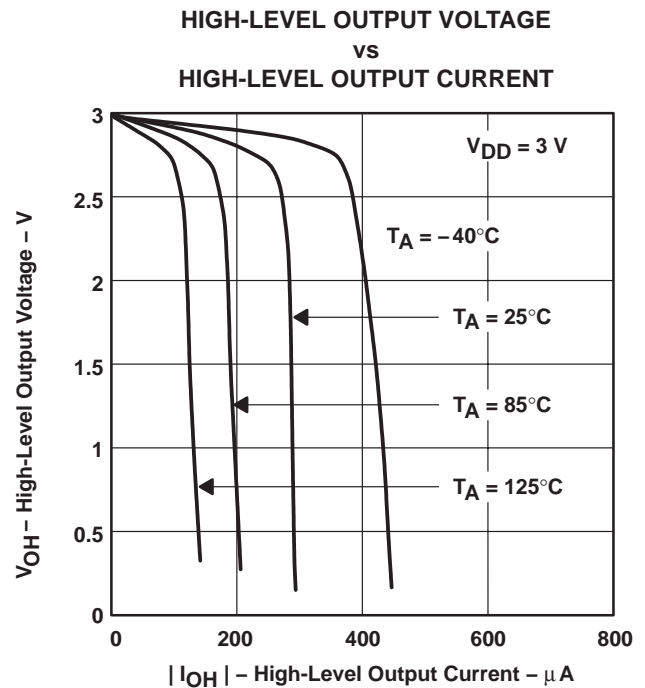- Qualified for Automotive Applications
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 150 V (TLV2252/52A) and 100 V (TLV2254/54A) Using Machine Model (C = 200 pF, R = 0)
- Output Swing Includes Both Supply Rails
- Low Noise . . . 19 nV/$\sqrt{Hz}$ Typ at f = 1 kHz
- Low Input Bias Current . . . 1 pA Typ
- Fully Specified for Both Single-Supply and Split-Supply Operation

- Very Low Power . . . 34 µA Per Channel Typ
- Common-Mode Input Voltage Range Includes Negative Rail
- Low Input Offset Voltage 850 µV Max at T_A = 25°C
- Wide Supply Voltage Range 2.7 V to 16 V
- Macromodel Included

description

The TLV2252 and TLV2254 are dual and quadruple low-voltage operational amplifiers from Texas Instruments. Both devices exhibit rail-to-rail output performance for increased dynamic range in single- or split-supply applications. The TLV225x family consumes only 34 µA of supply current per channel. This micropower operation makes them good choices for battery-powered applications. This family is fully characterized at 3 V and 5 V and is optimized for low-voltage applications. The noise performance has been dramatically improved over previous generations of CMOS amplifiers. The TLV225x has a noise level of 19 nV/$\sqrt{Hz}$ at 1kHz, four times lower than competitive micropower solutions.

The TLV225x, exhibiting high input impedance and low noise, are 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). For precision applications, the TLV225xA family is available and has a maximum input offset voltage of 850 µV.

The TLV2252/4 also make great upgrades to the TLV2322/4 in standard designs. They offer increased output dynamic range, lower noise voltage, and lower input offset voltage. This enhanced feature set allows them to be used in a wider range of applications. For applications that require higher output drive and wider input voltage range, see the TLV2432 and TLV2442 devices. If your design requires single amplifiers, please see the TLV2211/21/31 family. These devices are single rail-to-rail operational amplifiers in the SOT-23 package. Their small size and low power consumption, make them ideal for high density, battery-powered equipment.

HIGH-LEVEL OUTPUT VOLTAGE
vs
HIGH-LEVEL OUTPUT CURRENT

Figure 1

Advanced LinCMOS is a trademark of Texas Instruments.

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ORDERING INFORMATION†

T_A	V_{IO}max AT 25°C	PACKAGE‡		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	850 μV	SOIC (D)	Tape and reel	TLV2252AQDRQ1	2252AQ
		TSSOP (PW)	Tape and reel	TLV2252AQPWRQ1§	
	1500 μV	SOIC (D)	Tape and reel	TLV2252QDRQ1	2252Q1
		TSSOP (PW)	Tape and reel	TLV2252QPWRQ1§	
–40°C to 125°C	850 μV	SOIC (D)	Tape and reel	TLV2254AQDRQ1	TLV2254AQ1
		TSSOP (PW)	Tape and reel	TLV2254AQPWRQ1§	
	1500 μV	SOIC (D)	Tape and reel	TLV2254QDRQ1	TLV2254Q1
		TSSOP (PW)	Tape and reel	TLV2254QPWRQ1§	

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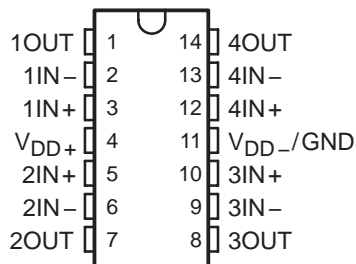
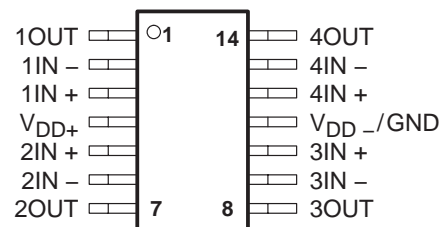‡ Package drawings, thermal data, and symbolization are available at http://www.ti.com/packaging.

§ Product preview

TLV2252, TLV2252A
D OR PW PACKAGE
(TOP VIEW)

```
         ___ ___
1OUT  [ 1    8 ] V_DD+
1IN−  [ 2    7 ] 2OUT
1IN+  [ 3    6 ] 2IN−
V_DD−/GND [ 4  5 ] 2IN+
```
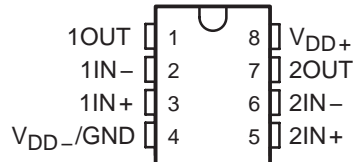
TLV2254, TLV2254A
D PACKAGE
(TOP VIEW)

```
          ___ ___
1OUT  [ 1     14 ] 4OUT
1IN−  [ 2     13 ] 4IN−
1IN+  [ 3     12 ] 4IN+
V_DD+ [ 4     11 ] V_DD−/GND
2IN+  [ 5     10 ] 3IN+
2IN−  [ 6      9 ] 3IN−
2OUT  [ 7      8 ] 3OUT
```

TLV2254, TLV2254A
PW PACKAGE
(TOP VIEW)

```
1OUT  ⊏ ○1    14 ⊐ 4OUT
1IN−  ⊏            ⊐ 4IN−
1IN+  ⊏            ⊐ 4IN+
V_DD+ ⊏            ⊐ V_DD−/GND
2IN+  ⊏            ⊐ 3IN+
2IN−  ⊏            ⊐ 3IN−
2OUT  ⊏ 7     8  ⊐ 3OUT
```

![Texas Instruments logo]
TEXAS INSTRUMENTS

equivalent schematic (each amplifier)
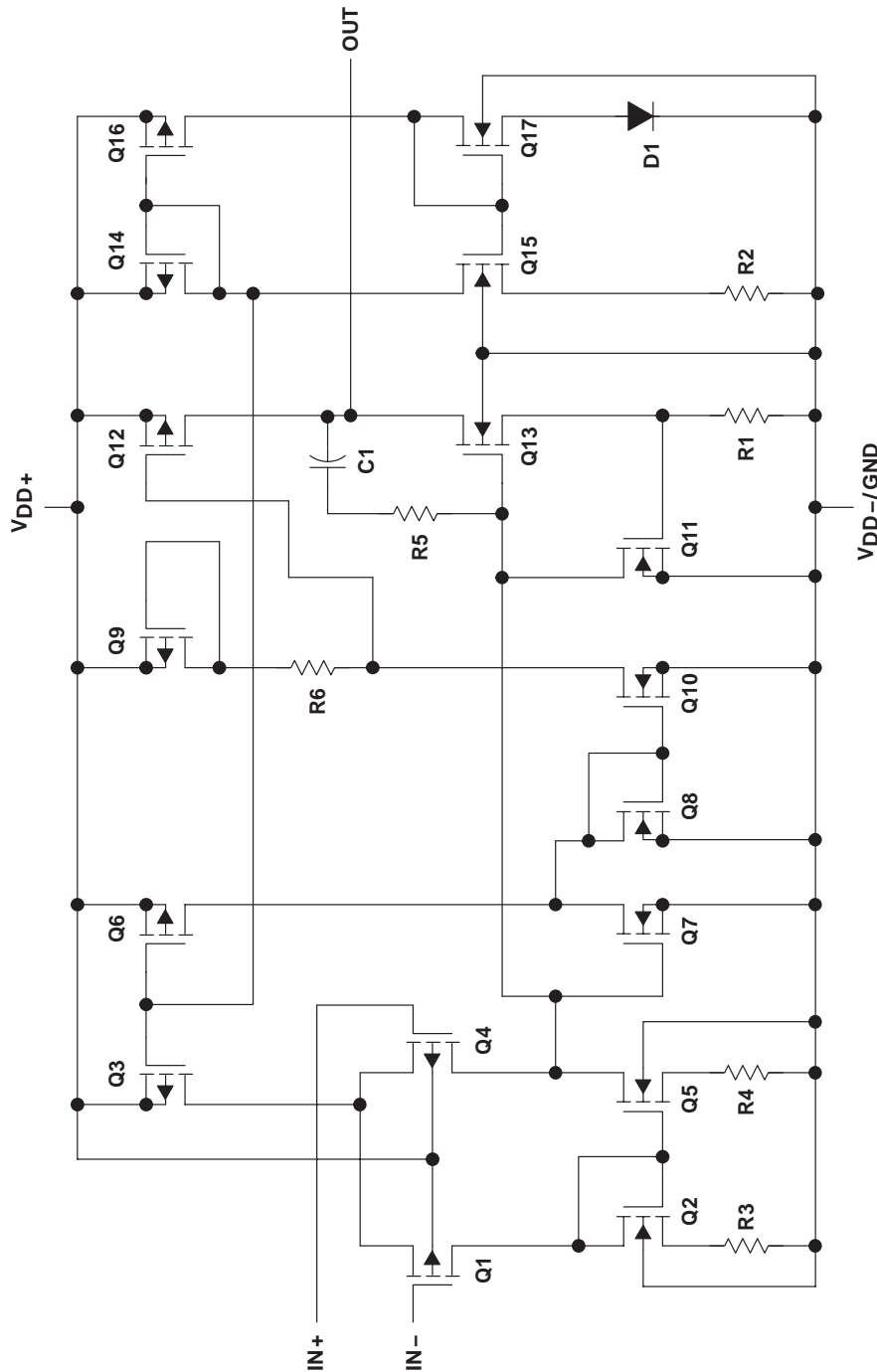
ACTUAL DEVICE COMPONENT COUNT†		
COMPONENT	TLV2252	TLV2254
Transistors	38	76
Resistors	30	56
Diodes	9	18
Capacitors	3	6

† 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) .... 16 V
Differential input voltage, V_{ID} (see Note 2) .... $\pm V_{DD}$
Input voltage range, V_I (any input, see Note 1) .... $V_{DD-} -0.3$ 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: 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: D and PW packages .... 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	$T_A \leq 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 85°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D–8	725 mW	5.8 mW/°C	377 mW	145 mW
D–14	950 mW	7.6 mW/°C	494 mW	190 mW
PW–8	525 mW	4.2 mW/°C	273 mW	105 mW
PW–14	700 mW	5.6 mW/°C	364 mW	140 mW

recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, V_{DD} (see Note 1)		2.7	16	V
Input voltage range, V_I		V_{DD-}	$V_{DD+} -1.3$	V
Common-mode input voltage, V_{IC}		V_{DD-}	$V_{DD+} -1.3$	V
Operating free-air temperature, T_A		−40	125	°C

NOTE 1: All voltage values, except differential voltages, are with respect to V_{DD-}.

TLV2252-Q1 electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2252-Q1 MIN	TLV2252-Q1 TYP	TLV2252-Q1 MAX	TLV2252A-Q1 MIN	TLV2252A-Q1 TYP	TLV2252A-Q1 MAX	UNIT
V_{IO}	Input offset voltage			25°C		200	1500		200	850	µV
				Full range			1750			1000	
α_{VIO}	Temperature coefficient of input offset voltage			25°C to 85°C		0.5			0.5		µV/°C
	Input offset voltage long-term drift (see Note 4)	$V_{DD\pm}$ = ±1.5 V, V_{IC} = 0, V_O = 0, R_S = 50 Ω		25°C		0.003			0.003		µV/mo
I_{IO}	Input offset current			25°C		0.5	60		0.5	60	pA
				125°C			1000			1000	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				125°C			1000			1000	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω,	$|V_{IO}|$ ≤5 mV	25°C	0 to 2	−0.3 to 2.2		0 to 2	−0.3 to 2.2		V
				Full range	0 to 1.7			0 to 1.7			
V_{OH}	High-level output voltage	I_{OH} = −20 µA		25°C		2.98			2.98		V
		I_{OH} = −75 µA		25°C	2.9			2.9			
				Full range	2.8			2.8			
		I_{OH} = −150 µA		25°C	2.8			2.8			
V_{OL}	Low-level output voltage	V_{IC} = 1.5 V,	I_{OL} = 50 µA	25°C		10			10		mV
		V_{IC} = 1.5 V,	I_{OL} = 500 µA	25°C		100	150		100	150	
				Full range			165			165	
		V_{IC} = 1.5 V,	I_{OL} = 1 mA	25°C		200	300		200	300	
				Full range			300			300	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 1.5 V, V_O = 1 V to 2 V	R_L = 100 kΩ‡	25°C	100	250		100	250		V/mV
				Full range	10			10			
			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		8			8		pF
z_o	Closed-loop output impedance	f = 25 kHz,	A_V = 10	25°C		220			220		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	75		65	77		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	100		dB
				Full range	80			80			
I_{DD}	Supply current	V_O = 1.5 V, No load		25°C		68	125		68	125	µA
				Full range			150			150	

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

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TLV2252-Q1 operating characteristics at specified free-air temperature, V_{DD} = 3 V

PARAMETER		TEST CONDITIONS	T_A†	TLV2252-Q1 MIN	TLV2252-Q1 TYP	TLV2252-Q1 MAX	TLV2252A-Q1 MIN	TLV2252A-Q1 TYP	TLV2252A-Q1 MAX	UNIT
SR	Slew rate at unity gain	V_O = 0.8 V to 1.4 V, R_L = 100 kΩ‡, C_L = 100 pF‡	25°C	0.07	0.1		0.07	0.1		V/µs
			Full range	0.05			0.05			
V_n	Equivalent input noise voltage	f = 10 Hz	25°C		35			35		nV/√Hz
		f = 1 kHz	25°C		19			19		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz	25°C		0.6			0.6		µV
		f = 0.1 Hz to 10 Hz	25°C		1.1			1.1		
I_n	Equivalent input noise current		25°C		0.6			0.6		fA/√Hz
	Gain-bandwidth product	f = 1 kHz, R_L = 50 kΩ‡, C_L = 100 pF‡	25°C		0.187			0.187		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 1 V, A_V = 1, R_L = 50 kΩ‡, C_L = 100 pF‡	25°C		60			60		kHz
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡, C_L = 100 pF‡	25°C		63°			63°		
	Gain margin		25°C		15			15		dB

† Full range is –40°C to 125°C for Q level part.
‡ Referenced to 1.5 V

TLV2252-Q1 electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2252-Q1 MIN	TYP	MAX	TLV2252A-Q1 MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_{DD\pm}$ = ±2.5 V, V_O = 0,	V_{IC} = 0, R_S = 50 Ω	25°C		200	1500		200	850	μV
				Full range			1750			1000	
α_{VIO}	Temperature coefficient of input offset voltage			25°C to 85°C		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	60		0.5	60	pA
				125°C			1000			1000	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				125°C			1000			1000	
V_{ICR}	Common-mode input voltage range	$|V_{IO}|$ ≤5 mV, R_S = 50 Ω		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} = −20 μA		25°C		4.98			4.98		V
		I_{OH} = −75 μA		25°C	4.9	4.94		4.9	4.94		
				Full range	4.8			4.8			
		I_{OH} = −150 μA		25°C	4.8	4.88		4.8	4.88		
V_{OL}	Low-level output voltage	V_{IC} = 2.5 V,	I_{OL} = 50 μA	25°C		0.01			0.01		V
		V_{IC} = 2.5 V,	I_{OL} = 500 μA	25°C		0.09	0.15		0.09	0.15	
				Full range			0.15			0.15	
		V_{IC} = 2.5 V,	I_{OL} = 1 mA	25°C		0.2	0.3		0.2	0.3	
				Full range			0.3			0.3	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 2.5 V, V_O = 1 V to 4 V	R_L = 100 kΩ‡	25°C	100	350		100	350		V/mV
				Full range	10			10			
			R_L = 1 MΩ‡	25°C		1700			1700		
$r_{i(d)}$	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		8			8		pF
z_o	Closed-loop output impedance	f = 25 kHz, A_V = 10		25°C		200			200		Ω
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.7 V, V_O = 2.5 V, R_S = 50 Ω		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, V_{IC} = V_{DD}/2, No load		25°C	80	95		80	95		dB
				Full range	80			80			

† 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°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2252-Q1 electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLV2252-Q1			TLV2252A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current	V_O = 2.5 V,	No load	25°C		70	125		70	125	μA
				Full range			150			150	

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

TLV2252-Q1 operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2252-Q1			TLV2252A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 1.25 V to 2.75 V, R_L = 100 kΩ‡, C_L = 100 pF‡		25°C	0.07	0.12		0.07	0.12		V/μs
				Full range	0.05			0.05			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		36			36		nV/√Hz
		f = 1 kHz		25°C		19			19		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.7			0.7		μV
		f = 0.1 Hz to 10 Hz		25°C		1.1			1.1		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA/√Hz
THD + N	Total harmonic distortion plus noise	V_O = 0.5 V to 2.5 V, f = 20 kHz, R_L = 50 kΩ‡	A_V = 1	25°C		0.2%			0.2%		
			A_V = 10			1%			1%		
	Gain-bandwidth product	f = 50 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.2			0.2		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		30			30		kHz
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		63°			63°		
	Gain margin			25°C		15			15		dB

† Full range is –40°C to 125°C for Q level part.
‡ Referenced to 2.5 V

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TLV2254-Q1 electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2254-Q1 MIN	TYP	MAX	TLV2254A-Q1 MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage			25°C		200	1500		200	850	μV
				Full range			1750			1000	
α_{VIO}	Temperature coefficient of input offset voltage	$V_{DD\pm}$ = ±1.5 V, V_{IC} = 0, V_O = 0, R_S = 50 Ω		25°C to 125°C		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	60		0.5	60	pA
				125°C			1000			1000	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				125°C			1000			1000	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω, $|V_{IO}| \le 5$ mV		25°C	0 to 2	−0.3 to 2.2		0 to 2	−0.3 to 2.2		V
				Full range	0 to 1.7			0 to 1.7			
V_{OH}	High-level output voltage	I_{OH} = −20 μA		25°C		2.98			2.98		V
		I_{OH} = −75 μA		25°C	2.9			2.9			
				Full range	2.8			2.8			
		I_{OH} = −150 μA		25°C	2.8			2.8			
V_{OL}	Low-level output voltage	V_{IC} = 1.5 V,	I_{OL} = 50 μA	25°C		10			10		mV
		V_{IC} = 1.5 V,	I_{OL} = 500 μA	25°C		100	150		100	150	
				Full range			165			165	
		V_{IC} = 1.5 V,	I_{OL} = 1 mA	25°C		200	300		200	300	
				Full range			300			300	
A_{VD}	Large-signal differential voltage amplification	V_{IC} = 1.5 V, V_O = 1 V to 2 V	R_L = 100 kΩ‡	25°C	100	225		100	225		V/mV
				Full range	10			10			
			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		8			8		pF
z_O	Closed-loop output impedance	f = 25 kHz, A_V = 10		25°C		220			220		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	75		65	77		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	100		dB
				Full range	80			80			

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

TLV2254-Q1 electrical characteristics at specified free-air temperature, V_{DD} = 3 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLV2254-Q1			TLV2254A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current (four amplifiers)	V_O = 1.5 V,	No load	25°C		135	250		135	250	µA
				Full range			300			300	

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

TLV2254-Q1 operating characteristics at specified free-air temperature, V_{DD} = 3 V

PARAMETER		TEST CONDITIONS	T_A†	TLV2254-Q1			TLV2254A-Q1			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 0.5 V to 1.7 V, R_L = 100 kΩ‡, C_L = 100 pF‡	25°C	0.07	0.1		0.07	0.1		V/µs
			Full range	0.05			0.05			
V_n	Equivalent input noise voltage	f = 10 Hz	25°C		35			35		nV/√Hz
		f = 1 kHz	25°C		19			19		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz	25°C		0.6			0.6		µV
		f = 0.1 Hz to 10 Hz	25°C		1.1			1.1		
I_n	Equivalent input noise current		25°C		0.6			0.6		fA/√Hz
	Gain-bandwidth product	f = 1 kHz, R_L = 50 kΩ‡, C_L = 100 pF‡	25°C		0.187			0.187		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 1 V, A_V = 1, R_L = 50 kΩ‡, C_L = 100 pF‡	25°C		60			60		kHz
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡, C_L = 100 pF‡	25°C		63°			63°		
	Gain margin		25°C		15			15		dB

† Full range is –40°C to 125°C for Q level part.
‡ Referenced to 1.5 V

TEXAS INSTRUMENTS

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TLV2254-Q1 electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLV2254-Q1			TLV2254A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage			25°C		200	1500		200	850	µV
				Full range			1750			1000	
α_{VIO}	Temperature coefficient of input offset voltage			25°C to 125°C		0.5			0.5		µV/°C
	Input offset voltage long-term drift (see Note 4)	$V_{DD\pm} = \pm2.5$ V, $V_O = 0$,	$V_{IC} = 0$, $R_S = 50\ \Omega$	25°C		0.003			0.003		µV/mo
I_{IO}	Input offset current			25°C		0.5	60		0.5	60	pA
				125°C			1000			1000	
I_{IB}	Input bias current			25°C		1	60		1	60	pA
				125°C			1000			1000	
V_{ICR}	Common-mode input voltage range	$|V_{IO}| \leq 5$ 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	$I_{OH} = -20$ µA		25°C		4.98			4.98		V
		$I_{OH} = -75$ µA		25°C	4.9	4.94		4.9	4.94		
				Full range	4.8			4.8			
		$I_{OH} = -150$ µA		25°C	4.8	4.88		4.8	4.88		
V_{OL}	Low-level output voltage	$V_{IC} = 2.5$ V,	$I_{OL} = 50$ µA	25°C		0.01			0.01		V
		$V_{IC} = 2.5$ V,	$I_{OL} = 500$ µA	25°C		0.09	0.15		0.09	0.15	
				Full range			0.15			0.15	
		$V_{IC} = 2.5$ V,	$I_{OL} = 1$ mA	25°C		0.2	0.3		0.2	0.3	
				Full range			0.3			0.3	
A_{VD}	Large-signal differential voltage amplification	$V_{IC} = 2.5$ V, $V_O = 1$ V to 4 V	$R_L = 100$ kΩ‡	25°C	100	350		100	350		V/mV
				Full range	10			10			
			$R_L = 1$ MΩ‡	25°C		1700			1700		
$r_{i(d)}$	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		8			8		pF
z_o	Closed-loop output impedance	$f = 25$ kHz,	$A_V = 10$	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, $V_{IC} = V_{DD}/2$,	No load	25°C	80	95		80	95		dB
				Full range	80			80			

† 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 $T_A = 150$°C extrapolated to $T_A = 25$°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLV2254-Q1 electrical characteristics at specified free-air temperature, V_{DD} = 5 V (unless otherwise noted) (continued)

PARAMETER		TEST CONDITIONS		T_A†	TLV2254-Q1			TLV2254A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
I_{DD}	Supply current (four amplifiers)	V_O = 2.5 V,	No load	25°C		140	250		140	250	μA
				Full range			300			300	

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

TLV2254-Q1 operating characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS		T_A†	TLV2254-Q1			TLV2254A-Q1			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 0.5 V to 3.5 V, C_L = 100 pF‡	R_L = 100 kΩ‡,	25°C	0.07	0.12		0.07	0.12		V/μs
				Full range	0.05			0.05			
V_n	Equivalent input noise voltage	f = 10 Hz		25°C		36			36		nV/√Hz
		f = 1 kHz		25°C		19			19		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 Hz to 1 Hz		25°C		0.7			0.7		μV
		f = 0.1 Hz to 10 Hz		25°C		1.1			1.1		
I_n	Equivalent input noise current			25°C		0.6			0.6		fA/√Hz
THD + N	Total harmonic distortion plus noise	V_O = 0.5 V to 2.5 V, f = 20 kHz, R_L = 50 kΩ‡	A_V = 1	25°C		0.2%			0.2%		
			A_V = 10			1%			1%		
	Gain-bandwidth product	f = 50 kHz, C_L = 100 pF‡	R_L = 50 kΩ‡,	25°C		0.2			0.2		MHz
B_{OM}	Maximum output-swing bandwidth	$V_{O(PP)}$ = 2 V, R_L = 50 kΩ‡,	A_V = 1, C_L = 100 pF‡	25°C		30			30		kHz
ϕ_m	Phase margin at unity gain	R_L = 50 kΩ‡,	C_L = 100 pF‡	25°C		63°			63°		
	Gain margin			25°C		15			15		dB

† Full range is –40°C to 125°C for Q level part.
‡ Referenced to 2.5 V

TEXAS INSTRUMENTS

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
V_{IO}	Input offset voltage	Distribution	2 – 5
		vs Common-mode voltage	6, 7
α_{VIO}	Input offset voltage temperature coefficient	Distribution	8 – 11
I_{IB}/I_{IO}	Input bias and input offset currents	vs Free-air temperature	12
V_I	Input voltage	vs Supply voltage	13
		vs Free-air temperature	14
V_{OH}	High-level output voltage	vs High-level output current	15, 18
V_{OL}	Low-level output voltage	vs Low-level output current	16, 17, 19
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	20
I_{OS}	Short-circuit output current	vs Supply voltage	21
		vs Free-air temperature	22
V_{ID}	Differential input voltage	vs Output voltage	23, 24
A_{VD}	Differential voltage amplification	vs Load resistance	25
A_{VD}	Large-signal differential voltage amplification	vs Frequency	26, 27
		vs Free-air temperature	28, 29
z_o	Output impedance	vs Frequency	30, 31
CMRR	Common-mode rejection ratio	vs Frequency	32
		vs Free-air temperature	33
k_{SVR}	Supply-voltage rejection ratio	vs Frequency	34, 35
		vs Free-air temperature	36
I_{DD}	Supply current	vs Supply voltage	37, 38
SR	Slew rate	vs Load capacitance	39
		vs Free-air temperature	40
V_O	Inverting large-signal pulse response		41, 42
V_O	Voltage-follower large-signal pulse response		43, 44
V_O	Inverting small-signal pulse response		45, 46
V_O	Voltage-follower small-signal pulse response		47, 48
V_n	Equivalent input noise voltage	vs Frequency	49, 50
	Input noise voltage	Over a 10-second period	51
	Integrated noise voltage	vs Frequency	52
THD + N	Total harmonic distortion plus noise	vs Frequency	53
	Gain-bandwidth product	vs Supply voltage	54
		vs Free-air temperature	55
ϕ_m	Phase margin	vs Frequency	26, 27
		vs Load capacitance	56
	Gain margin	vs Load capacitance	57
B_1	Unity-gain bandwidth	vs Load capacitance	58
	Overestimation of phase margin	vs Load capacitance	59

TEXAS
INSTRUMENTS

POST OFFICE BOX 655303 ● DALLAS, TEXAS 75265

TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLV2252
INPUT OFFSET VOLTAGE**

1020 Amplifiers From 1 Wafer Lot
$V_{DD} = \pm 1.5$ V
$T_A = 25°C$

Precentage of Amplifiers – %
V_{IO} – Input Offset Voltage – mV
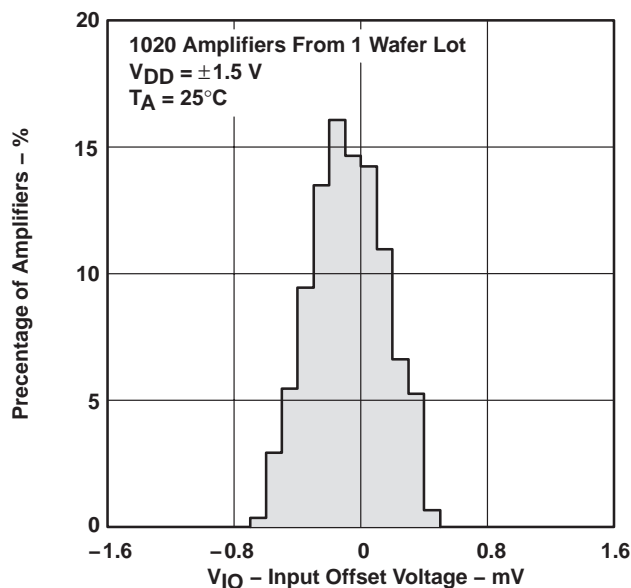
Figure 2

**DISTRIBUTION OF TLV2252
INPUT OFFSET VOLTAGE**

1020 Amplifiers From 1 Wafer Lot
$V_{DD} = \pm 2.5$ V
$T_A = 25°C$

Precentage of Amplifiers – %
V_{IO} – Input Offset Voltage – mV
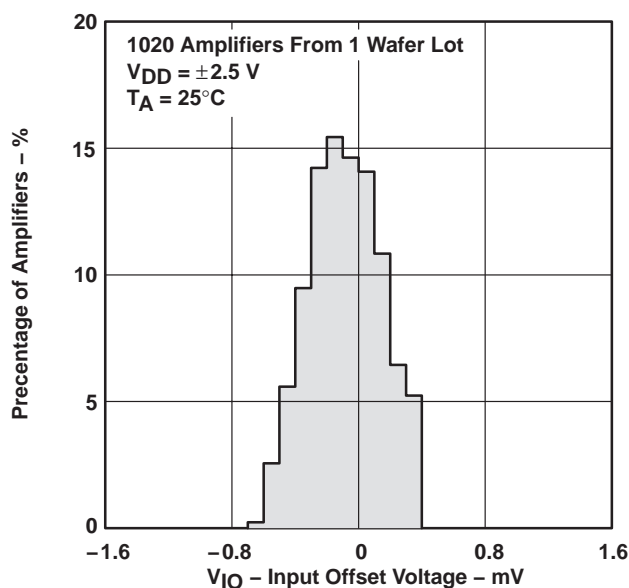
Figure 3

**DISTRIBUTION OF TLV2254
INPUT OFFSET VOLTAGE**

682 Amplifiers From 1 Wafer Lot
$V_{DD\pm} = \pm 1.5$ V
$T_A = 25°C$

Percentage of Amplifiers – %
V_{IO} – Input Offset Voltage – mV
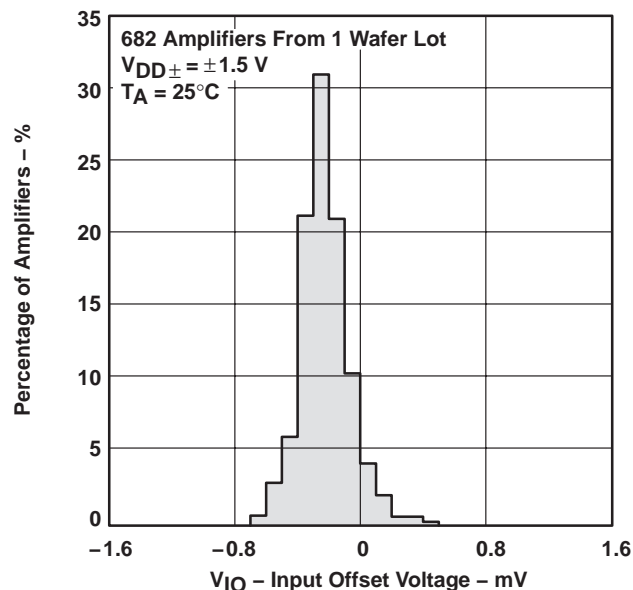
Figure 4

**DISTRIBUTION OF TLV2254
INPUT OFFSET VOLTAGE**

682 Amplifiers From 1 Wafer Lot
$V_{DD\pm} = \pm 2.5$ V
$T_A = 25°C$

Percentage of Amplifiers – %
V_{IO} – Input Offset Voltage – mV
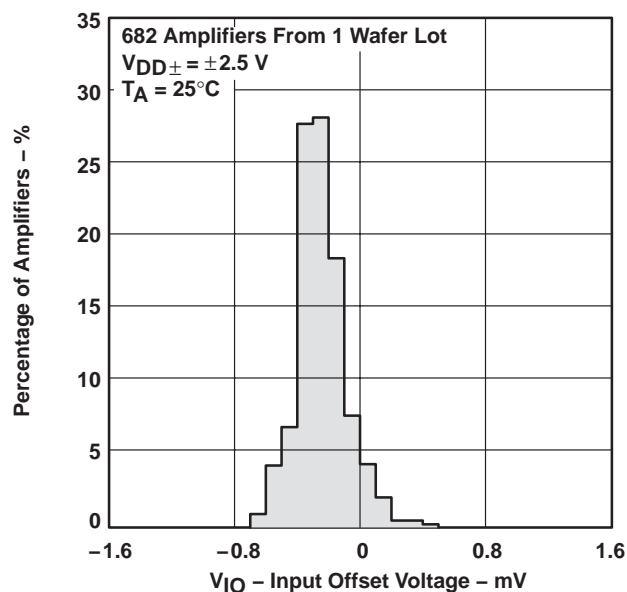
Figure 5

TYPICAL CHARACTERISTICS

INPUT OFFSET VOLTAGE†
vs
COMMON-MODE INPUT VOLTAGE

Figure 6

INPUT OFFSET VOLTAGE†
vs
COMMON-MODE INPUT VOLTAGE

Figure 7

DISTRIBUTION OF TLV2252 INPUT OFFSET
VOLTAGE TEMPERATURE COEFFICIENT†

Figure 8

DISTRIBUTION OF TLV2252 INPUT OFFSET
VOLTAGE TEMPERATURE COEFFICIENT†
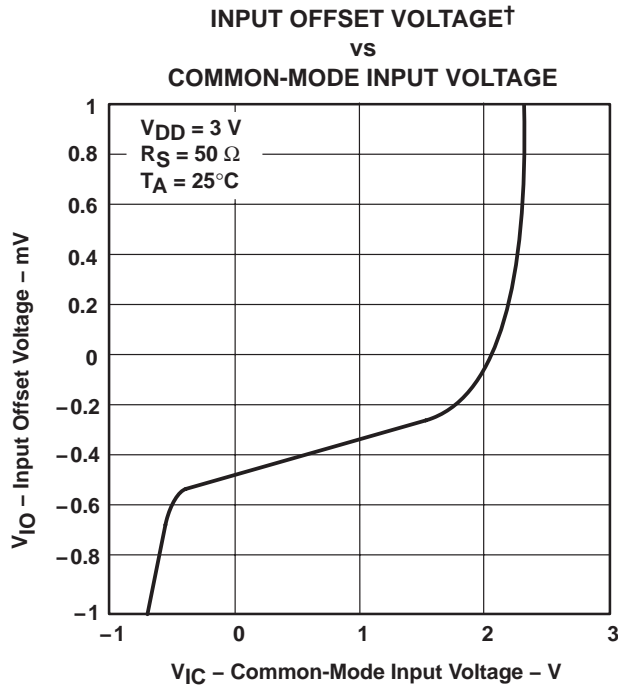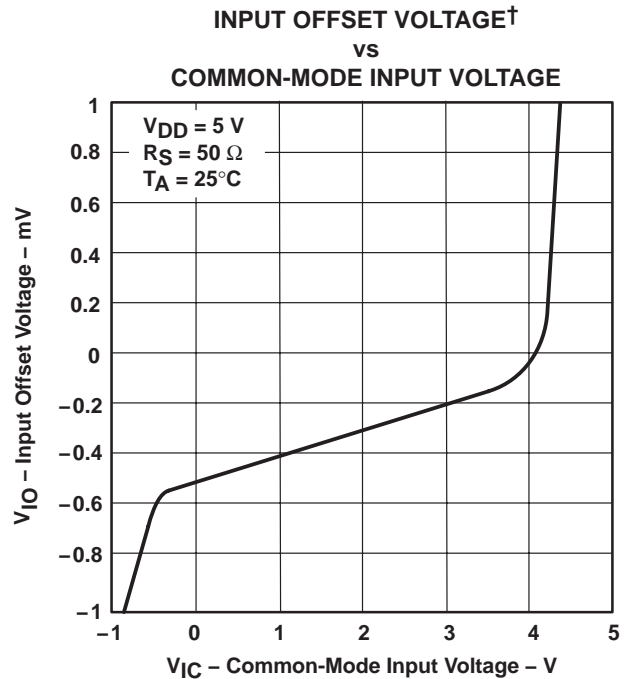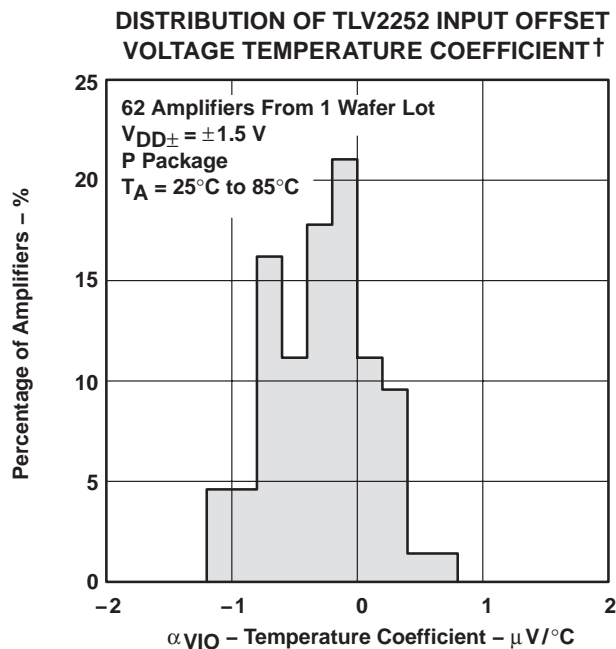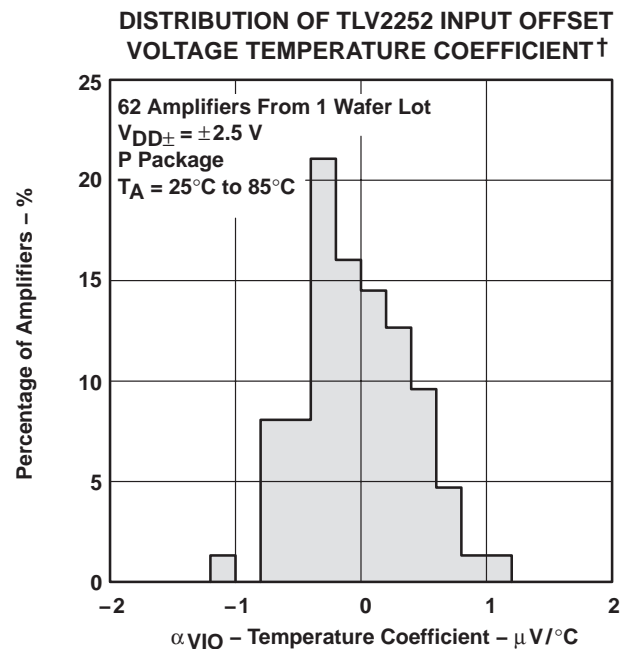
Figure 9

† 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.
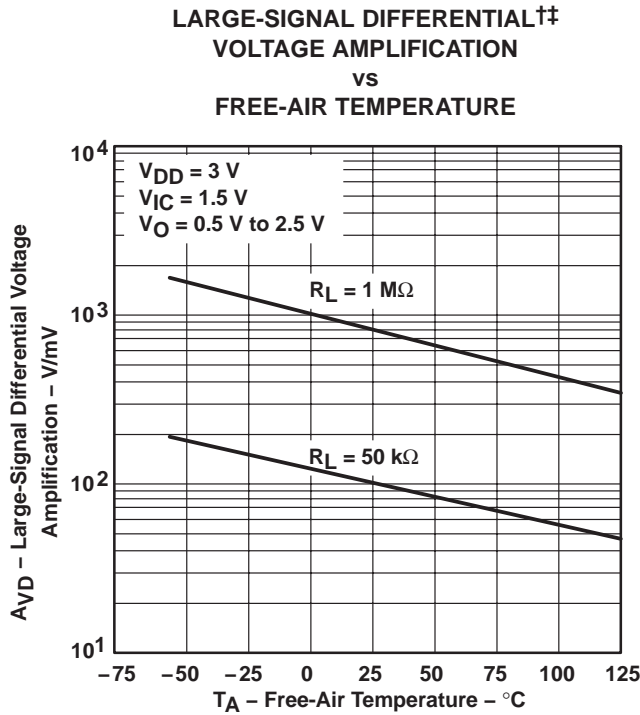
TEXAS
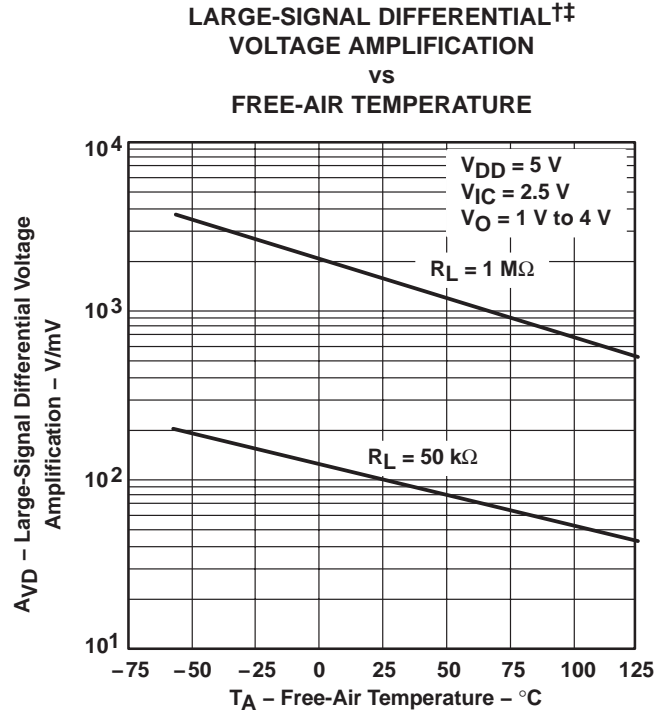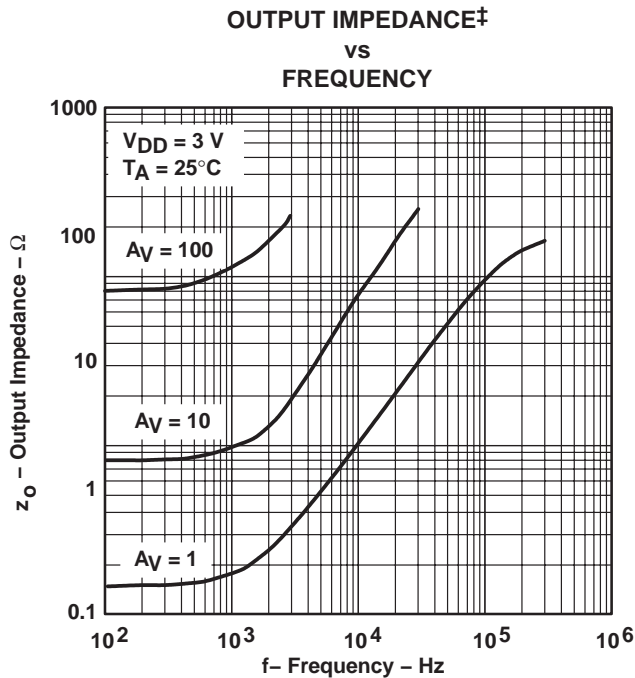INSTRUMENTS

TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLV2254 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

62 Amplifiers From 1 Wafer Lot
$V_{DD\pm} = \pm 1.5$ V
P Package
$T_A = 25°C$ to $85°C$

Figure 10

DISTRIBUTION OF TLV2254 INPUT OFFSET VOLTAGE TEMPERATURE COEFFICIENT

62 Amplifiers From 1 Wafer Lot
$V_{DD\pm} = \pm 2.5$ V
P Package
$T_A = 25°C$ to $85°C$

Figure 11

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

$V_{DD\pm} = \pm 2.5$ V
$V_{IC} = 0$
$V_O = 0$
$R_S = 50\ \Omega$

Figure 12

**INPUT VOLTAGE
vs
SUPPLY VOLTAGE**

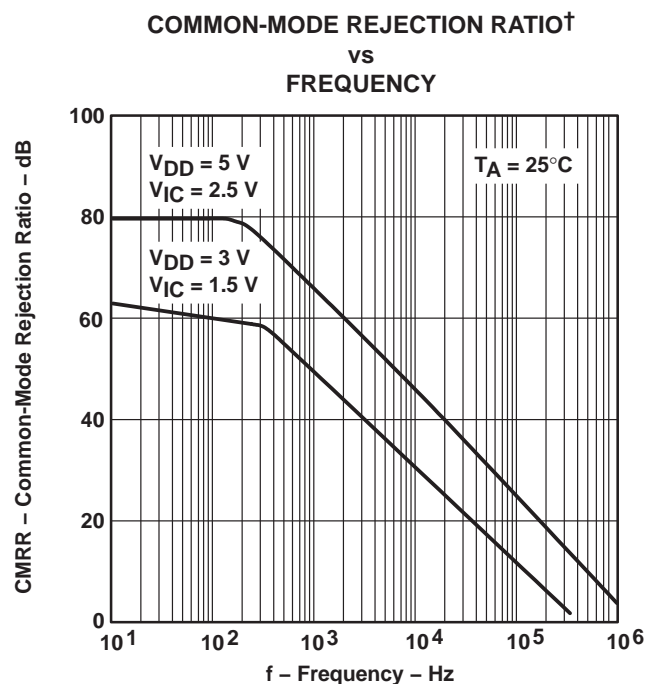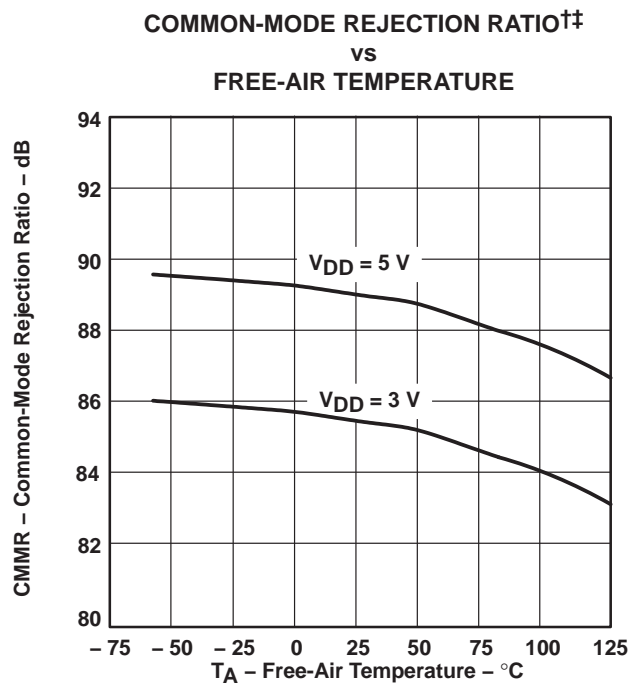

$R_S = 50\ \Omega$
$T_A = 25°C$

$|V_{IO}| \leq 5$ mV
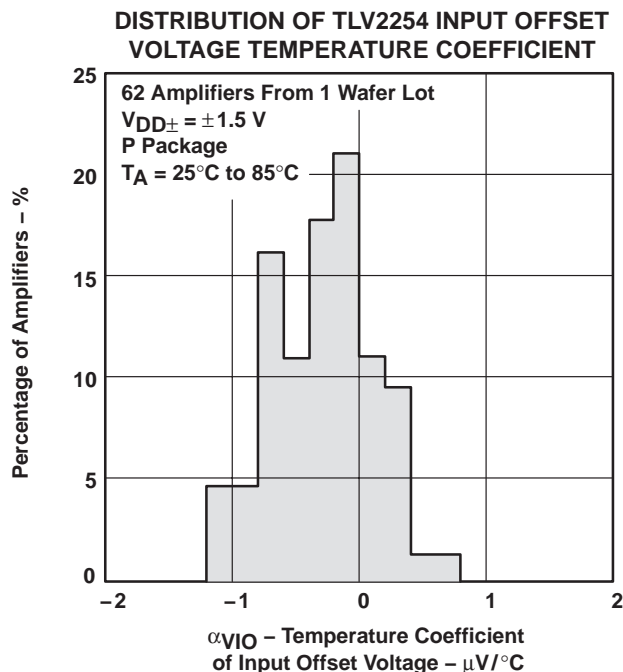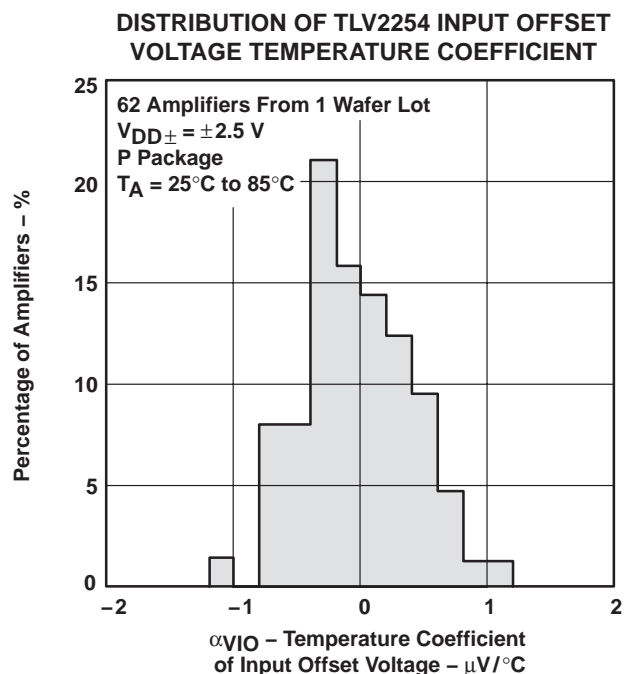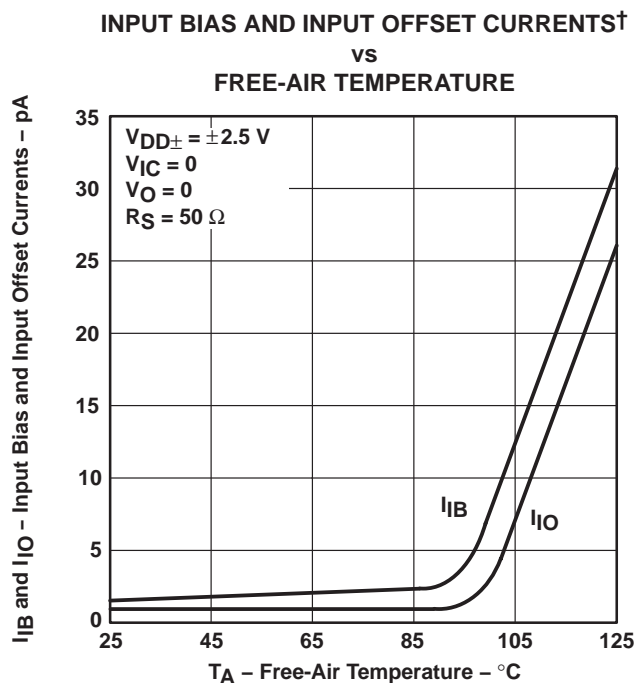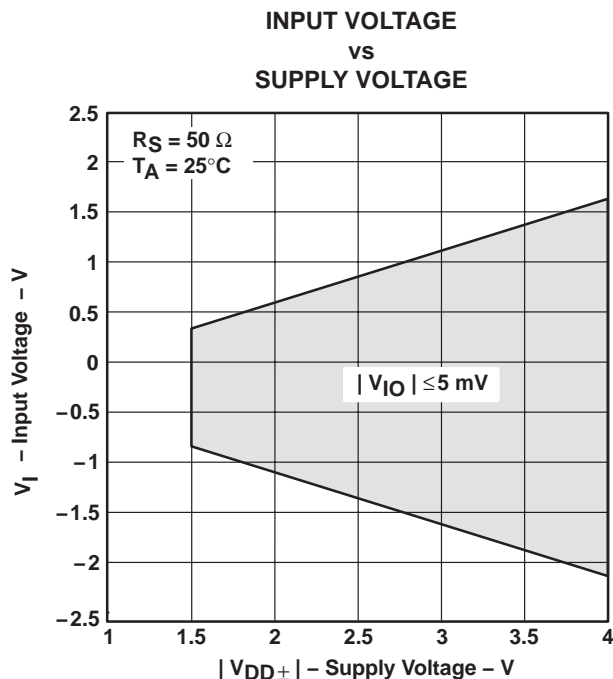
Figure 13

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

TYPICAL CHARACTERISTICS
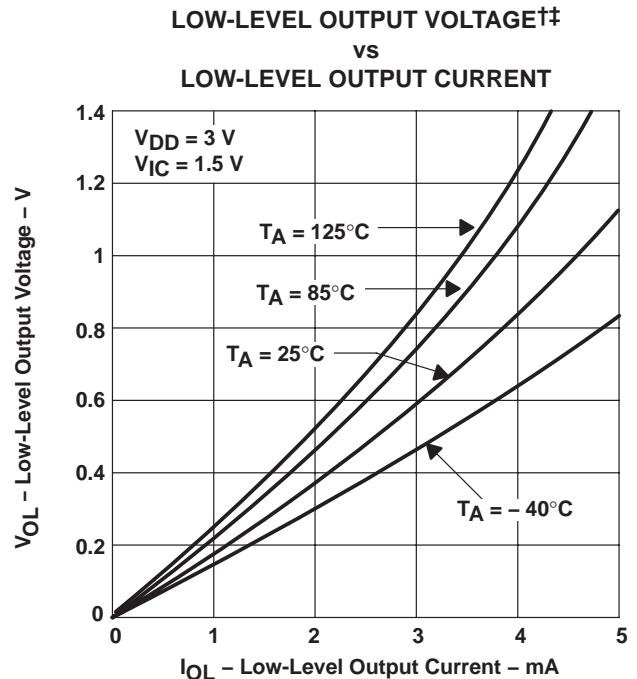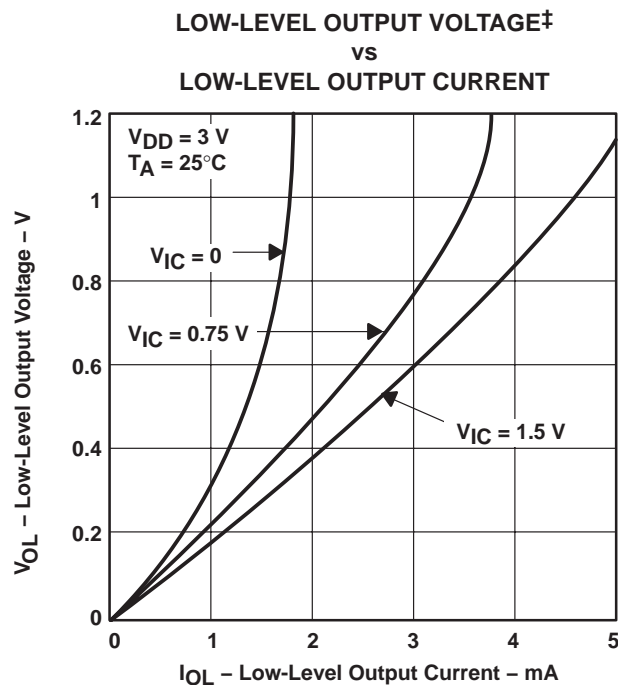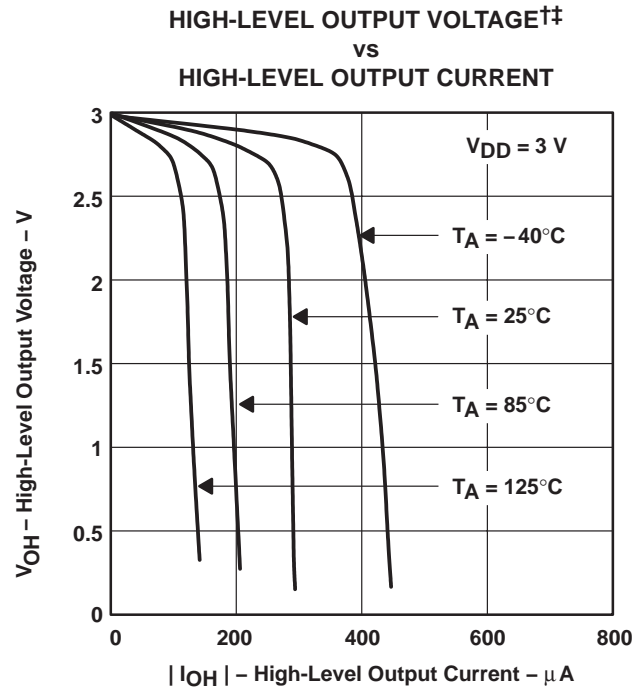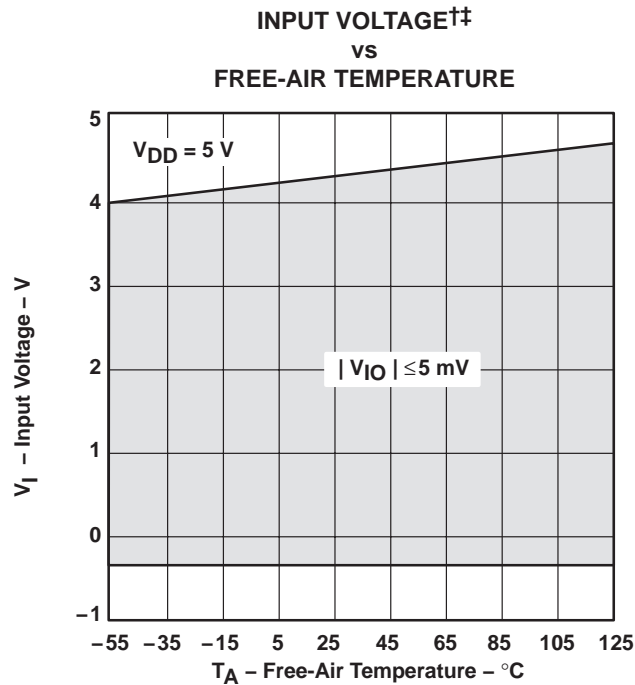
INPUT VOLTAGE†‡
vs
FREE-AIR TEMPERATURE

Figure 14

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

Figure 15

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

Figure 16

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

Figure 17

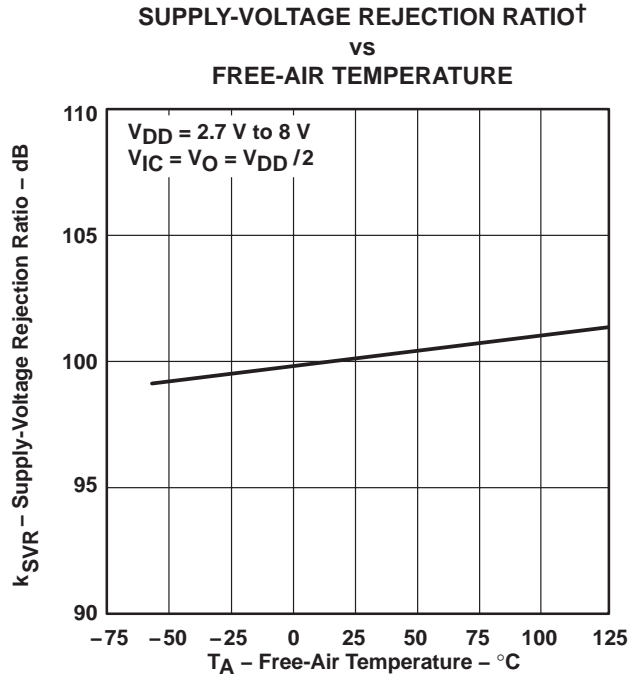† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
‡ For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

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TYPICAL CHARACTERISTICS

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

Figure 18

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

Figure 19

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE‡
vs
FREQUENCY

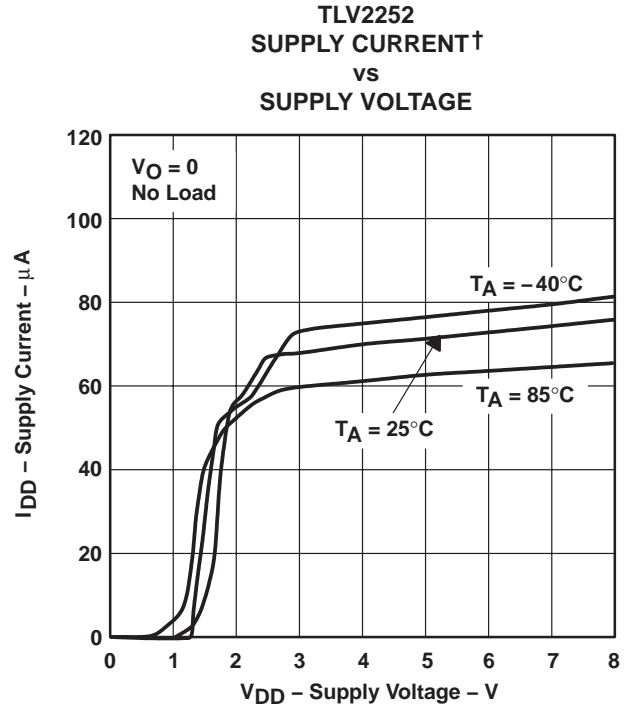**Figure 20**
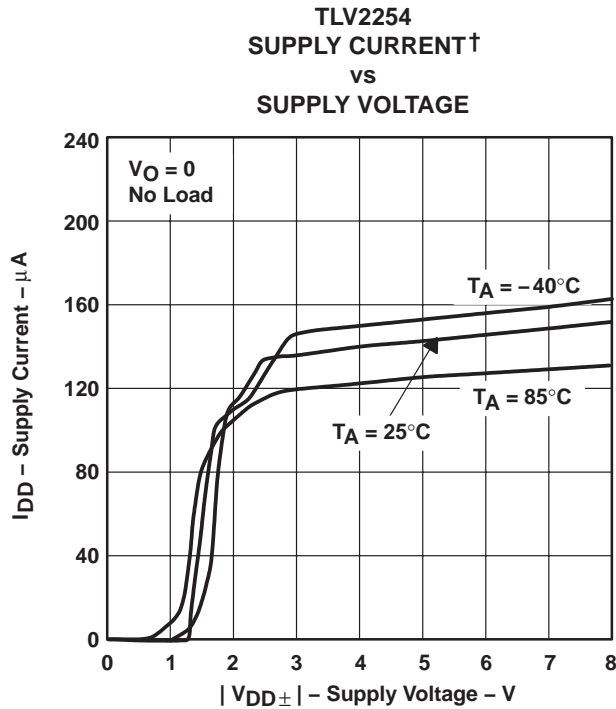
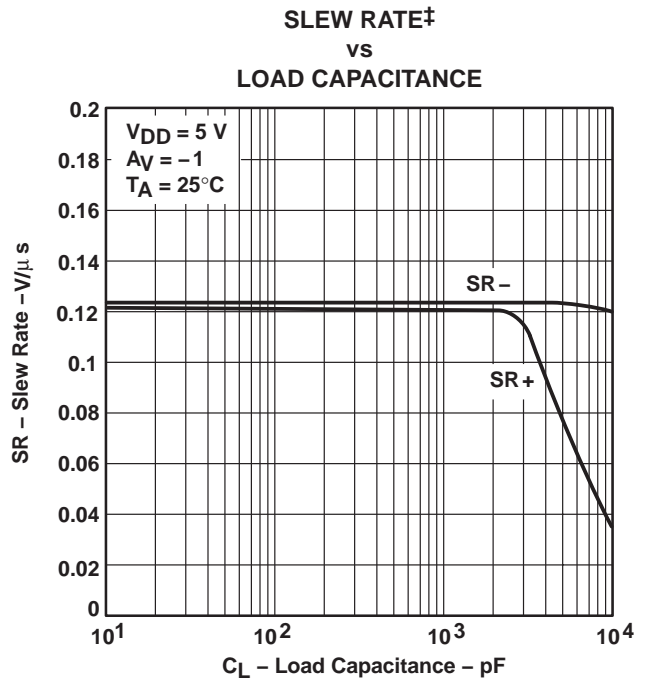**SHORT-CIRCUIT OUTPUT CURRENT**
vs
SUPPLY VOLTAGE
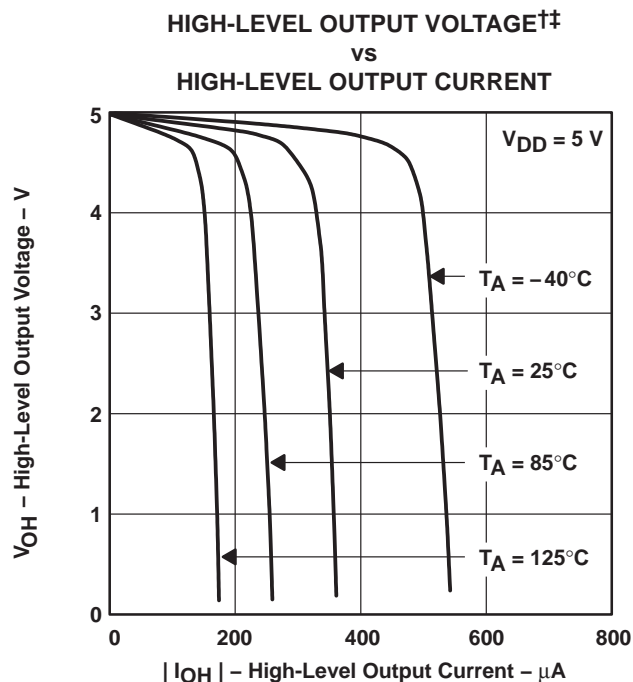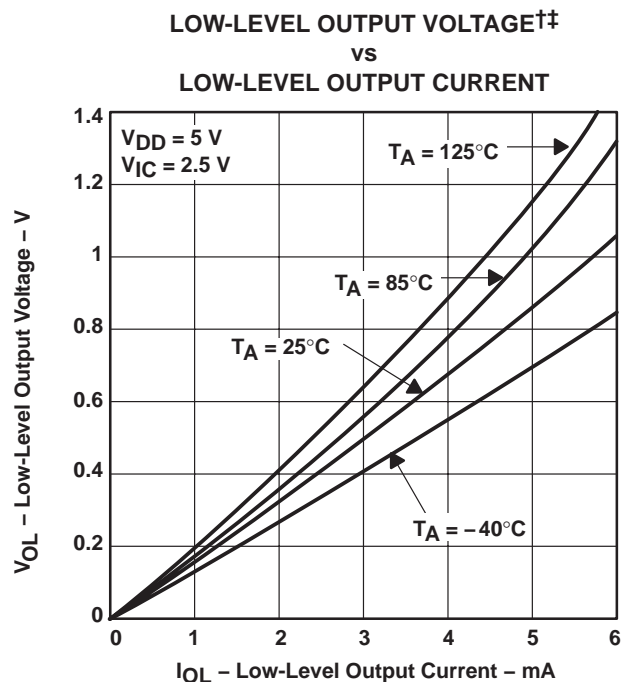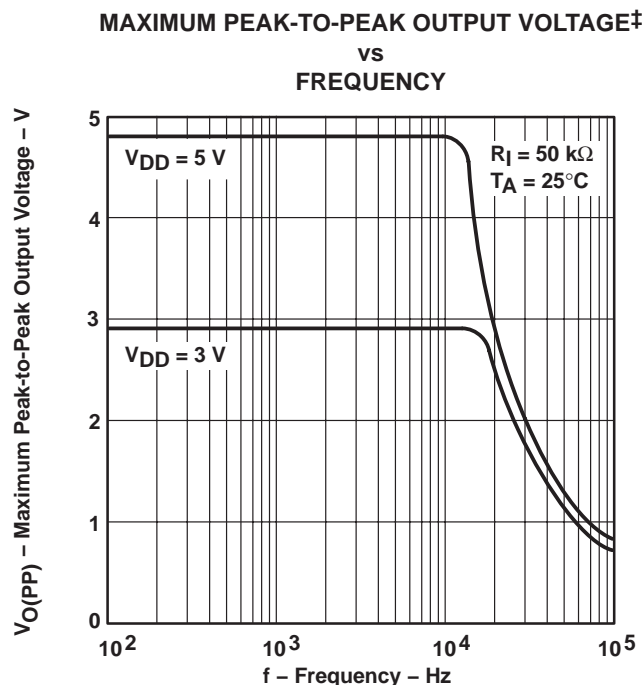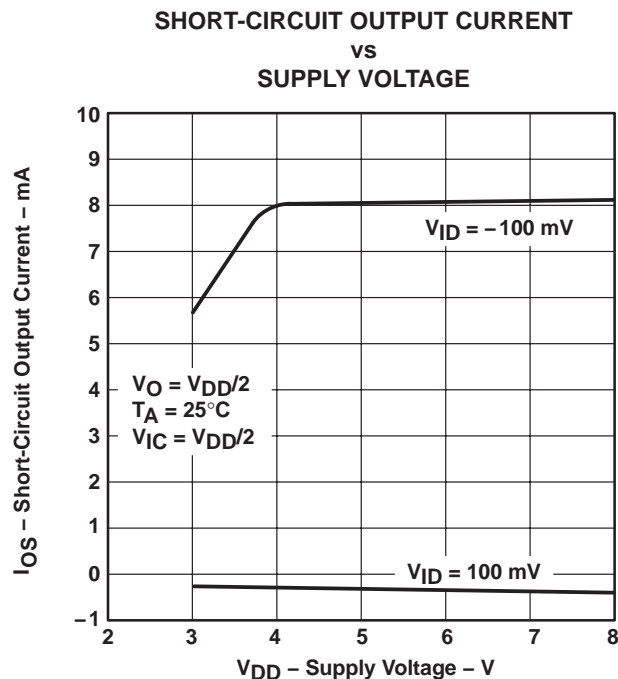
Figure 21

† 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.

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TYPICAL CHARACTERISTICS

SHORT-CIRCUIT OUTPUT CURRENT†
vs
FREE-AIR TEMPERATURE

Figure 22

DIFFERENTIAL INPUT VOLTAGE‡
vs
OUTPUT VOLTAGE

Figure 23

DIFFERENTIAL INPUT VOLTAGE‡
vs
OUTPUT VOLTAGE

Figure 24

DIFFERENTIAL VOLTAGE AMPLIFICATION†‡
vs
LOAD RESISTANCE
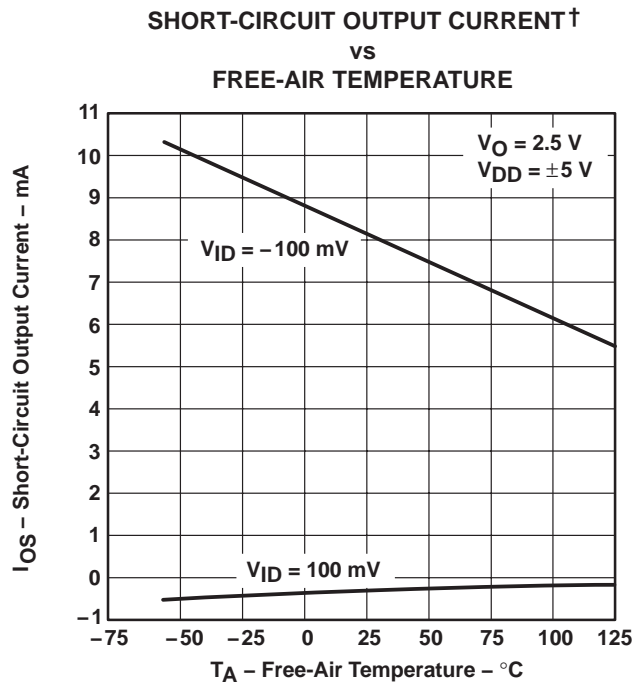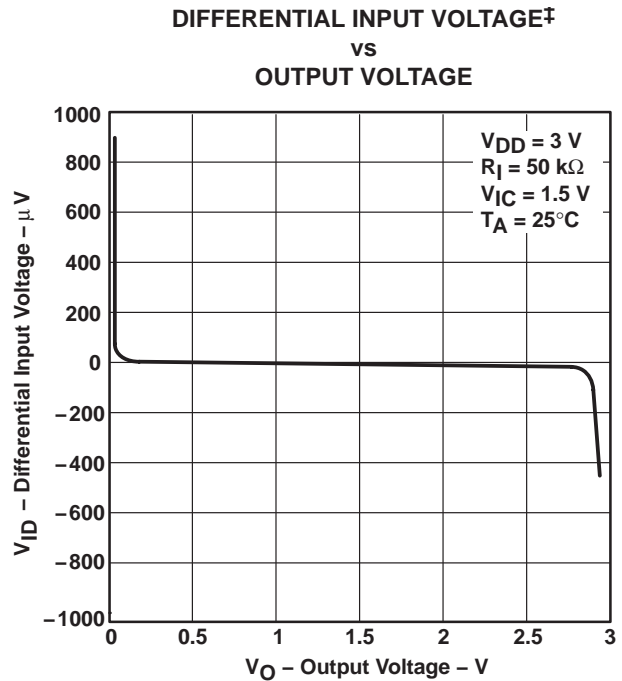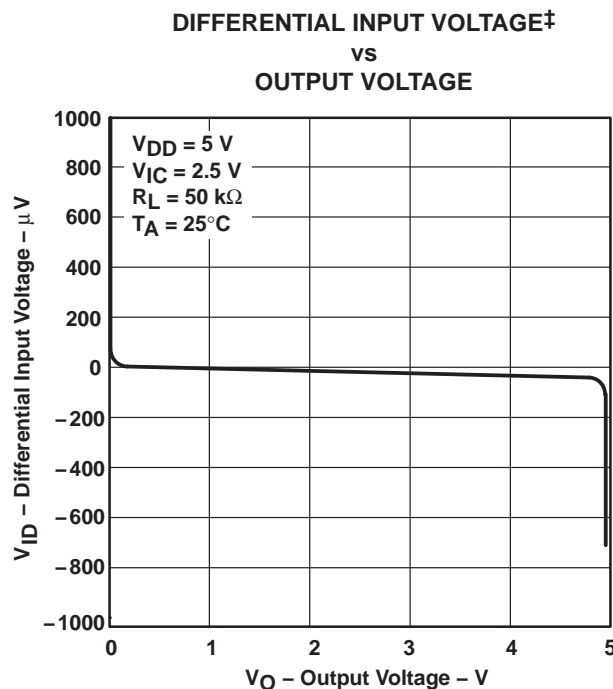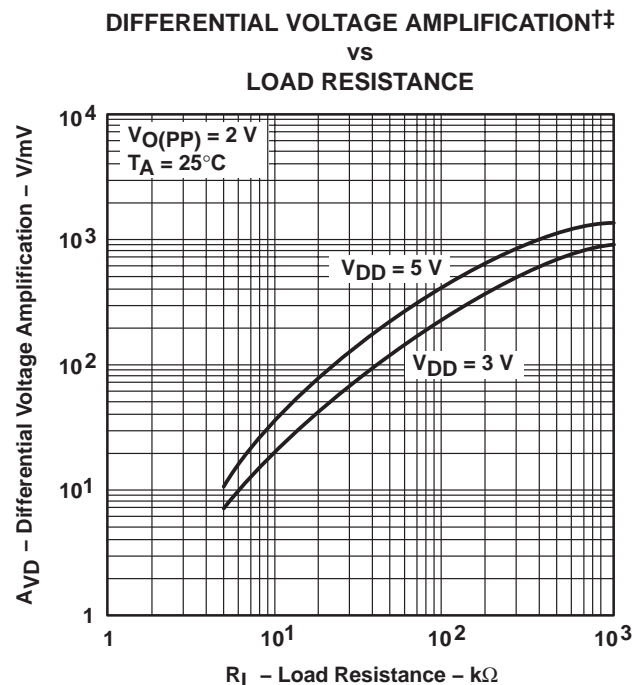
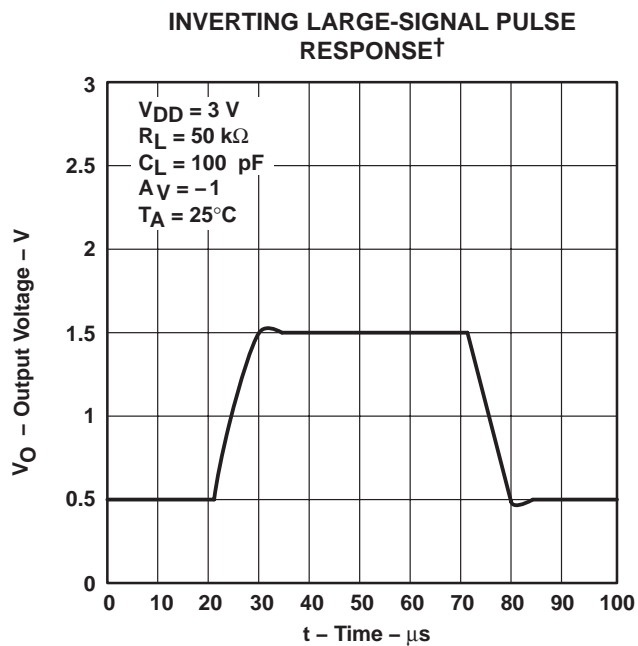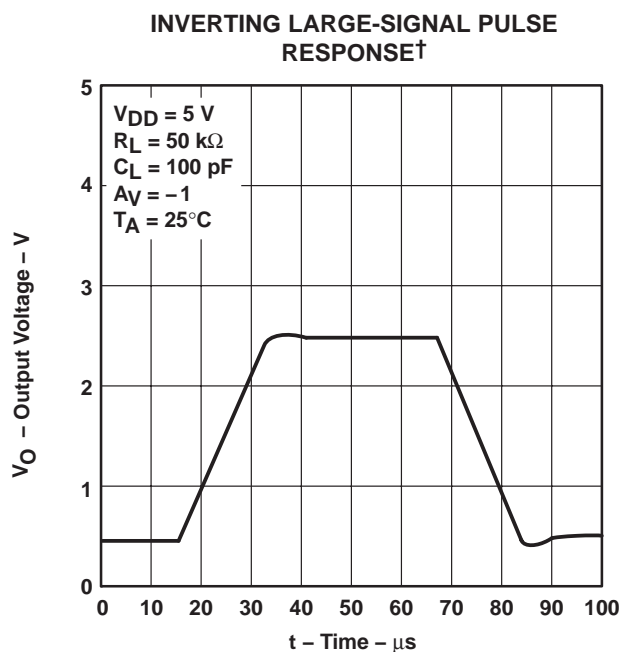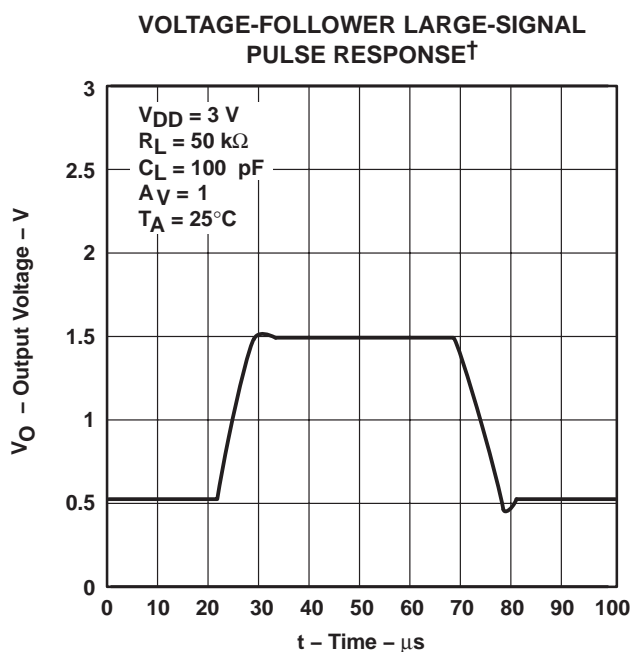**Figure 25**

† 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

V_{DD} = 5 V
R_L = 50 kΩ
C_L = 100 pF
T_A = 25°C
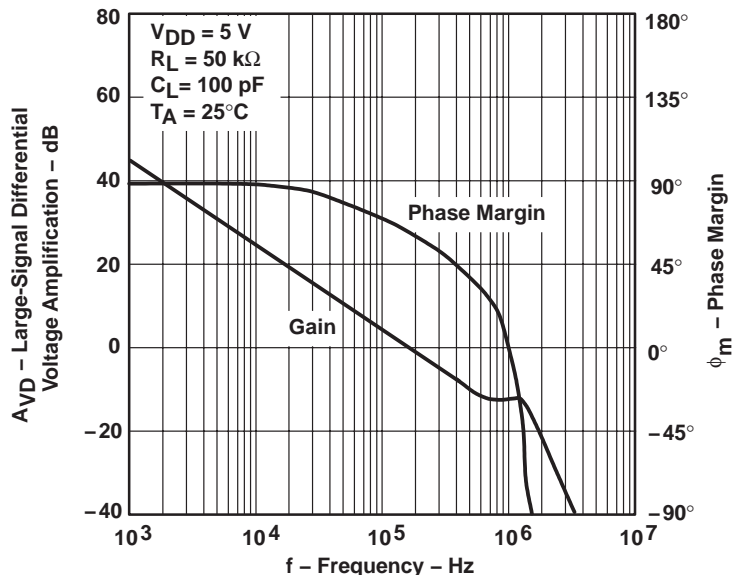
Figure 26

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

V_{DD} = 3 V
R_L = 50 kΩ
C_L = 100 pF
T_A = 25°C
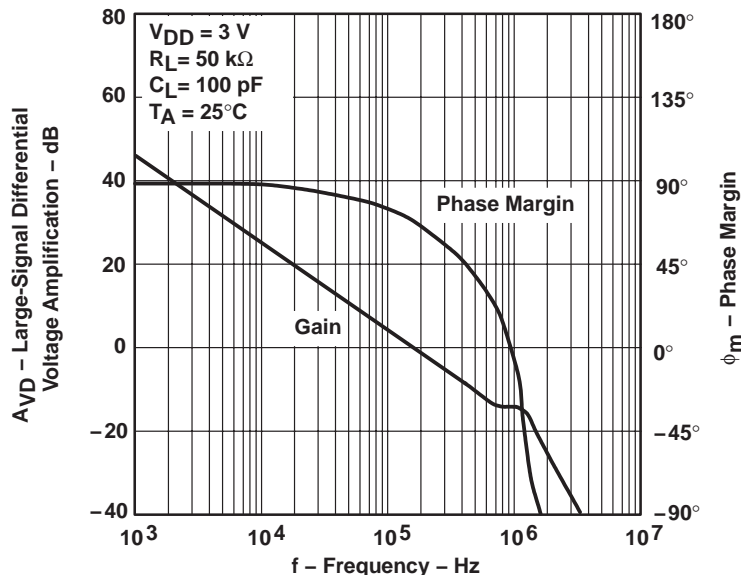
Figure 27

† 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.

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TYPICAL CHARACTERISTICS

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

Figure 28

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

Figure 29

**OUTPUT IMPEDANCE‡
vs
FREQUENCY**

Figure 30

**OUTPUT IMPEDANCE‡
vs
FREQUENCY**
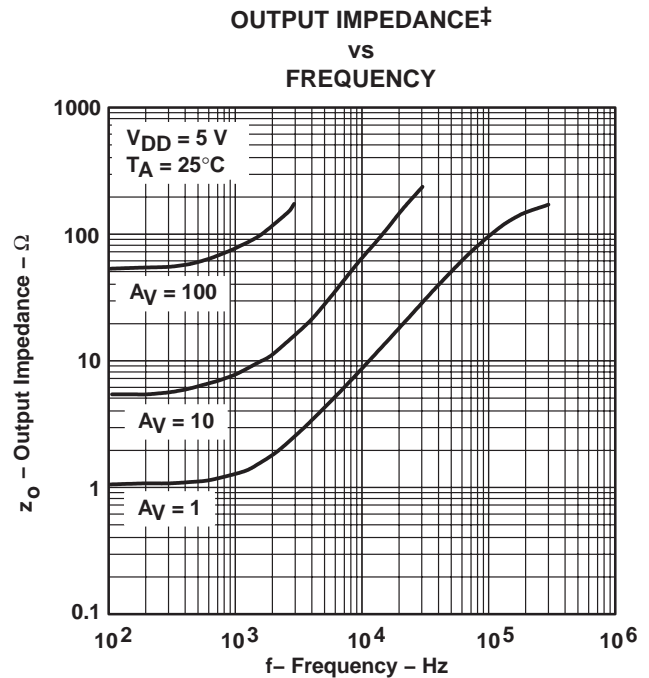
Figure 31

† 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

COMMON-MODE REJECTION RATIO†
vs
FREQUENCY

Figure 32

COMMON-MODE REJECTION RATIO†‡
vs
FREE-AIR TEMPERATURE

Figure 33

SUPPLY-VOLTAGE REJECTION RATIO†
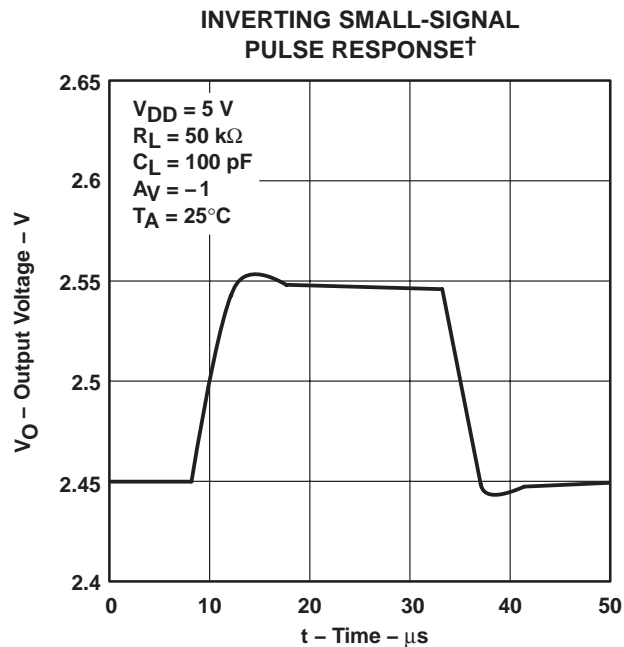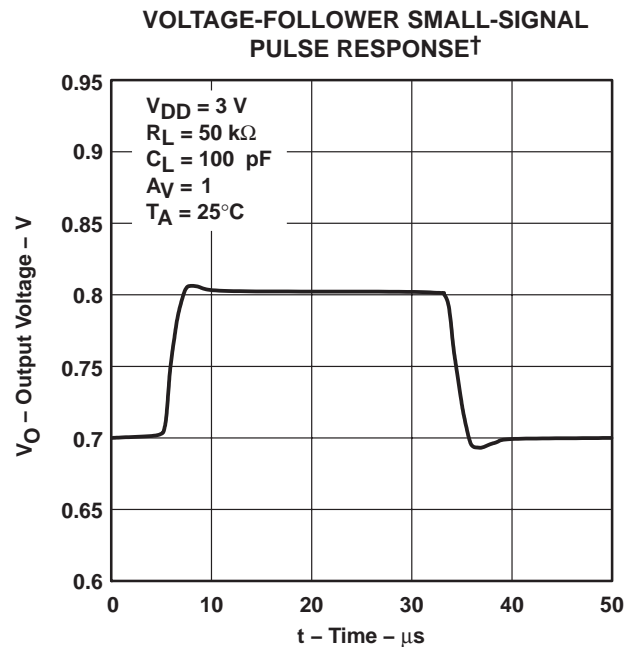vs
FREQUENCY

Figure 34

SUPPLY-VOLTAGE REJECTION RATIO†
vs
FREQUENCY

Figure 35

† 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.

![Texas Instruments logo] **TEXAS INSTRUMENTS**

TYPICAL CHARACTERISTICS

SUPPLY-VOLTAGE REJECTION RATIO†
vs
FREE-AIR TEMPERATURE

V_{DD} = 2.7 V to 8 V
$V_{IC} = V_O = V_{DD}/2$

Figure 36

TLV2252
SUPPLY CURRENT†
vs
SUPPLY VOLTAGE

V_O = 0
No Load

T_A = −40°C
T_A = 85°C
T_A = 25°C

Figure 37

TLV2254
SUPPLY CURRENT†
vs
SUPPLY VOLTAGE

V_O = 0
No Load

T_A = −40°C
T_A = 85°C
T_A = 25°C

Figure 38

SLEW RATE‡
vs
LOAD CAPACITANCE

V_{DD} = 5 V
A_V = −1
T_A = 25°C

SR −
SR +

Figure 39

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.
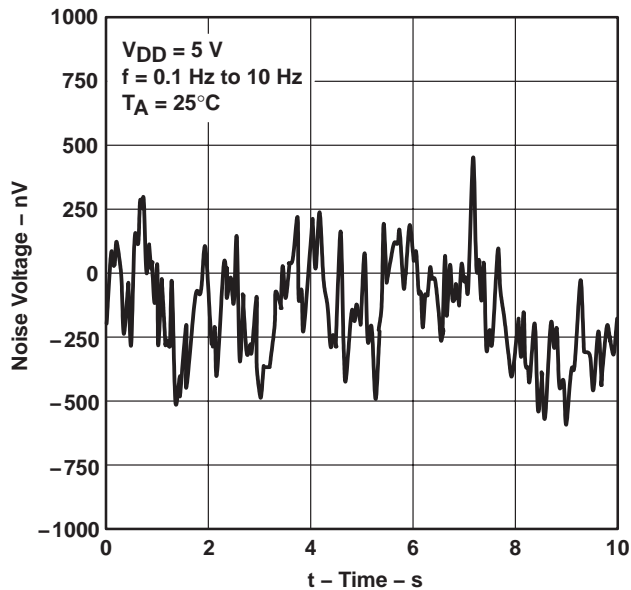‡ For all curves where V_{DD} = 5 V, all loads are referenced to 2.5 V. For all curves where V_{DD} = 3 V, all loads are referenced to 1.5 V.

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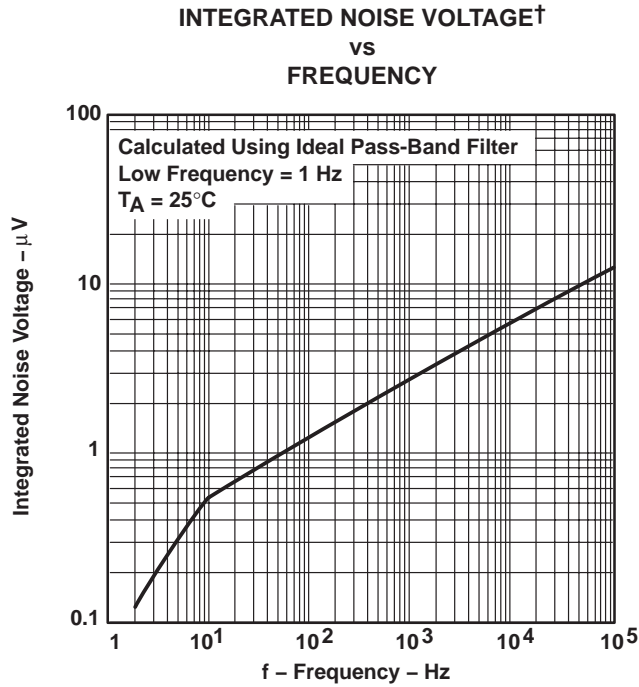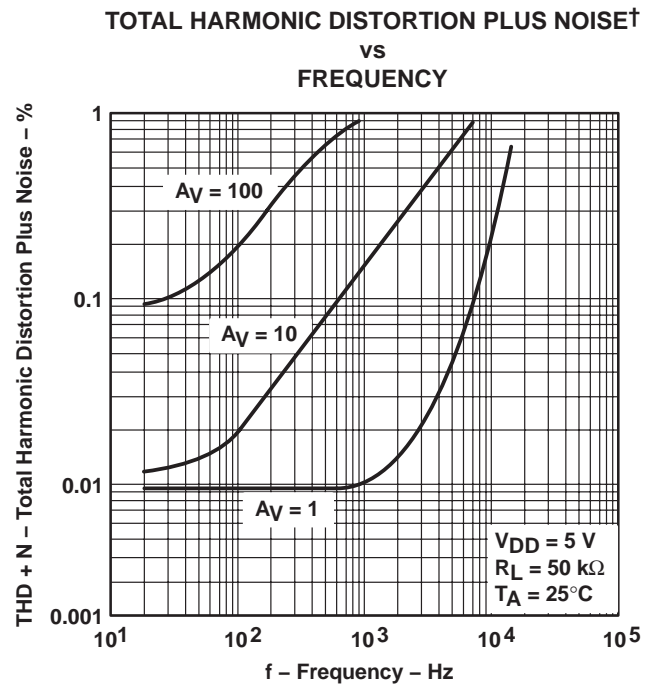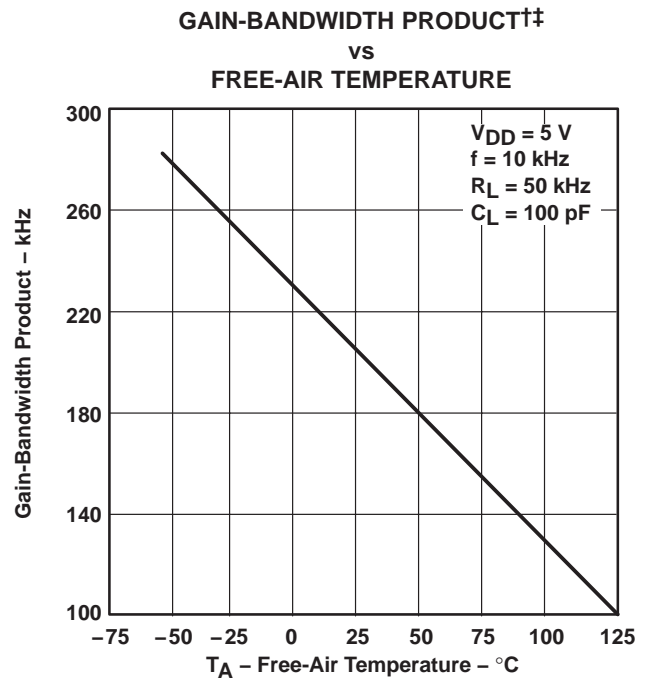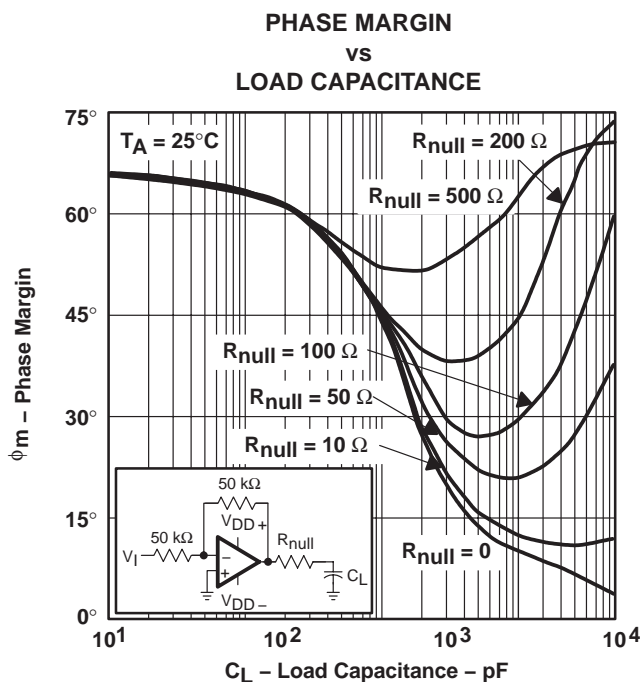POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

23

TYPICAL CHARACTERISTICS

SLEW RATE†‡
vs
FREE-AIR TEMPERATURE

V_{DD} = 5 V
R_L = 50 kΩ
C_L = 100 pF
A_V = 1

SR –

SR +

SR – Slew Rate – V/μs

T_A – Free-Air Temperature – °C

Figure 40

INVERTING LARGE-SIGNAL PULSE
RESPONSE†

V_{DD} = 3 V
R_L = 50 kΩ
C_L = 100 pF
A_V = −1
T_A = 25°C

V_O – Output Voltage – V

t – Time – μs

Figure 41

INVERTING LARGE-SIGNAL PULSE
RESPONSE†

V_{DD} = 5 V
R_L = 50 kΩ
C_L = 100 pF
A_V = −1
T_A = 25°C

V_O – Output Voltage – V

t – Time – μs

Figure 42

VOLTAGE-FOLLOWER LARGE-SIGNAL
PULSE RESPONSE†

V_{DD} = 3 V
R_L = 50 kΩ
C_L = 100 pF
A_V = 1
T_A = 25°C

V_O – Output Voltage – V

t – Time – μs

Figure 43

† 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.

TEXAS
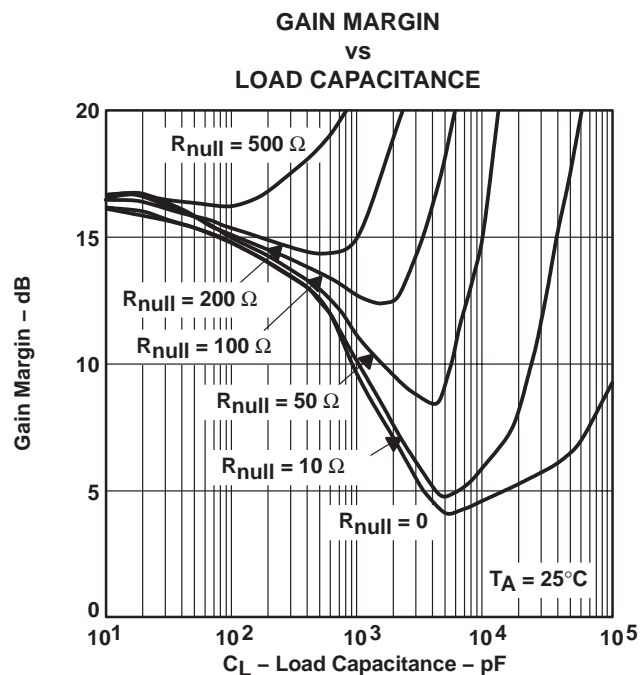**INSTRUMENTS**

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TYPICAL CHARACTERISTICS

**VOLTAGE-FOLLOWER LARGE-SIGNAL
PULSE RESPONSE†**

V_{DD} = 5 V
R_L = 50 kΩ
C_L = 100 pF
A_V = 1
T_A = 25°C

V_O – Output Voltage – V

t – Time – µs

Figure 44

**INVERTING SMALL-SIGNAL
PULSE RESPONSE†**

V_{DD} = 3 V
R_L = 50 kΩ
C_L = 100 pF
A_V = –1
T_A = 25°C

V_O – Output Voltage – V

t – Time – µs

Figure 45

**INVERTING SMALL-SIGNAL
PULSE RESPONSE†**

V_{DD} = 5 V
R_L = 50 kΩ
C_L = 100 pF
A_V = –1
T_A = 25°C

V_O – Output Voltage – V

t – Time – µs

Figure 46

**VOLTAGE-FOLLOWER SMALL-SIGNAL
PULSE RESPONSE†**

V_{DD} = 3 V
R_L = 50 kΩ
C_L = 100 pF
A_V = 1
T_A = 25°C

V_O – Output Voltage – V

t – Time – µs
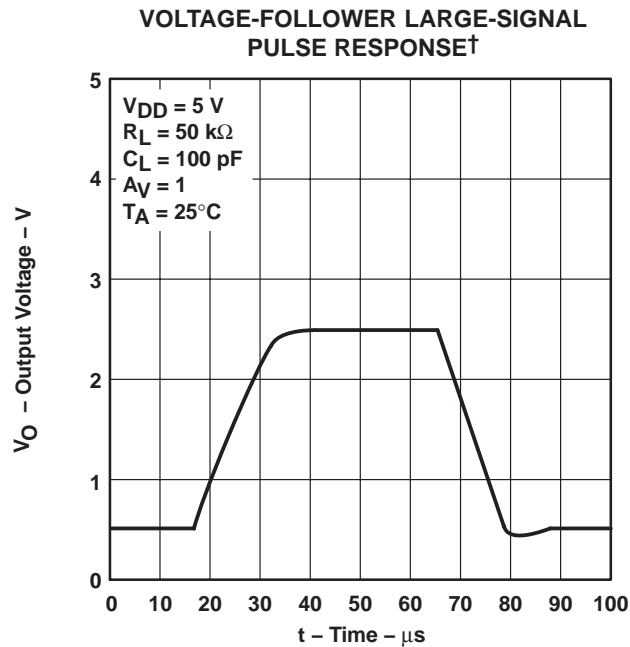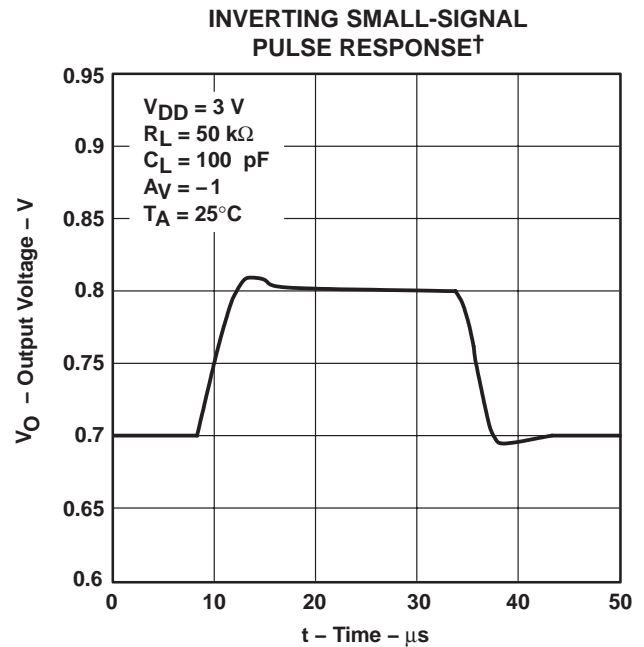
Figure 47

† 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

**VOLTAGE-FOLLOWER SMALL-SIGNAL
PULSE RESPONSE†**

$V_{DD} = 5$ V
$R_L = 50$ kΩ
$C_L = 100$ pF
$A_V = 1$
$T_A = 25°C$
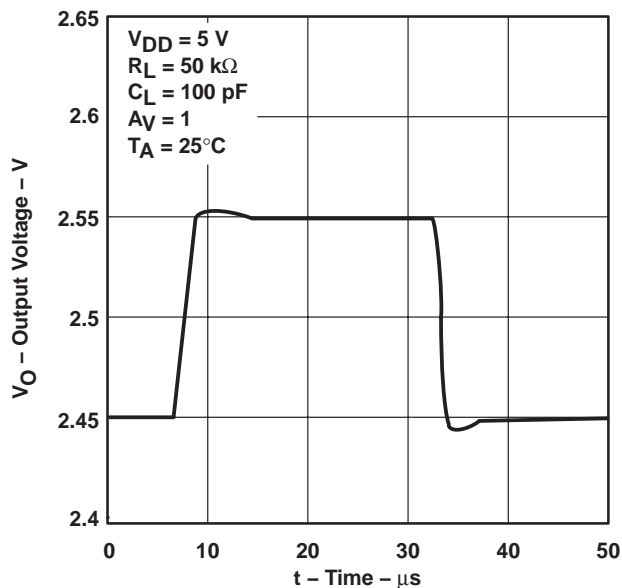
Figure 48

**EQUIVALENT INPUT NOISE VOLTAGE†
vs
FREQUENCY**
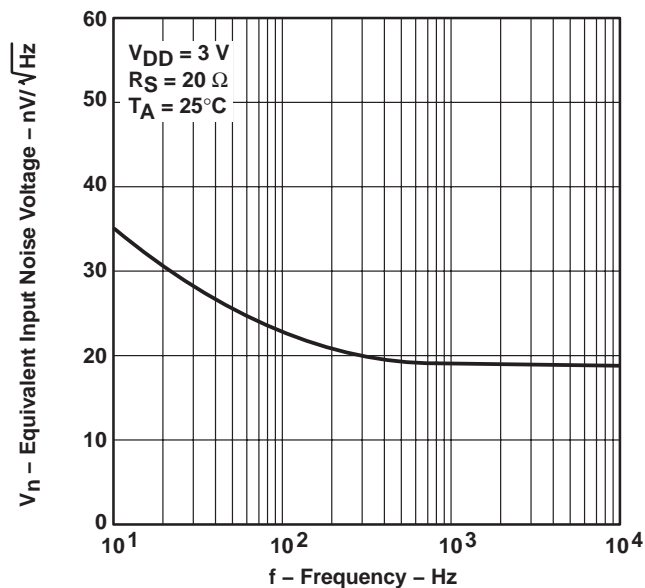
$V_{DD} = 3$ V
$R_S = 20$ Ω
$T_A = 25°C$

Figure 49

**EQUIVALENT INPUT NOISE VOLTAGE†
vs
FREQUENCY**
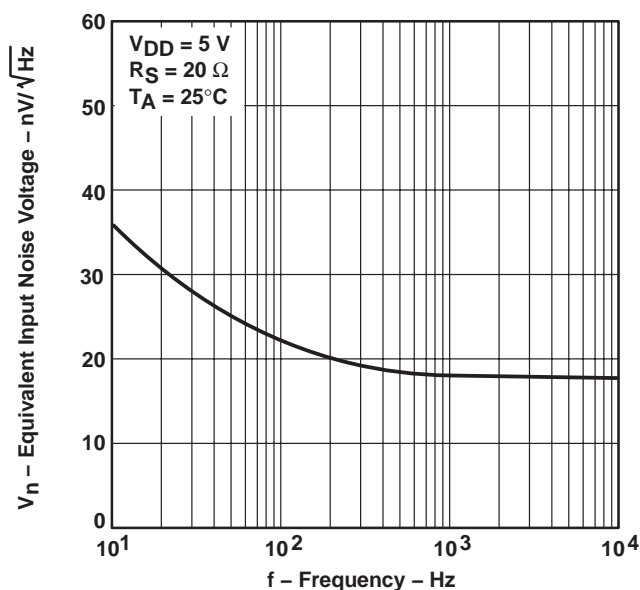
$V_{DD} = 5$ V
$R_S = 20$ Ω
$T_A = 25°C$

Figure 50

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

$V_{DD} = 5$ V
$f = 0.1$ Hz to 10 Hz
$T_A = 25°C$

Figure 51

† 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

INTEGRATED NOISE VOLTAGE†
vs
FREQUENCY

Calculated Using Ideal Pass-Band Filter
Low Frequency = 1 Hz
T_A = 25°C

Integrated Noise Voltage – μV

f – Frequency – Hz

Figure 52

TOTAL HARMONIC DISTORTION PLUS NOISE†
vs
FREQUENCY

A_V = 100

A_V = 10

A_V = 1

V_{DD} = 5 V
R_L = 50 kΩ
T_A = 25°C

THD + N – Total Harmonic Distortion Plus Noise – %

f – Frequency – Hz

Figure 53

GAIN-BANDWIDTH PRODUCT
vs
SUPPLY VOLTAGE

Gain-Bandwidth Product – kHz

V_{DD} – Supply Voltage – V

Figure 54

GAIN-BANDWIDTH PRODUCT†‡
vs
FREE-AIR TEMPERATURE

V_{DD} = 5 V
f = 10 kHz
R_L = 50 kHz
C_L = 100 pF

Gain-Bandwidth Product – kHz

T_A – Free-Air Temperature – °C
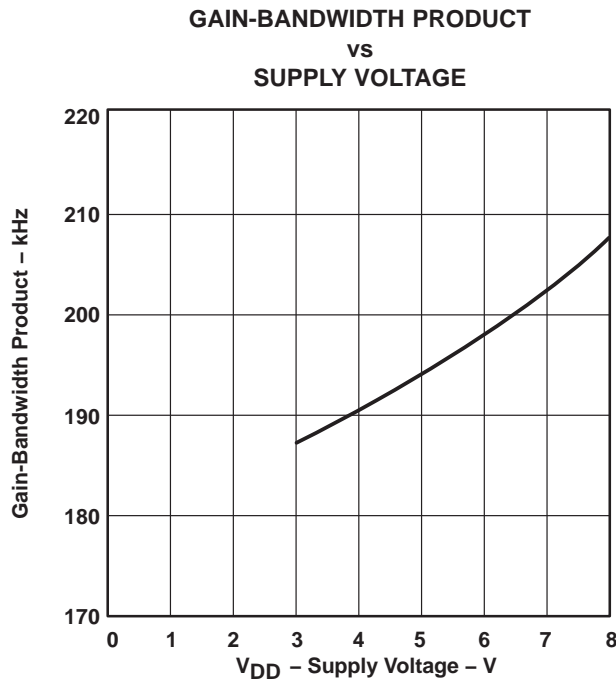
Figure 55

† 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.

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TYPICAL CHARACTERISTICS

**PHASE MARGIN
vs
LOAD CAPACITANCE**

Figure 56

**GAIN MARGIN
vs
LOAD CAPACITANCE**

Figure 57

**UNITY-GAIN BANDWIDTH
vs
LOAD CAPACITANCE**

Figure 58

**OVERESTIMATION OF PHASE MARGIN†
vs
LOAD CAPACITANCE**
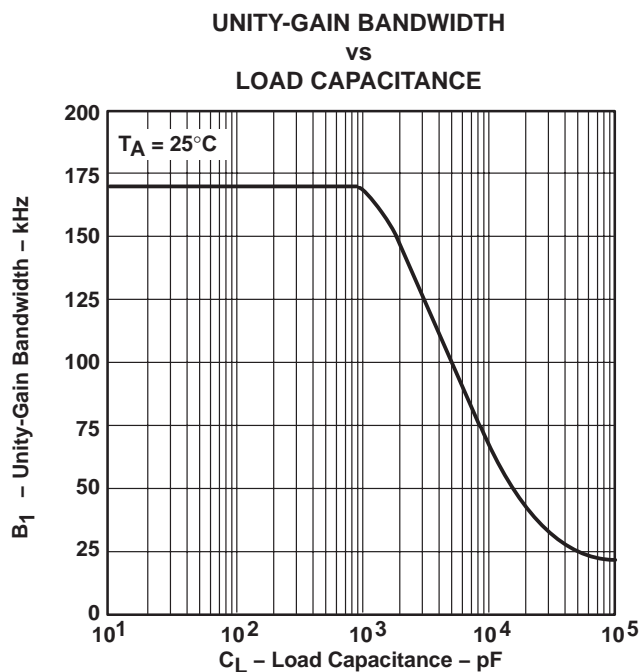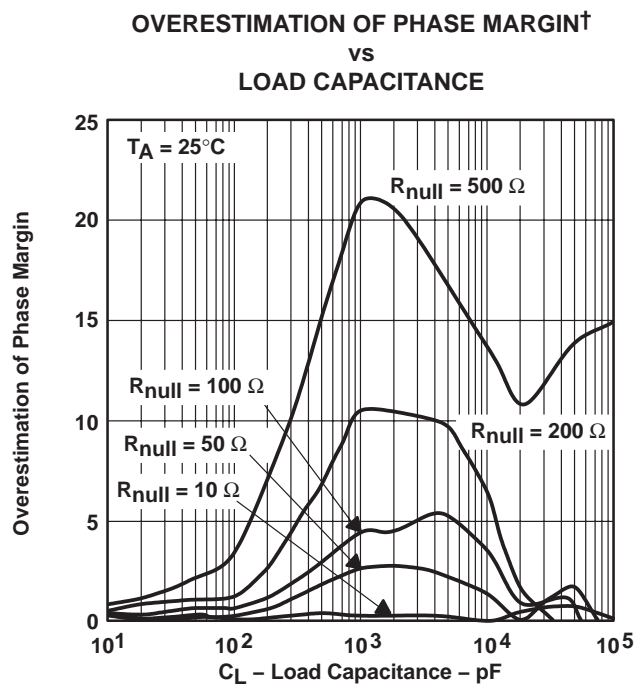
Figure 59

† 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.

TEXAS INSTRUMENTS

APPLICATION INFORMATION

driving large capacitive loads

The TLV2252 is designed to drive larger capacitive loads than most CMOS operational amplifiers. Figure 56 and Figure 57 illustrate its ability to drive loads up to 1000 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 60) improves the gain and phase margins when driving large capacitive loads. Figure 55 and Figure 56 show the effects of adding series resistances of 10 Ω, 50 Ω, 100 Ω, 200 Ω, and 500 Ω. The addition of this series resistor has two effects: the first adds a zero to the transfer function and the second 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.

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

Where :

$\Delta\phi_{m1}$ = improvement in phase margin

UGBW = unity-gain bandwidth frequency

R_{null} = output series resistance

C_L = load capacitance

The unity-gain bandwidth (UGBW) frequency decreases as the capacitive load increases (see Figure 58). To use equation 1, UGBW must be approximated from Figure 58.

Using equation 1 alone overestimates the improvement in phase margin as illustrated in Figure 59. The overestimation is caused by the decrease in the frequency of the pole associated with the load, providing additional phase shift and reducing the overall improvement in phase margin.

Using Figure 60, with equation 1 enables the designer to choose the appropriate output series resistance to optimize the design of circuits driving large capacitance loads.
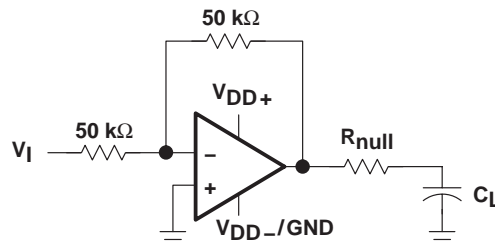
Figure 60. Series-Resistance Circuit

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 61 are generated using the TLV2252 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 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).

```
.SUBCKT TLV225x 1 2 3 4 5
       C1       11   12    6.369E−12
       C2       6    7     25.00E−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 57.62E6 −60E6 60E6 60E6 −60E6
       GA       6    0     11    12 26.86E−6
       GCM      0    6     10    99 2.686E−9
       ISS      3    10    DC 3.1E−6
       HLIM     90   0     VLIM 1K
       J1       11   2     10 JX
       J2       12   1     10 JX
       R2       6    9     100.0E3

       RD1      60   11    37.23E3
       RD2      60   12    37.23E3
       R01      8    5     84
       R02      7    99    84
       RP       3    4     71.43E3
       RSS      10   99    64.52E6
       VAD      60   4     −.5
       VB       9    0     DC 0
       VC       3    53    DC .605
       VE       54   4     DC .605
       VLIM     7    8     DC 0
       VLP      91   0     DC −0.235
       VLN      0    92    DC 7.5
.MODEL DX D (IS=800.0E−18)
.MODEL JX PJF (IS=500.0E−15 BETA=139E−6
+ VTO=−.05)
.ENDS
```

Figure 61. Boyle Macromodel and Subcircuit

PSpice and *Parts* are trademarks of MicroSim Corporation.

PACKAGING INFORMATION

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
TLV2252AQDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2252AQDRQ1	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
TLV2252QDRG4Q1	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2252QDRQ1	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
TLV2254AQDRG4Q1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2254AQDRQ1	ACTIVE	SOIC	D	14	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
TLV2254QDRG4Q1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLV2254QDRQ1	ACTIVE	SOIC	D	14	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.

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OTHER QUALIFIED VERSIONS OF TLV2252-Q1, TLV2252A-Q1, TLV2254-Q1, TLV2254A-Q1 :
● Catalog: TLV2252, TLV2252A, TLV2254, TLV2254A
● Enhanced Product: TLV2252-EP, TLV2252A-EP, TLV2254-EP, TLV2254A-EP
● Military: TLV2252M, TLV2252AM, TLV2254M, TLV2254AM

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications
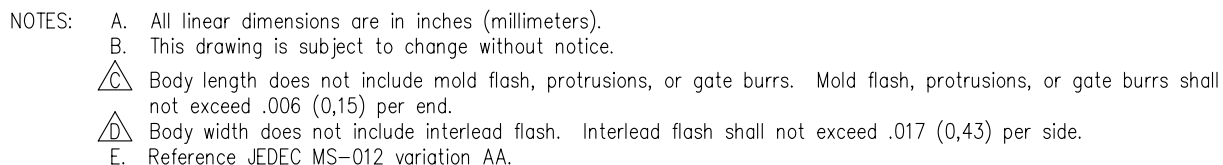- Military - QML certified for Military and Defense Applications

D (R−PDSO−G14)   PLASTIC SMALL−OUTLINE PACKAGE

4040047−4/J 09/09

NOTES: A. All linear dimensions are in inches (millimeters).
         B. This drawing is subject to change without notice.
         C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall
             not exceed .006 (0,15) per end.
         D. Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
         E. Reference JEDEC MS−012 variation AB.

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D (R−PDSO−G8)   PLASTIC SMALL−OUTLINE PACKAGE

0.197 (5,00)
0.189 (4,80)
△C

8   5

0.244 (6,20)
0.228 (5,80)

0.157 (4,00)   △D
0.150 (3,80)

Pin 1
Index Area

1   4

0.050 (1,27)

0.020 (0,51)
0.012 (0,31)

⊕ 0.010 (0,25) Ⓜ

0.069 (1,75) Max

0.010 (0,25)
0.004 (0,10)

0.010 (0,25)
0.005 (0,13)

0.004 (0,10)

Gauge Plane

Seating Plane

0.010 (0,25)

0°−8°

0.050 (1,27)
0.016 (0,40)

4040047−3/J   09/09

NOTES: A.   All linear dimensions are in inches (millimeters).
         B.   This drawing is subject to change without notice.
      △C   Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall
             not exceed .006 (0,15) per end.
      △D   Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
         E.   Reference JEDEC MS−012 variation AA.

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