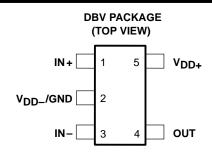
- Output Swing Includes Both Supply Rails
- Low Noise . . . 15 nV/ $\sqrt{\text{Hz}}$ Typ at f = 1 kHz
- Low Input Bias Current . . . 1 pA Typ
- Fully Specified for Single-Supply 3-V and 5-V Operation
- Common-Mode Input Voltage Range Includes Negative Rail
- High Gain Bandwidth . . . 2 MHz at
 V_{DD} = 5 V With 600-Ω Load
- High Slew Rate . . . 1.6 V/μs at V_{DD} = 5 V
- Wide Supply Voltage Range 2.7 V to 10 V
- Macromodel Included



description

The TLV2231 is a single low-voltage operational amplifier available in the SOT-23 package. It offers 2 MHz of bandwidth and 1.6 V/ μ s 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 3 V and 5 V and is optimized for low-voltage applications.

The TLV2231, exhibiting high input impedance and low noise, is excellent for small-signal conditioning of high-impedance sources, such as piezoelectric transducers. Because of the micropower dissipation levels combined with 3-V 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 can also drive $600-\Omega$ 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, minimizing noise pick-up from long PCB traces. TI has also taken special care to provide a pinout that is optimized for board layout (see Figure 1). Both inputs are separated by GND to prevent coupling or leakage paths. The OUT and IN- terminals are on the same end of the board for providing negative feedback. Finally, gain setting resistors and the decoupling capacitor are easily placed around the package.

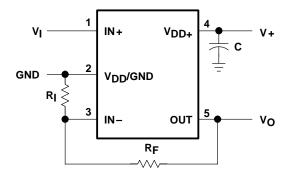


Figure 1. Typical Surface Mount Layout for a Fixed-Gain Noninverting Amplifier



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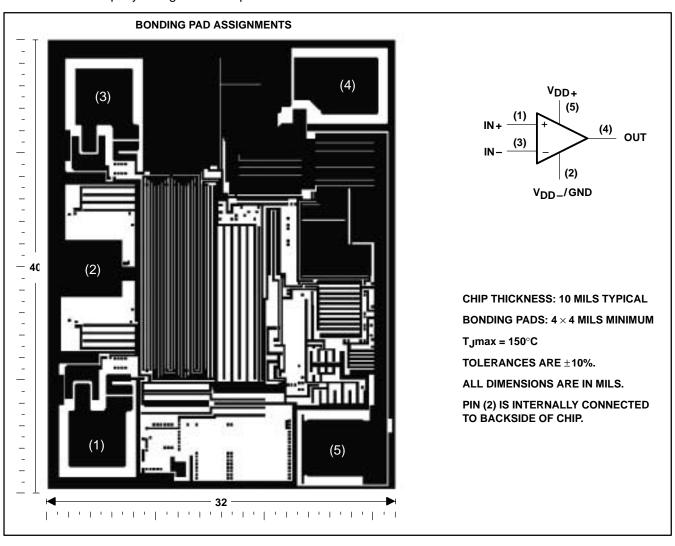
AVAILABLE OPTIONS

т.	V may AT 25°C	PACKAGED DEVICES	SYMBOL	CHIP FORM‡
T _A	V _{IO} max AT 25°C	SOT-23 (DBV) [†]	STWIBOL	(Y)
0°C to 70°C	3 mV	TLV2231CDBV	VAEC	TLV2231Y
-40°C to 85°C	3 mV	TLV2231IDBV	VAEI	11022311

[†] The DBV package available in tape and reel only.

TLV2231Y chip information

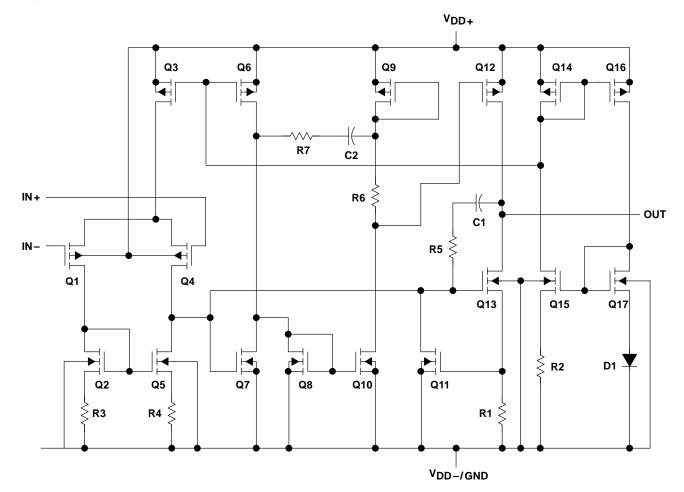
This chip, when properly assembled, displays characteristics similar to the TLV2231C. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. This chip may be mounted with conductive epoxy or a gold-silicon preform.





[‡] Chip forms are tested at $T_A = 25$ °C only.

equivalent schematic



COMPONENT COUNT [†]						
Transistors	23					
Diodes	5					
Resistors	11					
Capacitors	2					

[†] Includes both amplifiers and all ESD, bias, and trim circuitry

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V _{DD} (see Note 1)	12 V
Differential input voltage, V _{ID} (see Note 2)	±V _{DD}
Input voltage range, V _I (any input, see Note 1)	0.3 V to V _{DD}
Input current, I _I (each input)	±5 mA
Output current, I _O	±50 mA
Total current into V _{DD+}	±50 mA
Total current out of V _{DD}	±50 mA
Duration of short-circuit current (at or below) 25°C (see Note 3)	unlimited
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, T _A : TLV2231C	0°C to 70°C
TLV2231I	40°C to 85°C
Storage temperature range, T _{stq}	–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: DBV package	

[†] 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.

- NOTES: 1. All voltage values, except differential voltages, are with respect to V_{DD} _.
 - 2. Differential voltages are at the noninverting input with respect to the inverting input. Excessive current flows when input is brought below V_{DD} = 0.3 V.
 - 3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

DISSIPATION RATING TABLE

PACKAGE	$T_{\mbox{A}} \le 25^{\circ}\mbox{C}$ POWER RATING	DERATING FACTOR ABOVE T _A = 25°C	T _A = 70°C POWER RATING	T _A = 85°C POWER RATING
DBV	150 mW	1.2 mW/°C	96 mW	78 mW

recommended operating conditions

	TL	V2231C	Τι	UNIT	
	MIN	MAX	MIN	MAX	UNIT
Supply voltage, V _{DD} (see Note 1)	2.7	10	2.7	10	V
Input voltage range, V _I	V _{DD} -	V _{DD+} -1.3	V_{DD-}	V _{DD+} -1.3	V
Common-mode input voltage, V _{IC}	V _{DD} _	V _{DD+} -1.3	V _{DD} _	V _{DD+} -1.3	V
Operating free-air temperature, T _A	0	70	-40	85	°C

NOTE 1: All voltage values, except differential voltages, are with respect to V_{DD} -.



electrical characteristics at specified free-air temperature, $V_{DD} = 3 \text{ V}$ (unless otherwise noted)

					TLV2231C		Т	LV2231	1			
	PARAMETER	TEST CON	IDITIONS	T _A †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT	
۷ıO	Input offset voltage					0.75	3		0.75	3	mV	
αVIO	Temperature coefficient of input offset voltage			Full range		0.5			0.5		μV/°C	
	Input offset voltage long-term drift (see Note 4)	$V_{DD\pm} = \pm 1.5 \text{ V},$ $V_{O} = 0,$		25°C		0.003			0.003		μV/mo	
ΙΙΟ	Input offset current			25°C		0.5	60		0.5	60	pА	
		-		Full range 25°C			150			150		
ΙΒ	Input bias current			Full range		1	60 150		1	60 150	pА	
				Full range		0.0	150		0.0	150		
.,	Common-mode input	D 50.0	N/ 1.45 mV	25°C	0 to 2	-0.3 to 2.2		0 to 2	-0.3 to 2.2		V	
VICR	voltage range	$R_S = 50 \Omega$,	V _{IO} ≤5 mV	Full range	0 to 1.7			0 to 1.7			V	
		$I_{OH} = -1 \text{ mA}$		25°C		2.87			2.87			
∨он	/OH voltage	Jan. 2 mA		25°C		2.74			2.74		V	
	voltage	$I_{OH} = -2 \text{ mA}$		Full range	2			2				
		V _{IC} = 1.5 V,	$I_{OL} = 50 \mu A$	25°C		10			10			
VOL	Low-level output voltage	V _{IC} = 1.5 V,	I _{OL} = 500 μA	25°C		100			100		mV	
		V ₁ C = 1.5 V,	ΙΟΕ = 300 μΑ	Full range			300			300		
	Large-signal	\/ 4 E \/	$R_L = 600 \Omega^{\ddagger}$	25°C	1	1.6		1	1.6			
A_{VD}	differential voltage	$V_{IC} = 1.5 \text{ V},$ $V_{O} = 1 \text{ V to 2 V}$	KL = 000 22+	Full range	0.3			0.3			V/mV	
	amplification		$R_L = 1 M\Omega^{\ddagger}$	25°C		250			250			
^r id	Differential input resistance			25°C		1012			1012		Ω	
r _{ic}	Common-mode input resistance			25°C		1012			1012		Ω	
c _{ic}	Common-mode input capacitance	f = 10 kHz		25°C		6			6		pF	
z _o	Closed-loop output impedance	f = 1 MHz,	A _V = 1	25°C		156			156		Ω	
ONDE	Common-mode	V _{IC} = 0 to 1.7 V,		25°C	60	70		60	70		4F	
CMRR	rejection ratio	$V_0 = 1.5 \text{ V},$	$R_S = 50 \Omega$	Full range	55			55			dB	
ksvr	Supply voltage rejection ratio	$V_{DD} = 2.7 \text{ V to } 8$		25°C	70	96		70	96		dB	
-541	(ΔV _{DD} /ΔV _{IO})	$V_{IC} = V_{DD}/2,$	= V _{DD} /2, No load Full ra	Full range	70			70			dB	
la a	Cumply ourrest	Vo = 1 5 V	No lood	25°C		750	1200		750	1200	^	
IDD	Supply current	$V_0 = 1.5 V$,	No load	Full range			1500			1500	μΑ	

[†] Full range for the TLV2231C is 0°C to 70°C. Full range for the TLV2231I is -40°C to 85°C.



[‡]Referenced to 1.5 V

NOTE 4: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A = 150^{\circ}C$ extrapolated to $T_A = 25^{\circ}C$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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operating characteristics at specified free-air temperature, $V_{DD} = 3 V$

	A D A METED	TEST CONDITIONS		- +	Т	LV22310	:	1	TLV2231	l		
'	PARAMETER	IEST COND	IIIONS	T _A †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT	
	Clausesta at units			25°C	0.75	1.25		0.75	1.25			
SR	Slew rate at unity gain	$V_O = 1.1 \text{ V to } 1.9 \text{ V},$ $C_L = 100 \text{ pF}^{\ddagger}$	$R_L = 600 \Omega^{\ddagger}$,	Full range	0.5			0.5			V/μs	
V	Equivalent input	f = 10 Hz		25°C		105			105		-> //s/I I=	
Vn	noise voltage	f = 1 kHz		25°C		16			16		nV/√Hz	
V (22)	Peak-to-peak	f = 0.1 Hz to 1 Hz		25°C		1.4			1.4		μV	
VN(PP)	equivalent input noise voltage	f = 0.1 Hz to 10 Hz		25°C 1.5				μν				
In	Equivalent input noise current			25°C	0.6			0.6		fA /√Hz		
	Total harmonic	V _O = 1 V to 2 V, f = 20 kHz.	A _V = 1	25°C		0.285%			0.285%			
			A _V = 10	25 0		7.2%			7.2%			
THD+N	distortion plus noise	V _O = 1 V to 2 V,	A _V = 1	25°C		0.014%			0.014%			
	noise	f = 20 kHz,	A _V = 10			0.098%			0.098%			
		R _L = 600 Ω§	$A_{V} = 100$		0.13%				0.13%			
	Gain-bandwidth product	f = 10 kHz, $C_L = 100 \text{ pF}^{\ddagger}$	$R_L = 600 \Omega^{\ddagger}$,	25°C		1.9			1.9		MHz	
ВОМ	Maximum output- swing bandwidth	$V_{O(PP)} = 1 \text{ V},$ $R_{L} = 600 \Omega^{\ddagger},$	$A_V = 1,$ $C_L = 100 \text{ pF}^{\ddagger}$	25°C		60			60		kHz	
+_	Settling time	$A_{V} = -1,$ $Step = 1 \ V \text{ to } 2 \ V,$ $To 0.1\%$		25°C		0.9			0.9		μs	
t _S	Octaing ame	$R_L = 600 \Omega^{\ddagger},$ $C_L = 100 pF^{\ddagger}$	To 0.01%	25 0		1.5			1.5		μδ	
φm	Phase margin at unity gain	R _L = 600 Ω [‡] ,	C _L = 100 pF‡	25°C	°C 50°			50°				
	Gain margin]	·	25°C		8			8		dB	

[†] Full range is –40°C to 85°C.



[‡]Referenced to 1.5 V

[§] Referenced to 0 V

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

					TLV2231C		Т	LV2231			
	PARAMETER	TEST CON	IDITIONS	T _A †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
VIO	Input offset voltage					0.71	3		0.71	3	mV
αVIO	Temperature coefficient of input offset voltage			Full range		0.5			0.5		μV/°C
	Input offset voltage long-term drift (see Note 4)	$V_{DD\pm} = \pm 2.5 \text{ V},$ $V_{O} = 0,$	$V_{IC} = 0$, R _S = 50 Ω	25°C		0.003			0.003		μV/mo
ΙΙΟ	Input offset current]		25°C		0.5	60		0.5	60	pА
		1		Full range			150			150	·
I _{IB}	Input bias current			25°C		1	60		1	60	pА
				Full range			150			150	
\/	Common-mode input	Do 50.0	1)/1-21 < 5 m)/	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2		V
VICR	voltage range	$R_S = 50 \Omega$,	V _{IO} ≤5 mV	Full range	0 to 3.7			0 to 3.7			V
		$I_{OH} = -1 \text{ mA}$		25°C		4.9			4.9		
Vон	High-level output	10.1- 1 mA		25°C		4.6			4.6		V
	voltage	I _{OH} = -4 mA		Full range	4			4			
	Law law Law tand	$V_{IC} = 2.5 V$,	$I_{OL} = 500 \mu\text{A}$	25°C		80			80		
VOL	Low-level output voltage	V _{IC} = 2.5 V,	I _{OL} = 1 mA	25°C		160			160		m∨
		VIC = 2.5 V,	10L = 1111A	Full range			500			500	
	Large-signal	V _{IC} = 2.5 V,	$R_{L} = 600 \Omega^{\ddagger}$	25°C	1	1.5		1	1.5		
A_{VD}	differential voltage	$V_{O} = 2.5 \text{ V},$ $V_{O} = 1 \text{ V to 4 V}$	TKL = 000 32+	Full range	0.3			0.3			V/mV
	amplification		$R_L = 1 M\Omega^{\ddagger}$	25°C		400			400		
^r id	Differential input resistance			25°C		1012			1012		Ω
r _{ic}	Common-mode input resistance			25°C		10 ¹²			1012		Ω
c _{ic}	Common-mode input capacitance	f = 10 kHz		25°C		6			6		pF
z _o	Closed-loop output impedance	f = 1 MHz,	A _V = 1	25°C		138			138		Ω
CMDD	Common-mode	$V_{IC} = 0 \text{ to } 2.7 \text{ V},$		25°C	60	70		60	70		40
CMRR	rejection ratio	$V_0 = 2.5 \text{ V},$	$R_S = 50 \Omega$	Full range	55			55			dB
kova	Supply voltage rejection ratio		DD = 4.4 V to 8 V,		70	96		70	96		dB
ksvr	(ΔV _{DD} /ΔV _{IO})	$V_{IC} = V_{DD}/2$,			70			70			ub ub
Inc	Supply current	V _O = 2.5 V,	No load	25°C		850	1300		850	1300	μΑ
^I DD	Сарру оштоп	10 = 2.5 v,	140 1044	Full range			1600			1600	μΑ

[†] Full range for the TLV2231C is 0°C to 70°C. Full range for the TLV2231I is -40°C to 85°C.



[‡]Referenced to 2.5 V

NOTE 5: Typical values are based on the input offset voltage shift observed through 500 hours of operating life test at $T_A = 150^{\circ}C$ extrapolated to $T_A = 25^{\circ}C$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2231, TLV2231Y Advanced LinCMOS™ RAIL-TO-RAIL LOW-POWER SINGLE OPERATIONAL AMPLIFIERS SLOS158D – JUNE 1996 – REVISED APRIL 2001

operating characteristics at specified free-air temperature, $V_{DD} = 5 V$

PARAMETER TEST CONDITIONS TA 1 MIN TYP MAX MIN TYP MAX WIN TYP MAX		DADAMETED	TEST CONDITIONS		- +	Т	LV22310	3	7	ΓLV2231		UNIT
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	·	PARAMETER	TEST CONDITIONS		'A'	MIN	TYP	MAX	MIN	TYP	MAX	UNII
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		Slow rate at unity	Vo = 15 V to 3 5 V	D. con ot	25°C	1	1.6		1	1.6		
Vn Equivalent input noise voltage f = 1 kHz 25°C 15 15 nV/NHz VN(PP) Peak-to-peak equivalent input noise voltage f = 0.1 Hz to 10 Hz 25°C 1.4 1.4 μ/V In Equivalent input noise current VO = 1.5 V to 3.5 V, f = 0.1 Hz to 10 Hz 25°C 0.6 0.6 0.6 fA//Hz THD+N Total harmonic distortion plus noise VO = 1.5 V to 3.5 V, f = 20 kHz, RL = 600 Ω‡ AV = 10 AV = 1	SR	•		RL = 600 \$2+,		0.7			0.7			V/μs
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	V.	Equivalent input	f = 10 Hz		25°C		100			100		n\//s/ Uz
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	٧n	noise voltage	f = 1 kHz		25°C		15			15		IIV/VHZ
$ \begin{array}{ c c c c c c }\hline H_{D} & \text{noise voltage} & \text{f} = 0.1 \text{Hz to } 10 \text{Hz} \\ \hline H_{D} & \text{Equivalent input noise current} \\ \hline H_{D} & \text{Equivalent input noise} \\ \hline H_{D} & Equivalent$	\/\.\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	•	f = 0.1 Hz to 1 Hz		25°C		1.4			1.4		\/
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	VN(PP)		f = 0.1 Hz to 10 Hz		25°C		1.5			1.5		μν
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	In				25°C		0.6			0.6		fA/√ Hz
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$				A _V = 1	25°C		0.409%			0.409%		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		distortion plus		A _V = 10	25 C		3.68%			3.68%		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	THD+N		Vo = 1.5 V to 3.5 V.	A _V = 1	25°C		0.018%			0.018%		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			f = 20 kHz,	A _V = 10			0.045%			0.045%		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			R _L = 600 Ω§	A _V = 100		0.116%			0.116%			
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$			- ,	$R_L = 600 \Omega^{\ddagger}$,	25°C		2			2		MHz
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	ВОМ	output-swing	$V_{O(PP)} = 1 \text{ V},$ $R_L = 600 \Omega^{\ddagger},$	A _V = 1, C _L = 100 pF‡	25°C	300			300		kHz	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		Settling time	Step = 1.5 V to 3.5 V,	To 0.1%	25°C		0.95			0.95		ue
$^{\phi}$ m unity gain $R_L = 600 \Omega^{\ddagger}$, $C_L = 100 \text{ pF}^{\ddagger}$ 25 C 48 ° 48 °	'S	$R_L = 600 \Omega +$		To 0.01%	250		2.4			2.4		μδ
	фm	-	$R_{L} = 600 \Omega^{\ddagger}$	C _L = 100 pF‡	25°C		48°			48°		
		Gain margin	1 -		25°C		8			8		dB

[†] Full range is -40°C to 85°C.



[‡]Referenced to 2.5 V

[§] Referenced to 0 V

electrical characteristics at V_{DD} = 3 V, T_{A} = 25°C (unless otherwise noted)

DADAMETED		TECT	CONDITIONS		TI	LV2231\	1	
	PARAMETER	1531	CONDITIONS		MIN	TYP	MAX	UNIT
VIO	Input offset voltage					750		μV
lιο	Input offset current	$V_{DD} \pm = \pm 1.5 \text{ V},$ $R_S = 50 \Omega$	VIC = 0,	$V_{O} = 0$,		0.5		pА
I _{IB}	Input bias current	115 = 30 22				1		pА
VICR	Common-mode input voltage range	V _{IO} ≤5 mV,	R _S = 50 Ω			-0.3 to 2.2		V
Vон	High-level output voltage	I _{OH} = -1 mA				2.87		V
V/	Level even even veltere	V _{IC} = 1.5 V,	I _{OL} = 50 μA			10		\/
VOL	Low-level output voltage	V _{IC} = 1.5 V,	I _{OL} = 500 μA			100		m۷
	Large-signal differential voltage	V 4.V/- 0.V/	$R_L = 600 \Omega^{\dagger}$			1.6		\//\/
AVD	amplification	$V_O = 1 \text{ V to 2 V}$	$R_L = 1 M\Omega^{\dagger}$			250		V/mV
r _{id}	Differential input resistance		•			1012		Ω
r _{ic}	Common-mode input resistance					1012		Ω
Cic	Common-mode input capacitance	f = 10 kHz				6		pF
z _o	Closed-loop output impedance	f = 1 MHz,	A _V = 1			156		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = 0 \text{ to } 1.7 \text{ V},$	V _O = 0,	R _S = 50 Ω	60	70		dB
ksvr	Supply voltage rejection ratio (ΔV _{DD} /ΔV _{IO})	V _{DD} = 2.7 V to 8 V,	V _{IC} = 0,	No load		96		dB
l _{DD}	Supply current	V _O = 0,	No load	_		750		μΑ

[†] Referenced to 1.5 V

electrical characteristics at $V_{DD} = 5 \text{ V}$, $T_A = 25^{\circ}\text{C}$ (unless otherwise noted)

PARAMETER		TEST	CONDITIONS		TI	V2231Y	,	LINUT
	PARAMETER	1531	CONDITIONS		MIN	TYP	MAX	UNIT
VIO	Input offset voltage					710		μV
lio	Input offset current	$V_{DD} \pm = \pm 1.5 \text{ V},$ $R_S = 50 \Omega$	$V_{IC} = 0$,	$V_{O} = 0$,		0.5		pА
I _{IB}	Input bias current	115 = 30 22				1		pА
VICR	Common-mode input voltage range	V _{IO} ≤5 mV,	R _S = 50 Ω			-0.3 to 4.2		٧
Vон	High-level output voltage	$I_{OH} = -1 \text{ mA}$				4.9		V
\/-·	Low level output valtage	V _{IC} = 2.5 V,	I _{OL} = 500 μA			80		\/
VOL	Low-level output voltage	V _{IC} = 2.5 V,	I _{OL} = 1 mA			160		mV
Δ	Large-signal differential voltage	V- 4.V4-0.V	$R_L = 600 \Omega^{\dagger}$			15		\//m\/
AVD	amplification	$V_O = 1 \text{ V to 2 V}$	$R_L = 1 M\Omega^{\dagger}$			400		V/mV
r _{id}	Differential input resistance					1012		Ω
r _{ic}	Common-mode input resistance					1012		Ω
c _{ic}	Common-mode input capacitance	f = 10 kHz				6		pF
z _O	Closed-loop output impedance	f = 1 MHz,	A _V = 1			138		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = 0 \text{ to } 1.7 \text{ V},$	V _O = 0,	$R_S = 50 \Omega$	60	70		dB
k _{SVR}	Supply voltage rejection ratio $(\Delta V_{DD}/\Delta V_{IO})$	$V_{DD} = 2.7 \text{ V to 8 V},$	V _{IC} = 0,	No load		96		dB
I _{DD}	Supply current	$V_{O} = 0,$	No load			850		μΑ

[†] Referenced to 2.5 V



Table of Graphs

			FIGURE
VIO	Input offset voltage	Distribution vs Common-mode input voltage	2, 3 4, 5
αVIO	Input offset voltage temperature coefficient	Distribution	6, 7
I _{IB} /I _{IO}	Input bias and input offset currents	vs Free-air temperature	8
VI	Input voltage	vs Supply voltage vs Free-air temperature	9 10
Vон	High-level output voltage	vs High-level output current	11, 14
VOL	Low-level output voltage	vs Low-level output current	12, 13, 15
VO(PP)	Maximum peak-to-peak output voltage	vs Frequency	16
los	Short-circuit output current	vs Supply voltage vs Free-air temperature	17 18
VO	Output voltage	vs Differential input voltage	19, 20
AVD	Differential voltage amplification	vs Load resistance	21
AVD	Large-signal differential voltage amplification	vs Frequency vs Free-air temperature	22, 23 24, 25
z _o	Output impedance	vs Frequency	26, 27
CMRR	Common-mode rejection ratio	vs Frequency vs Free-air temperature	28 29
ksvr	Supply-voltage rejection ratio	vs Frequency vs Free-air temperature	30, 31 32
I _{DD}	Supply current	vs Supply voltage	33
SR	Slew rate	vs Load capacitance vs Free-air temperature	34 35
VO	Inverting large-signal pulse response	vs Time	36, 37
VO	Voltage-follower large-signal pulse response	vs Time	38, 39
VO	Inverting small-signal pulse response	vs Time	40, 41
VO	Voltage-follower small-signal pulse response	vs Time	42, 43
Vn	Equivalent input noise voltage	vs Frequency	44, 45
	Noise voltage (referred to input)	Over a 10-second period	46
THD + N	Total harmonic distortion plus noise	vs Frequency	47
	Gain-bandwidth product	vs Free-air temperature vs Supply voltage	48 49
	Gain margin	vs Load capacitance	50, 51
φm	Phase margin	vs Frequency vs Load capacitance	22, 23 52, 53
B ₁	Unity-gain bandwidth	vs Load capacitance	54, 55



TYPICAL CHARACTERISTICS

Precentage of Amplifiers – %

DISTRIBUTION OF TLV2231 INPUT OFFSET VOLTAGE

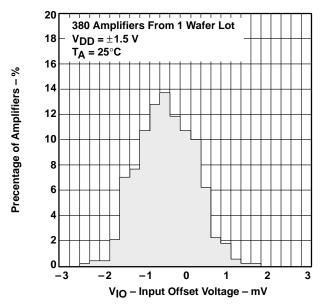


Figure 2

DISTRIBUTION OF TLV2231 INPUT OFFSET VOLTAGE

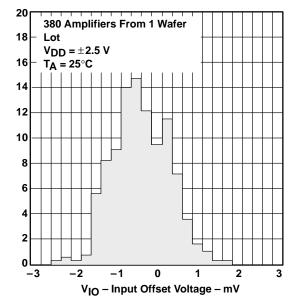
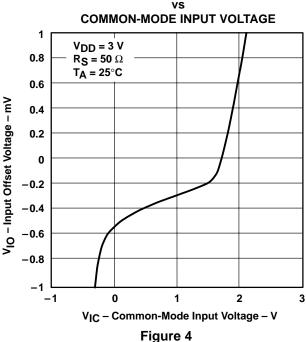
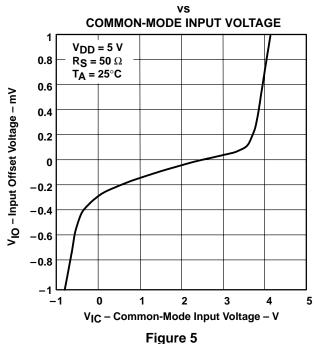


Figure 3

INPUT OFFSET VOLTAGE[†]



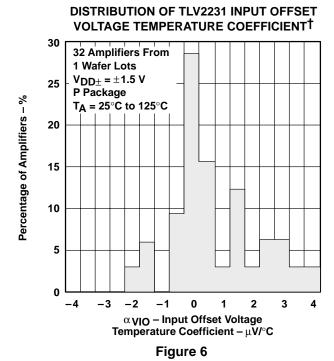
INPUT OFFSET VOLTAGET



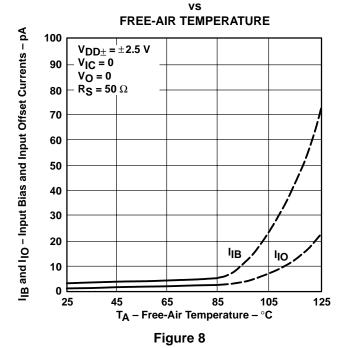
† For all curves where $V_{DD} = 5 \text{ V}$, all loads are referenced to 2.5 V. For all curves where $V_{DD} = 3 \text{ V}$, all loads are referenced to 1.5 V.



TYPICAL CHARACTERISTICS







DISTRIBUTION OF TLV2231 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT[†]

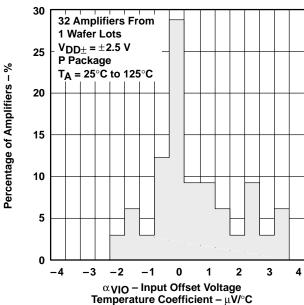
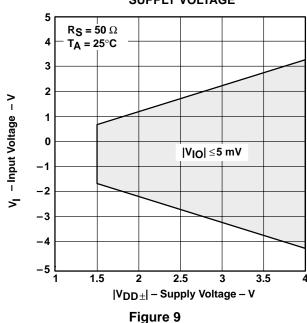


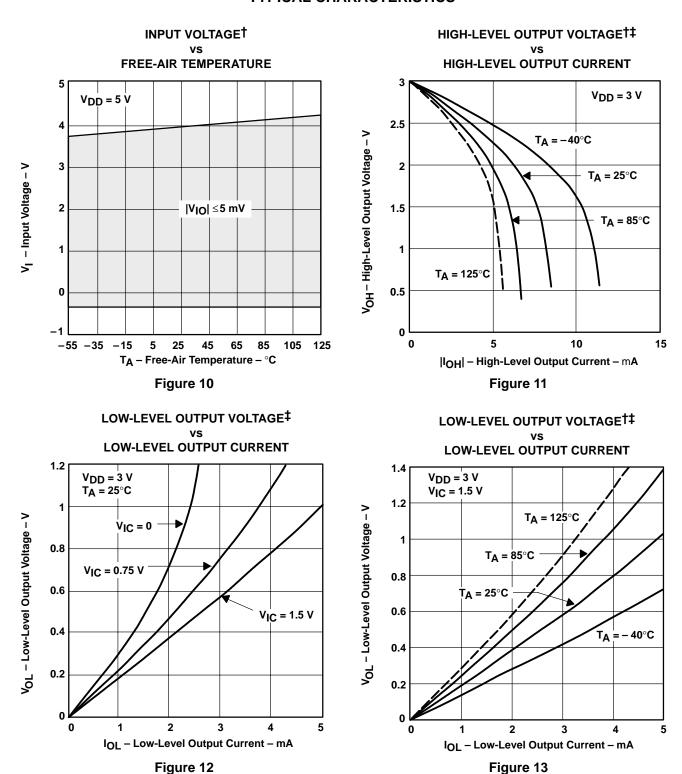
Figure 7

INPUT VOLTAGE vs SUPPLY VOLTAGE



[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.



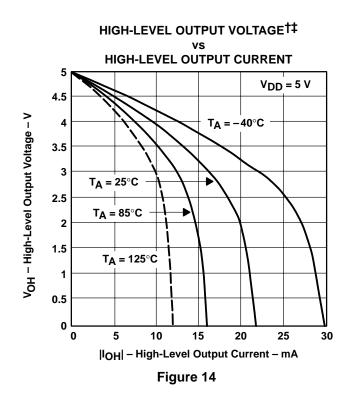


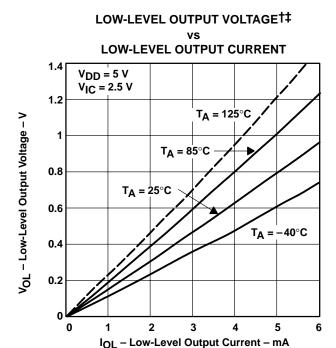
[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

[‡] For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

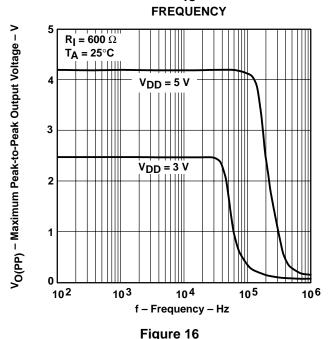


TYPICAL CHARACTERISTICS



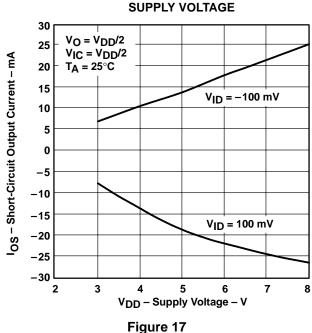


MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE‡



SHORT-CIRCUIT OUTPUT CURRENT vs SUPPLY VOLTAGE

Figure 15

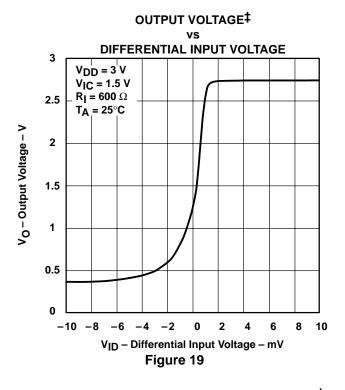


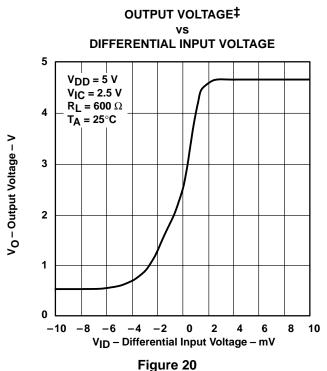
[†]Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

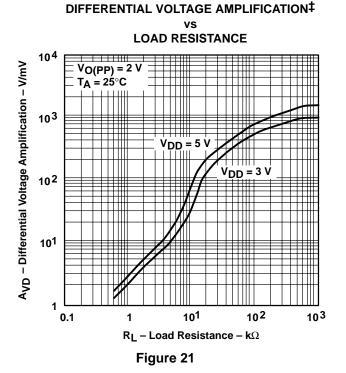
[‡] For all curves where $V_{DD} = 5 \text{ V}$, all loads are referenced to 2.5 V. For all curves where $V_{DD} = 3 \text{ V}$, all loads are referenced to 1.5 V.



SHORT-CIRCUIT OUTPUT CURRENT †‡ FREE-AIR TEMPERATURE 30 $V_{DD} = 5 V$ 25 $V_{IC} = 2.5 V$ IOS - Short-Circuit Output Current - mA V_O = 2.5 V 20 15 $V_{ID} = -100 \text{ mV}$ 10 5 0 -5 -10V_{ID} = 100 mV -15 -20 -25 -30-5025 50 75 100 125 -75 -250 TA - Free-Air Temperature - °C Figure 18







[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

[‡] For all curves where $V_{DD} = 5$ V, all loads are referenced to 2.5 V. For all curves where $V_{DD} = 3$ V, all loads are referenced to 1.5 V.



LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGINT

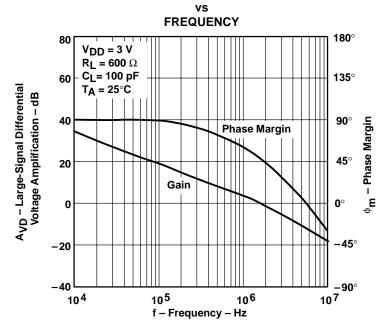
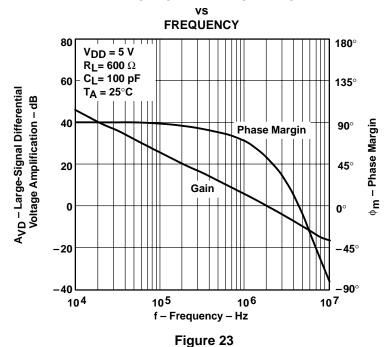


Figure 22

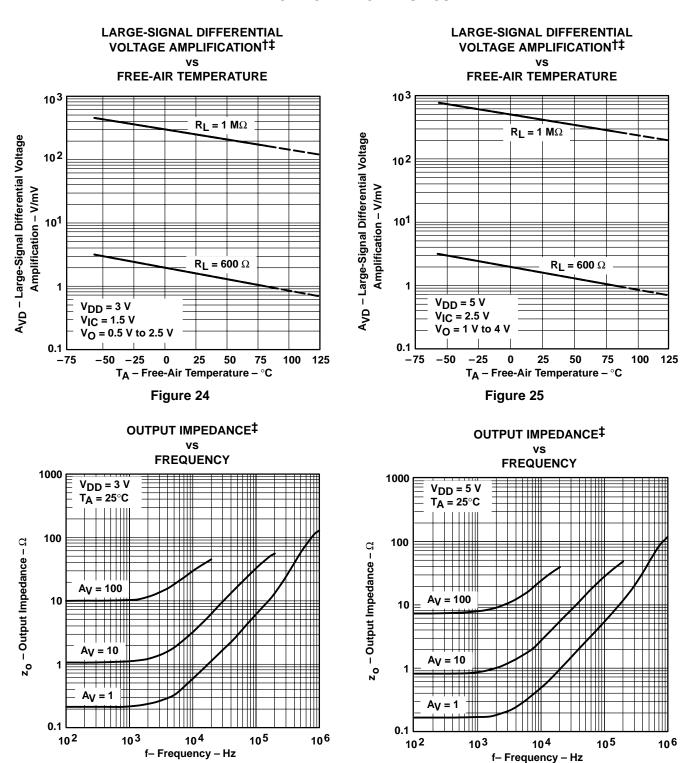
LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE MARGIN[†]



† For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.



TYPICAL CHARACTERISTICS



[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

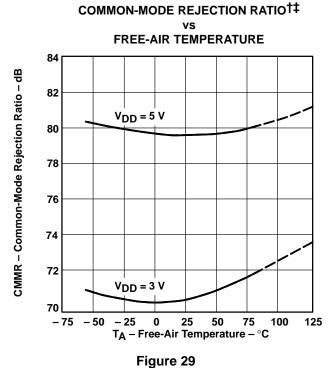
Figure 26

[‡] For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

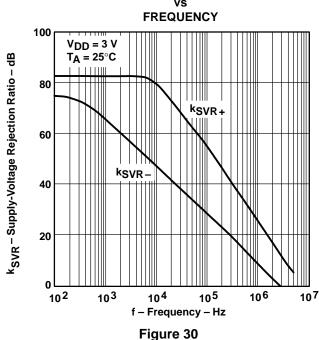


Figure 27

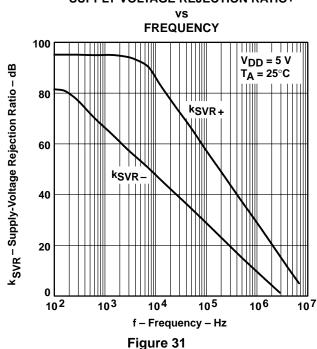
COMMON-MODE REJECTION RATIO[†] vs **FREQUENCY** 100 $T_A = 25^{\circ}C$ CMRR - Common-Mode Rejection Ratio - dB $V_{DD} = 5 V$ $V_{IC} = 2.5 V$ 80 $V_{DD} = 3 V$ 60 $V_{IC} = 1.5 V$ 40 20 105 106 102 104 103 107 f - Frequency - Hz Figure 28



SUPPLY-VOLTAGE REJECTION RATIO†



SUPPLY-VOLTAGE REJECTION RATIO†



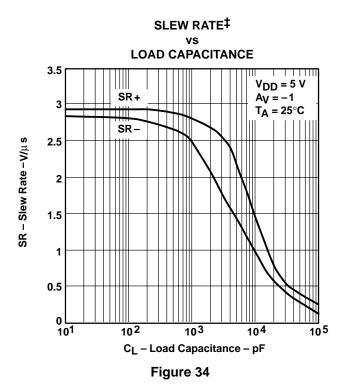
 $^{^{\}dagger}$ For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

[‡] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.



SUPPLY-VOLTAGE REJECTION RATIO[†] FREE-AIR TEMPERATURE 100 V_{DD} = 2.7 V to 8 V k_{SVR} – Supply-Voltage Rejection Ratio – dB $V_{IC} = V_O = V_{DD}/2$ 98 96 94 92 _75 -50 25 50 75 100 125 T_A – Free-Air Temperature – $^{\circ}C$

Figure 32



SUPPLY CURRENT[†] vs SUPPLY VOLTAGE

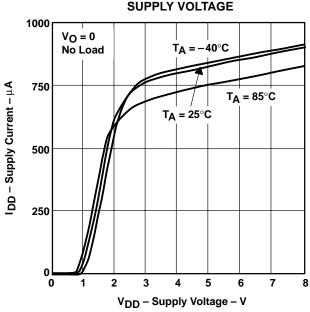


Figure 33

SLEW RATE†‡ vs FREE-AIR TEMPERATURE

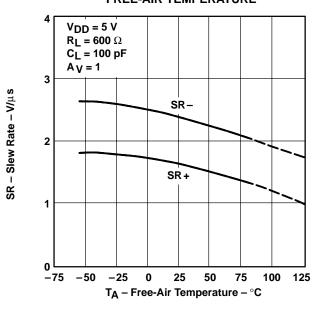


Figure 35

[‡] For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.



[†]Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

INVERTING LARGE-SIGNAL PULSE RESPONSE†

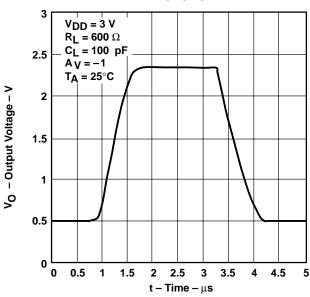


Figure 36

INVERTING LARGE-SIGNAL PULSE RESPONSE†

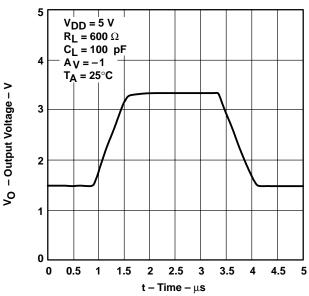


Figure 37

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE†

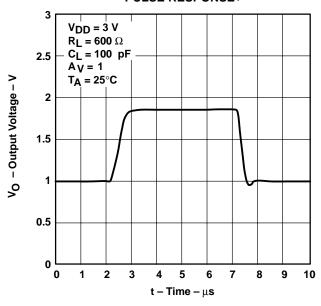


Figure 38

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE[†]

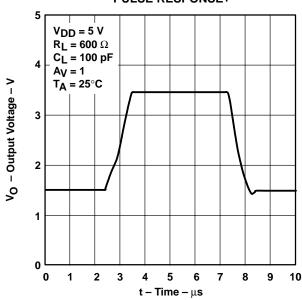


Figure 39

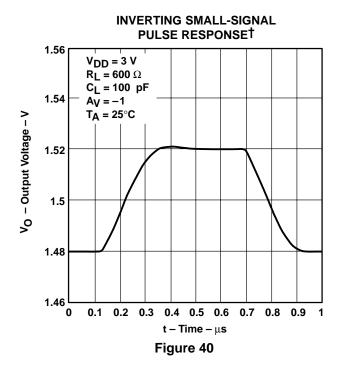
† For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.



INVERTING SMALL-SIGNAL

PULSE RESPONSE†

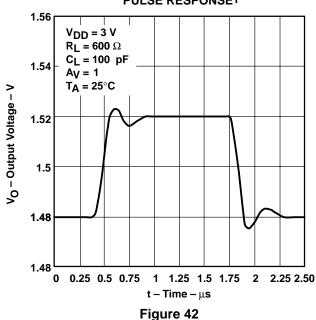
TYPICAL CHARACTERISTICS



2.56 $V_{DD} = 5 V$ $R_L = 600 \Omega$ $C_L = 100 pF$ 2.54 $A_V = -1$ $T_A = 25^{\circ}C$ V_O - Output Voltage - V 2.52 2.5 2.48

Figure 41





V_O - Output Voltage - V

2.46

0 0.1

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE[†]

t - Time - μs

0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

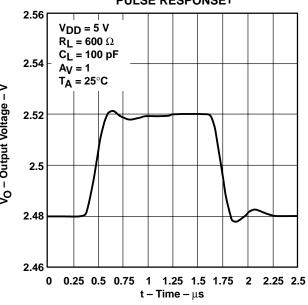


Figure 43

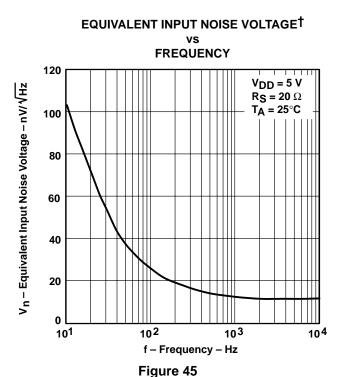
† For all curves where $V_{DD} = 5 \text{ V}$, all loads are referenced to 2.5 V. For all curves where $V_{DD} = 3 \text{ V}$, all loads are referenced to 1.5 V.

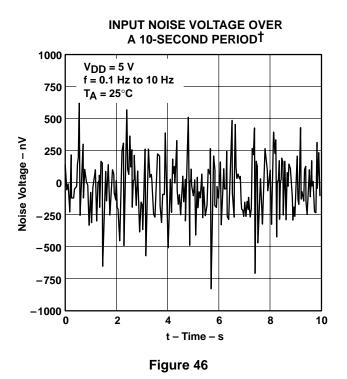


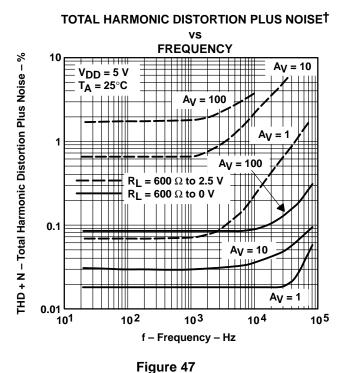
TYPICAL CHARACTERISTICS

EQUIVALENT INPUT NOISE VOLTAGE[†] vs **FREQUENCY** 120 $V_{DD} = 3 V$ V_{n} – Equivalent Input Noise Voltage – nV/ $\sqrt{\text{Hz}}$ $R_S = 20 \Omega$ T_A = 25°C 100 80 60 40 20 0 101 10² 103 104 f - Frequency - Hz

Figure 44



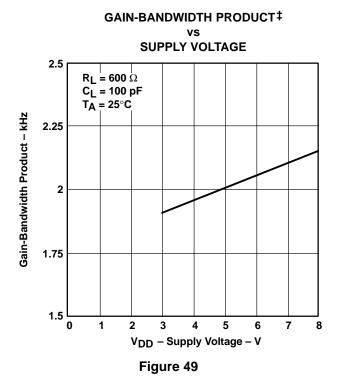


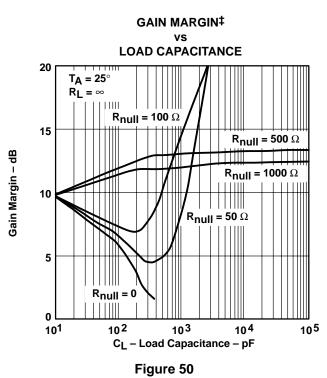


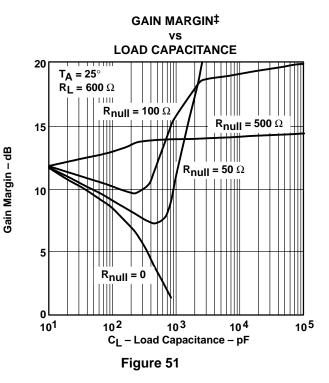
† For all curves where $V_{DD} = 5 \text{ V}$, all loads are referenced to 2.5 V. For all curves where $V_{DD} = 3 \text{ V}$, all loads are referenced to 1.5 V.



GAIN-BANDWIDTH PRODUCT †‡ FREE-AIR TEMPERATURE $V_{DD} = 5 V$ f = 10 kHz $R_L = 600 \Omega$ 3.5 Gain-Bandwidth Product - kHz $C_L = 100 pF$ 3 2.5 2 1.5 25 50 75 100 125 -75 -50 -25 0 T_A - Free-Air Temperature - °C Figure 48







[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

[‡] For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.



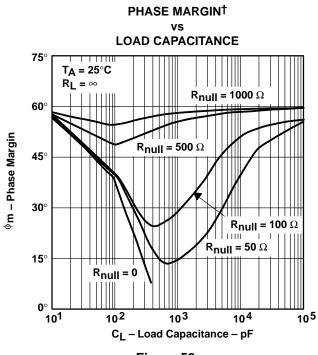


Figure 52

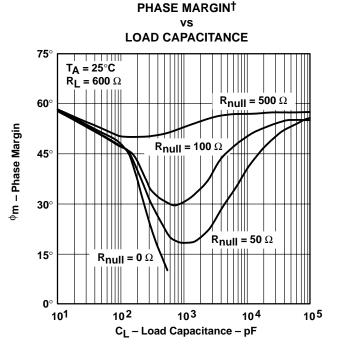
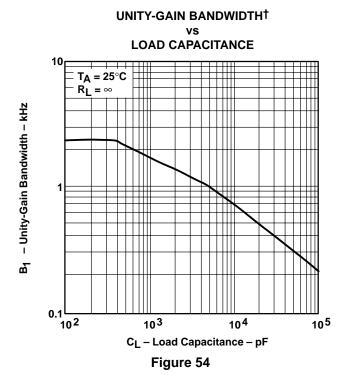
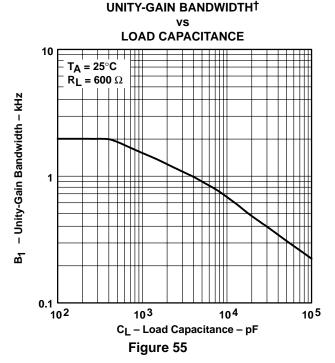


Figure 53





† For all curves where $V_{DD} = 5 \text{ V}$, all loads are referenced to 2.5 V. For all curves where $V_{DD} = 3 \text{ V}$, all loads are referenced to 1.5 V.



APPLICATION INFORMATION

driving large capacitive loads

The TLV2231 is designed to drive larger capacitive loads than most CMOS operational amplifiers. Figure 50 through Figure 55 illustrate its ability to drive loads greater than 100 pF while maintaining good gain and phase margins (R_{null} = 0).

A small series resistor (R_{null}) at the output of the device (see Figure 56) improves the gain and phase margins when driving large capacitive loads. Figure 50 through Figure 53 show the effects of adding series resistances of 50 Ω , 100 Ω , 500 Ω , and 1000 Ω . The addition of this series resistor has two effects: the first effect is that it adds a zero to the transfer function and the second effect is that it reduces the frequency of the pole associated with the output load in the transfer function.

The zero introduced to the transfer function is equal to the series resistance times the load capacitance. To calculate the approximate improvement in phase margin, equation 1 can be used.

$$\Delta \phi_{m1} = \tan^{-1} \left(2 \times \pi \times \text{UGBW} \times R_{\text{null}} \times C_{\text{L}} \right)$$
Where:

 $\Delta \phi_{m1}$ = Improvement in phase margin

UGBW = Unity - gain bandwidth frequency

R_{null} = Output series resistance

 C_1 = Load capacitance

The unity-gain bandwidth (UGBW) frequency decreases as the capacitive load increases (see Figure 54 and Figure 55). To use equation 1, UGBW must be approximated from Figure 54 and Figure 55.

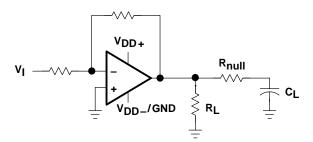


Figure 56. Series-Resistance Circuit

APPLICATION INFORMATION

macromodel information

Macromodel information provided was derived using Microsim $Parts^{TM}$, the model generation software used with Microsim $PSpice^{TM}$. The Boyle macromodel (see Note 6) and subcircuit in Figure 57 are generated using the TLV2231 typical electrical and operating characteristics at $T_A = 25$ °C. Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

- Maximum positive output voltage swing
- Maximum negative output voltage swing
- Slew rate
- Quiescent power dissipation
- Input bias current
- Open-loop voltage amplification

- Unity-gain frequency
- Common-mode rejection ratio
- Phase margin
- DC output resistance
- AC output resistance
- Short-circuit output current limit

NOTE 6: G. R. Boyle, B. M. Cohn, D. O. Pederson, and J. E. Solomon, "Macromodeling of Integrated Circuit Operational Amplifiers," *IEEE Journal of Solid-State Circuits*, SC-9, 353 (1974).

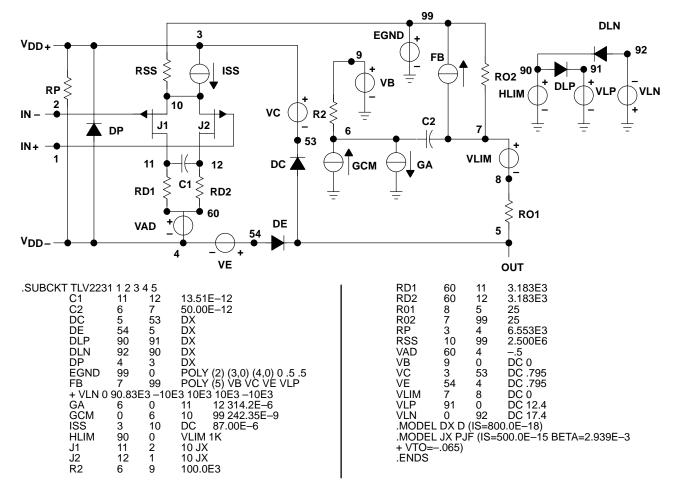


Figure 57. Boyle Macromodel and Subcircuit

PSpice and Parts are trademark of MicroSim Corporation.







i.com 4-Mar-2008

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	e Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TLV2231CDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2231CDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2231CDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2231CDBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2231IDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2231IDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2231IDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2231IDBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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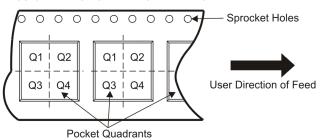
TAPE AND REEL INFORMATION





	Dimension designed to accommodate the component width
	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

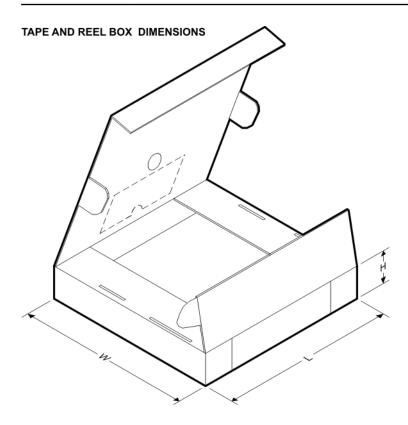
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLV2231CDBVR	SOT-23	DBV	5	3000	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2231CDBVT	SOT-23	DBV	5	250	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2231IDBVR	SOT-23	DBV	5	3000	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2231IDBVT	SOT-23	DBV	5	250	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3





*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV2231CDBVR	SOT-23	DBV	5	3000	182.0	182.0	20.0
TLV2231CDBVT	SOT-23	DBV	5	250	182.0	182.0	20.0
TLV2231IDBVR	SOT-23	DBV	5	3000	182.0	182.0	20.0
TLV2231IDBVT	SOT-23	DBV	5	250	182.0	182.0	20.0

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