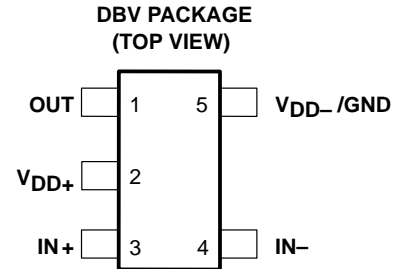


TLV2731, TLV2731Y
Advanced LinCMOS™ RAIL-TO-RAIL
LOW-POWER SINGLE OPERATIONAL AMPLIFIERS

SLOS198A – AUGUST 1997 – REVISED MARCH 2001

- **Output Swing Includes Both Supply Rails**
- **Low Noise . . . 15 nV/√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 TLV2731 is a single low-voltage operational amplifier available in the SOT-23 package. It offers 2 MHz of bandwidth and 1.6 V/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 TLV2731 is fully characterized at 3 V and 5 V and is optimized for low-voltage applications.

The TLV2731, 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-Ω 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.

AVAILABLE OPTIONS

T _A	V _{IO} max AT 25°C	PACKAGED DEVICES	SYMBOL	CHIP FORM‡ (Y)
		SOT-23 (DBV)†		
0°C to 70°C	3 mV	TLV2731CDBV	VALC	TLV2731Y
-40°C to 85°C	3 mV	TLV2731IDBV	VALI	

† The DBV package available in tape and reel only.

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



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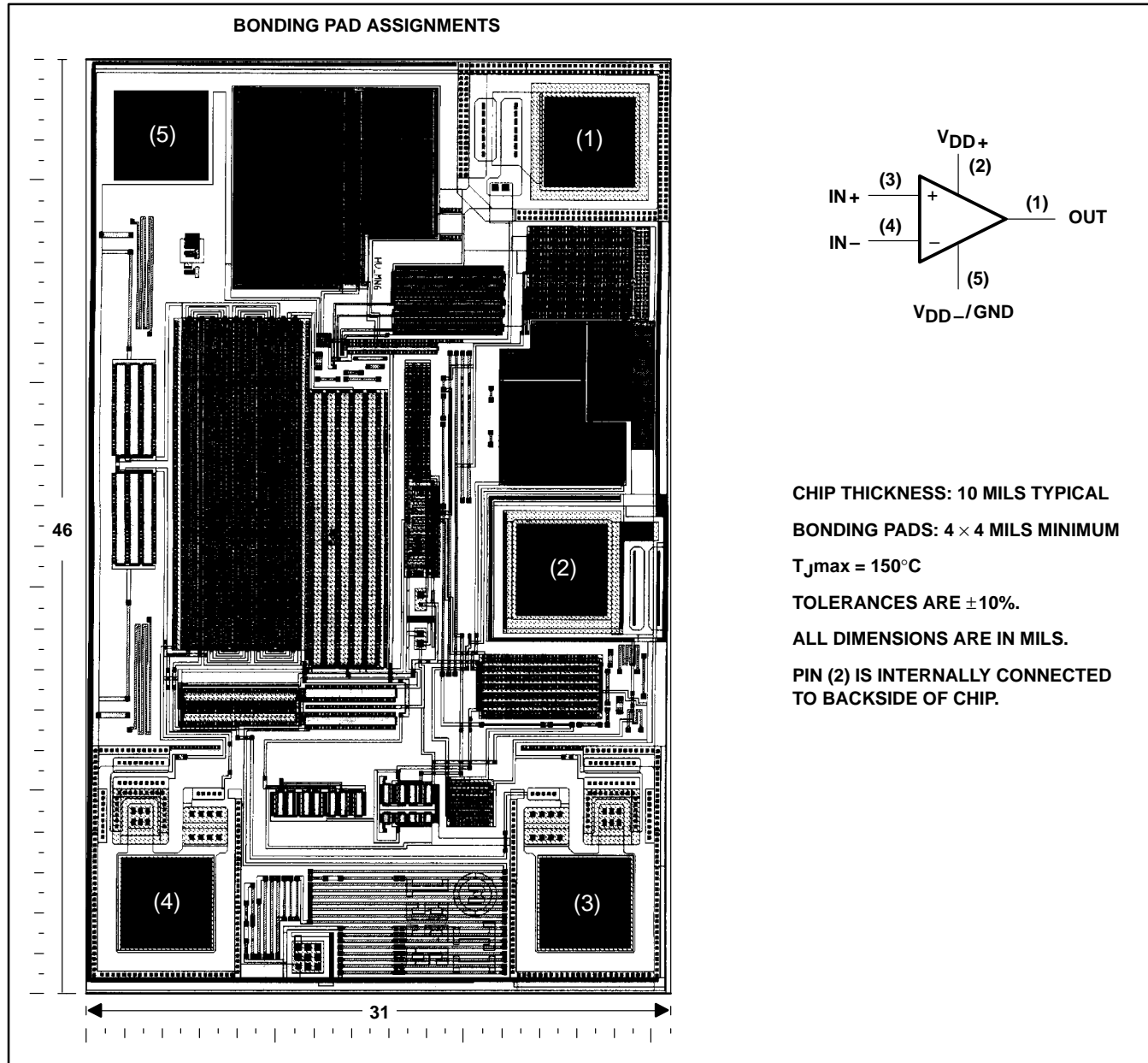
TLV2731, TLV2731Y
Advanced LinCMOS™ RAIL-TO-RAIL
LOW-POWER SINGLE OPERATIONAL AMPLIFIERS

SLOS198A – AUGUST 1997 – REVISED MARCH 2001

TLV2731Y chip information

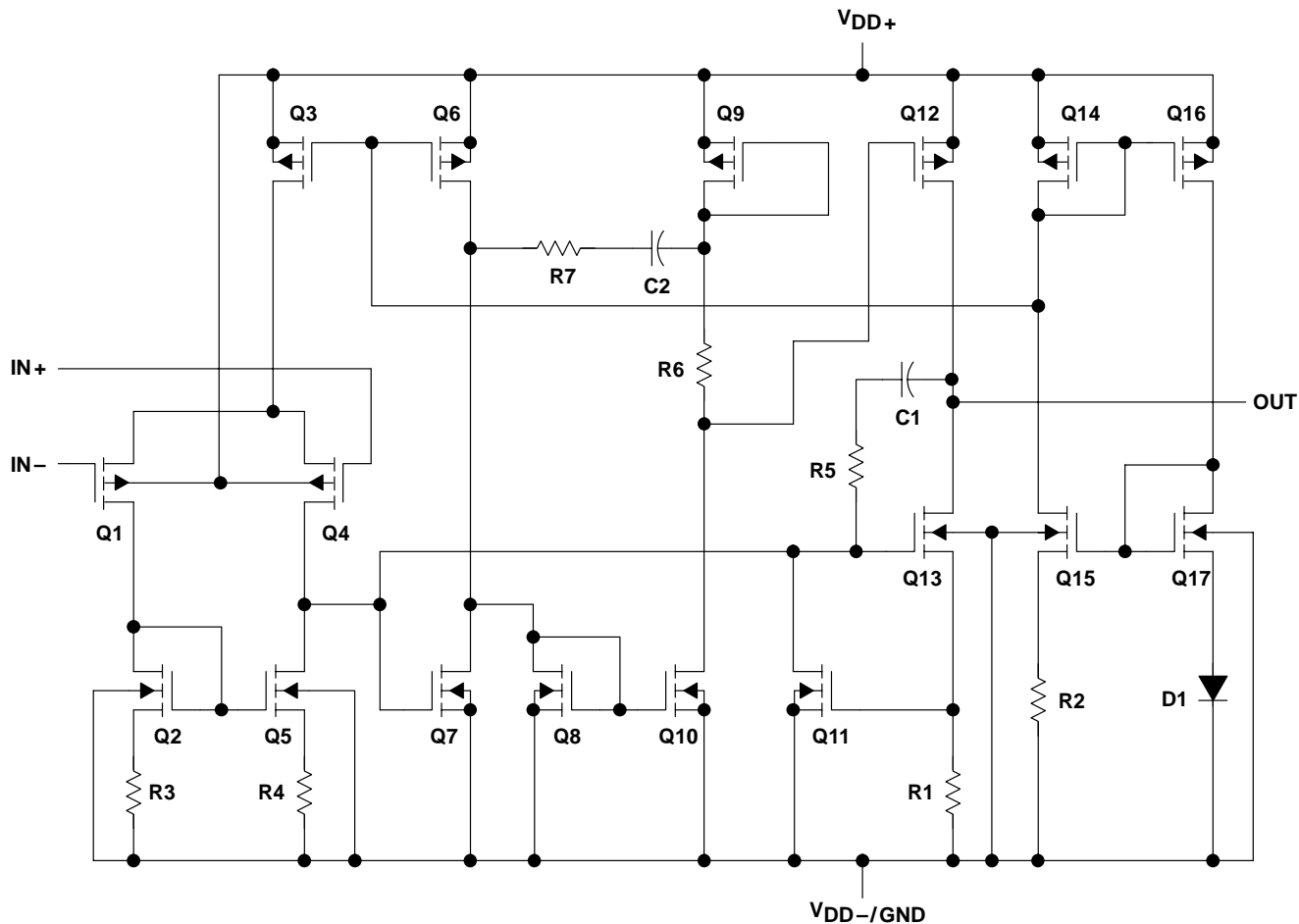
This chip, when properly assembled, displays characteristics similar to the TLV2731C. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. This chip may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS



CHIP THICKNESS: 10 MILS TYPICAL
 BONDING PADS: 4 x 4 MILS MINIMUM
 $T_{jmax} = 150^{\circ}\text{C}$
 TOLERANCES ARE $\pm 10\%$.
 ALL DIMENSIONS ARE IN MILS.
 PIN (2) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

equivalent schematic



COMPONENT COUNT†	
Transistors	23
Diodes	5
Resistors	11
Capacitors	2

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

TLV2731, TLV2731Y
Advanced LinCMOS™ RAIL-TO-RAIL
LOW-POWER SINGLE OPERATIONAL AMPLIFIERS

SLOS198A – AUGUST 1997 – REVISED MARCH 2001

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)	$\pm V_{DD}$
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 : TLV2731C	0°C to 70°C
TLV2731I	-40°C to 85°C
Storage temperature range, T_{stg}	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: DBV package	260°C

† 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	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING
DBV	150 mW	1.2 mW/°C	96 mW	78 mW

recommended operating conditions

	TLV2731C		TLV2731I		UNIT
	MIN	MAX	MIN	MAX	
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-} .



TLV2731, TLV2731Y
Advanced LinCMOS™ RAIL-TO-RAIL
LOW-POWER SINGLE OPERATIONAL AMPLIFIERS
 SLOS198A – AUGUST 1997 – REVISED MARCH 2001

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

PARAMETER	TEST CONDITIONS	T_A †	TLV2731C			TLV2731I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{DD} = \pm 1.5\text{ V}$, $V_{IC} = 0$, $V_O = 0$, $R_S = 50\ \Omega$	Full range		0.7	3		0.7	3	mV
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage				0.5			0.5		$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)		25°C		0.003			0.003		$\mu\text{V}/\text{mo}$
I_{IO} Input offset current		25°C		0.5	60		0.5	60	pA
		Full range			150			150	
I_{IB} Input bias current	25°C			1	60		1	60	pA
	Full range				150			150	
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$, $ V_{IO} \leq 5\text{ mV}$	25°C	0 to 2	-0.3 to 2.2		0 to 2	-0.3 to 2.2	V	
		Full range	0 to 1.7			0 to 1.7			
V_{OH} High-level output voltage	$I_{OH} = -1\text{ mA}$	25°C		2.87			2.87	V	
		25°C		2.74			2.74		
		Full range		2.3			2.3		
V_{OL} Low-level output voltage	$V_{IC} = 1.5\text{ V}$, $I_{OL} = 50\ \mu\text{A}$	25°C		10			10	mV	
		25°C		100			100		
		Full range			300				300
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 1.5\text{ V}$, $V_O = 1\text{ V to }2\text{ V}$	$R_L = 600\ \Omega$ ‡	25°C	1	1.6		1	1.6	V/mV
			Full range		0.3			0.3	
		$R_L = 1\text{ M}\Omega$ ‡	25°C		250			250	
r_{id} Differential input resistance		25°C		10^{12}			10^{12}	Ω	
r_{ic} Common-mode input resistance		25°C		10^{12}			10^{12}	Ω	
c_{ic} Common-mode input capacitance	$f = 10\text{ kHz}$	25°C		6			6	pF	
z_o Closed-loop output impedance	$f = 1\text{ MHz}$, $A_V = 1$	25°C		156			156	Ω	
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }1.7\text{ V}$, $V_O = 1.5\text{ V}$, $R_S = 50\ \Omega$	25°C	60	70		60	70	dB	
		Full range		55			55		
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD} / \Delta V_{IO}$)	$V_{DD} = 2.7\text{ V to }8\text{ V}$, $V_{IC} = V_{DD}/2$, No load	25°C	70	96		70	96	dB	
		Full range		70			70		
I_{DD} Supply current	$V_O = 1.5\text{ V}$, No load	25°C		750	1200		750	1200	μA
		Full range			1500			1500	

† Full range for the TLV2731C is 0°C to 70°C. Full range for the TLV2731I 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 $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2731, TLV2731Y
Advanced LinCMOS™ RAIL-TO-RAIL
LOW-POWER SINGLE OPERATIONAL AMPLIFIERS

SLOS198A – AUGUST 1997 – REVISED MARCH 2001

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

PARAMETER	TEST CONDITIONS	T_A †	TLV2731C			TLV2731I			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
SR	Slew rate at unity gain $V_O = 1.1\text{ V to }1.9\text{ V}, R_L = 600\ \Omega\ddagger, C_L = 100\text{ pF}\ddagger$	25°C	0.75	1.25		0.75	1.25	V/ μs		
		Full range	0.5			0.5				
V_n	Equivalent input noise voltage $f = 10\text{ Hz}$ $f = 1\text{ kHz}$	25°C	105			105			nV/ $\sqrt{\text{Hz}}$	
		25°C	16			16				
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage $f = 0.1\text{ Hz to }1\text{ Hz}$ $f = 0.1\text{ Hz to }10\text{ Hz}$	25°C	1.4			1.4			μV	
		25°C	1.5			1.5				
I_n	Equivalent input noise current	25°C	0.6			0.6			fA/ $\sqrt{\text{Hz}}$	
THD+N	$V_O = 1\text{ V to }2\text{ V}, f = 20\text{ kHz}, R_L = 600\ \Omega\ddagger$	$A_V = 1$	25°C	0.285%			0.285%			
		$A_V = 10$		7.2%			7.2%			
	$V_O = 1\text{ V to }2\text{ V}, f = 20\text{ kHz}, R_L = 600\ \Omega\§$	$A_V = 1$	25°C	0.014%			0.014%			
		$A_V = 10$		0.098%			0.098%			
		$A_V = 100$		0.13%			0.13%			
Gain-bandwidth product	$f = 10\text{ kHz}, R_L = 600\ \Omega\ddagger, C_L = 100\text{ pF}\ddagger$	25°C	1.9			1.9			MHz	
BOM	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	
t_s	Settling time $A_V = -1, \text{ Step} = 1\text{ V to }2\text{ V}, R_L = 600\ \Omega\ddagger, C_L = 100\text{ pF}\ddagger$	To 0.1%	25°C	0.9			0.9			μs
		To 0.01%		1.5			1.5			
ϕ_m	Phase margin at unity gain $R_L = 600\ \Omega\ddagger, C_L = 100\text{ pF}\ddagger$	25°C	50°			50°				
		25°C	8			8				dB

† Full range is -40°C to 85°C .

‡ Referenced to 1.5 V

§ Referenced to 0 V



TLV2731, TLV2731Y
Advanced LinCMOS™ RAIL-TO-RAIL
LOW-POWER SINGLE OPERATIONAL AMPLIFIERS
 SLOS198A – AUGUST 1997 – REVISED MARCH 2001

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

PARAMETER	TEST CONDITIONS	T_A †	TLV2731C			TLV2731I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{DD} = \pm 2.5\text{ V}$, $V_O = 0$, $V_{IC} = 0$, $R_S = 50\ \Omega$	Full range	0.7		3	0.7		3	mV
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage			0.5		0.5		$\mu\text{V}/^\circ\text{C}$		
Input offset voltage long-term drift (see Note 4)		25°C	0.003		0.003		$\mu\text{V}/\text{mo}$		
I_{IO} Input offset current		25°C	0.5	60	0.5	60	pA		
		Full range	150		150				
I_{IB} Input bias current	25°C	1	60	1	60	pA			
	Full range	150		150					
V_{ICR} Common-mode input voltage range	$R_S = 50\ \Omega$, $ V_{IO} \leq 5\text{ mV}$	25°C	0 to 4	-0.3 to 4.2	0 to 4	-0.3 to 4.2	V		
		Full range	0 to 3.7		0 to 3.7				
V_{OH} High-level output voltage	$I_{OH} = -1\text{ mA}$ $I_{OH} = -4\text{ mA}$	25°C	4.9		4.9		V		
		25°C	4.6		4.6				
		Full range	4.3		4.3				
V_{OL} Low-level output voltage	$V_{IC} = 2.5\text{ V}$, $I_{OL} = 500\ \mu\text{A}$ $V_{IC} = 2.5\text{ V}$, $I_{OL} = 1\text{ mA}$	25°C	80		80		mV		
		25°C	160		160				
		Full range	500		500				
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$, $V_O = 1\text{ V to }4\text{ V}$	25°C	$R_L = 600\ \Omega$ ‡		1 1.5		V/mV		
			Full range		0.3				
		25°C	$R_L = 1\text{ M}\Omega$ ‡		400				
r_{id} Differential input resistance		25°C	10^{12}		10^{12}		Ω		
r_{ic} Common-mode input resistance		25°C	10^{12}		10^{12}		Ω		
c_{ic} Common-mode input capacitance	$f = 10\text{ kHz}$	25°C	6		6		pF		
z_o Closed-loop output impedance	$f = 1\text{ MHz}$, $A_V = 1$	25°C	138		138		Ω		
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.7\text{ V}$, $V_O = 2.5\text{ V}$, $R_S = 50\ \Omega$	25°C	60	70	60	70	dB		
		Full range	55		55				
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD} / \Delta V_{IO}$)	$V_{DD} = 4.4\text{ V to }8\text{ V}$, $V_{IC} = V_{DD}/2$, No load	25°C	70	96	70	96	dB		
		Full range	70		70				
I_{DD} Supply current	$V_O = 2.5\text{ V}$, No load	25°C	850	1300	850	1300	μA		
		Full range	1600		1600				

† Full range for the TLV2731C is 0°C to 70°C. Full range for the TLV2731I 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 $T_A = 150^\circ\text{C}$ extrapolated to $T_A = 25^\circ\text{C}$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2731, TLV2731Y
Advanced LinCMOS™ RAIL-TO-RAIL
LOW-POWER SINGLE OPERATIONAL AMPLIFIERS

SLOS198A – AUGUST 1997 – REVISED MARCH 2001

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

PARAMETER	TEST CONDITIONS	T_A †	TLV2731C			TLV2731I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain $V_O = 1.5\text{ V to }3.5\text{ V},$ $R_L = 600\ \Omega\ddagger,$ $C_L = 100\ \text{pF}\ddagger$	25°C	1	1.6		1	1.6		V/ μs
		Full range	0.7			0.7			
V_n	Equivalent input noise voltage $f = 10\text{ Hz}$ $f = 1\text{ kHz}$	25°C		100			100		nV/ $\sqrt{\text{Hz}}$
		25°C		15			15		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage $f = 0.1\text{ Hz to }1\text{ Hz}$ $f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		1.4			1.4		μV
		25°C		1.5			1.5		
I_n	Equivalent input noise current	25°C		0.6			0.6		fA/ $\sqrt{\text{Hz}}$
THD+N	$V_O = 1.5\text{ V to }3.5\text{ V},$ $f = 20\text{ kHz},$ $R_L = 600\ \Omega\ddagger$	25°C	$A_V = 1$	0.409%			0.409%		
			$A_V = 10$	3.68%			3.68%		
	$V_O = 1.5\text{ V to }3.5\text{ V},$ $f = 20\text{ kHz},$ $R_L = 600\ \Omega\§$	25°C	$A_V = 1$	0.018%			0.018%		
			$A_V = 10$	0.045%			0.045%		
			$A_V = 100$	0.116%			0.116%		
	Gain-bandwidth product	$f = 10\text{ kHz},$ $R_L = 600\ \Omega\ddagger,$ $C_L = 100\ \text{pF}\ddagger$	25°C		2			2	
B_{OM}	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		300			300		kHz
t_s	Settling time $A_V = -1,$ Step = 1.5 V to 3.5 V, $R_L = 600\ \Omega\ddagger,$ $C_L = 100\ \text{pF}\ddagger$	25°C	To 0.1%	0.95			0.95		μs
			To 0.01%	2.4			2.4		
ϕ_m	Phase margin at unity gain $R_L = 600\ \Omega\ddagger,$ $C_L = 100\ \text{pF}\ddagger$	25°C		48°			48°		dB
		25°C		8			8		
	Gain margin	25°C		8			8		

† Full range is -40°C to 85°C .

‡ Referenced to 2.5 V

§ Referenced to 0 V



electrical characteristics at $V_{DD} = 3\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	TLV2731Y			UNIT
		MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{DD} \pm \pm 1.5\text{ V}$, $R_S = 50\ \Omega$	750			μV
I_{IO} Input offset current		0.5 60			pA
I_{IB} Input bias current		1 60			pA
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV}$, $R_S = 50\ \Omega$	-0.3 to 2.2			V
V_{OH} High-level output voltage	$I_{OH} = -1\text{ mA}$	2.87			V
V_{OL} Low-level output voltage	$V_{IC} = 1.5\text{ V}$, $I_{OL} = 50\ \mu\text{A}$	10			mV
	$V_{IC} = 1.5\text{ V}$, $I_{OL} = 500\ \mu\text{A}$	100			
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }2\text{ V}$	$R_L = 600\ \Omega^\dagger$	1.6		V/mV
		$R_L = 1\ \text{M}\Omega^\dagger$	250		
r_{id} Differential input resistance		10^{12}			Ω
r_{ic} Common-mode input resistance		10^{12}			Ω
c_{ic} Common-mode input capacitance	$f = 10\text{ kHz}$	6			pF
z_o Closed-loop output impedance	$f = 1\text{ MHz}$, $A_V = 1$	156			Ω
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }1.7\text{ V}$, $V_O = 0$, $R_S = 50\ \Omega$	70			dB
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 2.7\text{ V to }8\text{ V}$, $V_{IC} = 0$, No load	96			dB
I_{DD} Supply current	$V_O = 0$, No load	750			μA

† 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	TLV2731Y			UNIT
		MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{DD} \pm \pm 1.5\text{ V}$, $R_S = 50\ \Omega$	710			μV
I_{IO} Input offset current		0.5 60			pA
I_{IB} Input bias current		1 60			pA
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV}$, $R_S = 50\ \Omega$	-0.3 to 4.2			V
V_{OH} High-level output voltage	$I_{OH} = -1\text{ mA}$	4.9			V
V_{OL} Low-level output voltage	$V_{IC} = 2.5\text{ V}$, $I_{OL} = 500\ \mu\text{A}$	80			mV
	$V_{IC} = 2.5\text{ V}$, $I_{OL} = 1\text{ mA}$	160			
A_{VD} Large-signal differential voltage amplification	$V_O = 1\text{ V to }2\text{ V}$	$R_L = 600\ \Omega^\dagger$	15		V/mV
		$R_L = 1\ \text{M}\Omega^\dagger$	400		
r_{id} Differential input resistance		10^{12}			Ω
r_{ic} Common-mode input resistance		10^{12}			Ω
c_{ic} Common-mode input capacitance	$f = 10\text{ kHz}$	6			pF
z_o Closed-loop output impedance	$f = 1\text{ MHz}$, $A_V = 1$	138			Ω
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }1.7\text{ V}$, $V_O = 0$, $R_S = 50\ \Omega$	70			dB
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 2.7\text{ V to }8\text{ V}$, $V_{IC} = 0$, No load	96			dB
I_{DD} Supply current	$V_O = 0$, No load	850			μA

† Referenced to 2.5 V

TLV2731, TLV2731Y
Advanced LinCMOS™ RAIL-TO-RAIL
LOW-POWER SINGLE OPERATIONAL AMPLIFIERS

SLOS198A – AUGUST 1997 – REVISED MARCH 2001

TYPICAL CHARACTERISTICS

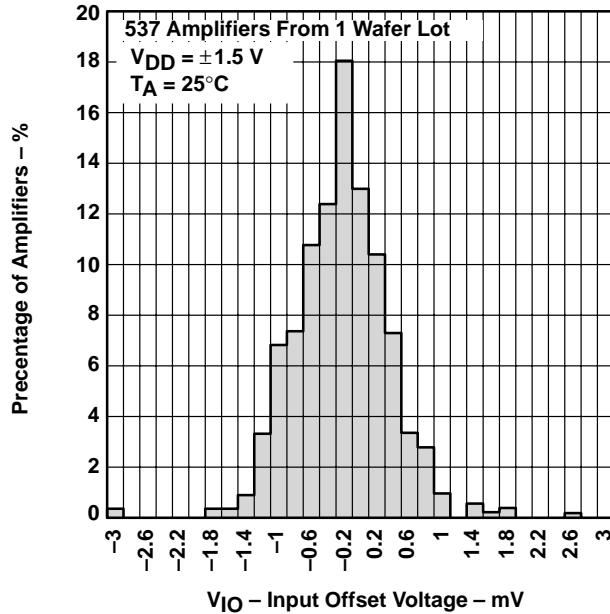
Table of Graphs

		FIGURE
V_{IO}	Input offset voltage	Distribution vs Common-mode input voltage 1, 2 3, 4
αV_{IO}	Input offset voltage temperature coefficient	Distribution 5, 6
I_{IB}/I_{IO}	Input bias and input offset currents	vs Free-air temperature 7
V_I	Input voltage	vs Supply voltage vs Free-air temperature 8 9
V_{OH}	High-level output voltage	vs High-level output current 10, 13
V_{OL}	Low-level output voltage	vs Low-level output current 11, 12, 14
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency 15
I_{OS}	Short-circuit output current	vs Supply voltage vs Free-air temperature 16 17
V_O	Output voltage	vs Differential input voltage 18, 19
A_{VD}	Differential voltage amplification	vs Load resistance 20
A_{VD}	Large-signal differential voltage amplification	vs Frequency vs Free-air temperature 21, 22 23, 24
z_o	Output impedance	vs Frequency 25, 26
$CMRR$	Common-mode rejection ratio	vs Frequency vs Free-air temperature 27 28
k_{SVR}	Supply-voltage rejection ratio	vs Frequency vs Free-air temperature 29, 30 31
I_{DD}	Supply current	vs Supply voltage 32
SR	Slew rate	vs Load capacitance vs Free-air temperature 33 34
V_O	Inverting large-signal pulse response	35, 36
V_O	Voltage-follower large-signal pulse response	37, 38
V_O	Inverting small-signal pulse response	39, 40
V_O	Voltage-follower small-signal pulse response	41, 42
V_n	Equivalent input noise voltage	vs Frequency 43, 44
	Noise voltage (referred to input)	Over a 10-second period 45
$THD + N$	Total harmonic distortion plus noise	vs Frequency 46
	Gain-bandwidth product	vs Free-air temperature vs Supply voltage 47 48
	Gain margin	vs Load capacitance 49, 50
ϕ_m	Phase margin	vs Frequency vs Load capacitance 21, 22 51, 52
B_1	Unity-gain bandwidth	vs Load capacitance 53, 54

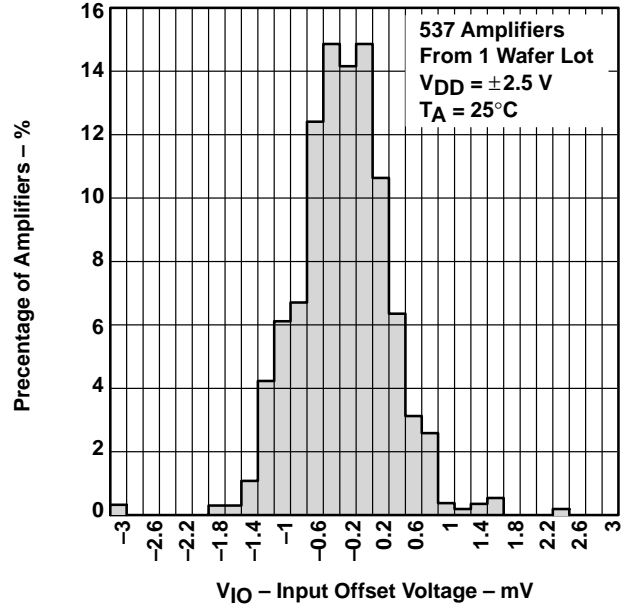


TYPICAL CHARACTERISTICS

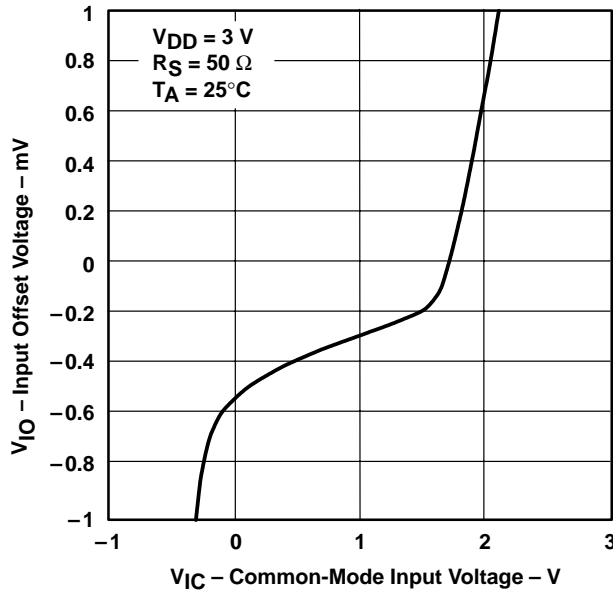
**DISTRIBUTION OF TLV2731
INPUT OFFSET VOLTAGE**



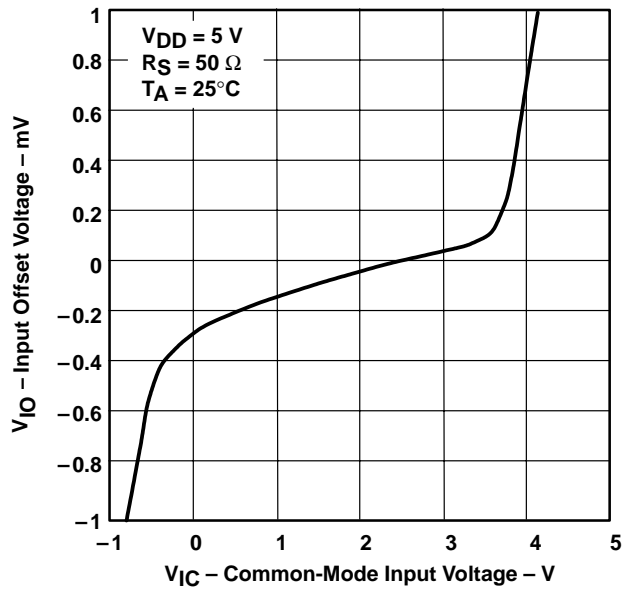
**DISTRIBUTION OF TLV2731
INPUT OFFSET VOLTAGE**



**INPUT OFFSET VOLTAGE†
vs
COMMON-MODE INPUT VOLTAGE**



**INPUT OFFSET VOLTAGE†
vs
COMMON-MODE INPUT VOLTAGE**



† 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

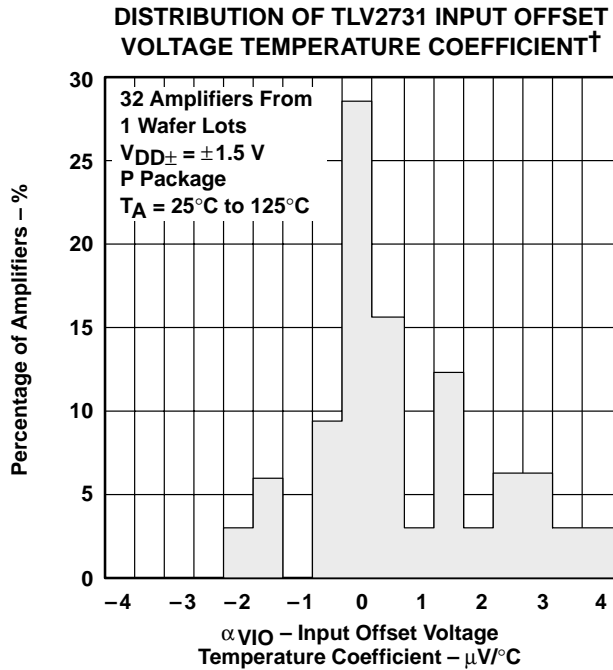


Figure 5

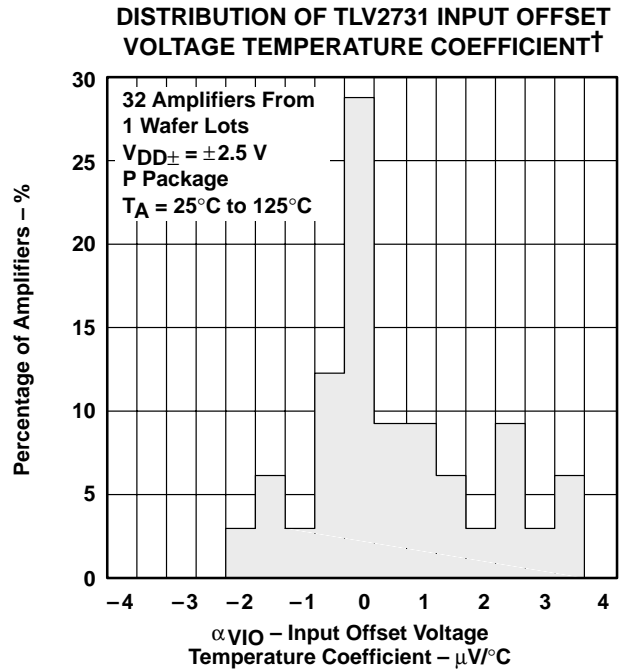


Figure 6

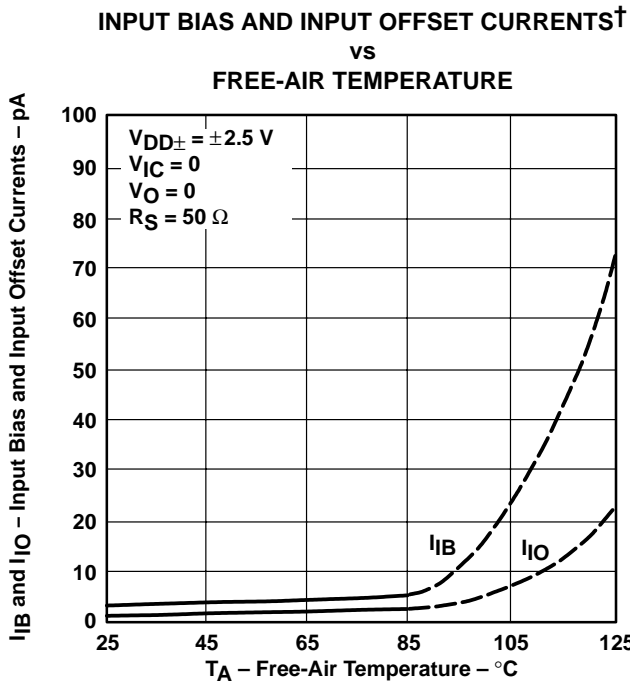


Figure 7

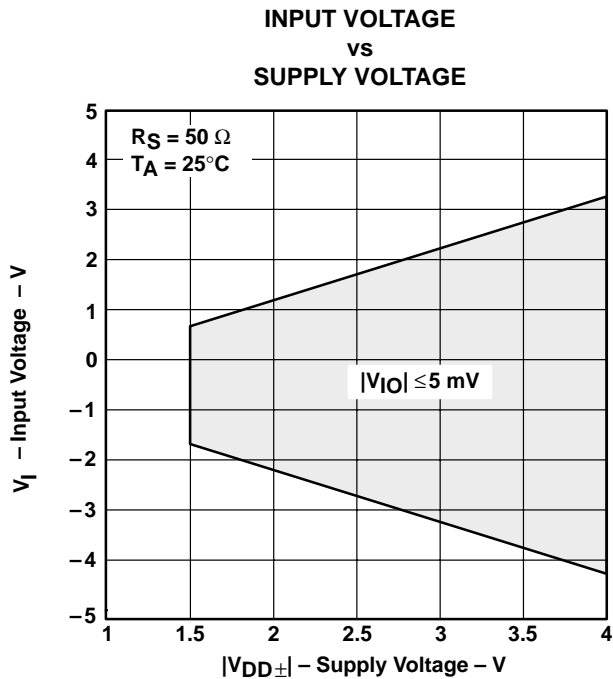


Figure 8

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

TYPICAL CHARACTERISTICS

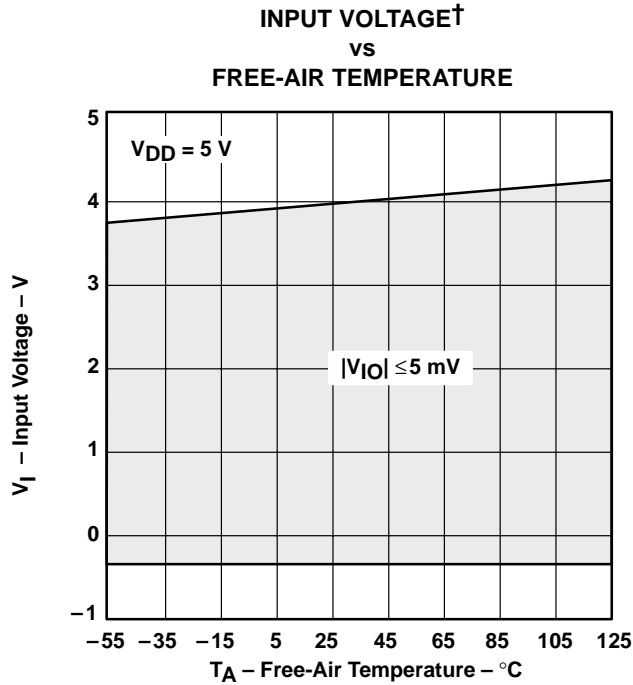


Figure 9

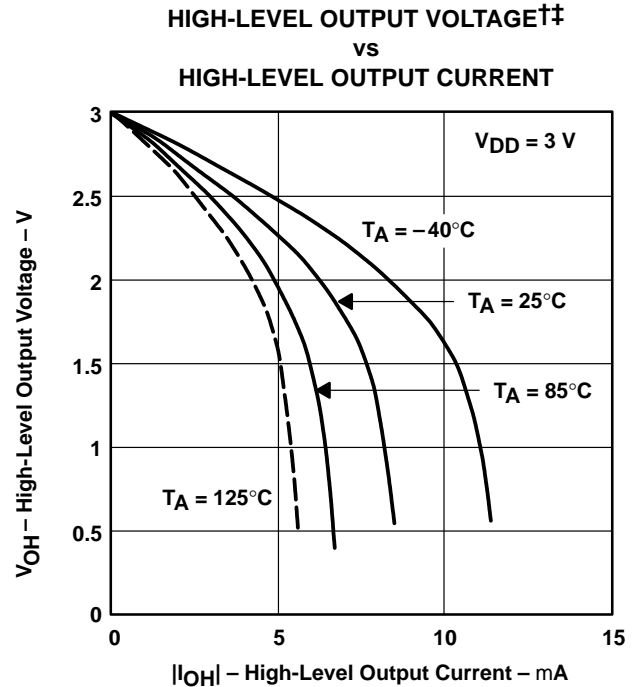


Figure 10

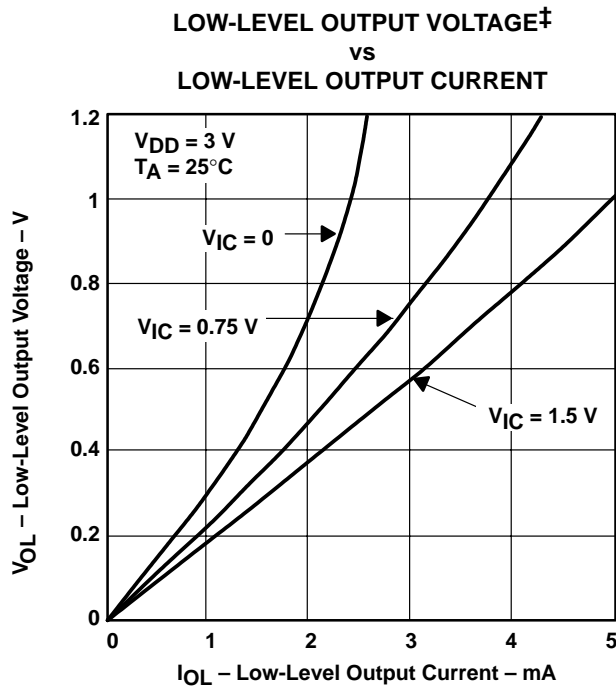


Figure 11

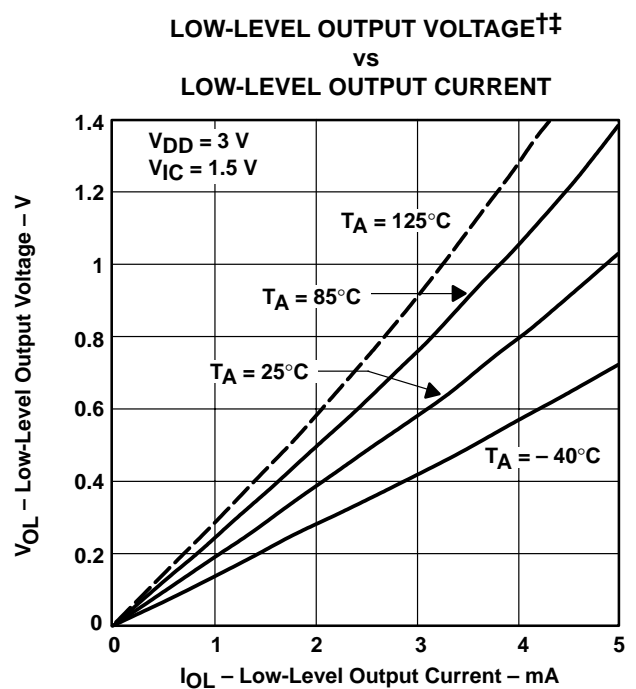


Figure 12

† 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.

TYPICAL CHARACTERISTICS

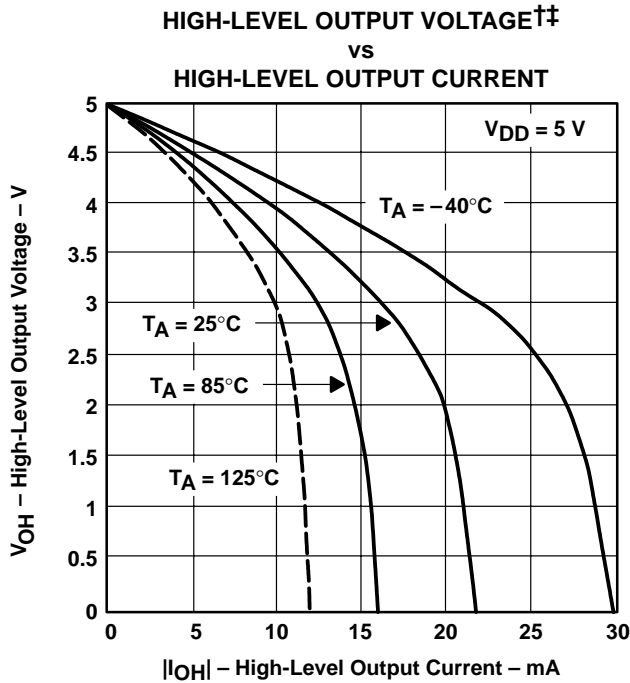


Figure 13

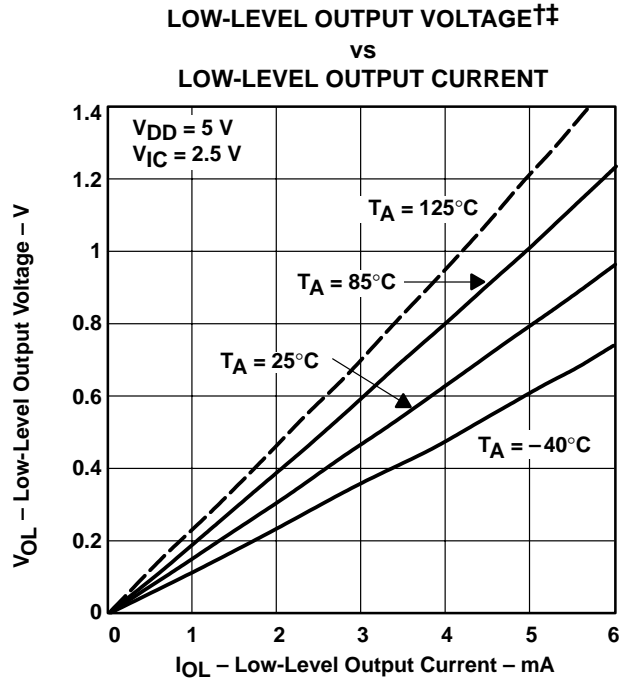


Figure 14

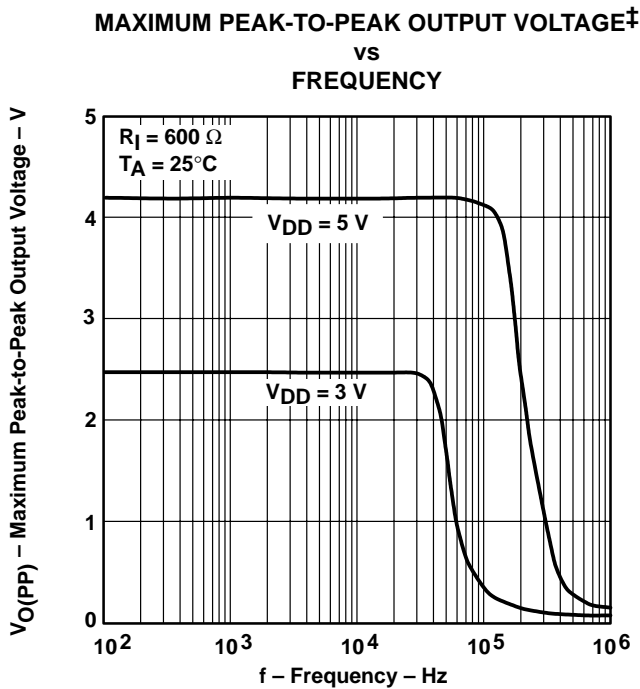


Figure 15

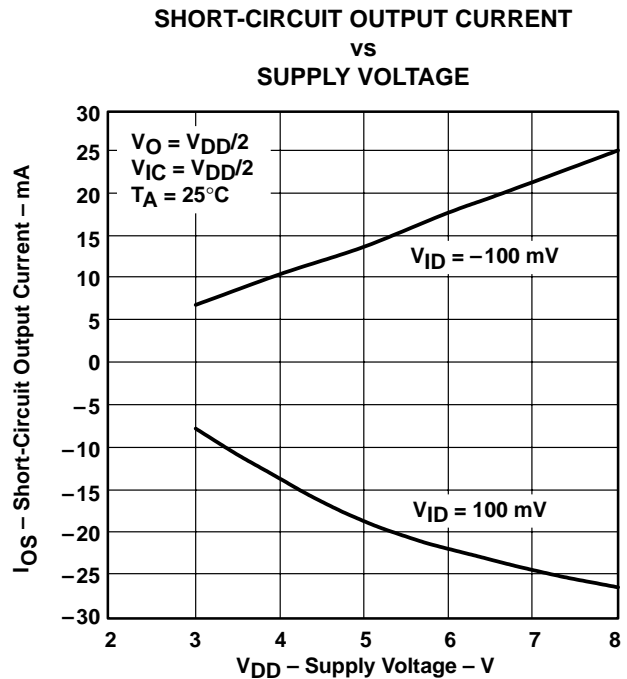
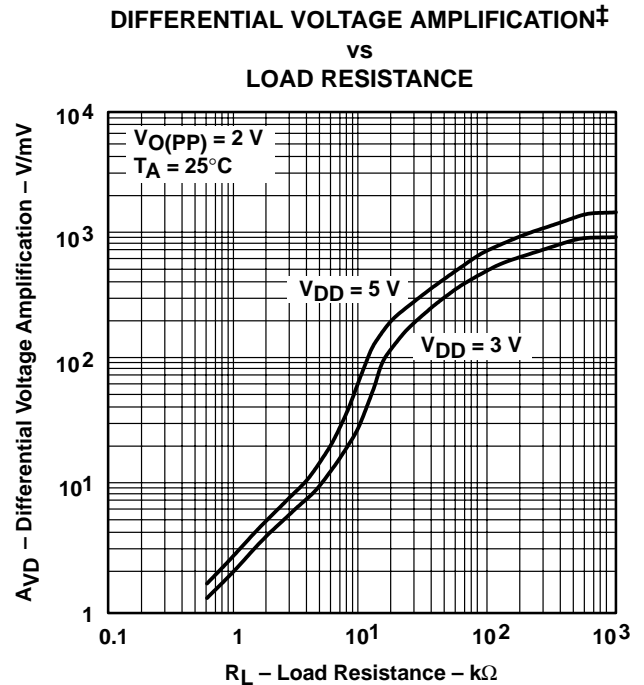
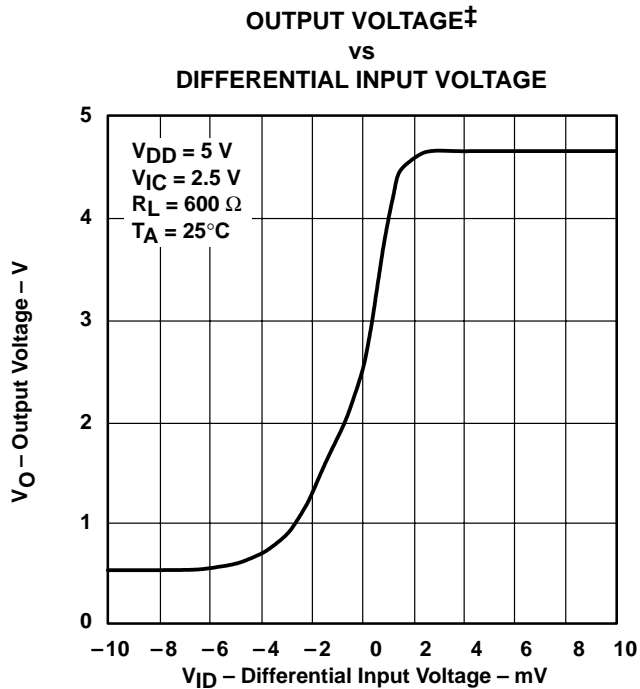
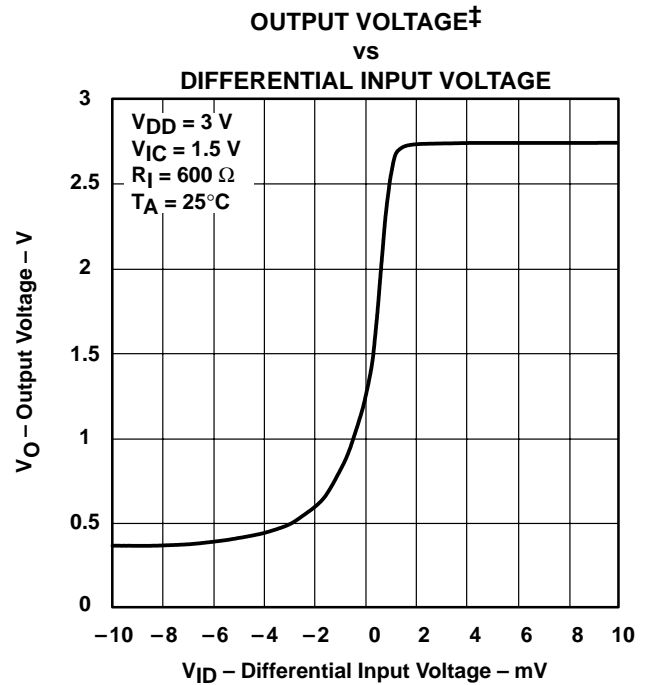
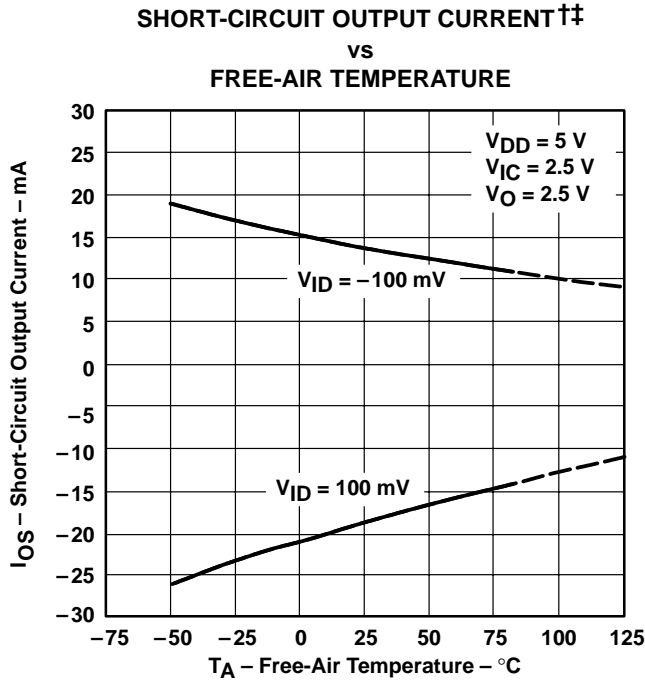


Figure 16

† 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.

TYPICAL CHARACTERISTICS



† 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.

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL VOLTAGE
 AMPLIFICATION AND PHASE MARGIN†

vs
 FREQUENCY

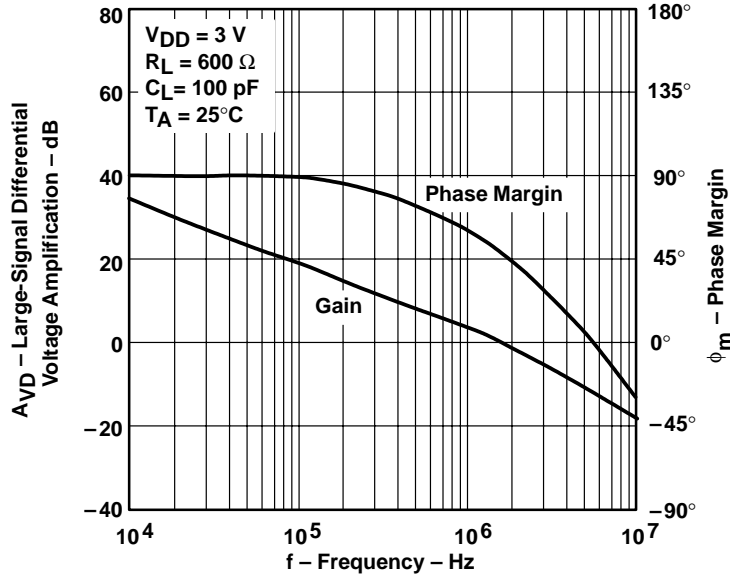


Figure 21

LARGE-SIGNAL DIFFERENTIAL VOLTAGE
 AMPLIFICATION AND PHASE MARGIN†

vs
 FREQUENCY

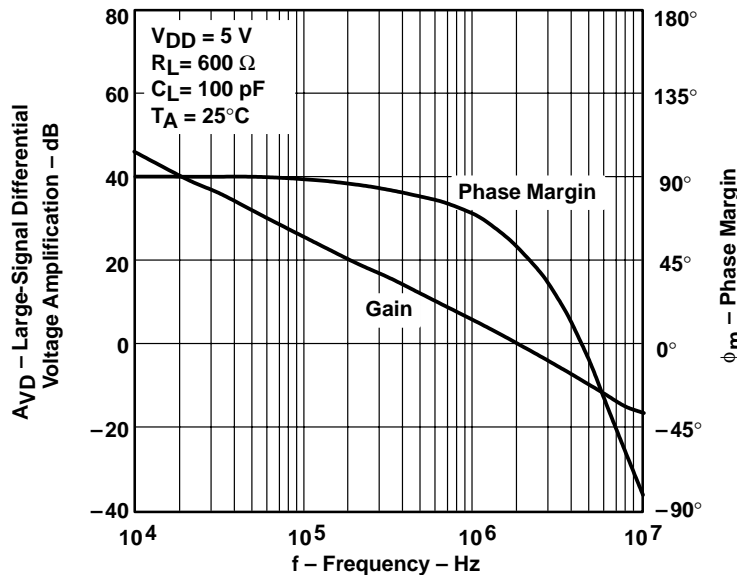
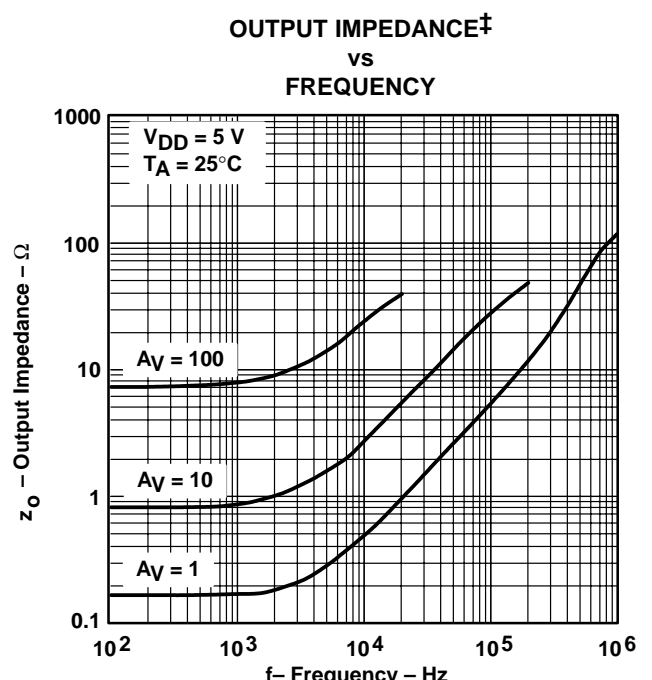
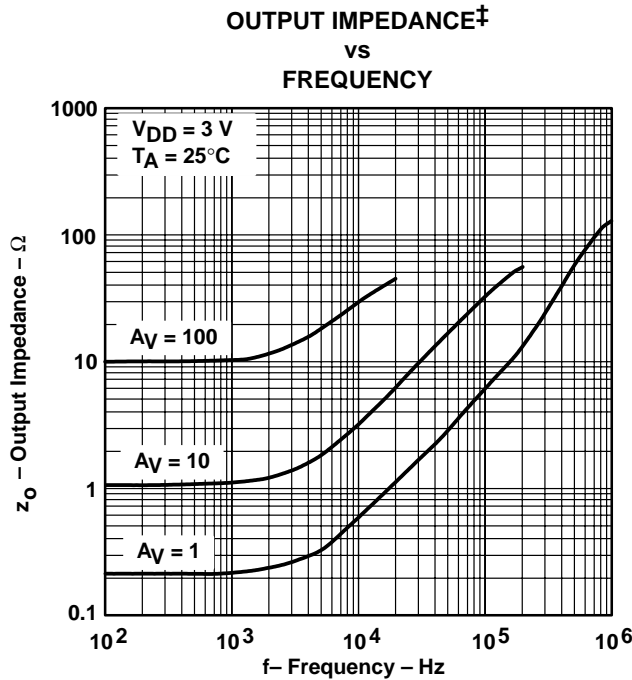
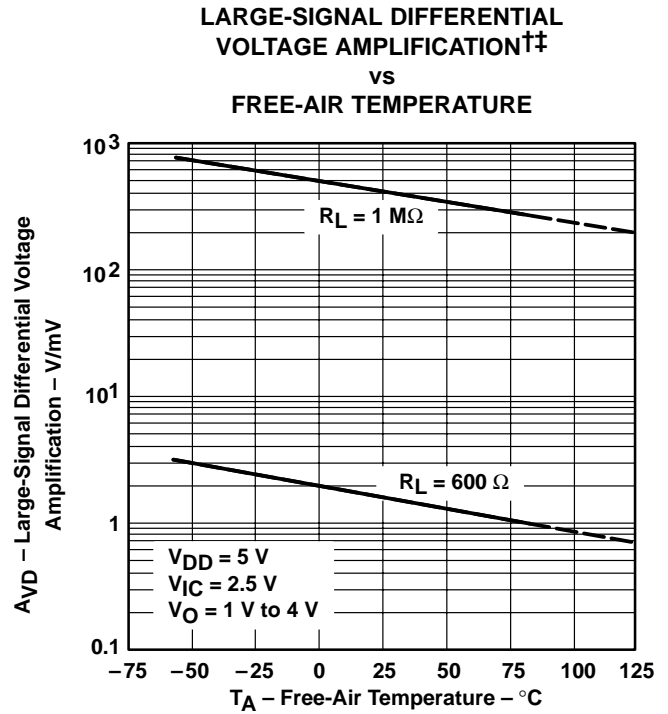
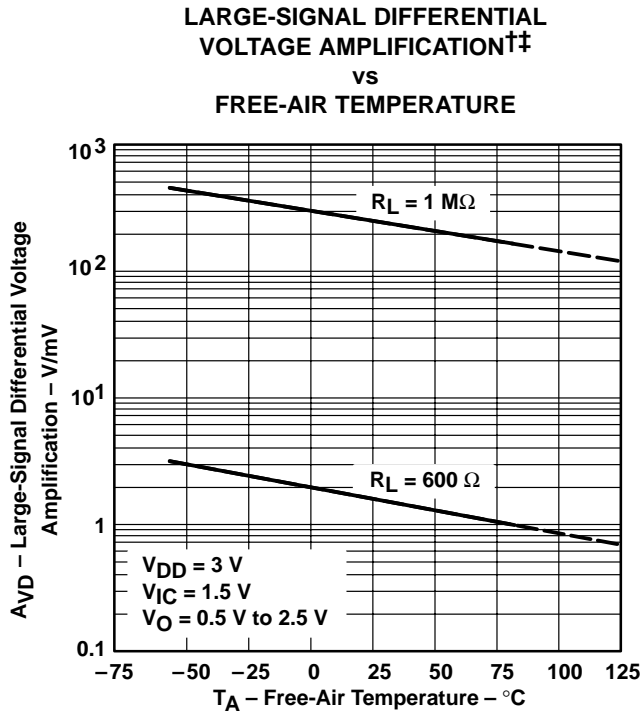


Figure 22

† 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



† 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.

TYPICAL CHARACTERISTICS

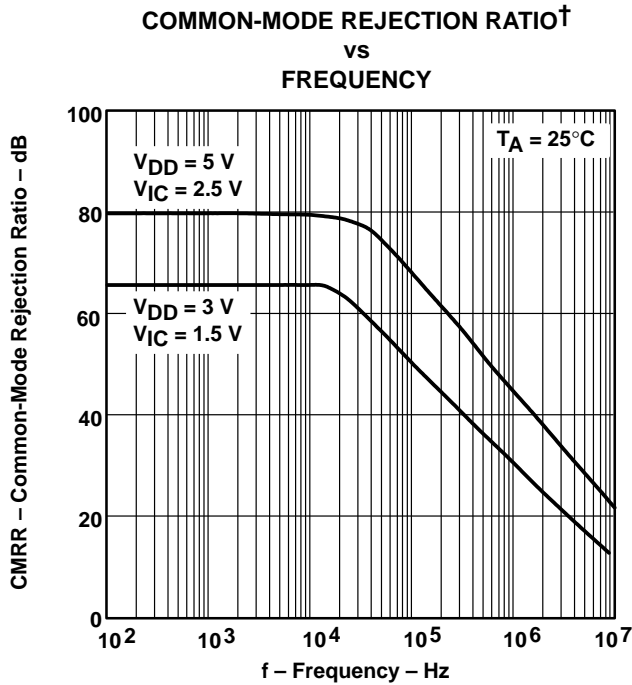


Figure 27

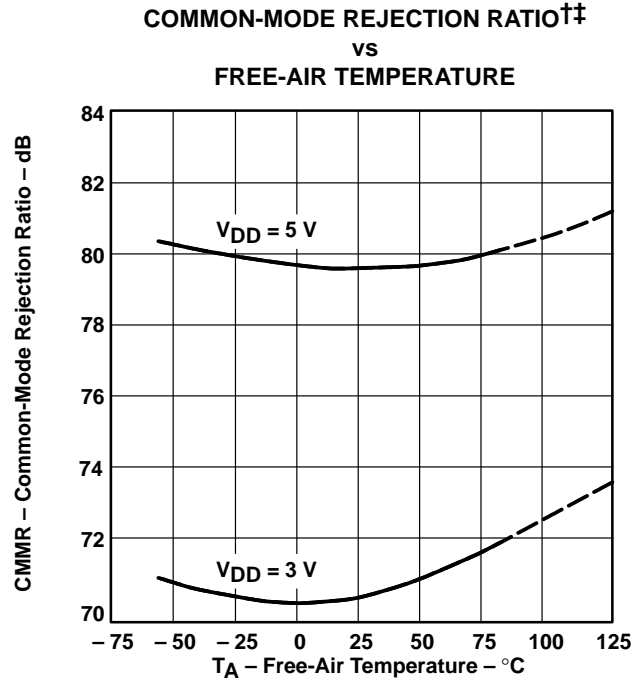


Figure 28

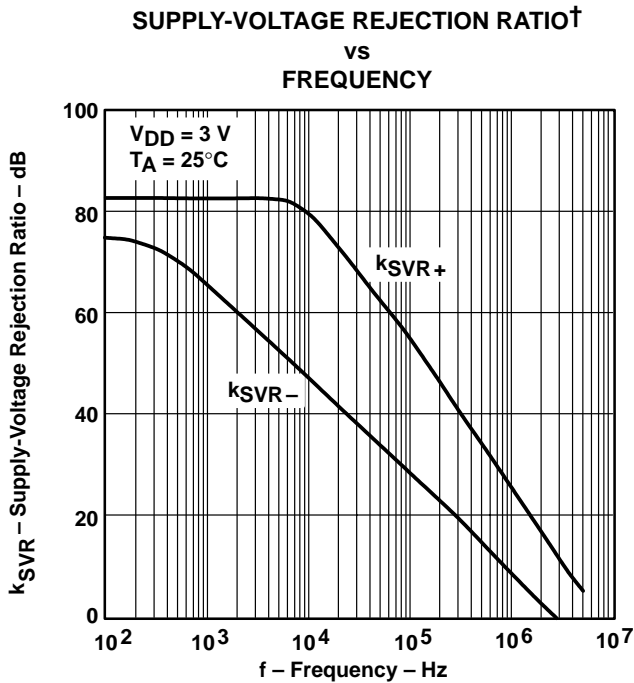


Figure 29

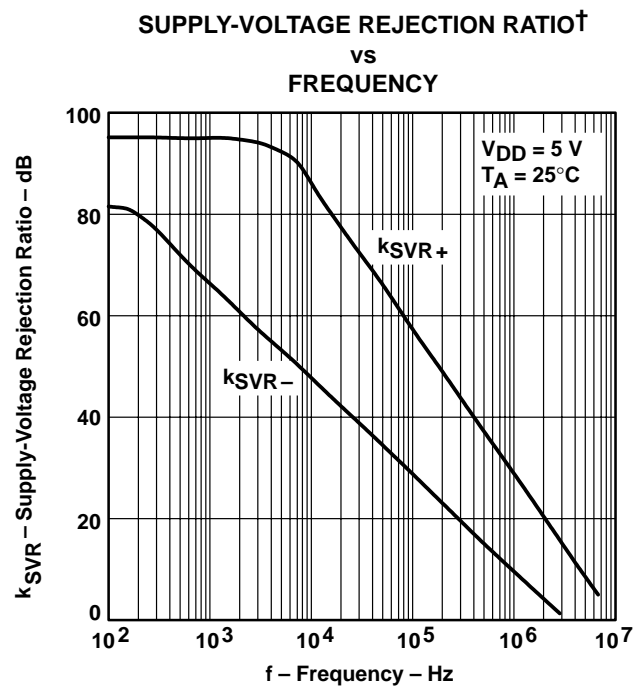
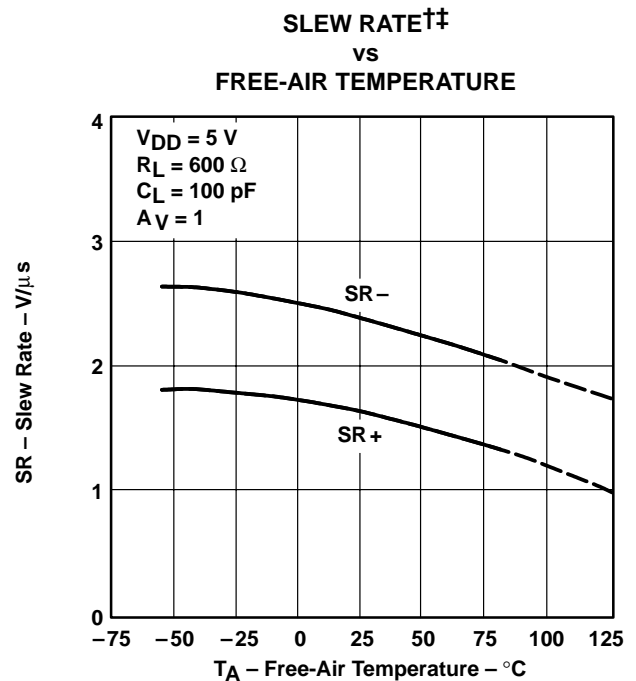
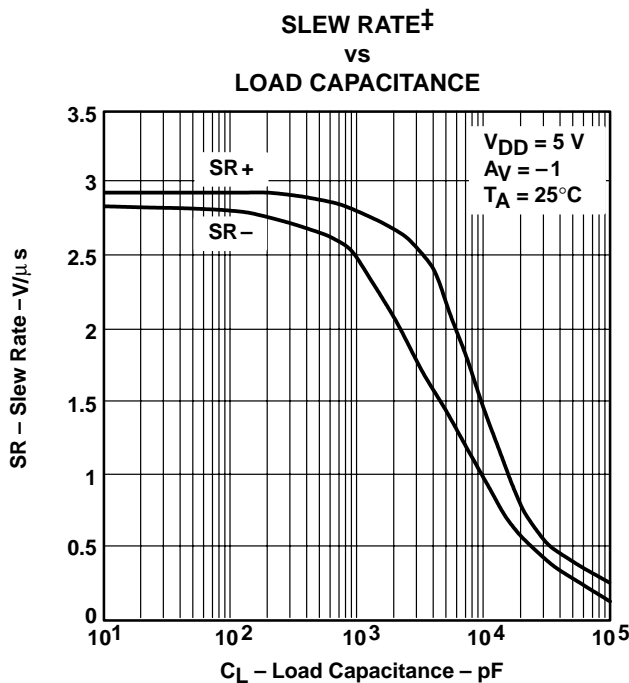
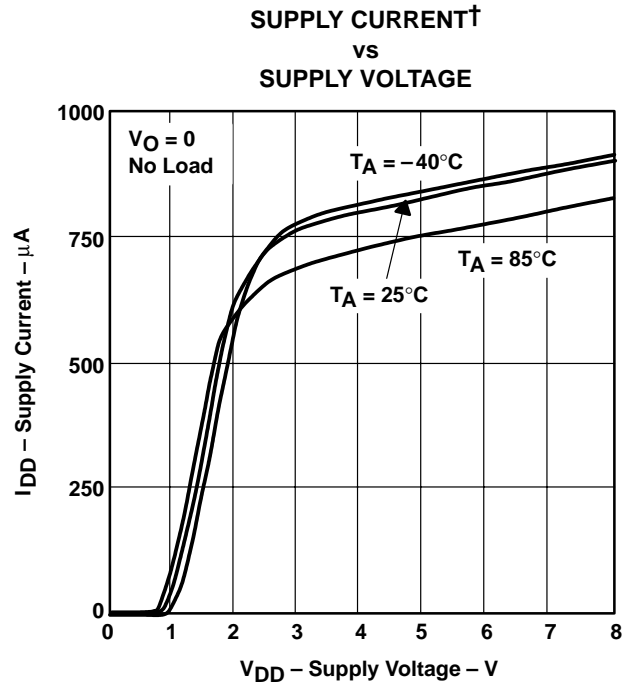
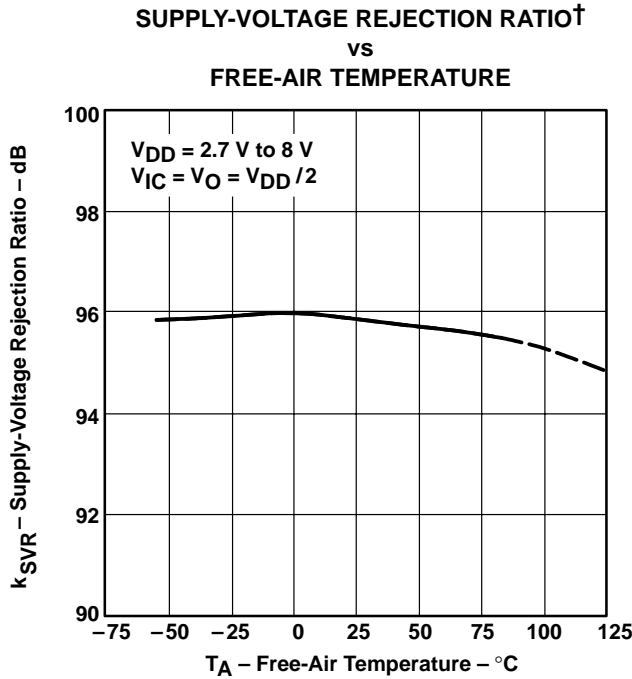


Figure 30

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

TYPICAL CHARACTERISTICS



† 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.

TYPICAL CHARACTERISTICS

INVERTING LARGE-SIGNAL PULSE RESPONSE†

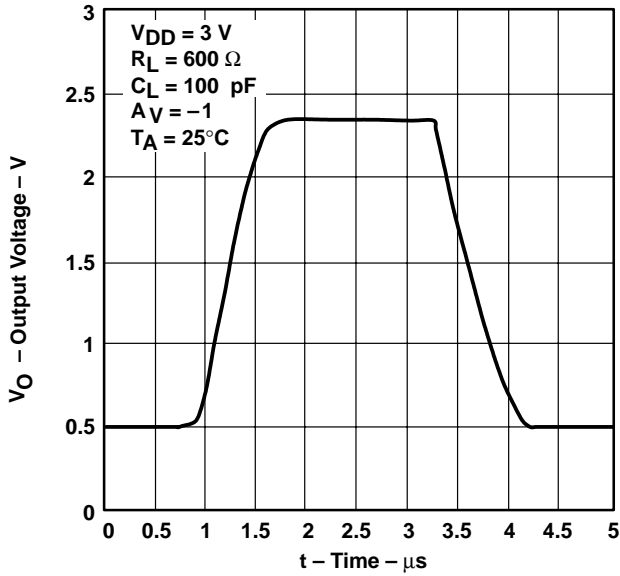


Figure 35

INVERTING LARGE-SIGNAL PULSE RESPONSE†

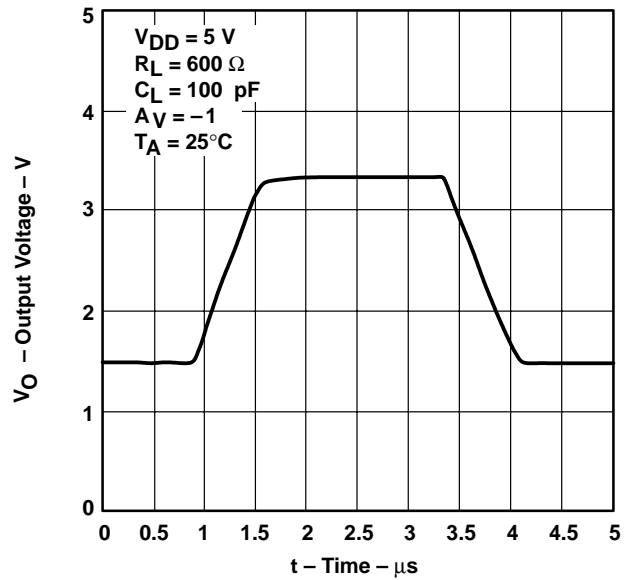


Figure 36

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE†

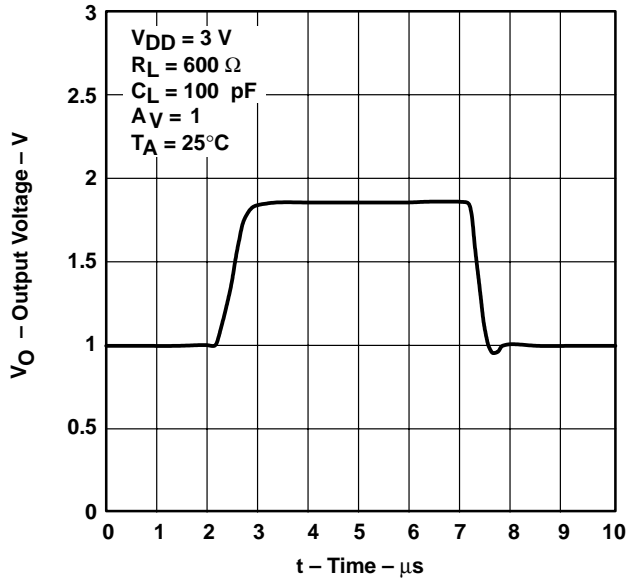


Figure 37

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE†

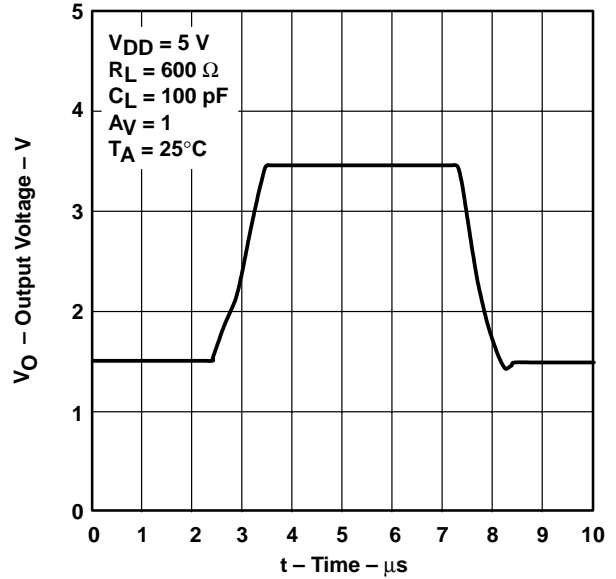
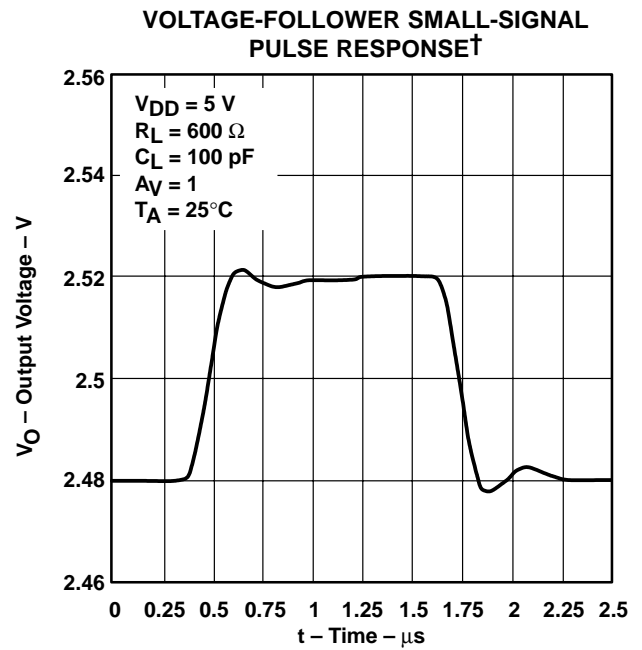
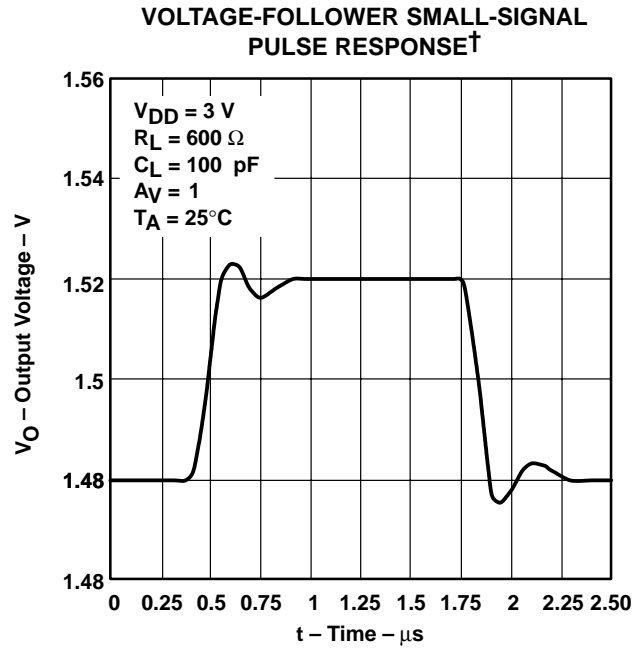
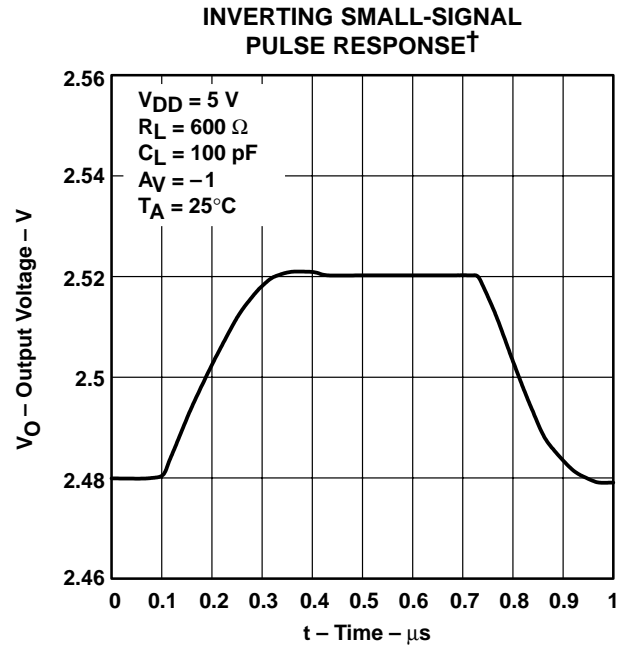
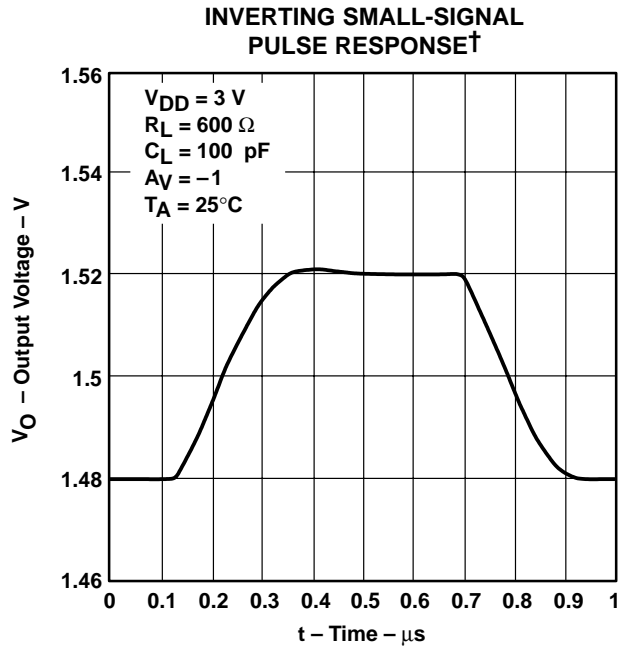


Figure 38

† 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



† 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**

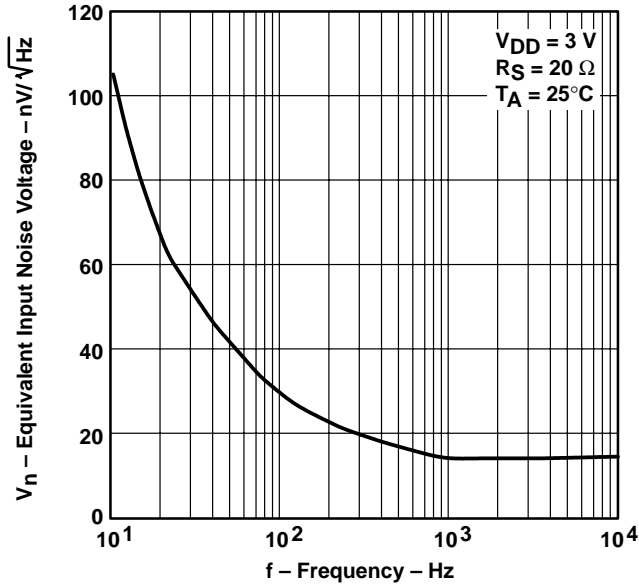


Figure 43

**EQUIVALENT INPUT NOISE VOLTAGE†
 VS
 FREQUENCY**

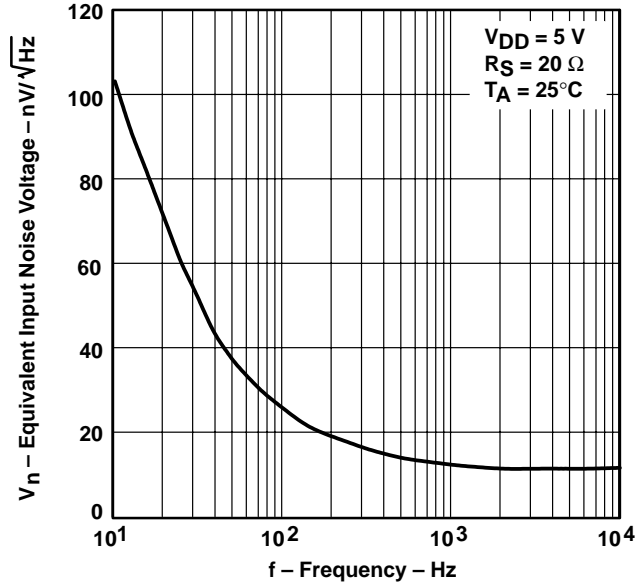


Figure 44

**INPUT NOISE VOLTAGE OVER
 A 10-SECOND PERIOD†**

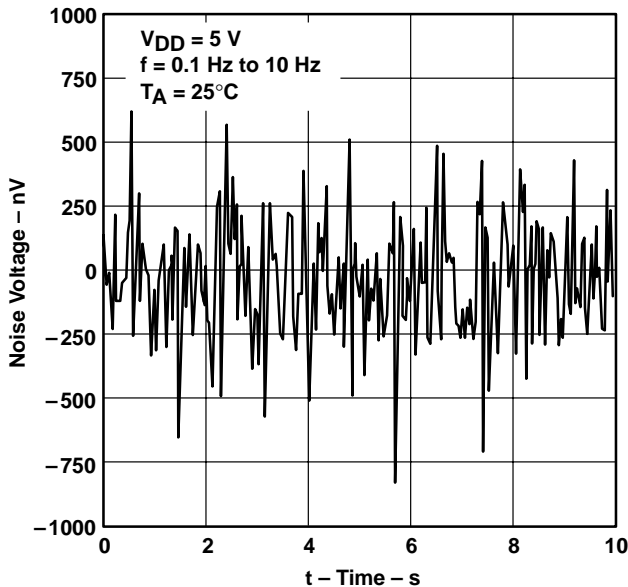


Figure 45

**TOTAL HARMONIC DISTORTION PLUS NOISE†
 VS
 FREQUENCY**

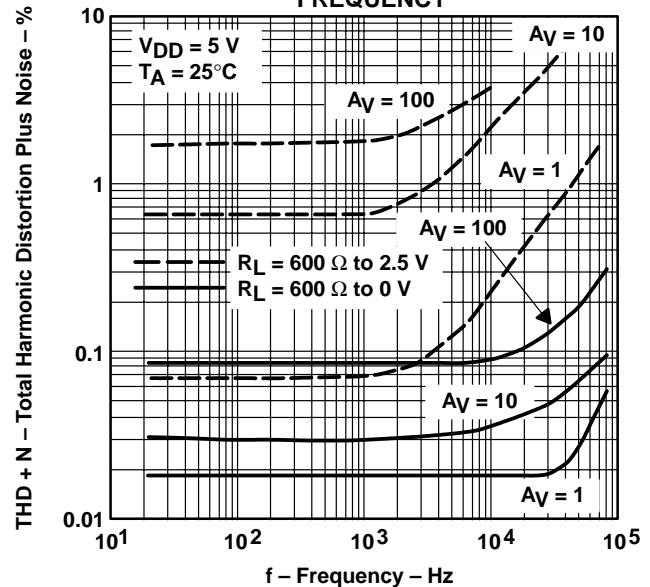
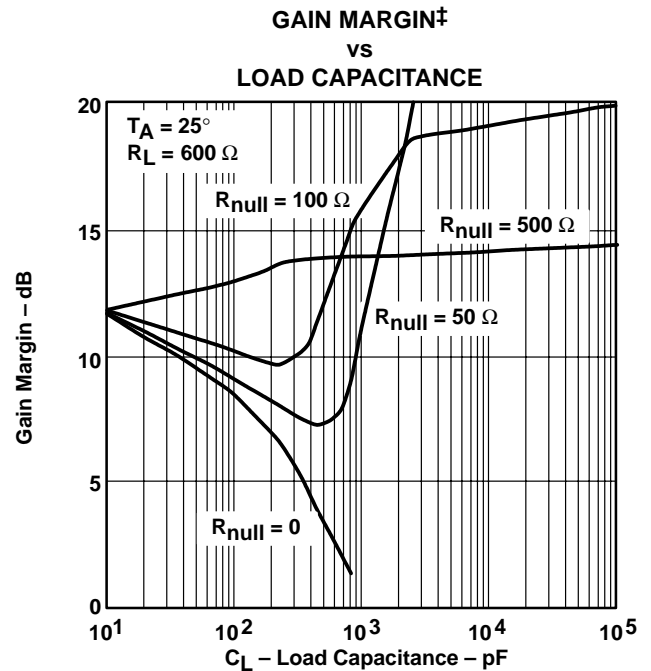
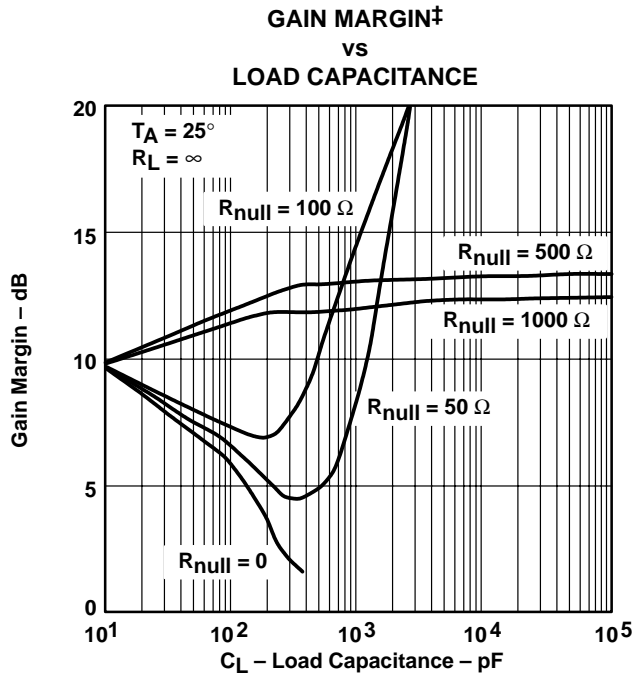
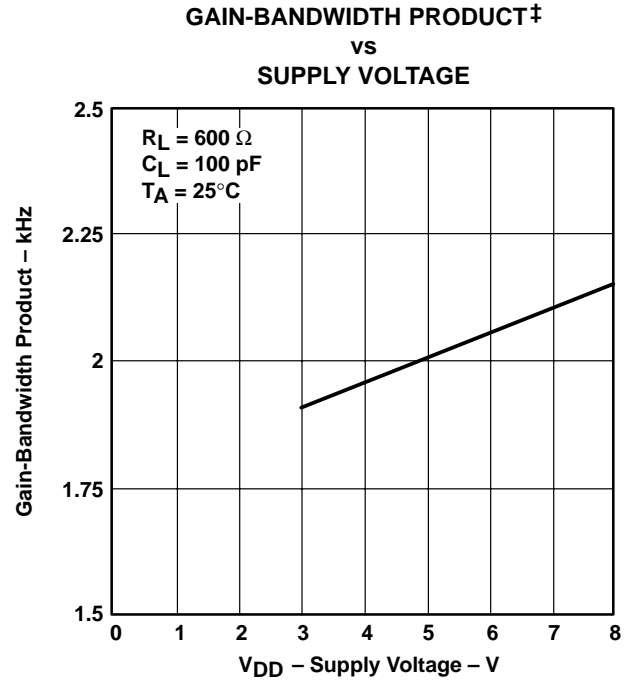
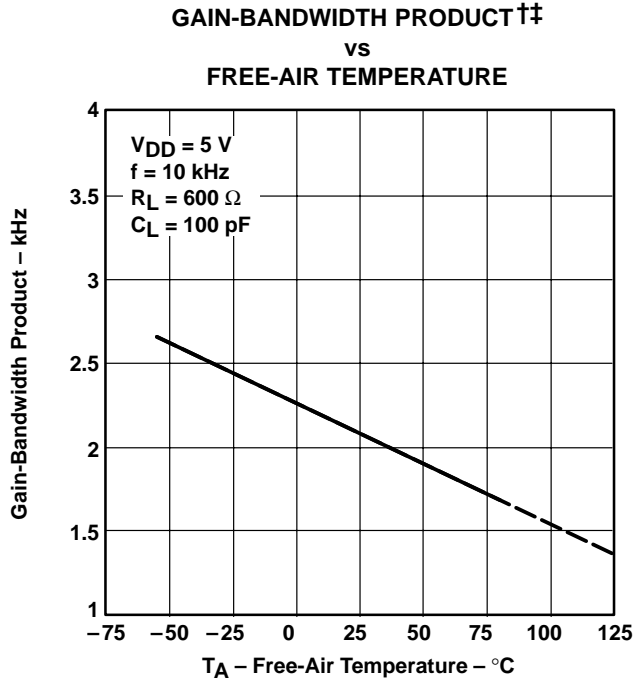


Figure 46

† 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



† 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.

TYPICAL CHARACTERISTICS

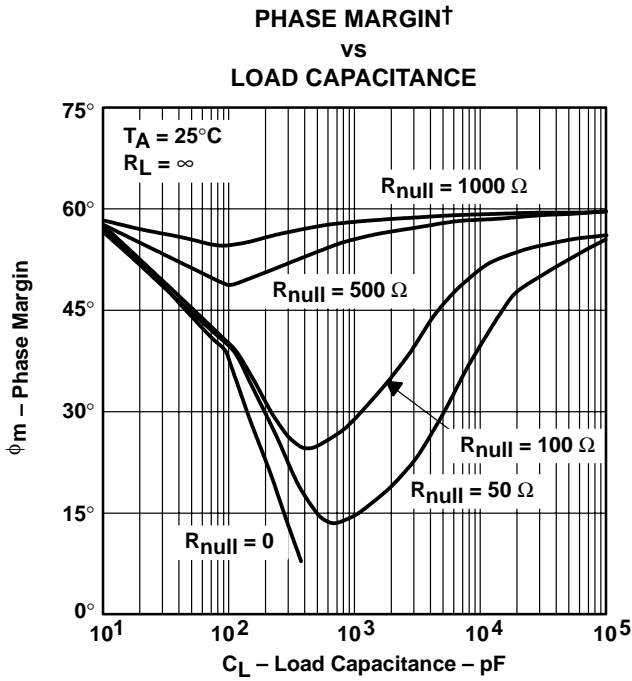


Figure 51

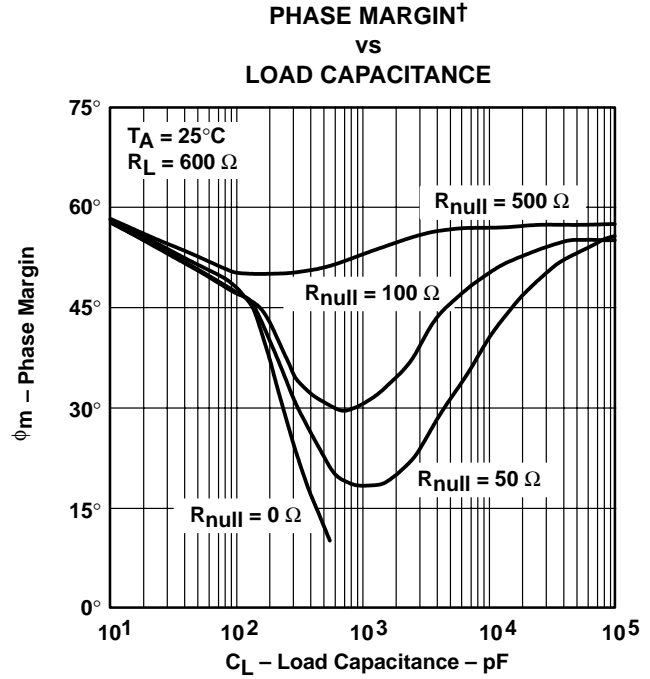


Figure 52

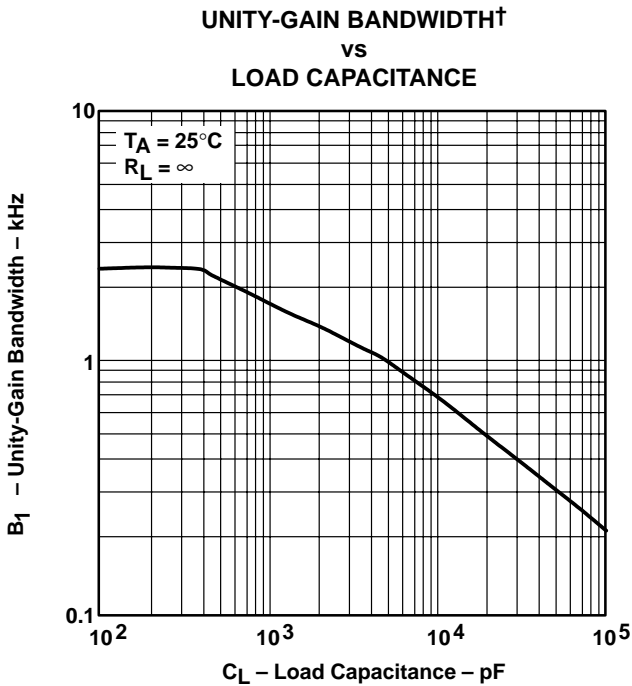


Figure 53

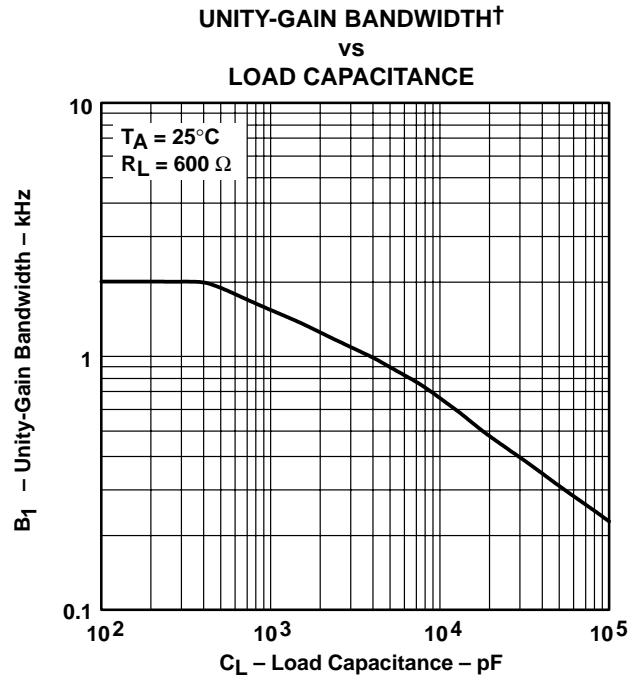


Figure 54

† 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 TLV2731 is designed to drive larger capacitive loads than most CMOS operational amplifiers. Figure 49 through Figure 54 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 55) improves the gain and phase margins when driving large capacitive loads. Figure 49 through Figure 52 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.

$$\Delta\phi_{m1} = \tan^{-1} \left(2 \times \pi \times \text{UGBW} \times R_{null} \times C_L \right) \quad (1)$$

Where :

- $\Delta\phi_{m1}$ = Improvement in phase margin
- UGBW = Unity-gain bandwidth frequency
- R_{null} = Output series resistance
- C_L = Load capacitance

The unity-gain bandwidth (UGBW) frequency decreases as the capacitive load increases (see Figure 53 and Figure 54). To use equation 1, UGBW must be approximated from Figure 53 and Figure 54.

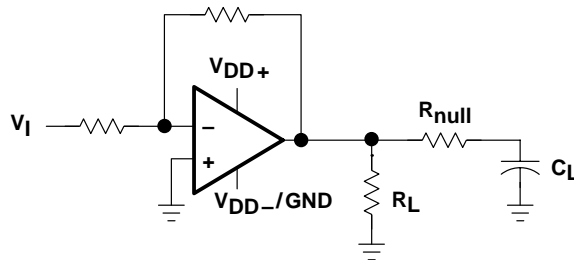


Figure 55. Series-Resistance Circuit

TLV2731, TLV2731Y Advanced LinCMOS™ RAIL-TO-RAIL LOW-POWER SINGLE OPERATIONAL AMPLIFIERS

SLOS198A – AUGUST 1997 – REVISED MARCH 2001

APPLICATION INFORMATION

macromodel information

Macromodel information provided was derived using Microsim *Parts*™, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 6) and subcircuit in Figure 56 are generated using the TLV2731 typical electrical and operating characteristics at $T_A = 25^\circ\text{C}$. 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).

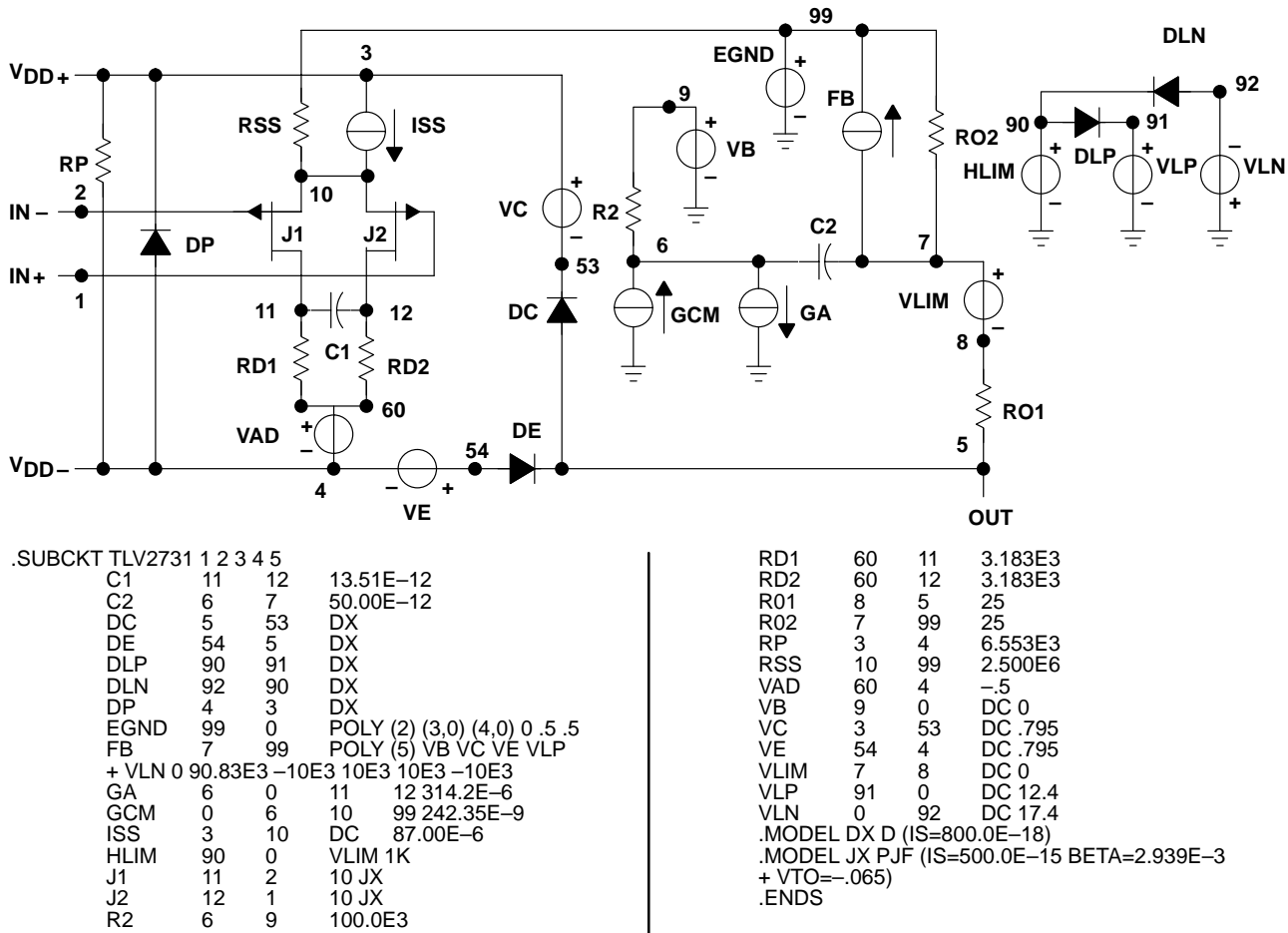


Figure 56. Boyle Macromodel and Subcircuit

PSpice and *Parts* are trademark of MicroSim Corporation.

Macromodels, simulation models, or other models provided by TI, directly or indirectly, are not warranted by TI as fully representing all of the specification and operating characteristics of the semiconductor product to which the model relates.

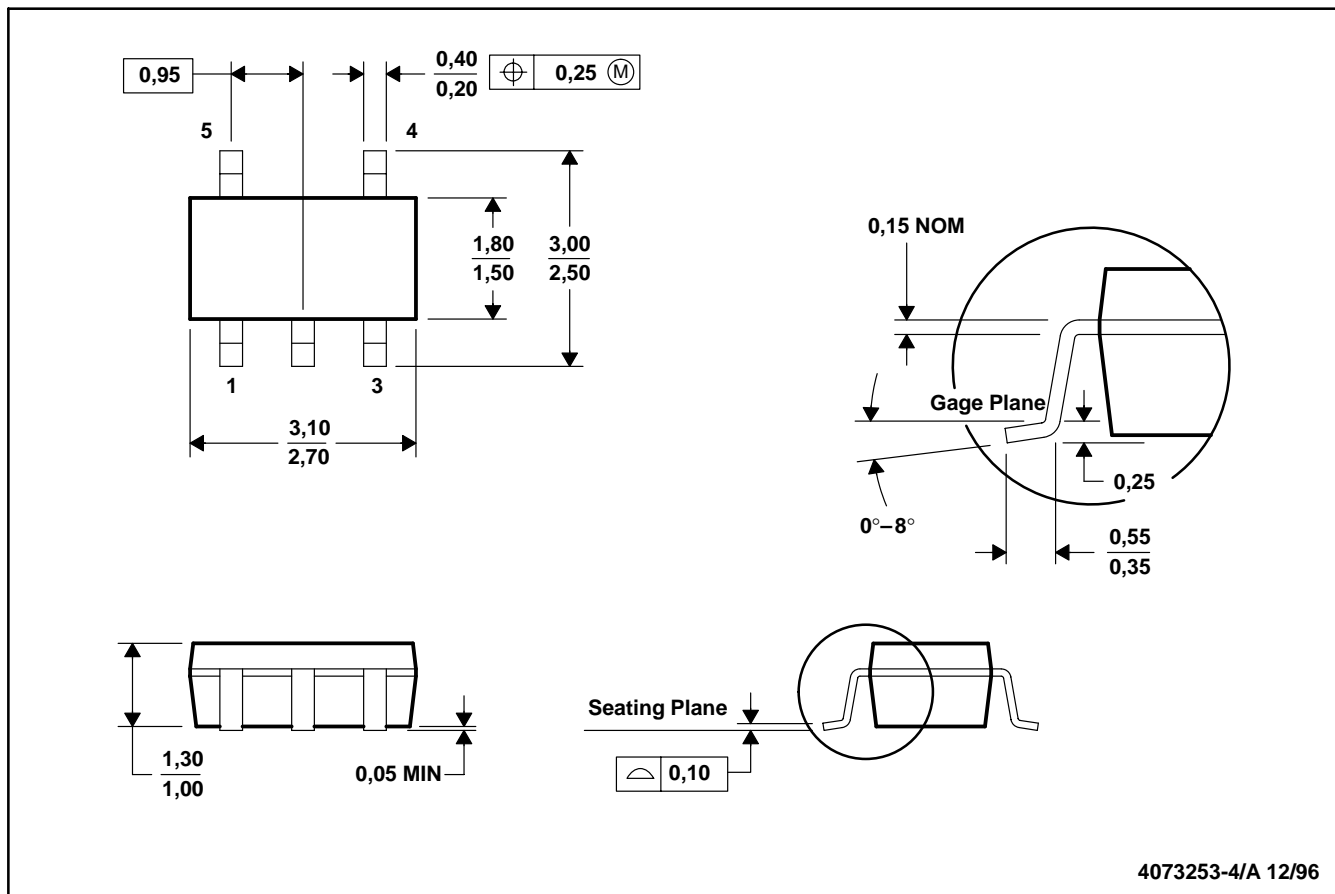


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MECHANICAL INFORMATION

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions include mold flash or protrusion.

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TLV2731CDBV	OBSOLETE	SOT-23	DBV	5		TBD	Call TI	Call TI
TLV2731CDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2731CDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2731CDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2731CDBVTG4	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2731IDBVR	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2731IDBVRG4	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2731IDBVT	ACTIVE	SOT-23	DBV	5	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2731IDBVTG4	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



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TLV2731CDBVR	SOT-23	DBV	5	3000	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2731CDBVT	SOT-23	DBV	5	250	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2731IDBVR	SOT-23	DBV	5	3000	180.0	9.0	3.15	3.2	1.4	4.0	8.0	Q3
TLV2731IDBVT	SOT-23	DBV	5	250	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)
TLV2731CDBVR	SOT-23	DBV	5	3000	182.0	182.0	20.0
TLV2731CDBVT	SOT-23	DBV	5	250	182.0	182.0	20.0
TLV2731IDBVR	SOT-23	DBV	5	3000	182.0	182.0	20.0
TLV2731IDBVT	SOT-23	DBV	5	250	182.0	182.0	20.0

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