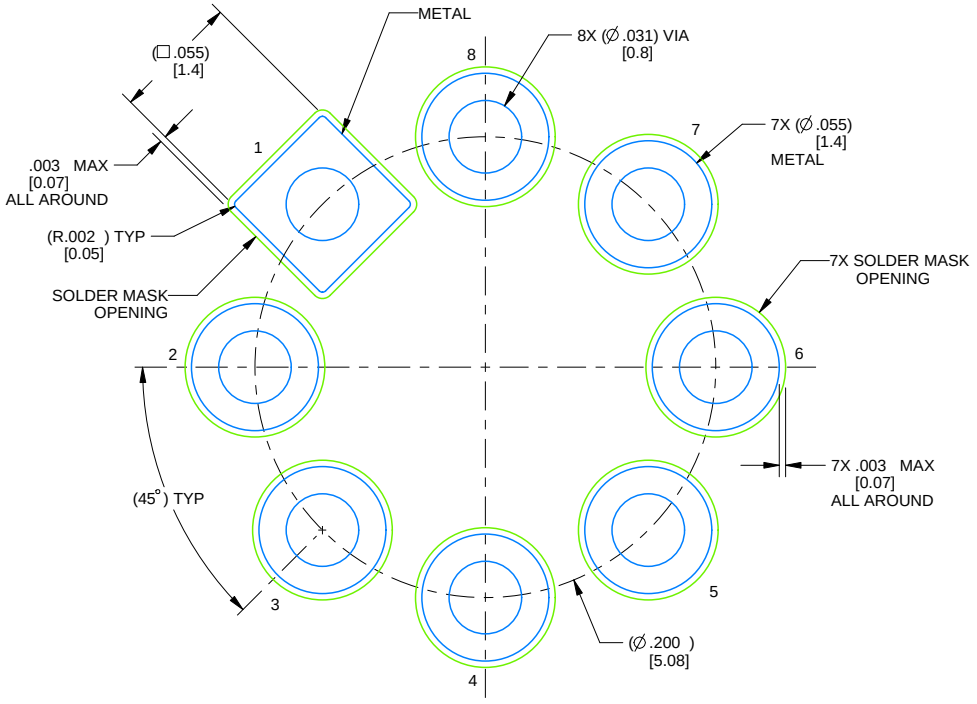
TO-CAN - 5.72 mm max height

TRANSISTOR OUTLINE



NOTES:

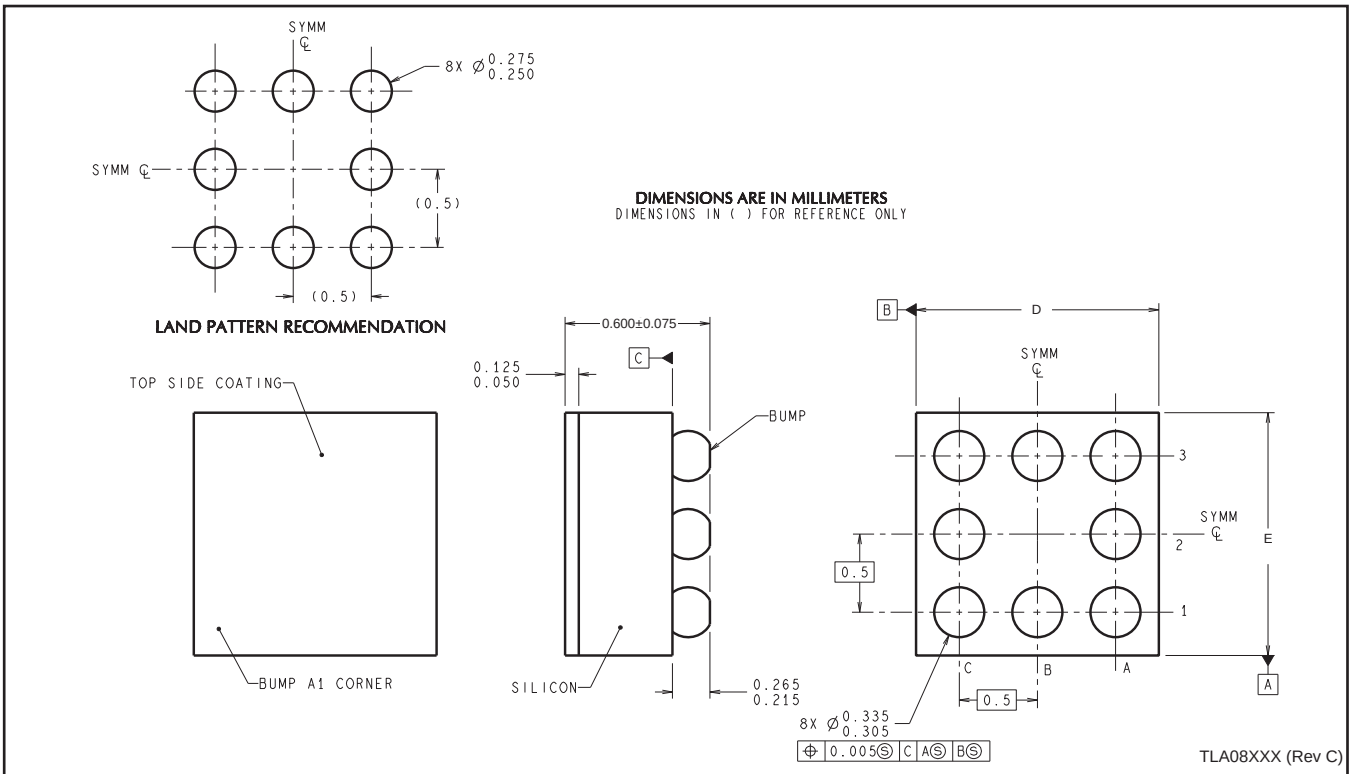
1. All linear dimensions are in inches [millimeters]. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Pin numbers shown for reference only. Numbers may not be marked on package.
4. Reference JEDEC registration MO-002/TO-99.



LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE: 12X

4220610/B 09/2024

YZR0008



D: Max = 1.54 mm, Min = 1.479 mm

E: Max = 1.54 mm, Min = 1.479 mm

4215045/A 12/12

NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
B. This drawing is subject to change without notice.

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