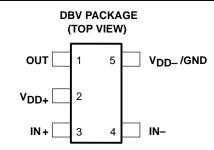
- **Output Swing Includes Both Supply Rails**
- Low Noise . . . 15 nV/ $\sqrt{\text{Hz}}$ Typ at f = 1 kHz
- Low Input Bias Current . . . 1 pA Typ
- Fully Specified for Single-Supply 3-V and 5-V Operation
- **Common-Mode Input Voltage Range Includes Negative Rail**
- High Gain Bandwidth . . . 2 MHz at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

AVAILABLE OPTIONS

т.	V mov AT 25°C	PACKAGED DEVICES	SYMBOL	CHIP FORM‡	
TA	V _{IO} max AT 25°C	SOT-23 (DBV) [†]	STWIBOL	(Y)	
0°C to 70°C	3 mV	TLV2731CDBV	VALC	TLV2731Y	
-40°C to 85°C	3 mV	TLV2731IDBV	VALI	1LV2/311	

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



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

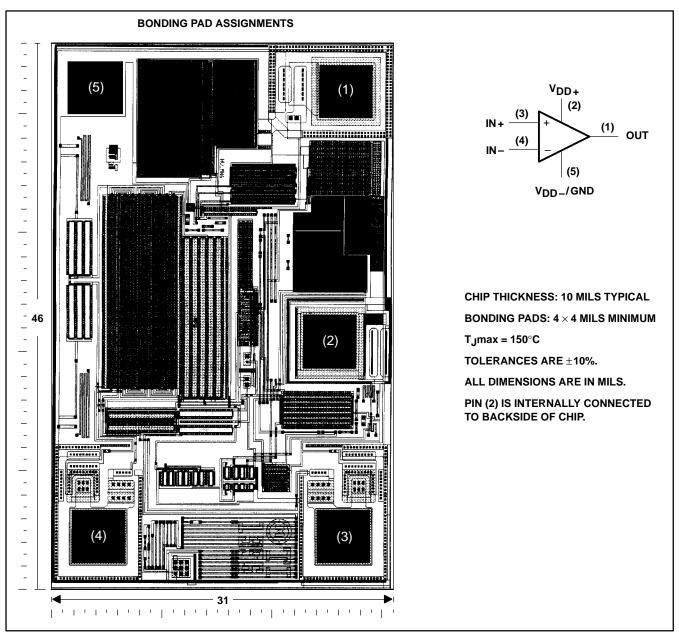
Advanced LinCMOS is a trademark of Texas Instruments



[‡] Chip forms are tested at $T_A = 25^{\circ}C$ only.

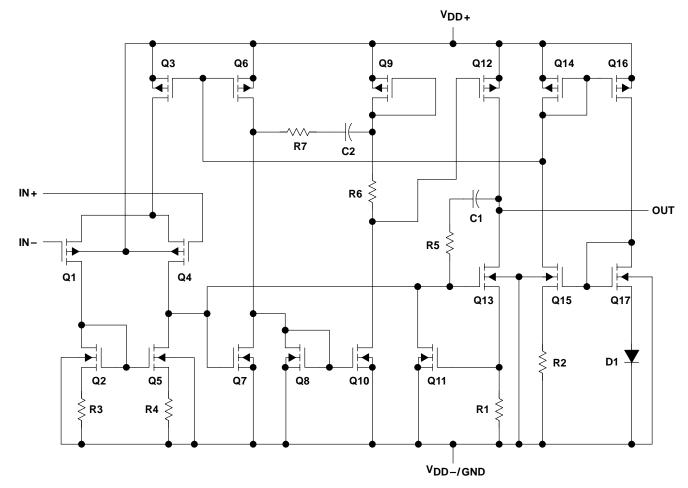
TLV2731Y chip information

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.





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)	±V _{DD}
Input voltage range, V _I (any input, see Note 1)	
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}	
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	
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	.V2731C	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)

	PARAMETER	TEST CON	TEST CONDITIONS TAT		LV27310	2	٦	TLV2731		UNIT		
	FARAWILTER	TEST CON	IDITIONS	'A'	MIN	TYP	MAX	MIN	TYP	MAX	UNIT	
۷ _{IO}	Input offset voltage					0.7	3		0.7	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	
lio	Input offset current			25°C		0.5	60		0.5	60	pА	
ΙΟ	input onset current			Full range			150			150	PΛ	
I _{IB}	Input bias current			25°C		1	60		1	60	pА	
מוי	input bias current			Full range			150			150	PA	
VICR	Common-mode input	R _S = 50 Ω,	V _O ≤5 mV	25°C	0 to 2	-0.3 to 2.2		0 to 2	-0.3 to 2.2		V	
TICK	voltage range	11.3 – 00 11,	14101 = 3 4	Full range	0 to 1.7			0 to 1.7			·	
	Lligh lovel output	$I_{OH} = -1 \text{ mA}$		25°C		2.87			2.87			
Vон	High-level output voltage	lou = -2 mA	o _H = −2 mA	25°C		2.74			2.74		V	
		10H - 211//	OH = 2111/A		2.3			2.3				
	Low-level output	$V_{IC} = 1.5 V,$	$I_{OL} = 50 \mu A$	25°C		10			10			
VOL		I _{OL} = 500 μA	25°C		100			100		mV		
		· (C,	.OL 000 p	Full range			300			300		
	Large-signal	V _{IC} = 1.5 V,	$R_L = 600 \Omega^{\ddagger}$	25°C	1	1.6		1	1.6			
AVD	differential voltage	$V_0 = 1.5 \text{ V},$ $V_0 = 1 \text{ V to 2 V}$		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		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 kHz		25°C		6			6		pF	
z ₀	Closed-loop output impedance	f = 1 MHz,	A _V = 1	25°C		156			156		Ω	
CMDD	Common-mode	$V_{IC} = 0 \text{ to } 1.7 \text{ V},$		25°C	60	70		60	70		٩D	
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	
	(ΔV _{DD} /ΔV _{IO})	vIC = v _{DD} /2,	$I_{IC} = V_{DD}/2$, No load	Full range	70			70				
Inn	Supply current	V _O = 1.5 V,	No load	25°C		750	1200		750	1200	μΑ	
IDD		vO = 1.5 v,	INO IOAU	Full range			1500			1500	μΑ	

[†] 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 $T_A = 150^{\circ}C$ 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, $V_{DD} = 3 V$

					Т	LV27310	2	1	LV2731										
'	PARAMETER	TEST COND	ITIONS	T _A †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT								
	Claus rata 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		nV/√Hz								
V _n	noise voltage	f = 1 kHz		25°C		16			16		nv/√HZ								
\/\.\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Peak-to-peak equivalent input	f = 0.1 Hz to 1 Hz		25°C		1.4			1.4		μV								
VN(PP)	noise voltage	f = 0.1 Hz to 10 Hz		25°C	1.5				1.5		μν								
In	Equivalent input noise current			25°C	0.6		0.6			fA/√ Hz									
		V _O = 1 V to 2 V,	A _V = 1	25°C		0.285%			0.285%										
	Total harmonic distortion plus poise $P(Q) = 1 \ V(Q) $		A _V = 10	25 C		7.2%			7.2%										
THD+N				0.014%			0.014%												
	noise	f = 20 kHz,	A _V = 10	25°C		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		1.9		1.9		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 to 2 V,	To 0.1%	25°C		0.9			0.9		μs								
t _S	octaing time	$R_L = 600 \Omega^{\ddagger},$ $C_L = 100 pF^{\ddagger}$	To 0.01%	25 0		1.5			1.5		μο								
φm	Phase margin at unity gain	R _L = 600 Ω [‡] ,	C _L = 100 pF‡	25°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)

	DADAMETED	TEOT 001	IDITIONS	_ +	Т	LV27310	3	-	ΓLV2731		
	PARAMETER	TEST CON	IDITIONS	T _A †	MIN	TYP	MAX	MIN	TYP	MAX	UNIT
V _{IO}	Input offset voltage					0.7	3		0.7	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)	$V_{DD\pm} = \pm 2.5 \text{ V},$ $V_{O} = 0,$	$V_{IC} = 0$, RS = 50 Ω	25°C		0.003			0.003		μV/mo
Ιο	Input offset current			25°C		0.5	60		0.5	60	pА
10	input onset durient			Full range			150			150	Ρ/ (
I _{IB}	Input bias current			25°C		1	60		1	60	pА
·ID				Full range			150			150	P/ ·
VICR	Common-mode input	$R_S = 50 \Omega$,	V _O ≤5 mV	25°C	0 to 4	-0.3 to 4.2		0 to 4	-0.3 to 4.2		V
VICK	voltage range	113 = 00 22,	V O = 0 III V	Full range	0 to 3.7			0 to 3.7			
	I Pale Javed autout	$I_{OH} = -1 \text{ mA}$		25°C		4.9			4.9		
Vон	High-level output voltage	I _{OH} = -4 mA		25°C		4.6			4.6		V
	vollago	IOH = -4 IIIA		Full range	4.3			4.3			
	Law law Law Instant	$V_{IC} = 2.5 V$,	$I_{OL} = 500 \mu\text{A}$	25°C		80			80		
VOL	Low-level output voltage	V _{IC} = 2.5 V,	I _{OL} = 1 mA	25°C		160			160		mV
		VIC = 2.5 V, IOL = 1 IIIA	Full rang	Full range			500			500	
	Large-signal	V _{IC} = 2.5 V,	$R_1 = 600 \Omega^{\ddagger}$	25°C	1	1.5		1	1.5		
AVD	differential voltage	$V_{O} = 2.5 \text{ V},$ $V_{O} = 1 \text{ V to 4 V}$		Full range	0.3			0.3			V/mV
	amplification	Ŭ	$R_L = 1 M\Omega^{\ddagger}$	25°C		400			400		
^r id	Differential input resistance			25°C		10 ¹²			10 ¹²		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 ₀	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		4D
CMRR	rejection ratio	$V_0 = 2.5 \text{ V},$	$R_S = 50 \Omega$	Full range	55			55			dB
ksvr	Supply voltage rejection ratio	$V_{DD} = 4.4 \text{ V to 8}$		25°C	70	96		70	96		dB
	$(\Delta V_{DD} / \Delta V_{IO})$	$V_{IC} = V_{DD}/2$,	No load	Full range	70			70			
IDD	Supply current	V _O = 2.5 V,	No load	25°C		850	1300		850	1300	μΑ
טט		V = 2.5 v,	. 10 1044	Full range			1600			1600	μΛ

[†] Full range for the TLV2731C is 0°C to 70°C. Full range for the TLV2731I is – 40°C to 85°C.

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.



[‡]Referenced to 2.5 V

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, $V_{DD} = 5 V$

PARAMETER TEST CONDITIONS Table 100 μ ($L_{\rm e} = 100 {\rm pF}^{\pm}$) Table 100 μ ($L_{\rm e} = 100 {\rm pF}^{\pm}$) Table 100 μ ($L_{\rm e} = 100 {\rm pF}^{\pm}$) Max Min Typ MAX MIN 10 10 10 10 10 10 10 10 Typ MAX MIN M		DADAMETED	TEST CONDITIONS		- +	Т	LV27310	3	7	ΓLV2731		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/Hz VN(PP) Peak-to-peak equivalent input noise voltage f = 0.1 Hz to 10 Hz 25°C 1.4 1.4 1.4 μ/V In Equivalent input noise current f = 0.1 Hz to 10 Hz 25°C 0.6 0.6 6	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$				A _V = 10	25 0		3.68%			3.68%		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	THD+N	•	Vo = 1.5 V to 3.5 V.	A _V = 1			0.018%			0.018%		
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		noise	f = 20 kHz,	A _V = 10	25°C		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 $R_L = 600 \Omega^{\ddagger}$, $C_L = 100 pF^{\ddagger}$ 25 C 48 48	'S	Setting time	$R_L = 600 \Omega^{\ddagger},$ $C_L = 100 pF^{\ddagger}$	To 0.01%	250		2.4			2.4		μς
- ' - '	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)

PARAMETER		TEST C	ONDITIONS	TI	_V2731Y	,	ш
	PARAMETER	lesi c	UNDITIONS	MIN	TYP	MAX	UNIT
VIO	Input offset voltage				750		μV
lιO	Input offset current	$V_{DD} \pm = \pm 1.5 \text{ V},$ $R_{S} = 50 \Omega$	$V_{IC} = 0, V_{O} = 0,$		0.5	60	pА
I _{IB}	Input bias current	115 = 30 12			1	60	pА
VICR	Common-mode input voltage range	$ V_{IO} \le 5 \text{ mV},$	$R_S = 50 \Omega$		-0.3 to 2.2		V
Vон	High-level output voltage	$I_{OH} = -1 \text{ mA}$			2.87		V
Var	Low lovel output voltage	V _{IC} = 1.5 V,	I _{OL} = 50 μA		10		mV
VOL	Low-level output voltage	$V_{IC} = 1.5 \text{ V}, \qquad I_{OL} = 500 \mu\text{A}$			100		1110
_		N 4 1/4 = 0 1/4	$R_L = 600 \Omega^{\dagger}$		1.6		\//\/
AVD	Large-signal differential voltage 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
c _{ic}	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	$V_{IC} = 0 \text{ to } 1.7 \text{ V},$	$V_0 = 0$, $R_S = 50 \Omega$		70		dB
kSVR	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		750		μΑ

[†] Referenced to 1.5 V

electrical characteristics at V_{DD} = 5 V, T_A = 25°C (unless otherwise noted)

	PARAMETER	TEST C	ONDITIONS	TI	V2731Y	,		
	PARAMETER	1551 C	UNDITIONS	MIN	TYP	MAX	UNIT	
VIO	Input offset voltage				710		μV	
IIO	Input offset current	$V_{DD} \pm = \pm 1.5 \text{ V},$ $R_S = 50 \Omega$	$V_{IC} = 0, V_{O} = 0,$		0.5	60	pА	
I _{IB}	Input bias current	115 - 00 12			1	60	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 mA			4.9		V	
\/a:	Low-level output voltage	V _{IC} = 2.5 V,	I _{OL} = 500 μA		80		mV	
VOL	Low-level output voltage	$V_{IC} = 2.5 \text{ V}, \qquad I_{OL} = 1 \text{ mA}$			160		111.4	
Δ	Lorgo pignol differential valte as appolitication	V - 4 V to 2 V	$R_L = 600 \Omega^{\dagger}$		15		V/mV	
AVD	Large-signal differential voltage amplification	$V_O = 1 \text{ V to 2 V}$	$R_L = 1 M\Omega^{\dagger}$	400			V/IIIV	
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		138		Ω	
CMRR	Common-mode rejection ratio	$V_{IC} = 0 \text{ to } 1.7 \text{ V},$	$V_0 = 0$, $R_S = 50 \Omega$		70		dB	
ksvr	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	

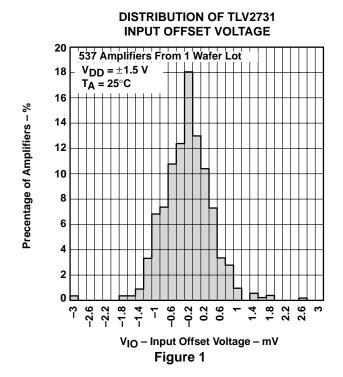
[†] Referenced to 2.5 V

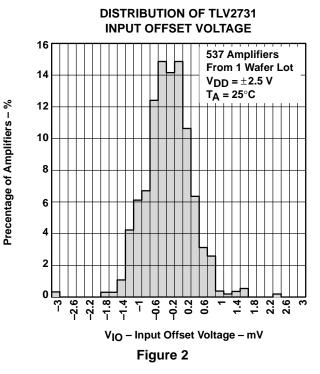


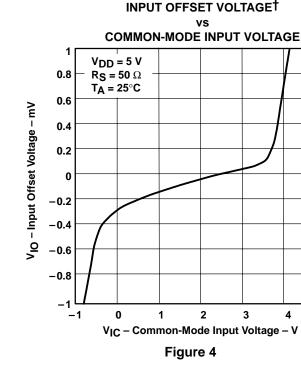
Table of Graphs

			FIGURE
VIO	Input offset voltage	Distribution vs Common-mode input voltage	1, 2 3, 4
αVIO	Input offset voltage temperature coefficient	Distribution	5, 6
I _{IB} /I _{IO}	Input bias and input offset currents	vs Free-air temperature	7
VI	Input voltage	vs Supply voltage vs Free-air temperature	8 9
Vон	High-level output voltage	vs High-level output current	10, 13
VOL	Low-level output voltage	vs Low-level output current	11, 12, 14
VO(PP)	Maximum peak-to-peak output voltage	vs Frequency	15
IOS	Short-circuit output current	vs Supply voltage vs Free-air temperature	16 17
VO	Output voltage	vs Differential input voltage	18, 19
AVD	Differential voltage amplification	vs Load resistance	20
AVD	Large-signal differential voltage amplification	vs Frequency vs Free-air temperature	21, 22 23, 24
z ₀	Output impedance	vs Frequency	25, 26
CMRR	Common-mode rejection ratio	vs Frequency vs Free-air temperature	27 28
ksvr	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
٧o	Inverting large-signal pulse response		35, 36
٧o	Voltage-follower large-signal pulse response		37, 38
٧o	Inverting small-signal pulse response		39, 40
٧o	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
фm	Phase margin	vs Frequency vs Load capacitance	21, 22 51, 52
B ₁	Unity-gain bandwidth	vs Load capacitance	53, 54









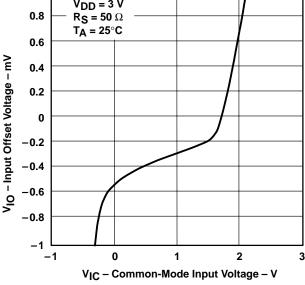


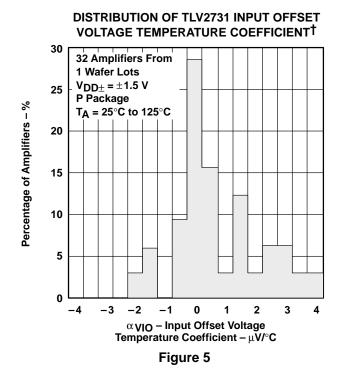
Figure 3

† 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.

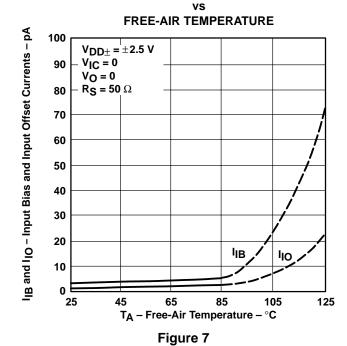


5

TYPICAL CHARACTERISTICS



INPUT BIAS AND INPUT OFFSET CURRENTS[†]



DISTRIBUTION OF TLV2731 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT[†]

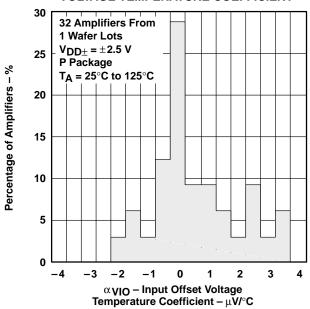
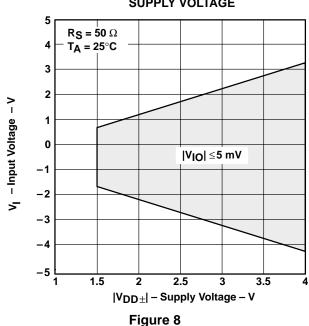


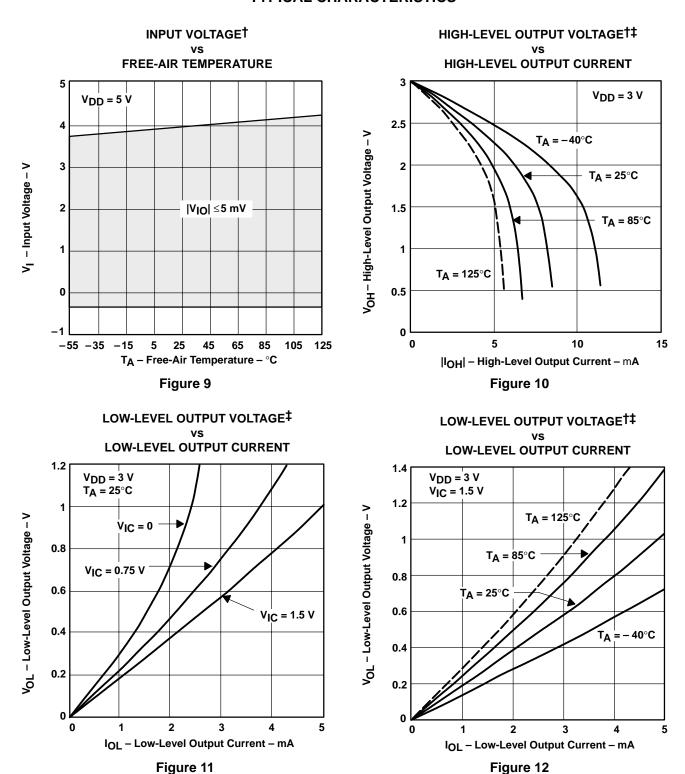
Figure 6

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.



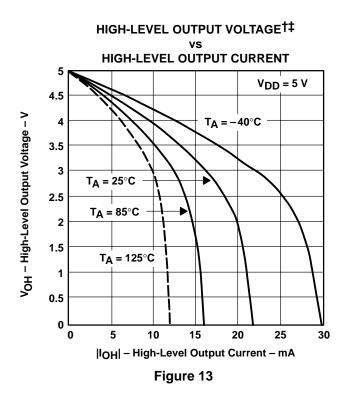


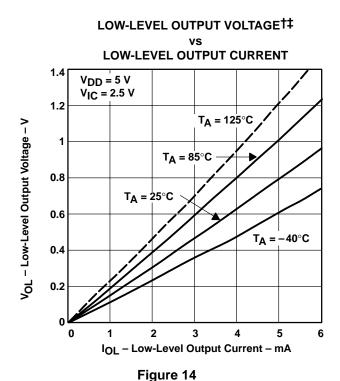
[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

[‡] 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‡ **FREQUENCY**

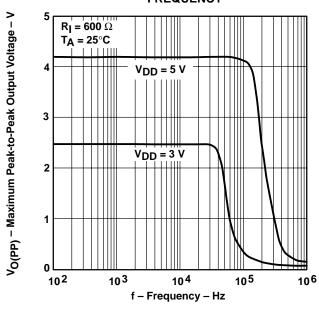
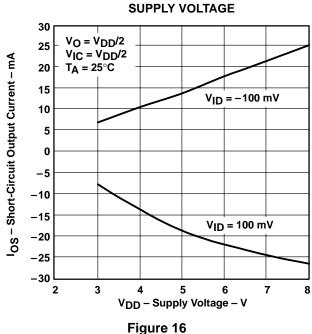


Figure 15

SHORT-CIRCUIT OUTPUT CURRENT

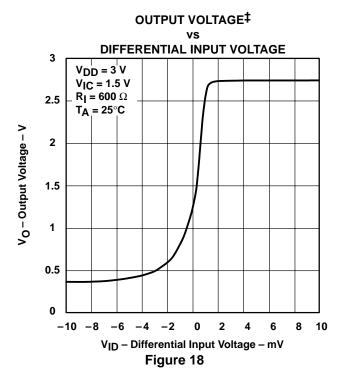


[†]Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

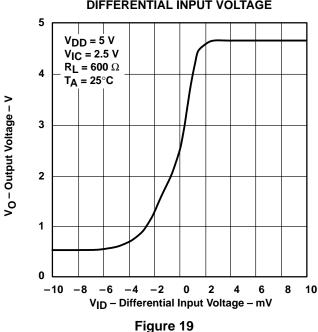
[‡] For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

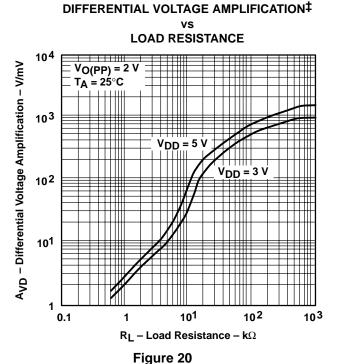


SHORT-CIRCUIT OUTPUT CURRENT †‡ FREE-AIR TEMPERATURE 30 $V_{DD} = 5 V$ 25 $V_{IC} = 2.5 V$ IOS - Short-Circuit Output Current - mA V_O = 2.5 V 20 15 $V_{ID} = -100 \text{ mV}$ 10 5 0 -5 -10V_{ID} = 100 mV -15 -20 -25 -30-5025 50 75 100 125 -75 -250 TA - Free-Air Temperature - °C Figure 17



OUTPUT VOLTAGE‡ vs DIFFERENTIAL INPUT VOLTAGE 5





[†] 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 MARGIN[†]

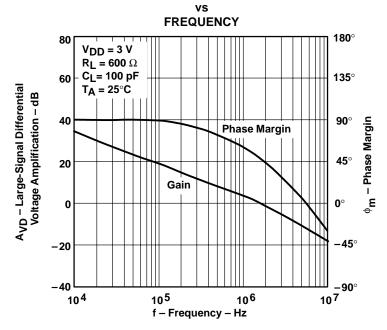
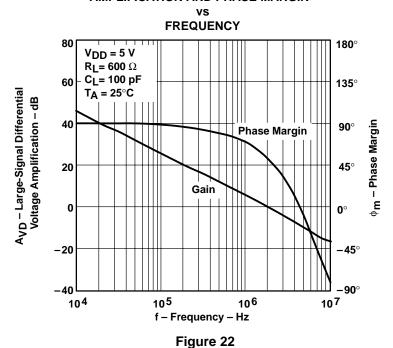


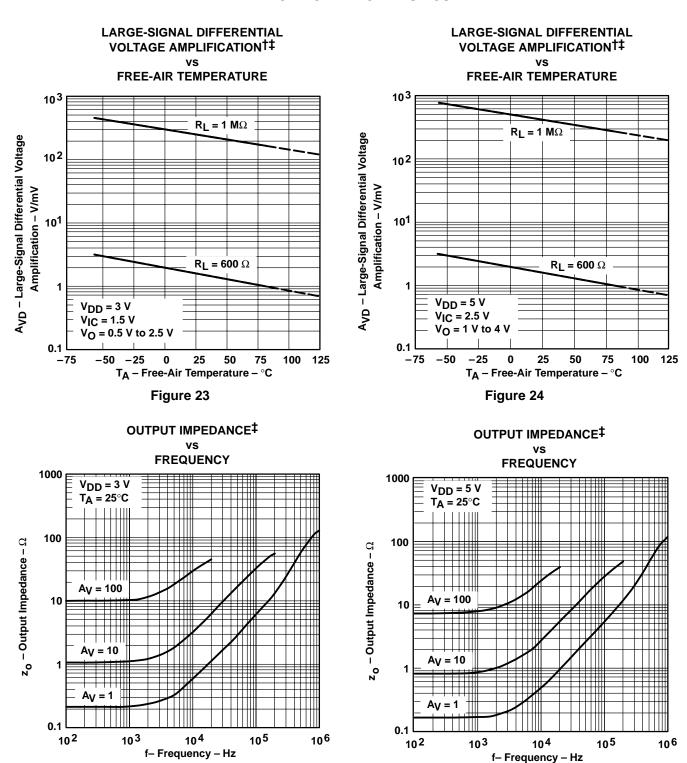
Figure 21

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



† 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.

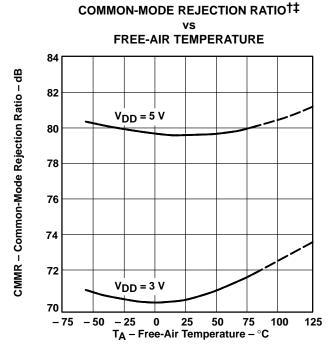
Figure 25

[‡] 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 26

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 27





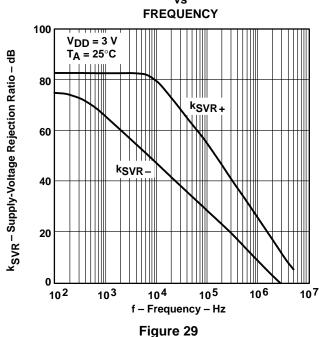
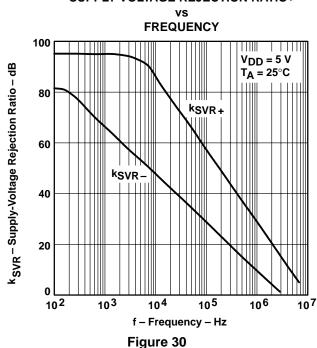




Figure 28



 $^{^{\}dagger}$ 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.



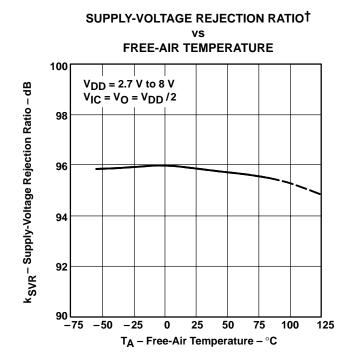
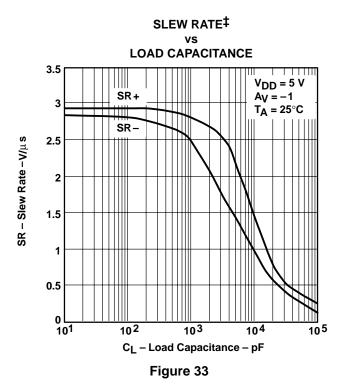


Figure 31



SUPPLY CURRENT[†] vs SUPPLY VOLTAGE

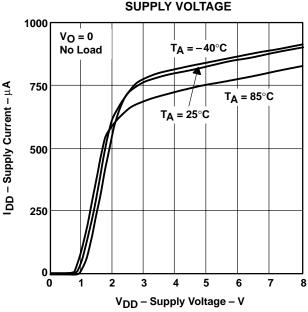


Figure 32

SLEW RATE†‡ vs FREE-AIR TEMPERATURE

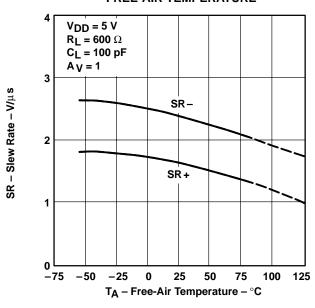


Figure 34

[‡] 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†

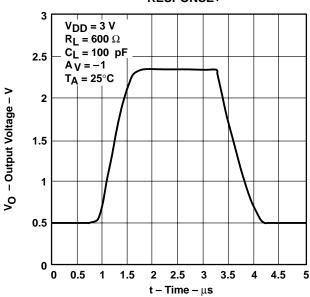


Figure 35

INVERTING LARGE-SIGNAL PULSE RESPONSE†

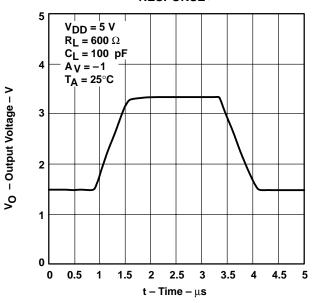


Figure 36

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE[†]

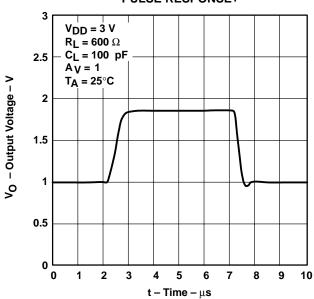


Figure 37

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE[†]

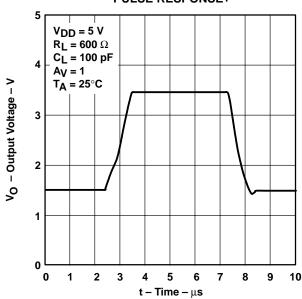
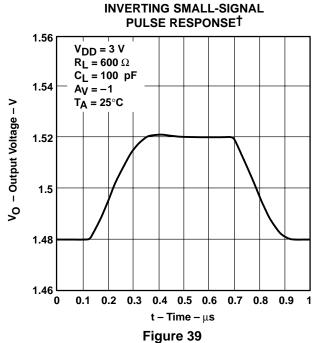


Figure 38

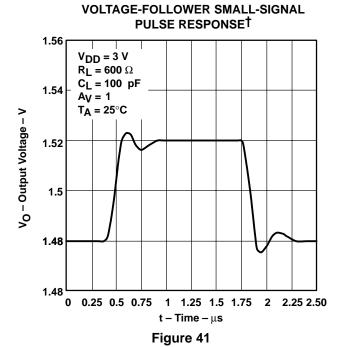
† For all curves where $V_{DD} = 5 \text{ V}$, all loads are referenced to 2.5 V. For all curves where $V_{DD} = 3 \text{ V}$, all loads are referenced to 1.5 V.



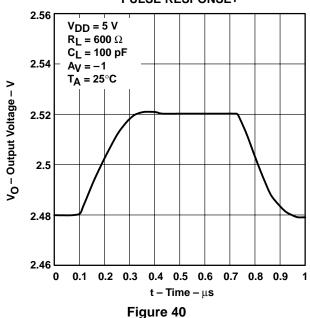
TYPICAL CHARACTERISTICS



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INVERTING SMALL-SIGNAL PULSE RESPONSE†



VOLTAGE-FOLLOWER SMALL-SIGNAL

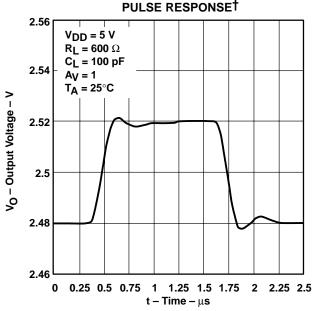
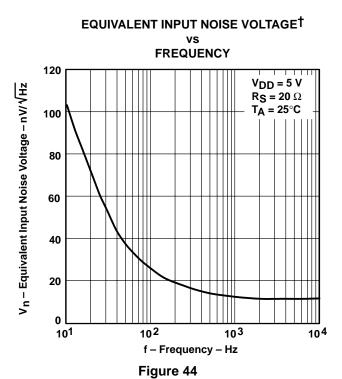


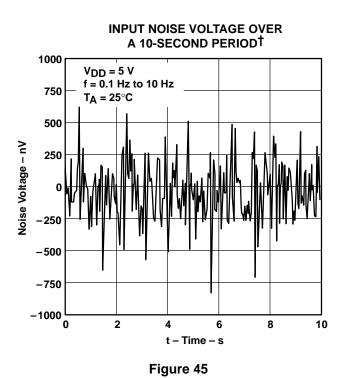
Figure 42

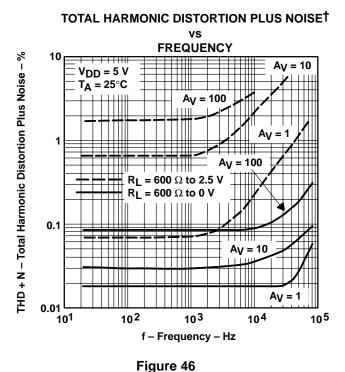
 \dagger For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.



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 43







 \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.



GAIN-BANDWIDTH PRODUCT‡ **GAIN-BANDWIDTH PRODUCT †**‡ **SUPPLY VOLTAGE** FREE-AIR TEMPERATURE 2.5 $R_L = 600 \Omega$ $V_{DD} = 5 V$ $C_{L}^{-} = 100 \text{ pF}$ f = 10 kHzT_A = 25°C $R_L = 600 \Omega$ 3.5 Gain-Bandwidth Product – kHz Gain-Bandwidth Product - kHz $C_L = 100 pF$ 2.25 3 2.5 2 1.75 1.5 1.5 2 3 7 8 25 50 75 100 125 -75 -50 -25 0 V_{DD} - Supply Voltage - V T_A - Free-Air Temperature - °C Figure 47 Figure 48 GAIN MARGIN‡ **GAIN MARGIN**[‡] LOAD CAPACITANCE **LOAD CAPACITANCE** 20 $T_A = 25^\circ$ T_A = 25° $R_L = \infty$ $R_L = 600 \Omega$ Ш $R_{null} = 100 \Omega$ $R_{null} = 100 \Omega$ $R_{null} = 500 \Omega$ 15 15 $R_{null} = 500 \Omega$ Gain Margin - dB Gain Margin – dB $R_{null} = 1000 \Omega$ $R_{null} = 50 \Omega$ 10 10

102 103 104 C_L - Load Capacitance - pF Figure 49

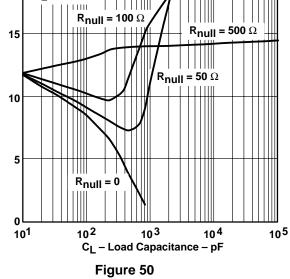
5

0

101

 $R_{null} = 0$

 $R_{null} = 50 \Omega$



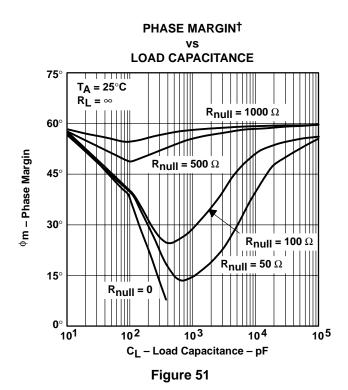
[†] Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

105

[‡] 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.

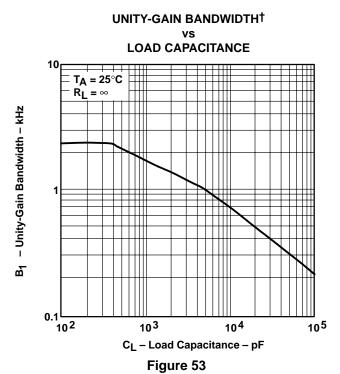


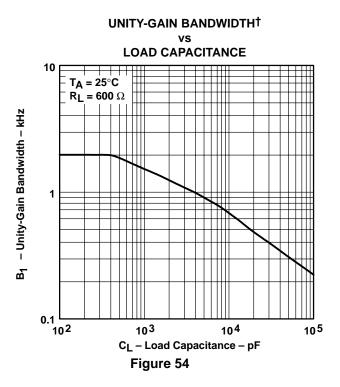
TYPICAL CHARACTERISTICS



PHASE MARGIN[†] **LOAD CAPACITANCE** 75° T_A = 25°C $R_L = 600 \Omega$ R_{null} = 500 Ω 60° ⁰m – Phase Margin R_{null} = 100 Ω 45° **30**° $R_{null} = 50 \Omega$ 15° $R_{null} = 0 \Omega$ 101 102 103 104 105 C_L - Load Capacitance - pF

Figure 52





† 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.

$$\Delta \phi_{m1} = \tan^{-1} \left(2 \times \pi \times \text{UGBW} \times R_{\text{null}} \times C_{\text{L}} \right)$$
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 53 and Figure 54). To use equation 1, UGBW must be approximated from Figure 53 and Figure 54.

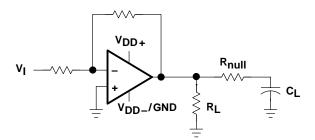


Figure 55. Series-Resistance Circuit

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 56 are generated using the TLV2731 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).

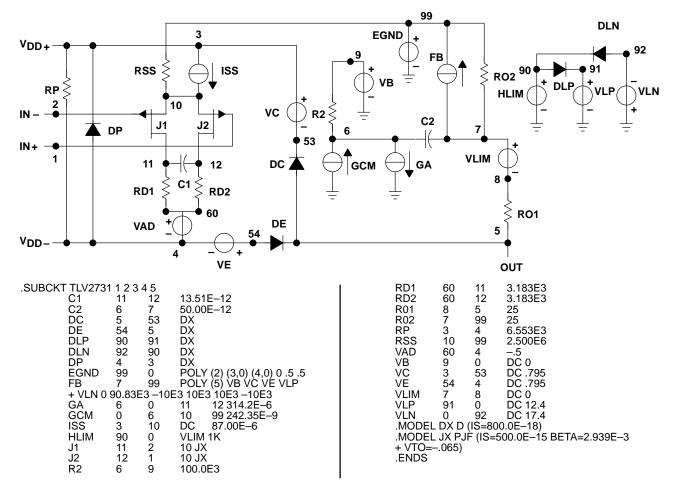


Figure 56. Boyle Macromodel and Subcircuit

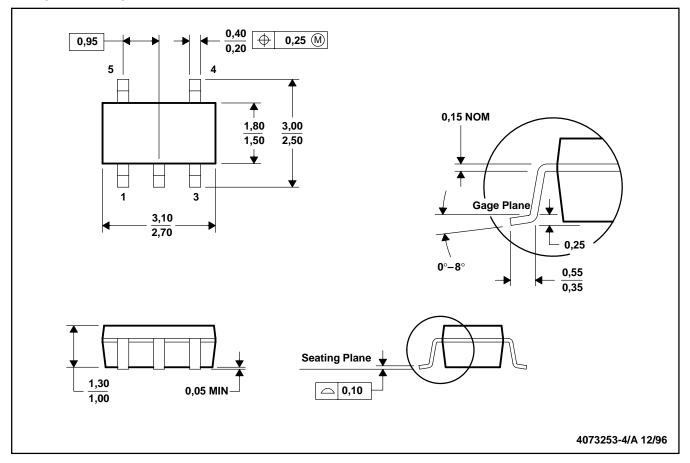
PSpice and Parts are trademark of MicroSim Corporation.



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.

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