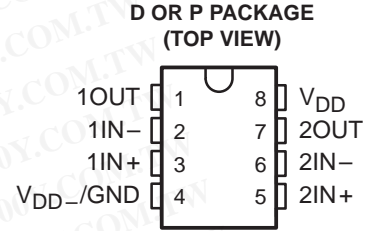


TLC252, TLC252A, TLC252B, TLC252Y, TLC25L2, TLC25L2A, TLC25L2B TLC25L2Y, TLC25M2, TLC25M2A, TLC25M2B, TLC25M2Y LinCMOS™ DUAL OPERATIONAL AMPLIFIERS

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- A-Suffix Versions Offer 5-mV V_{IO}
- B-Suffix Versions Offer 2-mV V_{IO}
- Wide Range of Supply Voltages
1.4 V to 16 V
- True Single-Supply Operation
- Common-Mode Input Voltage Includes the Negative Rail
- Low Noise . . . 30 nV/ $\sqrt{\text{Hz}}$ Typ at $f = 1$ kHz
(High-Bias Versions)

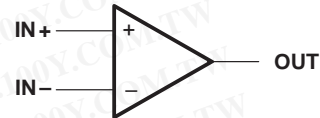


description

The TLC252, TLC25L2, and TLC25M2 are low-cost, low-power dual operational amplifiers designed to operate with single or dual supplies. These devices utilize the Texas Instruments silicon gate LinCMOS™ process, giving them stable input offset voltages that are available in selected grades of 2, 5, or 10 mV maximum, very high input impedances, and extremely low input offset and bias currents. Because the input common-mode range extends to the negative rail and the power consumption is extremely low, this series is ideally suited for battery-powered or energy-conserving applications. The series offers operation down to a 1.4-V supply, is stable at unity gain, and has excellent noise characteristics.

These devices have internal electrostatic-discharge (ESD) protection circuits that prevent catastrophic failures at voltages up to 2000 V as tested under MIL-STD-883C, Method 3015.1. However, care should be exercised in handling these devices as exposure to ESD may result in a degradation of the device parametric performance.

symbol (each amplifier)



AVAILABLE OPTIONS

T_A	V_{IOmax} AT 25°C	PACKAGED DEVICES		CHIP FORM (Y)
		SMALL OUTLINE (D)	PLASTIC DIP (P)	
0°C to 70°C	10 mV	TLC252CD	TLC252CP	TLC252Y
	5 mV	TLC252ACD	TLC252ACP	—
	2 mV	TLC252BCD	TLC252BCP	—
	10 mV	TLC25L2CD	TLC25L2CP	TLC25L2Y
	5 mV	TLC25L2ACD	TLC25L2ACP	—
	2 mV	TLC25L2BCD	TLC25L2BCP	—
	10 mV	TLC25M2CD	TLC25M2CP	TLC25M2Y
	5 mV	TLC25M2ACD	TLC25M2ACP	—
	2 mV	TLC25M2BCD	TLC25M2BCP	—

The D package is available taped and reeled. Add the suffix R to the device type (e.g., TLC252CDR). Chips are tested at 25°C.

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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**

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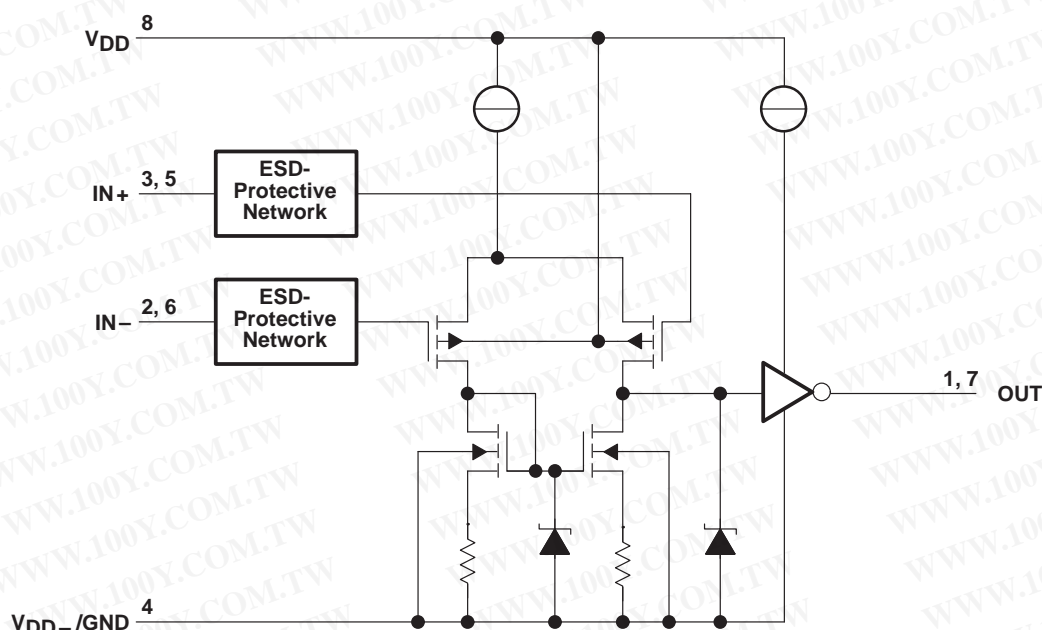
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description (continued)

Because of the extremely high input impedance and low input bias and offset currents, applications for the TLC252/25_2 series include many areas that have previously been limited to BIFET and NFET product types. Any circuit using high-impedance elements and requiring small offset errors is a good candidate for cost-effective use of these devices. Many features associated with bipolar technology are available with LinCMOS™ operational amplifiers without the power penalties of traditional bipolar devices. General applications such as transducer interfacing, analog calculations, amplifier blocks, active filters, and signal buffering are all easily designed with the TLC252/25_2 series devices. Remote and inaccessible equipment applications are possible using their low-voltage and low-power capabilities. The TLC252/25_2 series is well suited to solve the difficult problems associated with single-battery and solar-cell-powered applications. This series includes devices that are characterized for the commercial temperature range and are available in 8-pin plastic dip and the small-outline package. The device is also available in chip form.

The TLC252/25_2 series is characterized for operation from 0°C to 70°C.

equivalent schematic (each amplifier)



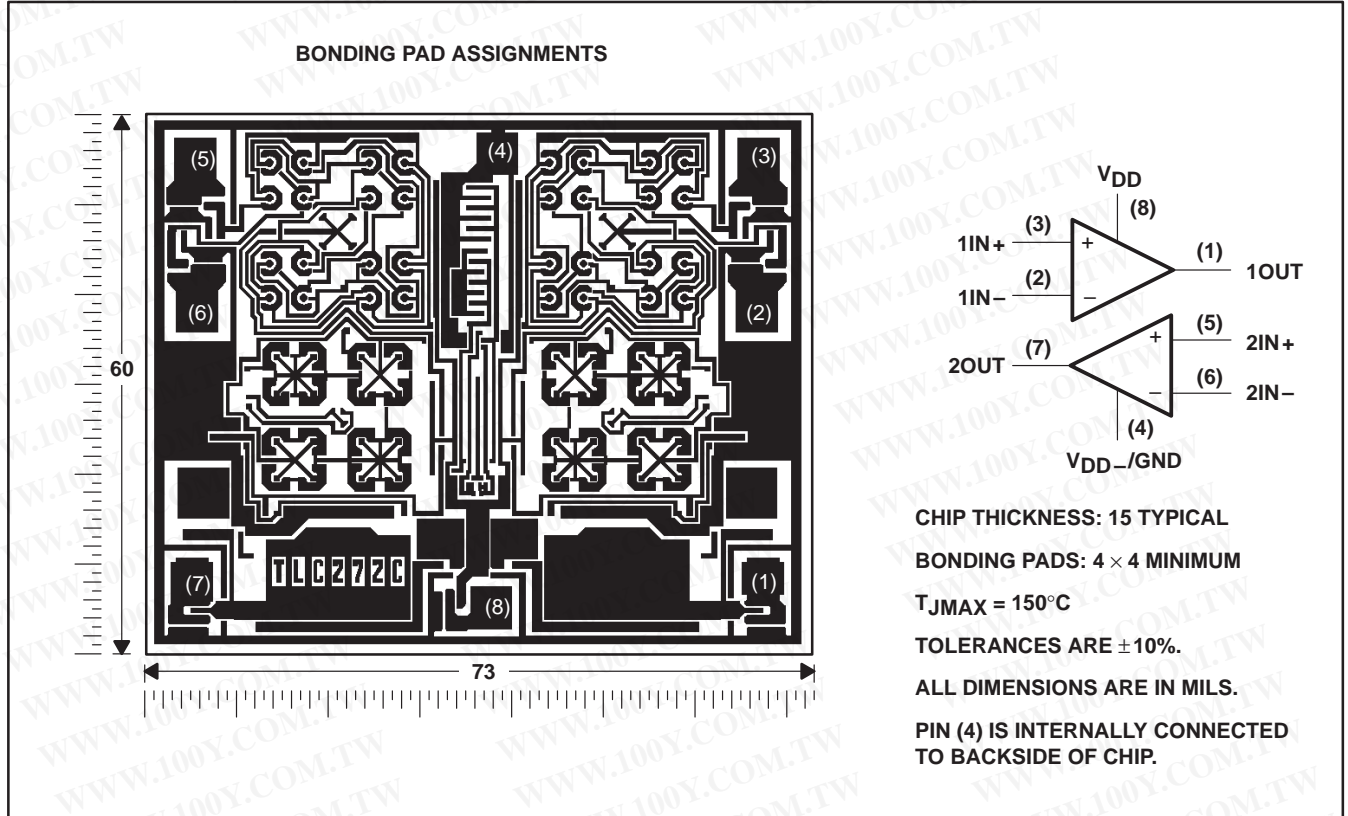
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TLC252Y, TLC25L2Y, and TLC25M2Y chip information

These chips, properly assembled, display characteristics similar to the TLC252/25_2. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.



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TLC25L2Y, TLC25M2, TLC25M2A, TLC25M2B, TLC25M2Y
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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{DD} (see Note 1)	18 V
Differential input voltage, V_{ID} (see Note 2)	± 18 V
Input voltage range, V_I (any input)	-0.3 V to 18 V
Duration of short circuit at (or below) 25°C free-air temperature (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, T_A	0°C to 70°C
Storage temperature range	-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 V_{DD-}/GND .
2. Differential voltages are at $IN+$, with respect to $IN-$.
3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure 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
D	725 mW	5.8 mW/°C	464 mW
P	1000 mW	8.0 mW/°C	640 mW

recommended operating conditions

		MIN	MAX	UNIT
Supply voltage, V_{DD}		1.4	16	V
Common-mode input voltage, V_{IC}	$V_{DD} = 1.4$ V	0	0.2	V
	$V_{DD} = 5$ V	-0.2	4	
	$V_{DD} = 10$ V	-0.2	9	
	$V_{DD} = 16$ V	-0.2	14	
Operating free-air temperature, T_A		0	70	°C

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electrical characteristics at specified free-air temperature, $V_{DD} = 1.4\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	TLC252_C			TLC25L2_C			TLC25M2_C			UNIT	
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX		
V_{IO}	Input offset voltage	$V_O = 0.2\text{ V}$, $R_S = 50\ \Omega$	25°C	10			10			10			mV
			0°C to 70°C	12			12			12			
			25°C	5			5			5			
			0°C to 70°C	6.5			6.5			6.5			
			25°C	2			2			2			
			0°C to 70°C	3			3			3			
α_{VIO}	Average temperature coefficient of input offset voltage		25°C to 70°C	1			1			1			$\mu\text{V}/^\circ\text{C}$
I_{IO}	Input offset current	$V_O = 0.2\text{ V}$	25°C	1			1			1			pA
			0°C to 70°C	300			300			300			
I_{IB}	Input bias current	$V_O = 0.2\text{ V}$	25°C	1			1			1			pA
			0°C to 70°C	600			600			600			
V_{ICR}	Common-mode input voltage range		25°C	0 to 0.2			0 to 0.2			0 to 0.2			V
V_{OM}	Peak output voltage swing‡	$V_{ID} = 100\text{ mV}$	25°C	450	700	450	700	450	700	450	700	mV	
A_{VD}	Large-signal differential voltage amplification	$V_O = 100\text{ to }300\text{ mV}$, $R_S = 50\ \Omega$	25°C	10			20			20			V/mV
CMRR	Common-mode rejection ratio	$V_O = 0.2\text{ V}$, $V_{IC} = V_{ICR\text{min}}$	25°C	60	77	60	77	60	77	60	77	dB	
I_{DD}	Supply current	$V_O = 0.2\text{ V}$, No load	25°C	300	375	25	34	200	250			μA	

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Unless otherwise noted, an output load resistor is connected from the output to ground and has the following value: for low bias $R_L = 1\text{ M}\Omega$, for medium bias $R_L = 100\text{ k}\Omega$, and for high bias $R_L = 10\text{ k}\Omega$.

‡ The output swings to the potential of V_{DD-}/GND .

operating characteristics, $V_{DD} = 1.4\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	TLC252_C			TLC25L2_C			TLC25M2_C			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
B_1	Unity-gain bandwidth	$A_V = 40\text{ dB}$, $C_L = 10\text{ pF}$, $R_S = 50\ \Omega$	12			12			12			kHz
SR	Slew rate at unity gain	See Figure 1	0.1			0.001			0.01			V/ μs
	Overshoot factor	See Figure 1	30%			35%			35%			

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

PARAMETER		TEST CONDITIONS		T_A^\dagger	TLC252C, TLC252AC, TLC252BC			UNIT
					MIN	TYP	MAX	
V_{IO}	Input offset voltage	TLC252C	$V_O = 1.4\text{ V},$ $R_S = 50\ \Omega,$	$V_{IC} = 0,$ $R_L = 10\text{ k}\Omega$	25°C	1.1	10	mV
					Full range		12	
		TLC252AC	$V_O = 1.4\text{ V},$ $R_S = 50\ \Omega,$	$V_{IC} = 0,$ $R_L = 10\text{ k}\Omega$	25°C	0.9	5	
					Full range		6.5	
		TLC252BC	$V_O = 1.4\text{ V},$ $R_S = 50\ \Omega,$	$V_{IC} = 0,$ $R_L = 10\text{ k}\Omega$	25°C	0.23	2	
					Full range		3	
α_{VIO}	Average temperature coefficient of input offset voltage			25°C to 70°C	1.8		$\mu\text{V}/^\circ\text{C}$	
I_{IO}	Input offset current (see Note 4)	$V_O = 2.5\text{ V},$	$V_{IC} = 2.5\text{ V}$	25°C	0.1		pA	
				70°C	7	300		
I_{IB}	Input bias current (see Note 4)	$V_O = 2.5\text{ V},$	$V_{IC} = 2.5\text{ V}$	25°C	0.6		pA	
				70°C	40	600		
V_{ICR}	Common-mode input voltage range (see Note 5)			25°C	-0.2 to 4	-0.3 to 4.2	V	
				Full range	-0.2 to 3.5		V	
V_{OH}	High-level output voltage	$V_{ID} = 100\text{ mV},$	$R_L = 10\text{ k}\Omega$	25°C	3.2	3.8	V	
				0°C	3	3.8		
				70°C	3	3.8		
V_{OL}	Low-level output voltage	$V_{ID} = -100\text{ mV},$	$I_{OL} = 0$	25°C		0 50	mV	
				0°C		0 50		
				70°C		0 50		
A_{VD}	Large-signal differential voltage amplification	$V_O = 0.25\text{ V to } 2\text{ V},$	$R_L = 10\text{ k}\Omega$	25°C	5	23	V/mV	
				0°C	4	27		
				70°C	4	20		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$		25°C	65	80	dB	
				0°C	60	84		
				70°C	60	85		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{DD}$)	$V_{DD} = 5\text{ V to } 10\text{ V},$	$V_O = 1.4\text{ V}$	25°C	65	95	dB	
				0°C	60	94		
				70°C	60	96		
I_{DD}	Supply current (two amplifiers)	$V_O = 2.5\text{ V},$ No load	$V_{IC} = 2.5\text{ V},$	25°C	1.4	3.2	mA	
				0°C	1.6	3.6		
				70°C	1.2	2.6		

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.

5. This range also applies to each input individually.

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electrical characteristics at specified free-air temperature, $V_{DD} = 10\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A †	TLC252C, TLC252AC, TLC252BC			UNIT
					MIN	TYP	MAX	
V_{IO}	Input offset voltage	TLC252C	$V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$	$V_{IC} = 0$, $R_L = 10\text{ k}\Omega$	25°C	1.1	10	mV
					Full range		12	
		TLC252AC	$V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$	$V_{IC} = 0$, $R_L = 10\text{ k}\Omega$	25°C	0.9	5	
					Full range		6.5	
		TLC252BC	$V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$	$V_{IC} = 0$, $R_L = 10\text{ k}\Omega$	25°C	0.29	2	
					Full range		3	
α_{VIO}	Average temperature coefficient of input offset voltage			25°C to 70°C	2		$\mu\text{V}/^\circ\text{C}$	
I_{IO}	Input offset current (see Note 4)	$V_O = 2.5\text{ V}$, $V_{IC} = 2.5\text{ V}$		25°C	0.1		pA	
				70°C	7	300		
I_{IB}	Input bias current (see Note 4)	$V_O = 2.5\text{ V}$, $V_{IC} = 2.5\text{ V}$		25°C	0.6		pA	
				70°C	50	600		
V_{ICR}	Common-mode input voltage range (see Note 5)			25°C	-0.2 to 9	-0.3 to 9.2	V	
				Full range	-0.2 to 8.5		V	
V_{OH}	High-level output voltage	$V_{ID} = 100\text{ mV}$, $R_L = 10\text{ k}\Omega$		25°C	8	8.5	V	
				0°C	8	8.5		
				70°C	7.8	8.4		
V_{OL}	Low-level output voltage	$V_{ID} = -100\text{ mV}$, $I_{OL} = 0$		25°C	0	50	mV	
				0°C	0	50		
				70°C	0	50		
A_{VD}	Large-signal differential voltage amplification	$V_O = 1\text{ V to }6\text{ V}$, $R_L = 10\text{ k}\Omega$		25°C	10	36	V/mV	
				0°C	7.5	42		
				70°C	7.5	32		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$		25°C	65	85	dB	
				0°C	60	88		
				70°C	60	88		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{DD}$)	$V_{DD} = 5\text{ V to }10\text{ V}$, $V_O = 1.4\text{ V}$		25°C	65	95	dB	
				0°C	60	94		
				70°C	60	96		
I_{DD}	Supply current (two amplifiers)	$V_O = 5\text{ V}$, No load		$V_{IC} = 5\text{ V}$	25°C	1.9	4	mA
					0°C	2.3	4.4	
					70°C	1.6	3.4	

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.

5. This range also applies to each input individually.

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operating characteristics, $V_{DD} = 5\text{ V}$

PARAMETER	TEST CONDITIONS	T_A	TLC252C, TLC252AC, TLC252BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, See Figure 1	$V_{I(PP)} = 1\text{ V}$	25°C	3.6		V/ μ s
			0°C	4		
			70°C	3		
		$V_{I(PP)} = 2.5\text{ V}$	25°C	2.9		
			0°C	3.1		
			70°C	2.5		
V_n Equivalent input noise voltage	$f = 1\text{ kHz}$, $R_S = 20\ \Omega$, See Figure 2	25°C	25		nV/ $\sqrt{\text{Hz}}$	
B_{OM} Maximum output-swing bandwidth	$V_O = V_{OH}$, See Figure 1	$C_L = 20\text{ pF}$, $R_L = 100\text{ k}\Omega$	25°C	320		kHz
			0°C	340		
			70°C	260		
B_1 Unity-gain bandwidth	$V_I = 10\text{ mV}$, $C_L = 20\text{ pF}$, See Figure 3	25°C	1.7		MHz	
		0°C	2			
		70°C	1.3			
ϕ_m Phase margin	$V_I = 10\text{ mV}$, See Figure 3	$f = B_1$, $C_L = 20\text{ pF}$	25°C	46°		
			0°C	47°		
			70°C	43°		

operating characteristics, $V_{DD} = 10\text{ V}$

PARAMETER	TEST CONDITIONS	T_A	TLC252C, TLC252AC, TLC252BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, See Figure 1	$V_{I(PP)} = 1\text{ V}$	25°C	5.3		V/ μ s
			0°C	5.9		
			70°C	4.3		
		$V_{I(PP)} = 5.5\text{ V}$	25°C	4.6		
			0°C	5.1		
			70°C	3.8		
V_n Equivalent input noise voltage	$f = 1\text{ kHz}$, $R_S = 20\ \Omega$, See Figure 2	25°C	25		nV/ $\sqrt{\text{Hz}}$	
B_{OM} Maximum output-swing bandwidth	$V_O = V_{OH}$, See Figure 1	$C_L = 20\text{ pF}$, $R_L = 100\text{ k}\Omega$	25°C	200		kHz
			0°C	220		
			70°C	140		
B_1 Unity-gain bandwidth	$V_I = 10\text{ mV}$, $C_L = 20\text{ pF}$, See Figure 3	25°C	2.2		MHz	
		0°C	2.5			
		70°C	1.8			
ϕ_m Phase margin	$V_I = 10\text{ mV}$, See Figure 3	$f = B_1$, $C_L = 20\text{ pF}$	25°C	49°		
			0°C	50°		
			70°C	46°		

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

PARAMETER		TEST CONDITIONS	T_A †	TLC25L2C TLC25L2AC TLC25L2BC			UNIT
				MIN	TYP	MAX	
V_{IO}	Input offset voltage	TLC252C $V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 0$, $R_L = 1\text{ M}\Omega$	25°C	1.1		10	mV
			Full range			12	
		TLC252AC $V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 0$, $R_L = 1\text{ M}\Omega$	25°C	0.9		5	
			Full range			6.5	
		TLC252BC $V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 0$, $R_L = 1\text{ M}\Omega$	25°C	0.204		2	
			Full range			3	
α_{VIO}	Average temperature coefficient of input offset voltage		25°C to 70°C	1.1		$\mu\text{V}/^\circ\text{C}$	
I_{IO}	Input offset current (see Note 4)	$V_O = 2.5\text{ V}$, $V_{IC} = 2.5\text{ V}$	25°C	0.1		pA	
			70°C	7	300		
I_{IB}	Input bias current (see Note 4)	$V_O = 2.5\text{ V}$, $V_{IC} = 2.5\text{ V}$	25°C	0.6		pA	
			70°C	50	600		
V_{ICR}	Common-mode input voltage range (see Note 5)		25°C	-0.2 to 4	-0.3 to 4.2	V	
			Full range	-0.2 to 3.5		V	
V_{OH}	High-level output voltage	$V_{ID} = 100\text{ mV}$, $R_L = 1\text{ M}\Omega$	25°C	3.2	4.1	V	
			0°C	3	4.1		
			70°C	3	4.2		
V_{OL}	Low-level output voltage	$V_{ID} = -100\text{ mV}$, $I_{OL} = 0$	25°C	0	50	mV	
			0°C	0	50		
			70°C	0	50		
A_{VD}	Large-signal differential voltage amplification	$V_O = 0.25\text{ V to } 2\text{ V}$, $R_L = 1\text{ M}\Omega$	25°C	50	700	V/mV	
			0°C	50	700		
			70°C	50	380		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	65	94	dB	
			0°C	60	95		
			70°C	60	95		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{DD}$)	$V_{DD} = 5\text{ V to } 10\text{ V}$, $V_O = 1.4\text{ V}$	25°C	70	97	dB	
			0°C	60	97		
			70°C	60	98		
I_{DD}	Supply current (two amplifiers)	$V_O = 2.5\text{ V}$, No load $V_{IC} = 2.5\text{ V}$	25°C	20	34	μA	
			0°C	24	42		
			70°C	16	28		

† Full range is 0°C to 70°C.

- NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
 5. This range also applies to each input individually.

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electrical characteristics at specified free-air temperature, $V_{DD} = 10\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A †	TLC25L2C TLC25L2AC TLC25L2BC			UNIT
				MIN	TYP	MAX	
V_{IO}	Input offset voltage	TLC252C $V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 0$, $R_L = 1\text{ M}\Omega$	25°C	1.1	10	mV	
			Full range		12		
		TLC252AC $V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 0$, $R_L = 1\text{ M}\Omega$	25°C	0.9	5		
			Full range		6.5		
		TLC252BC $V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 0$, $R_L = 1\text{ M}\Omega$	25°C	0.235	2		
			Full range		3		
α_{VIO}	Average temperature coefficient of input offset voltage		25°C to 70°C	1		$\mu\text{V}/^\circ\text{C}$	
I_{IO}	Input offset current (see Note 4)	$V_O = 5\text{ V}$, $V_{IC} = 5\text{ V}$	25°C	0.1		pA	
			70°C	8	300		
I_{IB}	Input bias current (see Note 4)	$V_O = 5\text{ V}$, $V_{IC} = 5\text{ V}$	25°C	0.7		pA	
			70°C	50	600		
V_{ICR}	Common-mode input voltage range (see Note 5)		25°C	-0.2 to 9	-0.3 to 9.2	V	
			Full range	-0.2 to 8.5			
V_{OH}	High-level output voltage	$V_{ID} = 100\text{ mV}$, $R_L = 1\text{ M}\Omega$	25°C	8	8.9	V	
			0°C	7.8	8.9		
			70°C	7.8	8.9		
V_{OL}	Low-level output voltage	$V_{ID} = -100\text{ mV}$, $I_{OL} = 0$	25°C	0	50	mV	
			0°C	0	50		
			70°C	0	50		
A_{VD}	Large-signal differential voltage amplification	$V_O = 1\text{ V to }6\text{ V}$, $R_L = 1\text{ M}\Omega$	25°C	50	860	V/mV	
			0°C	50	1025		
			70°C	50	660		
$CMRR$	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	65	97	dB	
			0°C	60	97		
			70°C	60	97		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{DD}$)	$V_{DD} = 5\text{ V to }10\text{ V}$, $V_O = 1.4\text{ V}$	25°C	70	97	dB	
			0°C	60	97		
			70°C	60	98		
I_{DD}	Supply current (two amplifiers)	$V_O = 5\text{ V}$, No load $V_{IC} = 5\text{ V}$	25°C	29	46	μA	
			0°C	36	66		
			70°C	22	40		

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.

5. This range also applies to each input individually.

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operating characteristics, $V_{DD} = 5\text{ V}$

PARAMETER	TEST CONDITIONS	T _A	TLC25L2C TLC25L2AC TLC25L2BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	R _L = 1 MΩ, C _L = 20 pF, See Figure 1	V _{I(PP)} = 1 V	25°C	0.03		V/μs
			0°C	0.04		
			70°C	0.03		
		V _{I(PP)} = 2.5 V	25°C	0.03		
			0°C	0.03		
			70°C	0.02		
V _n Equivalent input noise voltage	f = 1 kHz, R _S = 20 Ω, See Figure 2	25°C	68		nV/√Hz	
B _{OM} Maximum output-swing bandwidth	V _O = V _{OH} , C _L = 20 pF, R _L = 1 MΩ, See Figure	25°C	5		kHz	
		0°C	6			
		70°C	4.5			
B ₁ Unity-gain bandwidth	V _I = 10 mV, C _L = 20 pF, See Figure 3	25°C	85		MHz	
		0°C	100			
		70°C	65			
φ _m Phase margin	V _I = 10 mV, f = B ₁ , C _L = 20 pF, See Figure 3	25°C	34°			
		0°C	36°			
		70°C	30°			

operating characteristics, $V_{DD} = 10\text{ V}$

PARAMETER	TEST CONDITIONS	T _A	TLC25L2C TLC25L2AC TLC25L2BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	R _L = 1 MΩ, C _L = 20 pF, See Figure 1	V _{I(PP)} = 1 V	25°C	0.05		V/μs
			0°C	0.05		
			70°C	0.04		
		V _{I(PP)} = 5.5 V	25°C	0.04		
			0°C	0.05		
			70°C	0.04		
V _n Equivalent input noise voltage	f = 1 kHz, R _S = 20 Ω, See Figure 2	25°C	68		nV/√Hz	
B _{OM} Maximum output-swing bandwidth	V _O = V _{OH} , C _L = 20 pF, R _L = 1 MΩ, See Figure 1	25°C	1		kHz	
		0°C	1.3			
		70°C	0.9			
B ₁ Unity-gain bandwidth	V _I = 10 mV, C _L = 20 pF, See Figure 3	25°C	110		MHz	
		0°C	125			
		70°C	90			
φ _m Phase margin	V _I = 10 mV, f = B ₁ , C _L = 20 pF, See Figure 3	25°C	38°			
		0°C	40°			
		70°C	34°			

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

PARAMETER		TEST CONDITIONS		T_A †	TLC25M2C TLC25M2AC TLC25M2BC			UNIT
					MIN	TYP	MAX	
V_{IO}	Input offset voltage	TLC252C	$V_O = 1.4\text{ V},$ $R_S = 50\ \Omega,$	$V_{IC} = 0,$ $R_L = 100\text{ k}\Omega$	25°C	1.1	10	mV
					Full range		12	
		TLC252AC	$V_O = 1.4\text{ V},$ $R_S = 50\ \Omega,$	$V_{IC} = 0,$ $R_L = 100\text{ k}\Omega$	25°C	0.9	5	
					Full range		6.5	
		TLC252BC	$V_O = 1.4\text{ V},$ $R_S = 50\ \Omega,$	$V_{IC} = 0,$ $R_L = 100\text{ k}\Omega$	25°C	0.22	2	
					Full range		3	
α_{VIO}	Average temperature coefficient of input offset voltage			25°C to 70°C	1.7		$\mu\text{V}/^\circ\text{C}$	
I_{IO}	Input offset current (see Note 4)	$V_O = 2.5\text{ V},$	$V_{IC} = 2.5\text{ V}$	25°C	0.1		pA	
				70°C	7	300		
I_{IB}	Input bias current (see Note 4)	$V_O = 2.5\text{ V},$	$V_{IC} = 2.5\text{ V}$	25°C	0.6		pA	
				70°C	40	600		
V_{ICR}	Common-mode input voltage range (see Note 5)			25°C	-0.2 to 4	-0.3 to 4.2	V	
				Full range	-0.2 to 3.5		V	
V_{OH}	High-level output voltage	$V_{ID} = 100\text{ mV},$	$R_L = 100\text{ k}\Omega$	25°C	3.2	3.9	V	
				0°C	3	3.9		
				70°C	3	4		
V_{OL}	Low-level output voltage	$V_{ID} = -100\text{ mV},$	$I_{OL} = 0$	25°C	0	50	mV	
				0°C	0	50		
				70°C	0	50		
A_{VD}	Large-signal differential voltage amplification	$V_O = 0.25\text{ V to }2\text{ V},$	$R_L = 100\text{ k}\Omega$	25°C	25	170	V/mV	
				0°C	15	200		
				70°C	15	140		
$CMRR$	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$		25°C	65	91	dB	
				0°C	60	91		
				70°C	60	92		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{DD}$)	$V_{DD} = 5\text{ V to }10\text{ V},$	$V_O = 1.4\text{ V}$	25°C	70	93	dB	
				0°C	60	92		
				70°C	60	94		
I_{DD}	Supply current (two amplifiers)	$V_O = 2.5\text{ V},$ No load	$V_{IC} = 2.5\text{ V},$	25°C	210	560	μA	
				0°C	250	640		
				70°C	170	440		

† Full range is 0°C to 70°C.

NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.

5. This range also applies to each input individually.

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electrical characteristics at specified free-air temperature, $V_{DD} = 10\text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A †	TLC25M2C TLC25M2AC TLC25M2BC			UNIT
				MIN	TYP	MAX	
V_{IO}	Input offset voltage	TLC252C $V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 0$, $R_L = 100\text{ k}\Omega$	25°C	1.1		10	mV
			Full range			12	
		TLC252AC $V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 0$, $R_L = 100\text{ k}\Omega$	25°C	0.9		5	
			Full range			6.5	
		TLC252BC $V_O = 1.4\text{ V}$, $R_S = 50\ \Omega$, $V_{IC} = 0$, $R_L = 100\text{ k}\Omega$	25°C	0.224		2	
			Full range			3	
α_{VIO}	Average temperature coefficient of input offset voltage		25°C to 70°C	2.1		$\mu\text{V}/^\circ\text{C}$	
I_{IO}	Input offset current (see Note 4)	$V_O = 5\text{ V}$, $V_{IC} = 5\text{ V}$	25°C	0.1		pA	
			70°C	7	300		
I_{IB}	Input bias current (see Note 4)	$V_O = 5\text{ V}$, $V_{IC} = 5\text{ V}$	25°C	0.7		pA	
			70°C	50	600		
V_{ICR}	Common-mode input voltage range (see Note 5)		25°C	-0.2 to 9	-0.3 to 9.2	V	
			Full range	-0.2 to 8.5		V	
V_{OH}	High-level output voltage	$V_{ID} = 100\text{ mV}$, $R_L = 100\text{ k}\Omega$	25°C	8	8.7	V	
			0°C	7.8	8.7		
			70°C	7.8	8.7		
V_{OL}	Low-level output voltage	$V_{ID} = -100\text{ mV}$, $I_{OL} = 0$	25°C	0	50	mV	
			0°C	0	50		
			70°C	0	50		
A_{VD}	Large-signal differential voltage amplification	$V_O = 1\text{ V to }6\text{ V}$, $R_L = 100\text{ k}\Omega$	25°C	25	275	V/mV	
			0°C	15	320		
			70°C	15	230		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}$	25°C	65	94	dB	
			0°C	60	94		
			70°C	60	94		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{DD}$)	$V_{DD} = 5\text{ V to }10\text{ V}$, $V_O = 1.4\text{ V}$	25°C	70	93	dB	
			0°C	60	92		
			70°C	60	94		
I_{DD}	Supply current (two amplifiers)	$V_O = 5\text{ V}$, No load $V_{IC} = 5\text{ V}$	25°C	285	600	μA	
			0°C	345	800		
			70°C	220	560		

† Full range is 0°C to 70°C.

- NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
 5. This range also applies to each input individually.

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operating characteristics, $V_{DD} = 5\text{ V}$

PARAMETER	TEST CONDITIONS	T_A	TLC25M2C TLC25M2AC TLC25M2BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$R_L = 100\text{ k}\Omega$, $C_L = 20\text{ pF}$, See Figure 1	$V_{I(PP)} = 1\text{ V}$	25°C	0.43		V/ μ s
			0°C	0.46		
			70°C	0.36		
		$V_{I(PP)} = 2.5\text{ V}$	25°C	0.40		
			0°C	0.43		
			70°C	0.34		
V_n Equivalent input noise voltage	$f = 1\text{ kHz}$, $R_S = 20\ \Omega$, See Figure 2	25°C	32		nV/ $\sqrt{\text{Hz}}$	
B_{OM} Maximum output-swing bandwidth	$V_O = V_{OH}$, $C_L = 20\text{ pF}$, See Figure 1	$R_L = 100\text{ k}\Omega$	25°C	55		kHz
			0°C	60		
			70°C	50		
B_1 Unity-gain bandwidth	$V_I = 10\text{ mV}$, $C_L = 20\text{ pF}$, See Figure 3	25°C	525		MHz	
		0°C	600			
		70°C	400			
ϕ_m Phase margin	$V_I = 10\text{ mV}$, $f = B_1$, See Figure 3	$C_L = 20\text{ pF}$	25°C	40°		
			0°C	41°		
			70°C	39°		

operating characteristics, $V_{DD} = 10\text{ V}$

PARAMETER	TEST CONDITIONS	T_A	TLC25M2C TLC25M2AC TLC25M2BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain	$R_L = 100\text{ k}\Omega$, $C_L = 20\text{ pF}$, See Figure 1	$V_{I(PP)} = 1\text{ V}$	25°C	0.62		V/ μ s
			0°C	0.67		
			70°C	0.51		
		$V_{I(PP)} = 5.5\text{ V}$	25°C	0.56		
			0°C	0.61		
			70°C	0.46		
V_n Equivalent input noise voltage	$f = 1\text{ kHz}$, $R_S = 20\ \Omega$, See Figure 2	25°C	32		nV/ $\sqrt{\text{Hz}}$	
B_{OM} Maximum output-swing bandwidth	$V_O = V_{OH}$, $C_L = 20\text{ pF}$, See Figure 1	$R_L = 100\text{ k}\Omega$	25°C	35		kHz
			0°C	40		
			70°C	30		
B_1 Unity-gain bandwidth	$V_I = 10\text{ mV}$, $C_L = 20\text{ pF}$, See Figure 3	25°C	635		MHz	
		0°C	710			
		70°C	510			
ϕ_m Phase margin	$V_I = 10\text{ mV}$, $f = B_1$, See Figure 3	$C_L = 20\text{ pF}$	25°C	43°		
			0°C	44°		
			70°C	42°		

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electrical characteristics, $V_{DD} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS	TLC252Y			TLC25L2Y			TLC25M2Y			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage $V_O = 1.4\text{ V}$, $V_{IC} = 0\text{ V}$, $R_S = 50\ \Omega$, See Note 6		1.1	10		1.1	10		1.1	10	mV
α_{VIO}	Average temperature coefficient of input offset voltage		1.8			1.1			1.7		$\mu\text{V}/^\circ\text{C}$
I_{IO}	Input offset current (see Note 4) $V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$		0.1			0.1			0.1		pA
I_{IB}	Input bias current (see Note 4) $V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$		0.6			0.6			0.6		pA
V_{ICR}	Common-mode input voltage range (see Note 5)	-0.2 to 4	-0.3 to 4.2		-0.2 to 4	-0.3 to 4.2		-0.2 to 4	-0.3 to 4.2		V
V_{OH}	High-level output voltage $V_{ID} = 100\text{ mV}$, See Note 6	3.2	3.8		3.2	4.1		3.2	3.9		V
V_{OL}	Low-level output voltage $V_{ID} = -100\text{ mV}$, $I_{OL} = 0$		0	50		0	50		0	50	mV
A_{VD}	Large-signal differential voltage amplification $V_O = 0.25\text{ V}$, See Note 6	5	23		50	700		25	170		V/mV
CMRR	Common-mode rejection ratio $V_{IC} = V_{ICRmin}$	65	80		65	94		65	91		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) $V_{DD} = 5\text{ V to }10\text{ V}$, $V_O = 1.4\text{ V}$	65	95		70	97		70	93		dB
I_{DD}	Supply current $V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$, No load		1.4	3.2		0.02	0.034		0.21	0.56	mA

operating characteristics, $V_{DD} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

PARAMETER	TEST CONDITIONS		TLC252Y			TLC25L2Y			TLC25M2Y			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Slew rate at unity gain	$C_L = 20\text{ pF}$, See Note 6	$V_{I(PP)} = 1\text{ V}$ $V_{I(PP)} = 2.5\text{ V}$		3.6			0.03			0.43	V/ μs	
				2.9			0.03			0.40		
V_n	Equivalent input noise voltage $f = 1\text{ kHz}$, $R_S = 20\ \Omega$		2.5			68			32		nV/ $\sqrt{\text{Hz}}$	
B_{OM}	Maximum output-swing bandwidth $V_O = V_{OH}$, $C_L = 20\text{ pF}$, $R_L = 10\text{ k}\Omega$		320			5			55		kHz	
B_1	Unity-gain bandwidth $V_I = 10\text{ mV}$, $C_L = 20\text{ pF}$		1.7			0.085			0.525		MHz	
ϕ_m	Phase margin $f = B_1$, $C_L = 20\text{ pF}$, $V_I = 10\text{ mV}$		46°			34°			40°			

- NOTES: 4. The typical values of input bias current and input offset current below 5 pA were determined mathematically.
 5. This range also applies to each input individually.
 6. For low-bias mode, $R_L = 1\text{ M}\Omega$; for medium-bias mode, $R_L = 100\text{ k}\Omega$, and for high-bias mode, $R_L = 10\text{ k}\Omega$.

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PARAMETER MEASUREMENT INFORMATION

single-supply versus split-supply test circuits

Because the TLC252, TLC25L2, and TLC25M2 are optimized for single-supply operation, circuit configurations used for the various tests often present some inconvenience since the input signal, in many cases, must be offset from ground. This inconvenience can be avoided by testing the device with split supplies and the output load tied to the negative rail. A comparison of single-supply versus split-supply test circuits is shown below. The use of either circuit gives the same result.

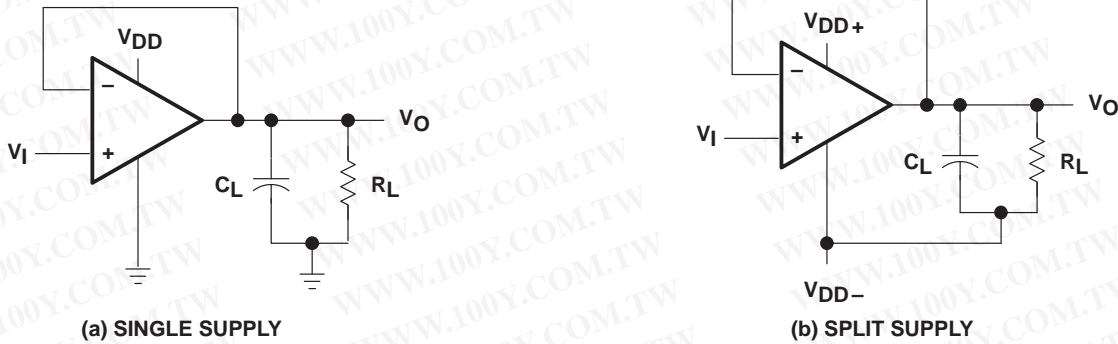


Figure 1. Unity-Gain Amplifier

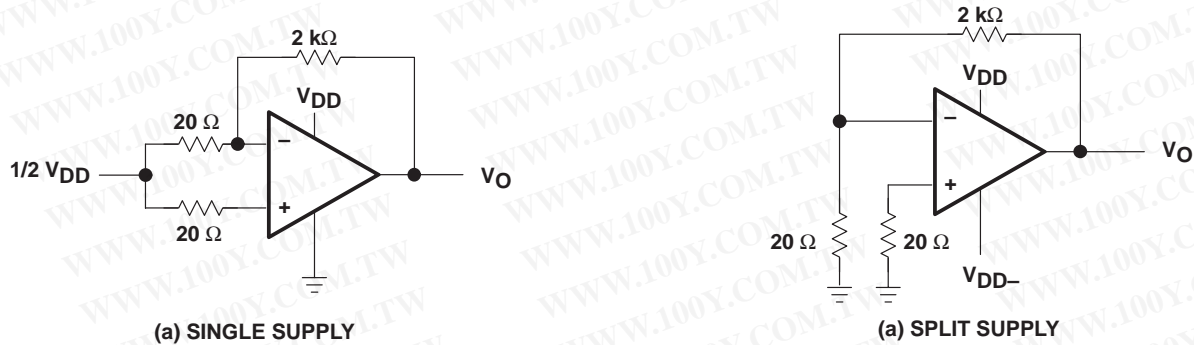


Figure 2. Noise-Test Circuit

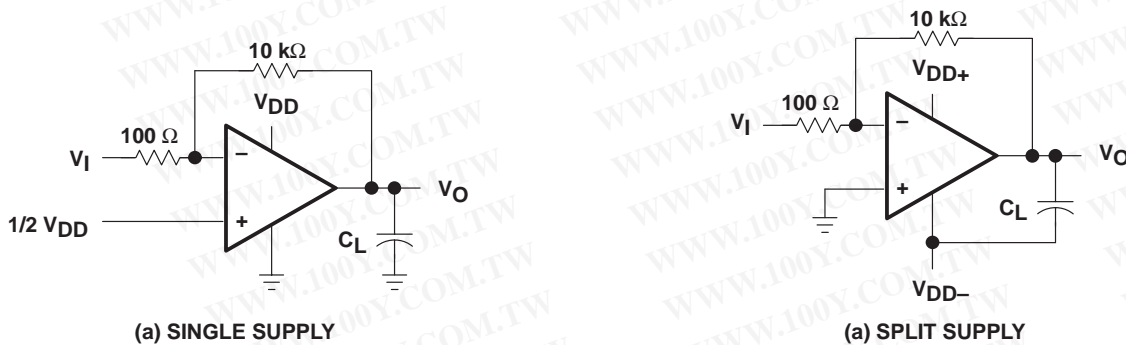


Figure 3. Gain-of-100 Inverting Amplifier

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TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
I _{DD}	Supply current	vs Supply voltage	4
		vs Free-air temperature	5
A _V D	Large-signal differential voltage amplification	Low bias	6
		Medium bias	7
		High bias	8
Phase shift		Low bias	6
		Medium bias	7
		High bias	8

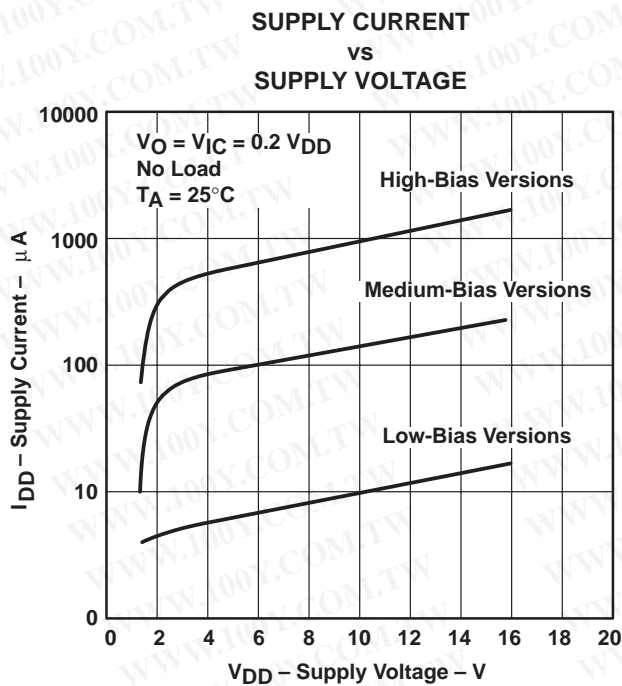


Figure 4

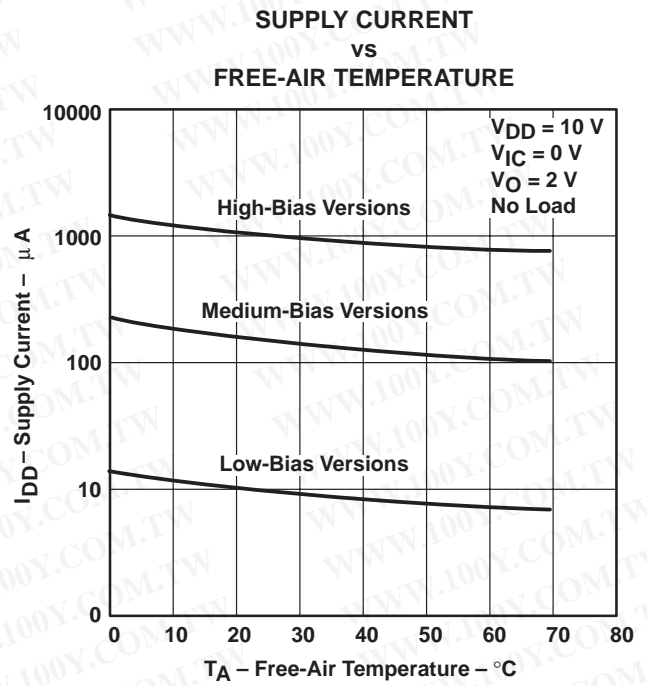


Figure 5

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TYPICAL CHARACTERISTICS

**LOW-BIAS LARGE-SIGNAL
 DIFFERENTIAL VOLTAGE AMPLIFICATION
 AND PHASE SHIFT
 vs
 FREQUENCY**

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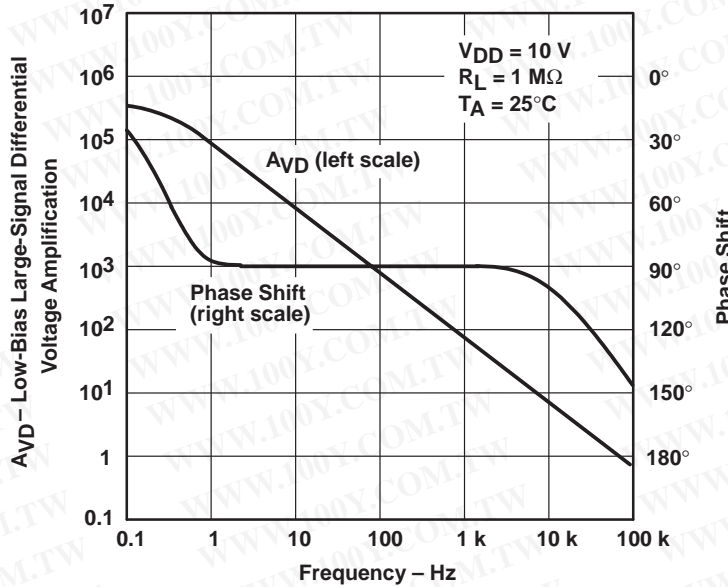


Figure 6

**MEDIUM-BIAS LARGE-SIGNAL
 DIFFERENTIAL VOLTAGE AMPLIFICATION
 AND PHASE SHIFT
 vs
 FREQUENCY**

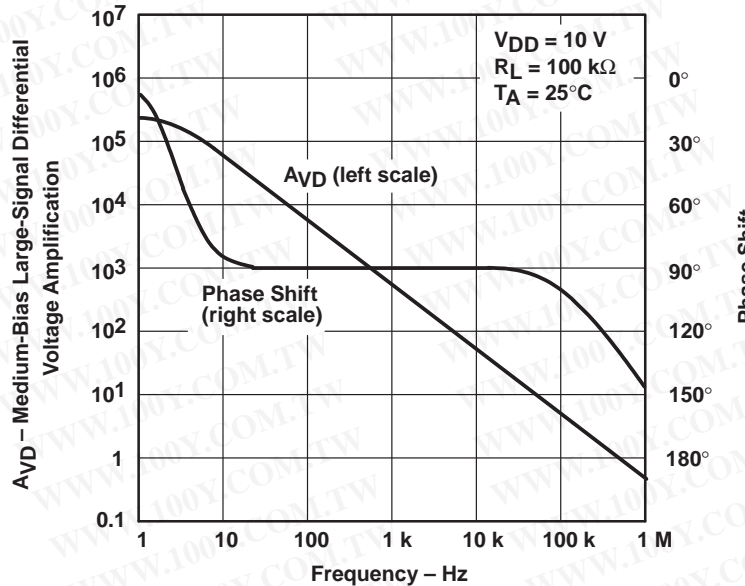


Figure 7



TYPICAL CHARACTERISTICS

HIGH-BIAS LARGE-SIGNAL
 DIFFERENTIAL VOLTAGE AMPLIFICATION
 AND PHASE SHIFT
 VS
 FREQUENCY

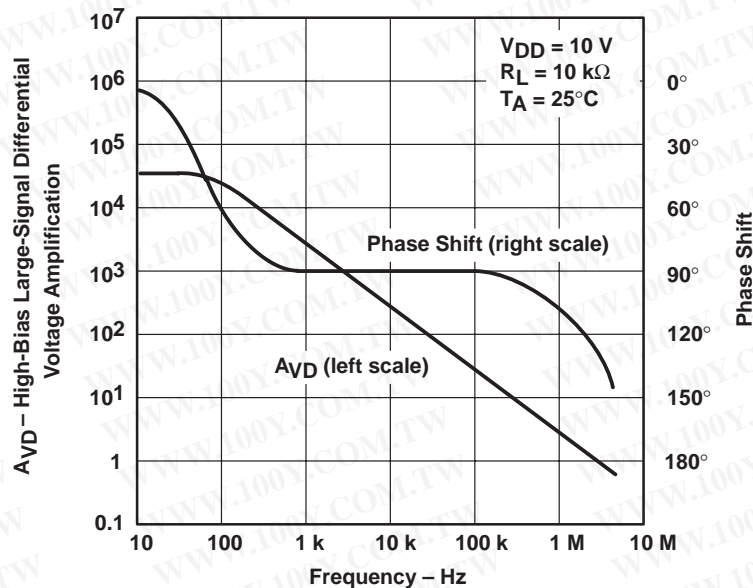


Figure 8

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APPLICATION INFORMATION

latch-up avoidance

Junction-isolated CMOS circuits have an inherent parasitic PNP structure that can function as an SCR. Under certain conditions, this SCR may be triggered into a low-impedance state, resulting in excessive supply current. To avoid such conditions, no voltage greater than 0.3 V beyond the supply rails should be applied to any pin. In general, the operational amplifier supplies should be applied simultaneously with, or before, application of any input signals.

output stage considerations

The amplifier's output stage consists of a source-follower-connected pullup transistor and an open-drain pulldown transistor. The high-level output voltage (V_{OH}) is virtually independent of the I_{DD} selection and increases with higher values of V_{DD} and reduced output loading. The low-level output voltage (V_{OL}) decreases with reduced output current and higher input common-mode voltage. With no load, V_{OL} is essentially equal to the potential of V_{DD-}/GND .

supply configurations

Even though the TLC252/25_2C series is characterized for single-supply operation, it can be used effectively in a split-supply configuration if the input common-mode voltage (V_{ICR}), output swing (V_{OL} and V_{OH}), and supply voltage limits are not exceeded.

circuit layout precautions

The user is cautioned that whenever extremely high circuit impedances are used, care must be exercised in layout, construction, board cleanliness, and supply filtering to avoid hum and noise pickup, as well as excessive dc leakages.

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