



TLV2172-Q1 低コスト・システム向け36V、単一電源、低消費電力 オペアンプ

1 特長

- 車載アプリケーションに対応
- 下記内容でAEC-Q100認定済み：
 - デバイス温度グレード1: 動作時周囲温度範囲 $-40^{\circ}\text{C} \sim +125^{\circ}\text{C}$
 - デバイスHBM ESD分類レベル3A
 - デバイスCDM ESD分類レベルC6
- 電源電圧範囲: 4.5V \sim 36V、 $\pm 2.25\text{V} \sim \pm 18\text{V}$
- 低ノイズ: $9\text{nV}/\sqrt{\text{Hz}}$
- 低いオフセット・ドリフト: $\pm 1\mu\text{V}/^{\circ}\text{C}$ (標準値)
- EMI強化
- 入力範囲は負の電源電圧にも対応
- レール・ツー・レール出力
- ゲイン帯域幅: 10MHz
- スルーレート: 10V/ μs
- 低い静止電流: アンプごとに1.6mA
- 高い同相除去: 116dB (標準値)
- 低い入力バイアス電流: 10pA

2 アプリケーション

- 車載用
- HEVおよびEVパワートレイン
- 先進運転支援システム (ADAS)
- カーエアコン
- 航空電子機器/着陸装置
- 医療用計測機器
- 電流検出

3 概要

TLV2172-Q1オペアンプは、THD+Nが1kHzにおいて0.0002%で、4.5V ($\pm 2.25\text{V}$)から36V ($\pm 18\text{V}$)までの電源で動作できます。このような特長に加え、TLV2172-Q1は低ノイズで電源電圧除去比(PSRR)も非常に高いことから、HEV/EV自動車およびパワー・トレイン、医療機器などのアプリケーションで、マイクロボルト・レベルの信号を増幅するのに適しています。TLV2172-Q1デバイスはオフセット・ドリフトが小さく、帯域幅は10MHzと広く、スルーレートは10V/ μs 、温度範囲全体にわたる静止電流はわずか2.3mA (最大値)です。

ほとんどのオペアンプは1つの電源電圧でのみ動作が規定されているのに対して、TLV2172-Q1デバイスは4.5V \sim 36Vで規定されており、電源レールの範囲外の入力信号でも位相反転を起こすことはありません。TLV2172-Q1デバイスは、最大300pFの容量性負荷で安定して動作します。通常の動作時に、入力は負のレールより100mV下、および正のレールから2V以内で動作できます。なお、完全なレール・ツー・レール入力で、正のレールを100mV超えて動作しますが、正のレールから2V以内では性能が低下します。

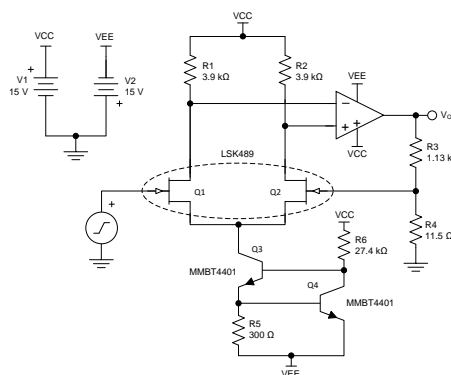
TLV2172-Q1オペアンプは、 $-40^{\circ}\text{C} \sim +125^{\circ}\text{C}$ での動作が規定されています。

製品情報⁽¹⁾

型番	パッケージ	本体サイズ(公称)
TLV2172-Q1	VSSOP (8)	3.00mm \times 3.00mm

(1) 提供されているすべてのパッケージについては、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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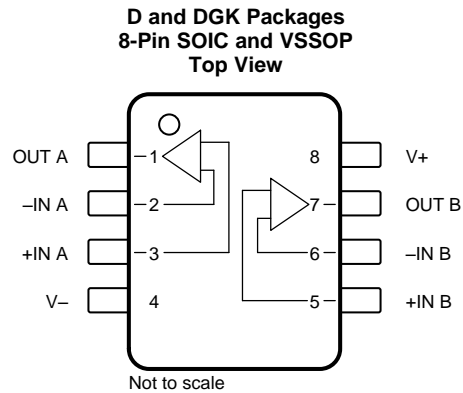
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4 改訂履歴

日付	改訂内容	注
2017年12月	*	初版

5 Pin Configuration and Functions



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
-IN A	2	I	Inverting input, channel A
-IN B	6	I	Inverting input, channel B
+IN A	3	I	Noninverting input, channel A
+IN B	5	I	Noninverting input, channel B
OUT A	1	O	Output, channel A
OUT B	7	O	Output, channel B
V-	4	—	Negative (lowest) power supply
V+	8	—	Positive (highest) power supply

6 Specifications

6.1 Absolute Maximum Ratings

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

				MIN	MAX	UNIT
Voltage	Supply voltage, V+ to V–			–20	20	V
	Single-supply voltage			40		
	Signal input pin ⁽²⁾	Common-mode		(V–) – 0.5	(V+) + 0.5	
		Differential ⁽³⁾		–0.5	0.5	
Current	Signal input pin			–10	10	mA
	Output short-circuit ⁽⁴⁾			Continuous		
Operating, T _A				–55	150	°C
Junction, T _J				150		
Storage, T _{stg}				–65	150	

(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) Transient conditions that exceed these voltage ratings must be current limited to 10 mA or less.

(3) See the *Electrical Overstress* section for more information.

(4) Short-circuit to ground, one amplifier per package.

6.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002 ⁽¹⁾	±4000	V
		Charged-device model (CDM), per AEC Q100-011	±1000	

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

6.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
Supply voltage, (V+) – (V–)	Single-supply	4.5		36	V
	Dual-supply	±2.25		±18	
Specified temperature		–40		125	°C

6.4 Thermal Information: TLV2172-Q1

THERMAL METRIC ⁽¹⁾		TLV2172-Q1		UNIT
		D (SOIC)	DGK (VSSOP)	
		8 PINS	8 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	116.1	158	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	69.8	48.6	°C/W
R _{θJB}	Junction-to-board thermal resistance	56.6	78.7	°C/W
ψ _{JT}	Junction-to-top characterization parameter	22.5	3.9	°C/W
ψ _{JB}	Junction-to-board characterization parameter	56.1	77.3	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) 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 $T_A = 25^\circ\text{C}$, $V_S = \pm 2.25\text{ V}$ to $\pm 18\text{ V}$, $V_{CM} = V_{OUT} = V_S / 2$, and $R_L = 10\text{ k}\Omega$ connected to $V_S / 2$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
OFFSET VOLTAGE							
V _{OS}	Input offset voltage	T _A = 25°C			0.5	1.7	mV
		T _A = −40°C to +125°C				2	
dV _{OS} /dT	Input offset voltage drift	T _A = −40°C to +125°C			1		μV/°C
PSRR	Power-supply rejection ratio	V _S = 4 V to 36 V, T _A = −40°C to +125°C		100	120		dB
	Channel separation, DC				5		μV/V
INPUT BIAS CURRENT							
I _B	Input bias current	T _A = 25°C			±10		pA
I _{OS}	Input offset current	T _A = 25°C			±2		pA
NOISE							
	Input voltage noise	f = 0.1 Hz to 10 Hz			2.5		μV _{PP}
e _n	Input voltage noise density	f = 100 Hz			14		nV/√Hz
		f = 1 kHz			9		nV/√Hz
i _n	Input current noise density	f = 1 kHz			1.6		fA/√Hz
INPUT VOLTAGE							
V _{CM}	Common-mode voltage range ⁽¹⁾			(V _−) − 0.1		(V ₊) − 2	V
CMRR	Common-mode rejection ratio	V _S = ±18 V, (V _−) − 0.1 V < V _{CM} < (V ₊) − 2 V T _A = −40°C to +125°C		94	116		dB
INPUT IMPEDANCE							
	Differential				100 4		MΩ pF
	Common-mode				6 4		10 ¹³ Ω pF
OPEN-LOOP GAIN							
A _{OL}	Open-loop voltage gain	(V _−) + 0.35 V < V _O < (V ₊) − 0.35 V, T _A = −40°C to +125°C		97	115		dB
		(V _−) + 0.5 V < V _O < (V ₊) − 0.5 V, R _L = 2 kΩ, T _A = −40°C to +125°C			107		
FREQUENCY RESPONSE							
GBP	Gain bandwidth product				10		MHz
SR	Slew rate	G = +1			10		V/μs
t _S	Settling time	To 0.1%, V _S = ±18 V, G = 1, 10-V step			2		μs
		To 0.01% (12-bit), V _S = ±18 V, G = +1, 10-V step			3.2		
	Overload recovery time	V _{IN} × gain > V _S			200		ns
THD+N	Total harmonic distortion + noise	V _S = 36 V, G = +1, f = 1 kHz, V _O = 3.5 V _{RMS}			0.0002%		
OUTPUT							
V _O	Voltage output swing from rail	V _S = ±18 V, R _L = 10 kΩ	T _A = 25°C		70		mV
			T _A = −40°C to +125°C		95		
		V _S = ±18 V, R _L = 2 kΩ	T _A = 25°C		330	400	
			T _A = −40°C to +125°C		470	530	
I _{SC}	Short-circuit current				±75		mA
C _{LOAD}	Capacitive load drive				See Typical Characteristics		pF
R _O	Open-loop output resistance	f = 1 MHz, I _O = 0 A			60		Ω
POWER SUPPLY							
V _S	Specified voltage range			4.5		36	V
I _Q	Quiescent current per amplifier	I _O = 0 A, T _A = −40°C to +125°C			1.6	2.3	mA

(1) The input range can be extended beyond $(V_+) - 2\text{ V}$ up to V_+ . See the [Typical Characteristics](#) and [Application and Implementation](#) sections for additional information.

6.6 Typical Characteristics

at $V_S = \pm 18\text{ V}$, $V_{CM} = V_S / 2$, $R_{LOAD} = 10\text{ k}\Omega$ connected to $V_S / 2$, and $C_L = 100\text{ pF}$ (unless otherwise noted)

表 1. Characteristic Performance Measurements

DESCRIPTION	FIGURE
Offset Voltage Production Distribution	图 1
Offset Voltage vs Common-Mode Voltage	图 2
Offset Voltage vs Common-Mode Voltage (Upper Stage)	图 3
Input Bias Current vs Temperature	图 4
Output Voltage Swing vs Output Current (Maximum Supply)	图 5
CMRR and PSRR vs Frequency (Referred-to-Input)	图 6
0.1-Hz to 10-Hz Noise	图 7
Input Voltage Noise Spectral Density vs Frequency	图 8
Quiescent Current vs Supply Voltage	图 9
Open-Loop Gain and Phase vs Frequency	图 10
Closed-Loop Gain vs Frequency	图 11
Open-Loop Output Impedance vs Frequency	图 12
Small-Signal Overshoot vs Capacitive Load	图 13 , 图 14
No Phase Reversal	图 15
Small-Signal Step Response (10 mV)	图 16 , 图 17
Large-Signal Step Response	图 18 , 图 19
Large-Signal Settling Time	图 20 , 图 21
Short-Circuit Current vs Temperature	图 22
Maximum Output Voltage vs Frequency	图 23
EMIRR IN+ vs Frequency	图 24

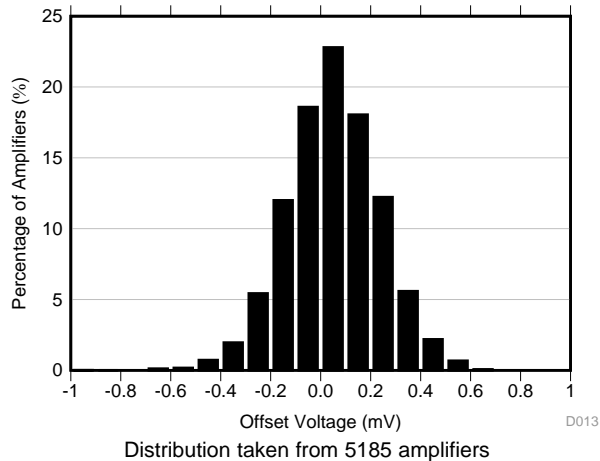


Figure 1. Offset Voltage Production Distribution Histogram

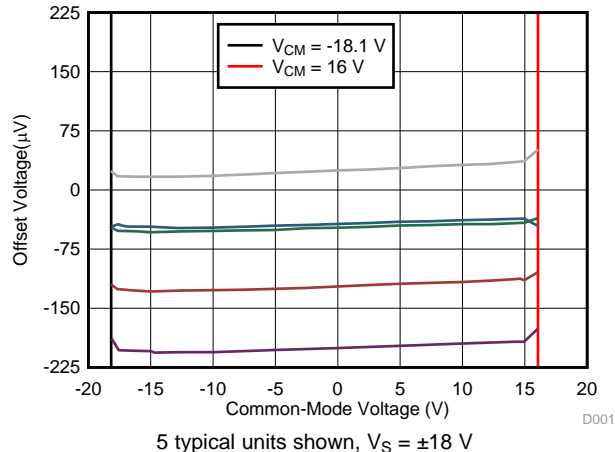


Figure 2. Offset Voltage vs Common-Mode Voltage

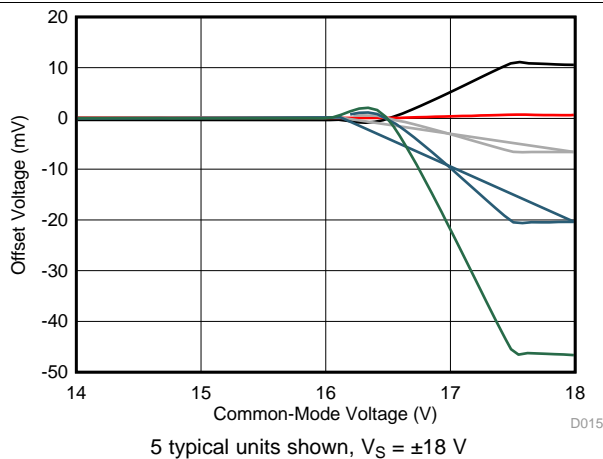


Figure 3. Offset Voltage vs Common-Mode Voltage (Upper Stage)

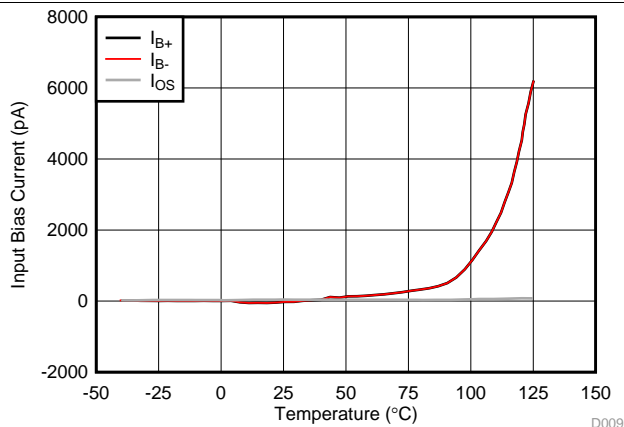


Figure 4. Input Bias Current vs Temperature

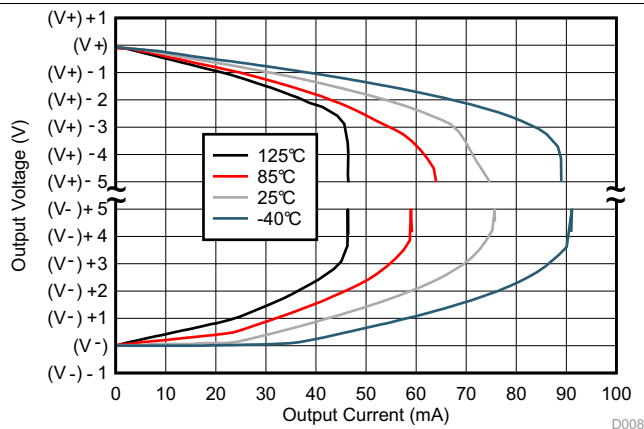


Figure 5. Output Voltage Swing vs Output Current (Maximum Supply)

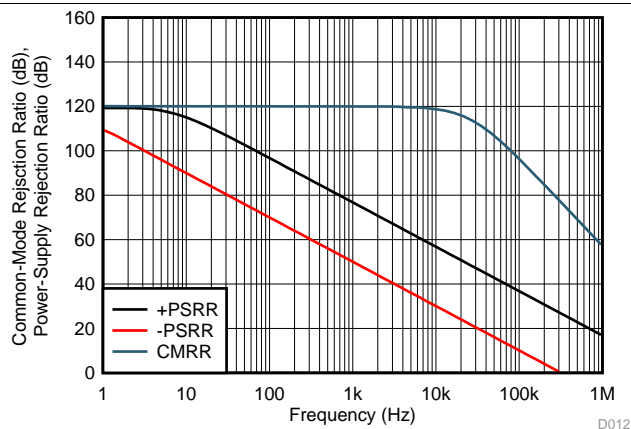


Figure 6. CMRR and PSRR vs Frequency (Referred-to-Input)

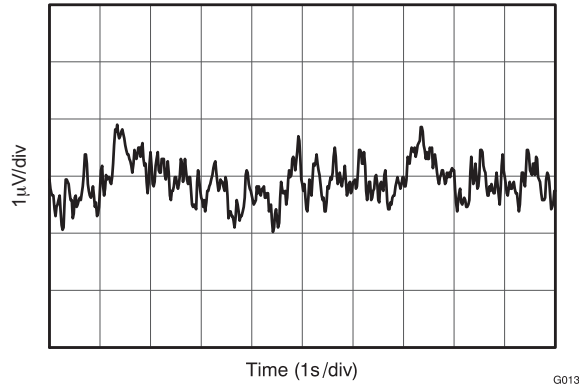


图 7. 0.1-Hz to 10-Hz Noise

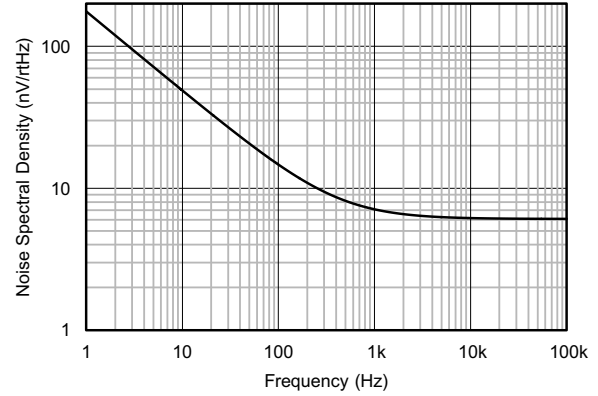


图 8. Input Voltage Noise Spectral Density vs Frequency

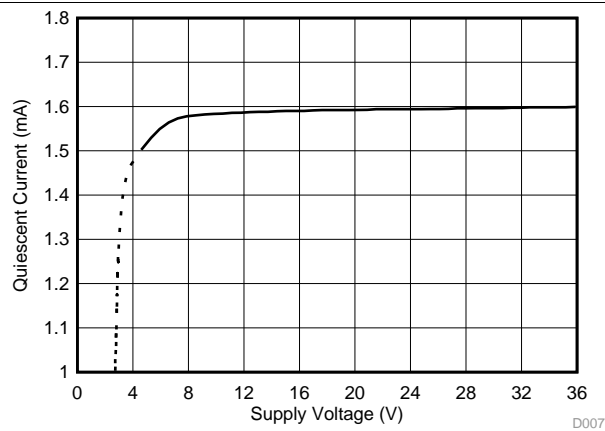


图 9. Quiescent Current vs Supply Voltage

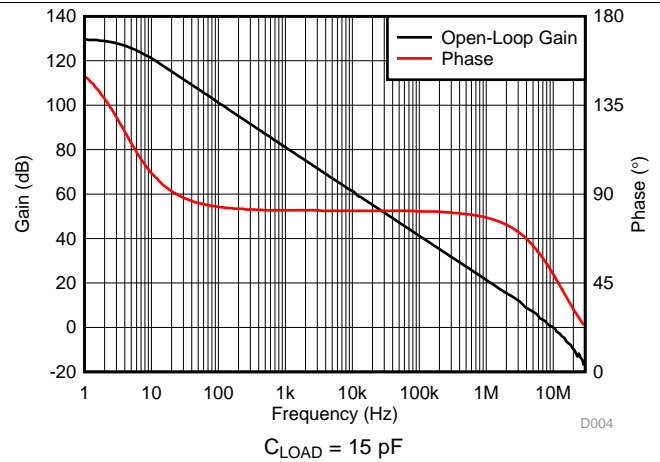


图 10. Open-Loop Gain and Phase vs Frequency

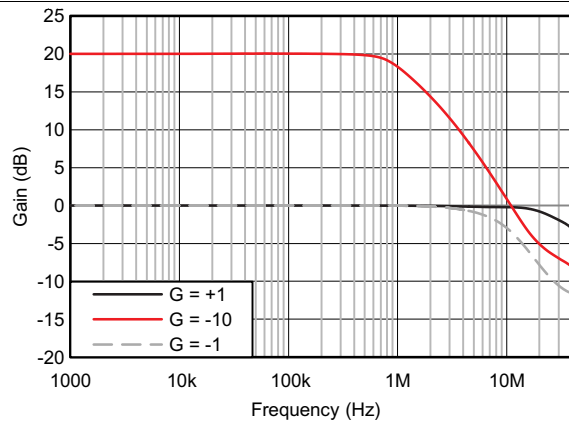


图 11. Closed-Loop Gain vs Frequency

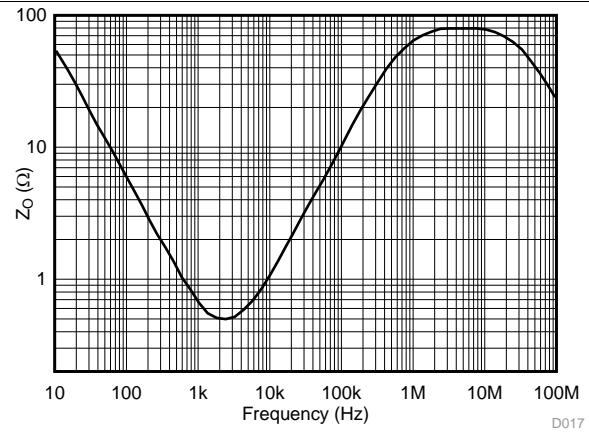


图 12. Open-Loop Output Impedance vs Frequency

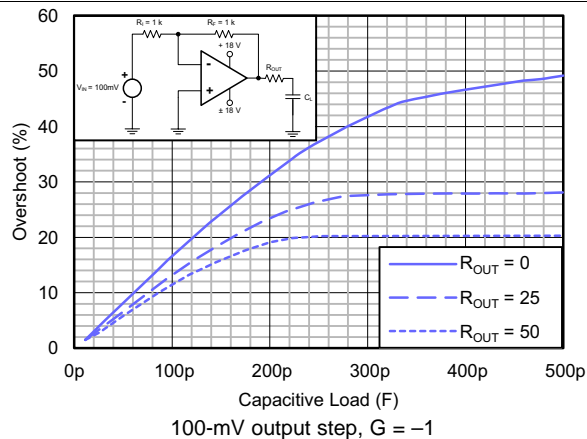


图 13. Small-Signal Overshoot vs Capacitive Load

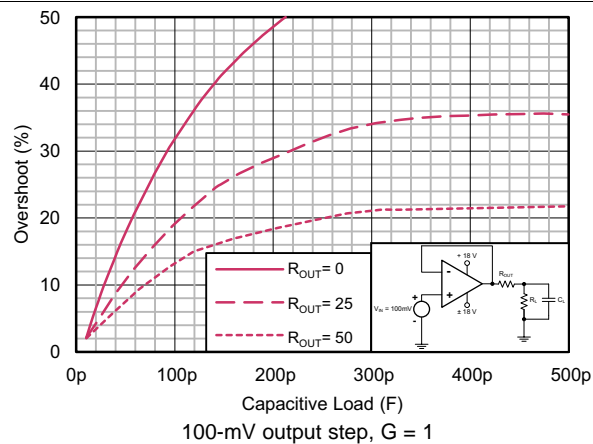
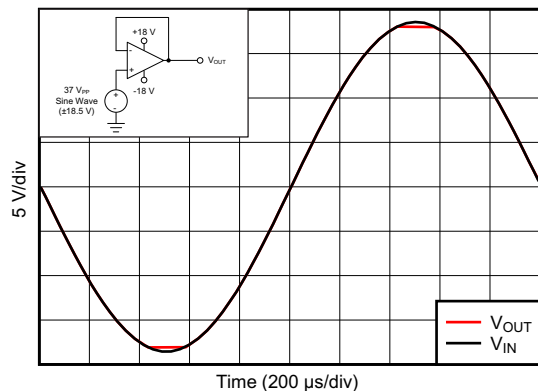
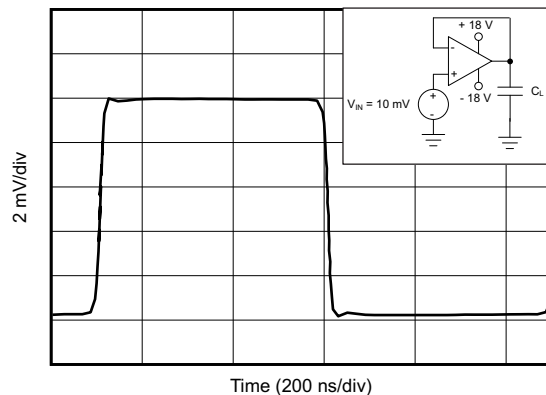


图 14. Small-Signal Overshoot vs Capacitive Load



D011

图 15. No Phase Reversal

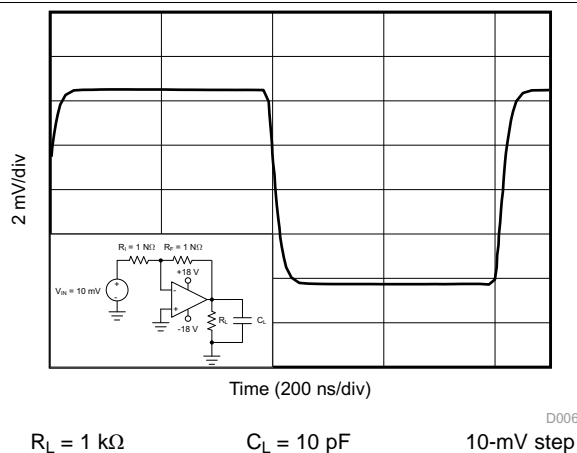


$C_L = 10$ pF

10-mV step

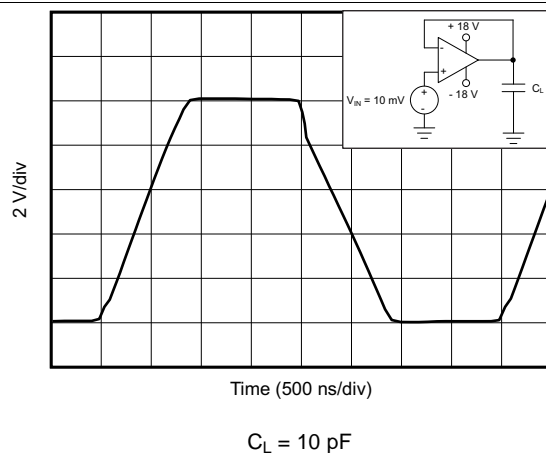
D016

图 16. Small-Signal Step Response



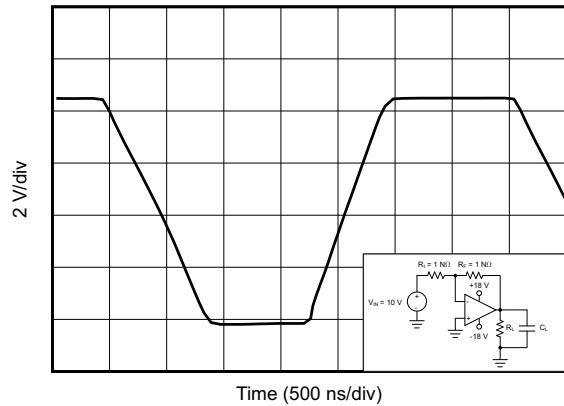
D006

图 17. Small-Signal Step Response



D014

图 18. Large-Signal Step Response

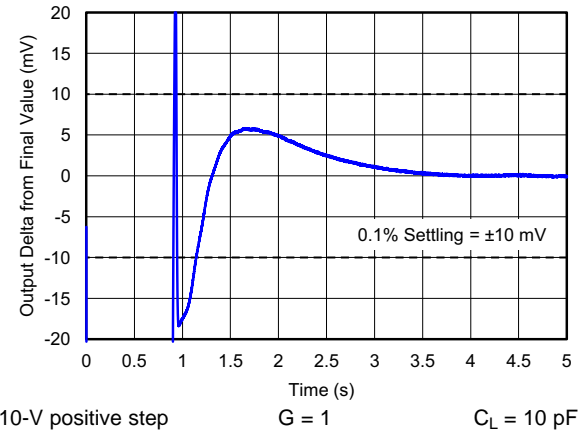


$R_L = 1\text{ k}\Omega$

$C_L = 10\text{ pF}$

D005

图 19. Large-Signal Step Response

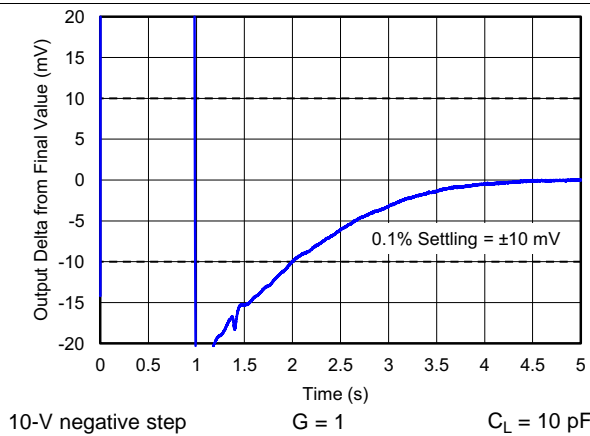


10-V positive step

$G = 1$

$C_L = 10\text{ pF}$

图 20. Large-Signal Settling Time

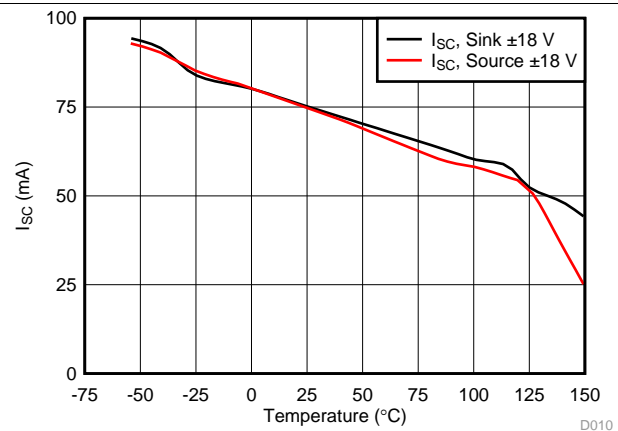


10-V negative step

$G = 1$

$C_L = 10\text{ pF}$

图 21. Large-Signal Settling Time



D010

图 22. Short-Circuit Current vs Temperature

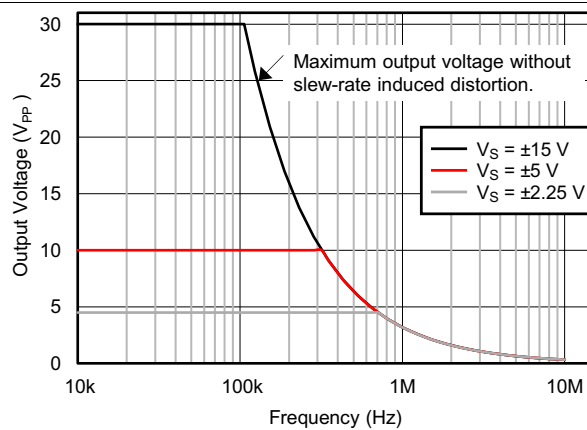
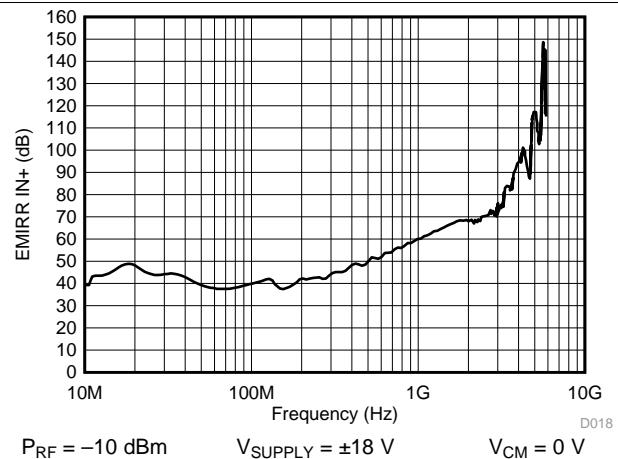


图 23. Maximum Output Voltage vs Frequency



D018

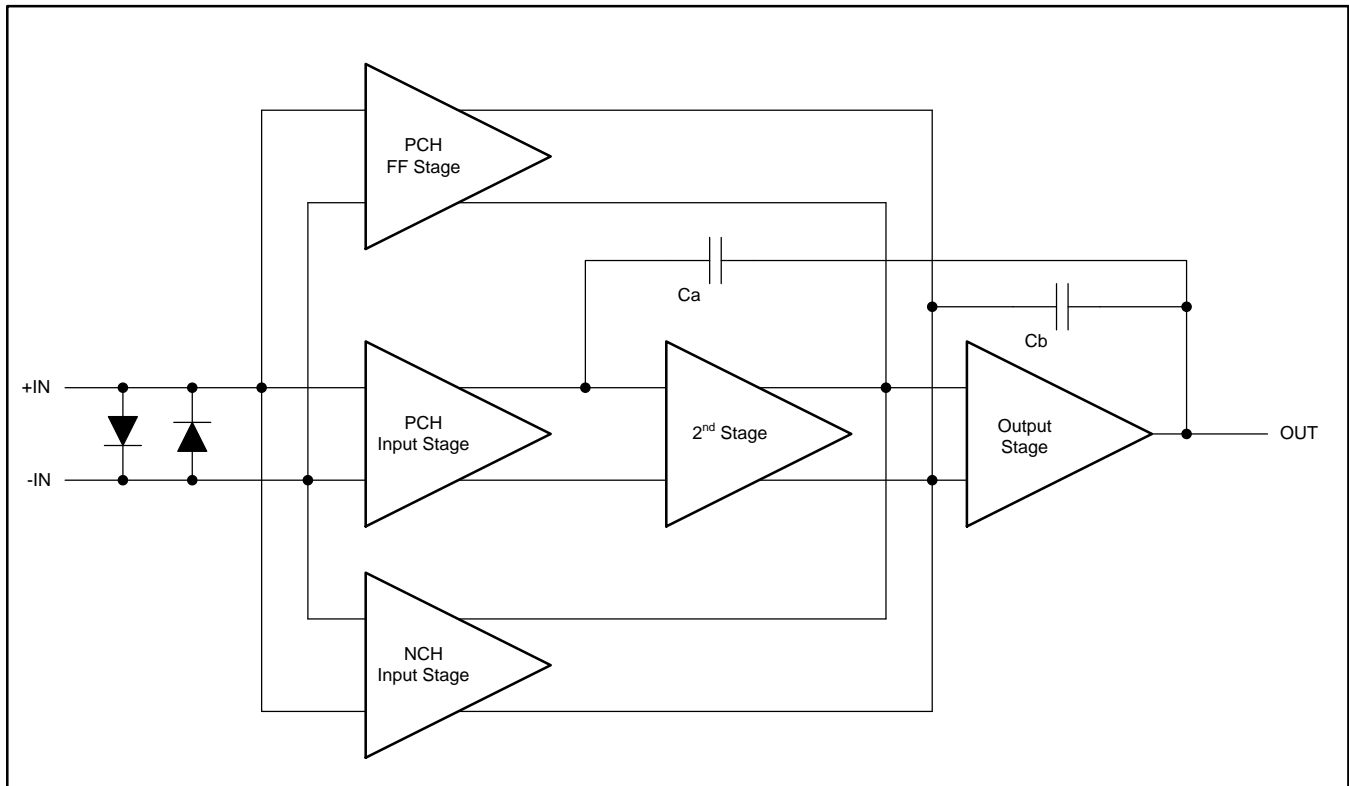
图 24. EMIRR IN+ vs Frequency

7 Detailed Description

7.1 Overview

The TLV2172-Q1 operational amplifier provides high overall performance, making these devices designed for many general-purpose applications. The excellent offset drift of only $1 \mu\text{V}/^\circ\text{C}$ provides excellent stability over the entire temperature range. In addition, the device offers very good overall performance with high CMRR, PSRR, and A_{OL} .

7.2 Functional Block Diagram



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7.3 Feature Description

7.3.1 Operating Characteristics

The TLV2172-Q1 amplifier is specified for operation from 4.5 V to 36 V (± 2.25 V to ± 18 V). Many of the specifications apply from -40°C to $+125^{\circ}\text{C}$. Parameters that can exhibit significant variance with regard to operating voltage or temperature are shown in the [Typical Characteristics](#) section.

7.3.2 Phase-Reversal Protection

The TLV2172-Q1 device has an internal phase-reversal protection. Many operational amplifiers exhibit a phase reversal when the input is driven beyond the linear common-mode range. This condition is most often encountered in noninverting circuits when the input is driven beyond the specified common-mode voltage range, causing the output to reverse into the opposite rail. The input of the TLV2172-Q1 prevents phase reversal with excessive common-mode voltage. Instead, the output limits into the appropriate rail. This performance is shown in [Figure 25](#).

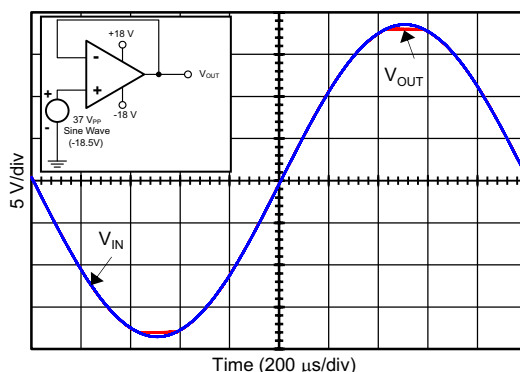


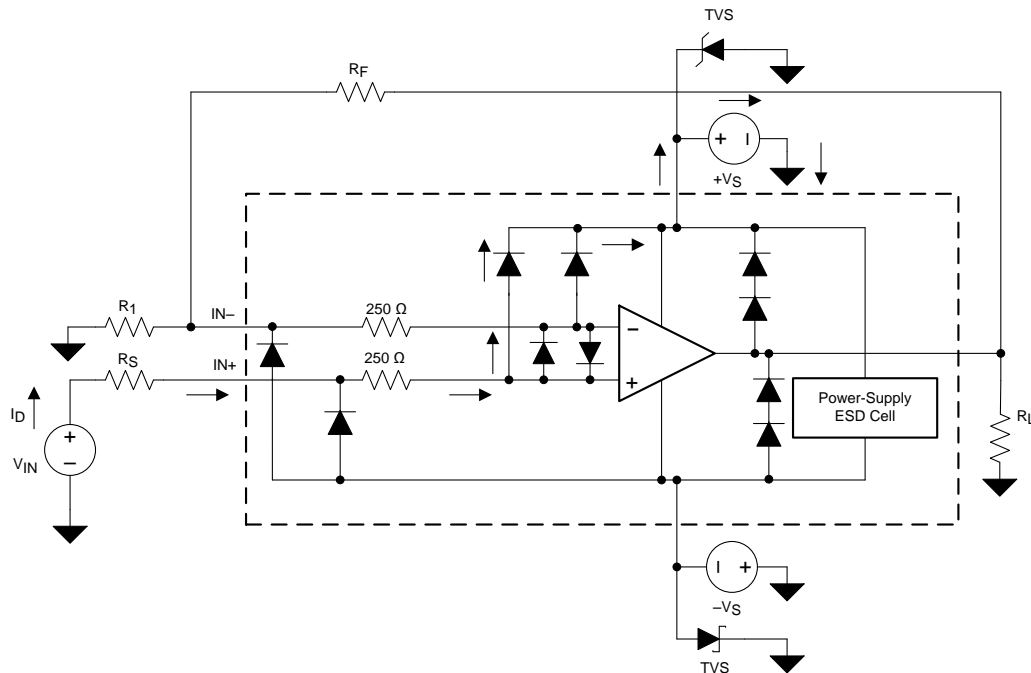
Figure 25. No Phase Reversal

7.3.3 Electrical Overstress

Designers often ask questions about the capability of an operational amplifier to withstand electrical overstress. These questions tend to focus on the device inputs, but can involve the supply voltage pins or even the output pin. Each of these different pin functions have electrical stress limits determined by the voltage breakdown characteristics of the particular semiconductor fabrication process and specific circuits connected to the pin. Additionally, internal electrostatic discharge (ESD) protection is built into these circuits for protection from accidental ESD events both before and during product assembly.

A good understanding of this basic ESD circuitry and the relevance to an electrical overstress event is helpful. [Figure 26](#) shows the ESD circuits contained in the TLV2172-Q1 (indicated by the dashed box). The ESD protection circuitry involves several current-steering diodes connected from the input and output pins and routed back to the internal power-supply lines, where the diodes meet at an absorption device internal to the operational amplifier. This protection circuitry is intended to remain inactive during normal circuit operation.

Feature Description (continued)



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Figure 26. Equivalent Internal ESD Circuitry Relative to a Typical Circuit Application

An ESD event produces a short-duration, high-voltage pulse that is transformed into a short-duration, high-current pulse when discharging through a semiconductor device. The ESD protection circuits are designed to provide a current path around the operational amplifier core to prevent damage. The energy absorbed by the protection circuitry is then dissipated as heat.

When an ESD voltage develops across two or more amplifier device pins, current flows through one or more steering diodes. Depending on the path that the current takes, the absorption device can activate. The absorption device has a trigger, or threshold voltage, that is above the normal operating voltage of the TLV2172-Q1 but below the device breakdown voltage level. When this threshold is exceeded, the absorption device quickly activates and clamps the voltage across the supply rails to a safe level.

When the operational amplifier connects into a circuit, as shown in Figure 26, the ESD protection components are intended to remain inactive and do not become involved in the application circuit operation. However, circumstances can arise where an applied voltage exceeds the operating voltage range of a given pin. If this condition occurs, there is a risk that some internal ESD protection circuits can turn on and conduct current. Any such current flow occurs through steering-diode paths and rarely involves the absorption device.

Figure 26 shows a specific example where the input voltage (V_{IN}) exceeds the positive supply voltage ($V+$) by 500 mV or more. Much of what happens in the circuit depends on the supply characteristics. If $V+$ can sink the current, then one of the upper input steering diodes conducts and directs current to $V+$. Excessively high current levels can flow with increasingly higher V_{IN} . As a result, the data sheet specifications recommend that applications limit the input current to 10 mA.

If the supply is not capable of sinking the current, V_{IN} can begin sourcing current to the operational amplifier and then take over as the source of positive supply voltage. The danger in this case is that the voltage can rise to levels that exceed the operational amplifier absolute maximum ratings.

Feature Description (continued)

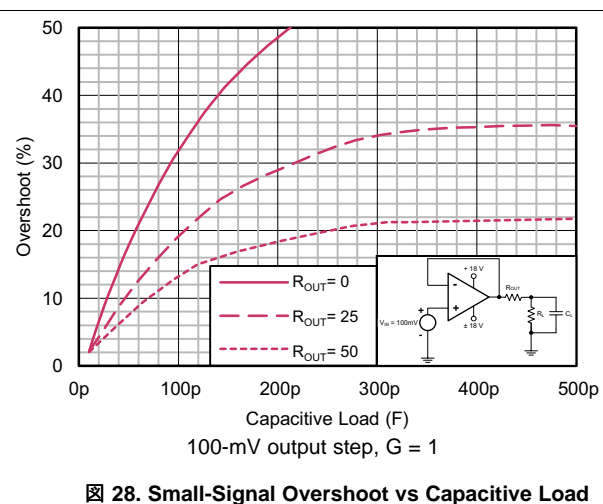
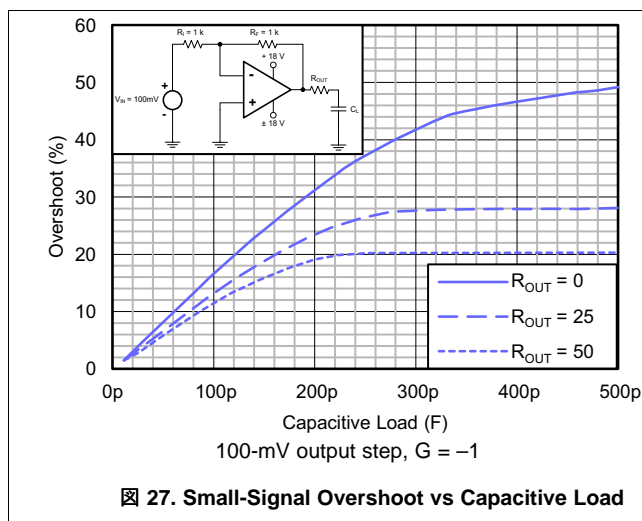
Another common question involves what happens to the amplifier if an input signal is applied to the input when the power supplies ($V+$ or $V-$) are at 0 V. Again, this question depends on the supply characteristic when at 0 V, or at a level below the input signal amplitude. If the supplies appear as high impedance, then the input source supplies the operational amplifier current through the current-steering diodes. This state is not a normal bias condition; most likely, the amplifier does not operate normally. If the supplies are low impedance, then the current through the steering diodes can become quite high. The current level depends on the ability of the input source to deliver current and any resistance in the input path.

If there is any uncertainty about the ability of the supply to absorb this current, add external Zener diodes to the supply pins; see [Figure 26](#). Select the Zener voltage so that the diode does not turn on during normal operation. However, the Zener voltage must be low enough so that the Zener diode conducts if the supply pin begins to rise above the safe-operating, supply-voltage level.

The input pins of the TLV2172-Q1 are protected from excessive differential voltage with back-to-back diodes; see [Figure 26](#). In most circuit applications, the input protection circuitry has no effect. However, in low-gain or $G = 1$ circuits, fast-ramping input signals can forward-bias these diodes because the output of the amplifier cannot respond rapidly enough to the input ramp. If the input signal is fast enough to create this forward-bias condition, then limit the input signal current to 10 mA or less. If the input signal current is not inherently limited, an input series resistor can limit the input signal current. This input series resistor degrades the low-noise performance of the TLV2172-Q1. [Figure 26](#) shows an example configuration that implements a current-limiting feedback resistor.

7.3.4 Capacitive Load and Stability

The dynamic characteristics of the TLV2172-Q1 are optimized for common operating conditions. The combination of low closed-loop gain and high capacitive loads decreases the phase margin of the amplifier and can lead to gain peaking or oscillations. As a result, heavier capacitive loads must be isolated from the output. The simplest way to achieve this isolation is to add a small resistor (for example, R_{OUT} equal to 50 Ω) in series with the output. [Figure 27](#) and [Figure 28](#) show graphs of small-signal overshoot versus capacitive load for several values of R_{OUT} . See the [Feedback Plots Define Op Amp AC Performance](#) application note for details of analysis techniques and application circuits.



7.4 Device Functional Modes

7.4.1 Common-Mode Voltage Range

The input common-mode voltage range of the TLV2172-Q1 device extends 100 mV below the negative rail and within 2 V of the top rail for normal operation.

This device can operate with full rail-to-rail input 100 mV beyond the top rail, but with reduced performance within 2 V of the top rail. 表 2 lists the typical performances in this range.

表 2. Typical Performance for Common-Mode Voltages Within 2 V of the Positive Supply

PARAMETER	MIN	TYP	MAX	UNIT
Input common-mode voltage	$(V+) - 2$		$(V+) + 0.1$	V
Offset voltage		7		mV
Offset voltage vs temperature		12		$\mu\text{V}/^{\circ}\text{C}$
Common-mode rejection		65		dB
Open-loop gain		60		dB
Gain-bandwidth product		0.3		MHz
Slew rate		0.3		V/ μs

7.4.2 Overload Recovery

Overload recovery is defined as the time required for the operational amplifier output to recover from the saturated state to the linear state. The output devices of the operational amplifier enter the saturation region when the output voltage exceeds the rated operating voltage, which is a result from the high input voltage or the high gain. After the device enters the saturation region, the charge carriers in the output devices require time to return back to the normal state. After the charge carriers return back to the equilibrium state, the device begins to slew at the normal slew rate. As a result, the propagation delay in case of an overload condition is the sum of the overload recovery time and the slew time. The overload recovery time for the TLV2172-Q1 is approximately 2 μs .

8 Application and Implementation

注

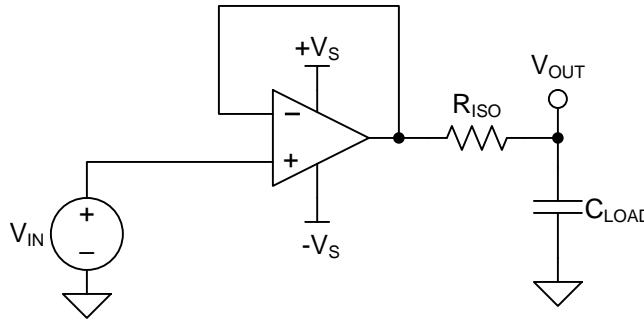
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

The TLV2172-Q1 operational amplifier provides high overall performance in a large number of general-purpose applications. As with all amplifiers, applications with noisy or high-impedance power supplies require decoupling capacitors placed close to the device pins. In most cases, 0.1-μF capacitors are adequate. Follow the additional recommendations in the [Layout Guidelines](#) section to achieve the maximum performance from this device. Many applications introduce capacitive loading to the output of the amplifier (which potentially causes instability). To stabilize the amplifier, add an isolation resistor between the amplifier output and the capacitive load. [Typical Application](#) section shows the process for selecting a resistor.

8.2 Typical Application

This circuit can drive capacitive loads (such as cable shields, reference buffers, MOSFET gates, and diodes). The circuit uses an isolation resistor (R_{ISO}) to stabilize the output of an operational amplifier. R_{ISO} modifies the open-loop gain of the system to ensure that the circuit has sufficient phase margin.



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图 29. Unity-Gain Buffer With R_{ISO} Stability Compensation

8.2.1 Design Requirements

The design requirements are:

- Supply voltage: 30 V (± 15 V)
- Capacitive loads: 100 pF, 1000 pF, 0.01 μF, 0.1 μF, and 1 μF
- Phase margin: 45° and 60°

8.2.2 Detailed Design Procedure

图 29 shows a unity-gain buffer driving a capacitive load. 式 1 shows the transfer function for the circuit in 图 29. 图 29 does not show the open-loop output resistance of the operational amplifier (R_o).

$$T(s) = \frac{1 + C_{LOAD} \times R_{ISO} \times s}{1 + (R_o + R_{ISO}) \times C_{LOAD} \times s} \quad (1)$$

The transfer function in 式 1 has a pole and a zero. The frequency of the pole (f_p) is determined by $(R_o + R_{ISO})$ and C_{LOAD} . The R_{ISO} and C_{LOAD} components determine the frequency of the zero (f_z). A stable system is obtained by selecting R_{ISO} so that the rate of closure (ROC) between the open-loop gain (A_{OL}) and $1/\beta$ is 20 dB per decade. 图 30 shows the concept. The $1/\beta$ curve for a unity-gain buffer is 0 dB.

Typical Application (continued)

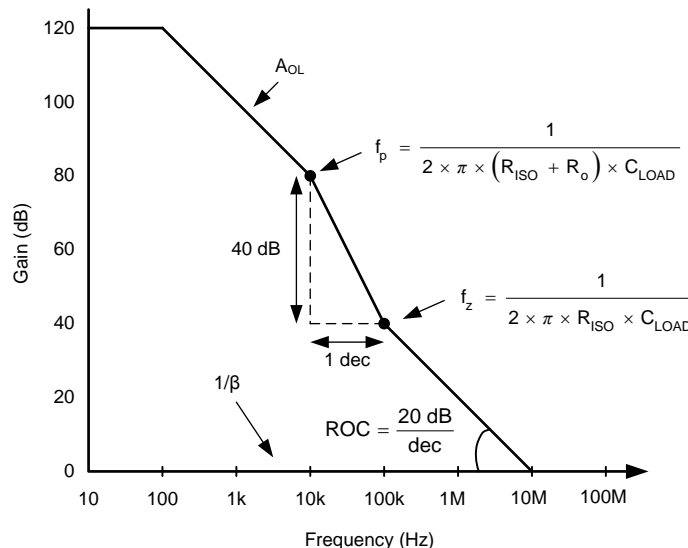


图 30. Unity-Gain Amplifier With R_{ISO} Compensation

Typically, ROC stability analysis is simulated. The validity of the analysis depends on multiple factors, especially the accurate modeling of R_o . In addition to simulating the ROC, a robust stability analysis includes a measurement of overshoot percentage and AC gain peaking of the circuit using a function generator, oscilloscope, and gain and phase analyzer. Phase margin is then calculated from these measurements. 表 3 shows the overshoot percentage and AC gain peaking that correspond to phase margins of 45° and 60°. For more details on this design and other alternative devices that can replace the TLV2172-Q1, see the [Capacitive Load Drive Solution Using an Isolation Resistor](#) precision design.

表 3. Phase Margin versus Overshoot and AC Gain Peaking

PHASE MARGIN	OVERSHOOT	AC GAIN PEAKING
45°	23.3%	2.35 dB
60°	8.8%	0.28 dB

8.2.3 Application Curve

The values of R_{ISO} that yield phase margins of 45° and 60° for various capacitive loads are determined using the described methodology. 图 31 shows the results.

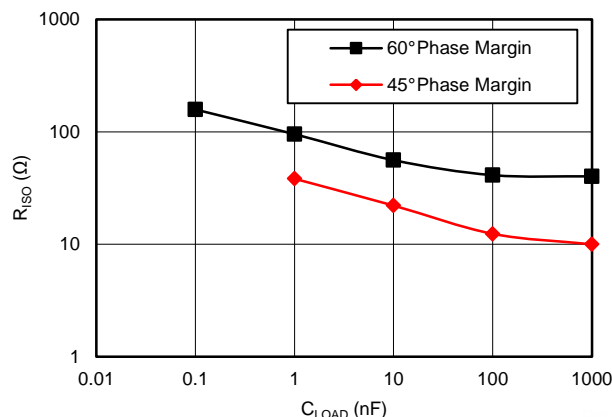


图 31. Isolation Resistor Required for Various Capacitive Loads to Achieve a Target Phase Margin

9 Power Supply Recommendations

The TLV2172-Q1 is specified for operation from 4.5 V to 36 V (± 2.25 V to ± 18 V); many specifications apply from -40°C to $+125^{\circ}\text{C}$. Parameters that can exhibit significant variance with regard to operating voltage or temperature are shown in the [Typical Characteristics](#) section.

注意

Supply voltages larger than 40 V can permanently damage the device; see the [Absolute Maximum Ratings](#) table.

Place 0.1- μF bypass capacitors close to the power-supply pins to reduce errors coupling in from noisy or high-impedance power supplies. For more detailed information on bypass capacitor placement, see the [Layout](#) section.

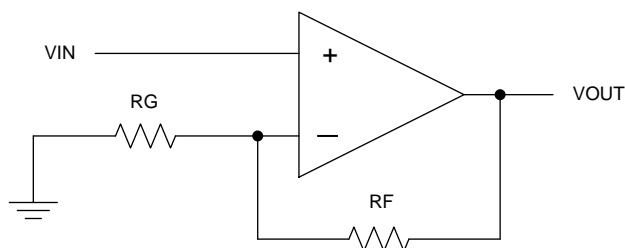
10 Layout

10.1 Layout Guidelines

For best operational performance of the device, use good printed circuit board (PCB) layout practices, including:

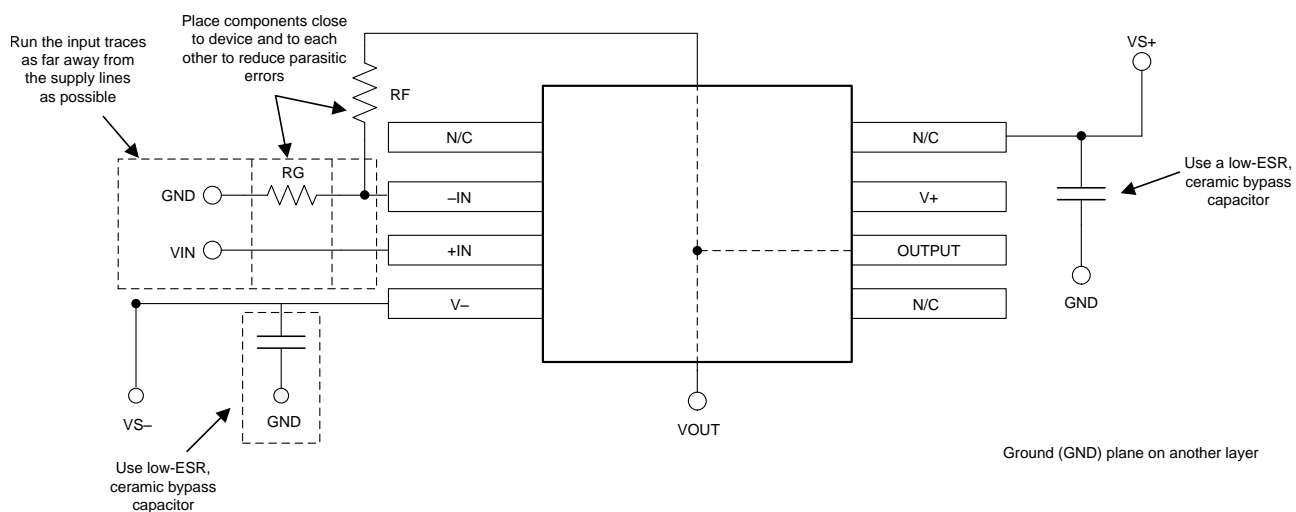
- Noise can propagate into analog circuitry through the power pins of the circuit as a whole and the operational amplifier itself. Bypass capacitors are used to reduce the coupled noise by providing low-impedance power sources local to the analog circuitry.
 - Connect low-ESR, 0.1- μF ceramic bypass capacitors between each supply pin and ground, placed as close to the device as possible. A single bypass capacitor from V+ to ground is applicable for single-supply applications.
- Separate grounding for analog and digital portions of the circuitry is one of the simplest and most-effective methods of noise suppression. One or more layers on multilayer PCBs are usually devoted to ground planes. A ground plane helps distribute heat and reduces electromagnetic interference (EMI) noise pickup. Make sure to physically separate digital and analog grounds, paying attention to the flow of the ground current.
- In order to reduce parasitic coupling, run the input traces as far away from the supply or output traces as possible. If these traces cannot be kept separate, crossing the sensitive trace perpendicularly is much better than in parallel with the noisy trace.
- Place the external components as close to the device as possible. As shown in [Figure 33](#), keeping R_F and R_G close to the inverting input minimizes parasitic capacitance.
- Keep the length of input traces as short as possible. Always remember that the input traces are the most sensitive part of the circuit.
- Consider a driven, low-impedance guard ring around the critical traces. A guard ring can significantly reduce leakage currents from nearby traces that are at different potentials.

10.2 Layout Example



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32. Schematic Representation



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33. Operational Amplifier Board Layout for a Noninverting Configuration

11 デバイスおよびドキュメントのサポート

11.1 デバイス・サポート

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注

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デバイス・サポート (continued)

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11.2 ドキュメントのサポート

11.2.1 関連資料

関連資料については、以下を参照してください。

- 『フィードバック・プロットによるオペアンプAC性能の定義』
- 『オペアンプのEMI除去率』
- 『トランスインピーダンス・アンプの直感的な補正』
- 『高速オペアンプの雑音解析』

11.3 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。

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11.8 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

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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)
TLV2172QDGKRQ1	Active	Production	VSSOP (DGK) 8	2500 LARGE T&R	Yes	NIPDAU NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	11Q6
TLV2172QDGKRQ1.B	Active	Production	VSSOP (DGK) 8	2500 LARGE T&R	Yes	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	11Q6

⁽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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OTHER QUALIFIED VERSIONS OF TLV2172-Q1 :

- Catalog : [TLV2172](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION


*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
TLV2172QDGKRQ1	VSSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV2172QDGKRQ1	VSSOP	DGK	8	2500	366.0	364.0	50.0

DGK0008A**PACKAGE OUTLINE****VSSOP - 1.1 mm max height**

SMALL OUTLINE PACKAGE



4214862/A 04/2023

NOTES:

PowerPAD is a trademark of Texas Instruments.

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

EXAMPLE BOARD LAYOUT

DGK0008A

™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 15X



SOLDER MASK DETAILS

4214862/A 04/2023

NOTES: (continued)

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

EXAMPLE STENCIL DESIGN

DGK0008A

TM VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
SCALE: 15X

4214862/A 04/2023

NOTES: (continued)

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

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