

TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1 Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182A – SEPTEMBER 2003 – REVISED APRIL 2008

- Qualified for Automotive Applications
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)
- Output Swing Includes Both Supply Rails
- Extended Common-Mode Input Voltage Range . . . 0 V to 4.5 V (Min) with 5-V Single Supply
- No Phase Inversion
- Low Noise . . . 18 nV/√Hz Typ at f = 1 kHz
- Low Input Offset Voltage
950 μV Max at T_A = 25°C (TLV243xA)
- Low Input Bias Current . . . 1 pA Typ
- Very Low Supply Current . . . 125 μA Per Channel Max
- 600-Ω Output Drive
- Macromodel Included

description

The TLV243x and TLV243xA are low-voltage operational amplifier from Texas Instruments. The common-mode input voltage range for each device is extended over the typical CMOS amplifiers making them suitable for a wide range of applications. In addition, these devices do not phase invert when the common-mode input is driven to the supply rails. This satisfies most design requirements without paying a premium for rail-to-rail input performance. They also exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. This family is fully characterized at 3-V and 5-V supplies and is optimized for low-voltage operation. The TLV243x only requires 100 μA (typ) of supply current per channel, making it ideal for battery-powered applications. The TLV243x also has increased output drive over previous rail-to-rail operational amplifiers and can drive 600-Ω loads for telecom applications.

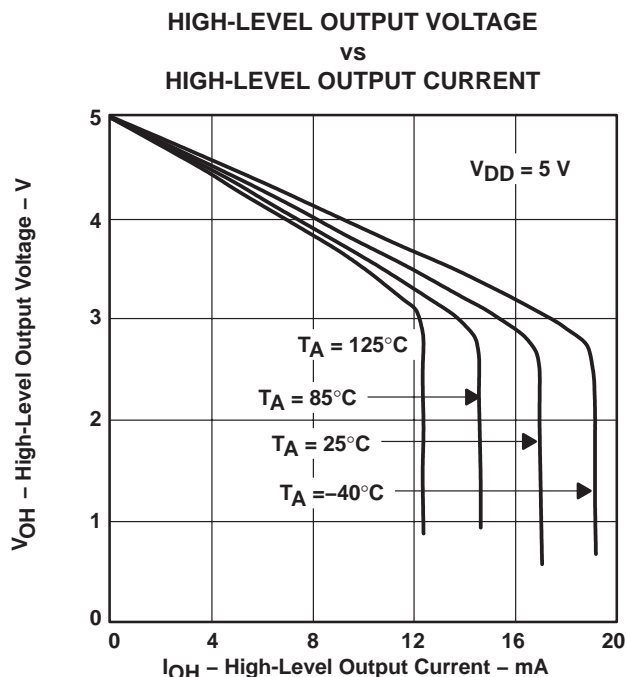


Figure 1

The other members in the TLV243x family are the high-power, TLV244x, and micro-power, TLV2422, versions.

The TLV243x, 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 and low-voltage 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). For precision applications, the TLV243xA is available and has a maximum input offset voltage of 950 μV.

If the design requires single operational amplifiers, see the TI TLV2211/21/31. This is a family of rail-to-rail output operational amplifiers in the SOT-23 package. Their small size and low power consumption, make them ideal for high density, battery-powered equipment.



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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2008 Texas Instruments Incorporated

TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1

Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT

WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182A – SEPTEMBER 2003 – REVISED APRIL 2008

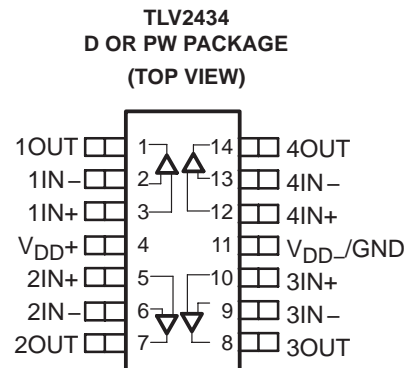
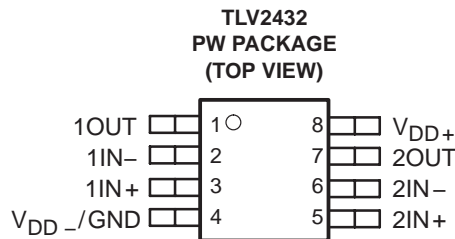
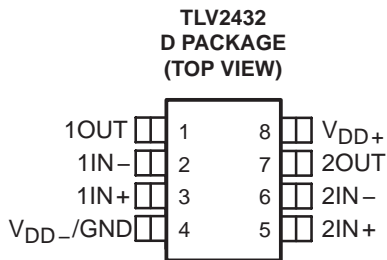
ORDERING INFORMATION†

T _A	V _{IO} max AT 25°C	PACKAGE‡		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 125°C	950 µV	SOIC (D)	Tape and reel	TLV2432AQDRQ1	2432AQ
		TSSOP (PW)	Tape and reel	TLV2432AQPWRQ1§	
	2.5 mV	SOIC (D)	Tape and reel	TLV2432QDRQ1	2432Q1
		TSSOP (PW)	Tape and reel	TLV2432QPWRQ1§	
-40°C to 125°C	950 µV	SOIC (D)	Tape and reel	TLV2434AQDRQ1§	
		TSSOP (PW)	Tape and reel	TLV2434AQPWRQ1§	
	2.5 mV	SOIC (D)	Tape and reel	TLV2434QDRQ1§	
		TSSOP (PW)	Tape and reel	TLV2434QPWRQ1§	

† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at <http://www.ti.com>.

‡ Package drawings, thermal data, and symbolization are available at <http://www.ti.com/packaging>.

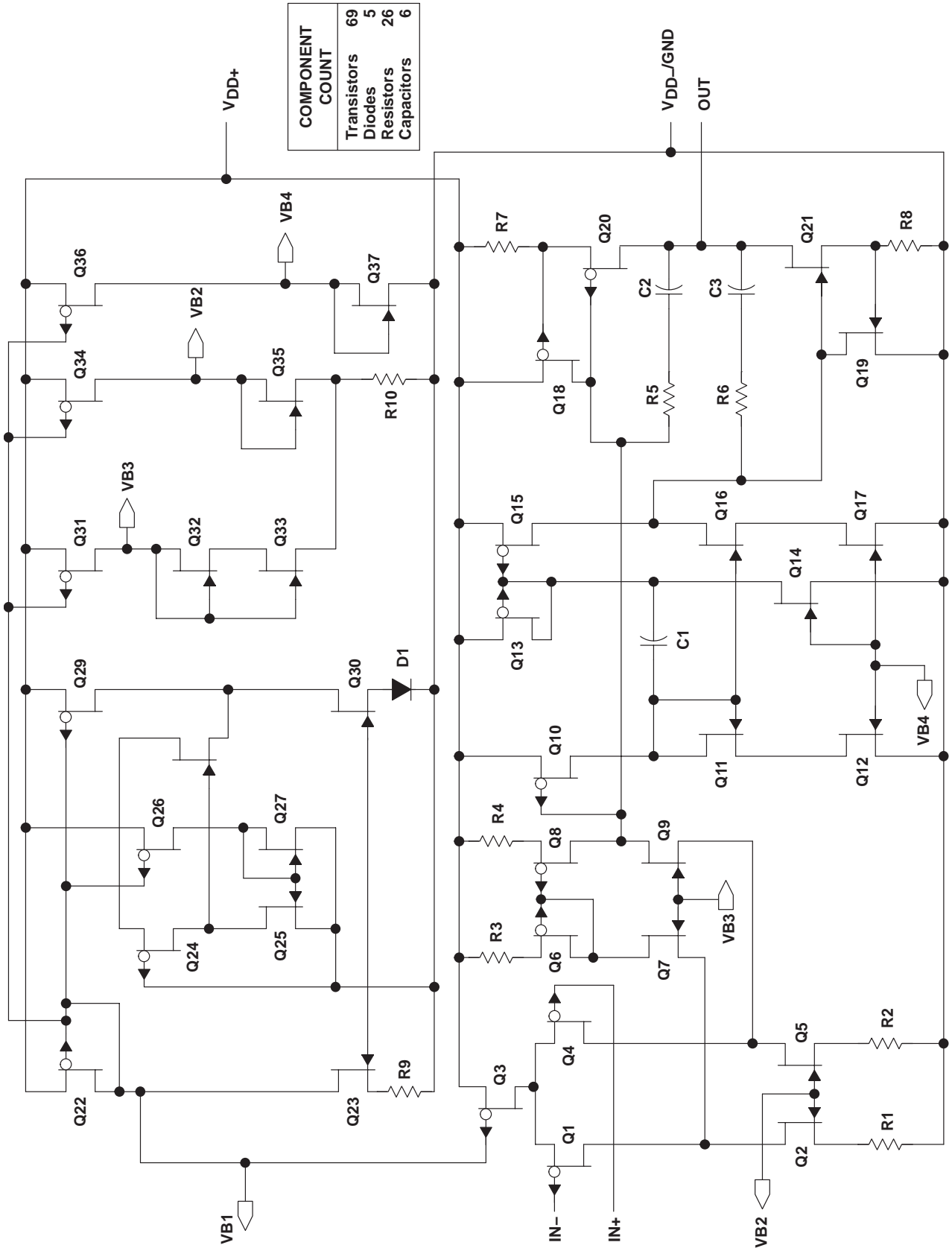
§ Product Preview.



TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1
 Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
 WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182 – SEPTEMBER 2003

equivalent schematic (each amplifier)



COMPONENT COUNT	
Transistors	69
Diodes	5
Resistors	26
Capacitors	6

TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182 – SEPTEMBER 2003

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 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 dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A : Q suffix	-40°C to 125°C
Storage temperature range, T_{stg}	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	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 the midpoint between V_{DD+} and V_{DD-} .
 2. Differential voltages are at $IN+$ with respect to $IN-$. Excessive current flows if 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	$T_A = 125^\circ\text{C}$ POWER RATING
D (8)	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
D (14)	1022 mW	7.6 mW/°C	900 mW	777 mW	450 mW
PW (8)	525 mW	4.2 mW/°C	336 mW	273 mW	105 mW
PW (14)	720 mW	5.6 mW/°C	634 mW	547 mW	317 mW

recommended operating conditions

	MIN	MAX	UNIT
Supply voltage, V_{DD}	2.7	10	V
Input voltage range, V_I	V_{DD-}	$V_{DD+} - 0.8$	V
Common-mode input voltage, V_{IC}	V_{DD-}	$V_{DD+} - 0.8$	V
Operating free-air temperature, T_A	-40	125	°C



TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182 – SEPTEMBER 2003

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

PARAMETER	TEST CONDITIONS		T_A †	TLV243x-Q1			UNIT
				MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0,$ $V_O = 0,$ $V_{DD} \pm \pm 1.5\text{ V},$ $R_S = 50\ \Omega$	TLV243x	25°C	300	2000	μV	
			Full range	2500			
		TLV243xA	25°C	300	950		
			Full range	2000			
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage	$V_{IC} = 0,$ $V_O = 0,$ $V_{DD} \pm \pm 1.5\text{ V},$ $R_S = 50\ \Omega$		25°C to 70°C	2		$\mu\text{V}/^\circ\text{C}$	
Input offset voltage long-term drift (see Note 4)			25°C	0.003		$\mu\text{V}/\text{mo}$	
I_{IO} Input offset current			25°C	0.5		pA	
			Full range	150			
I_{IB} Input bias current			25°C	1		pA	
			Full range	300			
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV},$ $R_S = 50\ \Omega$		25°C	0 to 2.5	-0.25 to 2.75	V	
			Full range	0 to 2.2			
V_{OH} High-level output voltage			25°C	$I_{OH} = -100\ \mu\text{A}$ 2.98		V	
			25°C	$I_{OH} = -3\text{ mA}$ 2.5			
			Full range	2.25			
V_{OL} Low-level output voltage	$V_{IC} = 1.5\text{ V},$ $V_{IC} = 1.5\text{ V},$	$I_{OL} = 100\ \mu\text{A}$ $I_{OL} = 3\text{ mA}$	25°C	0.02		V	
			25°C	0.83			
			Full range	1			
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }2\text{ V}$	$R_L = 2\text{ k}\Omega^\ddagger$	25°C	1.5	2.5	V/mV	
			Full range	0.5			
		$R_L = 1\text{ M}\Omega^\ddagger$	25°C	750			
$r_{i(d)}$ Differential input resistance			25°C	1000		G Ω	
$r_{i(c)}$ Common-mode input resistance			25°C	1000		G Ω	
$c_{i(c)}$ Common-mode input capacitance	$f = 10\text{ kHz}$		25°C	8		pF	
z_o Closed-loop output impedance	$f = 100\text{ kHz},$ $A_V = 10$		25°C	130		Ω	
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR}\text{ MIN},$ $V_O = 1.5\text{ V},$ $R_S = 50\ \Omega$		25°C	70	83	dB	
			Full range	70			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 2.7\text{ V to }8\text{ V},$ $V_{IC} = V_{DD}/2,$ No load		25°C	80	95	dB	
			Full range	80			
I_{DD} Supply current	$V_O = 1.5\text{ V},$ No load		25°C	195	250	μA	
			Full range	260			

† Full range is -40°C to 125°C for Q level part.

‡ Referenced to 2.5 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.



TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182 – SEPTEMBER 2003

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

PARAMETER	TEST CONDITIONS	T_A^\dagger	TLV243x-Q1, TLV243xA-Q1			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 1\text{ V to }2\text{ V},$ $C_L = 100\text{ pF}^\ddagger$ $R_L = 2\text{ k}\Omega^\ddagger$	25°C	0.15	0.25		V/ μ s
		Full range	0.1			
V_n Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C		120		nV/ $\sqrt{\text{Hz}}$
	$f = 1\text{ kHz}$	25°C		22		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$	25°C		2.7		μ V
	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		4		
I_n Equivalent input noise current		25°C		0.6		fA/ $\sqrt{\text{Hz}}$
THD + N Total harmonic distortion plus noise	$V_O = 0.5\text{ V to }2.5\text{ V},$ $f = 1\text{ kHz},$ $R_L = 2\text{ k}\Omega^\ddagger$	$A_V = 1$	0.065%			
		$A_V = 10$	0.5%			
Gain-bandwidth product	$f = 10\text{ kHz},$ $C_L = 100\text{ pF}^\ddagger$ $R_L = 2\text{ k}\Omega^\ddagger$	25°C		0.5		MHz
BOM Maximum output-swing bandwidth	$V_{O(PP)} = 1\text{ V},$ $R_L = 2\text{ k}\Omega^\ddagger$ $A_V = 1,$ $C_L = 100\text{ pF}^\ddagger$	25°C		220		kHz
t_s Settling time	$A_V = -1,$ Step = 0.5 V to 2.5 V, $R_L = 2\text{ k}\Omega^\ddagger,$ $C_L = 100\text{ pF}^\ddagger$	$T_o = 0.1\%$	6.4			μ s
		$T_o = 0.01\%$	14.1			
ϕ_m Phase margin at unity gain		25°C		62°		
Gain margin	$R_L = 2\text{ k}\Omega^\ddagger$ $C_L = 100\text{ pF}^\ddagger$	25°C		11		dB

† Full range is -40°C to 125°C for Q level part.

‡ Referenced to 2.5 V

TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182 – SEPTEMBER 2003

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

PARAMETER	TEST CONDITIONS		T_A^\dagger	TLV243x-Q1			UNIT
				MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = 0,$ $V_O = 0,$ $V_{DD} \pm = \pm 2.5\text{ V},$ $R_S = 50\ \Omega$	TLV243x	25°C	300	2000	μV	
			Full range	2500			
		TLV243xA	25°C	300	950		
			Full range	2000			
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage	$V_{IC} = 0,$ $V_O = 0,$ $V_{DD} \pm = \pm 2.5\text{ V},$ $R_S = 50\ \Omega$		25°C to 70°C	2		$\mu\text{V}/^\circ\text{C}$	
Input offset voltage long-term drift (see Note 4)			25°C	0.003		$\mu\text{V}/\text{mo}$	
I_{IO} Input offset current			25°C	0.5		pA	
			Full range	150			
I_{IB} Input bias current			25°C	1		pA	
			Full range	300			
V_{ICR} Common-mode input voltage range	$ V_{IO} \leq 5\text{ mV},$ $R_S = 50\ \Omega$		25°C	0 to 4.5	-0.25 to 4.75	V	
			Full range	0 to 4.2			
V_{OH} High-level output voltage	$I_{OH} = -100\ \mu\text{A}$ $I_{OH} = -5\text{ mA}$		25°C	4.97		V	
			25°C	4	4.35		
			Full range	4			
V_{OL} Low-level output voltage	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 100\ \mu\text{A}$		25°C	0.01		V	
			25°C	0.8			
	$V_{IC} = 2.5\text{ V},$ $I_{OL} = 5\text{ mA}$	Full range	1.25				
A_{VD} Large-signal differential voltage amplification	$V_{IC} = 2.5\text{ V},$ $V_O = 1\text{ V to }4\text{ V}$	$R_L = 2\text{ k}\Omega^\ddagger$	25°C	2.5	3.8	V/mV	
			Full range	0.5			
		$R_L = 1\text{ M}\Omega^\ddagger$	25°C	950			
$r_{i(d)}$ Differential input resistance			25°C	1000		G Ω	
$r_{i(c)}$ Common-mode input resistance			25°C	1000		G Ω	
$c_{i(c)}$ Common-mode input capacitance	$f = 10\text{ kHz}$		25°C	8		pF	
z_o Closed-loop output impedance	$f = 100\text{ kHz},$ $A_V = 10$		25°C	130		Ω	
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR}\text{ MIN},$ $V_O = 2.5\text{ V},$ $R_S = 50\ \Omega$		25°C	70	90	dB	
			Full range	70			
k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	$V_{DD} = 4.4\text{ V to }8\text{ V},$ $V_{IC} = V_{DD}/2,$ No load		25°C	80	95	dB	
			Full range	80			
I_{DD} Supply current	$V_O = 2.5\text{ V},$ No load		25°C	200	250	μA	
			Full range	270			

† Full range is -40°C to 125°C for Q level part.

‡ Referenced to 2.5 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.



TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182 – SEPTEMBER 2003

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

PARAMETER	TEST CONDITIONS	T_A †	TLV243x-Q1, TLV243xA-Q1			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$V_O = 1.5\text{ V to }3.5\text{ V},$ $R_L = 2\text{ k}\Omega^\ddagger,$ $C_L = 100\text{ pF}^\ddagger$	25°C	0.15	0.25		V/ μ s
		Full range	0.1			
V_n Equivalent input noise voltage	$f = 10\text{ Hz}$	25°C	100		nV/ $\sqrt{\text{Hz}}$	
	$f = 1\text{ kHz}$	25°C	18			
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }1\text{ Hz}$	25°C	1.9		μ V	
	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C	2.8			
I_n Equivalent input noise current		25°C	0.6		fA/ $\sqrt{\text{Hz}}$	
THD + N Total harmonic distortion plus noise	$V_O = 1.5\text{ V to }3.5\text{ V},$ $f = 1\text{ kHz},$ $R_L = 2\text{ k}\Omega^\ddagger$	$A_V = 1$	0.045%			
		$A_V = 10$	0.4%			
Gain-bandwidth product	$f = 10\text{ kHz},$ $C_L = 100\text{ pF}^\ddagger$	$R_L = 2\text{ k}\Omega^\ddagger,$ 25°C	0.55		MHz	
BOM Maximum output-swing bandwidth	$V_{O(PP)} = 2\text{ V},$ $R_L = 2\text{ k}\Omega^\ddagger,$	$A_V = 1,$ $C_L = 100\text{ pF}^\ddagger$ 25°C	100		kHz	
t_s Settling time	$A_V = -1,$ Step = 1.5 V to 3.5 V, $R_L = 2\text{ k}\Omega^\ddagger,$ $C_L = 100\text{ pF}^\ddagger$	$T_o = 0.1\%$	6.4		μ s	
		$T_o = 0.01\%$	13.1			
ϕ_m Phase margin at unity gain	$R_L = 2\text{ k}\Omega^\ddagger,$ $C_L = 100\text{ pF}^\ddagger$	25°C	66°			
Gain margin		25°C	11		dB	

† Full range is -40°C to 125°C for Q level part.

‡ Referenced to 2.5 V

TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182 – SEPTEMBER 2003

TYPICAL CHARACTERISTICS

Table of Graphs

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

TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1
Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT
WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182 – SEPTEMBER 2003

TYPICAL CHARACTERISTICS

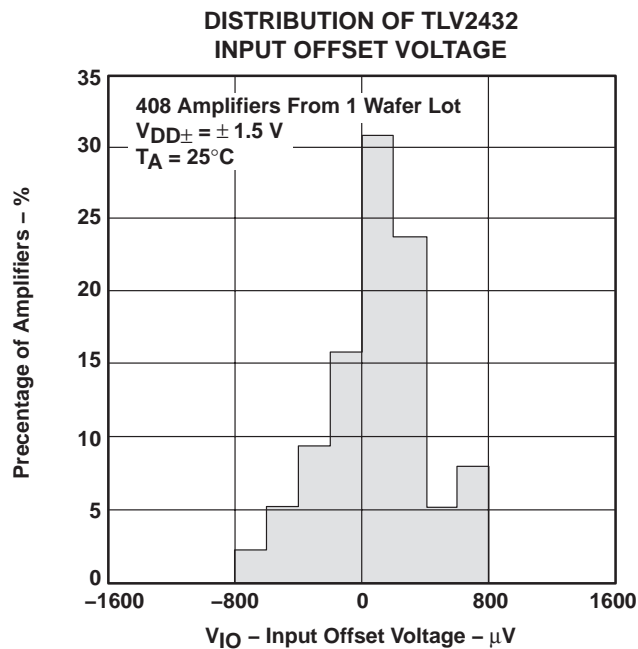


Figure 2

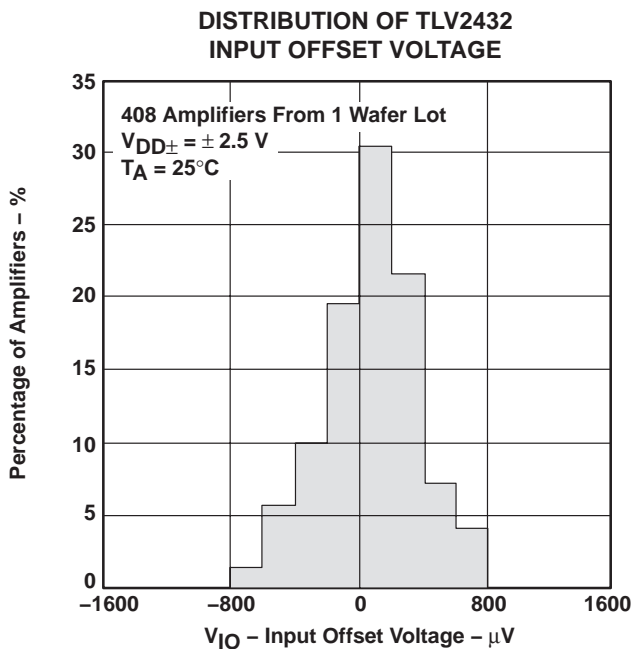


Figure 3

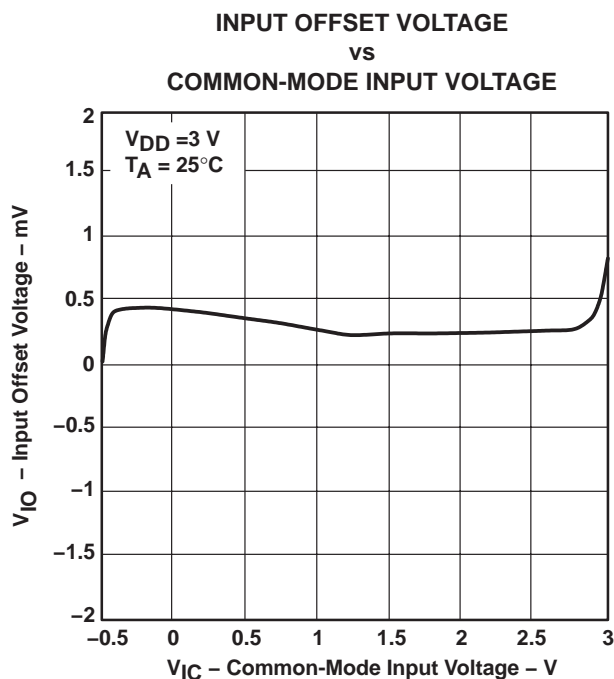


Figure 4

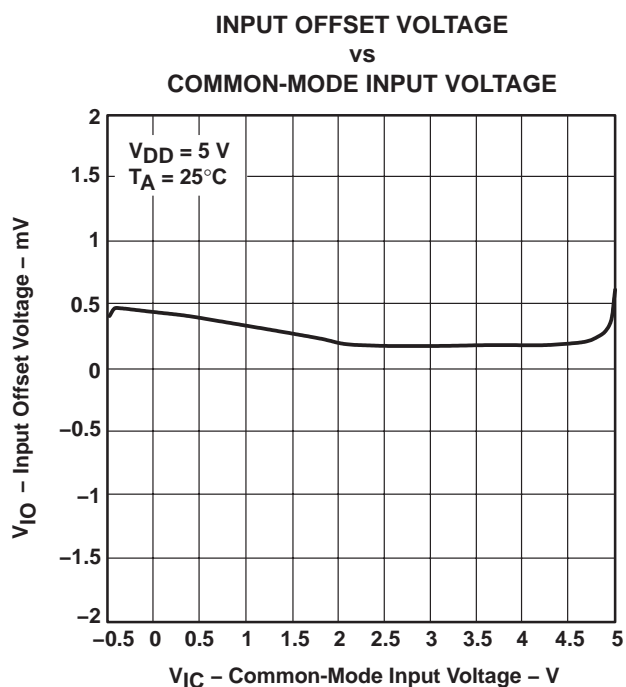


Figure 5



TYPICAL CHARACTERISTICS

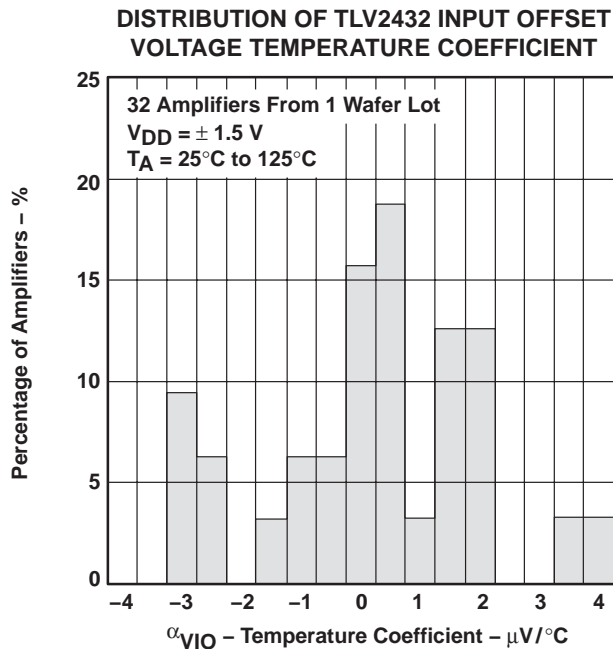


Figure 6

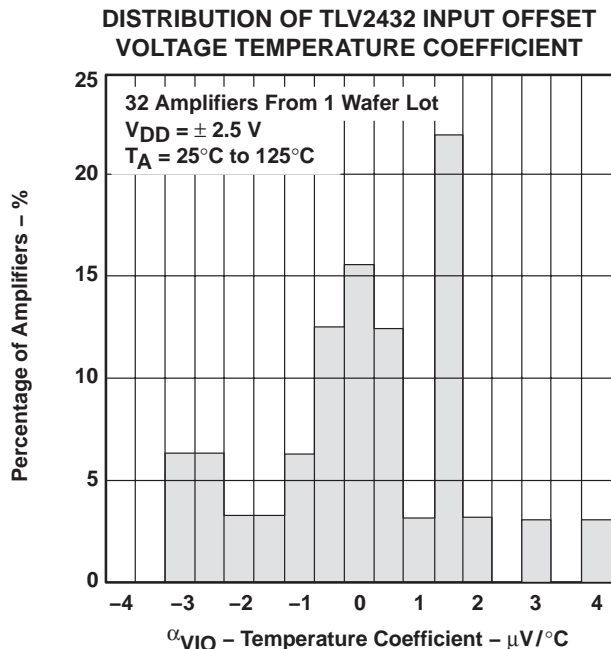


Figure 7

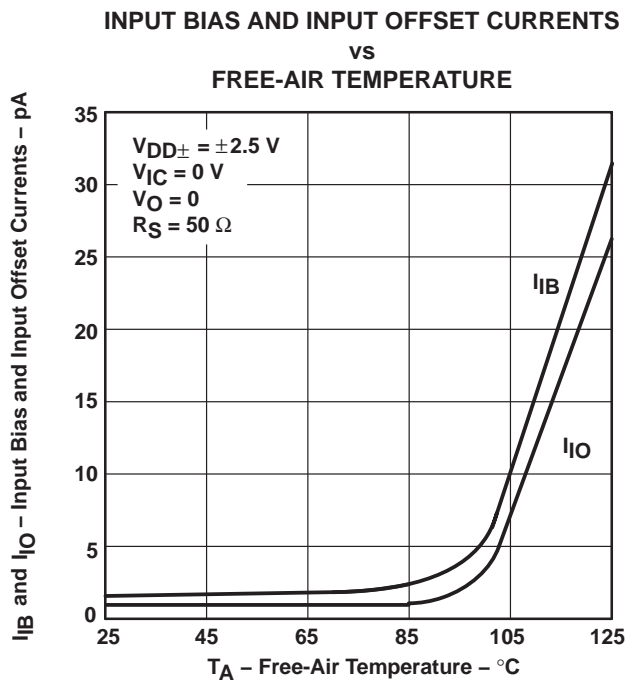


Figure 8

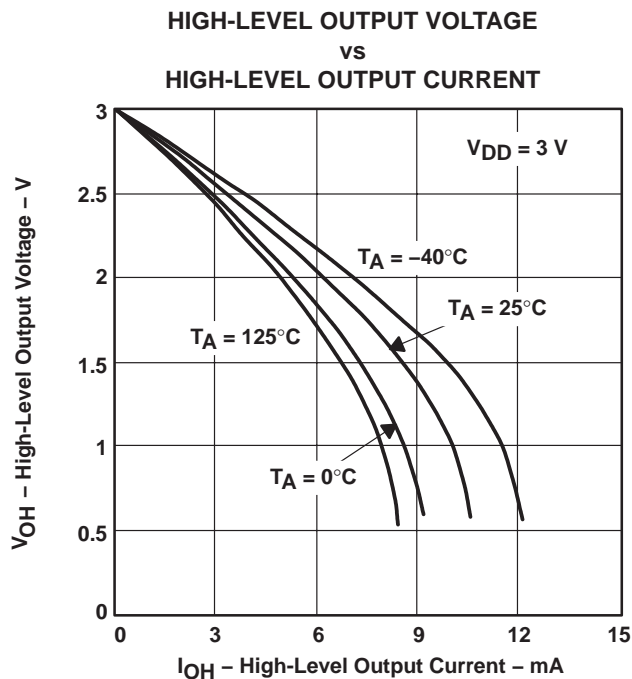


Figure 9

TYPICAL CHARACTERISTICS

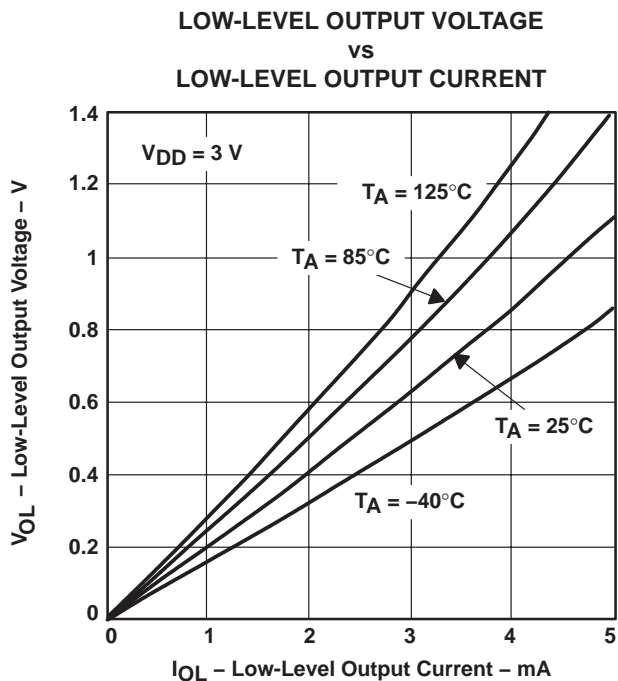


Figure 10

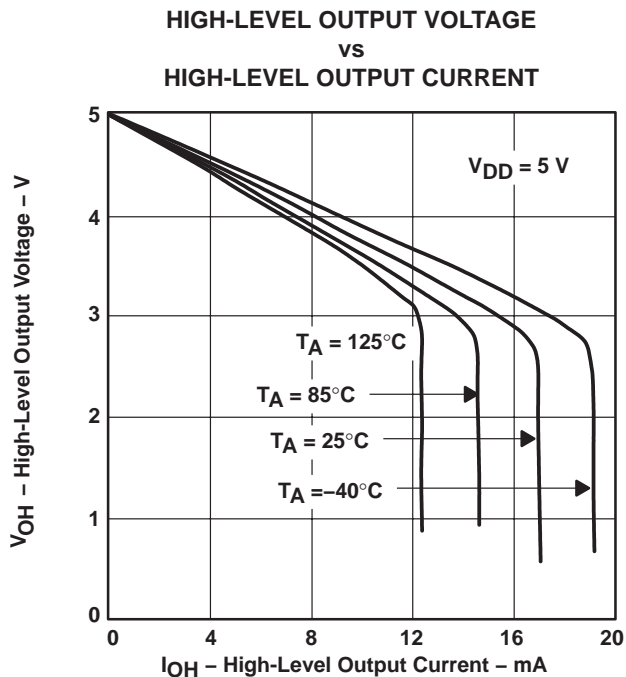


Figure 11

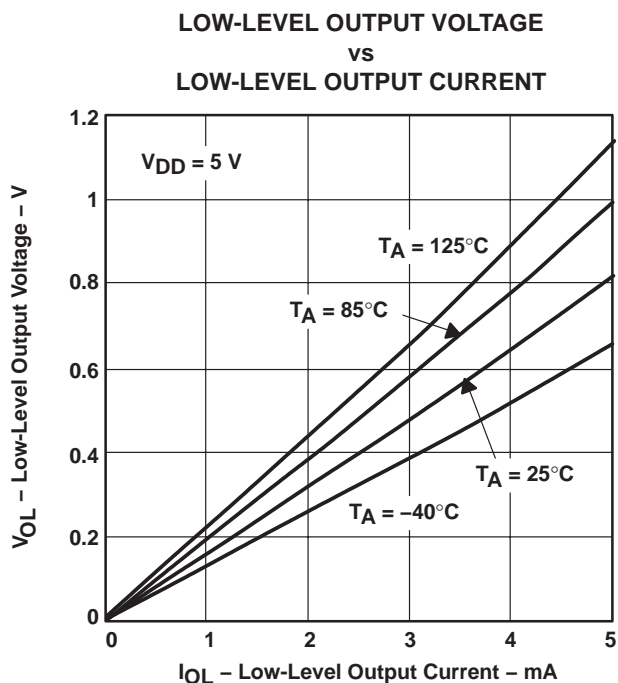


Figure 12

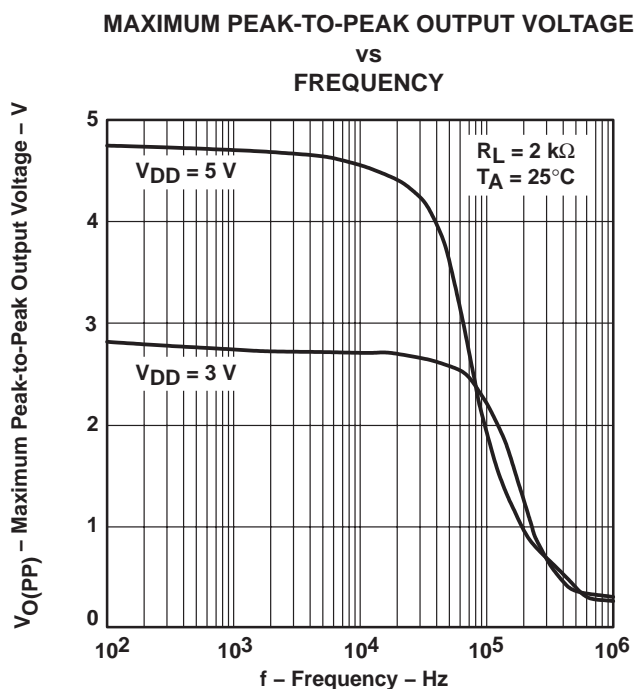


Figure 13

TYPICAL CHARACTERISTICS

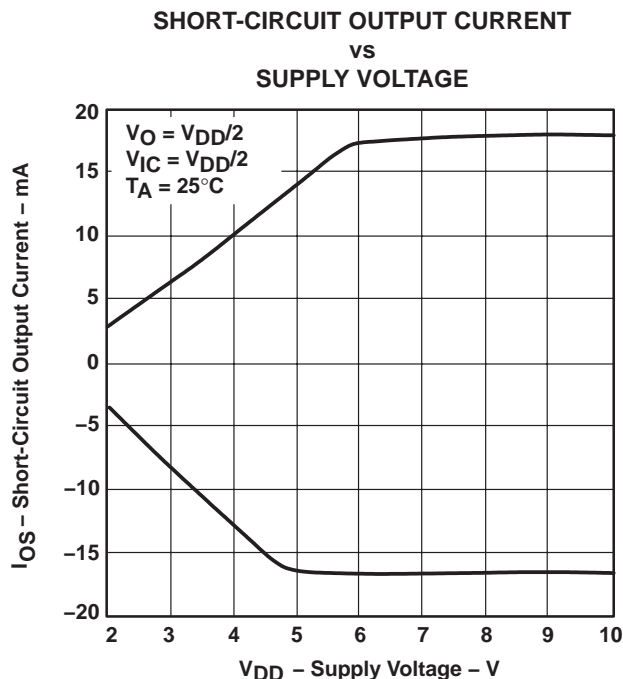


Figure 14

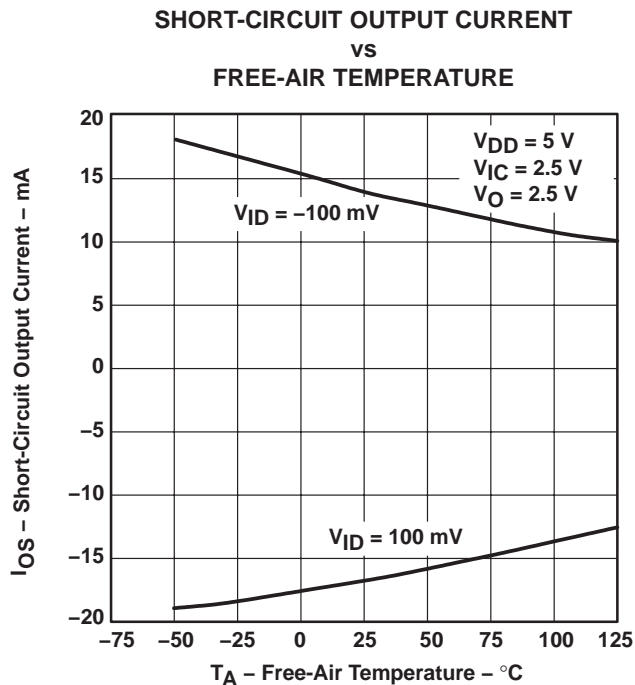


Figure 15

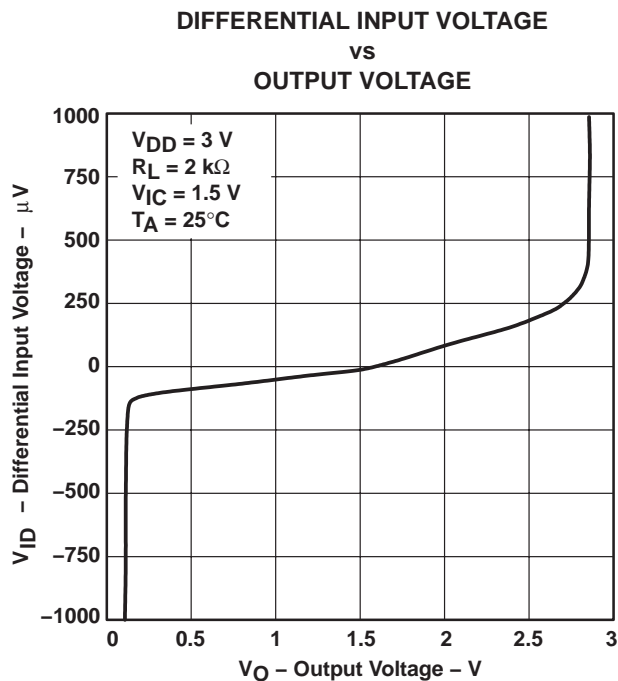


Figure 16

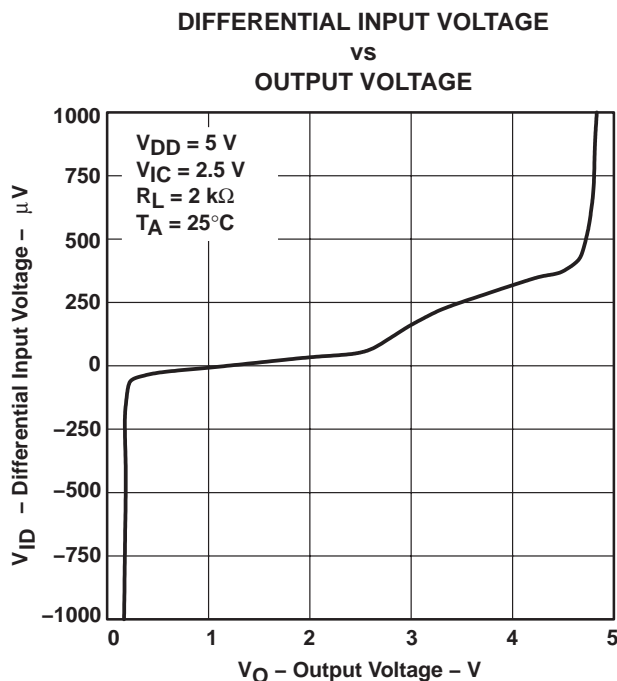


Figure 17

TYPICAL CHARACTERISTICS

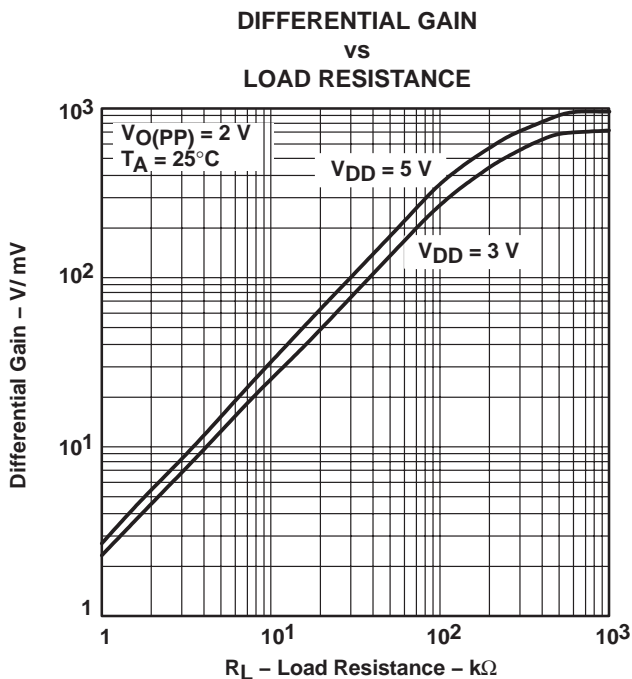


Figure 18

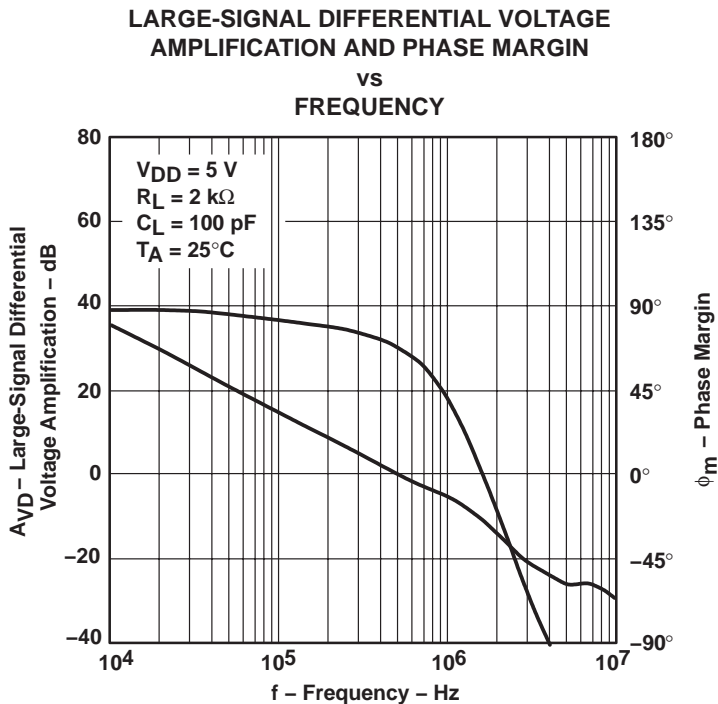


Figure 19

TYPICAL CHARACTERISTICS

LARGE-SIGNAL DIFFERENTIAL VOLTAGE
 AMPLIFICATION AND PHASE MARGIN

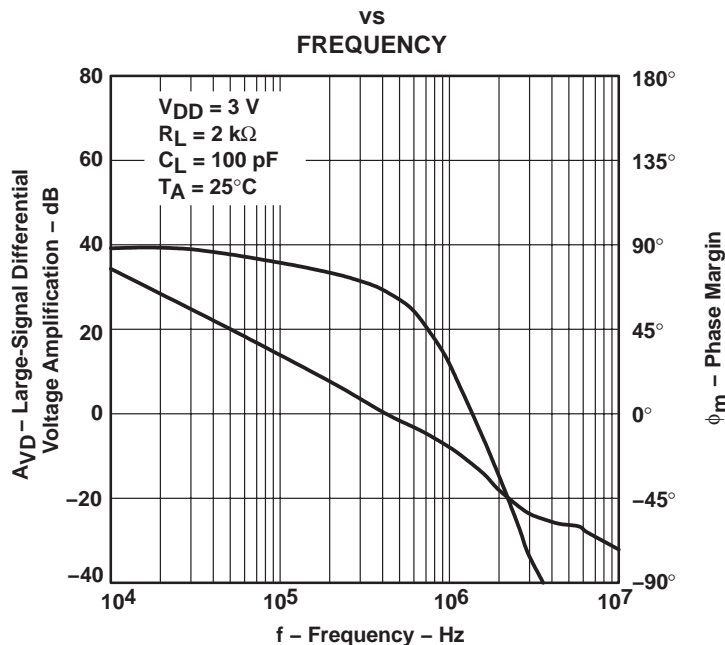


Figure 20

DIFFERENTIAL VOLTAGE AMPLIFICATION
 vs
 FREE-AIR TEMPERATURE

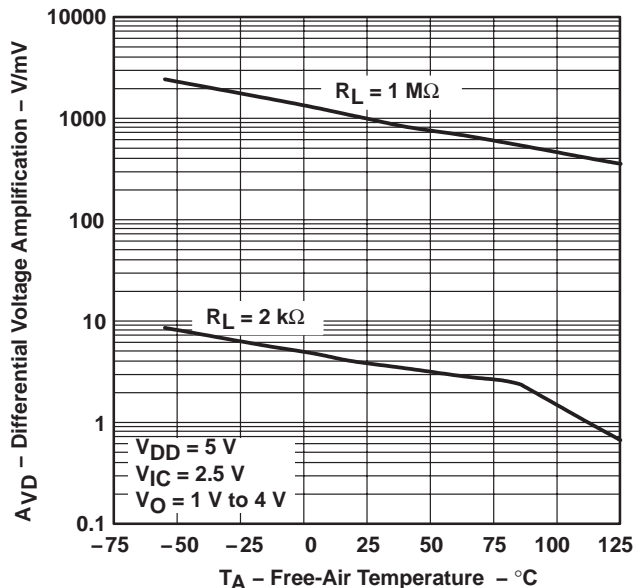


Figure 21

DIFFERENTIAL VOLTAGE AMPLIFICATION
 vs
 FREE-AIR TEMPERATURE

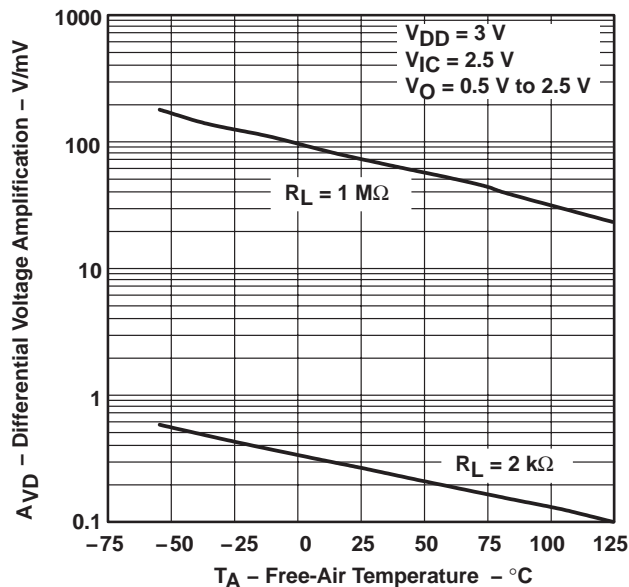


Figure 22

TYPICAL CHARACTERISTICS

**OUTPUT IMPEDANCE
 VS
 FREQUENCY**

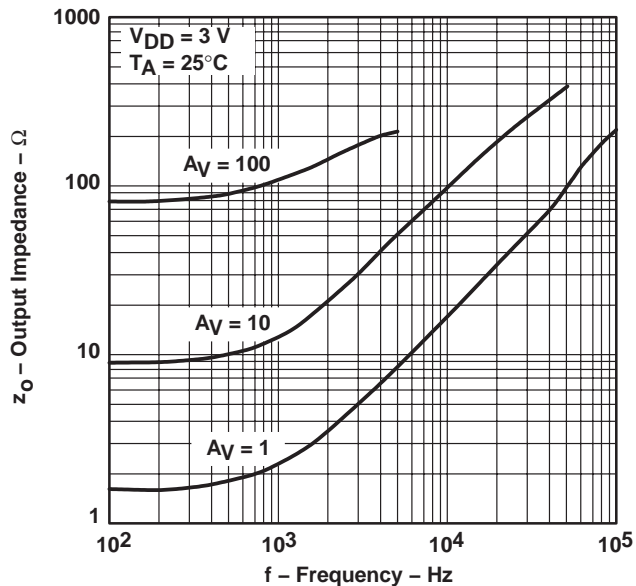


Figure 23

**OUTPUT IMPEDANCE
 VS
 FREQUENCY**

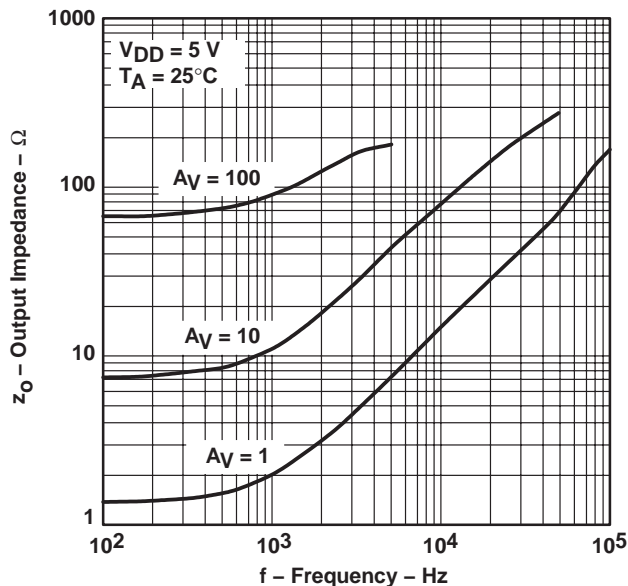


Figure 24

**COMMON-MODE REJECTION RATIO
 VS
 FREQUENCY**

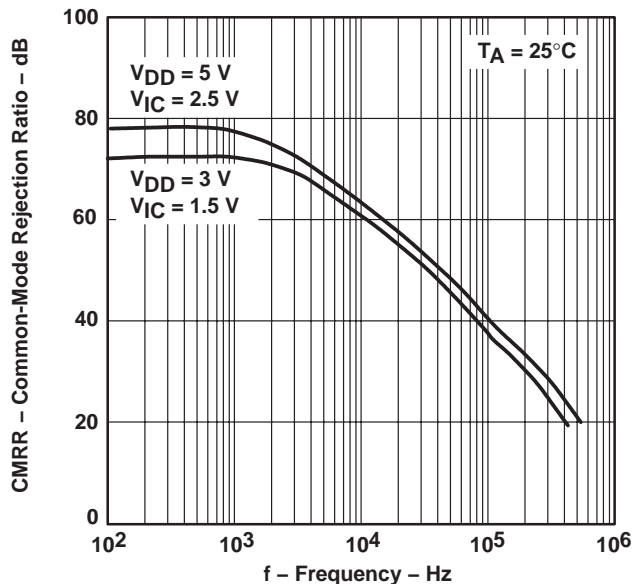


Figure 25

**COMMON-MODE REJECTION RATIO
 VS
 FREE-AIR TEMPERATURE**

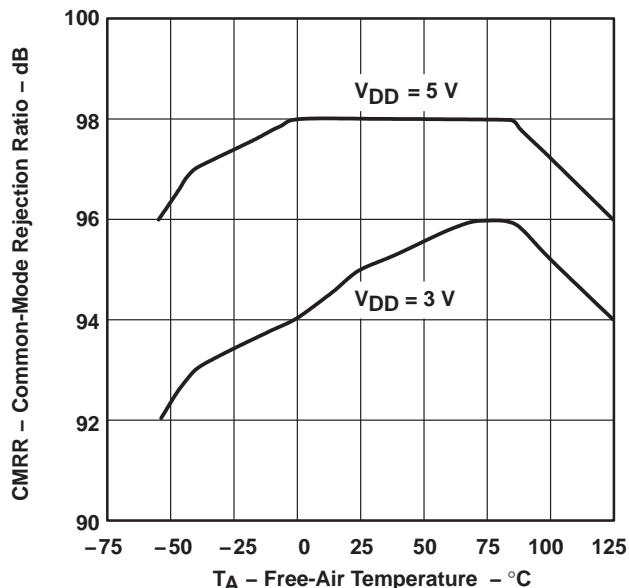


Figure 26

TYPICAL CHARACTERISTICS

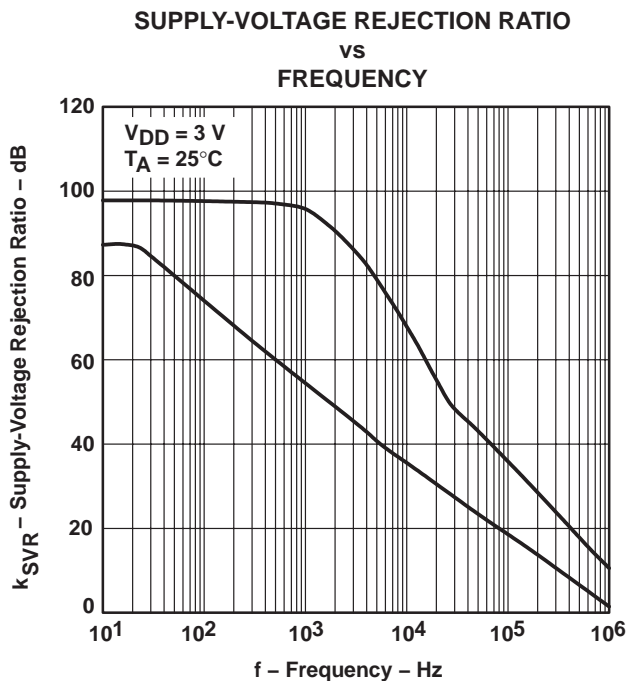


Figure 27

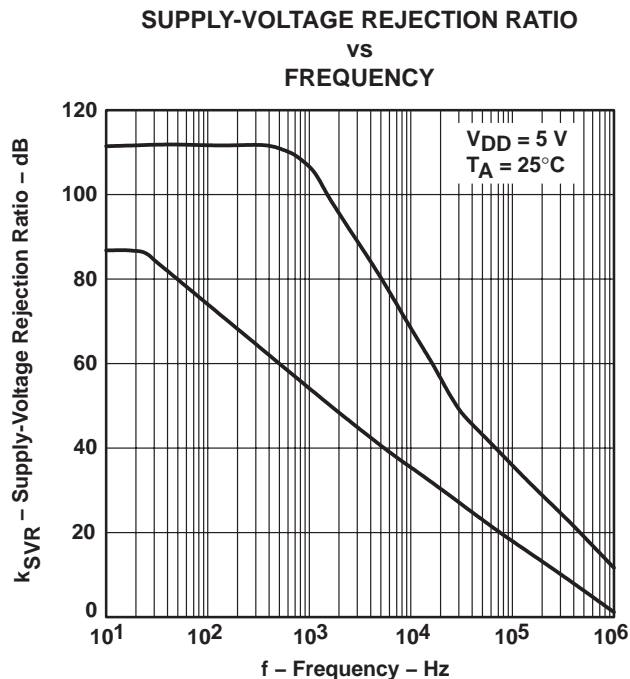


Figure 28

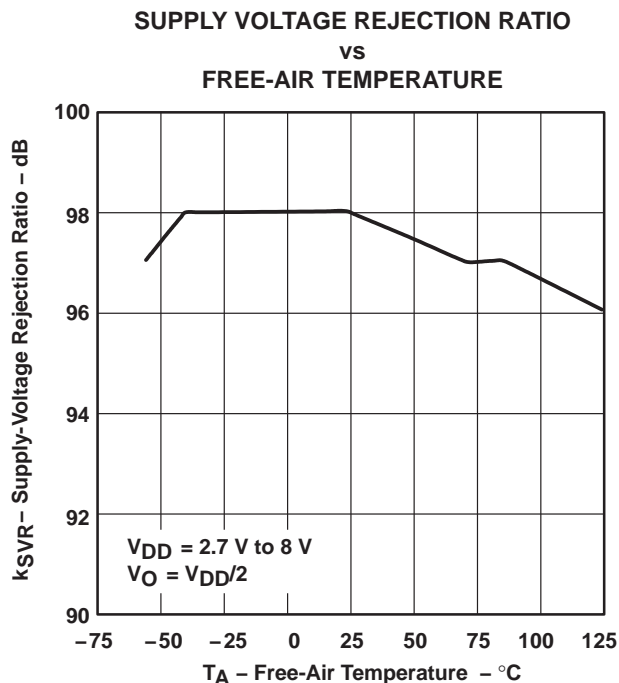


Figure 29

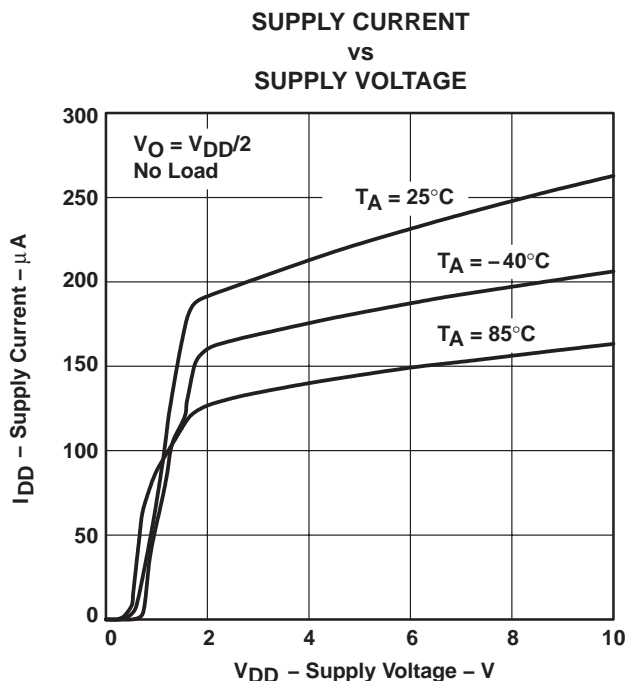


Figure 30

TYPICAL CHARACTERISTICS

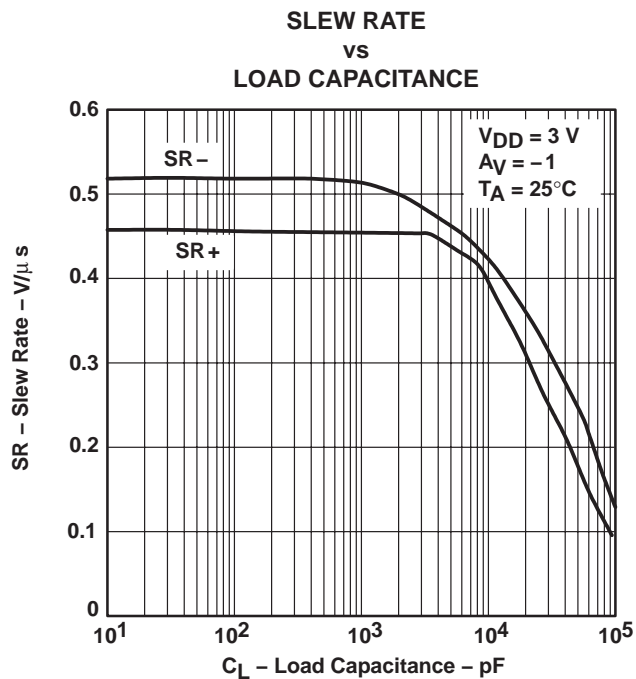


Figure 31

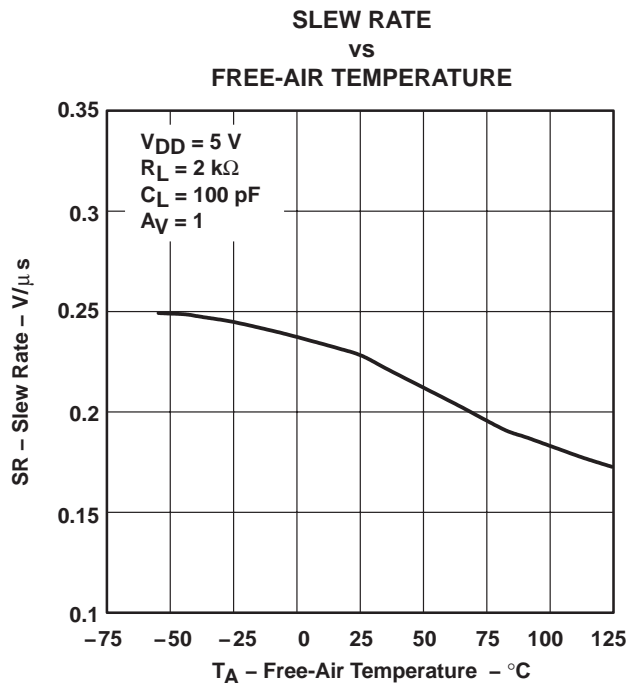


Figure 32

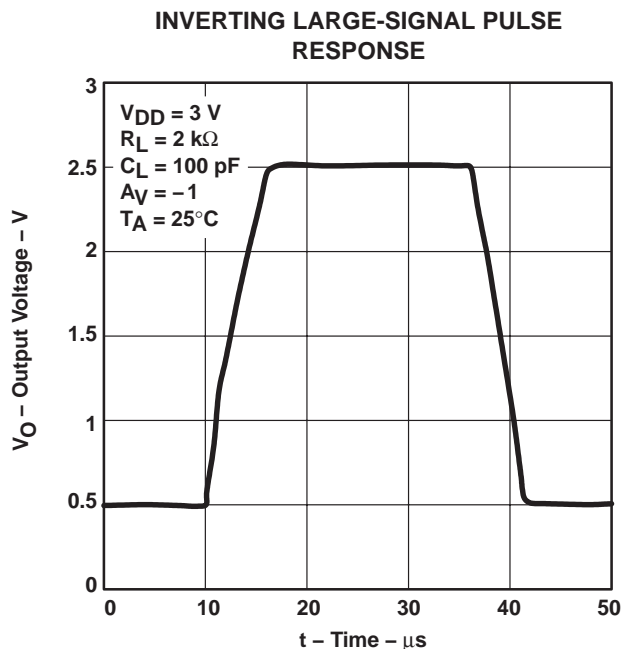


Figure 33

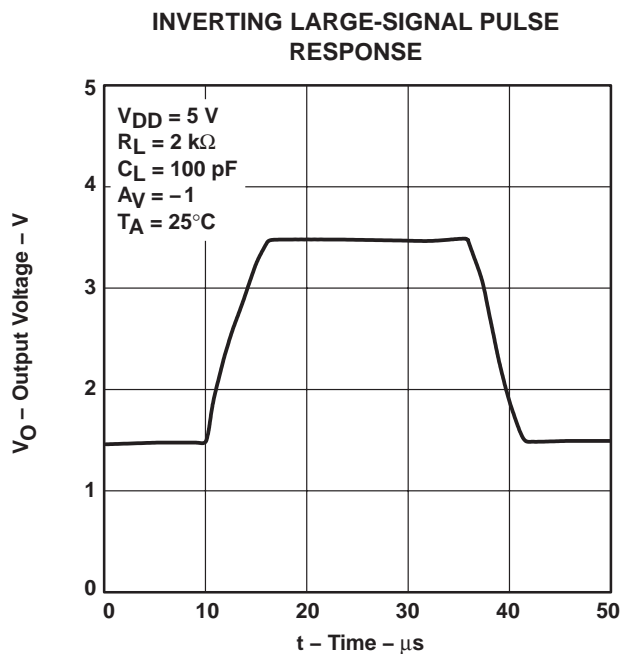


Figure 34

TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

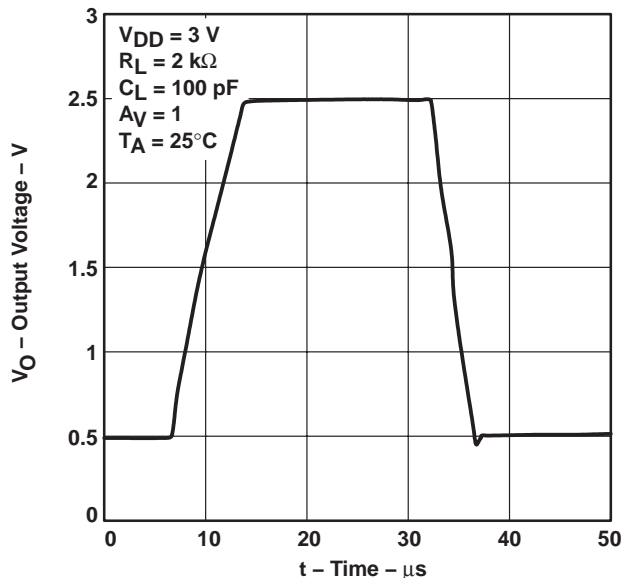


Figure 35

VOLTAGE-FOLLOWER LARGE-SIGNAL PULSE RESPONSE

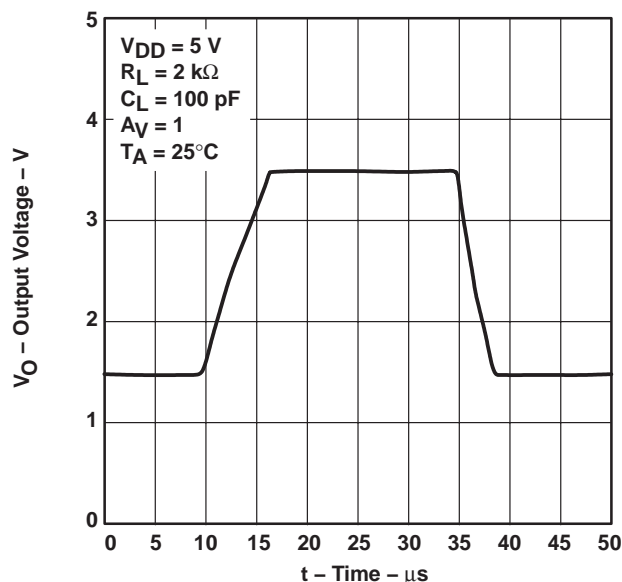


Figure 36

INVERTING SMALL-SIGNAL PULSE RESPONSE

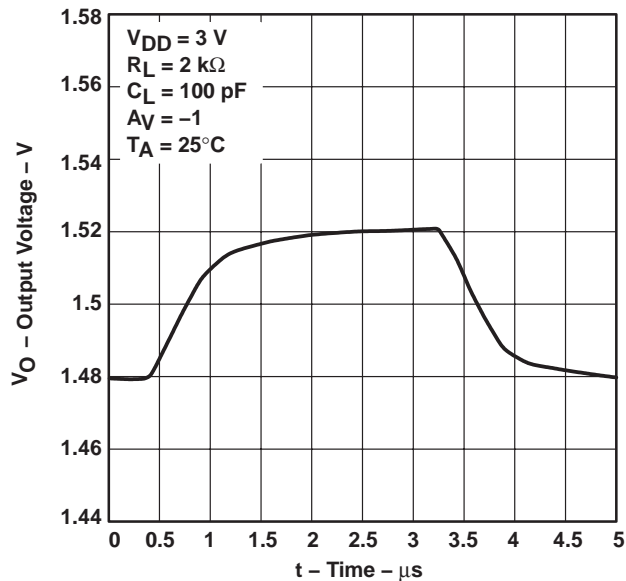


Figure 37

INVERTING SMALL-SIGNAL PULSE RESPONSE

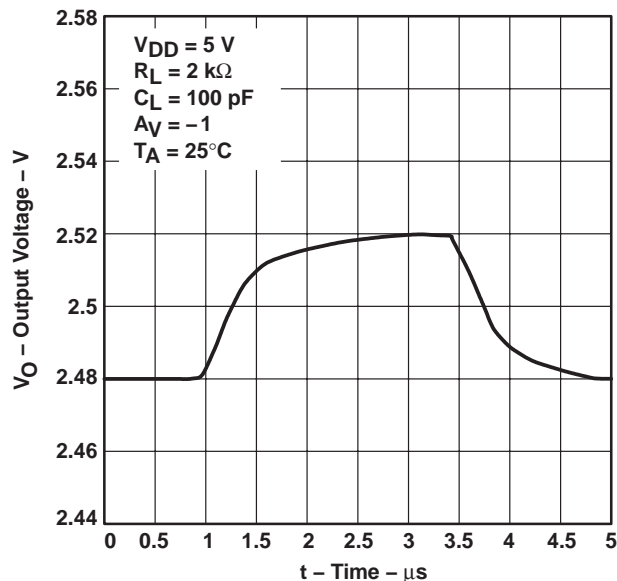


Figure 38

TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

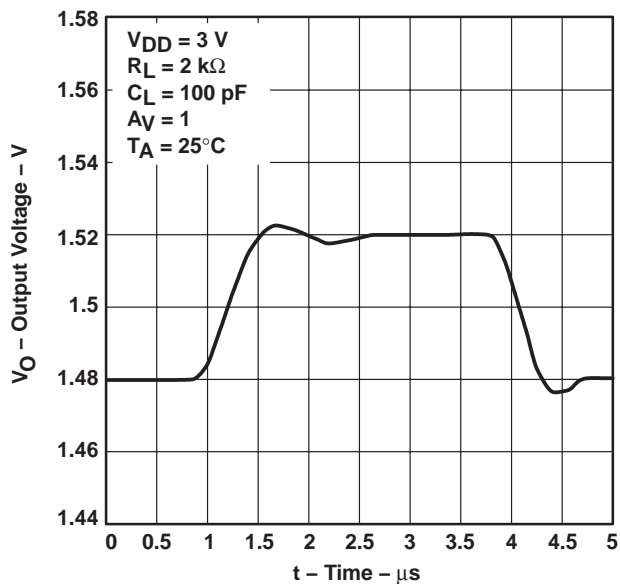


Figure 39

VOLTAGE-FOLLOWER SMALL-SIGNAL PULSE RESPONSE

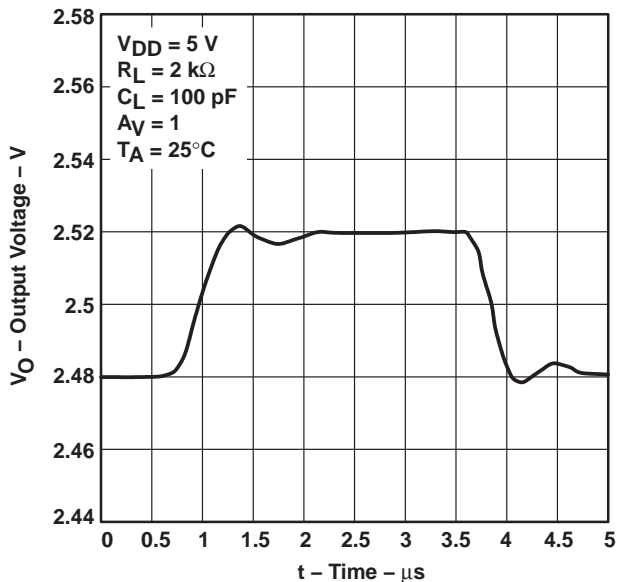


Figure 40

EQUIVALENT INPUT NOISE VOLTAGE VS FREQUENCY

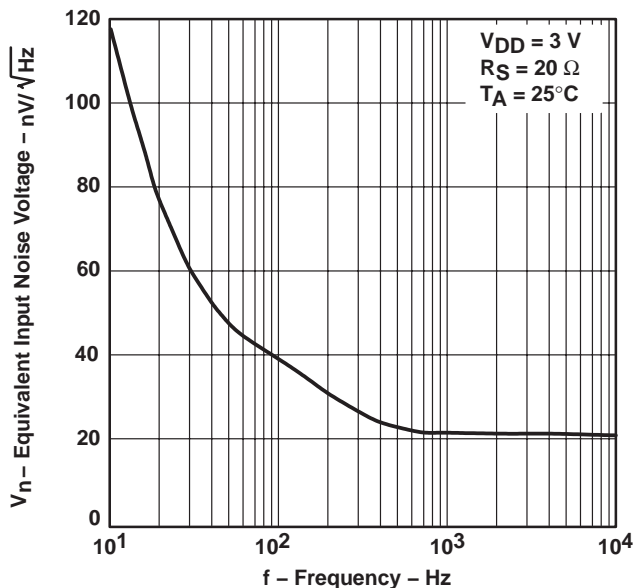


Figure 41

EQUIVALENT INPUT NOISE VOLTAGE VS FREQUENCY

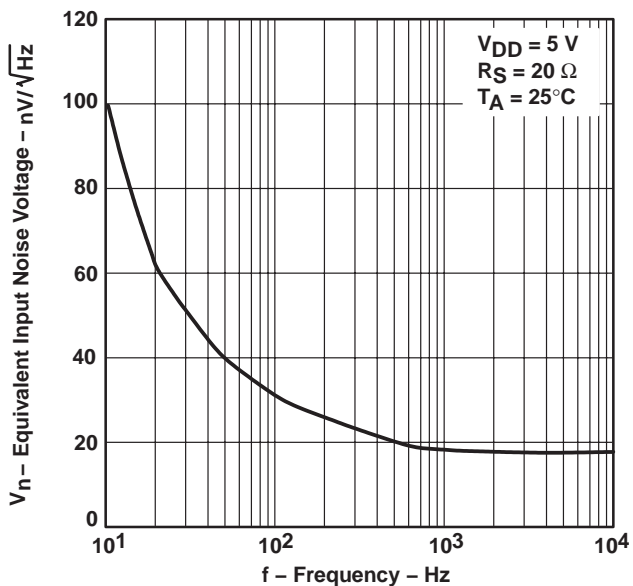


Figure 42

TYPICAL CHARACTERISTICS

NOISE VOLTAGE OVER A 10-SECOND PERIOD

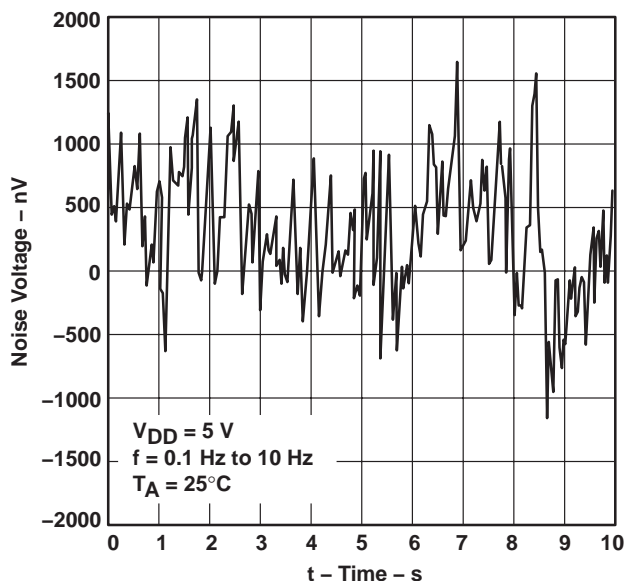


Figure 43

TOTAL HARMONIC DISTORTION PLUS NOISE
 VS
 FREQUENCY

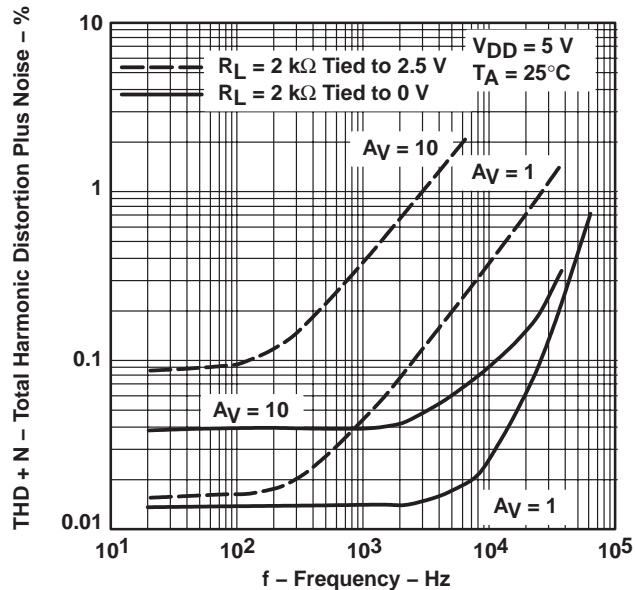


Figure 44

TOTAL HARMONIC DISTORTION PLUS NOISE
 VS
 FREQUENCY

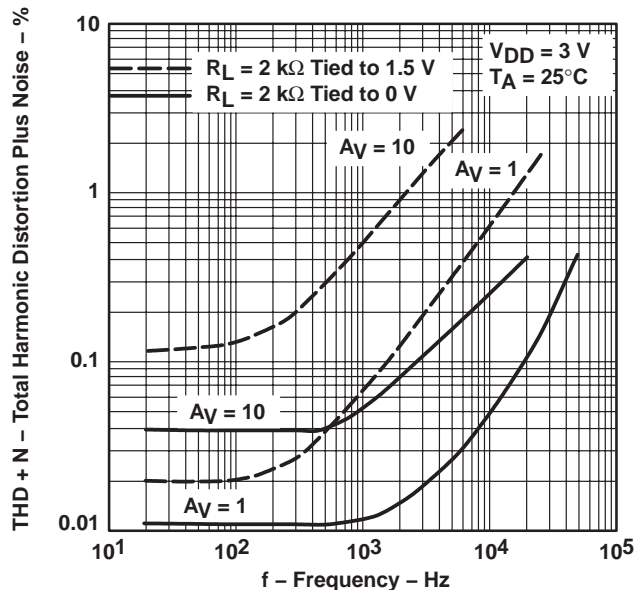


Figure 45

TYPICAL CHARACTERISTICS

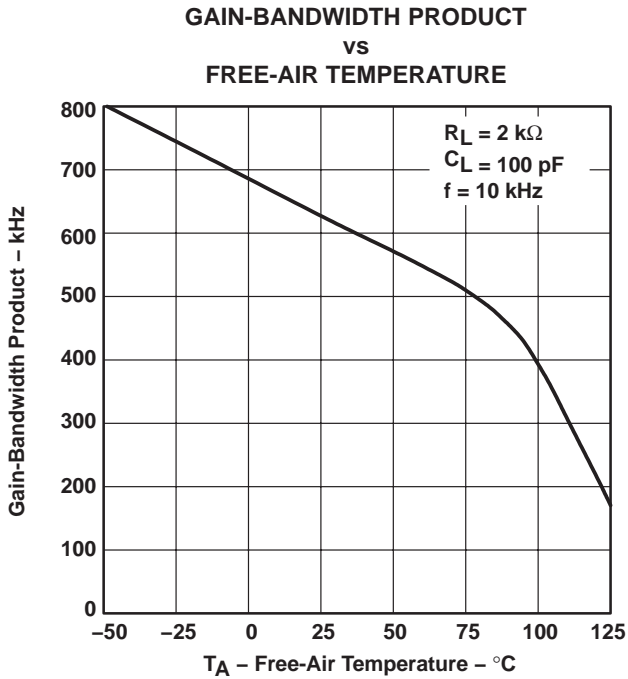


Figure 46

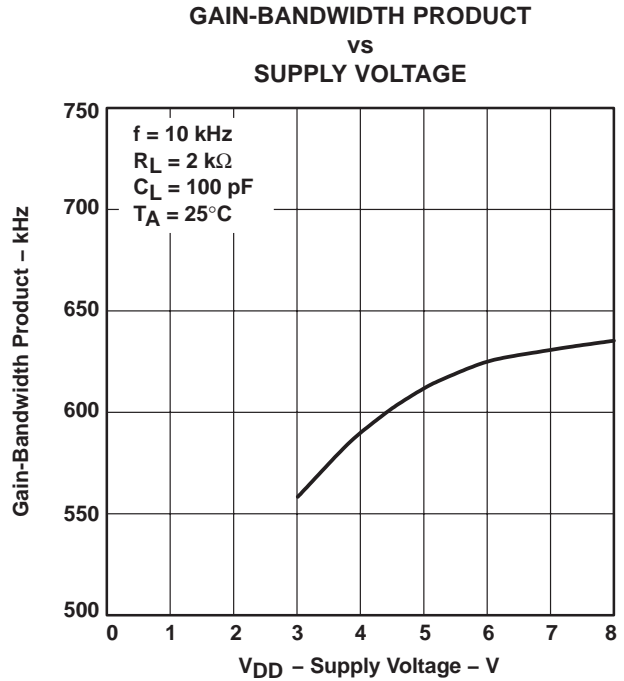


Figure 47

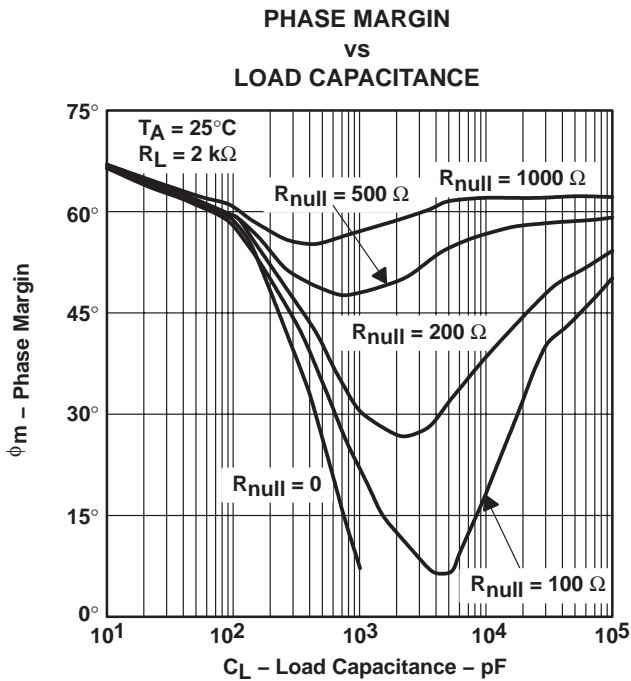


Figure 48

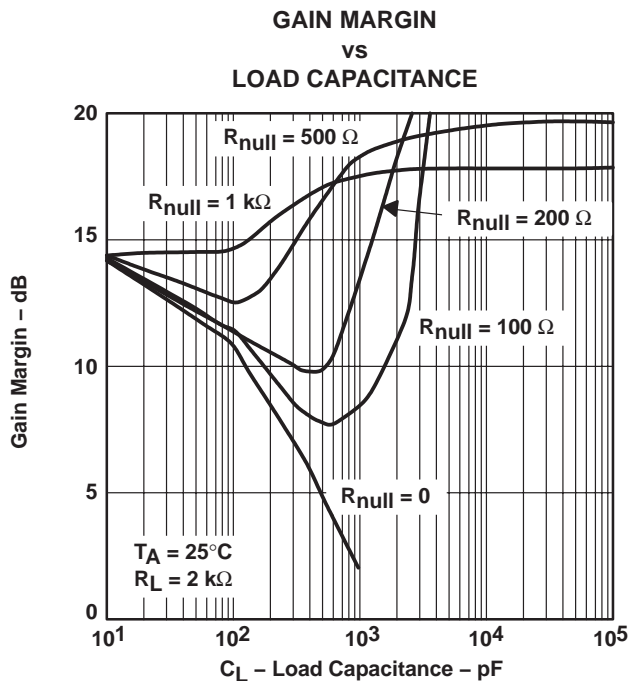


Figure 49

TYPICAL CHARACTERISTICS

UNITY-GAIN BANDWIDTH
vs
LOAD CAPACITANCE

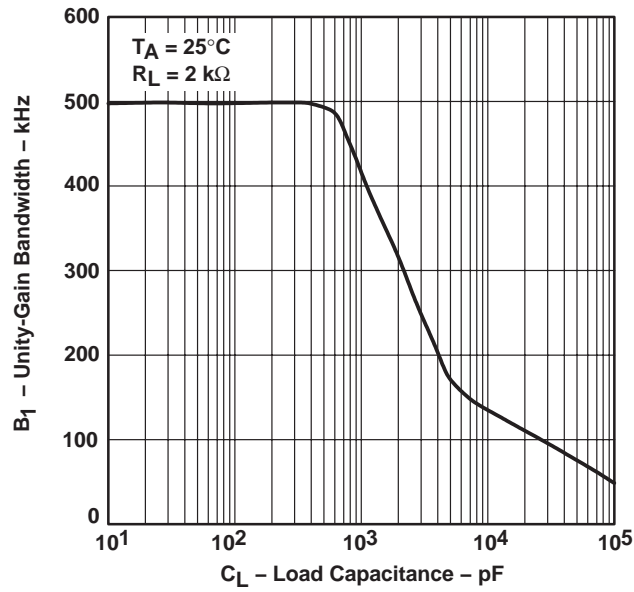


Figure 50

TLV2432-Q1, TLV2432A-Q1, TLV2434-Q1, TLV2434A-Q1

Advanced LinCMOS™ RAIL-TO-RAIL OUTPUT

WIDE-INPUT-VOLTAGE OPERATIONAL AMPLIFIERS

SGLS182 – SEPTEMBER 2003

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 5) and subcircuit in Figure 51 are generated using the TLV243x 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 4: 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).

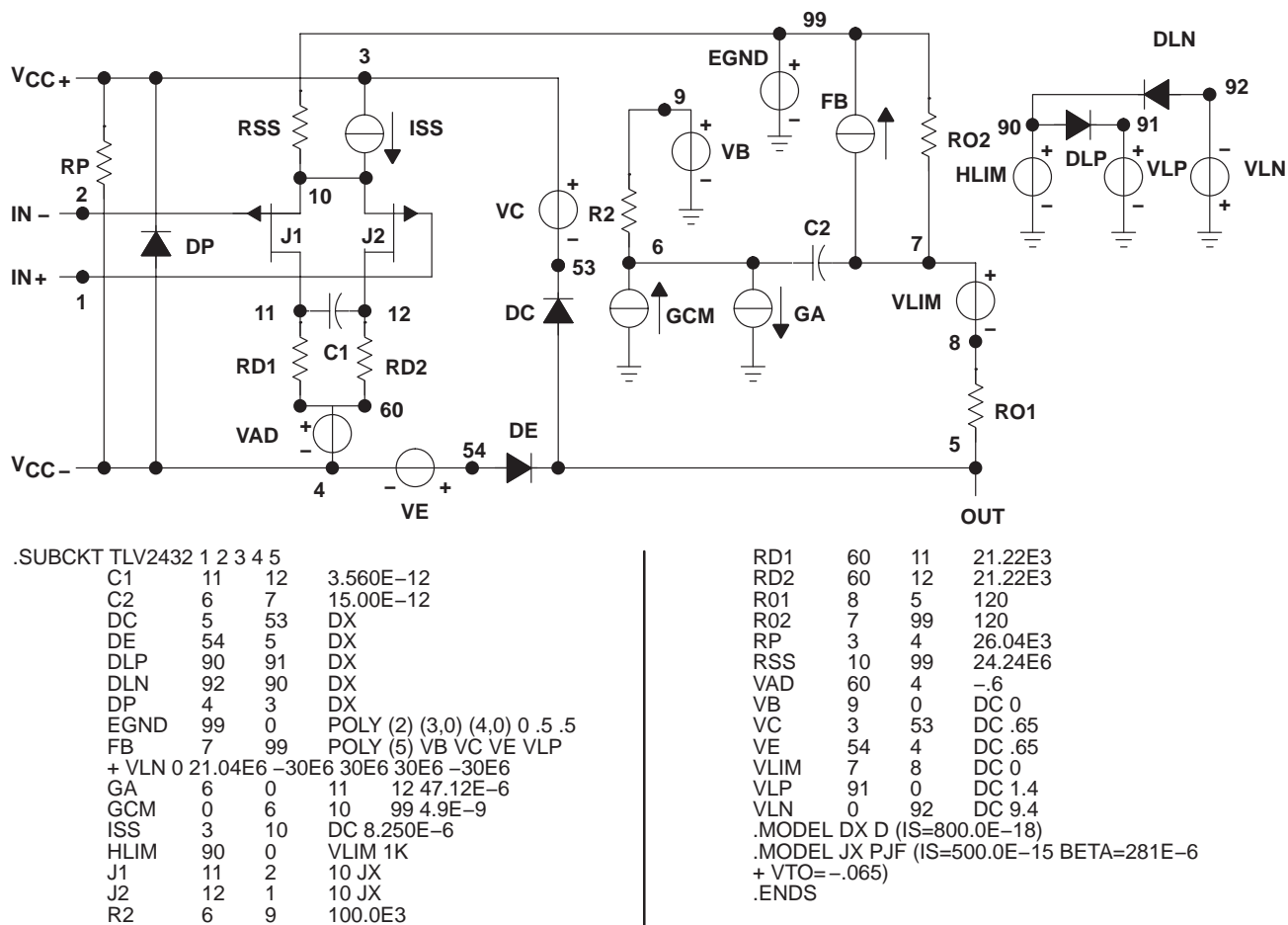


Figure 51. Boyle Macromodel and Subcircuit

PSpice and Parts are trademarks of MicroSim Corporation.



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TLV2432AQDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2432AQDRQ1	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
TLV2432QDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2432QDRQ1	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM

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

ACTIVE: Product device recommended for new designs.

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

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

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

OBSOLETE: TI has discontinued the production of the device.

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

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

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

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

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

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

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF TLV2432-Q1, TLV2432A-Q1 :

- Catalog: [TLV2432](#), [TLV2432A](#)
- Military: [TLV2432M](#), [TLV2432AM](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated