



LM393-MIL デュアル差動コンパレータ

1 特長

- 単一電源またはデュアル電源
- 広い範囲の電源電圧
 - 最大定格: 2V～36V
 - 30Vでテスト
- 電源電圧に影響されない低い電源消費電流:
コンパレータごとに 0.4mA (標準値)
- 低い入力バイアス電流: 25nA (標準値)
- 低い入力オフセット電圧: 2mV (標準値)
- 同相入力電圧範囲にはグランドが含まれる
- 差動入力電圧範囲が最大定格電源電圧と
同じ: $\pm 36V$
- 低い出力飽和電圧
- TTL、MOS、CMOS互換出力
- MIL-PRF-38535準拠の製品については、特に記述
のない限り、すべてのパラメータはテスト済みで
す。
他のすべての製品については、量産プロセスにす
べてのパラメータのテストが含まれているとは限
りません。

2 アプリケーション

- 化学/ガス・センサ
- デスクトップPC
- モータ制御: AC誘導
- 重量計

3 概要

これらのデバイスは2つの独立した電圧コンパレータで構成され、広い電圧範囲の単一電源で動作するよう設計されています。デュアル電源での動作も可能です。この場合、2つの電源の差が2V～36Vで、 V_{CC} が入力同相電圧よりも1.5V以上高いことが条件です。消費電流は、電源電圧に依存しません。出力を他のオープン・コレクタ出力に接続し、ワイヤードAND関係を構築できます。

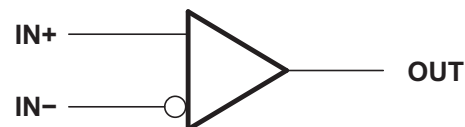
LM393-MILデバイスは、 $0^{\circ}C \sim 70^{\circ}C$ での動作が規定されています。

製品情報⁽¹⁾

型番	パッケージ	本体サイズ(公称)
LM393-MILD	SOIC (8)	4.90mm×6.00mm
LM393-MILDGK	VSSOP (8)	3.00mm×5.00mm
LM393-MILP	PDIP (8)	9.50mm×6.30mm
LM393-MILPS	SO (8)	6.20mm×7.90mm
LM393-MILPW	TSSOP (8)	6.40mm×3.00mm

(1) 提供されているすべてのパッケージについては、巻末の注文情報を参照してください。

概略回路図



目次

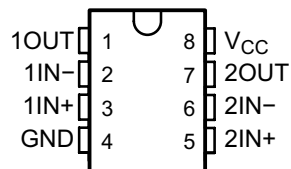
1	特長	1	7.3	Feature Description	7
2	アプリケーション	1	7.4	Device Functional Modes	7
3	概要	1	8	Application and Implementation	8
4	改訂履歴	2	8.1	Application Information	8
5	Pin Configuration and Functions	3	8.2	Typical Application	8
6	Specifications	4	9	Power Supply Recommendations	11
6.1	Absolute Maximum Ratings	4	10	Layout	11
6.2	ESD Ratings	4	10.1	Layout Guidelines	11
6.3	Recommended Operating Conditions	4	10.2	Layout Example	11
6.4	Thermal Information	4	11	デバイスおよびドキュメントのサポート	12
6.5	Electrical Characteristics	5	11.1	ドキュメントの更新通知を受け取る方法	12
6.6	Switching Characteristics	5	11.2	コミュニティ・リソース	12
6.7	Typical Characteristics	6	11.3	商標	12
7	Detailed Description	7	11.4	静電気放電に関する注意事項	12
7.1	Overview	7	11.5	Glossary	12
7.2	Functional Block Diagram	7	12	メカニカル、パッケージ、および注文情報	12

4 改訂履歴

日付	改訂内容	注
2017年6月	*	初版

5 Pin Configuration and Functions

D, DGK, P, PS, or PW
8-Pin SOIC, VSSOP, PDIP, SO, or TSSOP
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	SOIC, VSSOP, PDIP, SO, and TSSOP		
1OUT	1	Output	Output pin of comparator 1
1IN–	2	Input	Negative input pin of comparator 1
1IN+	3	Input	Positive input pin of comparator 1
GND	4	—	Ground
2IN+	5	Input	Positive input pin of comparator 2
2IN–	6	Input	Negative input pin of comparator 2
2OUT	7	Output	Output pin of comparator 2
V _{CC}	8	—	Supply Pin

6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V _{CC}	Supply voltage ⁽²⁾		36	V
V _{ID}	Differential input voltage ⁽³⁾		±36	V
V _I	Input voltage (either input)	–0.3	36	V
V _O	Output voltage		36	V
I _O	Output current		20	mA
	Duration of output short circuit to ground ⁽⁴⁾		Unlimited	
T _J	Operating virtual-junction temperature		300	°C
T _{stg}	Storage temperature	–65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values, except differential voltages, are with respect to network ground.
- (3) Differential voltages are at IN+ with respect to IN–.
- (4) Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

6.2 ESD Ratings

		VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	1000
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	750

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

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

		MIN	MAX	UNIT
V _{CC}		2	30	V
T _J	Operating junction temperature	–40	125	°C

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		LM393-MIL					UNIT
		D (SOIC)	DGK (VSSOP)	P (PDIP)	PS (SO)	PW (TSSOP)	
		8 PINS	8 PINS	8 PINS	8 PINS	8 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	97	172	85	95	149	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	—	—	—	—	—	°C/W

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

6.5 Electrical Characteristics

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

PARAMETER	TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{IO} Input offset voltage	$V_{CC} = 5\text{ V to }30\text{ V}$, $V_{IC} = V_{ICR\text{ min}}$, $V_O = 1.4\text{ V}$	$T_A = 25^\circ\text{C}$		2	5	mV
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$			9	
I_{IO} Input offset current	$V_O = 1.4\text{ V}$	$T_A = 25^\circ\text{C}$		5	50	nA
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$			250	
I_{IB} Input bias current	$V_O = 1.4\text{ V}$	$T_A = 25^\circ\text{C}$		–25	–250	nA
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$			–400	
V_{ICR} Common-mode input-voltage range ⁽¹⁾		$T_A = 25^\circ\text{C}$		0 to $V_{CC} - 1.5$		V
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$		0 to $V_{CC} - 2$		
A_{VD} Large-signal differential-voltage amplification	$V_{CC} = 15\text{ V}$, $V_O = 1.4\text{ V to }11.4\text{ V}$, $R_L \geq 15\text{ k}\Omega\text{ to }V_{CC}$	$T_A = 25^\circ\text{C}$		50	200	V/mV
I_{OH} High-level output current	$V_{OH} = 5\text{ V}$, $V_{ID} = 1\text{ V}$	$T_A = 25^\circ\text{C}$		0.1	50	nA
	$V_{OH} = 30\text{ V}$, $V_{ID} = 1\text{ V}$	$T_A = 0^\circ\text{C to }70^\circ\text{C}$			1	μA
V_{OL} Low-level output voltage	$I_{OL} = 4\text{ mA}$, $V_{ID} = -1\text{ V}$	$T_A = 25^\circ\text{C}$		150	400	mV
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$			700	
I_{OL} Low-level output current	$V_{OL} = 1.5\text{ V}$, $V_{ID} = -1\text{ V}$	$T_A = 25^\circ\text{C}$		6		mA
I_{CC} Supply current	$R_L = \infty$, $V_{CC} = 5\text{ V}$	$T_A = 25^\circ\text{C}$		0.8	1	mA
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$			2.5	
V_{IO} Input offset voltage	$V_{CC} = 5\text{ V to }30\text{ V}$, $V_O = 1.4\text{ V}$ $V_{IC} = V_{ICR(\text{min})}$	$T_A = 25^\circ\text{C}$		1	2	mV
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$			4	
I_{IO} Input offset current	$V_O = 1.4\text{ V}$	$T_A = 25^\circ\text{C}$		5	50	nA
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$			150	
I_{IB} Input bias current	$V_O = 1.4\text{ V}$	$T_A = 25^\circ\text{C}$		–25	–250	nA
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$			–400	
V_{ICR} Common-mode input-voltage range ⁽¹⁾		$T_A = 25^\circ\text{C}$		0 to $V_{CC} - 1.5$		V
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$		0 to $V_{CC} - 2$		
A_{VD} Large-signal differential-voltage amplification	$V_{CC} = 15\text{ V}$, $V_O = 1.4\text{ V to }11.4\text{ V}$, $R_L \geq 15\text{ k}\Omega\text{ to }V_{CC}$	$T_A = 25^\circ\text{C}$		50	200	V/mV
I_{OH} High-level output current	$V_{OH} = 5\text{ V}$, $V_{ID} = 1\text{ V}$	$T_A = 25^\circ\text{C}$		0.1	50	nA
	$V_{OH} = 30\text{ V}$, $V_{ID} = 1\text{ V}$	$T_A = 0^\circ\text{C to }70^\circ\text{C}$			1	μA
V_{OL} Low-level output voltage	$I_{OL} = 4\text{ mA}$, $V_{ID} = -1\text{ V}$	$T_A = 25^\circ\text{C}$		150	400	mV
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$			700	
I_{OL} Low-level output current	$V_{OL} = 1.5\text{ V}$, $V_{ID} = -1\text{ V}$	$T_A = 25^\circ\text{C}$		6		mA
I_{CC} Supply current (four comparators)	$R_L = \infty$, $V_{CC} = 5\text{ V}$	$T_A = 25^\circ\text{C}$		0.8	1	mA
		$T_A = 0^\circ\text{C to }70^\circ\text{C}$			2.5	

(1) The voltage at either input or common-mode should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is $V_{CC} + 1.5\text{ V}$, but either or both inputs can go to 30 V without damage.

6.6 Switching Characteristics

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

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

(1) C_L includes probe and jig capacitance.

(2) The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V.

6.7 Typical Characteristics

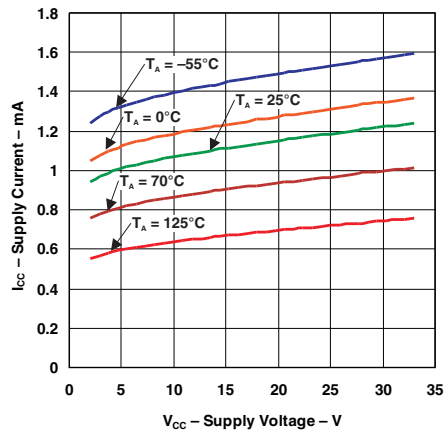


Figure 1. Supply Current vs Supply Voltage

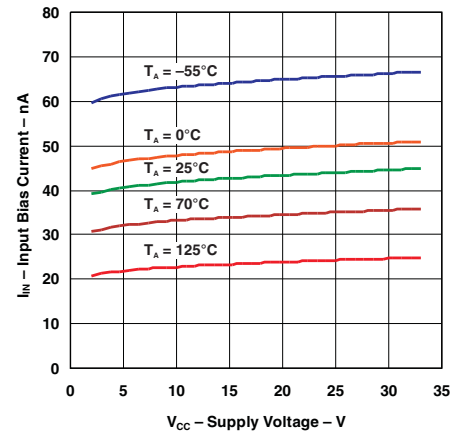


Figure 2. Input Bias Current vs Supply Voltage

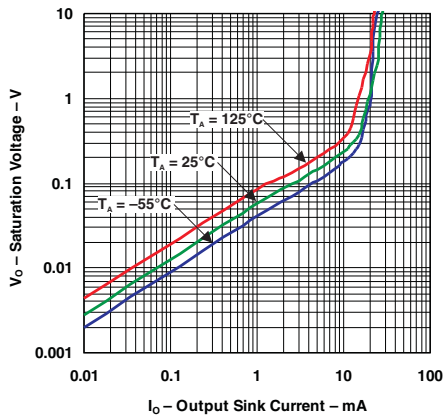


Figure 3. Output Saturation Voltage

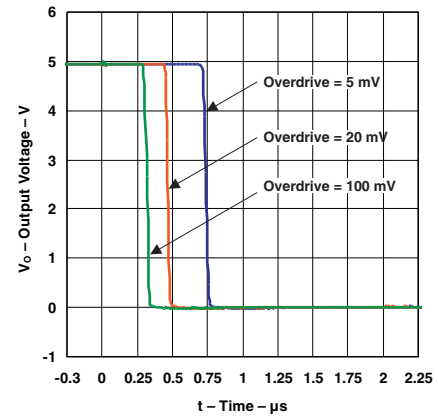


Figure 4. Response Time for Various Overdrives
Negative Transition

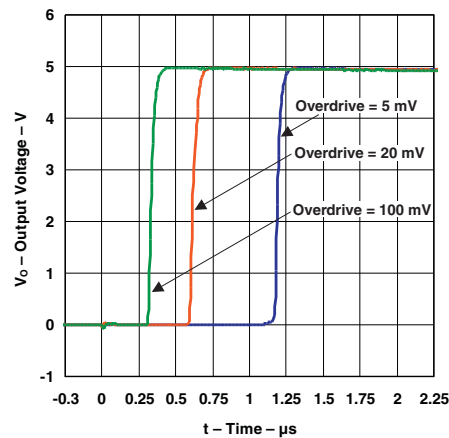


Figure 5. Response Time for Various Overdrives
Positive Transition

7 Detailed Description

7.1 Overview

The LM393-MIL is a dual comparator with the ability to operate up to 36 V on the supply pin. This standard device has proven ubiquity and versatility across a wide range of applications. This is due to very wide supply voltages range (2 V to 36 V), low I_q and fast response of the devices.

The open-drain output allows the user to configure the output logic low voltage (V_{OL}) and can be used to enable the comparator to be used in AND functionality.

7.2 Functional Block Diagram

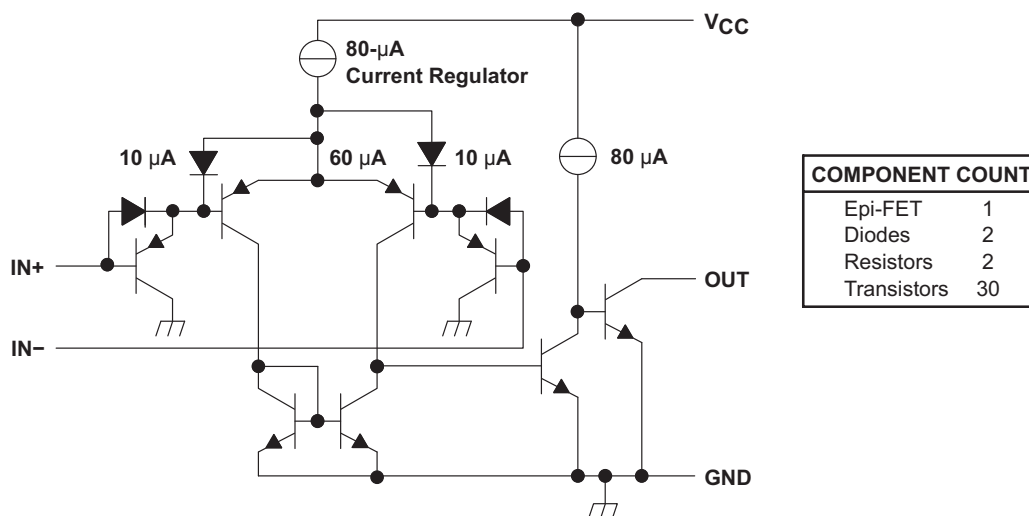


Figure 6. Schematic (Each Comparator)

7.3 Feature Description

LM393-MIL consists of a PNP darlington pair input, allowing the device to operate with very high gain and fast response with minimal input bias current. The input Darlington pair creates a limit on the input common mode voltage capability, allowing LM393-MIL to accurately function from ground to $V_{CC}-1.5\text{V}$ differential input. This enables much head room for modern day supplies of 3.3 V and 5 V.

The output consists of an open drain NPN (pull-down or low side) transistor. The output NPN will sink current when the positive input voltage is higher than the negative input voltage and the offset voltage. The V_{OL} is resistive and will scale with the output current. See Figure 3 for V_{OL} values with respect to the output current.

7.4 Device Functional Modes

7.4.1 Voltage Comparison

The LM393-MIL operates solely as a voltage comparator, comparing the differential voltage between the positive and negative pins and outputting a logic low or high impedance (logic high with pullup) based on the input differential polarity.

8 Application and Implementation

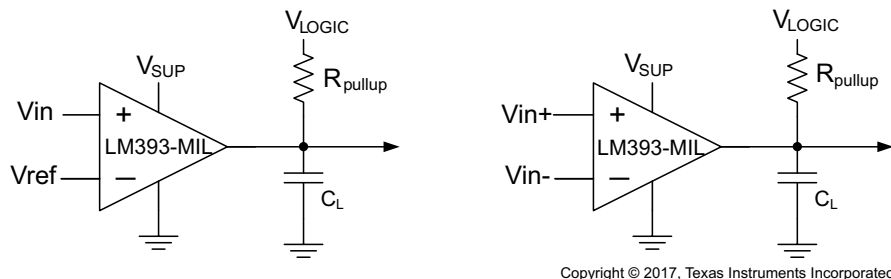
NOTE

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

LM393-MIL will typically be used to compare a single signal to a reference or two signals against each other. Many users take advantage of the open drain output to drive the comparison logic output to a logic voltage level to an MCU or logic device. The wide supply range and high voltage capability makes LM393-MIL optimal for level shifting to a higher or lower voltage.

8.2 Typical Application



Copyright © 2017, Texas Instruments Incorporated

Figure 7. Single-Ended and Differential Comparator Configurations

8.2.1 Design Requirements

For this design example, use the parameters listed in [Table 1](#) as the input parameters.

Table 1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Input Voltage Range	0 V to Vsup-1.5 V
Supply Voltage	2 V to 36 V
Logic Supply Voltage	2 V to 36 V
Output Current (R _{PULLUP})	1 μ A to 20 mA
Input Overdrive Voltage	100 mV
Reference Voltage	2.5 V
Load Capacitance (C _L)	15 pF

8.2.2 Detailed Design Procedure

When using LM393-MIL in a general comparator application, determine the following:

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

8.2.2.1 Input Voltage Range

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

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

1. When both IN- and IN+ are both within the common-mode range:
 - (a) If IN- is higher than IN+ and the offset voltage, the output is low and the output transistor is sinking current
 - (b) If IN- is lower than IN+ and the offset voltage, the output is high impedance and the output transistor is not conducting
2. When IN- is higher than common-mode and IN+ is within common-mode, the output is low and the output transistor is sinking current
3. When IN+ is higher than common-mode and IN- is within common-mode, the output is high impedance and the output transistor is not conducting
4. When IN- and IN+ are both higher than common-mode, the output is low and the output transistor is sinking current

8.2.2.2 Minimum Overdrive Voltage

Overdrive Voltage is the differential voltage produced between the positive and negative inputs of the comparator over the offset voltage (V_{IO}). To make an accurate comparison the Overdrive Voltage (V_{OD}) should be higher than the input offset voltage (V_{IO}). Overdrive voltage can also determine the response time of the comparator, with the response time decreasing with increasing overdrive. [Figure 8](#) and [Figure 9](#) show positive and negative response times with respect to overdrive voltage.

8.2.2.3 Output and Drive Current

Output current is determined by the load/pull-up resistance and logic/pullup voltage. The output current will produce a output low voltage (V_{OL}) from the comparator. In which V_{OL} is proportional to the output current. Use [Typical Characteristics](#) to determine V_{OL} based on the output current.

The output current can also effect the transient response. See [Response Time](#) for more information.

8.2.2.4 Response Time

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

- The positive response time (τ_P) is approximately $\tau_P \sim R_{PULLUP} \times C_L$
- The negative response time (τ_N) is approximately $\tau_N \sim R_{CE} \times C_L$
 - R_{CE} can be determine by taking the slope of [Typical Characteristics](#) in its linear region at the desired temperature, or by dividing the V_{OL} by I_{out}

8.2.3 Application Curves

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

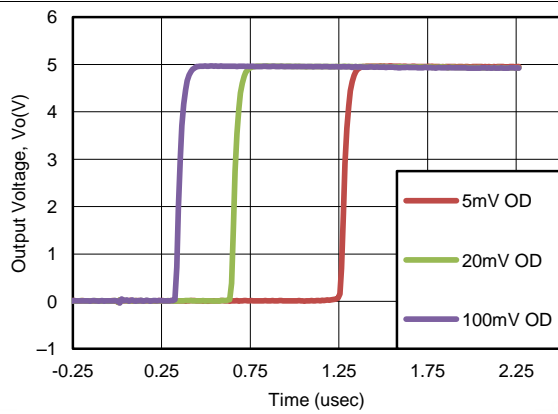


Figure 8. Response Time for Various Overdrives (Positive Transition)

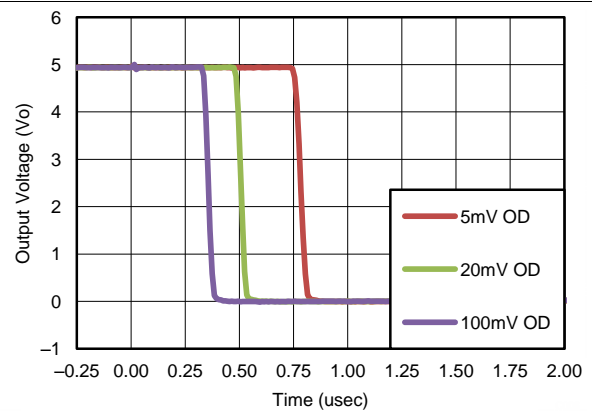


Figure 9. Response Time for Various Overdrives (Negative Transition)

9 Power Supply Recommendations

For fast response and comparison applications with noisy or AC inputs, TI recommends to use a bypass capacitor on the supply pin to reject any variation on the supply voltage. This variation can eat into the input common-mode range of the comparator and create an inaccurate comparison.

10 Layout

10.1 Layout Guidelines

For accurate comparator applications without hysteresis it is important maintain a stable power supply with minimized noise and glitches, which can affect the high level input common-mode voltage range. To achieve this, it is best to add a bypass capacitor between the supply voltage and ground. This should be implemented on the positive power supply and negative supply (if available). If a negative supply is not being used, do not put a capacitor between the IC GND pin and system ground.

10.2 Layout Example

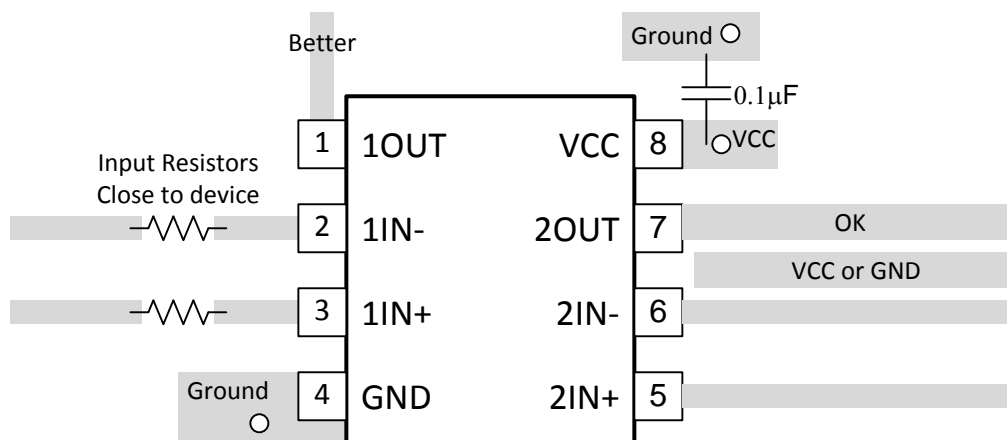


Figure 10. LM393-MIL Layout Example

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](#).

TI E2E™オンライン・コミュニティ *TIのE2E (Engineer-to-Engineer)* コミュニティ。エンジニア間の共同作業を促進するために開設されたものです。e2e.ti.comでは、他のエンジニアに質問し、知識を共有し、アイデアを検討して、問題解決に役立てることができます。

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

E2E is a trademark of Texas Instruments.

All other trademarks are the property of their respective owners.

11.4 静電気放電に関する注意事項



すべての集積回路は、適切なESD保護方法を用いて、取扱いと保存を行うようにして下さい。

静電気放電はわずかな性能の低下から完全なデバイスの故障に至るまで、様々な損傷を与えます。高精度の集積回路は、損傷に対して敏感であり、極めてわずかなパラメータの変化により、デバイスに規定された仕様に適合しなくなる場合があります。

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)
LM393 MDC	Active	Production	DIESALE (Y) 0	400 NOT REQUIRED	Yes	Call TI	Level-1-NA-UNLIM	-40 to 85	

⁽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.

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative 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.

重要なお知らせと免責事項

TI は、技術データと信頼性データ (データシートを含みます)、設計リソース (リファレンス デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、TI 製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した TI 製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとし、TI は一切の責任を拒否します。

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている TI 製品を使用するアプリケーションの開発の目的でのみ、TI はその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。TI や第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、TI およびその代理人を完全に補償するものとし、TI は一切の責任を拒否します。

TI の製品は、[TI の販売条件](#)、[TI の総合的な品質ガイドライン](#)、[ti.com](https://www.ti.com) または TI 製品などに関連して提供される他の適用条件に従い提供されます。TI がこれらのリソースを提供することは、適用される TI の保証または他の保証の放棄の拡大や変更を意味するものではありません。TI がカスタム、またはカスタマー仕様として明示的に指定していない限り、TI の製品は標準的なカタログに掲載される汎用機器です。

お客様がいかなる追加条項または代替条項を提案する場合も、TI はそれらに異議を唱え、拒否します。

Copyright © 2025, Texas Instruments Incorporated

最終更新日：2025 年 10 月