

TLV2231 Advanced, Rail-to-Rail, Low-Power, Single, LinCMOS™ Operational Amplifier

1 Features

- Output swing includes both supply rails
- Low noise: 15nV/√Hz typ at f = 1kHz
- Low input bias current: 1pA typ
- Fully specified for single-supply 3V and 5V operation
- Common-mode input voltage range includes negative rail
- High gain bandwidth: 2MHz at $V_{DD} = 5V$ with 600Ω load
- High slew rate: 1.6V/μs at $V_{DD} = 5V$
- Wide supply voltage range: 2.7V to 10V

2 Applications

- [Low-power audio preamplifier](#)
- [Multiplexed data-acquisition systems](#)
- [Test and measurement equipment](#)
- [Optical module](#)
- [Programmable logic controllers](#)
- [Server PSU](#)

3 Description

The TLV2231 is a single low-voltage operational amplifier available in the SOT-23 package. The TLV2231 offers 2MHz of bandwidth and 1.6V/μs of slew rate for applications requiring good ac performance. The device exhibits rail-to-rail output performance for increased dynamic range in single- or split-supply applications. The TLV2231 is fully characterized at 3V and 5V and is optimized for low-voltage applications.

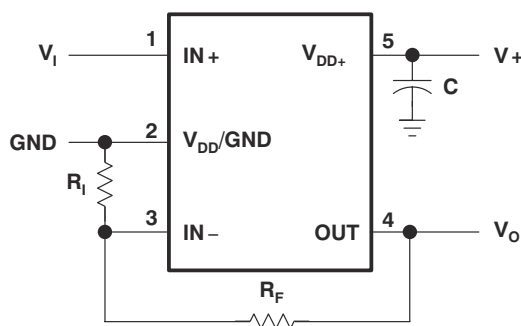
The TLV2231, with a high input impedance and low noise, is excellent for small-signal conditioning of high-impedance sources, such as piezoelectric transducers. As a result of the micropower dissipation levels combined with 3V operation, these devices work well in hand-held monitoring and remote-sensing applications. In addition, the rail-to-rail output feature with single- or split-supplies makes this family a great choice when interfacing with analog-to-digital converters (ADCs). The device also drives 600Ω loads for telecom applications.

With a total area of 5.6mm², the SOT-23 package only requires one-third the board space of the standard 8-pin SOIC package. This ultra-small package allows designers to place single amplifiers very close to the signal source, and minimizes noise pick-up from long printed circuit board (PCB) traces. TI also takes special care to provide a pinout that is optimized for board layout (see the following figure). Both inputs are separated by ground to prevent coupling or leakage paths. The OUT and IN– pins are on the same end of the board to provide negative feedback. Finally, gain setting resistors and the decoupling capacitor are easily placed around the package.

Package Information

PART NUMBER ⁽¹⁾	PACKAGE ⁽²⁾	PACKAGE SIZE ⁽³⁾
TLV2231	DBV (SOT-23, 5)	2.9mm × 2.8mm

- (1) See [Section 4](#).
- (2) For all available packages, see [Section 10](#).
- (3) The package size (length × width) is a nominal value and includes pins, where applicable.



Typical Surface-Mount Layout for a Fixed-Gain Noninverting Amplifier



Table of Contents

1 Features	1	6.8 Typical Characteristics	8
2 Applications	1	7 Application and Implementation	15
3 Description	1	7.1 Application Information.....	15
4 Available Options	2	8 Device and Documentation Support	16
5 Pin Configuration and Functions	2	8.1 Receiving Notification of Documentation Updates....	16
6 Specifications	3	8.2 Support Resources.....	16
6.1 Absolute Maximum Ratings.....	3	8.3 Trademarks.....	16
6.2 Dissipation Ratings.....	3	8.4 Electrostatic Discharge Caution.....	16
6.3 Recommended Operating Conditions.....	3	8.5 Glossary.....	16
6.4 Electrical Characteristics: $V_{DD} = 3V$	4	9 Revision History	16
6.5 Operating Characteristics, $V_{DD} = 3V$	5	10 Mechanical, Packaging, and Orderable Information	17
6.6 Electrical Characteristics, $V_{DD} = 5V$	6		
6.7 Operating Characteristics, $V_{DD} = 5V$	7		

4 Available Options

T_A	$V_{IO} \text{ MAX AT } +25^\circ\text{C}$	PACKAGED DEVICES	SYMBOL
		SOT23 (DBV) ⁽¹⁾	
0°C to +70°C	3mV	TLV2231CDBV	VAEC
–40°C to +85°C	3mV	TLV2231IDBV	VAEI

(1) The DBV package is available in tape and reel only.

5 Pin Configuration and Functions

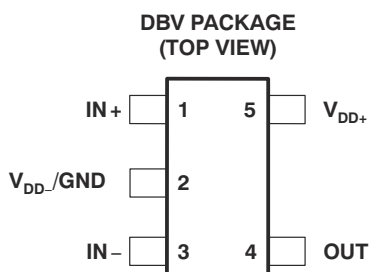


Table 5-1. Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
IN–	3	Input	Inverting input
IN+	1	Input	Noninverting input
OUT	4	Output	Output
V_{DD+}	5	Power	Positive (highest) power supply
V_{DD-}/GND	2	Power	Negative (lowest) power supply

6 Specifications

6.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V _{DD}	Supply voltage ⁽²⁾			12	V
V _{ID}	Differential input voltage ⁽³⁾		–V _{DD}	+V _{DD}	V
V _I	Input voltage range ⁽²⁾ , any input		–0.3V	V _{DD}	V
I _I	Input current, each input		–5	5	mA
I _O	Output current		–50	50	mA
	Total current into V _{DD+}		–50	50	mA
	Total current out of V _{DD–}		–50	50	mA
	Duration of short-circuit current at (or less than) 25°C ⁽⁴⁾			Unlimited	
	Continuous total power dissipation			See Section 6.2	
T _A	Operating free-air temperature	TLV2231C	0	70	°C
		TLV2231I	–40	85	
T _{stg}	Storage temperature		–65	150	°C
	Lead temperature 1.6mm (1/16inch) from case for 10s, DBV package			260	°C

- (1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
- (2) All voltage values, except differential voltages, are with respect to V_{DD–}.
- (3) Differential voltages are at the noninverting input with respect to the inverting input. Excessive current flows when input is brought to less than (V_{DD–}) – (0.3V).
- (4) The output is able to be shorted to either supply. Limit temperature, supply voltages, or both to not exceed the maximum dissipation rating.

6.2 Dissipation Ratings

PACKAGE	T _A ≤ +25°C POWER RATING	DERATING FACTOR ABOVE T _A = +25°C	T _A = +70°C POWER RATING	T _A = +85°C POWER RATING
DBV	150mW	1.2mW/°C	96mW	78mW

6.3 Recommended Operating Conditions

		TLV2231C		TLV2231I		UNIT
		MIN	MAX	MIN	MAX	
V _{DD}	Supply voltage ⁽¹⁾	2.7	10	2.7	10	V
V _I	Input voltage	V _{DD–}	(V _{DD+}) – 1.3	V _{DD–}	(V _{DD+}) – 1.3	V
V _{IC}	Common-mode input voltage	V _{DD–}	(V _{DD+}) – (1.3)	V _{DD–}	(V _{DD+}) – (1.3)	V
T _A	Operating free-air temperature	0	70	–40	85	°C

- (1) All voltage values, except differential voltages, are with respect to V_{DD–}.

6.4 Electrical Characteristics: $V_{DD} = 3V$

at specified free-air temperature and $V_{DD} = 3V$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T _A ⁽¹⁾	TLV2231C, TLV2231I			UNIT
					MIN	TYP	MAX	
V _{IO}	Input offset voltage	V _{DD±} = ±1.5V, V _{IC} = 0V, V _O = 0V, R _S = 50Ω		Full range		0.75	3	mV
α _{VIO}	Temperature coefficient of input offset voltage	V _{DD±} = ±1.5V, V _{IC} = 0V, V _O = 0V, R _S = 50Ω		Full range		0.5		μV/°C
I _{IO}	Input offset current ⁽²⁾	V _{DD±} = ±1.5V, V _{IC} = 0V, V _O = 0V, R _S = 50Ω		25°C		0.5	60	pA
				Full range			150	
I _{IB}	Input bias current ⁽²⁾	V _{DD±} = ±1.5V, V _{IC} = 0V, V _O = 0V, R _S = 50Ω		25°C		1	60	pA
				Full range			150	
V _{ICR}	Common-mode input voltage range	R _S = 50Ω, V _{IO} ≤ 5mV		25°C	0 to 2			V
V _{OH}	High-level output voltage	I _{OH} = −1mA		25°C	2.87			V
		I _{OH} = −2mA		25°C	2.74			
				Full range	2			
V _{OL}	Low-level output voltage	V _{IC} = 1.5V, I _{OL} = 50μA		25°C	10			mV
		V _{IC} = 1.5V, I _{OL} = 500μA		25°C	100			
				Full range	300			
A _{VD}	Large-signal differential voltage amplification	V _{IC} = 1.5V, V _O = 1V to 2V	R _L = 600Ω ⁽³⁾	25°C	1	1.6		V/mV
			R _L = 1MΩ ⁽³⁾	Full range	0.3			
					25°C	250		
r _{id}	Differential input resistance			25°C	540			GΩ
r _{ic}	Common-mode input resistance			25°C	1			TΩ
C _{ic}	Common-mode input capacitance	f = 10kHz		25°C	1			pF
Z _o	Open-loop output impedance	f = 1MHz, I _O = 0A		25°C	525			Ω
CMRR	Common-mode rejection ratio	V _{IC} = 0V to 1.7V, V _O = 1.5V, R _S = 50Ω		25°C	54	70		dB
				Full range	54			
k _{SVR}	Supply voltage rejection ratio (ΔV _{DD} /ΔV _{IO})	V _{DD} = 2.7V to 8V, V _{IC} = V _{DD} /2, no load		25°C	70	96		dB
				Full range	70			
I _{DD}	Supply current	V _O = 1.5V, no load		25°C		750	1200	μA
				Full range		1500		

(1) Full range for the TLV2231C is 0°C to 70°C. Full range for the TLV2231I is –40°C to +85°C.

(2) Specified by characterization.

(3) Referenced to 1.5V.

6.5 Operating Characteristics, $V_{DD} = 3V$

at specified free-air temperature and $V_{DD} = 3V$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A ⁽¹⁾	TLV2231C, TLV2231I			UNIT
				MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = 1.1V$ to $1.9V$, $R_L = 600\Omega$ ⁽²⁾ , $C_L = 100pF$ ⁽²⁾	+25°C	0.24	0.25		V/ μs
			Full range	0.24			V/ μs
V_n	Equivalent input noise voltage	$f = 1kHz$	+25°C		16		nV/ $\sqrt{Hz}$
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1Hz$ to $10Hz$	+25°C		1.8		μV
I_n	Equivalent input noise current		+25°C		2		fA/ $\sqrt{Hz}$
THD+N	Total harmonic distortion plus noise		+25°C	See Section 6.8			
	Gain-bandwidth product	$f = 10kHz$, $R_L = 600\Omega$ ⁽²⁾ , $C_L = 100pF$ ⁽²⁾	+25°C		1.9		MHz
B_{OM}	Maximum output swing bandwidth	$V_{O(PP)} = 1V$, $A_V = 1$, $R_L = 600\Omega$ ⁽²⁾ , $C_L = 100pF$ ⁽²⁾	+25°C		60		kHz
ϕ_m	Phase margin at unity gain	$R_L = 600\Omega$ ⁽²⁾ , $C_L = 100pF$ ⁽²⁾	+25°C		50		°

(1) Full range is –40°C to +85°C.

(2) Referenced to 1.5V.

6.6 Electrical Characteristics, $V_{DD} = 5V$

at specified free-air temperature and $V_{DD} = 5V$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A ⁽¹⁾	TLV2231C, TLV2231I			UNIT
				MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{DD\pm} = \pm 2.5V$, $V_{IC} = 0$, $V_O = 0$, $R_S = 50\Omega$	Full range		0.71	3	mV
α_{VIO}	Temperature coefficient of input offset voltage	$V_{DD\pm} = \pm 2.5V$, $V_{IC} = 0$, $V_O = 0$, $R_S = 50\Omega$	Full range		0.5		$\mu V/^\circ C$
I_{IO}	Input offset current ⁽²⁾	$V_{DD\pm} = \pm 2.5V$, $V_{IC} = 0$, $V_O = 0$, $R_S = 50\Omega$	+25°C		0.5	60	pA
			Full range			150	pA
I_{IB}	Input bias current ⁽²⁾	$V_{DD\pm} = \pm 2.5V$, $V_{IC} = 0$, $V_O = 0$, $R_S = 50\Omega$	+25°C		1	60	pA
			Full range			150	pA
V_{ICR}	Common-mode input voltage range	$R_S = 50\Omega$, $ V_{IO} \leq 5mV$	+25°C	0 to 4			V
V_{OH}	High-level output voltage	$I_{OH} = -1mA$	+25°C		4.9		V
		$I_{OH} = -4mA$	+25°C		4.6		V
			Full range	4			V
V_{OL}	Low-level output voltage	$V_{IC} = 2.5V$, $I_{OL} = 500\mu A$	+25°C		80		mV
		$V_{IC} = 2.5V$, $I_{OL} = 1mA$	+25°C		160		mV
			Full range			500	mV
A_{VD}	Large-signal differential voltage amplification	$V_{IC} = 2.5V$, $V_O = 1V$ to $4V$	+25°C	1	1.5		V/mV
			Full range	0.3			V/mV
			+25°C		400		V/mV
r_{id}	Differential input resistance		+25°C		540		GΩ
r_{ic}	Common-mode input resistance		+25°C		1		TΩ
c_{ic}	Common-mode input capacitance	$f = 10kHz$	+25°C		1		pF
z_o	Open-loop output impedance	$f = 1MHz$, $I_O = 0A$	+25°C		525		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = 0V$ to $2.7V$, $V_O = 2.5V$, $R_S = 50\Omega$	+25°C	60	70		dB
			Full range	55			dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 4.4V$ to $8V$, $V_{IC} = V_{DD}/2$, no load	+25°C	70	96		dB
			Full range	70			dB
I_{DD}	Supply current	$V_O = 2.5V$, no load	+25°C		850	1300	μA
			Full range			1600	μA

(1) Full range for the TLV2231C is 0°C to 70°C. Full range for the TLV2231I is –40°C to +85°C.

(2) Specified by characterization.

(3) Referenced to 2.5V.

6.7 Operating Characteristics, $V_{DD} = 5V$

at specified free-air temperature and $V_{DD} = 5V$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A ⁽¹⁾	TLV2231C, TLV2231I			UNIT
				MIN	TYP	MAX	
SR	Slew rate at unity gain	$V_O = 1.5V$ to $3.5V$, $R_L = 600\Omega$ ⁽²⁾ , $C_L = 100pF$ ⁽²⁾	+25°C	1	1.6		V/ μs
			Full range	0.7			V/ μs
V_n	Equivalent input noise voltage	$f = 1kHz$	+25°C		15		nV/ $\sqrt{Hz}$
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1Hz$ to $10Hz$	+25°C		1.8		μV
I_n	Equivalent input noise current		+25°C		2		fA/ $\sqrt{Hz}$
THD+N	Total harmonic distortion plus noise		+25°C	See Section 6.8			
	Gain-bandwidth product	$f = 10kHz$, $R_L = 600\Omega$ ⁽²⁾ , $C_L = 100pF$ ⁽²⁾	+25°C		2		MHz
B_{OM}	Maximum output swing bandwidth	$V_{O(PP)} = 1V$, $A_V = 1$, $R_L = 600\Omega$ ⁽²⁾ , $C_L = 100pF$ ⁽²⁾	+25°C		300		kHz
ϕ_m	Phase margin at unity gain	$R_L = 600\Omega$ ⁽²⁾ , $C_L = 100pF$ ⁽²⁾	+25°C		48		°

(1) Full range is –40°C to +85°C.

(2) Referenced to 2.5V.

6.8 Typical Characteristics

data at high and low temperatures applicable only within rated operating free-air temperature ranges of the various devices

Table 6-1. Table of Graphs

V_{IO}	Input offset voltage	Distribution	Figure 6-1, Figure 6-2
		vs Common-mode input voltage	Figure 6-3, Figure 6-4
αV_{IO}	Input offset voltage temperature coefficient	Distribution	Figure 6-5, Figure 6-6
I_B/I_{IO}	Input bias and input offset currents	vs Free-air temperature	Figure 6-7
V_{OH}	High-level output voltage	vs High-level output current	Figure 6-8, Figure 6-10
V_{OL}	Low-level output voltage	vs Low-level output current	Figure 6-9, Figure 6-11
I_{OS}	Short-circuit output current	vs Free-air temperature	Figure 6-12
A_{VD}	Large-signal differential voltage amplification	vs Frequency	Figure 6-13, Figure 6-14
		vs Free-air temperature	Figure 6-15
CMRR	Common-mode rejection ratio	vs Frequency	Figure 6-16
		vs Free-air temperature	Figure 6-17, Figure 6-18
k_{SVR}	Supply-voltage rejection ratio	vs Frequency	Figure 6-19
		vs Free-air temperature	Figure 6-20
I_{DD}	Supply current	vs Supply voltage	Figure 6-21, Figure 6-22
V_O	Inverting large-signal pulse response	vs Time	Figure 6-23, Figure 6-24
V_O	Voltage-follower large-signal pulse response	vs Time	Figure 6-25, Figure 6-26
V_O	Inverting small-signal pulse response	vs Time	Figure 6-27, Figure 6-28
V_O	Voltage-follower small-signal pulse response	vs Time	Figure 6-29, Figure 6-30
V_n	Equivalent input noise voltage	vs Frequency	Figure 6-31
	Noise voltage (referred to input)	Over a 10-second period	Figure 6-32
THD + N	Total harmonic distortion plus noise	vs Frequency	Figure 6-33
ϕ_m	Phase margin	vs Load capacitance	

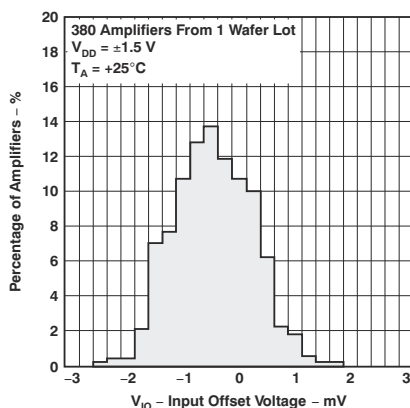


Figure 6-1. Distribution of TLV2231 Input Offset Voltage

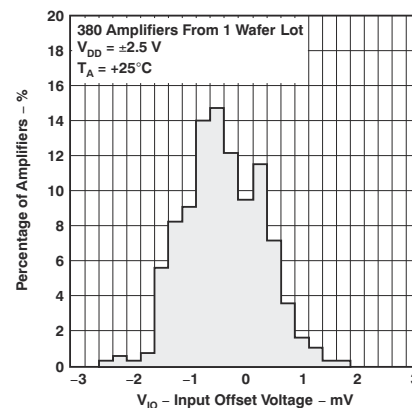


Figure 6-2. Distribution of TLV2231 Input Offset Voltage

6.8 Typical Characteristics (continued)

data at high and low temperatures applicable only within rated operating free-air temperature ranges of the various devices

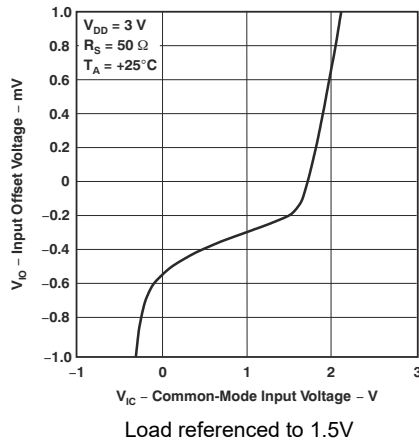


Figure 6-3. Input Offset Voltage vs Common-Mode Input Voltage

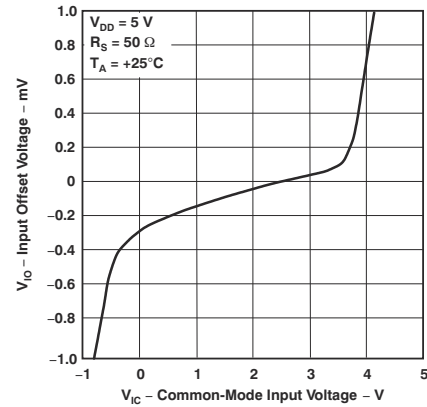


Figure 6-4. Input Offset Voltage vs Common-Mode Input Voltage

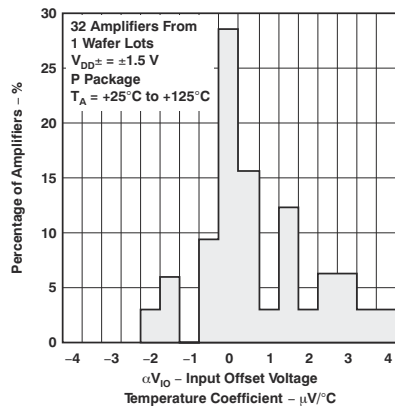


Figure 6-5. Distribution of TLV2231 Input Offset voltage Temperature Coefficient

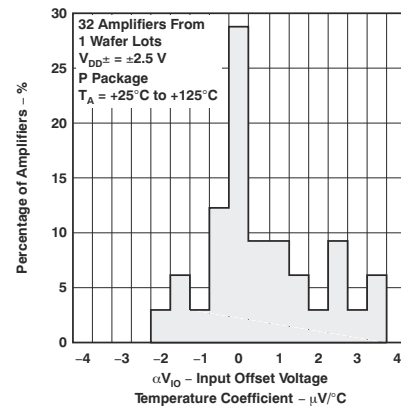


Figure 6-6. Distribution of TLV2231 Input Offset voltage Temperature Coefficient

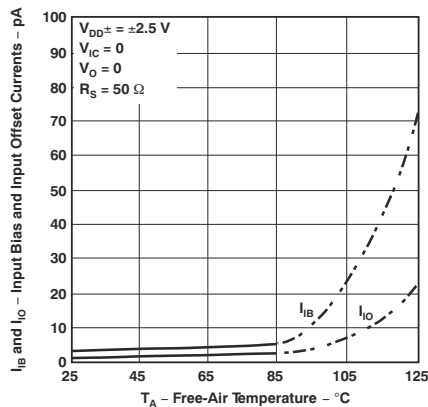


Figure 6-7. Input Bias and Input Offset Currents vs Free-Air Temperature

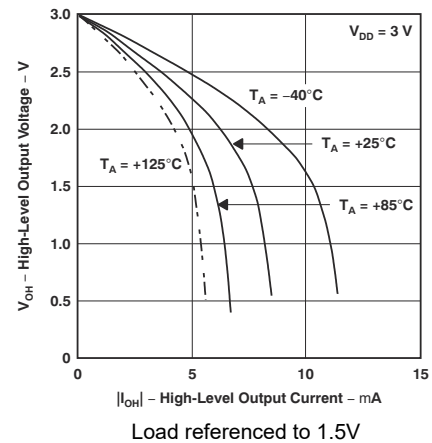


Figure 6-8. High-Level Output Voltage vs High-Level Output Current

6.8 Typical Characteristics (continued)

data at high and low temperatures applicable only within rated operating free-air temperature ranges of the various devices

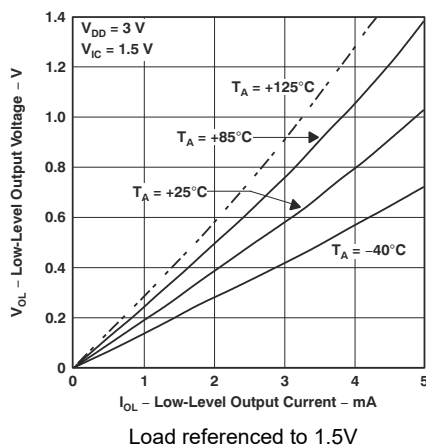


Figure 6-9. Low-level Output Voltage vs Low-Level Output Current

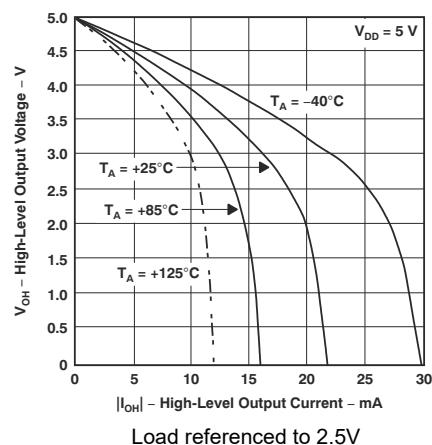


Figure 6-10. High-Level Output Voltage vs High-Level Output Current

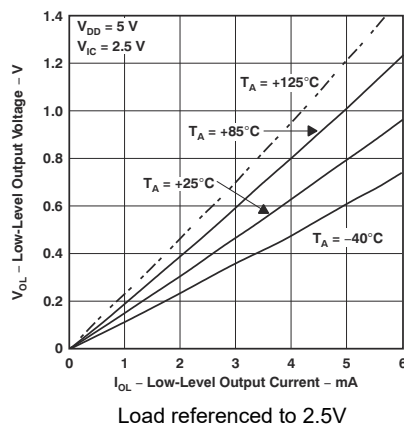


Figure 6-11. Low-Level Output Voltage vs Low-Level Output Current

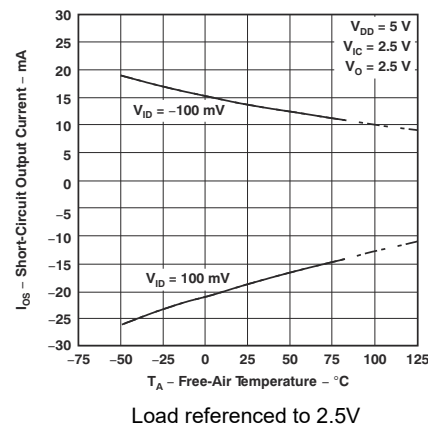


Figure 6-12. Short-Circuit Output Current vs Free-Air Temperature

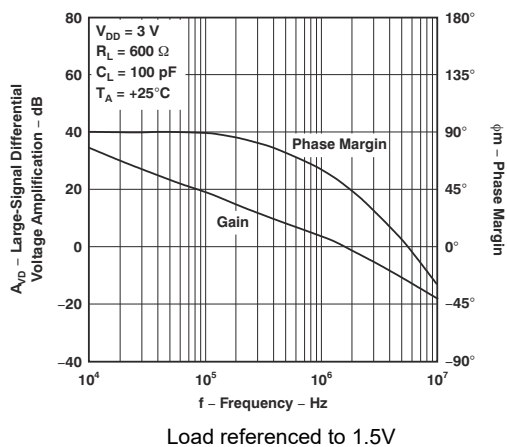


Figure 6-13. Large-Signal Differential Voltage Amplification and Phase Margin vs Frequency

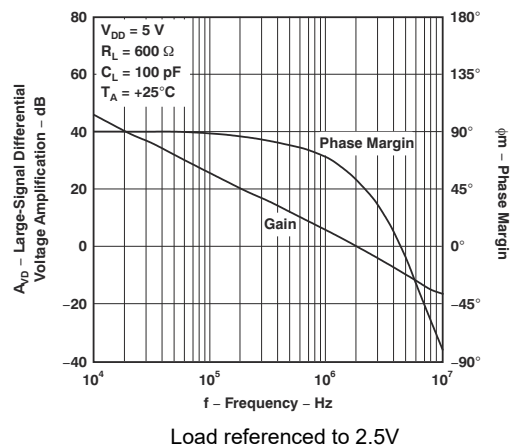


Figure 6-14. Large-Signal Differential Voltage Amplification and Phase Margin vs Frequency

6.8 Typical Characteristics (continued)

data at high and low temperatures applicable only within rated operating free-air temperature ranges of the various devices

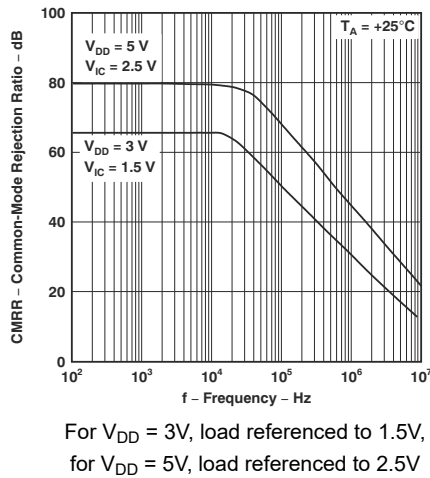


Figure 6-15. Common-Mode Rejection Ratio vs Frequency

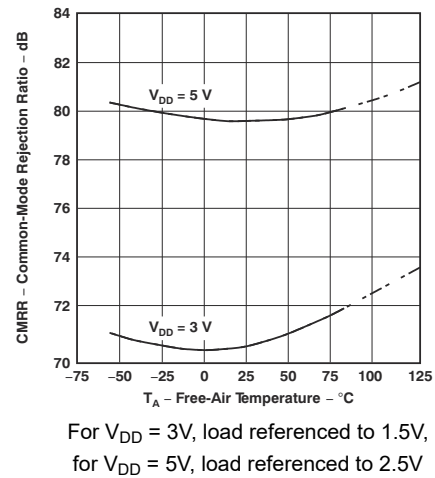


Figure 6-16. Common-Mode Rejection Ratio vs Free-Air Temperature

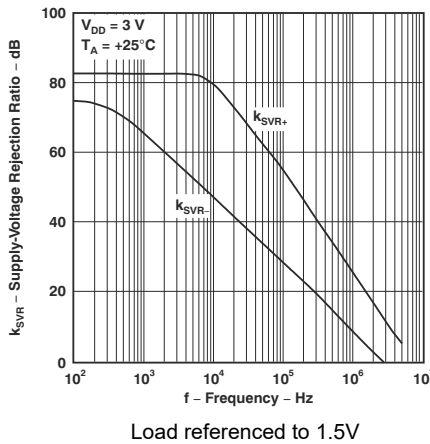


Figure 6-17. Supply-Voltage Rejection Ratio vs Frequency

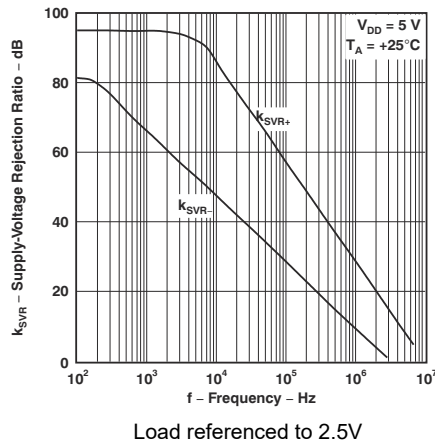


Figure 6-18. Supply-Voltage Rejection Ratio vs Frequency

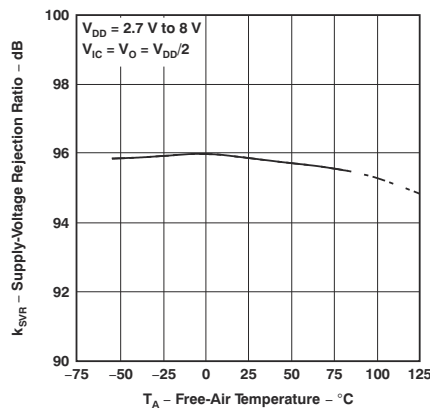


Figure 6-19. Supply-Voltage Rejection Ratio vs Free-Air Temperature

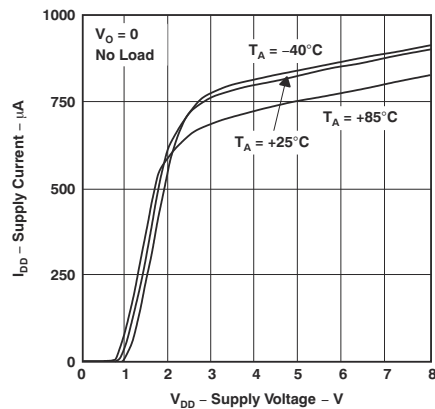


Figure 6-20. Supply Current vs Supply Voltage

6.8 Typical Characteristics (continued)

data at high and low temperatures applicable only within rated operating free-air temperature ranges of the various devices

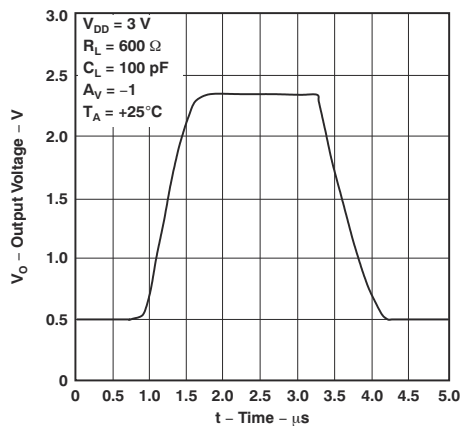
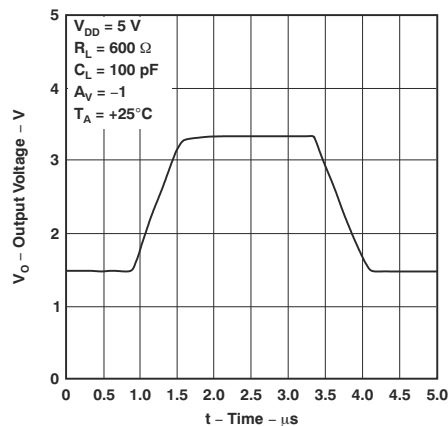
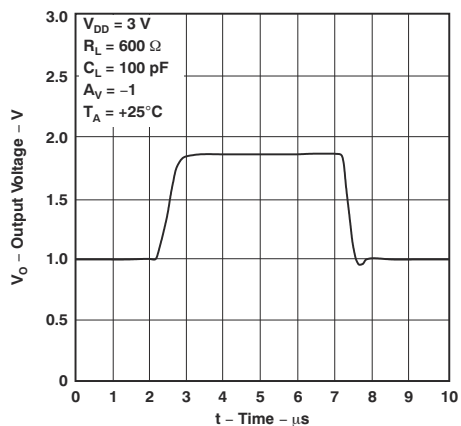


Figure 6-21. Inverting Large-Signal Pulse Response



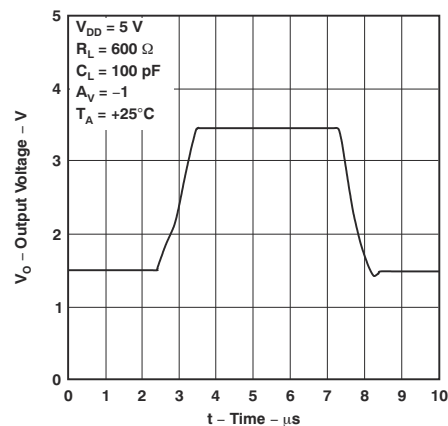
Load referenced to 2.5V

Figure 6-22. Inverting Large-Signal Pulse Response



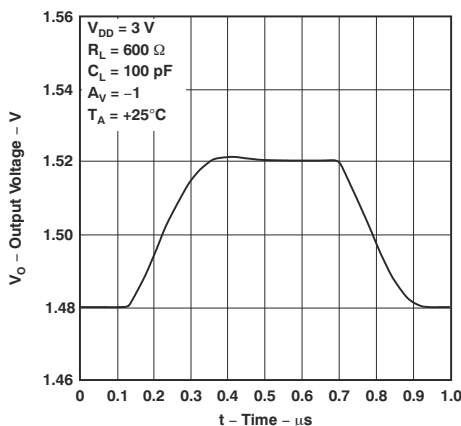
Load referenced to 1.5V

Figure 6-23. Voltage-Follower Large-Signal Pulse Response



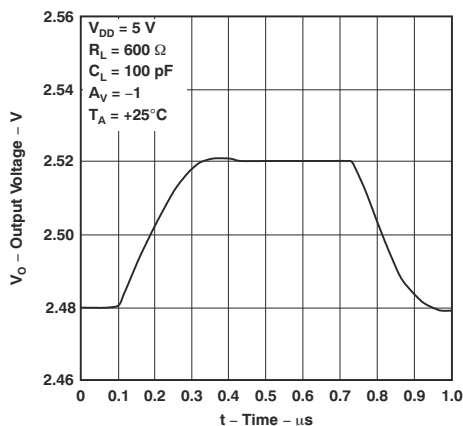
Load referenced to 2.5V

Figure 6-24. Voltage-Follower Large-Signal Pulse Response



Load referenced to 1.5V

Figure 6-25. Inverting Small-Signal Pulse Response



Load referenced to 2.5V

Figure 6-26. Inverting Small-Signal Pulse Response

6.8 Typical Characteristics (continued)

data at high and low temperatures applicable only within rated operating free-air temperature ranges of the various devices

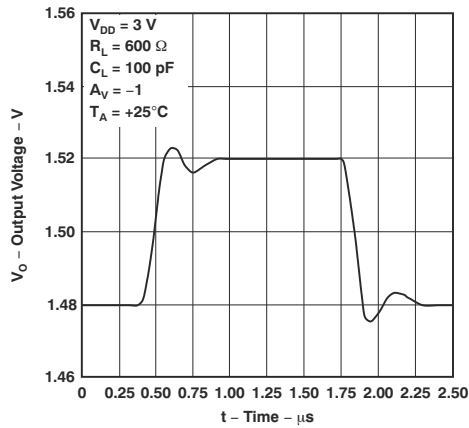


Figure 6-27. Voltage-Follower Small-Signal Pulse Response

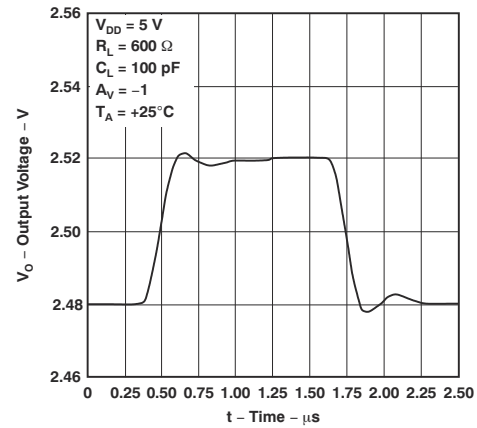


Figure 6-28. Voltage-Follower Small-Signal Pulse Response

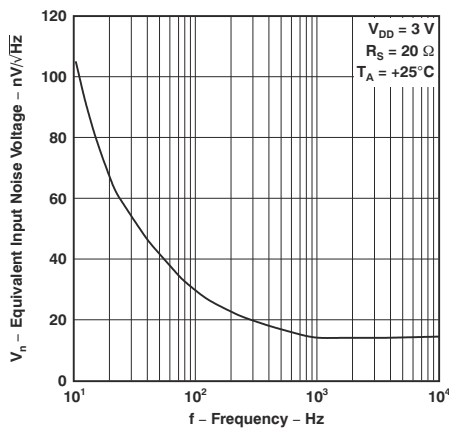


Figure 6-29. Equivalent Input Noise Voltage vs Frequency

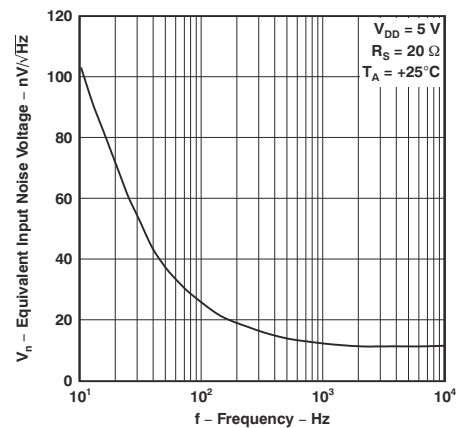


Figure 6-30. Equivalent Input Noise Voltage vs Frequency

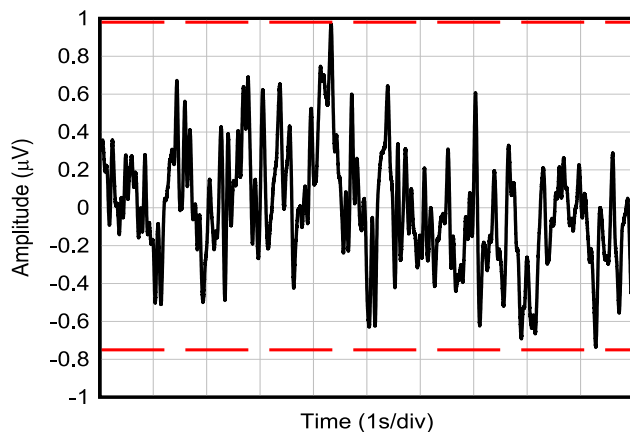


Figure 6-31. Input Noise Voltage Over a 10-Second Period

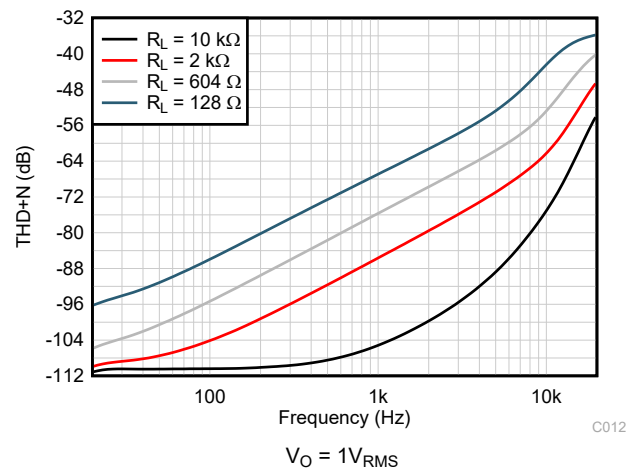


Figure 6-32. Total Harmonic Distortion Plus Noise vs Frequency

6.8 Typical Characteristics (continued)

data at high and low temperatures applicable only within rated operating free-air temperature ranges of the various devices

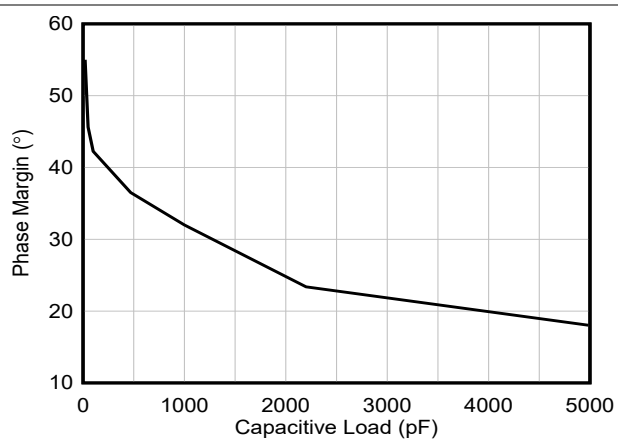


Figure 6-33. Phase Margin vs Load Capacitance

7 Application and Implementation

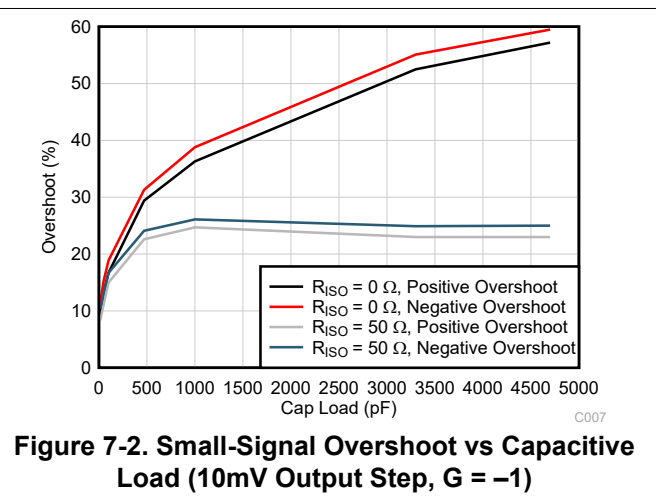
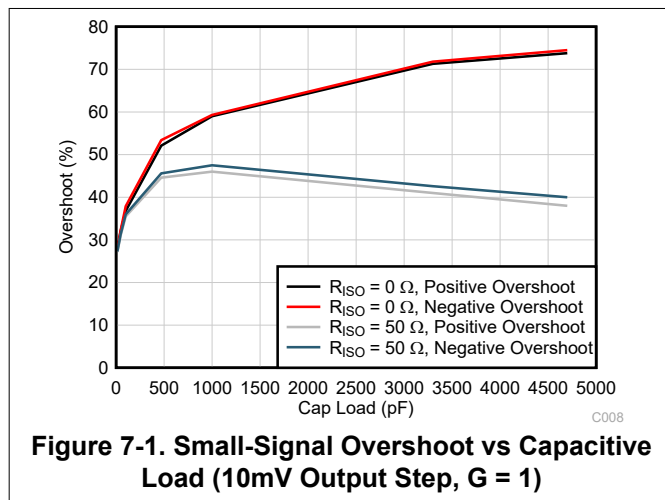
Note

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, as well as validating and testing their design implementation to confirm system functionality.

7.1 Application Information

7.1.1 Driving Large Capacitive Loads

The TLV2231 features a resistive output stage capable of driving moderate capacitive loads. By leveraging an isolation resistor, the device is easily configured to drive large capacitive loads. Increasing the gain enhances the ability of the amplifier to drive greater capacitive loads; see [Figure 7-1](#) and [Figure 7-2](#). The particular op amp circuit configuration, layout, gain, and output loading are some of the factors to consider when establishing whether an amplifier is stable in operation.



For additional drive capability in unity-gain configurations, improve capacitive load drive by inserting a small resistor, R_{ISO} , in series with the output; see [Figure 7-3](#). This resistor significantly reduces ringing and maintains dc performance for purely capacitive loads. However, if a resistive load is in parallel with the capacitive load, then a voltage divider is created. Thus a gain error is introduced at the output and a slight reduction the output swing. The error introduced is proportional to the ratio R_{ISO} / R_L , and is typically negligible at low output levels. A high capacitive load drive makes the TLV2231 an excellent choice for applications such as reference buffers, MOSFET gate drives, and cable-shield drives. The circuit in [Figure 7-3](#) uses an isolation resistor, R_{ISO} , to stabilize the output of an op amp. R_{ISO} modifies the open-loop gain of the system for increased phase margin.

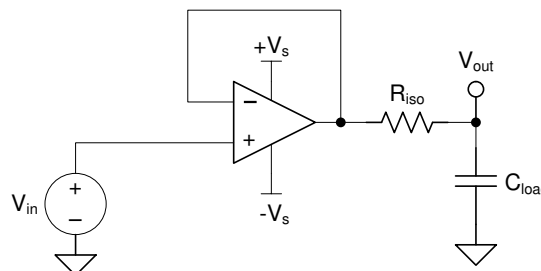


Figure 7-3. Extending Capacitive Load Drive With the TLV2231

8 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

8.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

8.2 Support Resources

TI E2E™ support forums are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is 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](#).

8.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.

All trademarks are the property of their respective owners.

8.4 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

8.5 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

9 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision D (April 2001) to Revision E (July 2025)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document.....	1
• Added <i>Applications, Pin Configuration and Functions, Specifications, Application and Implementation, Device and Documentation Support, and Mechanical, Packaging, and Orderable Information</i> sections.....	1
• Deleted TLV2231Y device and associated content from data sheet.....	1
• Deleted "Macromodel Included" from <i>Features</i>	1
• Deleted equivalent schematic.....	2
• Deleted input offset voltage long-term drift and associated table note.....	4
• Deleted common-mode input voltage range typical value.....	4
• Deleted common-mode input voltage range for full temperature range.....	4
• Changed differential input resistance typical value from $10^{12}\Omega$ to $540G\Omega$	4
• Changed unit of common-mode input resistance from $10^{12}\Omega$ to $1T\Omega$	4
• Changed common-mode input capacitance typical value from 6pF to 1pF.....	4
• Changed output impedance from closed-loop to open-loop.....	4
• Changed output impedance test condition from $A_V = 1$ to $I_O = 0A$	4
• Changed output impedance from 156Ω to 525Ω	4
• Changed CMRR minimum value for room temperature from 60dB to 54dB.....	4
• Changed CMRR minimum value for full temperature range from 55dB to 54dB.....	4
• Added table note 2 to input bias current and input offset current.....	4
• Changed slew rate typical value for room temperature from $1.25V/\mu s$ to $0.25V/\mu s$	5

• Changed slew rate minimum value for room temperature from 0.75V/μs to 0.24V/μs.....	5
• Changed slew rate minimum value for full temperature range from 0.5V/μs to 0.24V/μs.....	5
• Deleted equivalent input noise voltage for f = 10Hz.....	5
• Deleted peak-to-peak equivalent input noise voltage for f = 0.1Hz to 1Hz.....	5
• Changed peak-to-peak equivalent input noise voltage for f = 0.1Hz to 10Hz from 1.5μV to 1.8μV.....	5
• Changed equivalent input noise current typical value from 0.6fA/√Hz to 2fA/√Hz	5
• Deleted THD+N test conditions and changed values to "see <i>Typical Characteristics</i> ".....	5
• Deleted settling time.....	5
• Deleted gain margin.....	5
• Deleted input offset voltage long-term drift and associated table note.....	6
• Deleted common-mode input voltage range typical value.....	6
• Deleted common-mode input voltage range for full temperature range.....	6
• Changed differential input resistance typical value from 10 ¹² Ω to 540GΩ.....	6
• Changed common-mode input resistance from 10 ¹² Ω to 1TΩ.....	6
• Changed common-mode input capacitance from 6pF to 1pF.....	6
• Changed output impedance from closed-loop to open-loop.....	6
• Changed output impedance test condition from A _V = 1 to I _O = 0A.....	6
• Changed output impedance typical value from 138Ω to 525Ω.....	6
• Added table note to input bias current and input offset current.....	6
• Deleted equivalent input noise voltage for f = 10Hz.....	7
• Deleted peak-to-peak equivalent input noise voltage for f = 0.1Hz to 1Hz.....	7
• Changed peak-to-peak equivalent input noise voltage for f = 0.1Hz to 10Hz from 1.5μV to 1.8μV.....	7
• Changed equivalent input noise current typical value from 0.6fA/√Hz to 2fA/√Hz	7
• Deleted THD+N test conditions and changed values to "see <i>Typical Characteristics</i> ".....	7
• Deleted settling time.....	7
• Deleted gain margin.....	7
• Deleted Figures 9, 10, 12, 16, 17, 19–21, 24–27, 34, 35, 48–55,	8
• Updated Figure 6-31, 6-32, and 6-33.....	8
• Updated <i>Driving Large Capacitive Loads</i> section.....	15
• Deleted <i>Macromodel Information</i> section.....	15

10 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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)
TLV2231IDBVR	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	VAEI
TLV2231IDBVR.A	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	VAEI

⁽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.

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
TLV2231IDBVR	SOT-23	DBV	5	3000	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV2231IDBVR	SOT-23	DBV	5	3000	182.0	182.0	20.0

EXAMPLE BOARD LAYOUT

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

4214839/K 08/2024

NOTES: (continued)

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

EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4214839/K 08/2024

NOTES: (continued)

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

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](#) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2025, Texas Instruments Incorporated