# LM741-MIL オペアンプ

## 1 特長

- 入力および出力の過負荷保護
- 同相範囲の超過時にラッチアップなし

## 2 アプリケーション

- コンパレータ
- マルチバイブレータ
- DCアンプ
- 加算アンプ
- 積分器または微分器
- アクティブ・フィルタ

## 3 概要

LM741-MILは汎用オペアンプで、LM709など業界標準の製品と比べて性能が向上しています。ほとんどのアプリケーションにおいて、709C、LM201、MC1439、748の直接プラグイン代替品として使用できます。

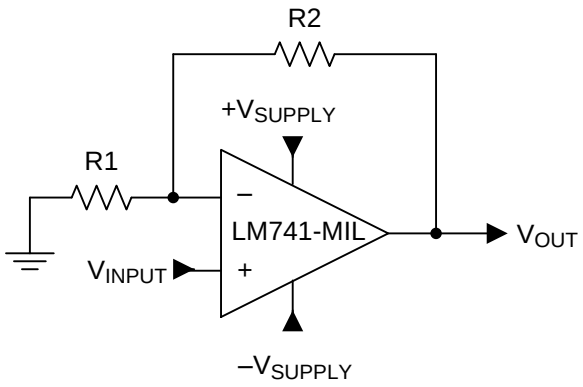
このアンプには、入力と出力の過負荷保護、同相範囲を超過したときにラッチアップが発生しない、発振の影響を受けないなど多くの特長があり、アプリケーションの誤使用をほぼ完全に防止できます。

**製品情報(1)**

| 型番 | パッケージ | 本体サイズ(公称) |
|---|---|---|
| LM741-MIL | TO-99 (8) | 9.08mm×9.08mm |
| | CDIP (8) | 10.16mm×6.502mm |
| | PDIP (8) | 9.81mm×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。

**アプリケーション概略図**



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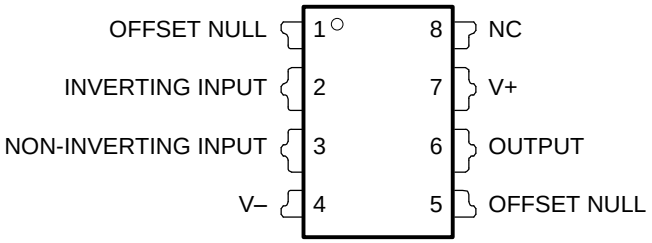
## 4 改訂履歴

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。

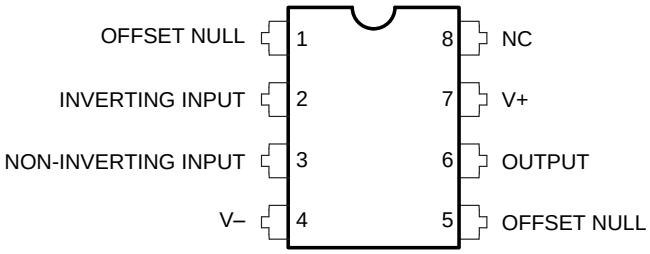
| 日付 | 改訂内容 | 注 |
|---|---|---|
| 2017年6月 | * | 初版 |

# 5 Pin Configuration and Functions

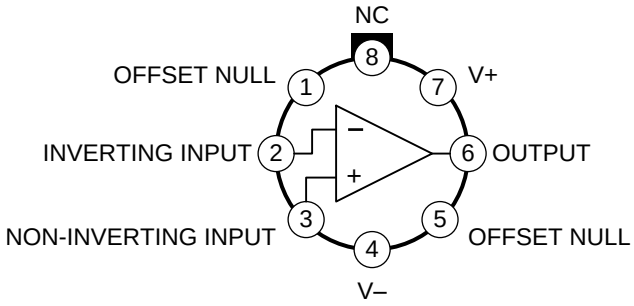
**P Package**
**8-Pin PDIP**
**Top View**




**NAB Package**
**8-Pin CDIP**
**Top View**




**LMC Package**
**8-Pin TO-99**
**Top View**




**Pin Functions**

| PIN | | I/O | DESCRIPTION |
|---|---|---|---|
| NAME | NO. | | |
| INVERTING INPUT | 2 | I | Inverting signal input |
| NC | 8 | N/A | No Connect, leave floating |
| NONINVERTING INPUT | 3 | I | Noninverting signal input |
| OFFSET NULL | 1 | I | Offset null pin used to eliminate the offset voltage and balance the input voltages. |
| OFFSET NULL | 5 | | |
| OUTPUT | 6 | O | Amplified signal output |
| V+ | 7 | I | Positive supply voltage |
| V– | 4 | I | Negative supply voltage |

# 6 Specifications

## 6.1 Absolute Maximum Ratings

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

| | MIN | MAX | UNIT |
|---|---|---|---|
| Supply voltage | | ±22 | V |
| Power dissipation (4) | | 500 | mW |
| Differential input voltage | | ±30 | V |
| Input voltage (5) | | ±15 | V |
| Output short circuit duration | Continuous | | |
| Operating temperature | –50 | 125 | °C |
| Junction temperature, $T_{J(max)}$ | | 150 | °C |
| 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 specified in the *Recommended Operating Conditions* table. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) For military specifications see RETS741X for LM741-MIL and RETS741AX for LM741-MILA.
(3) If Military/Aerospace specified devices are required, please contact the TI Sales Office/Distributors for availability and specifications.
(4) For operation at elevated temperatures, these devices must be derated based on thermal resistance, and $T_{J(max)}$. (listed in the *Absolute Maximum Ratings* table). $T_j = T_A + (\theta_{JA} \times P_D)$.
(5) For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.

## 6.2 ESD Ratings

| | | | VALUE | UNIT |
|---|---|---|---|---|
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per ANSI/ESDA/JEDEC JS-001(1) | ±400 | V |

(1) Level listed above is the passing level per ANSI, ESDA, and JEDEC JS-001. JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

## 6.3 Recommended Operating Conditions

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

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| Supply voltage (VDD-GND) | | ±10 | ±15 | ±22 | V |
| Temperature | | –55 | | 125 | °C |

## 6.4 Thermal Information

| THERMAL METRIC(1) | | LM741-MIL | | | UNIT |
|---|---|---|---|---|---|
| | | LMC (TO-99) | NAB (CDIP) | P (PDIP) | |
| | | 8 PINS | 8 PINS | 8 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 170 | 100 | 100 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 25 | — | — | °C/W |

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

## 6.5 Electrical Characteristics

$V_S$ = ±15 V, −55°C ≤ $T_A$ ≤ 125°C (unless otherwise specified)

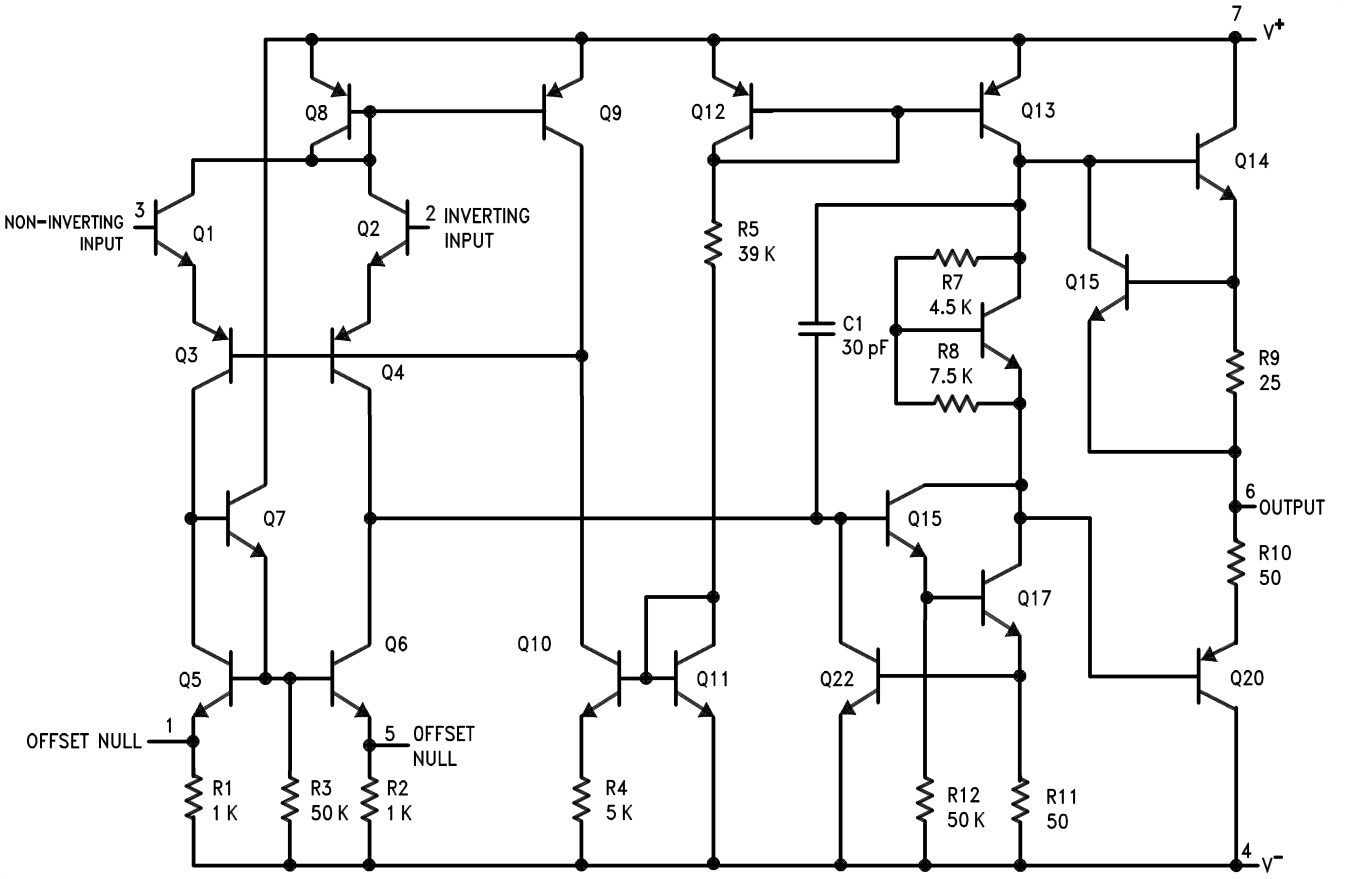
| PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| Input offset voltage | | $R_S$ ≤ 10 kΩ | $T_A$ = 25°C | | 1 | 5 | mV |
| | | | | | | 6 | mV |
| Input offset voltage adjustment range | | $T_A$ = 25°C, $V_S$ = ±20 V | | | ±15 | | mV |
| Input offset current | | $T_A$ = 25°C | | | 20 | 200 | nA |
| | | | | | 85 | 500 | |
| Input bias current | | $T_A$ = 25°C | | | 80 | 500 | nA |
| | | | | | | 1.5 | μA |
| Input resistance | | $T_A$ = 25°C, $V_S$ = ±20 V | | 0.3 | 2 | | MΩ |
| Input voltage range | | | | ±12 | ±13 | | V |
| Large signal voltage gain | | $V_S$ = ±15 V, $V_O$ = ±10 V, $R_L$ ≥ 2 kΩ | $T_A$ = 25°C | 50 | 200 | | V/mV |
| | | | | 25 | | | |
| Output voltage swing | | $V_S$ = ±15 V | $R_L$ ≥ 10 kΩ | ±12 | ±14 | | V |
| | | | $R_L$ ≥ 2 kΩ | ±10 | ±13 | | |
| Output short circuit current | | $T_A$ = 25°C | | | 25 | | mA |
| Common-mode rejection ratio | | $R_S$ ≤ 10 Ω, $V_{CM}$ = ±12 V | | 80 | 95 | | dB |
| Supply voltage rejection ratio | | $V_S$ = ±20 V to $V_S$ = ±5 V, $R_S$ ≤ 10 Ω | | 86 | 96 | | dB |
| Transient response | Rise time | $T_A$ = 25°C, unity gain | | | 0.3 | | μs |
| | Overshoot | | | | 5% | | |
| Slew rate | | $T_A$ = 25°C, unity gain | | | 0.5 | | V/μs |
| Supply current | | $T_A$ = 25°C | | | 1.7 | 2.8 | mA |
| Power consumption | | $V_S$ = ±15 V | $T_A$ = 25°C | | 50 | 85 | mW |
| | | | $T_A$ = $T_{A(min)}$ | | 60 | 100 | |
| | | | $T_A$ = $T_{A(min)}$ | | 45 | 75 | |

# 7 Detailed Description

## 7.1 Overview

The LM741-MIL device is a general-purpose operational amplifier which features improved performance over industry standards such as the LM709. It is intended for a wide range of analog applications. The high gain and wide range of operating voltage provide superior performance in integrator, summing amplifier, and general feedback applications. The LM741-MIL operates with either a single or dual power supply voltage. The LM741-MIL device is a direct, plug-in replacement for the 709C, LM201, MC1439, and 748 in most applications.

## 7.2 Functional Block Diagram




## 7.3 Feature Description

### 7.3.1 Overload Protection

The LM741-MIL features overload protection circuitry on the input and output. This prevents possible circuit damage to the device.

### 7.3.2 Latch-up Prevention

The LM741-MIL is designed so that there is no latch-up occurrence when the common-mode range is exceeded. This allows the device to function properly without having to power cycle the device.

### 7.3.3 Pin-to-Pin Capability

The LM741-MIL is a pin-to-pin direct replacement for the LM709C, LM201, MC1439, and LM748 in most applications. Direct replacement capabilities allows flexibility in design for replacing obsolete parts.

## 7.4 Device Functional Modes

### 7.4.1 Open-Loop Amplifier

The LM741-MIL can be operated in an open-loop configuration. The magnitude of the open-loop gain is typically large thus for a small difference between the non-inverting input terminals and the inverting input terminals, the amplifier output is driven near the supply voltage. Without negative feedback, the LM741-MIL can act as a comparator. If the inverting input is held at 0 V, and the input voltage applied to the non-inverting input is positive, the output will be positive. If the input voltage applied to the non-inverting input is negative, the output is negative.

### 7.4.2 Closed-Loop Amplifier

In a closed-loop configuration, negative feedback is used by applying a portion of the output voltage to the inverting input. Unlike the open-loop configuration, closed loop feedback reduces the gain of the circuit. The overall gain and response of the circuit is determined by the feedback network rather than the operational amplifier characteristics. The response of the operational amplifier circuit is characterized by the transfer function.

# 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 LM741-MIL is a general-purpose amplifier than can be used in a variety of applications and configurations. One common configuration is in a non-inverting amplifier configuration. In this configuration, the output signal is in phase with the input (not inverted as in the inverting amplifier configuration), the input impedance of the amplifier is high, and the output impedance is low. The characteristics of the input and output impedance is beneficial for applications that require isolation between the input and output. No significant loading will occur from the previous stage before the amplifier. The gain of the system is set accordingly so the output signal is a factor larger than the input signal.

## 8.2 Typical Application

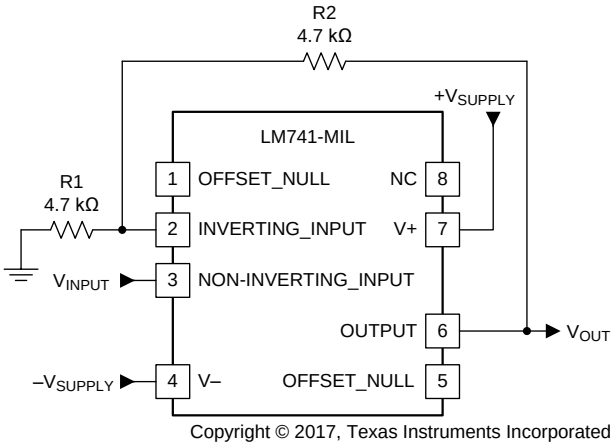



**Figure 1. LM741-MIL Noninverting Amplifier Circuit**

### 8.2.1 Design Requirements

As shown in Figure 1, the signal is applied to the noninverting input of the LM741-MIL. The gain of the system is determined by the feedback resistor and input resistor connected to the inverting input. The gain can be calculated by Equation 1:

$$\text{Gain} = 1 + (R2/R1) \quad (1)$$

The gain is set to 2 for this application. R1 and R2 are 4.7-kΩ resistors with 5% tolerance.

### 8.2.2 Detailed Design Procedure

The LM741-MIL can be operated in either single supply or dual supply. This application is configured for dual supply with the supply rails at ±15 V. The input signal is connected to a function generator. A 1-$V_{PP}$, 10-kHz sine wave was used as the signal input. 5% tolerance resistors were used, but if the application requires an accurate gain response, use 1% tolerance resistors.

### 8.2.3 Application Curve

The waveforms in Figure 2 show the input and output signals of the LM741-MIL non-inverting amplifier circuit. The blue waveform (top) shows the input signal, while the red waveform (bottom) shows the output signal. The input signal is 1.06 $V_{P-P}$ and the output signal is 1.94 $V_{P-P}$. With the 4.7-kΩ resistors, the theoretical gain of the system is 2. Due to the 5% tolerance, the gain of the system including the tolerance is 1.992. The gain of the system when measured from the mean amplitude values on the oscilloscope was 1.83.

## Typical Application (continued)

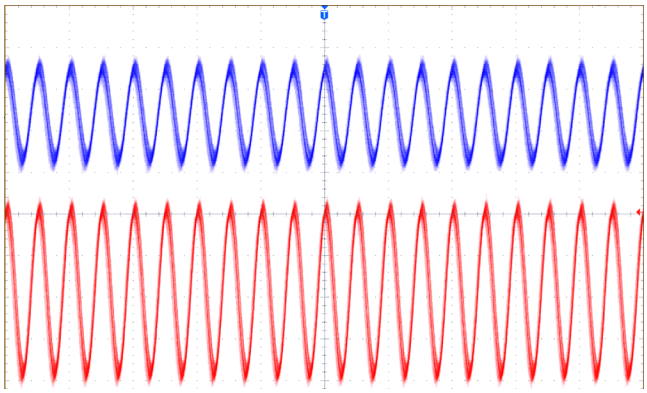


**Figure 2. Waveforms for LM741-MIL Non-inverting Amplifier Circuit**

# 9 Power Supply Recommendations

For proper operation, the power supplies must be properly decoupled. For decoupling the supply lines, a 0.1-µF capacitor is recommended and should be placed as close as possible to the LM741-MIL power supply pins.

# 10 Layout

## 10.1 Layout Guidelines

As with most amplifiers, take care with lead dress, component placement, and supply decoupling in order to ensure stability. For example, resistors from the output to an input should be placed with the body close to the input to minimize pick-up and maximize the frequency of the feedback pole by minimizing the capacitance from the input to ground. As shown in Figure 3, the feedback resistors and the decoupling capacitors are located close to the device to ensure maximum stability and noise performance of the system.

## 10.2 Layout Example

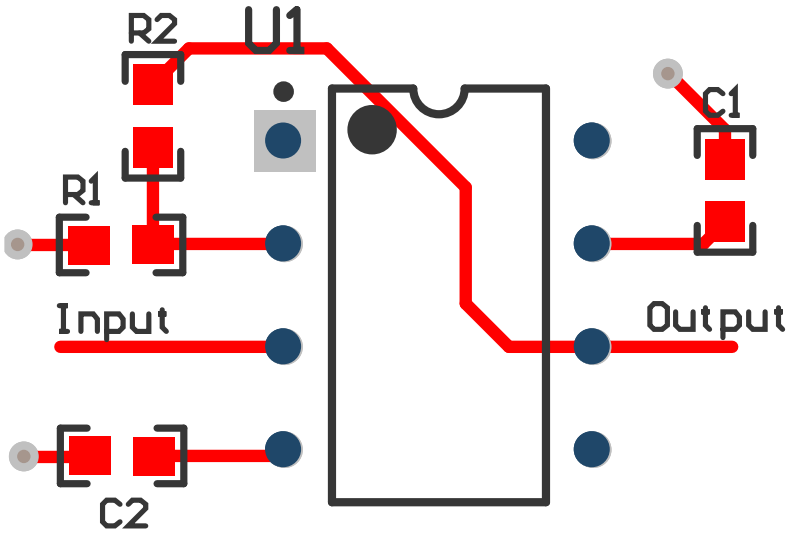



**Figure 3. LM741-MIL Layout**

# 11 デバイスおよびドキュメントのサポート

## 11.1 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.comのデバイス製品フォルダを開いてください。右上の隅にある「*通知を受け取る*」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

## 11.2 コミュニティ・リソース

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

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**設計サポート** ***TIの設計サポート*** **役に立つ**E2E**フォーラムや、設計サポート・ツールをすばやく見つけることができます。技術サポート用の連絡先情報も参照できます。**

## 11.3 商標

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## 11.4 静電気放電に関する注意事項

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## 11.5 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。

## 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) |
|---|---|---|---|---|---|---|---|---|---|
| LM741CH | Active | Production | TO-99 (LMC) \| 8 | 500 \| OTHER | No | Call TI | Level-1-NA-UNLIM | 0 to 70 | ( LM741CH, LM741CH ) |
| LM741CH/NOPB | Active | Production | TO-99 (LMC) \| 8 | 500 \| OTHER | Yes | Call TI | Level-1-NA-UNLIM | 0 to 70 | ( LM741CH, LM741CH ) |
| LM741H | Active | Production | TO-99 (LMC) \| 8 | 500 \| OTHER | No | Call TI | Level-1-NA-UNLIM | -55 to 125 | ( LM741H, LM741H) |
| LM741H/NOPB | Active | Production | TO-99 (LMC) \| 8 | 500 \| OTHER | Yes | Call TI | Level-1-NA-UNLIM | -55 to 125 | ( LM741H, LM741H) |
| LM741J | Active | Production | CDIP (NAB) \| 8 | 40 \| TUBE | No | SNPB | Level-1-NA-UNLIM | -55 to 125 | LM741J |
| U5B7741312 | Active | Production | TO-99 (LMC) \| 8 | 500 \| OTHER | No | Call TI | Level-1-NA-UNLIM | -55 to 125 | ( LM741H, LM741H) |
| U5B7741393 | Active | Production | TO-99 (LMC) \| 8 | 500 \| OTHER | No | Call TI | Level-1-NA-UNLIM | 0 to 70 | ( LM741CH, LM741CH ) |

(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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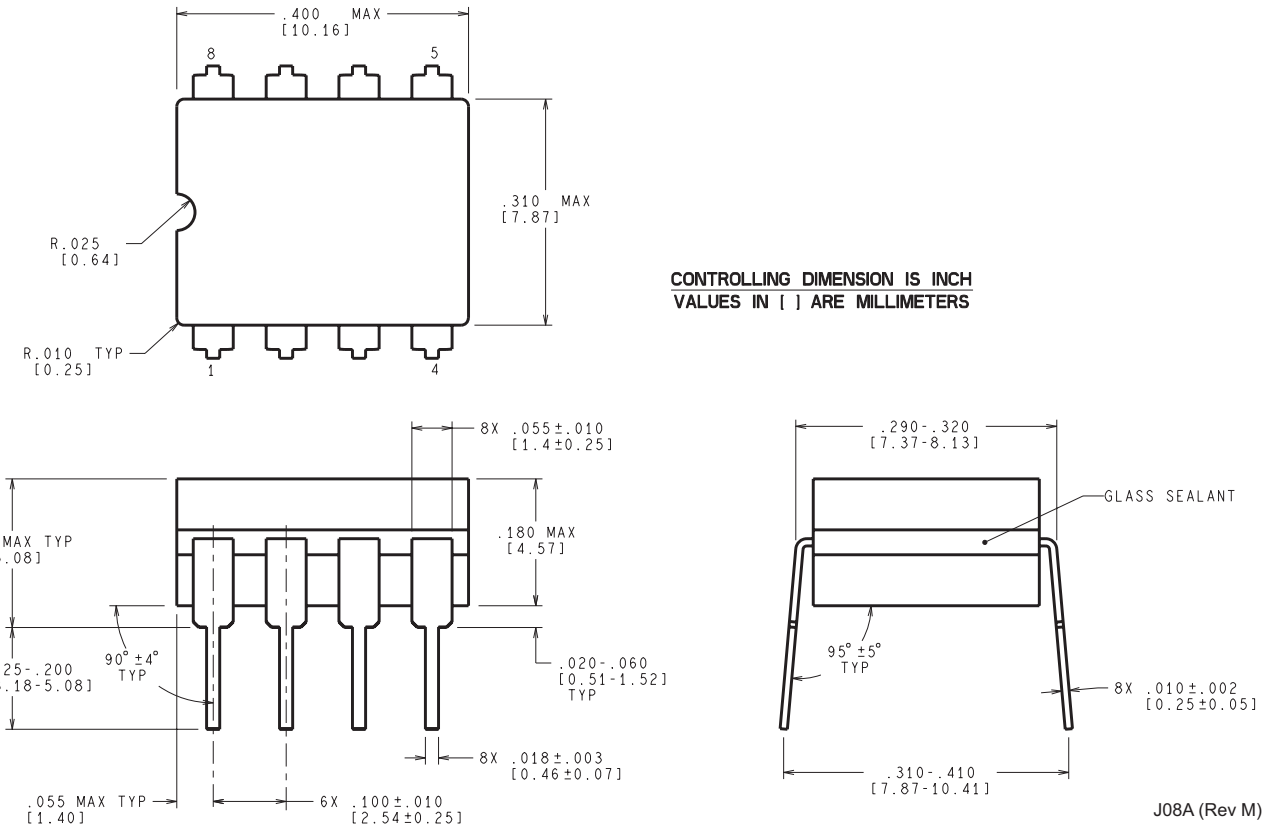
and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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.

# NAB0008A

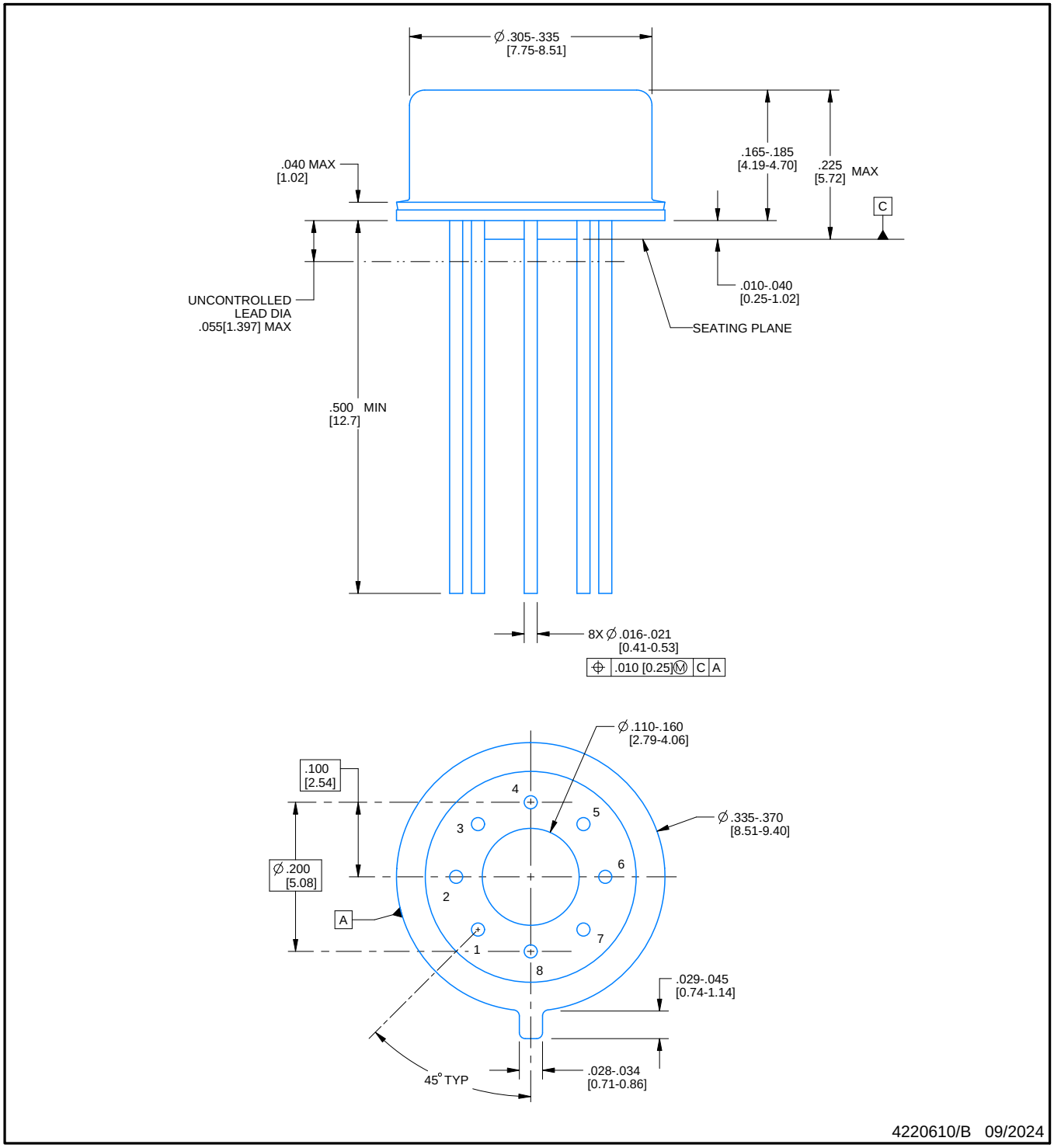

.400 MAX
[10.16]
8
5
.310 MAX
[7.87]
R.025
[0.64]
R.010 TYP
[0.25]
1
4
CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS
8X .055±.010
[1.4±0.25]
.200 MAX TYP
[5.08]
.180 MAX
[4.57]
8X .125-.200
[3.18-5.08]
90° ±4°
TYP
.020-.060
[0.51-1.52]
TYP
8X .018±.003
[0.46±0.07]
.055 MAX TYP
[1.40]
6X .100±.010
[2.54±0.25]
.290-.320
[7.37-8.13]
GLASS SEALANT
95° ±5°
TYP
8X .010±.002
[0.25±0.05]
.310-.410
[7.87-10.41]
J08A (Rev M)

# PACKAGE OUTLINE

## LMC0008A

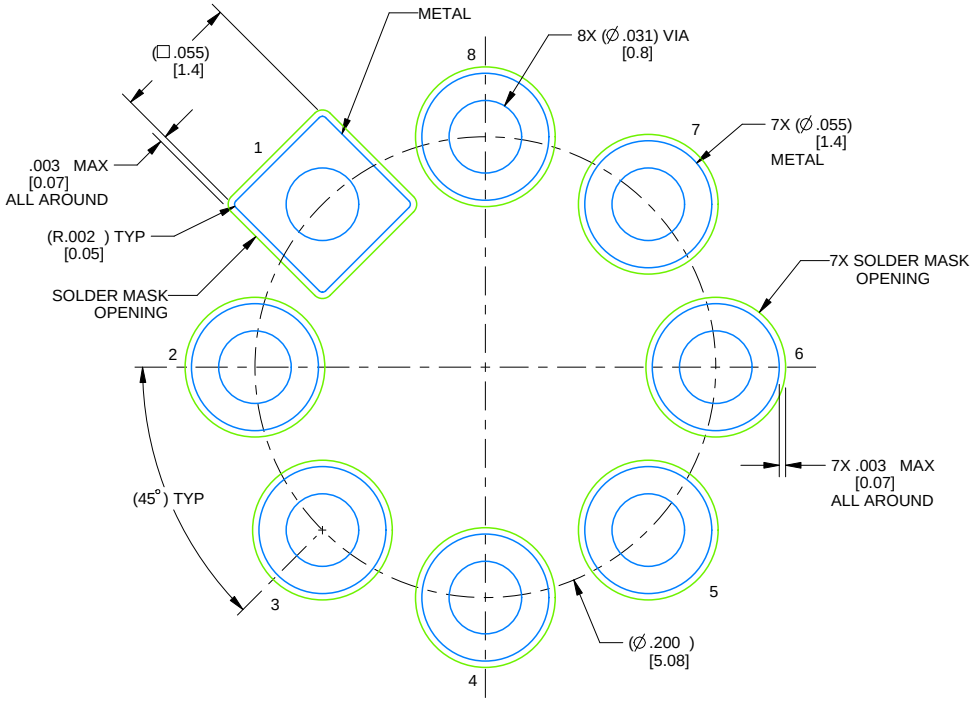
## TO-CAN - 5.72 mm max height

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

# 重要なお知らせと免責事項

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