

TLV2711, TLV2711Y

Advanced LinCMOS™ RAIL-TO-RAIL MICROPOWER SINGLE OPERATIONAL AMPLIFIERS

SLOS196A – AUGUST 1997 – REVISED MARCH 2001

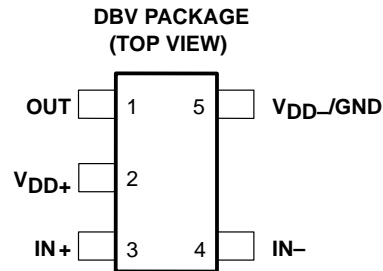
- Output Swing Includes Both Supply Rails
- Low Noise . . . 21 nV/√Hz Typ at f = 1 kHz
- Low Input Bias Current . . . 1 pA Typ
- Very Low Power . . . 11 μA Per Channel Typ
- Common-Mode Input Voltage Range Includes Negative Rail
- Wide Supply Voltage Range 2.7 V to 10 V
- Available in the SOT-23 Package
- Macromodel Included

description

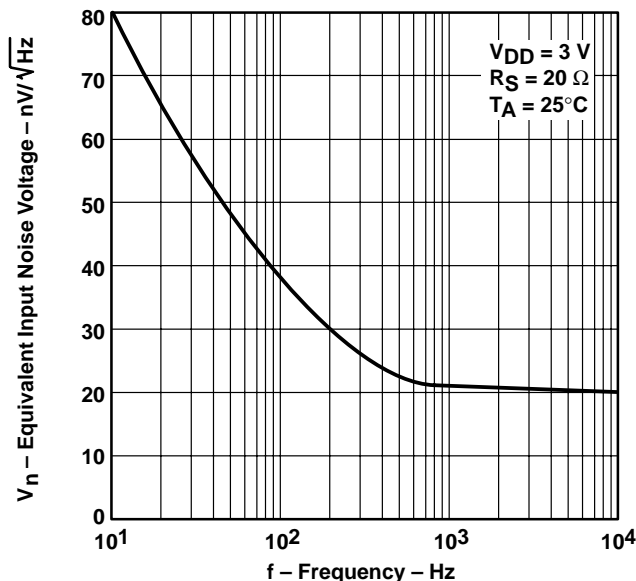
The TLV2711 is a single low-voltage operational amplifier available in the SOT-23 package. It consumes only 11 μA (typ) of supply current and is ideal for battery-power applications. Looking at Figure 1, the TLV2711 has a 3-V noise level of 21 nV/√Hz at 1 kHz; five times lower than competitive SOT-23 micropower solutions. The device exhibits rail-to-rail output performance for increased dynamic range in single- or split-supply applications. The TLV2711 is fully characterized at 3 V and 5 V and is optimized for low-voltage applications.

The TLV2711, exhibiting high input impedance and low noise, is excellent for small-signal conditioning for 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).

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.



EQUIVALENT INPUT NOISE VOLTAGE†
VS
FREQUENCY



† 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.

Figure 1. Equivalent Input Noise Voltage Versus Frequency

AVAILABLE OPTIONS

T_A	V_{IOmax} AT 25°C	PACKAGED DEVICES	SYMBOL	CHIP FORM‡ (Y)
		SOT-23 (DBV)†		
0°C to 70°C	3 mV	TLV2711CDBV	VAJC	TLV2711Y
-40°C to 85°C	3 mV	TLV2711IDBV	VAJI	

† The DBV package available in tape and reel only.

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



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**TEXAS
INSTRUMENTS**

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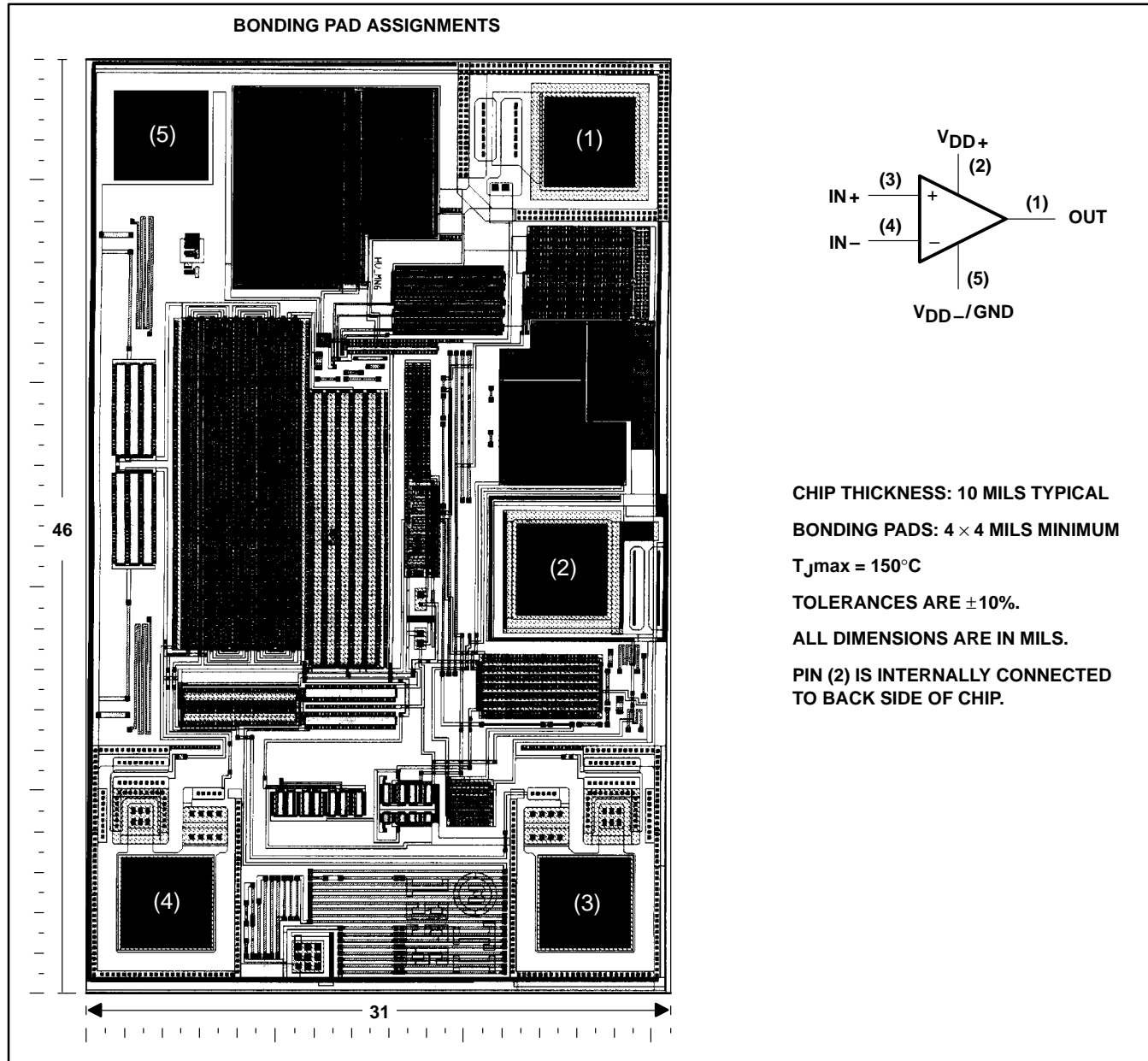
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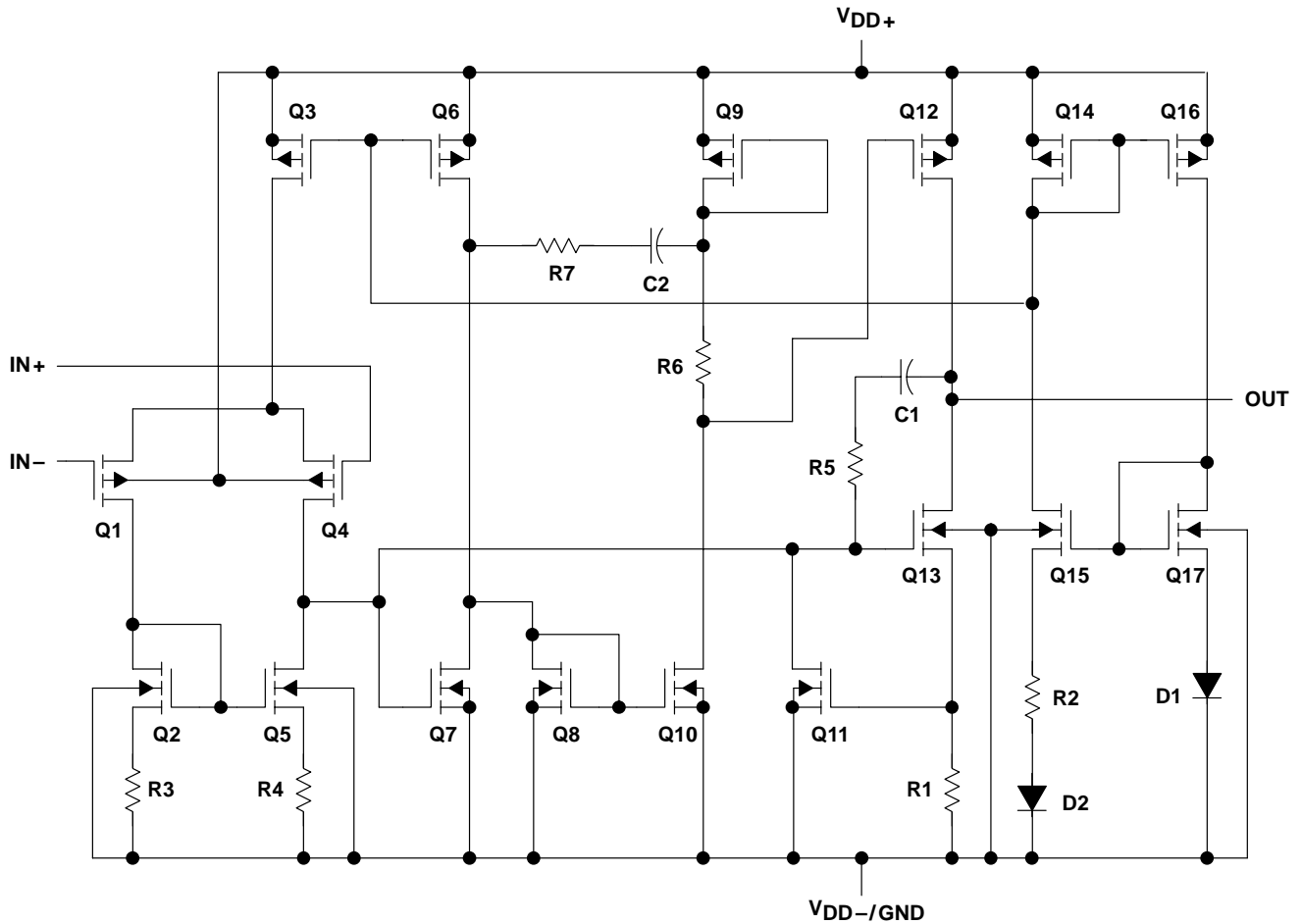
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TLV2711Y chip information

This chip, when properly assembled, displays characteristics similar to the TLV2711C. 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	6
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)	$\pm V_{DD}$
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 : TLV2711C	0°C to 70°C
TLV2711I	-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

	TLV2711C		TLV2711I		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-} .



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

PARAMETER	TEST CONDITIONS	T_A †	TLV2711C			TLV2711I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{DD\pm} = \pm 1.5\text{ V}$, $V_O = 0$, $V_{IC} = 0$, $R_S = 50\ \Omega$	Full range	0.4		3	0.4		3	mV
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage			1			1			$\mu\text{V}/^\circ\text{C}$
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		pA		
I_{IB} Input bias current		Full range	150		150				
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV}$, $R_S = 50\ \Omega$	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	$I_{OH} = -100\ \mu\text{A}$	25°C	2.94		2.94		V		
	$I_{OH} = -250\ \mu\text{A}$	25°C	2.85		2.85				
	Full range	2.6		2.6					
V_{OL} Low-level output voltage	$V_{IC} = 1.5\text{ V}$, $I_{OL} = 50\ \mu\text{A}$	25°C	15		15		mV		
	$V_{IC} = 1.5\text{ V}$, $I_{OL} = 500\ \mu\text{A}$	25°C	150		150				
	Full range	500		500					
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 1.5\text{ V}$, $V_O = 1\text{ V to }2\text{ V}$	$R_L = 10\text{ k}\Omega$ ‡	25°C	3	7	3	7	V/mV	
		$R_L = 1\text{ M}\Omega$ ‡	Full range	1		1			
			25°C	600		600			
$r_{i(d)}$ Differential input resistance		25°C	10^{12}		10^{12}		Ω		
$r_{i(c)}$ Common-mode input resistance		25°C	10^{12}		10^{12}		Ω		
$c_{i(c)}$ Common-mode input capacitance	$f = 10\text{ kHz}$,	25°C	5		5		pF		
z_o Closed-loop output impedance	$f = 7\text{ kHz}$, $A_V = 1$	25°C	200		200		Ω		
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }1.7\text{ V}$, $R_S = 50\ \Omega$, $V_O = 1.5\text{ V}$	25°C	65	83	65	83	dB		
		Full range	60		60				
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD} / \Delta V_{IO}$)	$V_{DD} = 2.7\text{ V to }8\text{ V}$, No load, $V_{IC} = V_{DD}/2$	25°C	80	95	80	95	dB		
		Full range	80		80				
I_{DD} Supply current	$V_O = 1.5\text{ V}$, No load	25°C	11	25	11	25	μA		
		Full range	30		30				

† Full range for the TLV2711C is 0°C to 70°C. Full range for the TLV2711I 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.

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

PARAMETER	TEST CONDITIONS	T_A †	TLV2711C			TLV2711I			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX		
SR	Slew rate at unity gain $V_O = 1.1\text{ V to }1.9\text{ V}$, $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	0.01	0.025		0.01	0.025		V/ μs	
		Full range	0.005			0.005				
V_n	Equivalent input noise voltage	f = 10 Hz	80			80			nV/ $\sqrt{\text{Hz}}$	
		f = 1 kHz	22			22				
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz	660			660			μV	
		f = 0.1 Hz to 10 Hz	880			880				
I_n	Equivalent input noise current	25°C	0.6			0.6			fA/ $\sqrt{\text{Hz}}$	
	Gain-bandwidth product	f = 10 kHz, $R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	56			56			kHz
BOM	Maximum output-swing bandwidth	$V_{O(PP)} = 1\text{ V}$, $R_L = 10\text{ k}\Omega$ ‡, $A_V = 1$, $C_L = 100\text{ pF}$ ‡	25°C	7			7			kHz
ϕ_m	Phase margin at unity gain	$R_L = 10\text{ k}\Omega$ ‡, $C_L = 100\text{ pF}$ ‡	25°C	56°			56°			
	Gain margin		25°C	20			20			dB

† Full range is -40°C to 85°C .

‡ Referenced to 1.5 V



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

PARAMETER	TEST CONDITIONS	T_A †	TLV2711C			TLV2711I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{DD\pm} = \pm 2.5\text{ V}$, $V_O = 0$, $V_{IC} = 0$, $R_S = 50\ \Omega$	Full range	0.45 3			0.45 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	$ V_{IO} \leq 5\text{ mV}$ $R_S = 50\ \Omega$	25°C	0 –0.3 to 4 to 4.2		0 –0.3 to 4 to 4.2		V		
		Full range	0 to 3.5		0 to 3.5				
V_{OH} High-level output voltage	$I_{OH} = -100\ \mu\text{A}$ $I_{OH} = -250\ \mu\text{A}$	25°C	4.95			4.95			V
		25°C	4.875			4.875			
		Full range	4.6			4.6			
V_{OL} Low-level output voltage	$V_{IC} = 2.5\text{ V}$, $I_{OL} = 50\ \mu\text{A}$ $V_{IC} = 2.5\text{ V}$, $I_{OL} = 500\ \mu\text{A}$	25°C	12			12			mV
		25°C	120			120			
		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	$R_L = 10\ \text{k}\Omega$ ‡		6 12		6 12		V/mV
			Full range		3		3		
		25°C	$R_L = 1\ \text{M}\Omega$ ‡		800		800		
$r_{i(d)}$ Differential input resistance		25°C	10 ¹²			10 ¹²			Ω
$r_{i(c)}$ Common-mode input resistance		25°C	10 ¹²			10 ¹²			Ω
$c_{i(c)}$ Common-mode input capacitance	$f = 10\ \text{kHz}$,	25°C	5			5			pF
z_o Closed-loop output impedance	$f = 7\ \text{kHz}$, $A_V = 1$	25°C	200			200			Ω
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.7\text{ V}$, $R_S = 50\ \Omega$, $V_O = 2.5\text{ V}$	25°C	70 83		70 83		dB		
		Full range	70		70				
k_{SVR} Supply voltage rejection ratio ($\Delta V_{DD} / \Delta V_{IO}$)	$V_{DD} = 4.4\text{ V to }8\text{ V}$, No load, $V_{IC} = V_{DD}/2$	25°C	80 95		80 95		dB		
		Full range	80		80				
I_{DD} Supply current	$V_O = 2.5\text{ V}$, No load	25°C	13 25		13 25		μA		
		Full range	30		30				

† Full range for the TLV2711C is 0°C to 70°C. Full range for the TLV2711I is –40°C to 85°C.

‡ Referenced to 1.5 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.

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

PARAMETER	TEST CONDITIONS	T_A †	TLV2711C			TLV2711I			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain $V_O = 1.5\text{ V to }3.5\text{ V}, R_L = 10\text{ k}\Omega^\ddagger,$ $C_L = 100\text{ pF}^\ddagger$	25°C	0.01	0.025		0.01	0.025		V/ μs
		Full range	0.005			0.005			
V_n	Equivalent input noise voltage	f = 10 Hz	72			72			nV/ $\sqrt{\text{Hz}}$
		f = 1 kHz	21			21			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz	600			600			μV
		f = 0.1 Hz to 10 Hz	800			800			
I_n	Equivalent input noise current	25°C	0.6			0.6			fA/ $\sqrt{\text{Hz}}$
	Gain-bandwidth product	f = 10 kHz, $R_L = 10\text{ k}\Omega^\ddagger,$ $C_L = 100\text{ pF}^\ddagger$	65			65			kHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)} = 2\text{ V},$ $R_L = 10\text{ k}\Omega^\ddagger,$ $A_V = 1,$ $C_L = 100\text{ pF}^\ddagger$	7			7			kHz
ϕ_m	Phase margin at unity gain	$R_L = 10\text{ k}\Omega^\ddagger,$ $C_L = 100\text{ pF}^\ddagger$	60°			60°			dB
		Gain margin	22			22			

† Full range is -40°C to 85°C .

‡ Referenced to 1.5 V

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

PARAMETER	TEST CONDITIONS	TLV2711Y			UNIT	
		MIN	TYP	MAX		
V_{IO}	Input offset voltage	0.47			mV	
I_{IO}	Input offset current	0.5			pA	
I_{IB}	Input bias current	1			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	$I_{OH} = -100\ \mu\text{A}$		2.94	V	
		$I_{OH} = -200\ \mu\text{A}$		2.85		
V_{OL}	Low-level output voltage	$V_{IC} = 0,$ $I_{OL} = 50\ \mu\text{A}$	15		mV	
		$V_{IC} = 0,$ $I_{OL} = 500\ \mu\text{A}$	150			
A_{VD}	Large-signal differential voltage amplification	$V_{IC} = 1.5\text{ V},$ $V_O = 1\text{ V to }2\text{ V}$	$R_L = 10\text{ k}\Omega^\ddagger$	7		V/mV
			$R_L = 1\text{ M}\Omega^\ddagger$	600		
$r_{i(d)}$	Differential input resistance	10 ¹²			Ω	
$r_{i(c)}$	Common-mode input resistance	10 ¹²			Ω	
$c_{i(c)}$	Common-mode input capacitance	f = 10 kHz			pF	
z_o	Closed-loop output impedance	f = 7 kHz, $A_V = 1$	200		Ω	
CMRR	Common-mode rejection ratio	$V_{IC} = 0\text{ to }1.7\text{ V},$ $V_O = 1.5\text{ V},$ $R_S = 50\ \Omega$	83		dB	
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 2.7\text{ V to }8\text{ V},$ $V_{IC} = V_{DD}/2,$ No load	95		dB	
I_{DD}	Supply current	$V_O = 1.5\text{ V},$ No load	11		μA	

† Referenced to 1.5 V



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

PARAMETER	TEST CONDITIONS	TLV2711Y			UNIT
		MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{DD} \pm \pm 2.5\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 0$, $V_O = 0$		0.45		mV
I_{IO} Input offset current			0.5		pA
I_{IB} Input bias current			1		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	$I_{OH} = -100\ \mu\text{A}$ $I_{OH} = -250\ \mu\text{A}$		4.95		V
			4.875		
V_{OL} Low-level output voltage	$V_{IC} = 2.5\text{ V}$, $I_{OL} = 50\ \mu\text{A}$		12		mV
	$V_{IC} = 2.5\text{ V}$, $I_{OL} = 500\ \mu\text{A}$		120		
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V}$, $V_O = 1\text{ V to }4\text{ V}$	$R_L = 10\text{ k}\Omega^\dagger$	12		V/mV
		$R_L = 1\text{ M}\Omega^\dagger$	800		
$r_{i(d)}$ Differential input resistance			10^{12}		Ω
$r_{i(c)}$ Common-mode input resistance			10^{12}		Ω
$c_{i(c)}$ Common-mode input capacitance	$f = 10\text{ kHz}$		5		pF
z_o Closed-loop output impedance	$f = 7\text{ kHz}$, $A_V = 1$		200		Ω
CMRR Common-mode rejection ratio	$V_{IC} = 0\text{ to }2.7\text{ V}$, $V_O = 2.5\text{ V}$, $R_S = 50\ \Omega$		83		dB
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		95		dB
I_{DD} Supply current	$V_O = 2.5\text{ V}$, No load		13		μA

† Referenced to 1.5 V

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TYPICAL CHARACTERISTICS

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TYPICAL CHARACTERISTICS

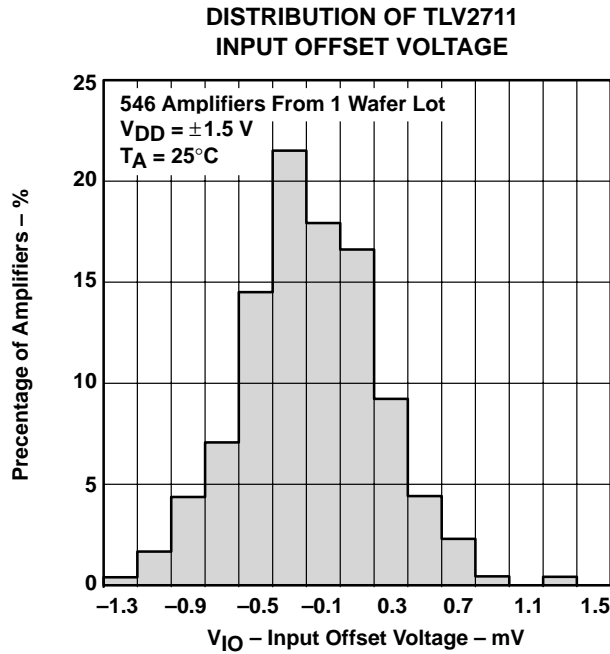


Figure 2

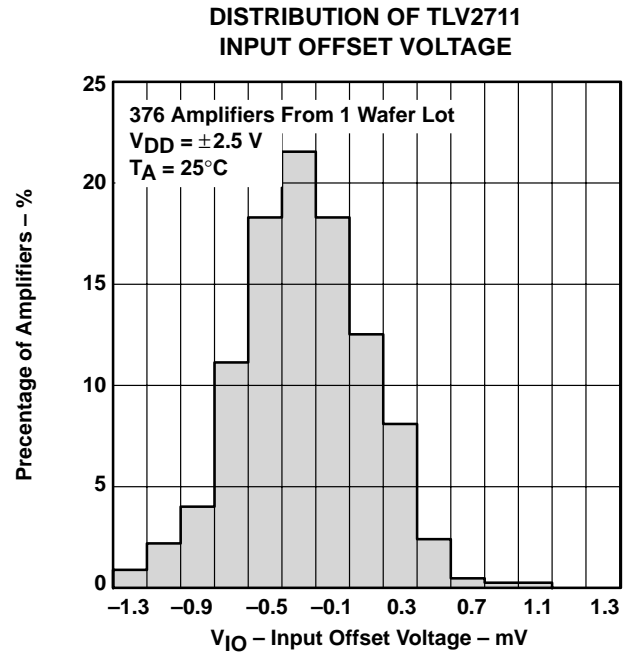


Figure 3

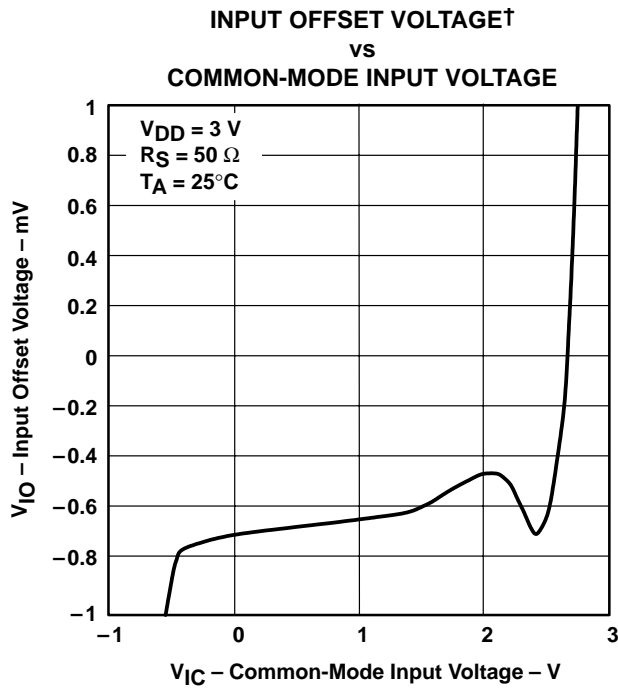


Figure 4

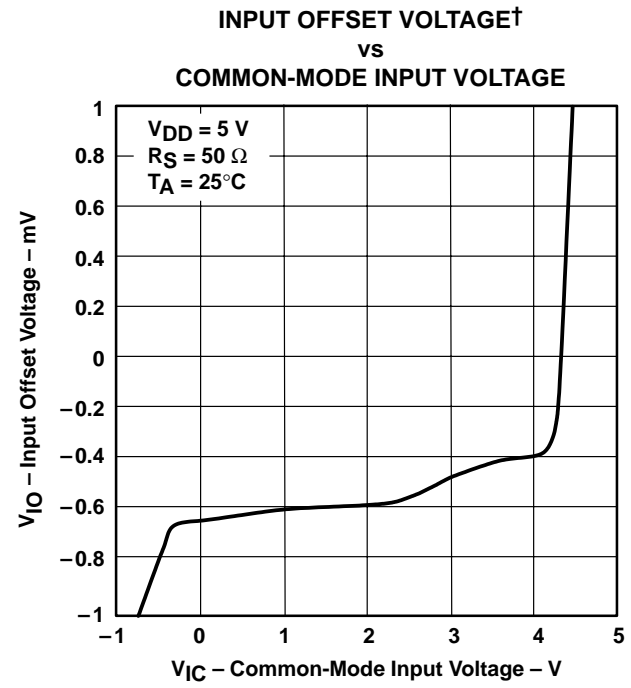


Figure 5

† 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

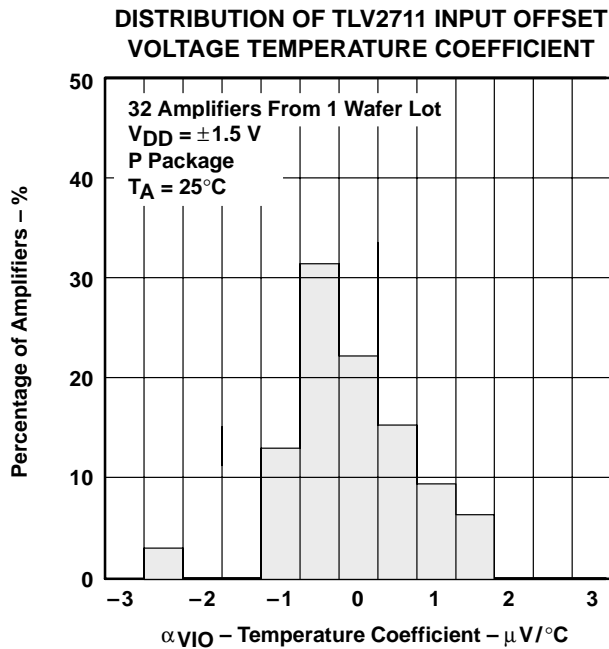


Figure 6

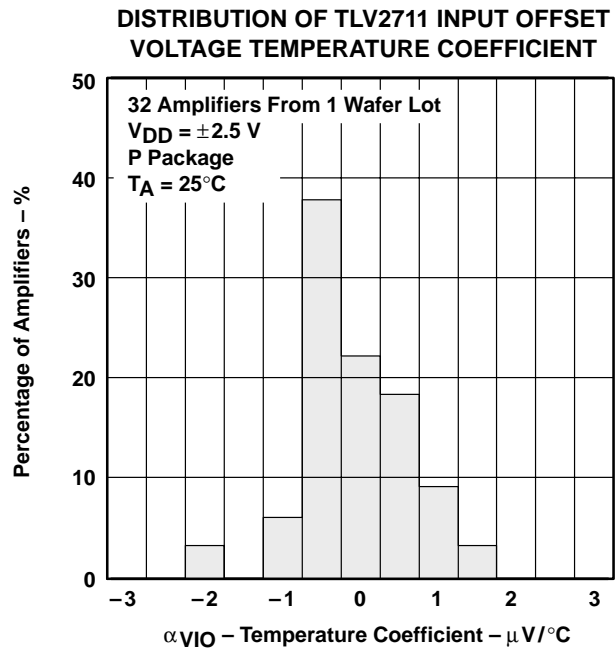


Figure 7

INPUT BIAS AND INPUT OFFSET CURRENTS†
vs
FREE-AIR TEMPERATURE

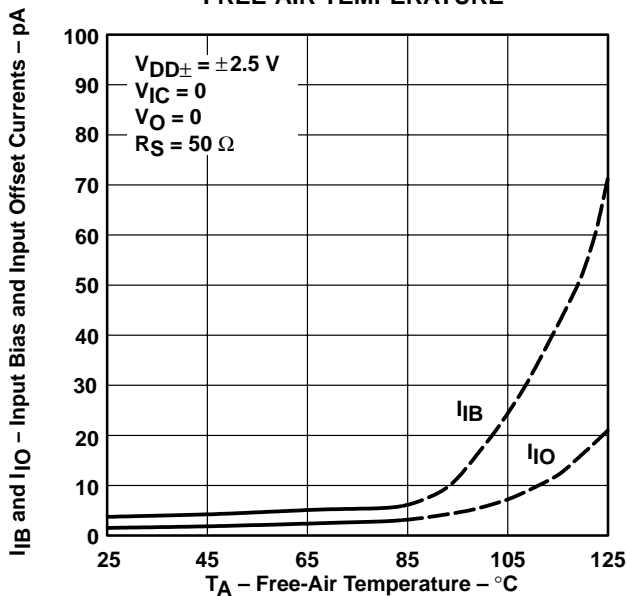


Figure 8

INPUT VOLTAGE
vs
SUPPLY VOLTAGE

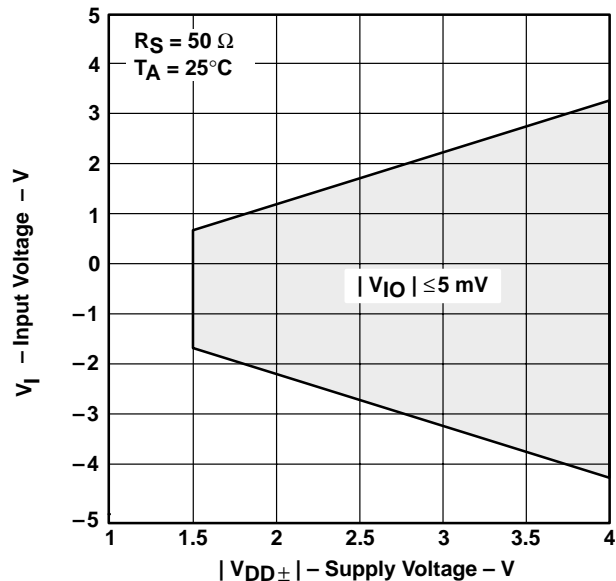
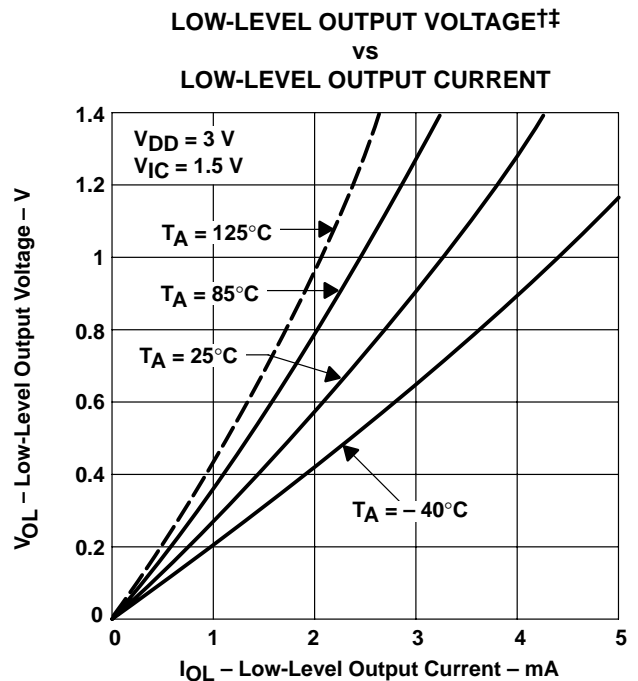
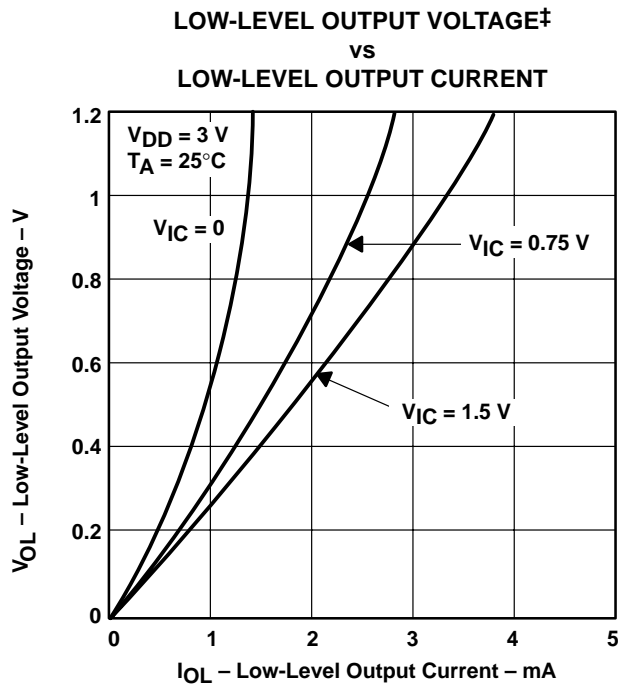
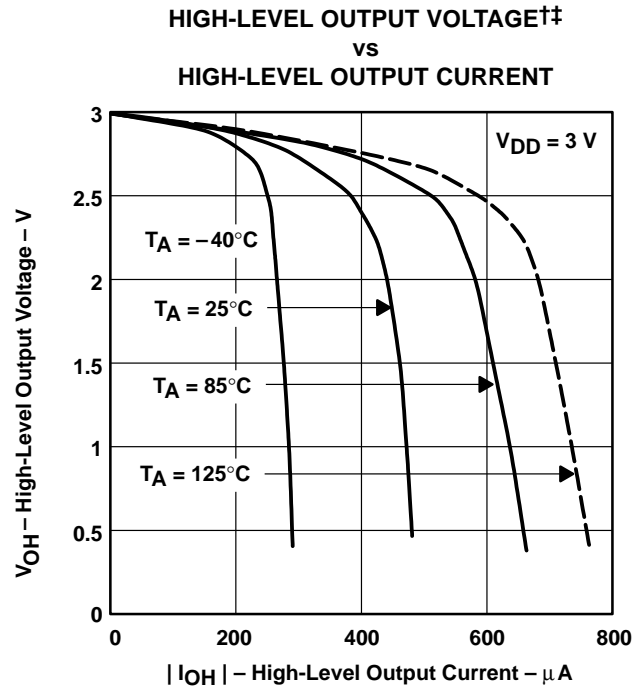
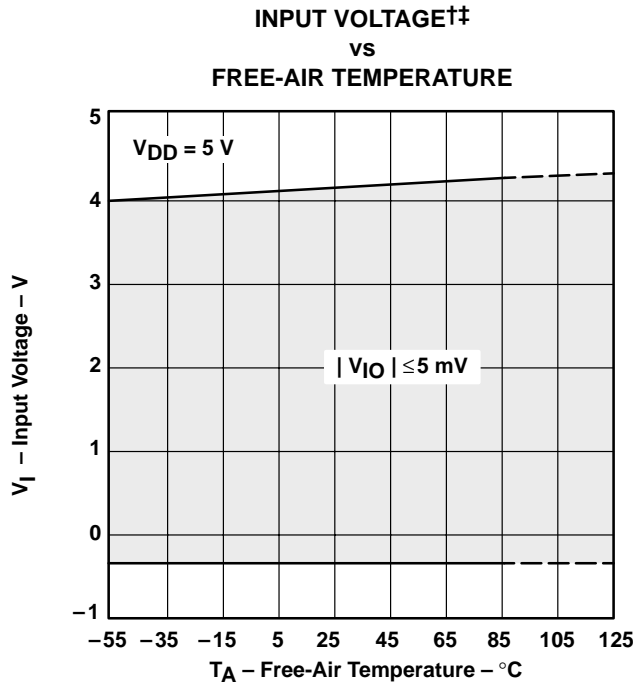


Figure 9

† 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

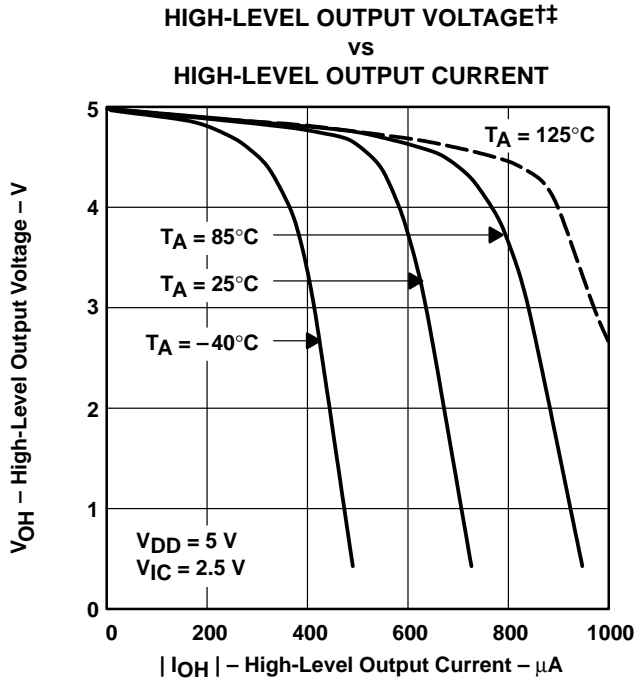


Figure 14

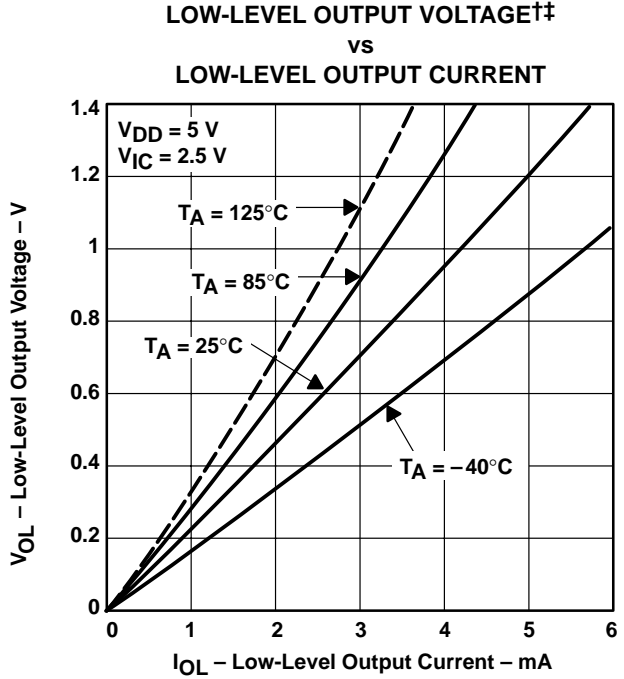


Figure 15

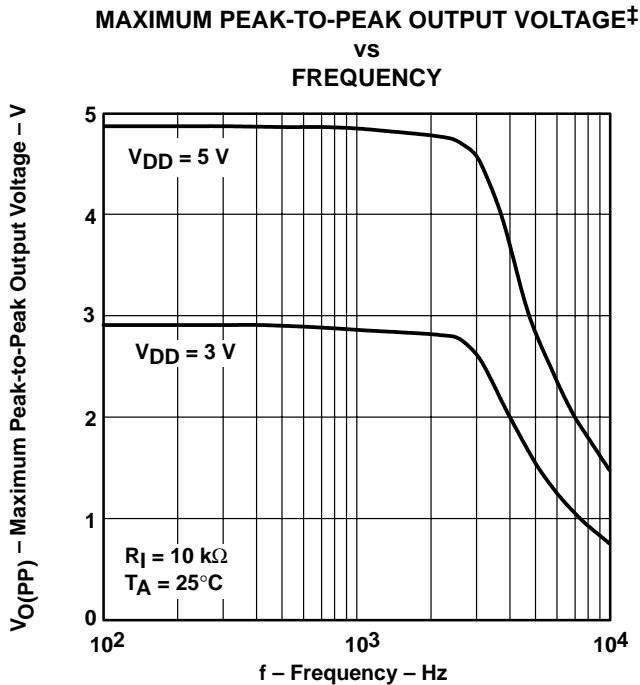


Figure 16

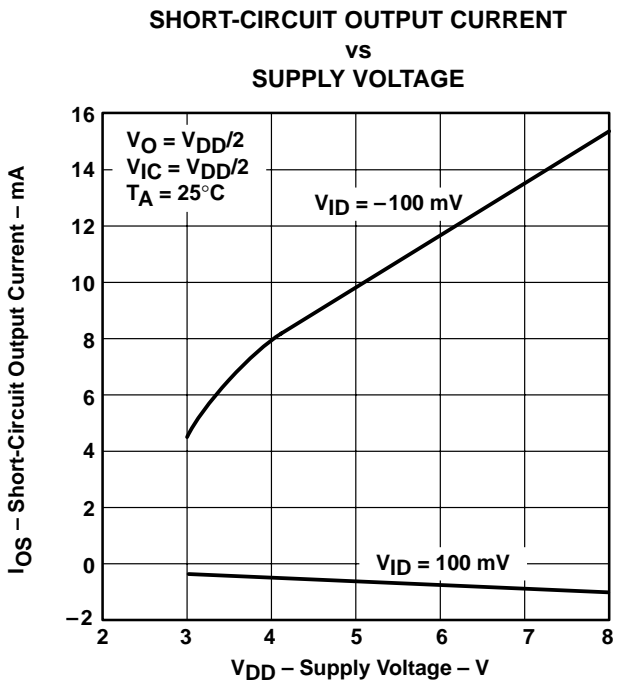
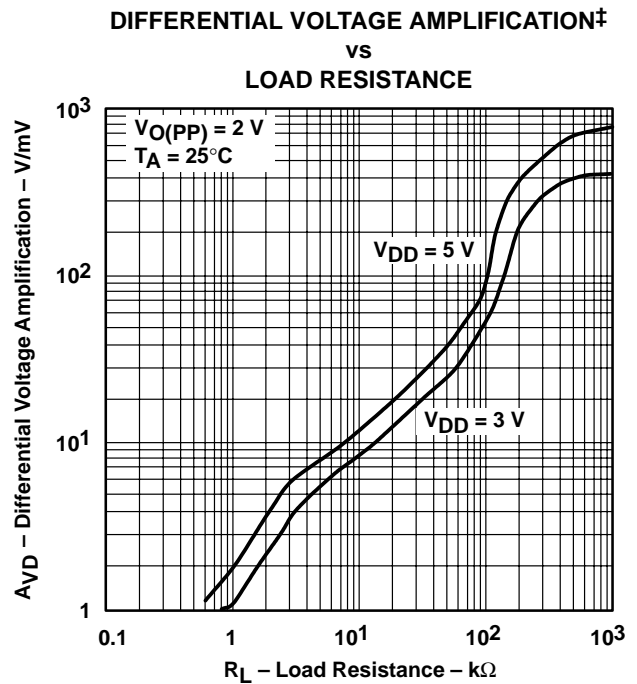
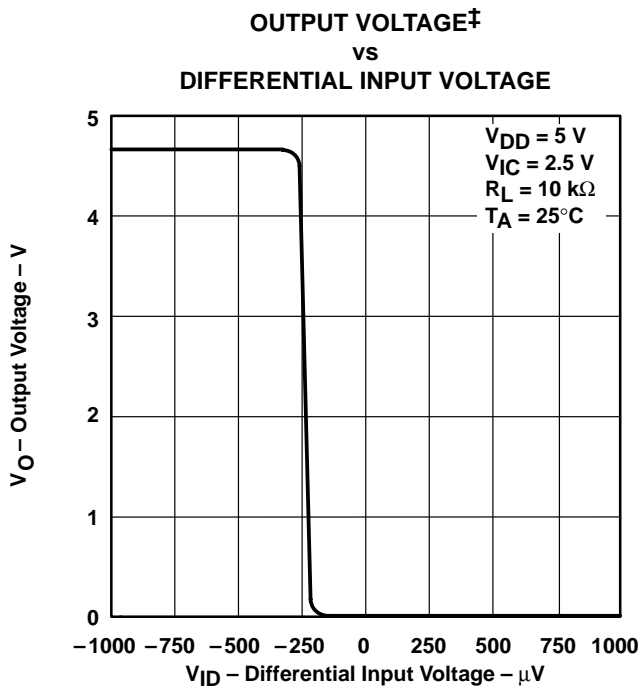
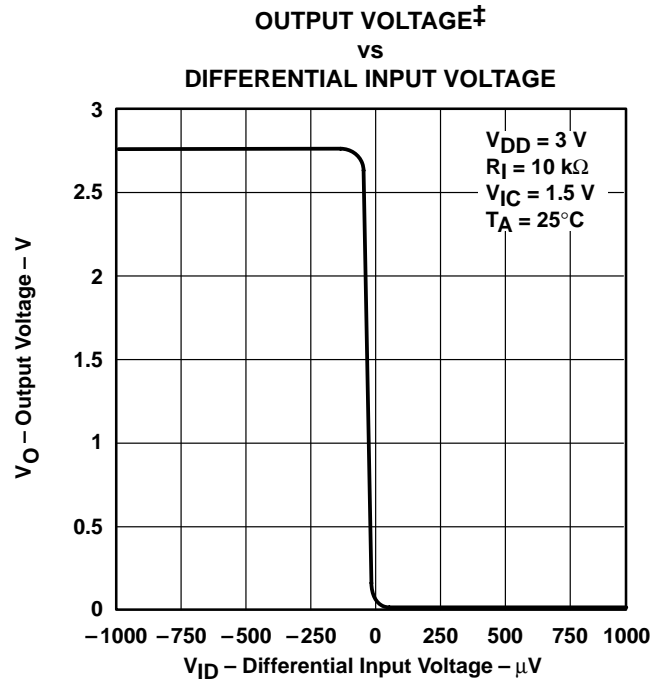
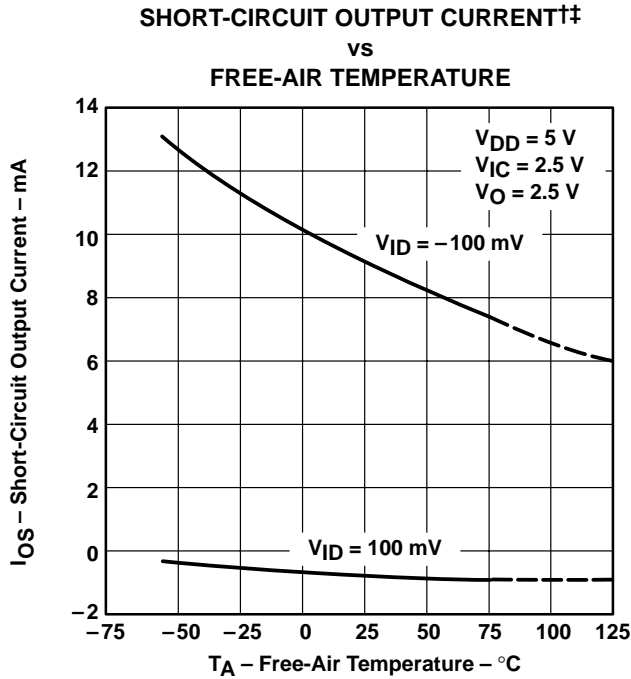


Figure 17

† 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



† 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

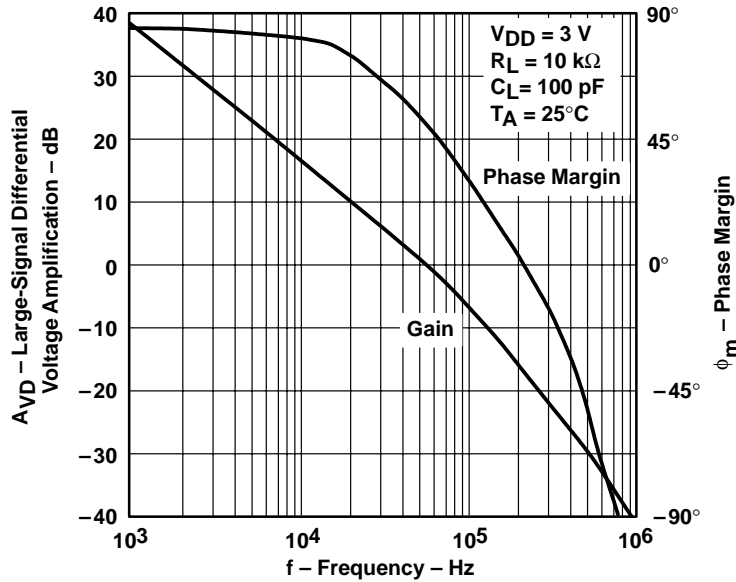


Figure 22

LARGE-SIGNAL DIFFERENTIAL VOLTAGE
 AMPLIFICATION AND PHASE MARGIN†
 vs
 FREQUENCY

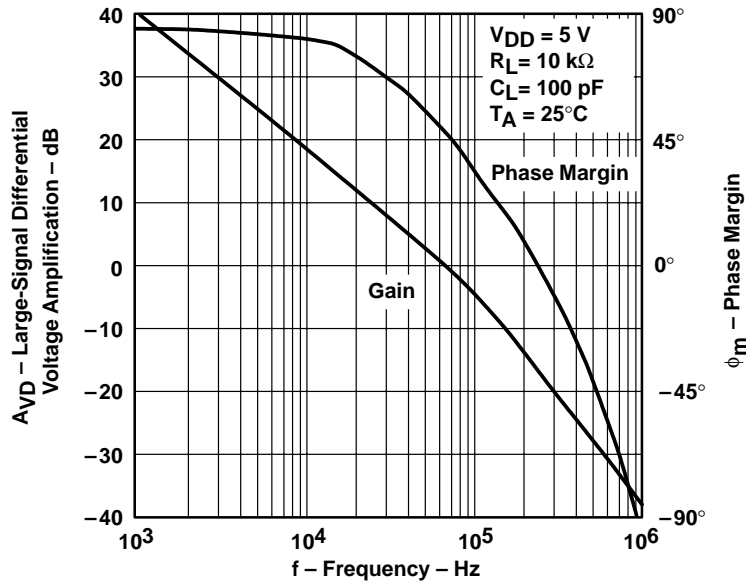
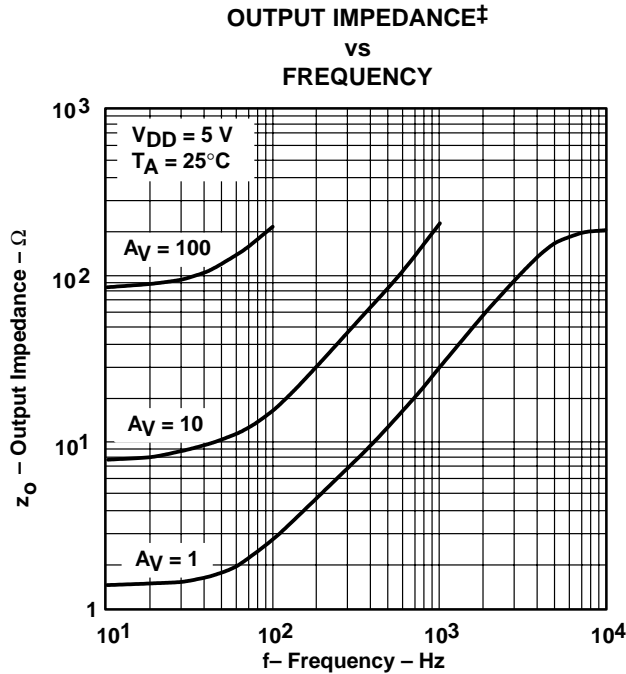
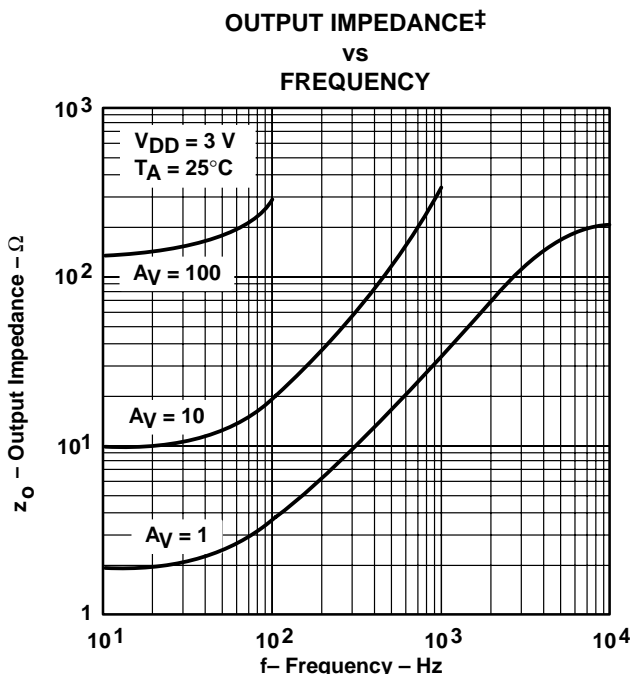
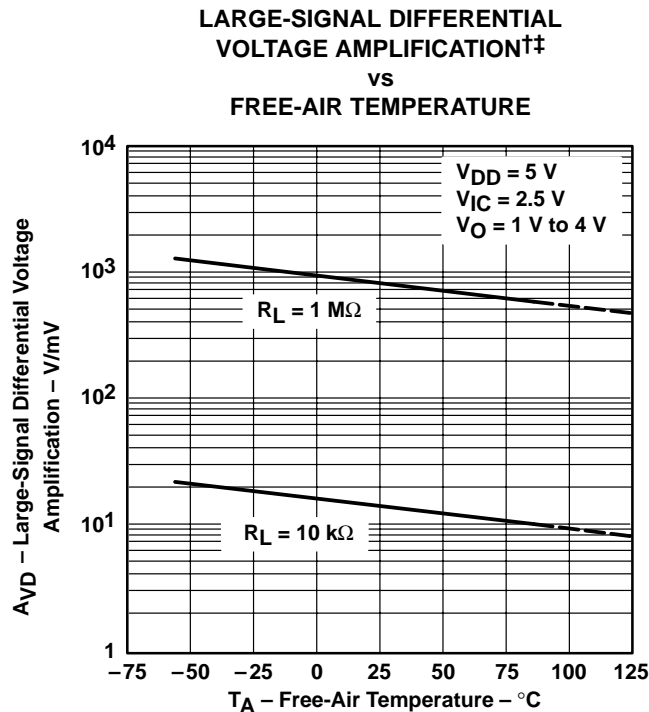
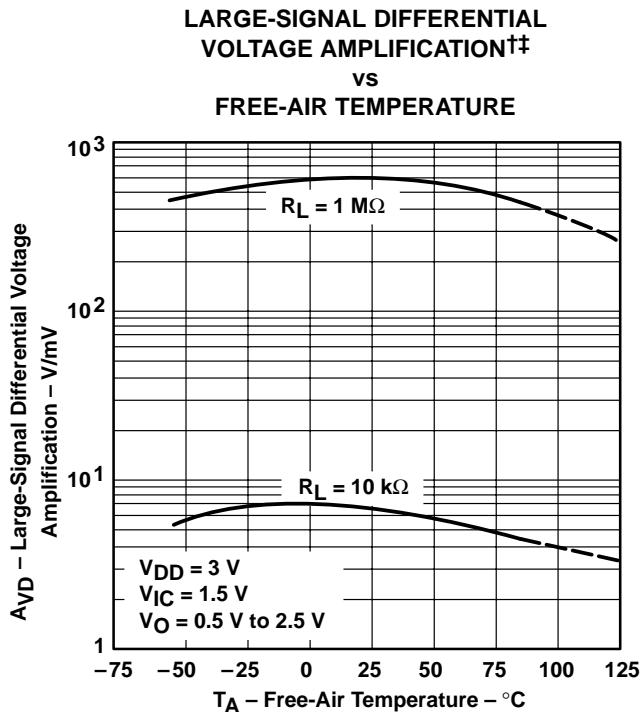


Figure 23

† 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

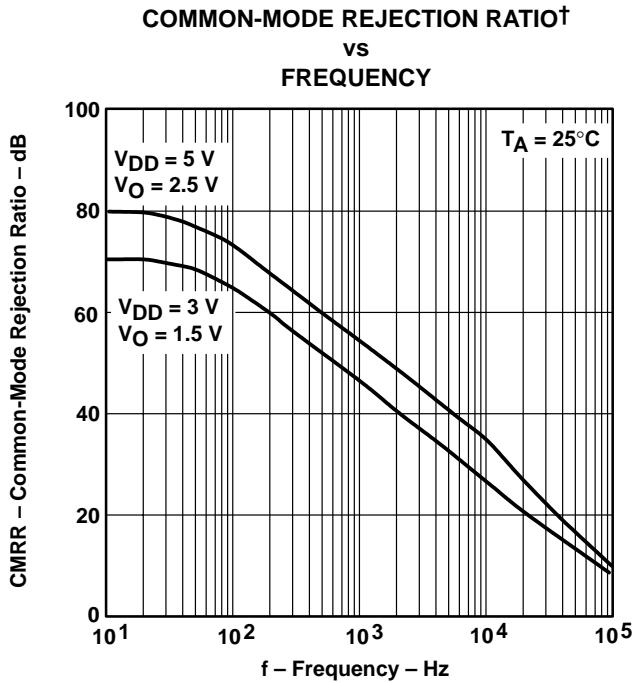


Figure 28

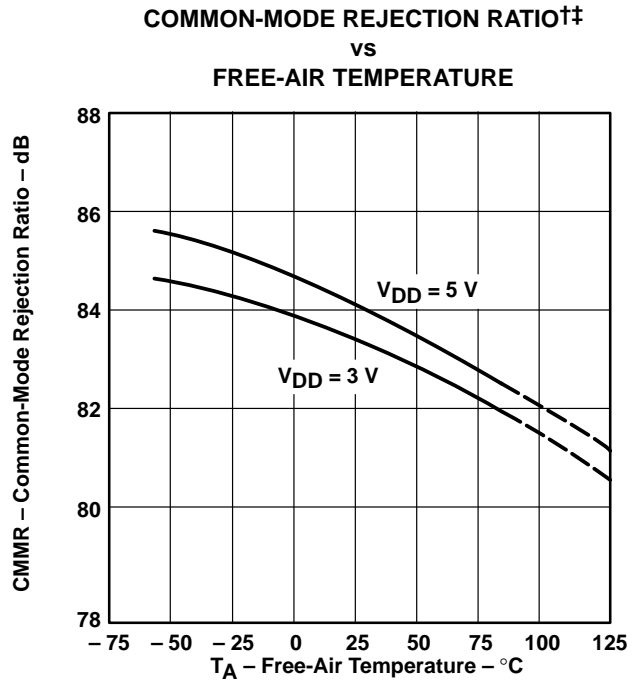


Figure 29

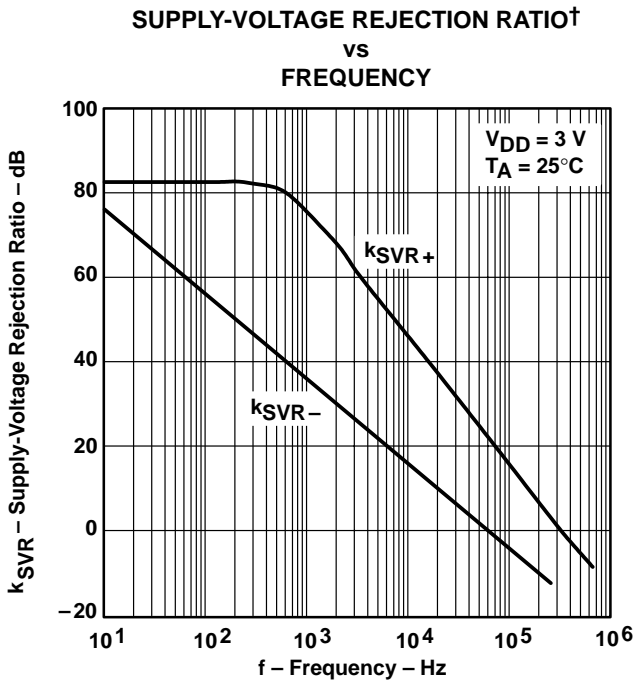


Figure 30

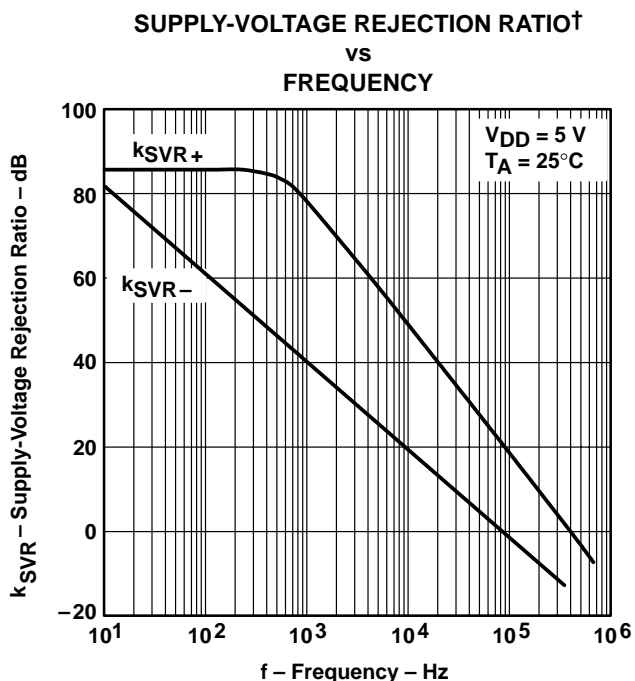
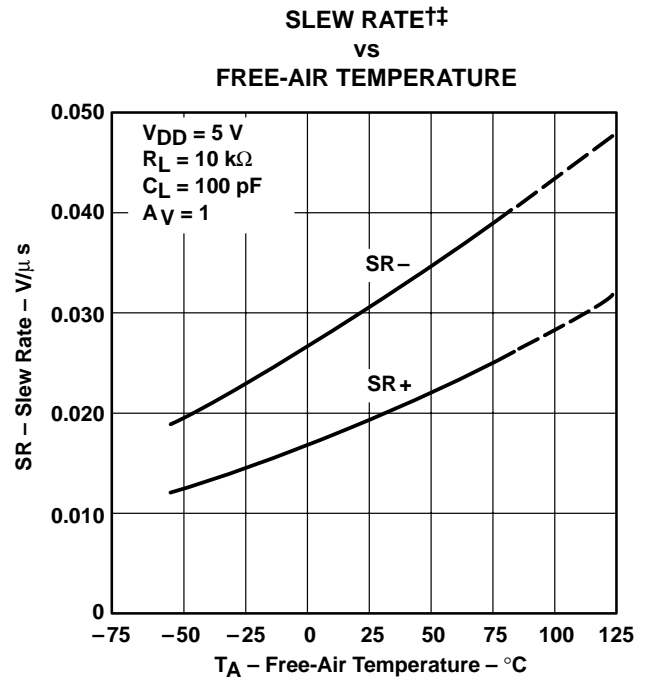
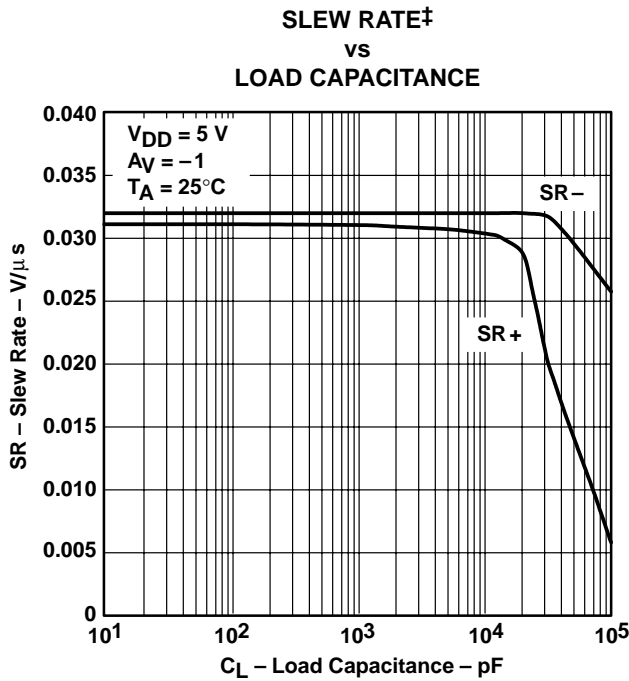
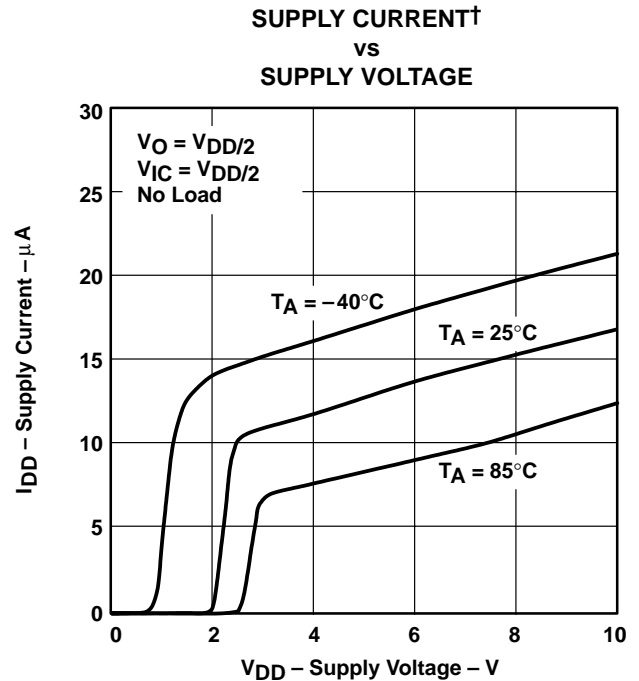
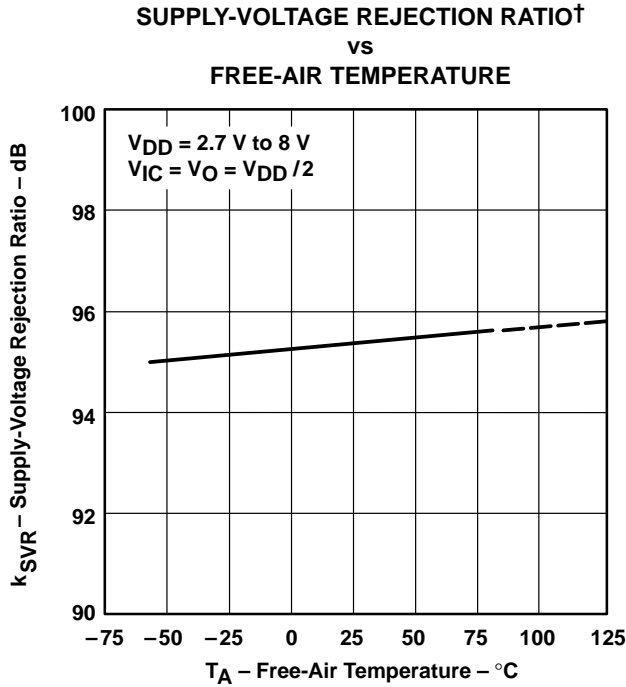


Figure 31

† 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†

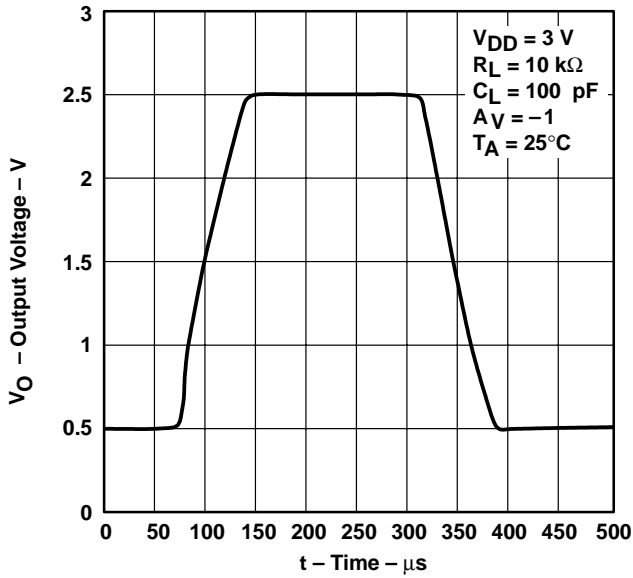


Figure 36

INVERTING LARGE-SIGNAL PULSE RESPONSE†

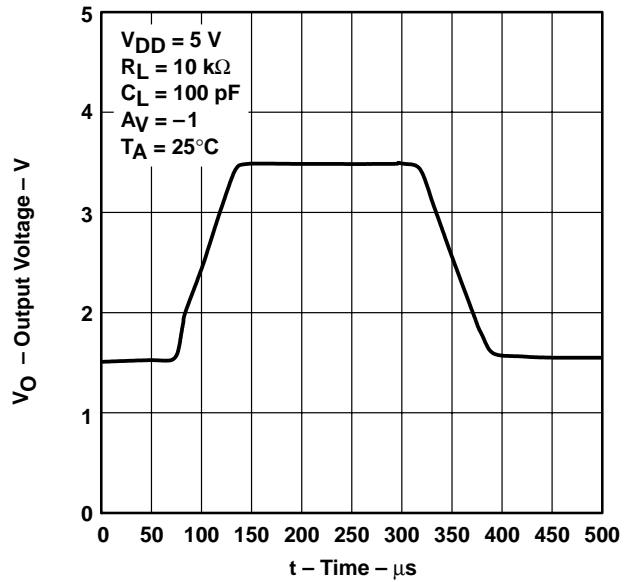


Figure 37

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE†

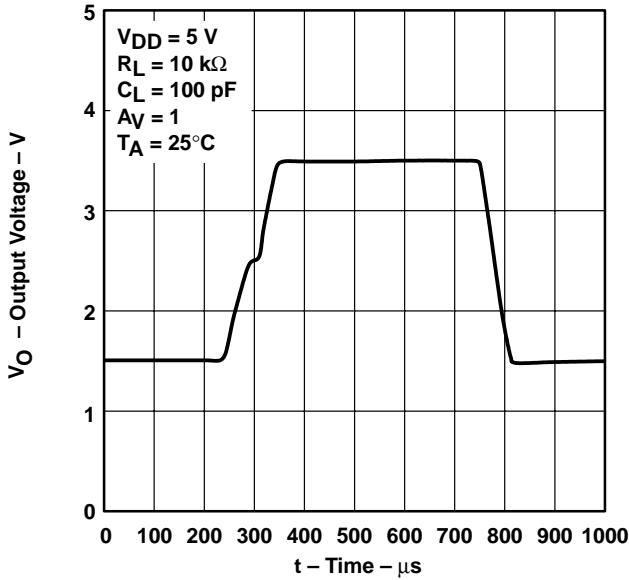


Figure 38

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE†

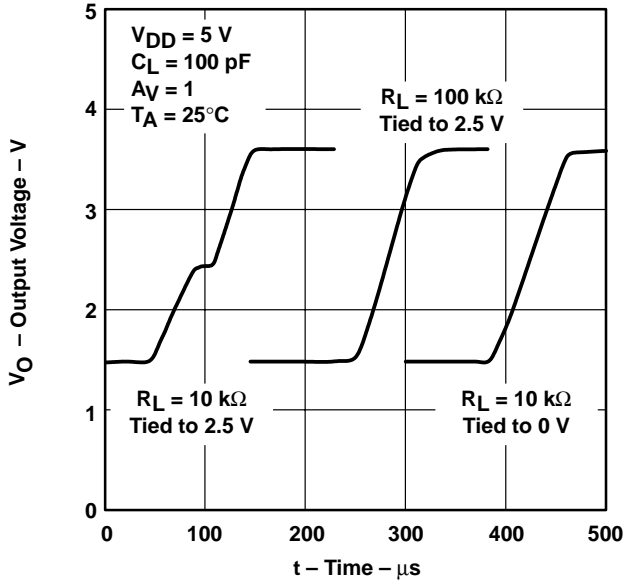


Figure 39

† For all curves where $V_{DD} = 5\text{ V}$, 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

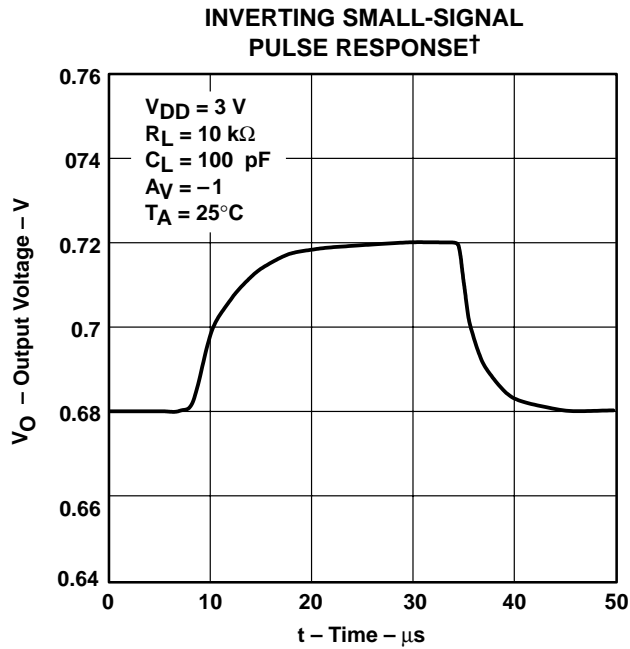


Figure 40

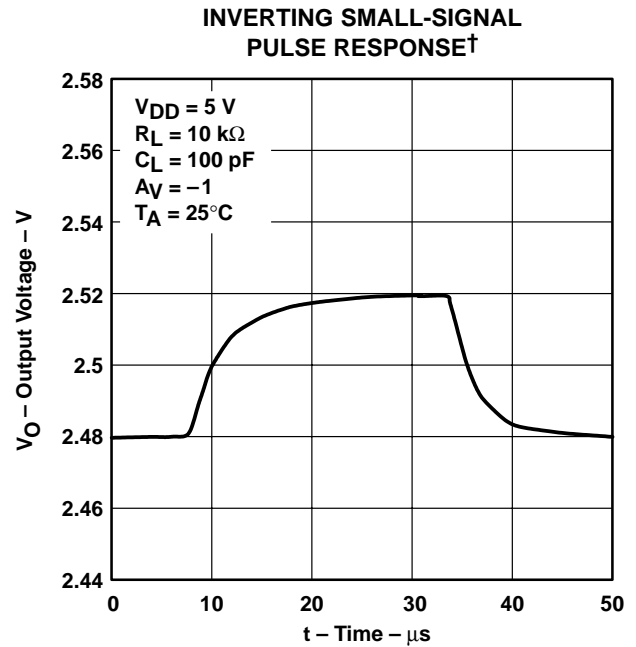


Figure 41

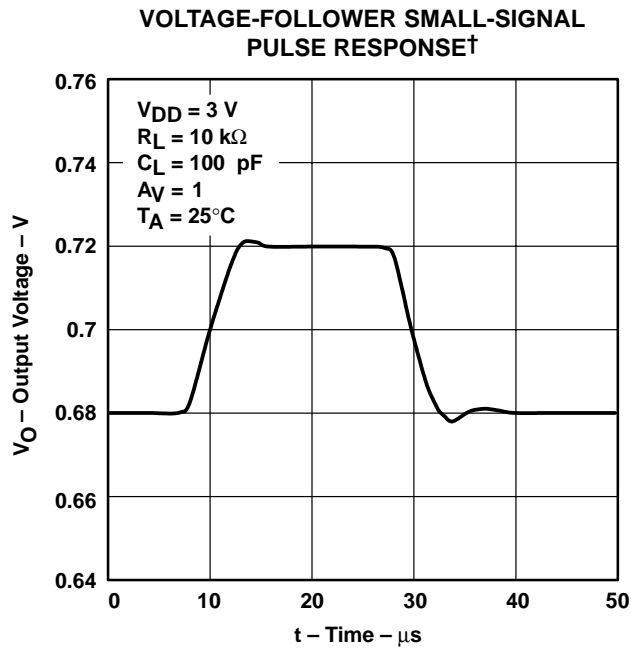


Figure 42

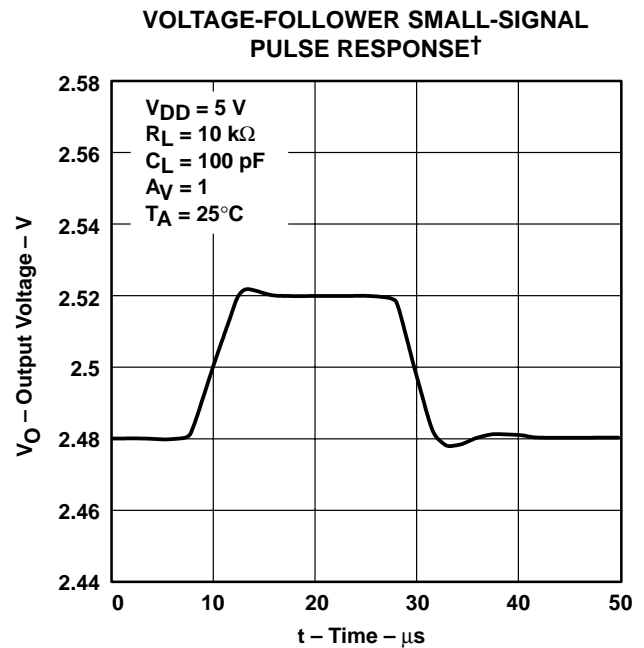


Figure 43

† 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

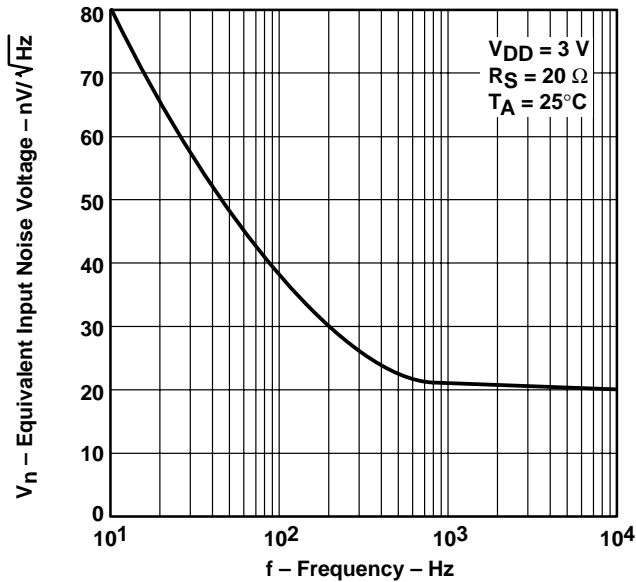


Figure 44

EQUIVALENT INPUT NOISE VOLTAGE†
 VS
 FREQUENCY

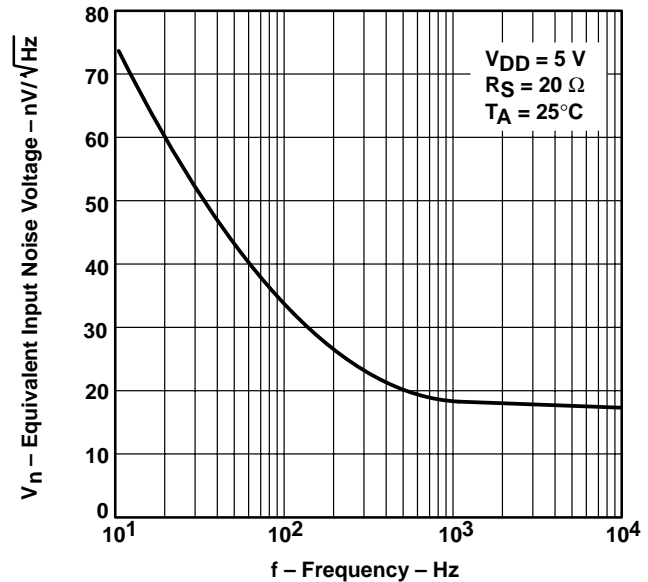


Figure 45

INPUT NOISE VOLTAGE OVER
 A 10-SECOND PERIOD†

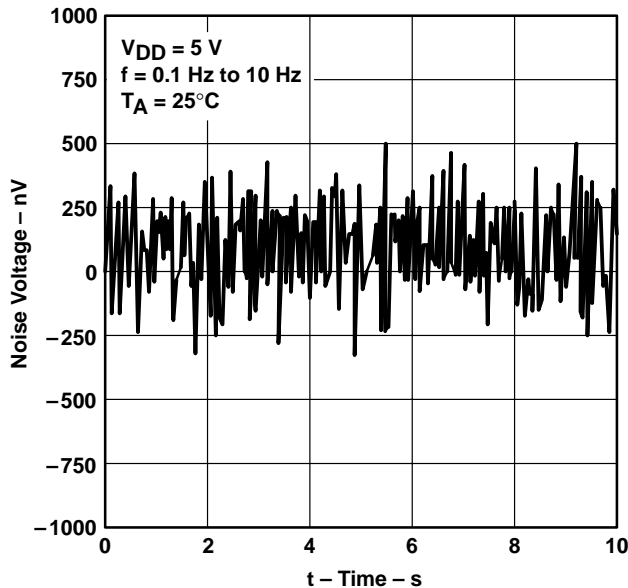


Figure 46

TOTAL HARMONIC DISTORTION PLUS NOISE†
 VS
 FREQUENCY

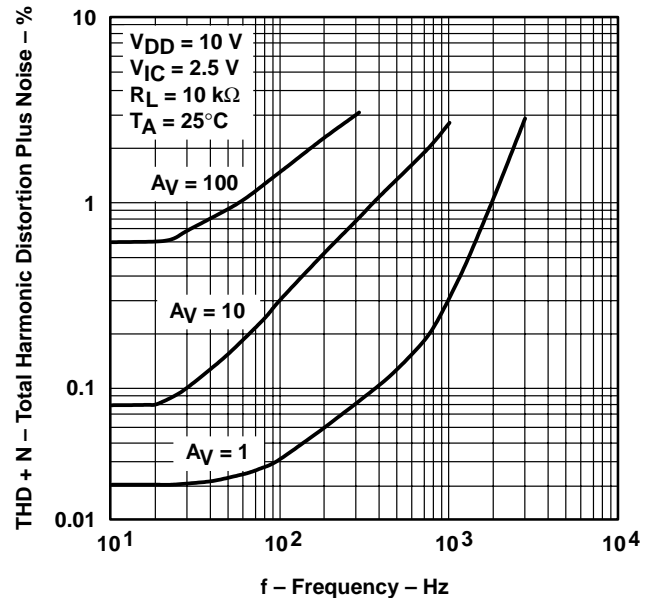
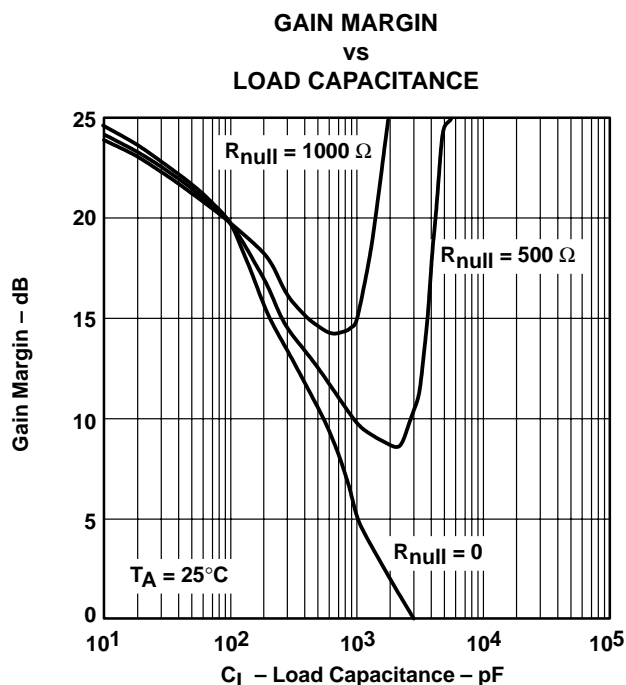
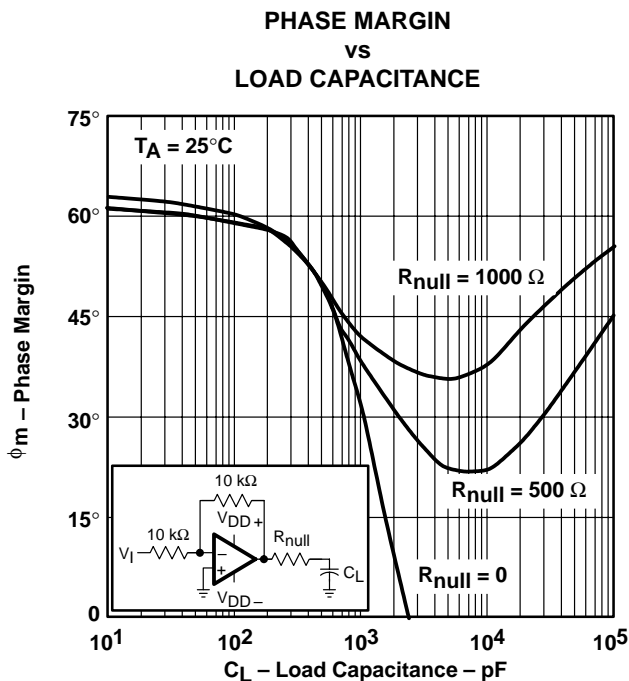
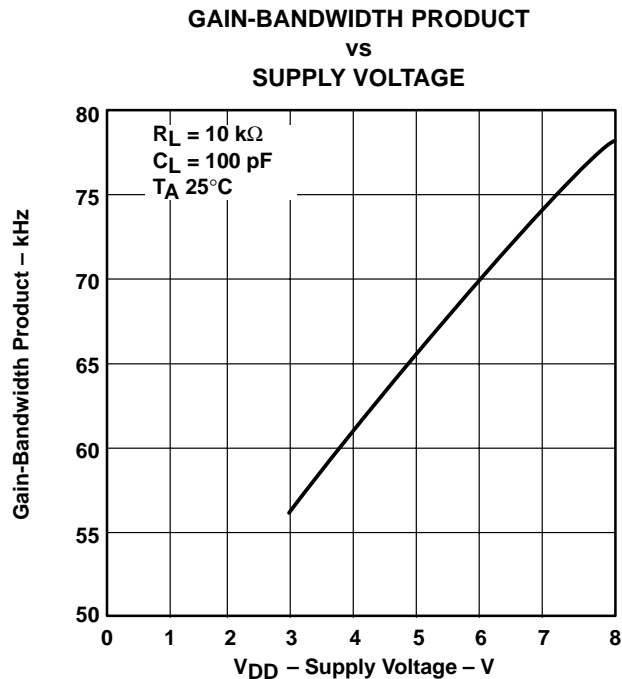
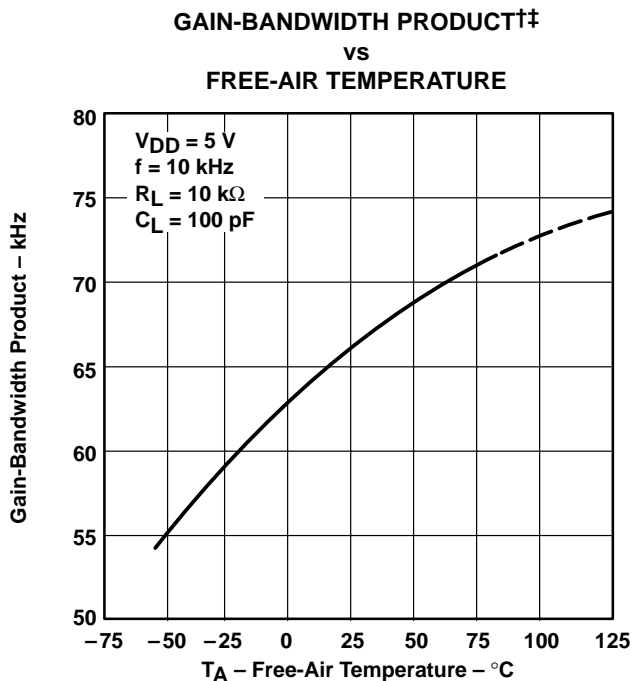


Figure 47

† 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

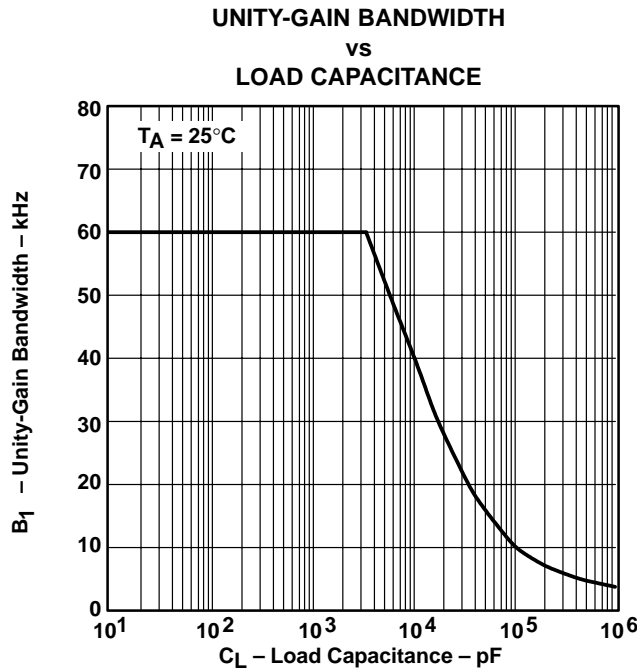


Figure 52

APPLICATION INFORMATION

driving large capacitive loads

The TLV2711 is designed to drive larger capacitive loads than most CMOS operational amplifiers. Figure 50 and Figure 51 illustrate its ability to drive loads up to 600 pF while maintaining good gain and phase margins ($R_{null} = 0$).

A smaller series resistor (R_{null}) at the output of the device (see Figure 53) improves the gain and phase margins when driving large capacitive loads. Figure 50 and Figure 51 show the effects of adding series resistances of 500 Ω and 1000 Ω. The addition of this series resistor has two effects: the first is that it adds a zero to the transfer function and the second 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 improvement in phase margin, equation 1 can be used.

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

Where :

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



APPLICATION INFORMATION

driving large capacitive loads (continued)

The unity-gain bandwidth (UGBW) frequency decreases as the capacitive load increases (see Figure 52). To use equation 1, UGBW must be approximated from Figure 52.

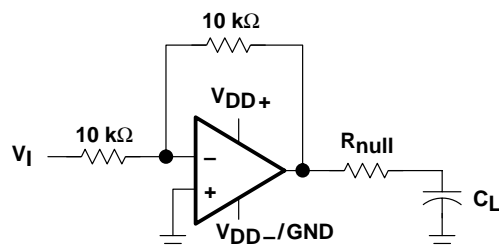


Figure 53. Series-Resistance Circuit

driving heavy dc loads

The TLV2711 is designed to provide better sinking and sourcing output currents than earlier CMOS rail-to-rail output devices. This device is specified to sink 500 μA and source 250 μA at $V_{\text{DD}} = 3\text{ V}$ and $V_{\text{DD}} = 5\text{ V}$ at a maximum quiescent I_{DD} of 25 μA . This provides a greater than 90% power efficiency.

When driving heavy dc loads, such as 10 k Ω , the positive edge under slewing conditions can experience some distortion. This condition can be seen in Figure 38. This condition is affected by three factors.

- Where the load is referenced. When the load is referenced to either rail, this condition does not occur. The distortion occurs only when the output signal swings through the point where the load is referenced. Figure 39 illustrates two 10-k Ω load conditions. The first load condition shows the distortion seen for a 10-k Ω load tied to 2.5 V. The third load condition shows no distortion for a 10-k Ω load tied to 0 V.
- Load resistance. As the load resistance increases, the distortion seen on the output decreases. Figure 39 illustrates the difference seen on the output for a 10-k Ω load and a 100-k Ω load with both tied to 2.5 V.
- Input signal edge rate. Faster input edge rates for a step input result in more distortion than with slower input edge rates.

TLV2711, TLV2711Y

Advanced LinCMOS™ RAIL-TO-RAIL

MICROPOWER SINGLE OPERATIONAL AMPLIFIERS

SLOS196A – 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 54 are generated using the TLV2711 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).

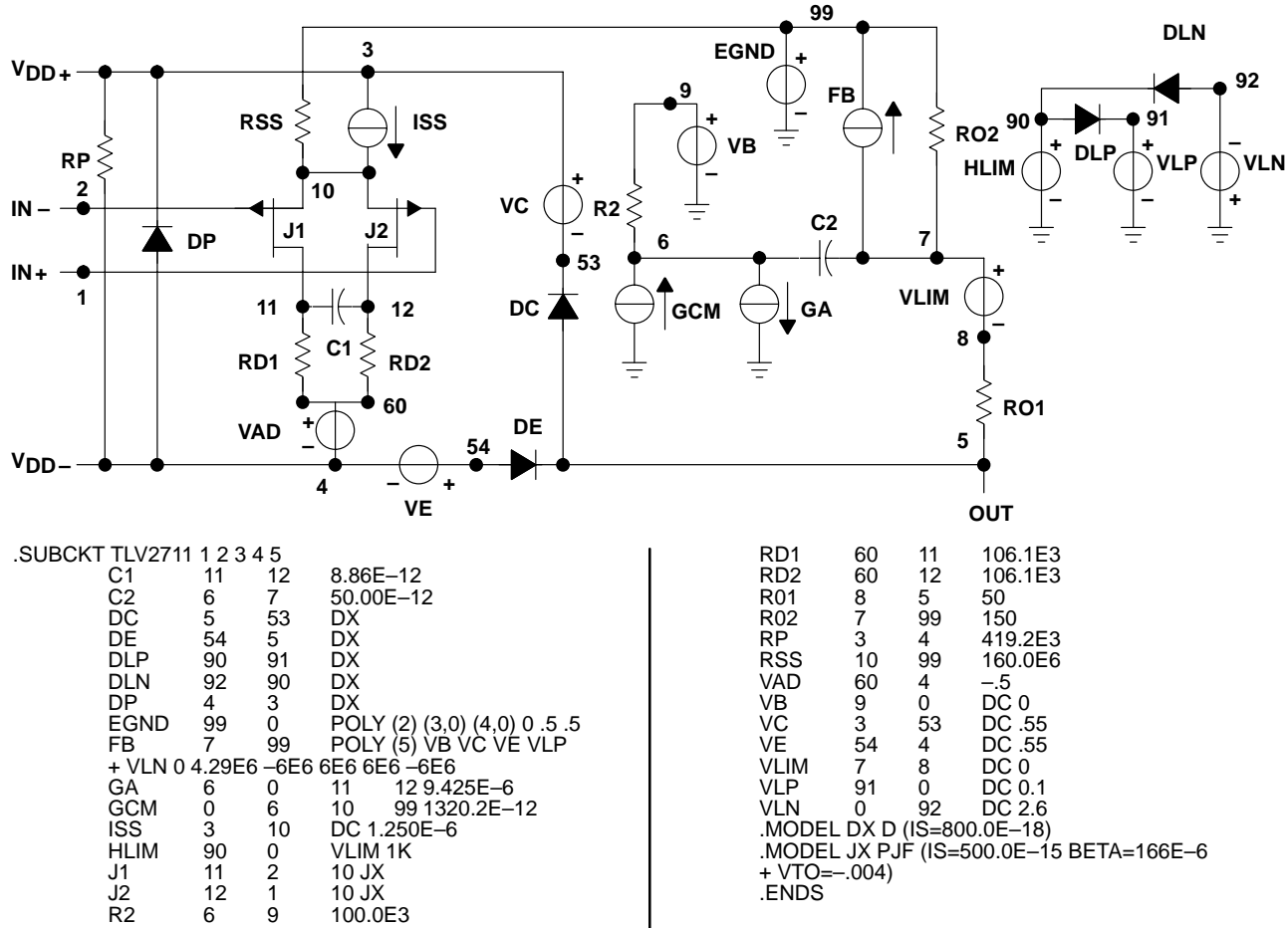


Figure 54. Boyle Macromodel and Subcircuit

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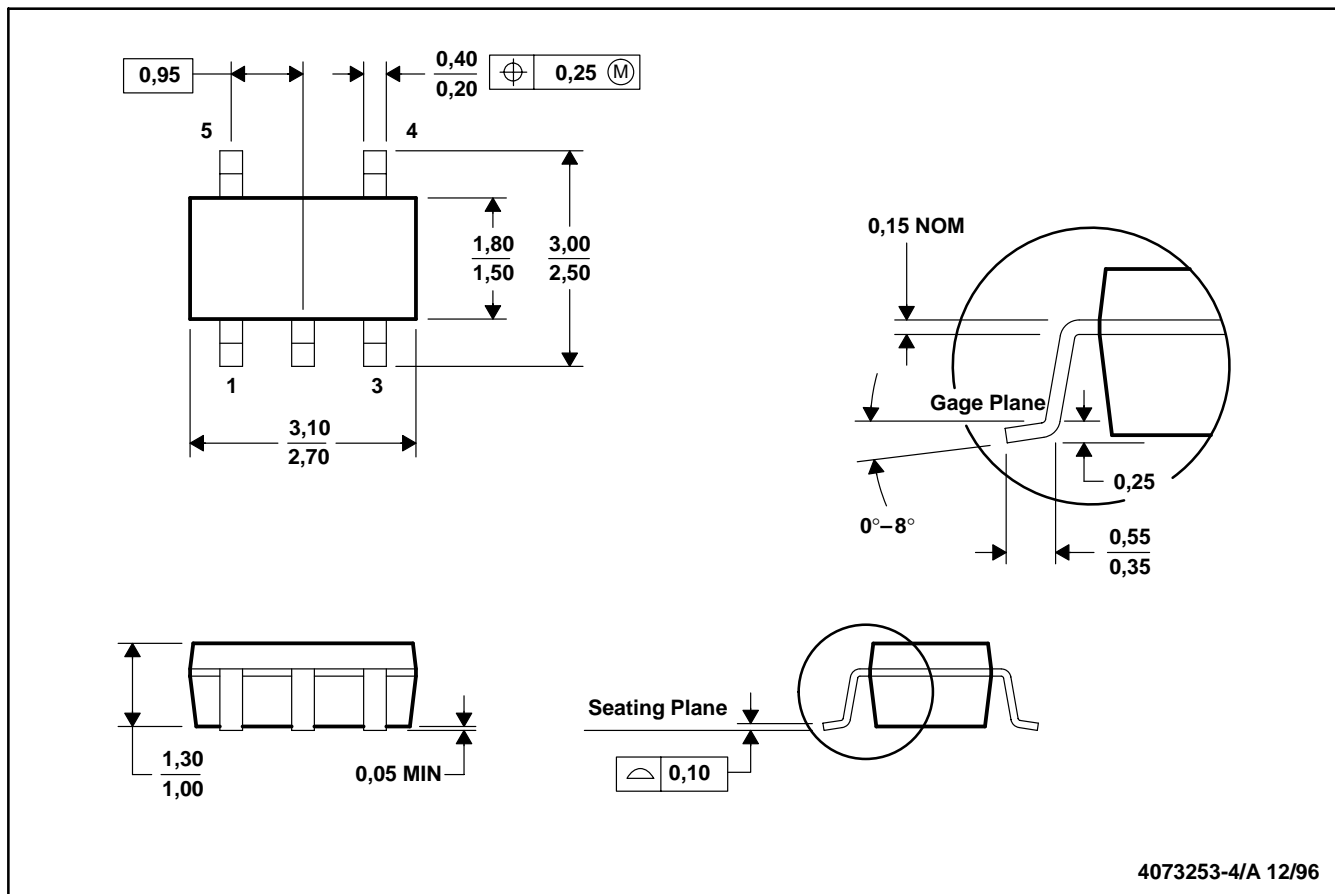


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MECHANICAL INFORMATION

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.

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