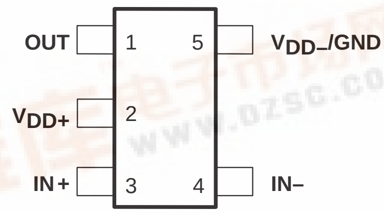
TLV2711, TLV2711Y
Advanced LinCMOS™ RAIL-TO-RAIL MICROPOWER SINGLE OPERATIONAL AMPLIFIERS

SLOS196 – AUGUST 1997

- 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

DBV PACKAGE
(TOP VIEW)



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 1kHz; 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 micro-power 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).

EQUIVALENT INPUT NOISE VOLTAGE†
vs
FREQUENCY

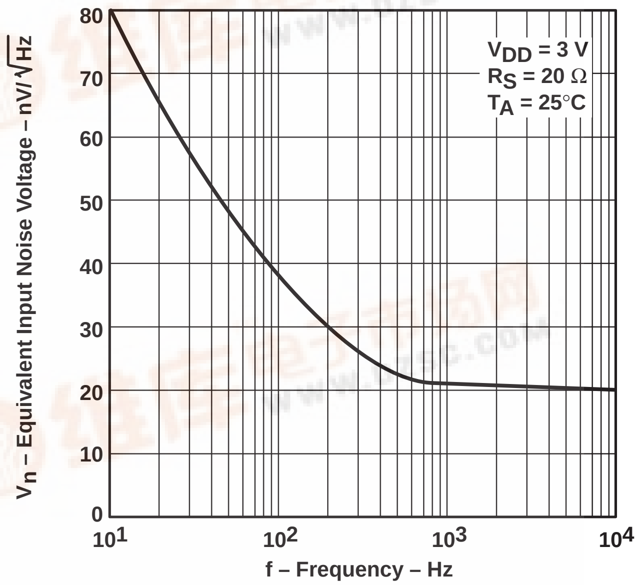


Figure 1. Equivalent Input Noise Voltage Versus Frequency

AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES SOT-23 (DBV)†	SYMBOL	CHIP FORM‡ (Y)
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°C only.

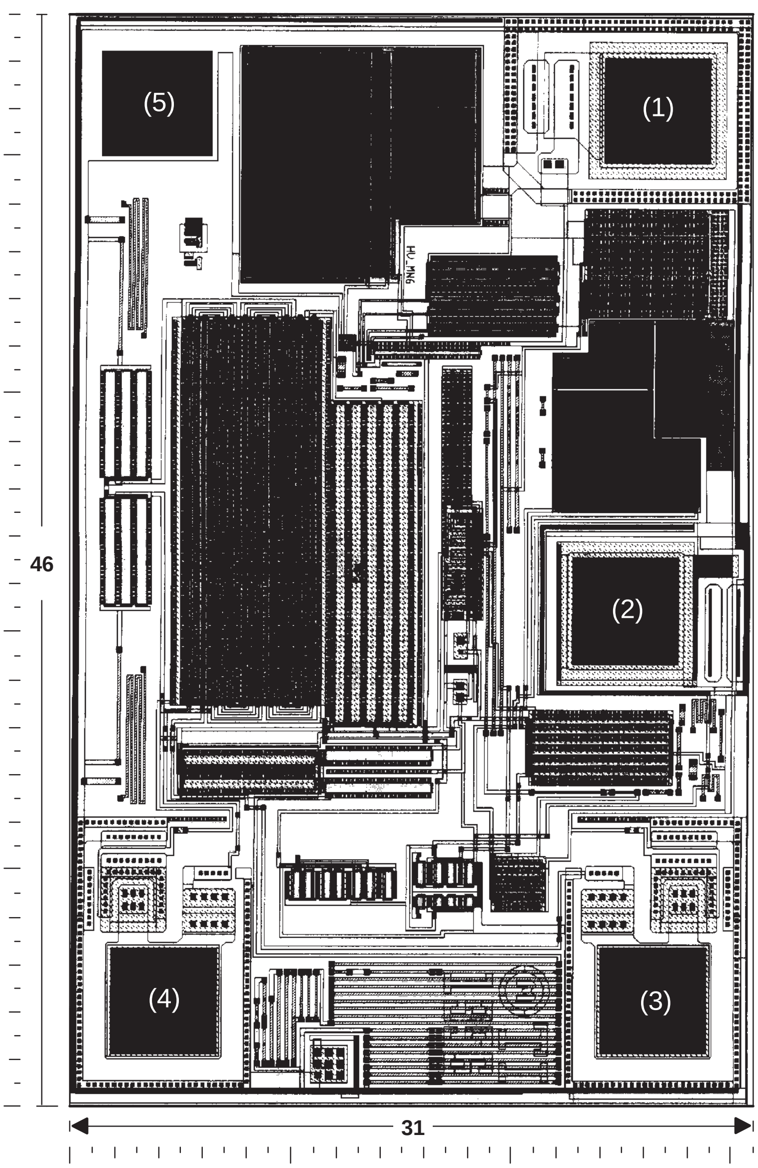
description (continued)

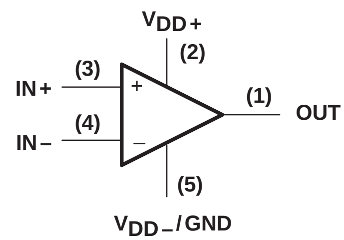
With a total area of 5.6mm^2, the SOT-23 package only requires one-third the board space of the standard 8-pin SOIC package. This ultra-small package allows designers to place single amplifiers very close to the signal source, minimizing noise pick-up from long PCB traces.

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.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 10 MILS TYPICAL

BONDING PADS: 4 × 4 MILS MINIMUM

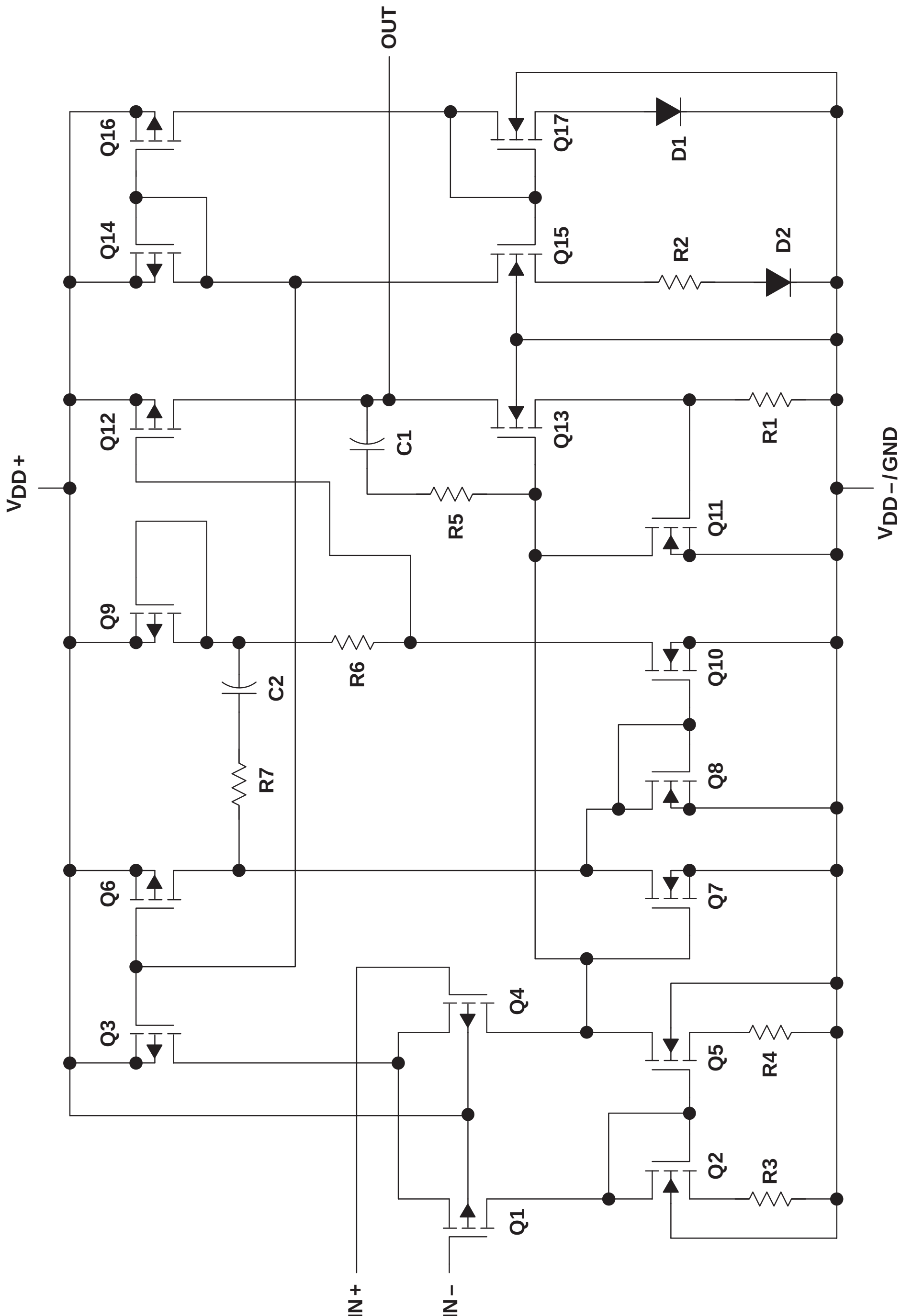
$T_J$max = 150°C

TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

PIN (2) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

equivalent schematic



COMPONENT COUNT†	
Transistors	23
Diodes	6
Resistors	11
Capacitors	2

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

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	$T_A \le 25°C$ 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

	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 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLV2711C MIN	TLV2711C TYP	TLV2711C MAX	TLV2711I MIN	TLV2711I TYP	TLV2711I MAX	UNIT
V_{IO}	Input offset voltage	$V_{DD\pm} = \pm1.5$ V, V_{IC} = 0, V_O = 0, R_S = 50 Ω	Full range		0.4	3		0.4	3	mV
α_{VIO}	Temperature coefficient of input offset voltage		Full range		1			1		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.003			0.003		μV/mo
I_{IO}	Input offset current		Full range		0.5	150		0.5	150	pA
I_{IB}	Input bias current		Full range		1	150		1	150	pA
V_{ICR}	Common-mode input voltage range	$\|V_{IO}\| \le 5$ mV, R_S = 50 Ω	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 μA	25°C		2.94			2.94		V
		I_{OH} = –250 μA	25°C		2.85			2.85		
			Full range	2.6			2.6			
V_{OL}	Low-level output voltage	V_{IC} = 1.5 V, I_{OL} = 50 μA	25°C		15			15		mV
		V_{IC} = 1.5 V, I_{OL} = 500 μA	25°C		150			150		
			Full range			500			500	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 1.5 V, V_O = 1 V to 2 V, R_L = 10 kΩ‡	25°C	3	7		3	7		V/mV
			Full range	1			1			
		V_{IC} = 1.5 V, V_O = 1 V to 2 V, R_L = 1 MΩ‡	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 kHz,	25°C		5			5		pF
z_o	Closed-loop output impedance	f = 7 kHz, A_V = 1	25°C		200			200		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 1.7 V, V_O = 1.5 V, R_S = 50 Ω	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 V to 8 V, $V_{IC} = V_{DD}/2$, No load	25°C	80	95		80	95		dB
			Full range	80			80			
I_{DD}	Supply current	V_O = 1.5 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°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

operating characteristics at specified free-air temperature, V_{DD} = 3 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 V to 1.9 V, R_L = 10 kΩ‡, C_L = 100 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	25°C		80			80		nV/√Hz
		f = 1 kHz	25°C		22			22		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz	25°C		660			660		µV
		f = 0.1 Hz to 10 Hz	25°C		880			880		
I_n	Equivalent input noise current		25°C		0.6			0.6		fA/√Hz
	Gain-bandwidth product	f = 10 kHz, R_L = 10 kΩ‡, C_L = 100 pF‡	25°C		56			56		kHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 1 V, A_V = 1, R_L = 10 kΩ‡, C_L = 100 pF‡	25°C		7			7		kHz
ϕ_m	Phase margin at unity gain	R_L = 10 kΩ‡, C_L = 100 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 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2711C MIN	TLV2711C TYP	TLV2711C MAX	TLV2711I MIN	TLV2711I TYP	TLV2711I MAX	UNIT
V_{IO}	Input offset voltage	$V_{DD\pm} = \pm2.5$ V, $V_O = 0$,	$V_{IC} = 0$, $R_S = 50\ \Omega$	Full range		0.45	3		0.45	3	mV
α_{VIO}	Temperature coefficient of input offset voltage			Full range		0.5			0.5		µV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.003			0.003		µV/mo
I_{IO}	Input offset current			25°C		0.5			0.5		pA
				Full range			150			150	
I_{IB}	Input bias current			25°C		1			1		pA
				Full range			150			150	
V_{ICR}	Common-mode input voltage range	$\lvert V_{IO} \rvert \le 5$ mV	$R_S = 50\ \Omega$	25°C	0 to 4	–0.3 to 4.2		0 to 4	–0.3 to 4.2		V
				Full range	0 to 3.5			0 to 3.5			
V_{OH}	High-level output voltage	$I_{OH} = -100$ µA		25°C		4.95			4.95		V
		$I_{OH} = -250$ µA		25°C		4.875			4.875		
				Full range	4.6			4.6			
V_{OL}	Low-level output voltage	$V_{IC} = 2.5$ V,	$I_{OL} = 50$ µA	25°C		12			12		mV
		$V_{IC} = 2.5$ V,	$I_{OL} = 500$ µA	25°C		120			120		
				Full range			500			500	
A_{VD}	Large-signal differential voltage amplification	$V_{IC} = 2.5$ V, $V_O = 1$ V to 4 V	$R_L = 10$ kΩ‡	25°C	6	12		6	12		V/mV
				Full range	3			3			
			$R_L = 1$ MΩ‡	25°C		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 kHz,		25°C		5			5		pF
z_o	Closed-loop output impedance	f = 7 kHz,	$A_V = 1$	25°C		200			200		Ω
CMRR	Common-mode rejection ratio	$V_{IC} = 0$ to 2.7 V, $R_S = 50\ \Omega$	$V_O = 2.5$ V,	25°C	70	83		70	83		dB
				Full range	70			70			
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{DD} / \Delta V_{IO}$)	$V_{DD} = 4.4$ V to 8 V, No load	$V_{IC} = V_{DD}/2$,	25°C	80	95		80	95		dB
				Full range	80			80			
I_{DD}	Supply current	$V_O = 2.5$ 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°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

operating characteristics at specified free-air temperature, V_{DD} = 5 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 V to 3.5 V, R_L = 10 kΩ‡, C_L = 100 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	25°C		72			72		nV/√Hz
		f = 1 kHz	25°C		21			21		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz	25°C		600			600		µV
		f = 0.1 Hz to 10 Hz	25°C		800			800		
I_n	Equivalent input noise current		25°C		0.6			0.6		fA/√Hz
	Gain-bandwidth product	f = 10 kHz, R_L = 10 kΩ‡, C_L = 100 pF‡	25°C		65			65		kHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, A_V = 1, R_L = 10 kΩ‡, C_L = 100 pF‡	25°C		7			7		kHz
ϕ_m	Phase margin at unity gain	R_L = 10 kΩ‡, C_L = 100 pF‡	25°C		60°			60°		
	Gain margin		25°C		22			22		dB

† Full range is –40°C to 85°C.
‡ Referenced to 1.5 V

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

PARAMETER		TEST CONDITIONS			TLV2711Y			UNIT
					MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{DD\pm}$ = ±1.5 V, R_S = 50 Ω	V_O = 0,	V_{IC} = 0,		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	$\lvert V_{IO} \rvert \le$ 5 mV,	R_S = 50 Ω			–0.3 to 2.2		V
V_{OH}	High-level output voltage	I_{OH} = –100 µA				2.94		V
		I_{OH} = –200 µA				2.85		
V_{OL}	Low-level output voltage	V_{IC} = 0,	I_{OL} = 50 µA			15		mV
		V_{IC} = 0,	I_{OL} = 500 µA			150		
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 1.5 V,	V_O = 1 V to 2 V	R_L = 10 kΩ†		7		V/mV
				R_L = 1 MΩ†		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				5		pF
z_o	Closed-loop output impedance	f = 7 kHz,	A_V = 1			200		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 1.7 V,	V_O = 1.5 V,	R_S = 50 Ω		83		dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 2.7 V to 8 V,	V_{IC} = V_{DD}/2,	No load		95		dB
I_{DD}	Supply current	V_O = 1.5 V,	No load			11		µA

† Referenced to 1.5 V

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

PARAMETER		TEST CONDITIONS			TLV2711Y MIN	TLV2711Y TYP	TLV2711Y MAX	UNIT
V_{IO}	Input offset voltage	$V_{DD}\pm = \pm 2.5$ V, R_S = 50 Ω	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	$\lvert V_{IO} \rvert \le 5$ mV,	R_S = 50 Ω			–0.3 to 4.2		V
V_{OH}	High-level output voltage	I_{OH} = –100 µA				4.95		V
		I_{OH} = –250 µA				4.875		
V_{OL}	Low-level output voltage	V_{IC} = 2.5 V,	I_{OL} = 50 µA			12		mV
		V_{IC} = 2.5 V,	I_{OL} = 500 µA			120		
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V,	V_O = 1 V to 4 V	R_L = 10 kΩ†		12		V/mV
				R_L = 1 MΩ†		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 kHz				5		pF
z_o	Closed-loop output impedance	f = 7 kHz,	A_V = 1			200		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.7 V,	V_O = 2.5 V,	R_S = 50 Ω		83		dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 4.4 V to 8 V,	$V_{IC} = V_{DD}/2$,	No load		95		dB
I_{DD}	Supply current	V_O = 2.5 V,	No load			13		µA

† Referenced to 1.5 V

TYPICAL CHARACTERISTICS

Table of Graphs

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

TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLV2711
INPUT OFFSET VOLTAGE

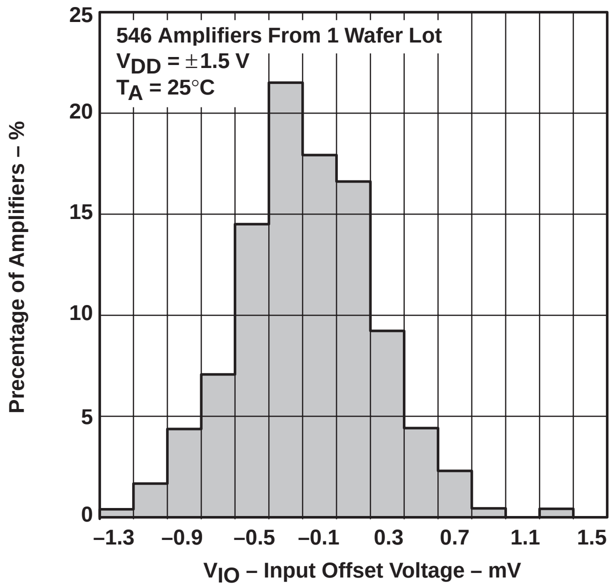


Figure 2

DISTRIBUTION OF TLV2711
INPUT OFFSET VOLTAGE

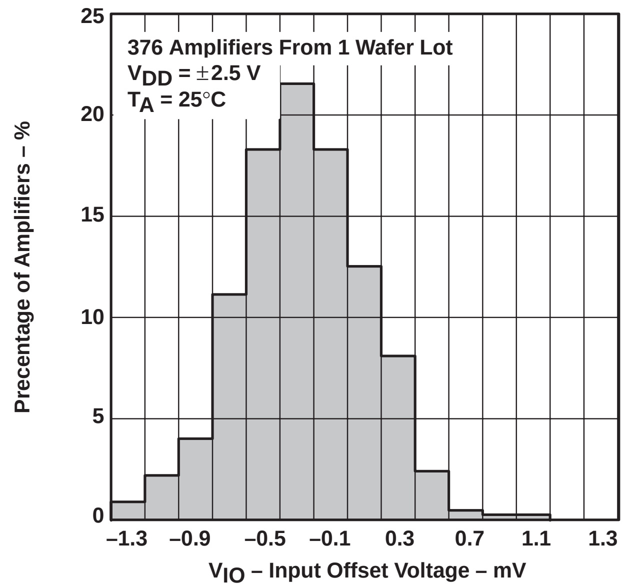


Figure 3

INPUT OFFSET VOLTAGE†
vs
COMMON-MODE INPUT VOLTAGE

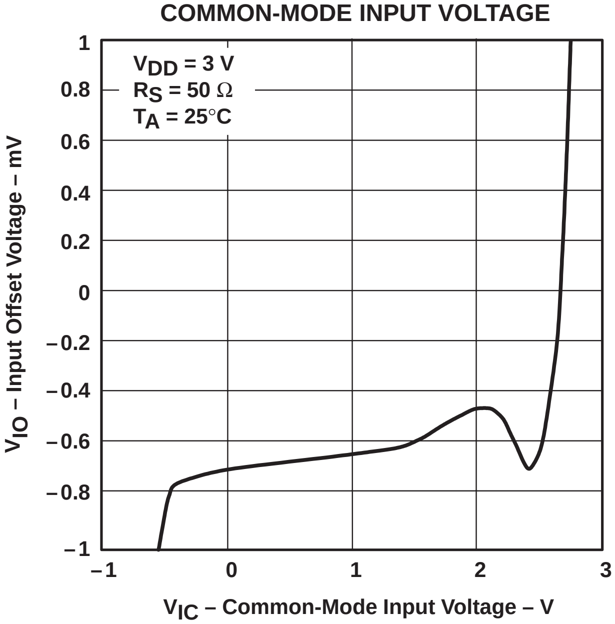


Figure 4

INPUT OFFSET VOLTAGE†
vs
COMMON-MODE INPUT VOLTAGE

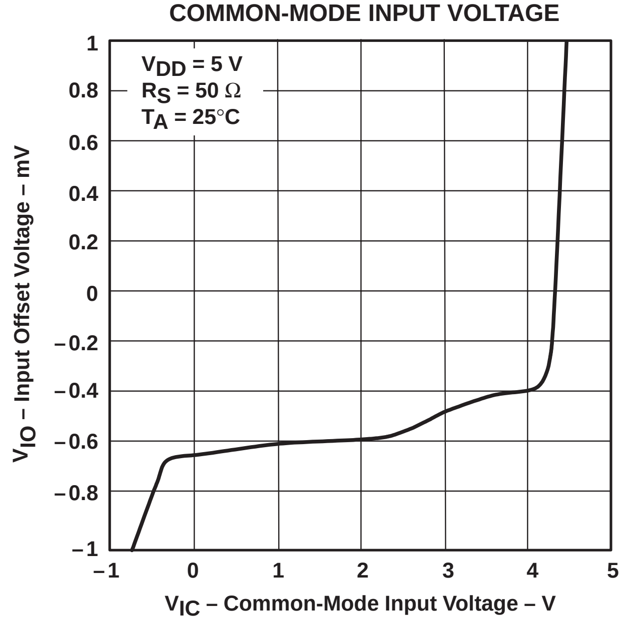


Figure 5

† 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

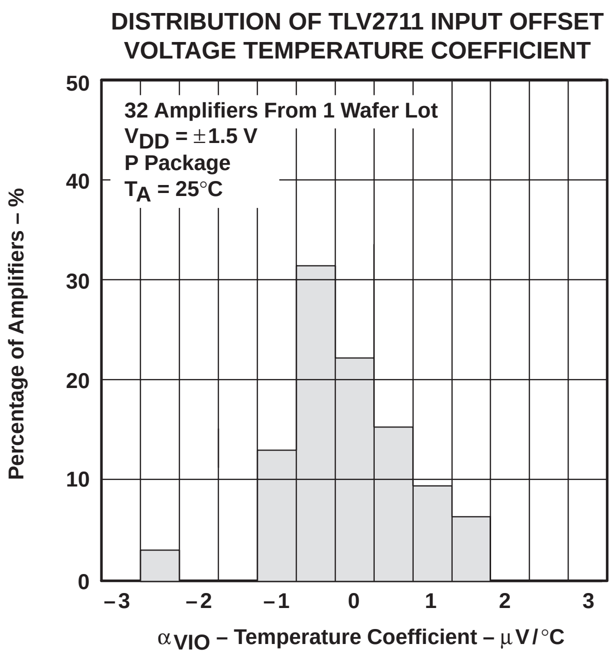


Figure 6

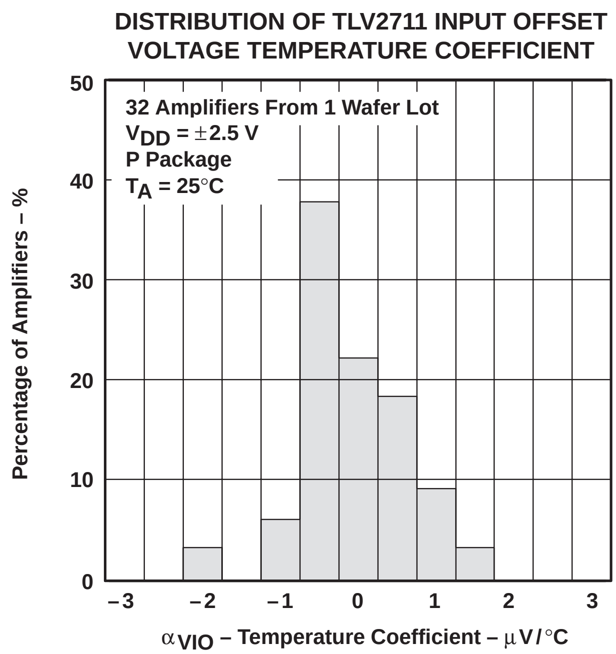


Figure 7

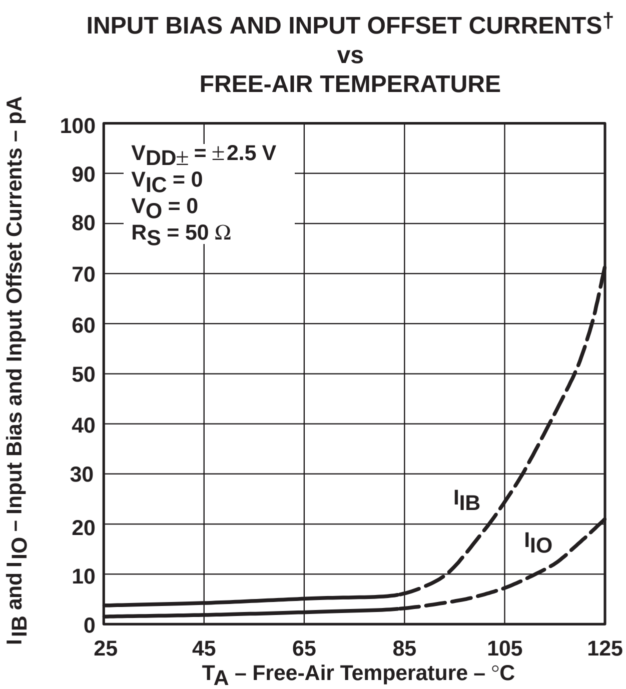


Figure 8

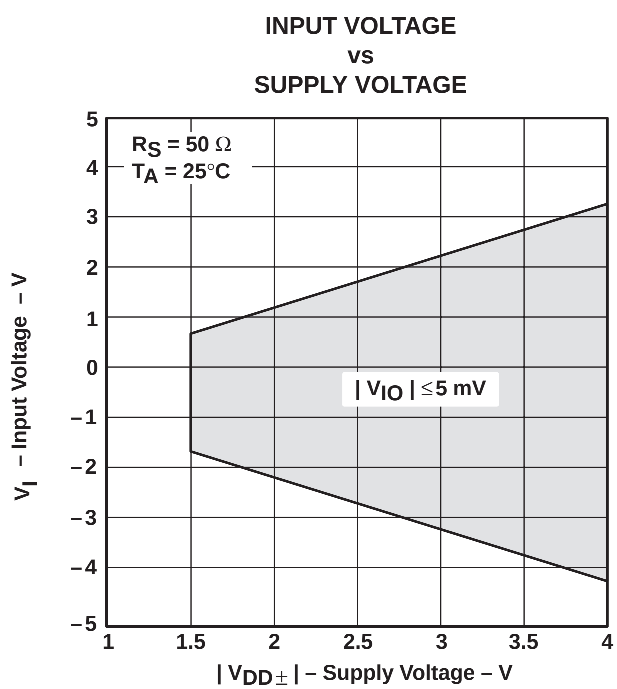


Figure 9

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

TYPICAL CHARACTERISTICS

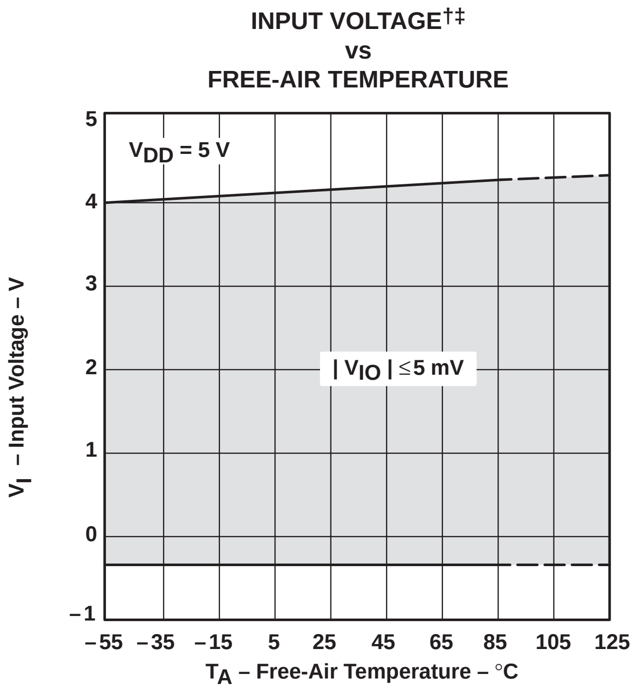
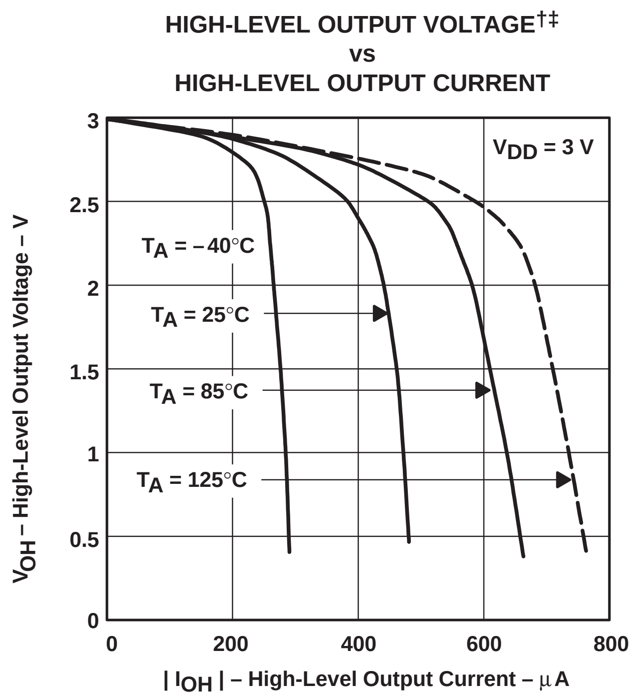


Figure 10



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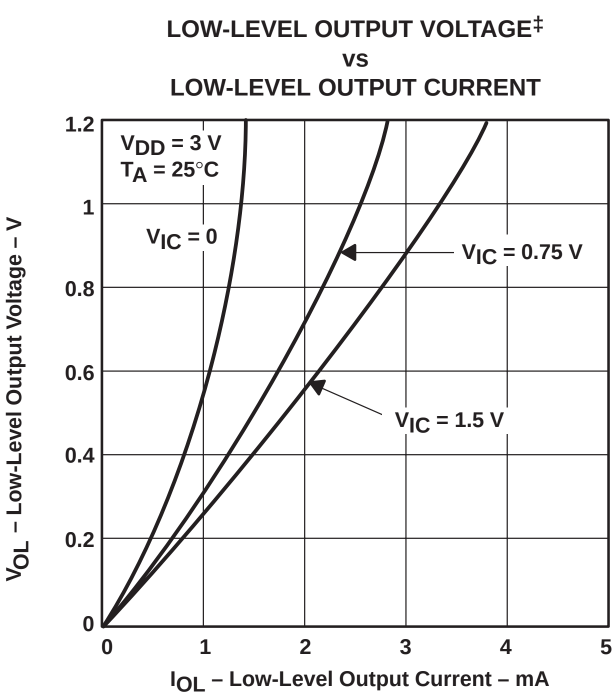

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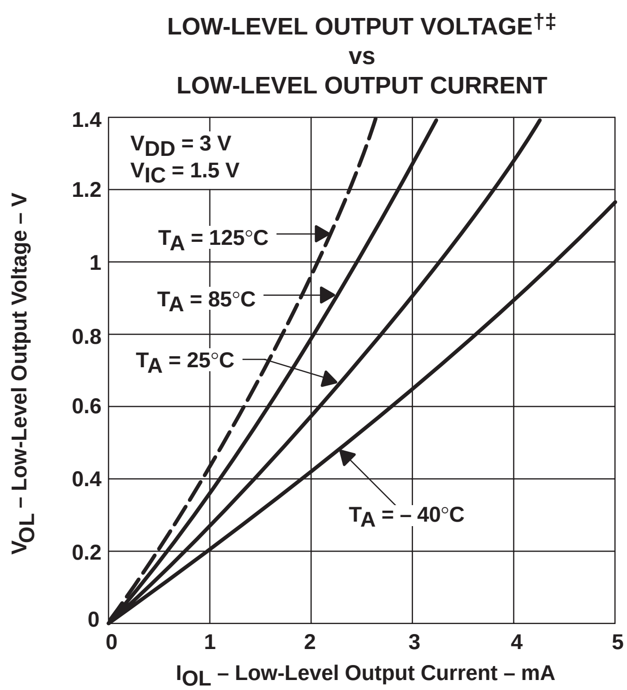


Figure 13

† 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

**HIGH-LEVEL OUTPUT VOLTAGE†‡
vs
HIGH-LEVEL OUTPUT CURRENT**

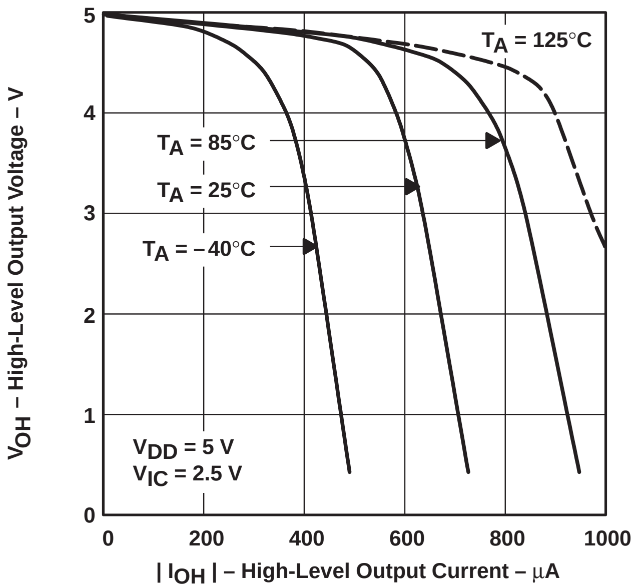


Figure 14

**LOW-LEVEL OUTPUT VOLTAGE†‡
vs
LOW-LEVEL OUTPUT CURRENT**

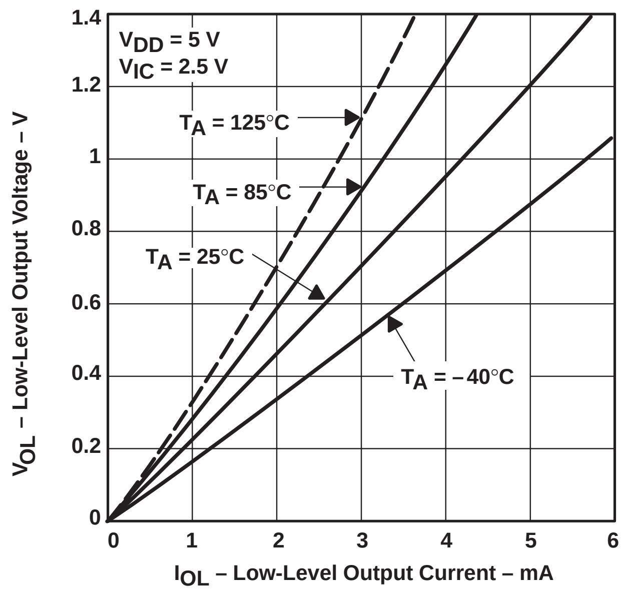


Figure 15

**MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE‡
vs
FREQUENCY**

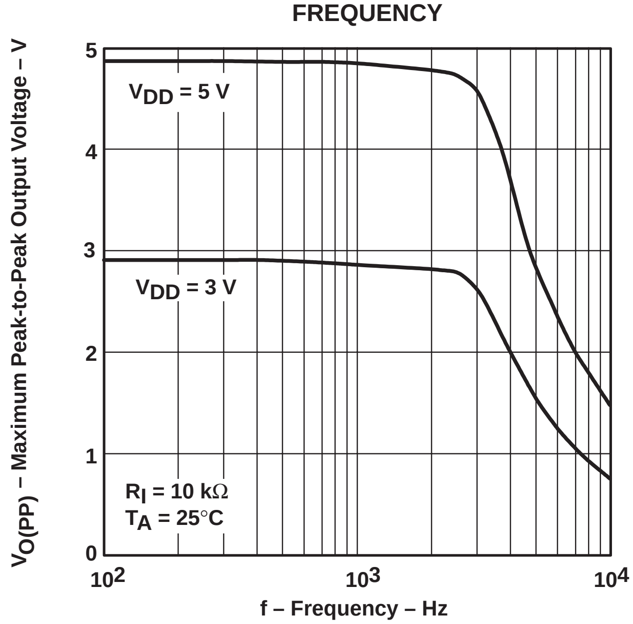


Figure 16

**SHORT-CIRCUIT OUTPUT CURRENT
vs
SUPPLY VOLTAGE**

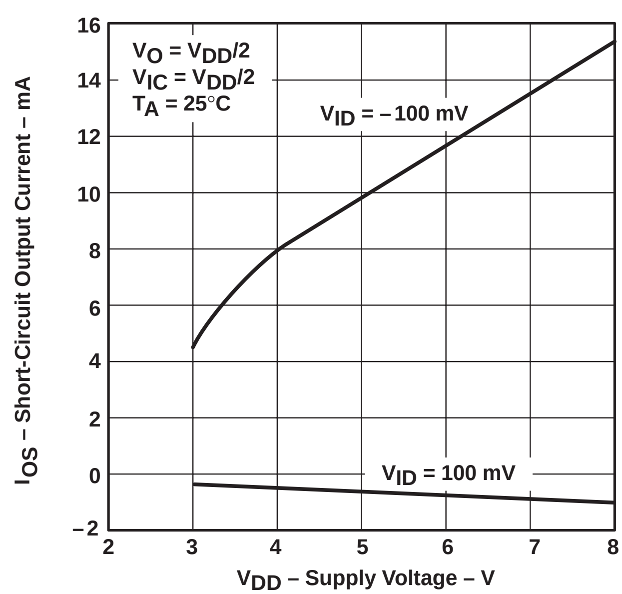


Figure 17

† 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

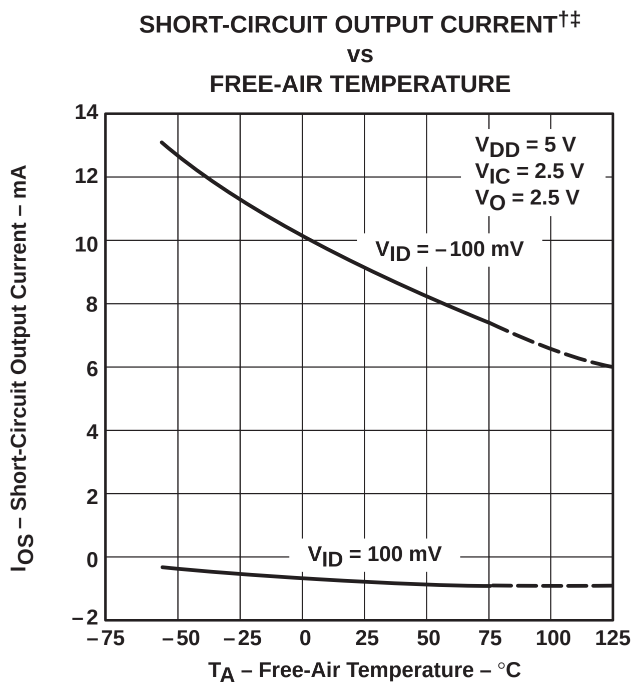


Figure 18

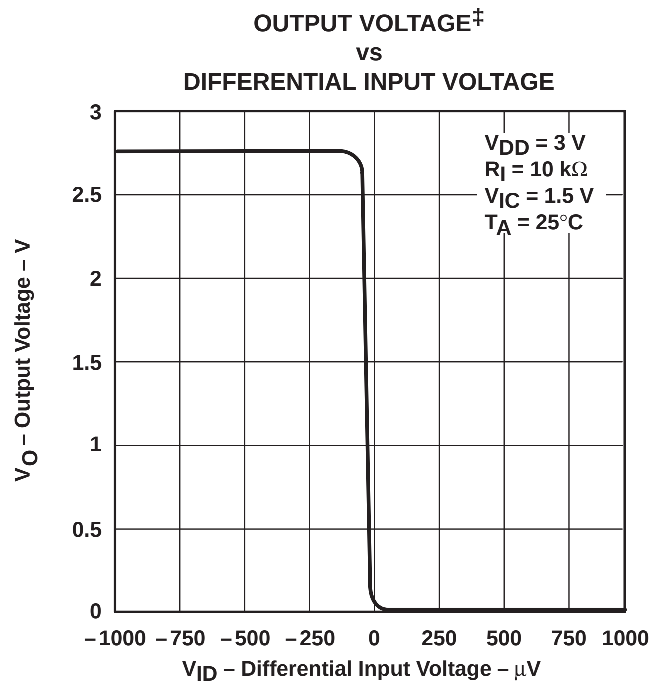


Figure 19

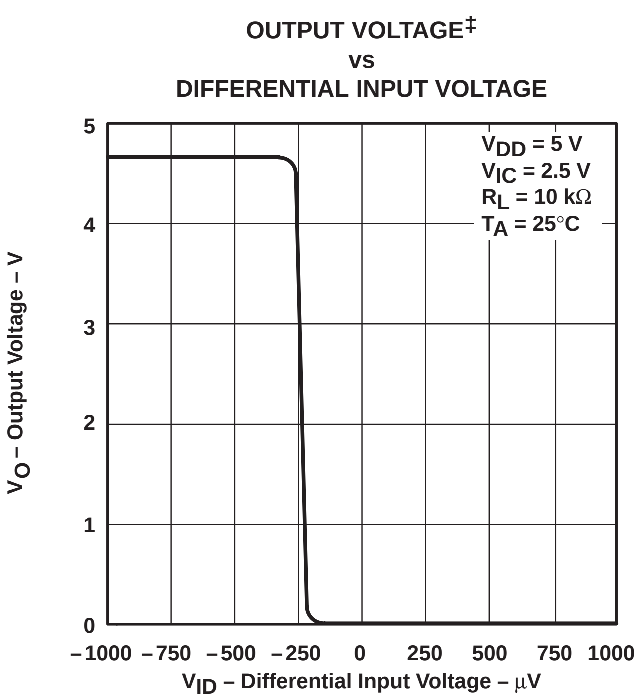


Figure 20

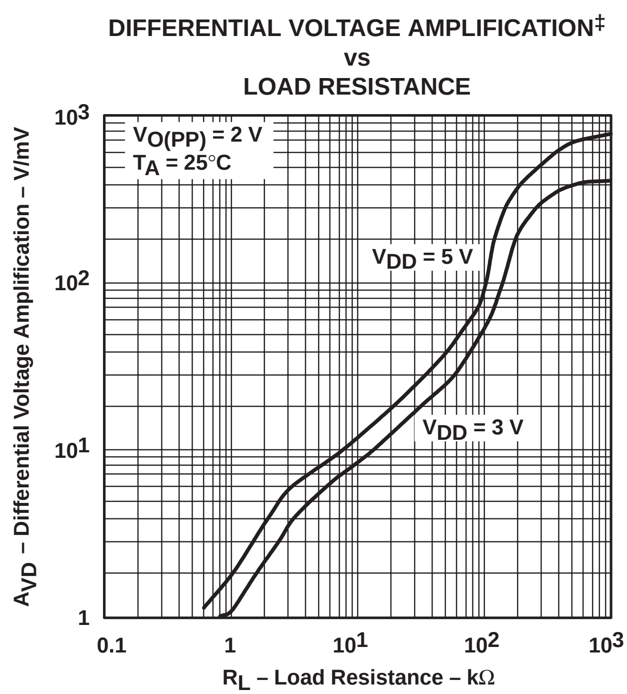


Figure 21

† 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

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

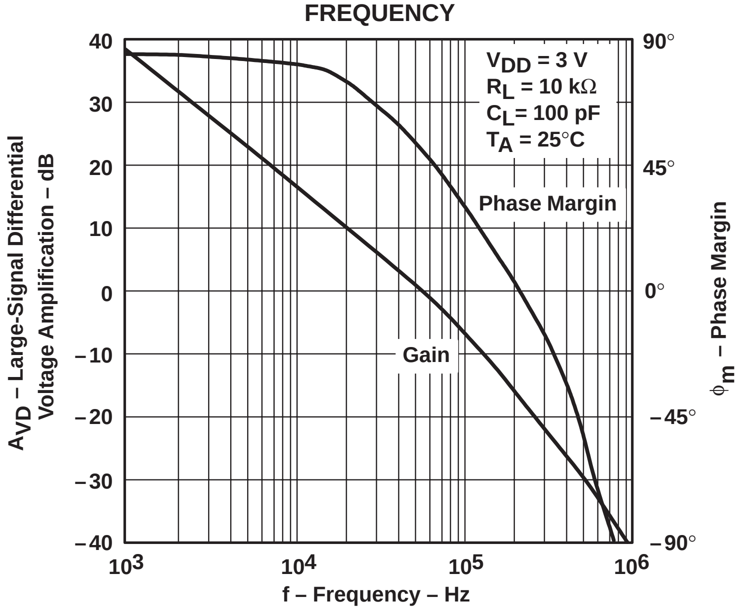


Figure 22

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

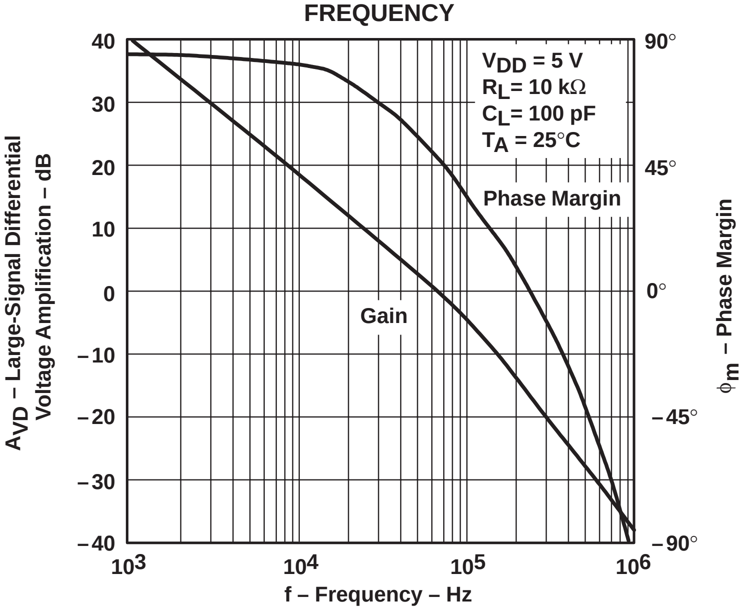


Figure 23

† For all curves where V_{DD} = 5 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

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION†‡ vs FREE-AIR TEMPERATURE

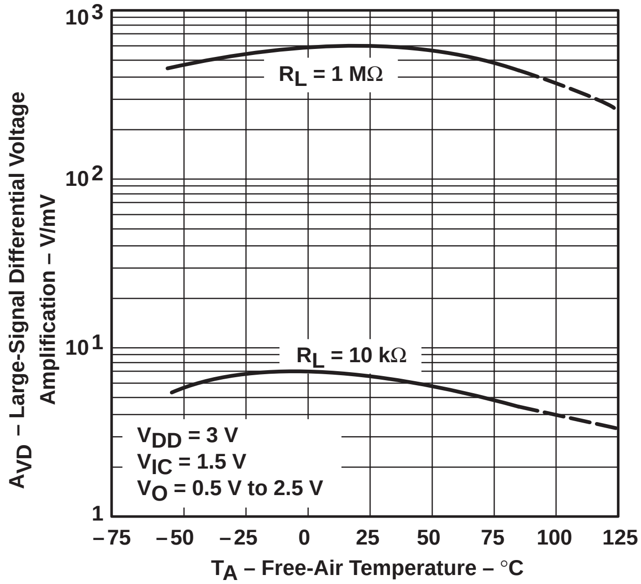


Figure 24

LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION†‡ vs FREE-AIR TEMPERATURE

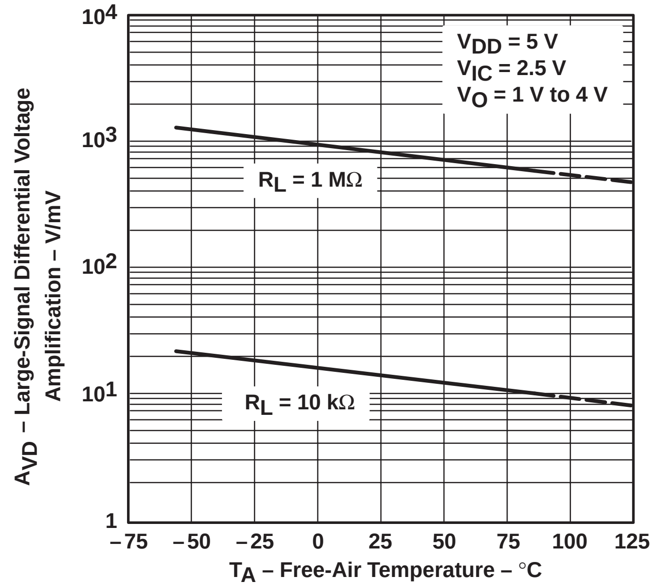


Figure 25

OUTPUT IMPEDANCE‡ vs FREQUENCY

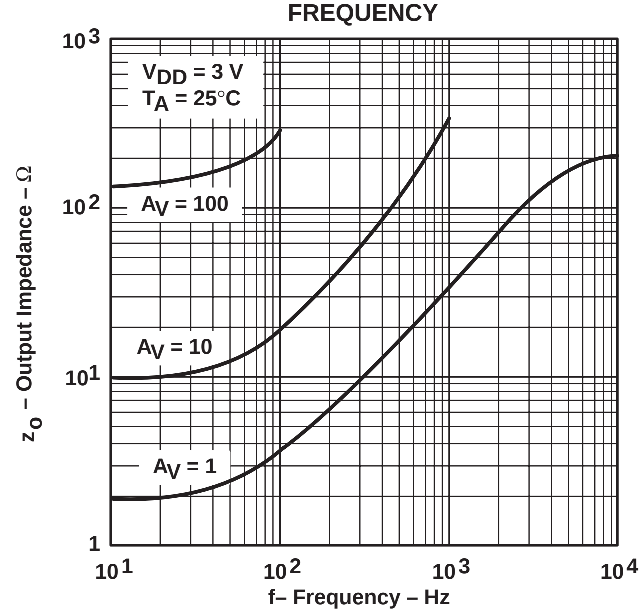


Figure 26

OUTPUT IMPEDANCE‡ vs FREQUENCY

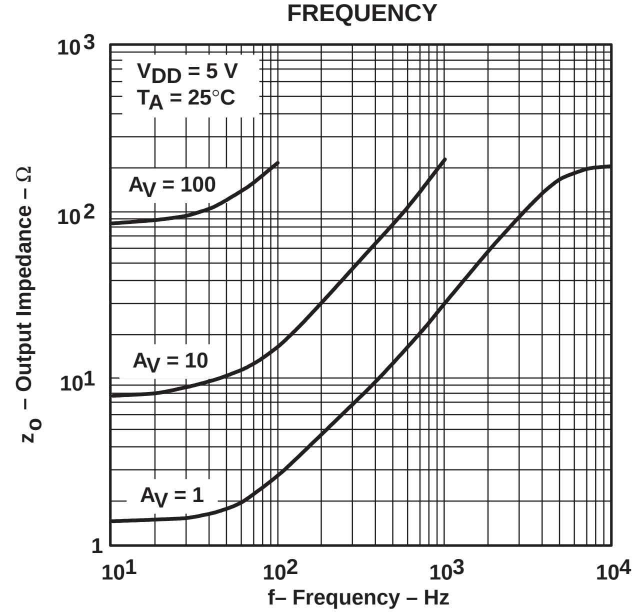


Figure 27

† 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

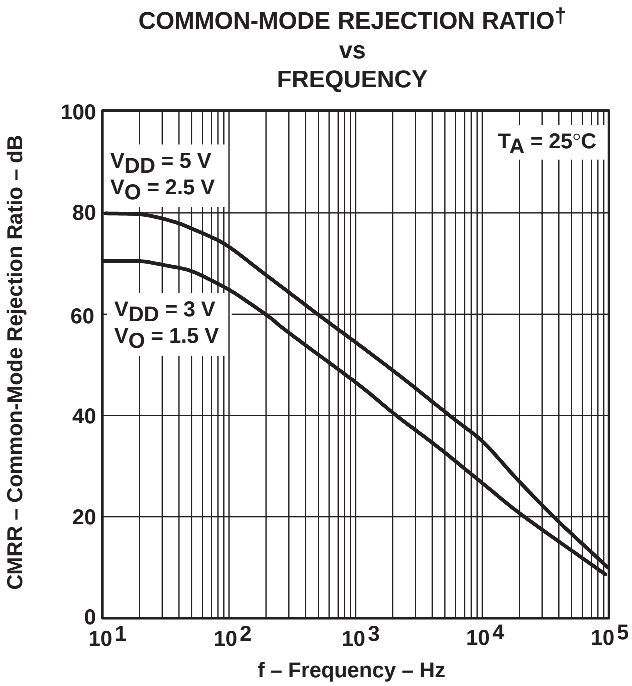


Figure 28

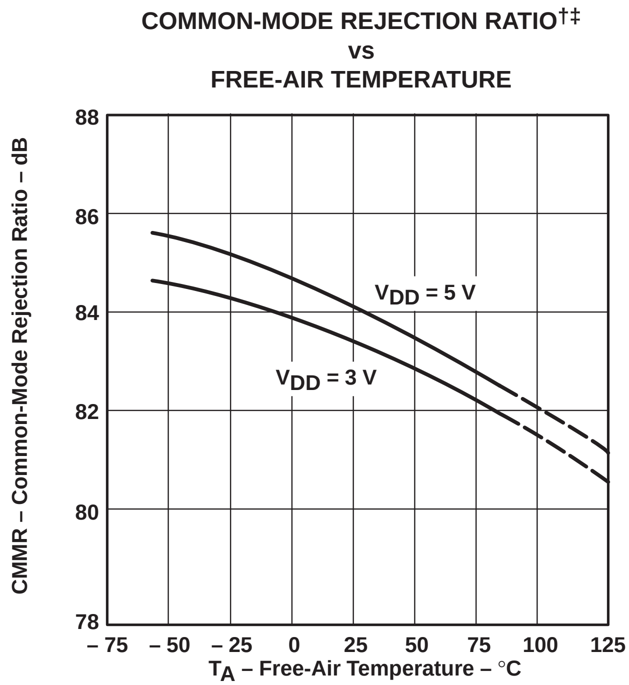


Figure 29

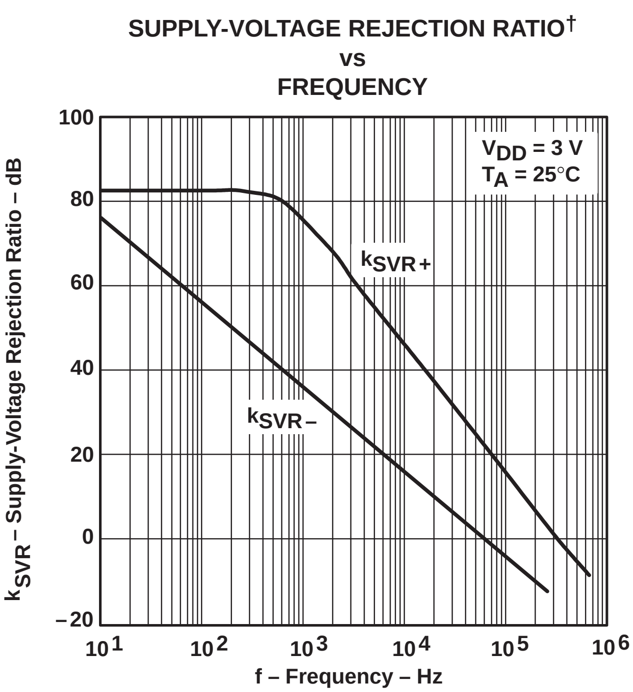


Figure 30

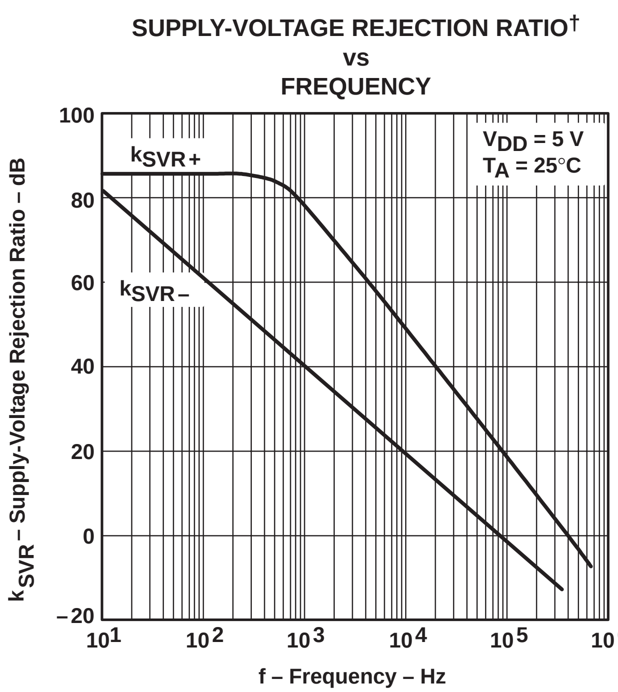


Figure 31

† 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.

TYPICAL CHARACTERISTICS

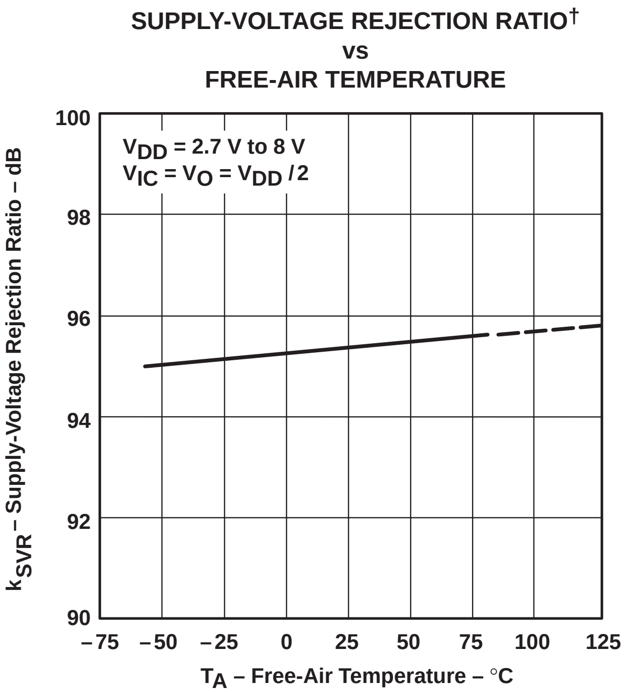


Figure 32

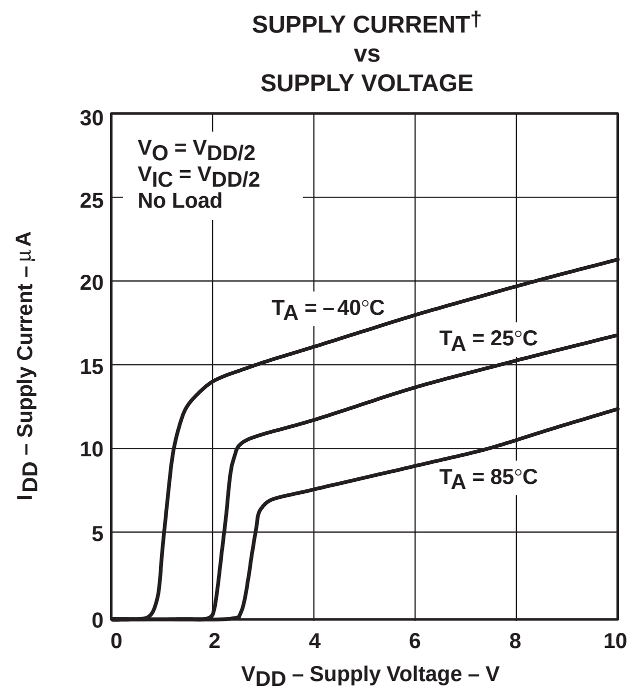


Figure 33

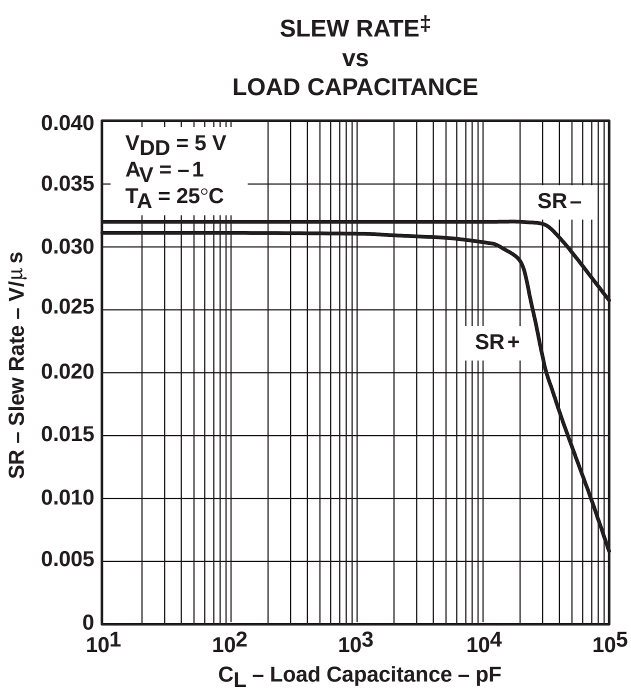


Figure 34

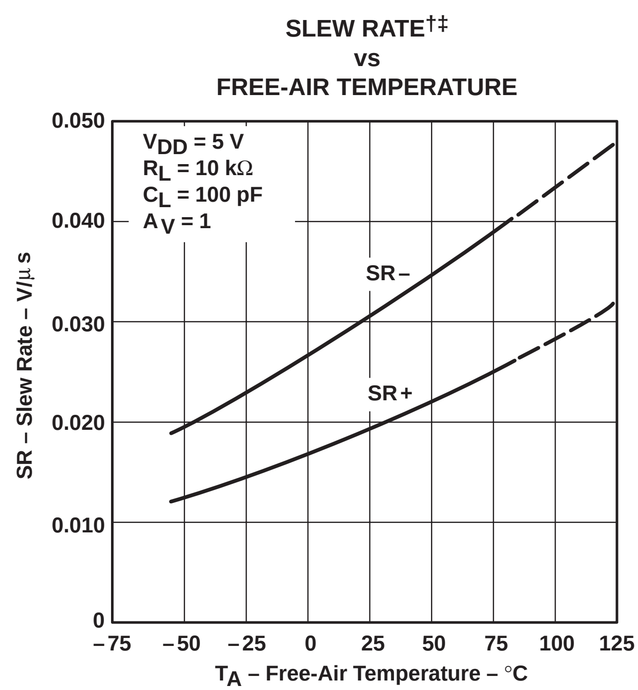


Figure 35

† 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

INVERTING LARGE-SIGNAL PULSE RESPONSE†

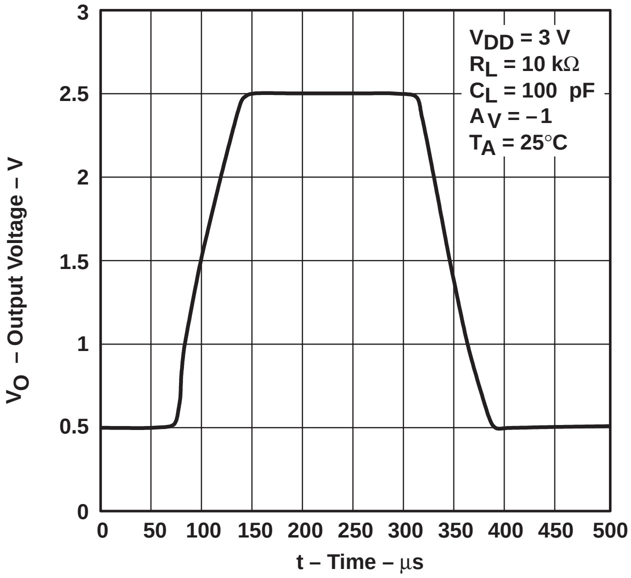


Figure 36

INVERTING LARGE-SIGNAL PULSE RESPONSE†

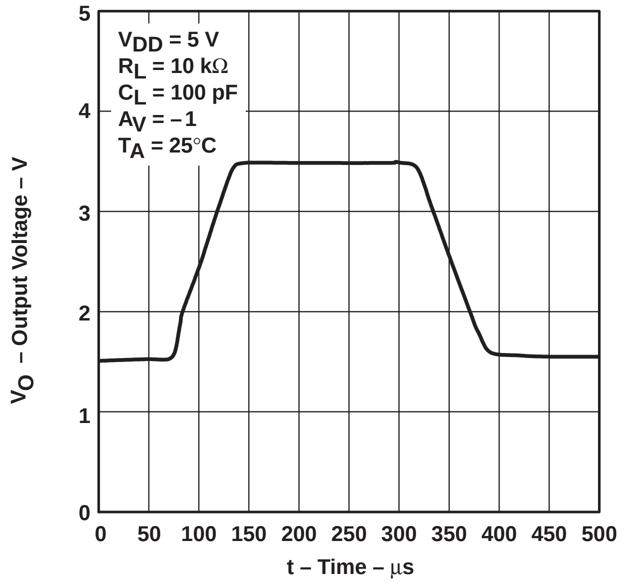


Figure 37

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE†

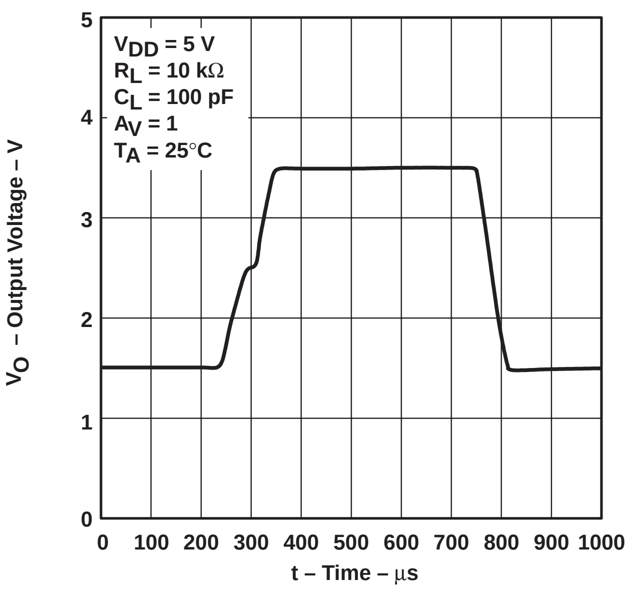


Figure 38

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE†

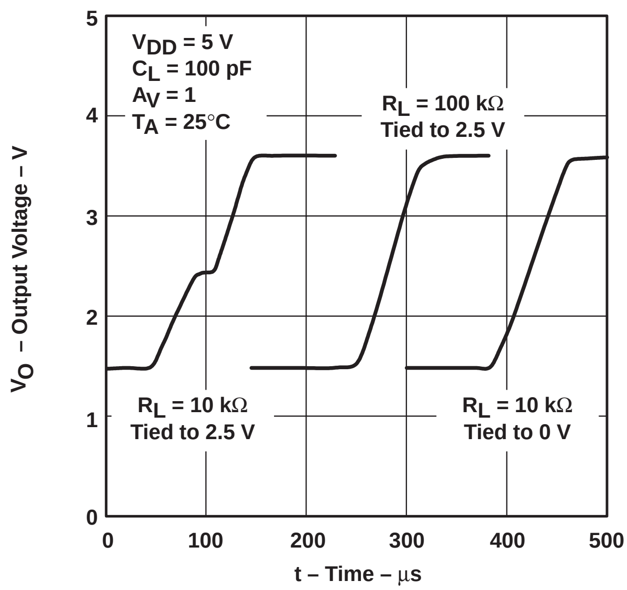


Figure 39

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

TYPICAL CHARACTERISTICS

INVERTING SMALL-SIGNAL PULSE RESPONSE†

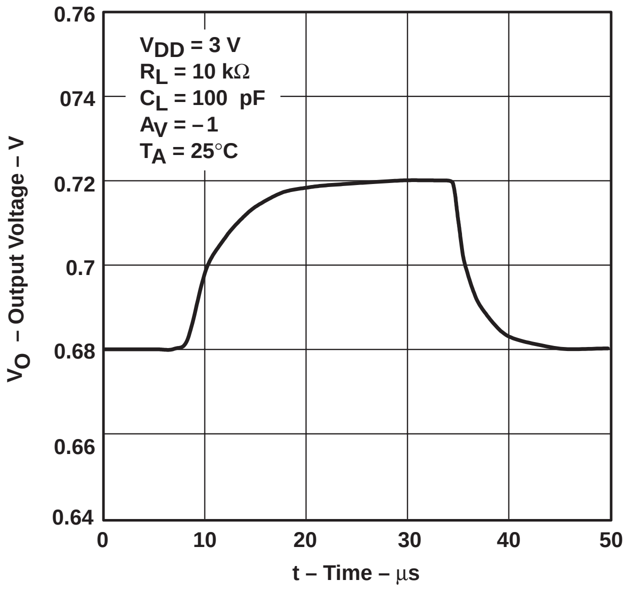


Figure 40

INVERTING SMALL-SIGNAL PULSE RESPONSE†

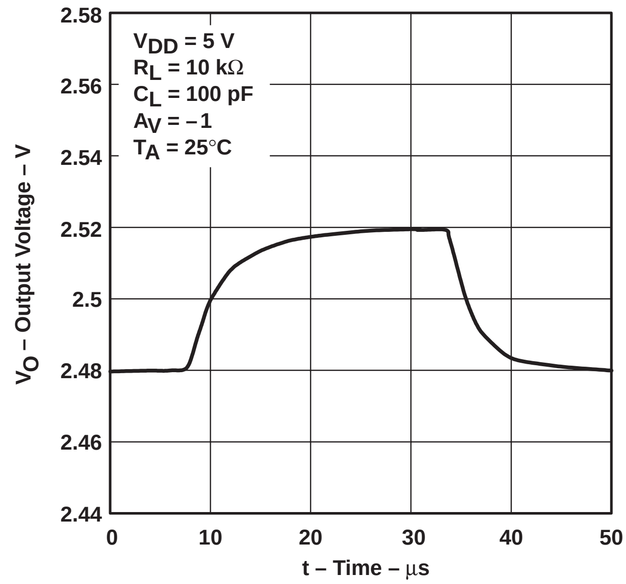


Figure 41

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE†

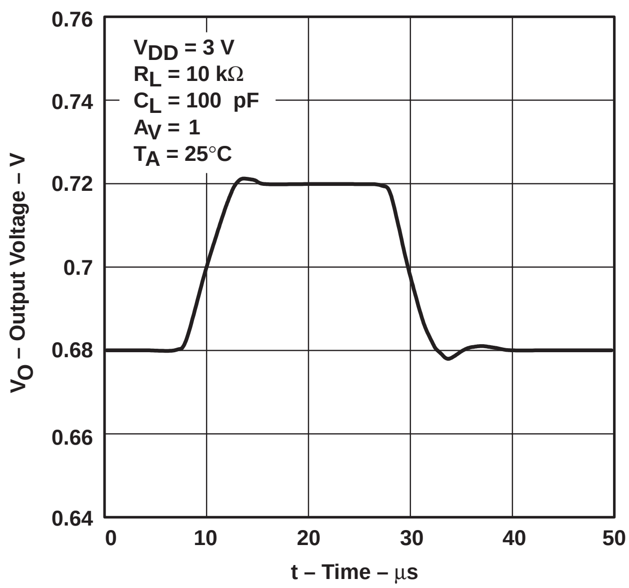


Figure 42

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE†

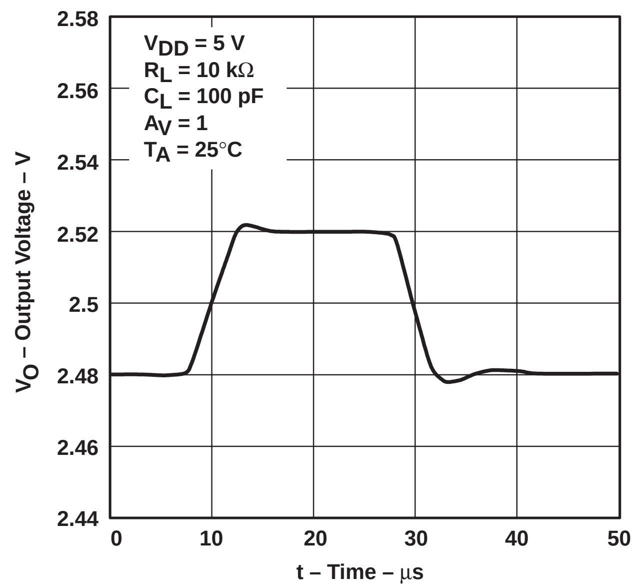


Figure 43

† 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

EQUIVALENT INPUT NOISE VOLTAGE† vs FREQUENCY

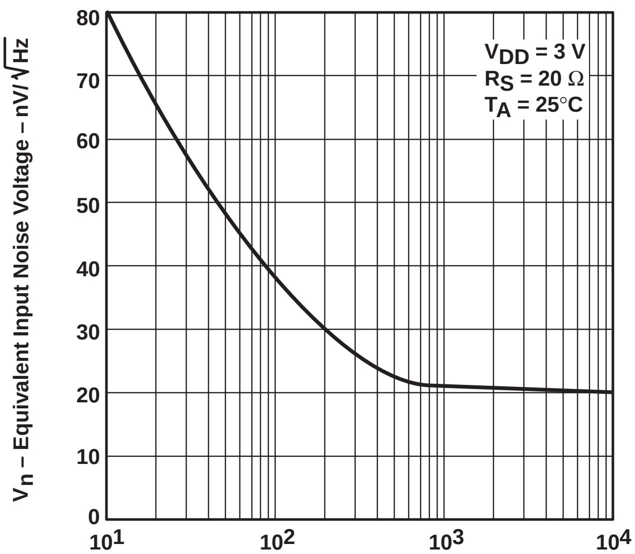


Figure 44

EQUIVALENT INPUT NOISE VOLTAGE† vs FREQUENCY

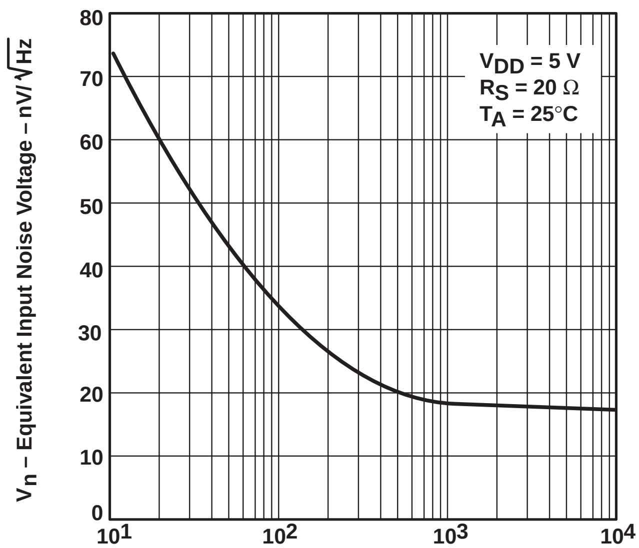


Figure 45

INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD†

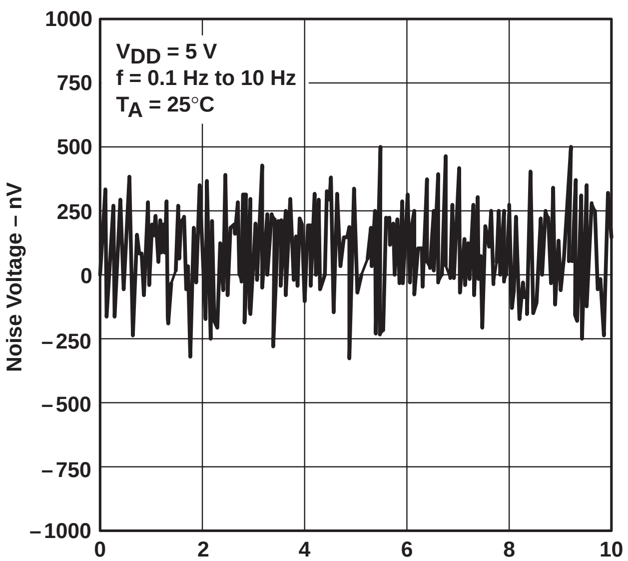


Figure 46

TOTAL HARMONIC DISTORTION PLUS NOISE† vs FREQUENCY

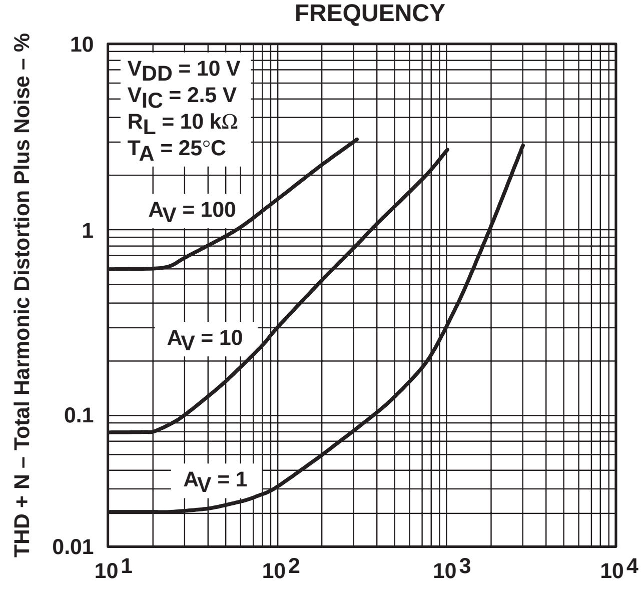


Figure 47

† For all curves where V_{DD} = 5 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

GAIN-BANDWIDTH PRODUCT†‡
vs
FREE-AIR TEMPERATURE

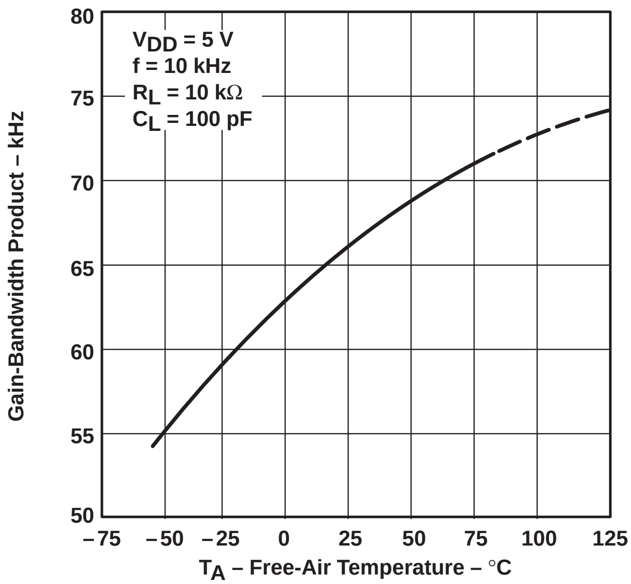


Figure 48

GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE

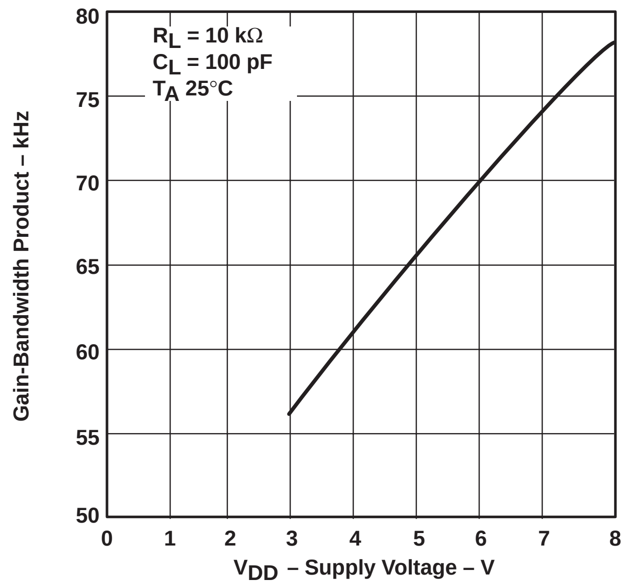


Figure 49

PHASE MARGIN
vs
LOAD CAPACITANCE

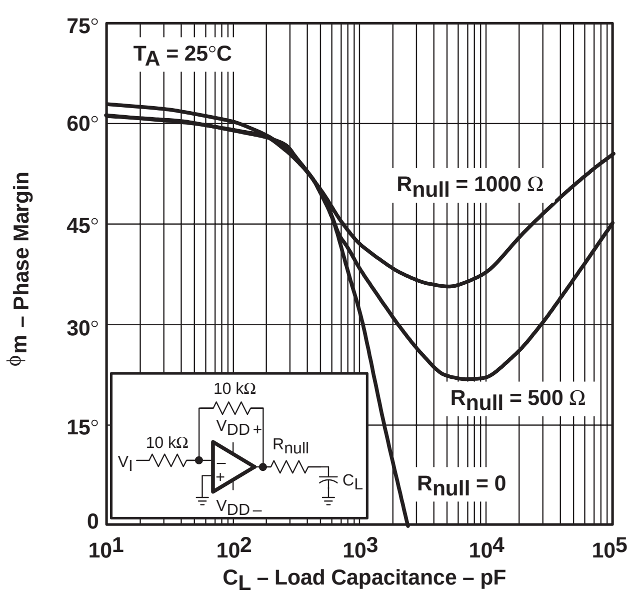


Figure 50

GAIN MARGIN
vs
LOAD CAPACITANCE

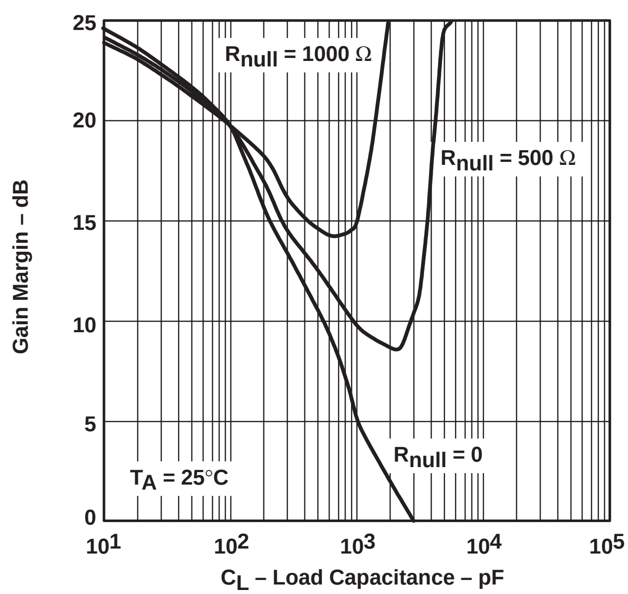


Figure 51

† 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

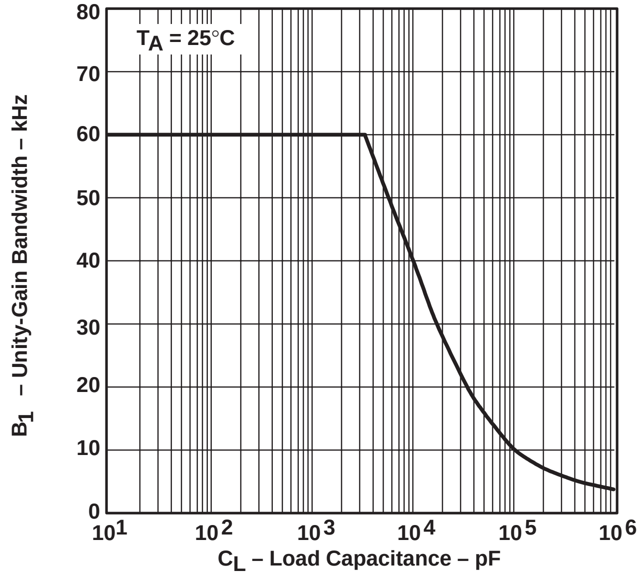


Figure 52

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.

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

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.

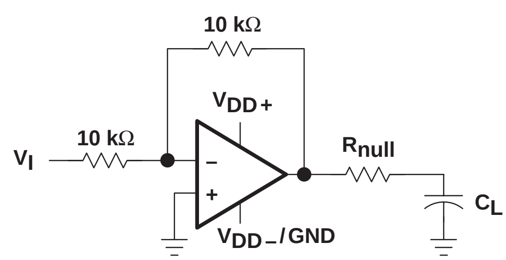


Figure 53. Series-Resistance Circuit

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_{DD} = 3 V and V_{DD} = 5 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 kΩ, 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-kΩ load conditions. The first load condition shows the distortion seen for a 10-kΩ load tied to 2.5 V. The third load condition shows no distortion for a 10-kΩ 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-kΩ load and a 100-kΩ 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.

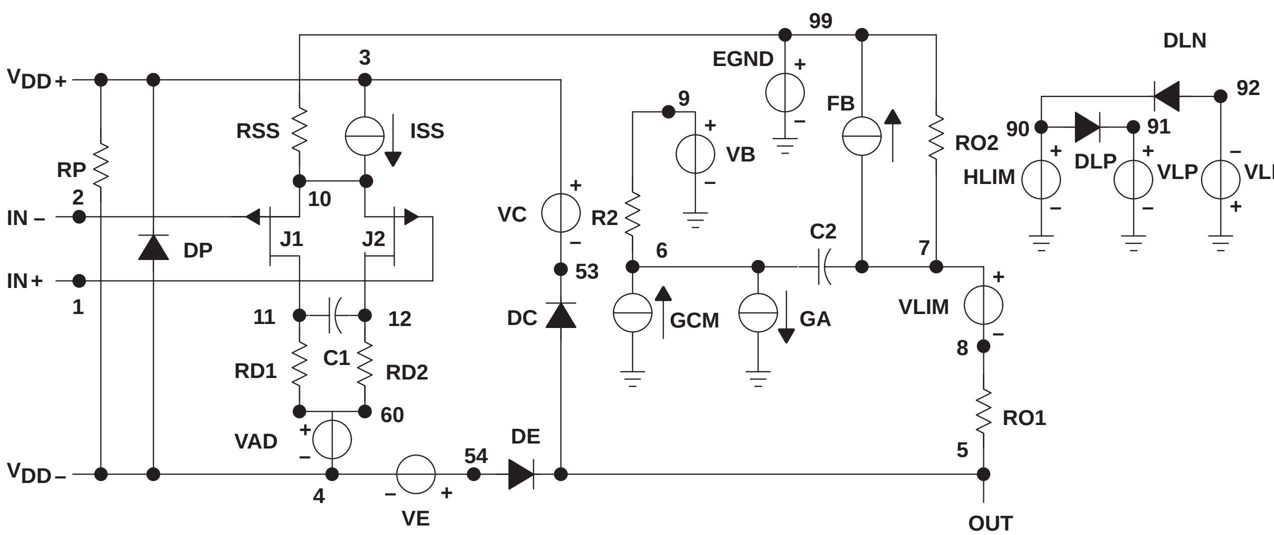
APPLICATION INFORMATION

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°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).



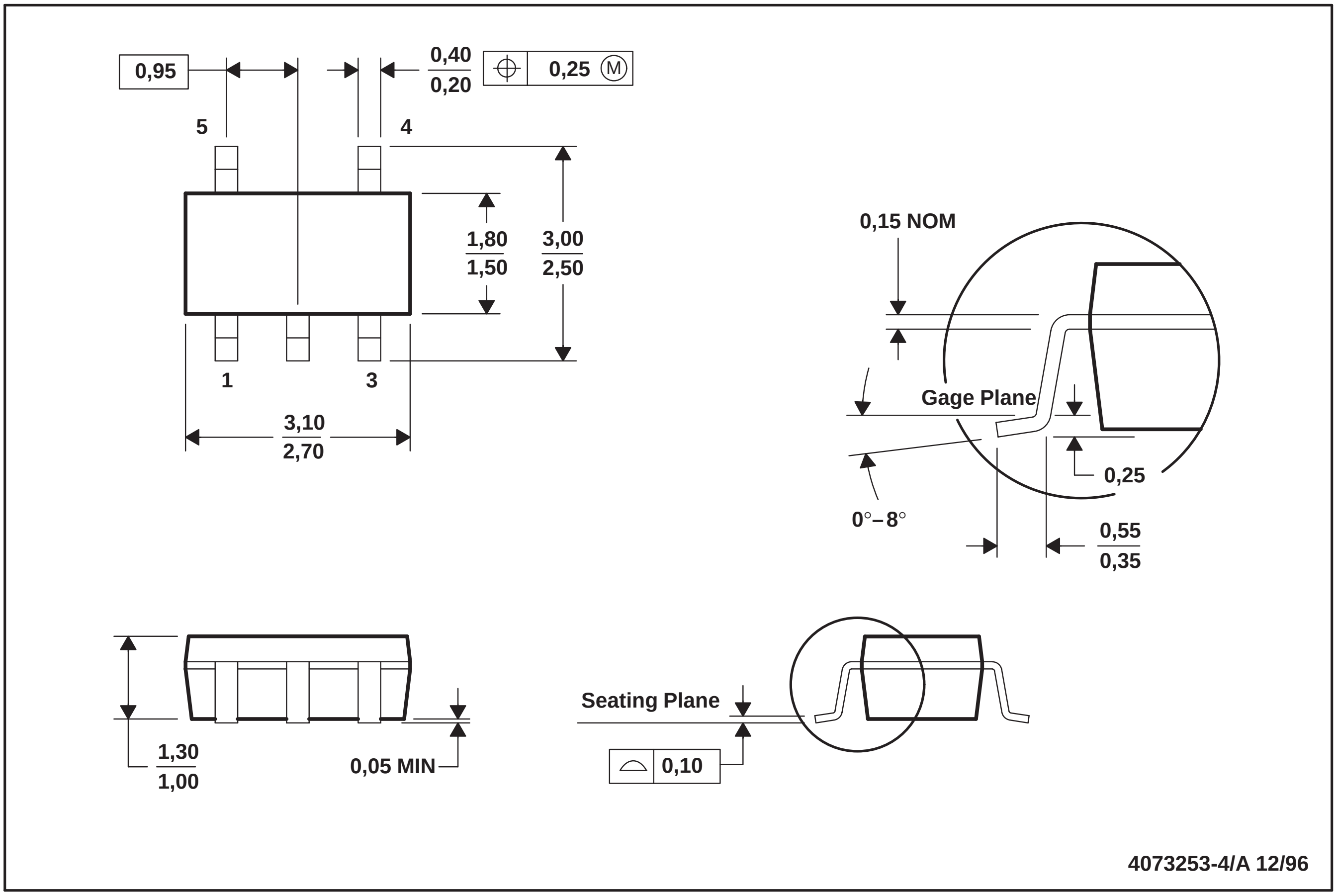

```
.SUBCKT TLV2711 1 2 3 4 5
C1      11   12   8.86E–12
C2      6    7    50.00E–12
DC      5    53   DX
DE      54   5    DX
DLP     90   91   DX
DLN     92   90   DX
DP      4    3    DX
EGND    99   0    POLY (2) (3,0) (4,0) 0 .5 .5
FB      7    99   POLY (5) VB VC VE VLP
+ VLN 0 4.29E6 –6E6 6E6 6E6 –6E6
GA      6    0    11    12 9.425E–6
GCM     0    6    10    99 1320.2E–12
ISS     3    10   DC 1.250E–6
HLIM    90   0    VLIM 1K
J1      11   2    10 JX
J2      12   1    10 JX
R2      6    9    100.0E3
RD1     60   11   106.1E3
RD2     60   12   106.1E3
R01     8    5    50
R02     7    99   150
RP      3    4    419.2E3
RSS     10   99   160.0E6
VAD     60   4    –.5
VB      9    0    DC 0
VC      3    53   DC .55
VE      54   4    DC .55
VLIM    7    8    DC 0
VLP     91   0    DC 0.1
VLN     0    92   DC 2.6
.MODEL DX D (IS=800.0E–18)
.MODEL JX PJF (IS=500.0E–15 BETA=166E–6
+ VTO=–.004)
.ENDS
```

Figure 54. 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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