LM339-MIL 低消費電力、低オフセット電圧のクワッド・コンパレータ

1 特長

- 広い電源電圧範囲
- 2～36V_{DC}または±1～±18V_{DC}
- 非常に低い電源消費電流(0.8mA) - 電源電圧の値には無関係
- 低い入力バイアス電流: 25nA
- 低い入力オフセット電流: ±5nA
- オフセット電圧: ±3mV
- 入力同相電圧範囲にGND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
- 利点:
  - 高精度のコンパレータ
  - V_{OS}ドリフト過熱の減少
  - デュアル電源が不要
  - GND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

- 制限コンパレータ
- 単純なアナログ/デジタル・コンバータ(ADC)
- パルス、方形波、時間遅延発生器
- 広い範囲のVCO、MOSクロック・タイマ
- マルチバイブレータおよび高電圧デジタル・ロジック・ゲート

3 概要

LM339-MILデバイスは4つの独立した高精度電圧コンパレータで構成され、4つのコンパレータすべてについて、オフセット電圧仕様が最大約2mVと低値です。これらのコンパレータは、広い範囲の電圧の単一電源で動作するよう特に設計されています。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、単一の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。

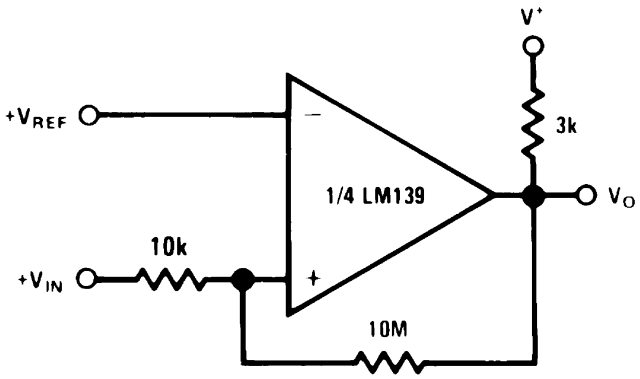
LM339-MILデバイスは、TTLおよびCMOSと直接接続可能に設計されています。正負両電源で動作するとき、デバイスはMOSロジックと直接接続します。この場合、LM339-MILの低い消費電力が、標準のコンパレータと比較して明確な利点になります。

製品情報(1)

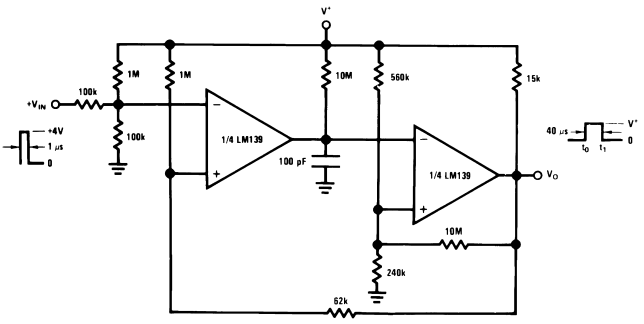
型番	パッケージ	本体サイズ(公称)
LM339-MIL	CDIP (14)	19.56mm×6.67mm
	SOIC (14)	8.65mm×3.91mm
	PDIP (14)	19.177mm×6.35mm

(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。

ヒステリシス付きの非反転コンパレータ



入力ロックアウト付きのワンショット・マルチバイブレータ



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4 改訂履歴

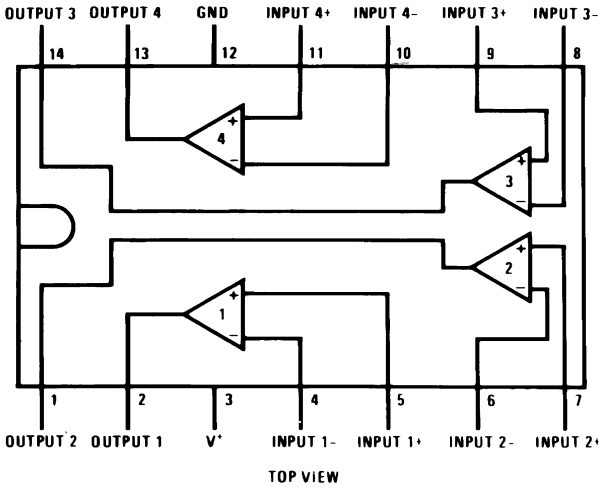
資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

日付	改訂内容	注
2017年6月	*	初版

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5 Pin Configuration and Functions

J, D, and NFF Packages
14-Pin CDIP, SOIC, and PDIP
Top View



Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	OUTPUT2	O	Output, Channel 2
2	OUTPUT1	O	Output, Channel 1
3	V+	P	Positive Supply
4	INPUT1-	I	Inverting Input, Channel 1
5	INPUT1+	I	Noninverting Input, Channel 1
6	INPUT2-	I	Inverting Input, Channel 2
7	INPUT2+	I	Noninverting Input, Channel 2
8	INPUT3-	I	Inverting Input, Channel 3
9	INPUT3+	I	Noninverting Input, Channel 3
10	INPUT4-	I	Inverting Input, Channel 4
11	INPUT4+	I	Noninverting Input, Channel 4
12	GND	P	Ground
13	OUTPUT4	O	Output, Channel 4
14	OUTPUT3	O	Output, Channel 3

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6 Specifications

6.1 Absolute Maximum Ratings

See (1)(2)

		MIN	MAX	UNIT
Supply voltage, V+			36	V_{DC}
Differential input voltage(3)			36	
Input voltage		–0.3	36	
Input current (V_{IN} ≤ 0.3 V_{DC})(4)			50	mA
Power dissipation(5)	PDIP		1050	mW
	Cavity DIP		1190	
	SOIC package		760	
Output short-circuit to GND(6)			Continuous	
Storage temperature, T_{stg}		−65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may 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 may affect device reliability.
(2) Refer to RETS139X for military specifications.
(3) 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 −0.3 V_{DC} (or 0.3 V_{DC} below the magnitude of the negative power supply, if used) (at 25°C).
(4) This input current will only exist when the voltage at any of the input leads is driven negative. It is because of 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 −0.3 V_{DC} (at 25°C).
(5) For operating at high temperatures, the device must be derated based on a 125°C maximum junction temperature and a thermal resistance of 95°C/W which applies for the device soldered in a printed circuit board, operating in a still air ambient. 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.
(6) 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+.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±600	V

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

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6.3 Recommended Operating Conditions

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

	MIN	MAX	UNIT
Supply voltage, single	2	36	V
Supply voltage, dual	±1	±18	
Operating temperature	0	70	°C

6.4 Thermal Information

THERMAL METRIC(1)		LM339-MIL			UNIT
		J (CDIP)	D (SOIC)	NFF (PDIP)	
		14 PINS	14 PINS	14 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	97.8	94.3	82.3	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	52.6	52.4	79	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	87.5	48.8	62.1	°C/W
ψ_{JT}	Junction-to-top characterization parameter	43.9	14.2	50.9	°C/W
ψ_{JB}	Junction-to-board characterization parameter	80.3	48.5	62	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	30.1	—	—	°C/W

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

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6.5 Electrical Characteristics

($V+ = 5\ V_{DC}$, $T_A = 25°C$, unless otherwise stated)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input offset voltage	At output switch point, $V_O \approx 1.4\ V_{DC}$, $R_S = 0\ \Omega$ with V+ from 5 V_{DC} to 30 V_{DC}; and over the full input common-mode range (0 V_{DC} to V+ −1.5 V_{DC}), at 25°C.		2	5	mV_{DC}
	At output switch point, $V_O \approx 1.4\ V_{DC}$, $R_S = 0\ \Omega$ with V+ from 5 V_{DC} to 30 V_{DC}; and over the full input common-mode range (0 V_{DC} to V+ −1.5 V_{DC}), at 25°C, 0°C ≤ T_A ≤ 70°C			9	
Input bias current(1)	$I_{IN(+)}$ or $I_{IN(-)}$ with output in linear range, $V_{CM} = 0$ V		25	250	nA_{DC}
	$I_{IN(+)}$ or $I_{IN(-)}$ with output in linear range, $V_{CM} = 0$ V, 0°C ≤ T_A ≤ 70°C			400	
Input offset current	$I_{IN(+)} - I_{IN(-)}$, $V_{CM} = 0$ V		5	50	nA_{DC}
	$I_{IN(+)} - I_{IN(-)}$, $V_{CM} = 0$ V, 0°C ≤ T_A ≤ 70°C			150	
Input common-mode voltage range(2)	V+ = 30 V_{DC}	0		V+ − 1.5	V_{DC}
	V+ = 30 V_{DC}, 0°C ≤ T_A ≤ 70°C			$V^+ - 2$	
Supply current	$R_L = \infty$ on all comparators		0.8	2	mA_{DC}
	$R_L = \infty$, V+ = 36 V		1	2.5	mA_{DC}
Voltage gain	$R_L \geq 15\ k\Omega$, V+ = 15 V_{DC}, V_O = 1 V_{DC} to 11 V_{DC}	50	200		V/mV
Large signal response time	V_{IN} = TTL logic swing, V_{REF} = 1.4 V_{DC}, V_{RL} = 5 V_{DC}, $R_L = 5.1\ k\Omega$		300		ns
Response time(3)	V_{RL} = 5 V_{DC}, $R_L = 5.1\ k\Omega$		1.3		µs
Output sink current	$V_{IN(-)}$= 1 V_{DC}, $V_{IN(+)} = 0$, $V_O \leq 1.5\ V_{DC}$	6	16		mA_{DC}
Saturation voltage	$V_{IN(-)}$ = 1 V_{DC}, $V_{IN(+)} = 0$, $I_{SINK} \leq 4$ mA		250	400	mV_{DC}
	$V_{IN(-)}$ = 1 V_{DC}, $V_{IN(+)} = 0$, $I_{SINK} \leq 4$ mA, 0°C ≤ T_A ≤ 70°C			700	
Output leakage current	$V_{IN(+)}$ = 1 V_{DC},$V_{IN(-)} = 0$, V_O = 5 V_{DC}		0.1		nA_{DC}
	$V_{IN(+)}$ = 1 V_{DC}, $V_{IN(-)} = 0$, V_O = 30 V_{DC}, 0°C ≤ T_A ≤ 70°C			1	μA_{DC}
Differential input voltage(4)	Keep all V_{IN}s ≥ 0 V_{DC} (or V–, if used), 0°C ≤ T_A ≤ 70°C			36	V_{DC}

(1) 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.
(2) The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. 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 30 V_{DC} without damage, independent of the magnitude of V+.
(3) The response time specified is a 100-mV input step with 5-mV overdrive. For larger overdrive signals 300 ns can be obtained, see typical performance characteristics section.
(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 −0.3 V_{DC} (or 0.3 V_{DC}below the magnitude of the negative power supply, if used) (at 25°C).

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6.6 Typical Characteristics

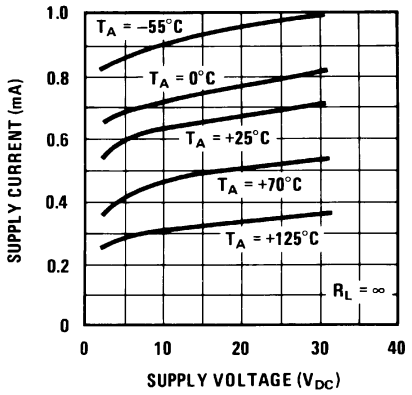


Figure 1. Supply Current

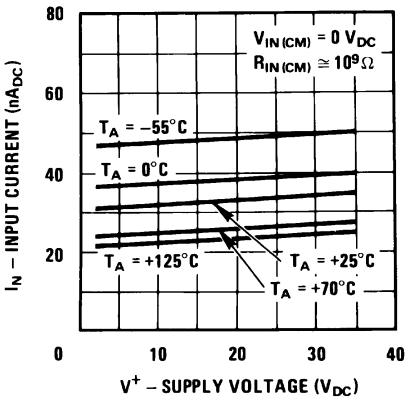


Figure 2. Input Current

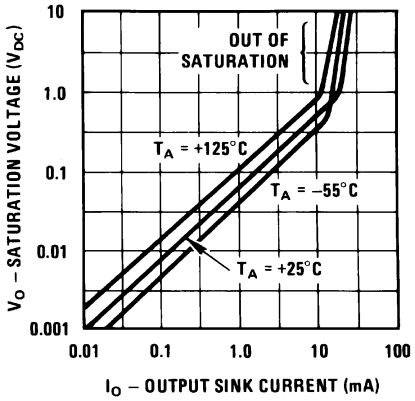


Figure 3. Output Saturation Voltage

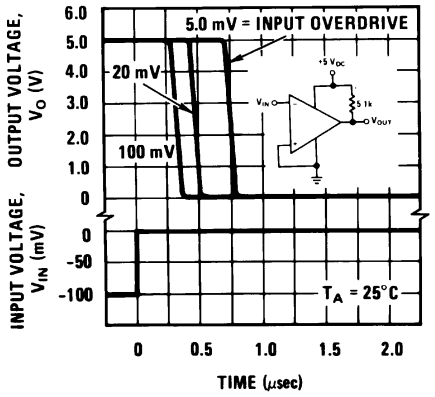


Figure 4. Response Time for Various Input Overdrives—Negative Transition

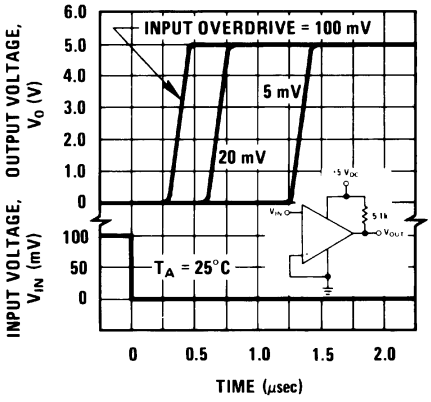


Figure 5. Response Time for Various Input Overdrives—Positive Transition

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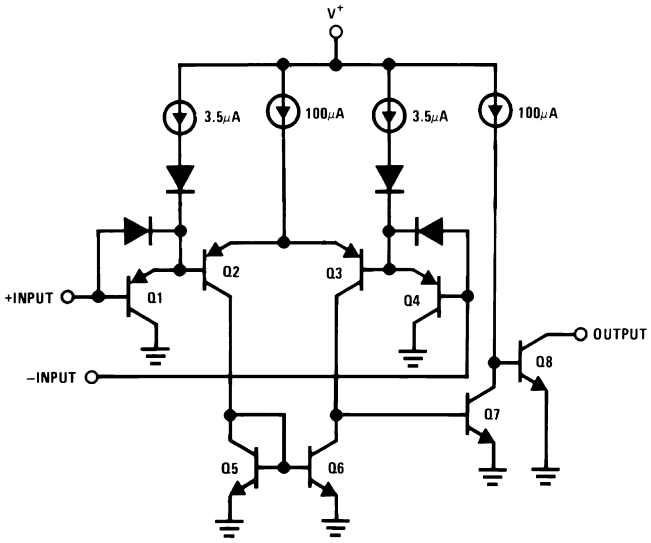
7 Detailed Description

7.1 Overview

The LM339-MIL device is a monolithic quad of independently functioning comparators designed to meet the requirements for a medium-speed, TTL-compatible comparator for industrial applications. Because no antisaturation clamps are used on the output, such as a Baker clamp or other active circuitry, the output leakage current in the OFF state is typically 0.1 nA. This OFF-state current level makes the device ideal for system applications where switching a node to ground while leaving it totally unaffected in the OFF state is desired. Other features include single supply, low-voltage operation with an input common mode range from ground up to approximately one volt below V_{CC} . The output is an uncommitted collector so it may be used with a pullup resistor and a separate output supply to give switching levels from any voltage up to 36 V down to a V CE SAT above ground (approximately 100 mV), sinking currents up to 16 mA. The open-collector output configuration allows the device to be used in wired-OR configurations, such as a window comparators.

The device can also be used as a single pole switch to ground, leaving the switched node unaffected while in the OFF state. Power dissipation with all four comparators in the OFF state is typically 4 mW from a single 5-V supply (1 mW/comparator).

7.2 Functional Block Diagram



7.3 Feature Description

The LM339-MIL device is a high-gain, wide bandwidth device which, like most comparators, can easily oscillate if the output lead is inadvertently allowed to capacitively couple to the inputs through stray capacitance. This shows up only during the output voltage transition intervals as the comparator changes states. Reducing the input resistors to < 10 kΩ reduces the feedback signal levels and finally, adding even a small amount (1 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.

The differential input voltage may be larger than V+ without damaging the device. 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 the *Application and Implementation* section.

The output of the LM339-MIL device is the uncommitted collector of a grounded-emitter NPN output transistor. Many collectors can be tied together to provide an output ORing 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 because of the magnitude of the voltage which is applied to the V+ pin. The output can also be used as a simple SPST switch to ground (when a pullup resistor is not used). The amount of current

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Feature Description (continued)

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 (4 mV) allows the output to clamp essentially to ground level for small load currents.

7.4 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 noninverting (+IN) input is greater than the inverting (-IN) input. The output is LOW when the voltage on the noninverting (+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.

The bias network of the LM339-MIL device establishes a drain current which is independent of the magnitude of the power supply voltage over the range of from 2 V_{DC} to 30 V_{DC}.

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8 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.

8.1 Application Information

The LM339-MIL device is specified for operation from 2 V to 36 V (±1 V to ±18 V) over the temperature range of 0°C to 70°C. While it may seem like a comparator has a well-defined and somewhat limited functionality as a *1-bit ADC*, a comparator is a versatile component which can be used for many functions.

8.2 Typical Application

8.2.1 Basic Comparator

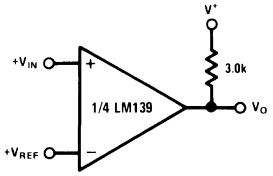


Figure 6. Basic Comparator Schematic

8.2.1.1 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 is tied to a reference voltage, and the positive input is connected to the input signal. The output is pulled up with a resistor to the logic supply voltage, V+.

For an example application, the supply voltage is 5 V. The input signal varies between 1 V and 3 V. Specifically as an example, to know when the input exceeds 2.5 V, set the V_{REF} voltage to 2.5 V.

8.2.1.2 Application Curve

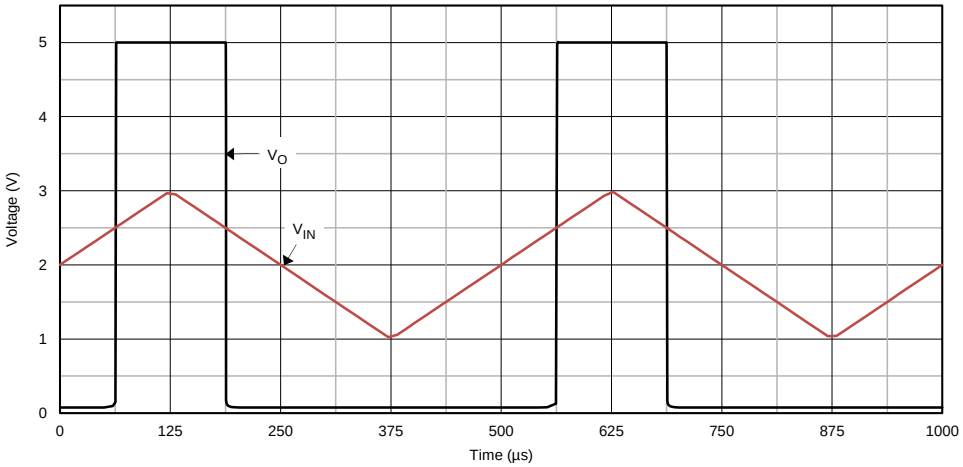


Figure 7. Basic Comparator Response

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8.3 System Examples

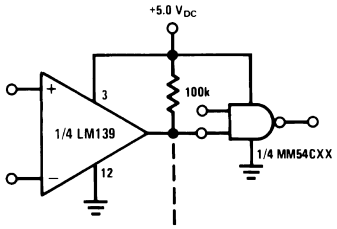


Figure 8. Driving CMOS ($V+ = 5\ V_{DC}$)

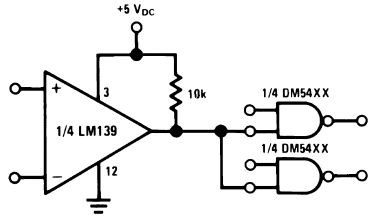


Figure 9. Driving TTL ($V+ = 5\ V_{DC}$)

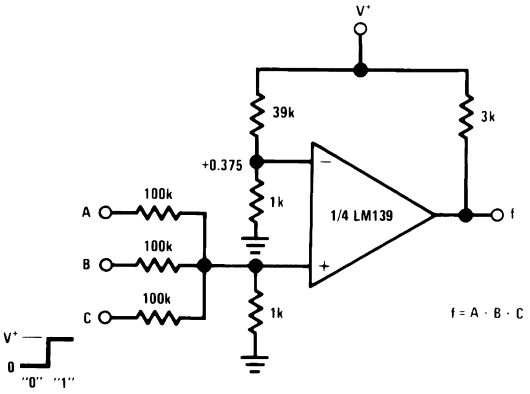


Figure 10. AND Gate ($V+ = 5\ V_{DC}$)

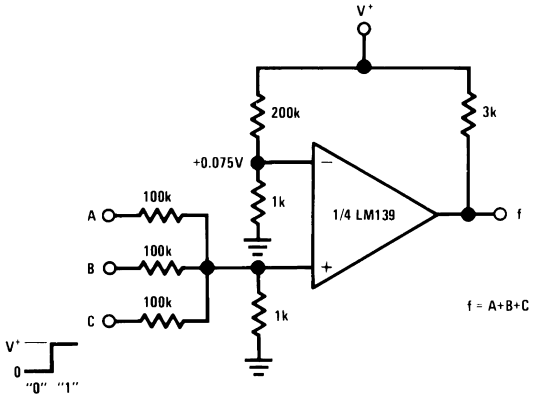


Figure 11. OR Gate ($V+ = 5\ V_{DC}$)

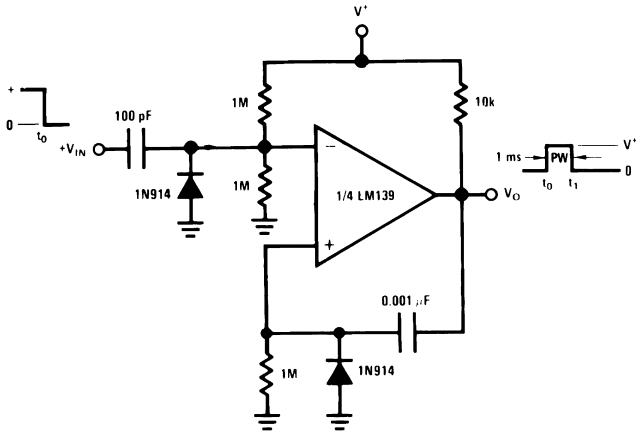


Figure 12. One-Shot Multivibrator ($V+= 15\ V_{DC}$)

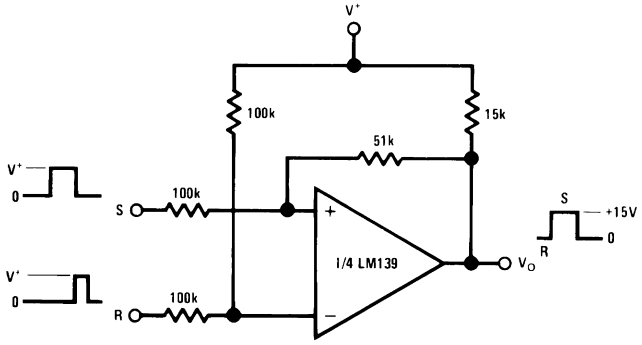


Figure 13. Bi-Stable Multivibrator ($V+= 15\ V_{DC}$)

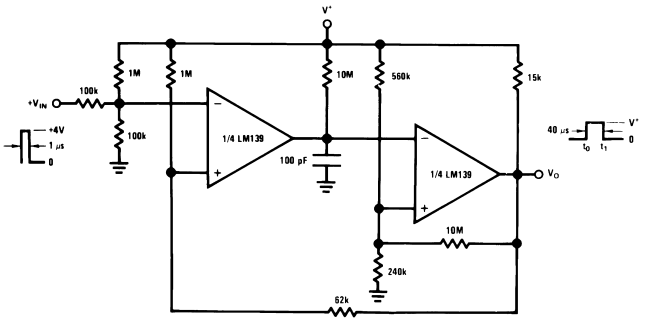


Figure 14. One-Shot Multivibrator With Input Lockout
(V+= 15 V_{DC})

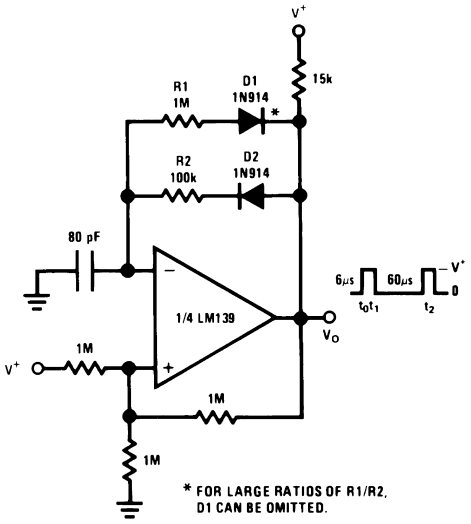


Figure 15. Pulse Generator
(V+= 15 V_{DC})

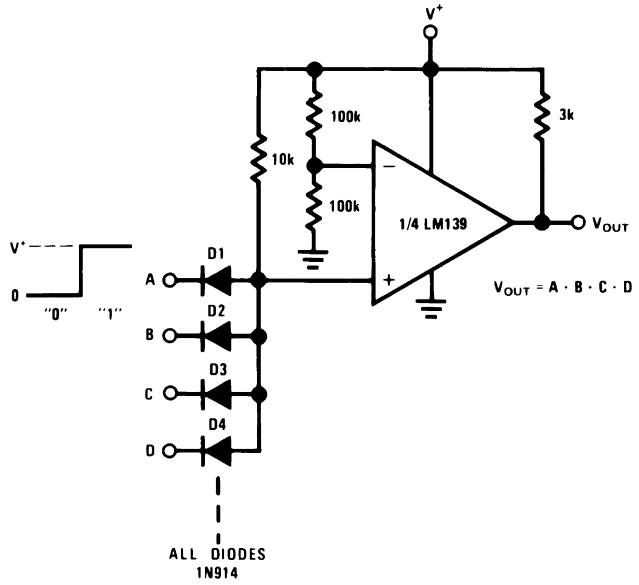


Figure 16. Large Fan-In AND Gate
(V+= 15 V_{DC})

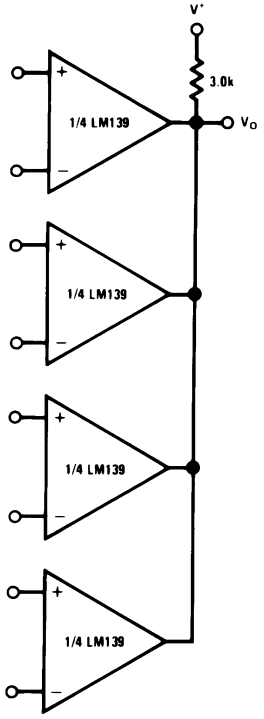


Figure 17. ORing the Outputs
(V+= 15 V_{DC})

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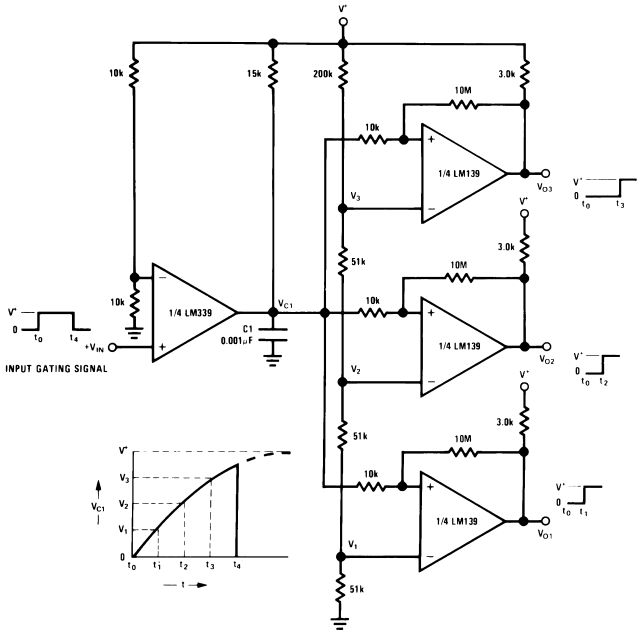


Figure 18. Time Delay Generator

(V+= 15 V_{DC})

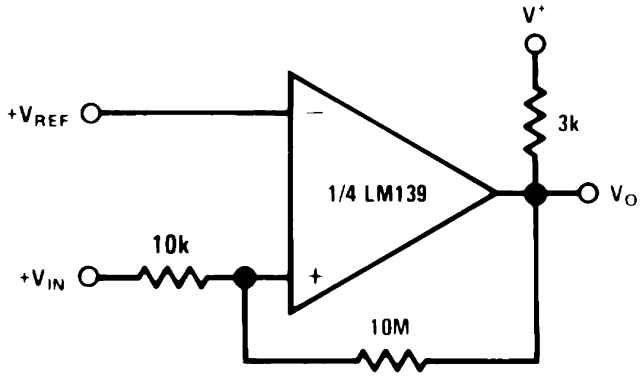


Figure 19. Noninverting Comparator with Hysteresis
(V+= 15 V_{DC})

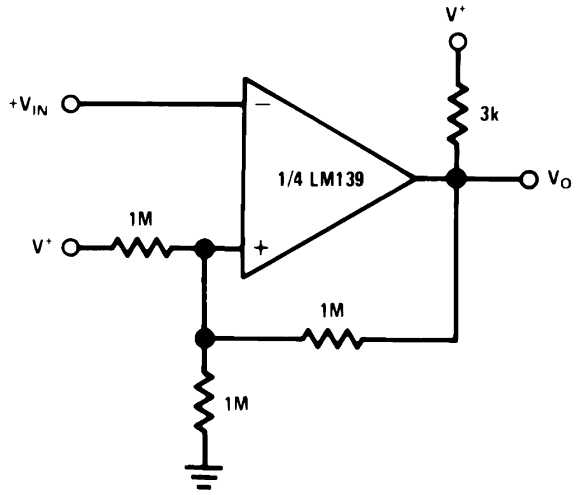


Figure 20. Inverting Comparator With Hysteresis
(V+= 15 V_{DC})

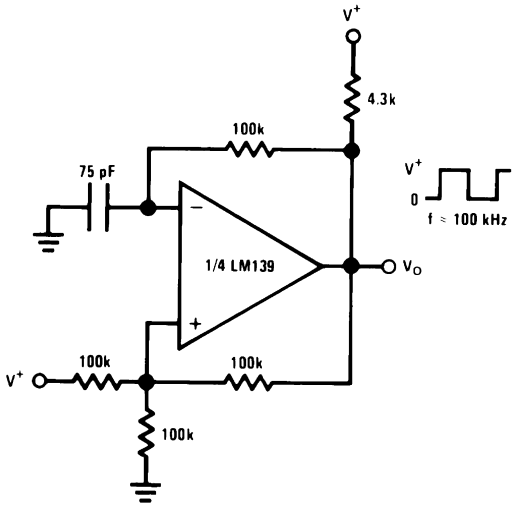


Figure 21. Squarewave Oscillator
(V+= 15 V_{DC})

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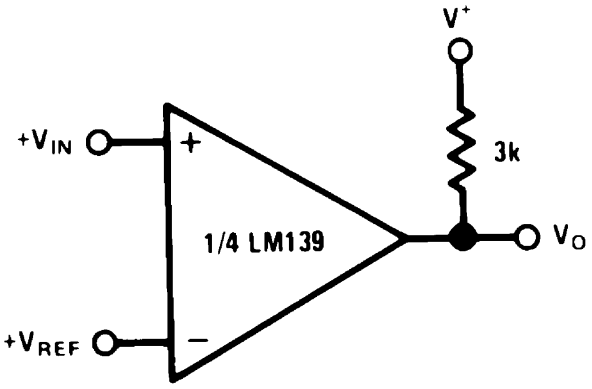


Figure 22. Basic Comparator
(V+= 15 V_{DC})

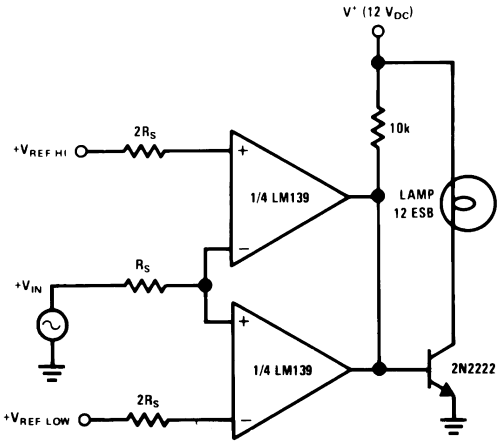


Figure 23. Limit Comparator
(V+= 15 V_{DC})

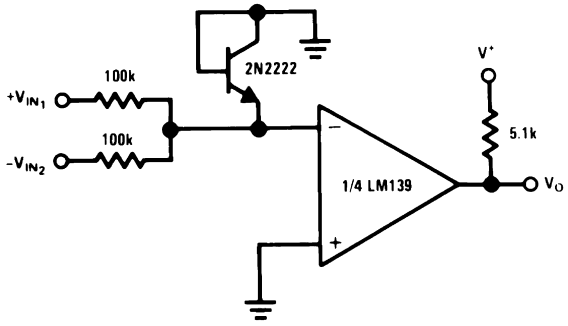
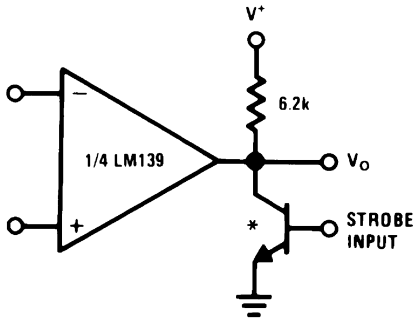


Figure 24. Comparing Input Voltages of Opposite Polarity
(V+= 15 V_{DC})



* Or open-collector logic gate without pullup resistor

Figure 25. Output Strobing
(V+= 15 V_{DC})

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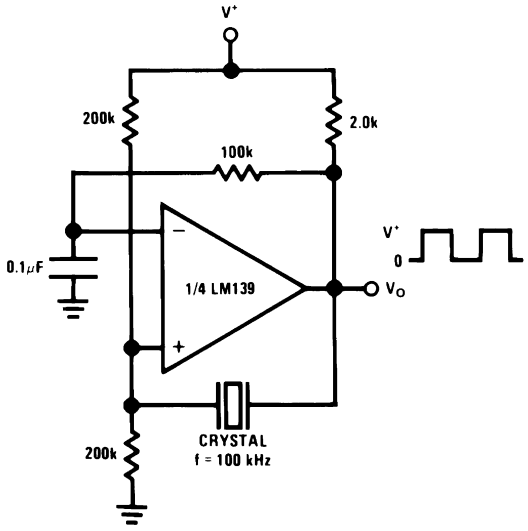
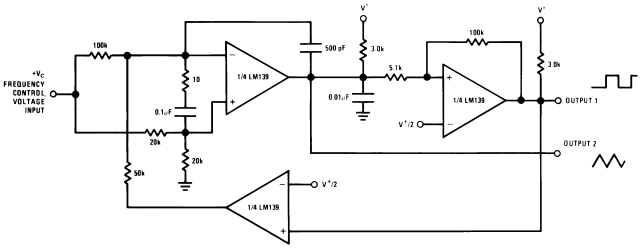


Figure 26. Crystal Controlled Oscillator

(V+= 15 V_{DC})



250 $mV_{DC} \le V_C \le +50\ V_{DC}$

700 Hz ≤ f_O ≤ 100 kHz

Figure 27. Two-Decade High-Frequency VCO
V+ = +30 V_{DC}

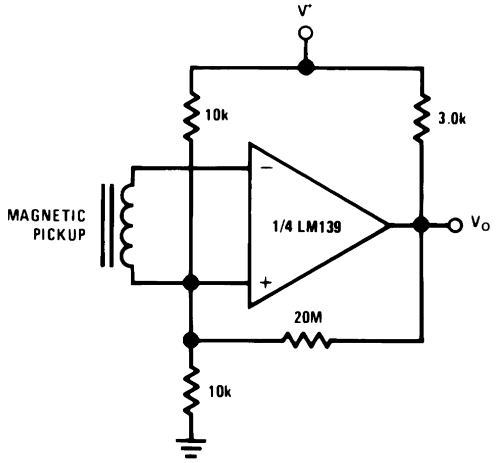


Figure 28. Transducer Amplifier
(V+= 15 V_{DC})

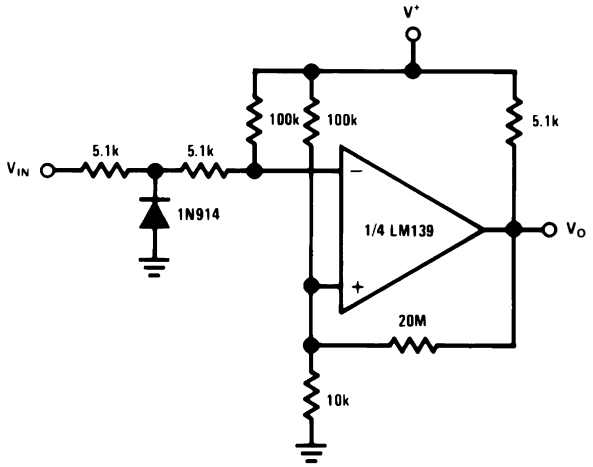


Figure 29. Zero Crossing Detector (Single Power Supply)
(V+= 15 V_{DC})

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8.3.1 Split-Supply Applications

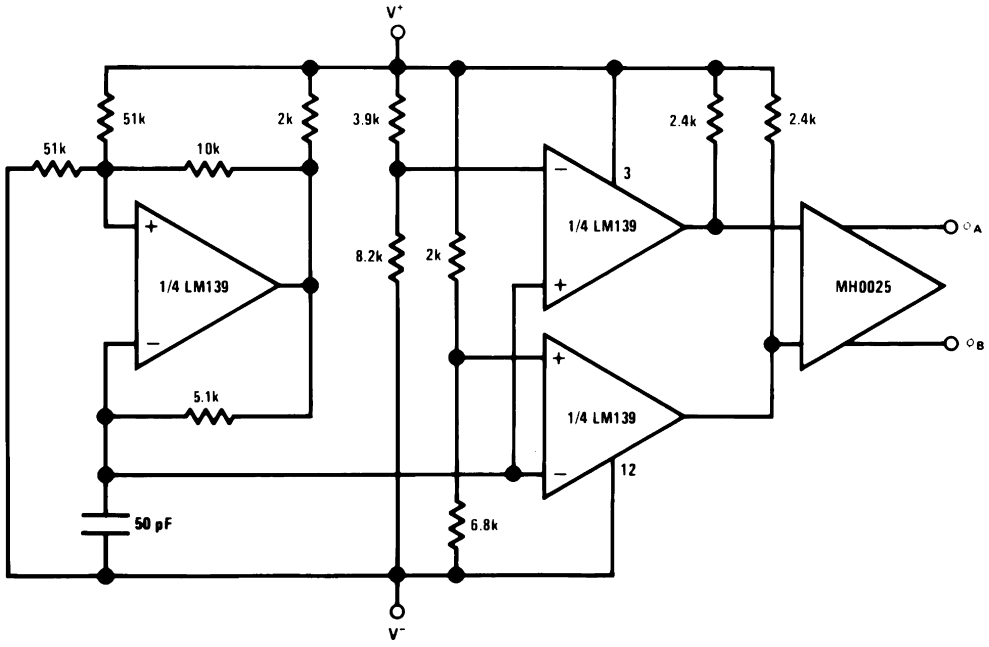


Figure 30. MOS Clock Driver
(V+ = +15 V_{DC} and V– = −15 V_{DC})

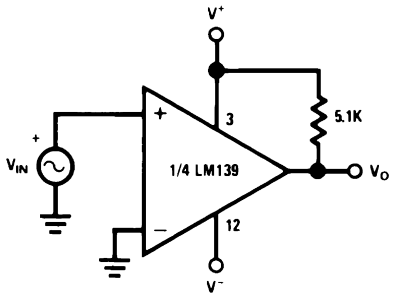


Figure 31. Zero Crossing Detector
(V+ = +15 V_{DC} and V– = −15 V_{DC})

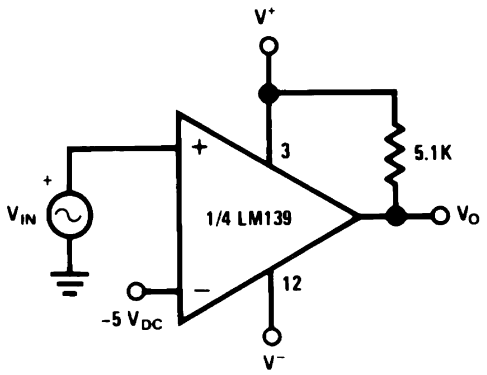


Figure 32. Comparator With a Negative Reference
(V+ = +15 V_{DC} and V– = −15 V_{DC})

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9 Power Supply Recommendations

Even in low-frequency applications, the device can have internal transients which are extremely quick. For this reason, bypassing the power supply with a 1-µF capacitor 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 capacitors should have a low ESR.

10 Layout

10.1 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. Ensure that the output pins do not couple to the inputs which can occur through capacitive coupling if the traces are too close and lead to oscillations on the output.

The optimum bypass capacitor placement is closest to the V+ and ground pins. 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.

10.2 Layout Example

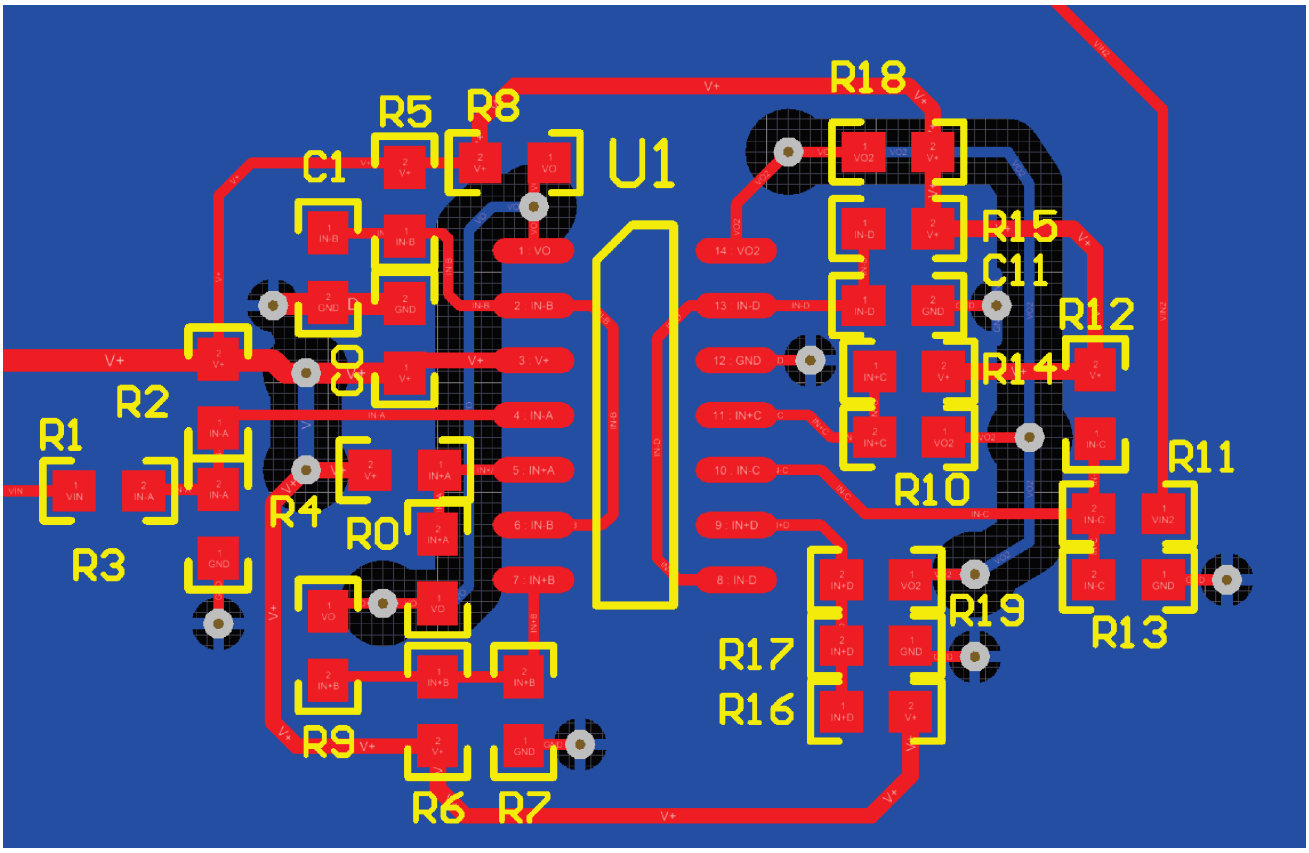


Figure 33. Layout Example

11 デバイスおよびドキュメントのサポート

11.1 ドキュメントのサポート

11.1.1 関連資料

関連資料については、以下を参照してください：

テキサス・インスツルメンツ、*『AN-74 LM139/LM239/LM339 独立に動作する4つのコンパレータ』アプリケーション・レポート*

11.2 ドキュメントの更新通知を受け取る方法

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11.3 コミュニティ・リソース

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11.6 Glossary

SLYZ022 — *TI Glossary*.

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

12 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。

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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)
LM339J	Active	Production	CDIP (J) | 14	25 | TUBE	No	SNPB	Level-1-NA-UNLIM	0 to 70	LM339J
LM339J.A	Active	Production	CDIP (J) | 14	25 | TUBE	No	SNPB	Level-1-NA-UNLIM	0 to 70	LM339J

(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.

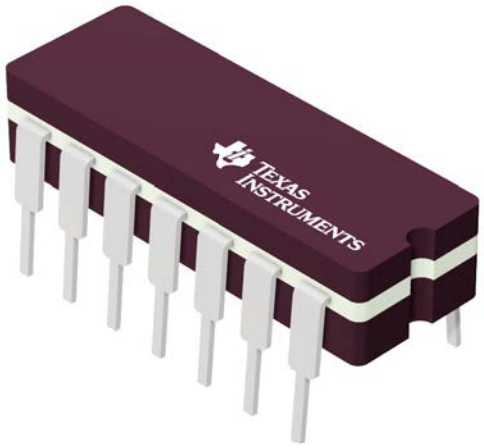
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GENERIC PACKAGE VIEW

J 14 CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4040083-5/G

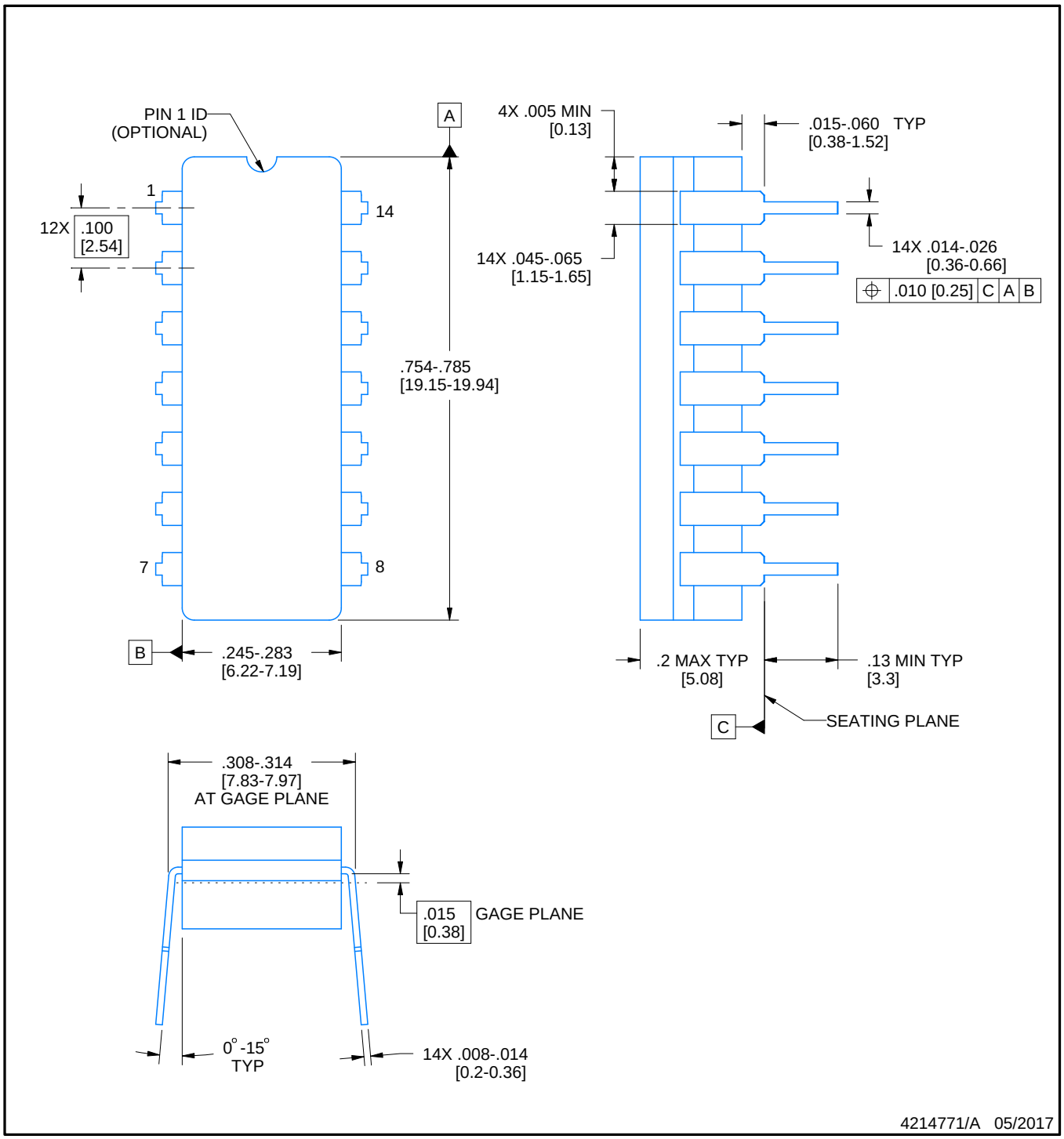


PACKAGE OUTLINE

J0014A

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



NOTES:

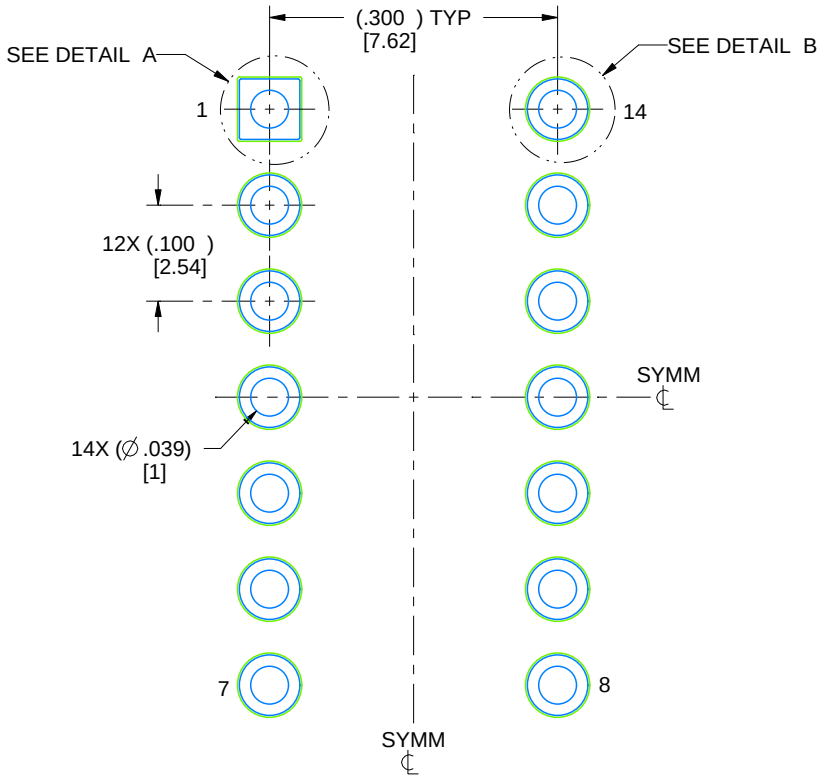
1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermitically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification only and on press ceramic glass frit seal only.
5. Falls within MIL-STD-1835 and GDIP1-T14.

EXAMPLE BOARD LAYOUT

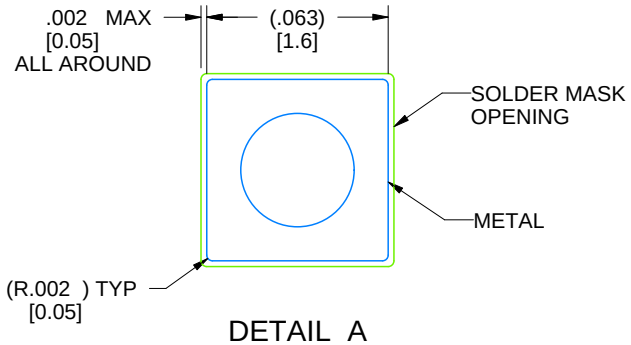
J0014A

CDIP - 5.08 mm max height

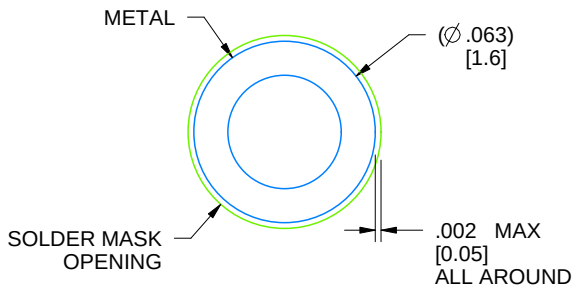
CERAMIC DUAL IN LINE PACKAGE



LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE: 5X



DETAIL A
SCALE: 15X



DETAIL B
13X, SCALE: 15X

4214771/A 05/2017

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