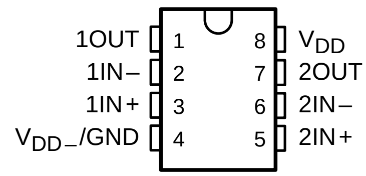
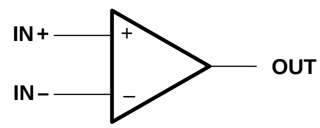
- **A-Suffix Versions Offer 5-mV V_{IO}**
- **B-Suffix Versions Offer 2-mV V_{IO}**
- **Wide Range of Supply Voltages 1.4 V to 16 V**
- **True Single-Supply Operation**
- **Common-Mode Input Voltage Includes the Negative Rail**
- **Low Noise . . . 30 nV/√Hz Typ at f = 1 kHz (High-Bias Versions)**

D, P, OR PW PACKAGE
(TOP VIEW)



symbol (each amplifier)



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.

AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES			CHIP FORM (Y)
		SMALL OUTLINE (D)	PLASTIC DIP (P)	TSSOP (PW)	
0°C to 70°C	10 mV 5 mV 2 mV	TLC252CD TLC252ACD TLC252BCD	TLC252CP TLC252ACP TLC252BCP	TLC252CPW TLC252ACPW TLC252BCPW	TLC252Y — —
	10 mV 5 mV 2 mV	TLC25L2CD TLC25L2ACD TLC25L2BCD	TLC25L2CP TLC25L2ACP TLC25L2BCP	TLC25L2CPW TLC25L2ACPW TLC25L2BCPW	TLC25L2Y — —
	10 mV 5 mV 2 mV	TLC25M2CD TLC25M2ACD TLC25M2BCD	TLC25M2CP TLC25M2ACP TLC25M2BCP	— — —	TLC25M2Y — —

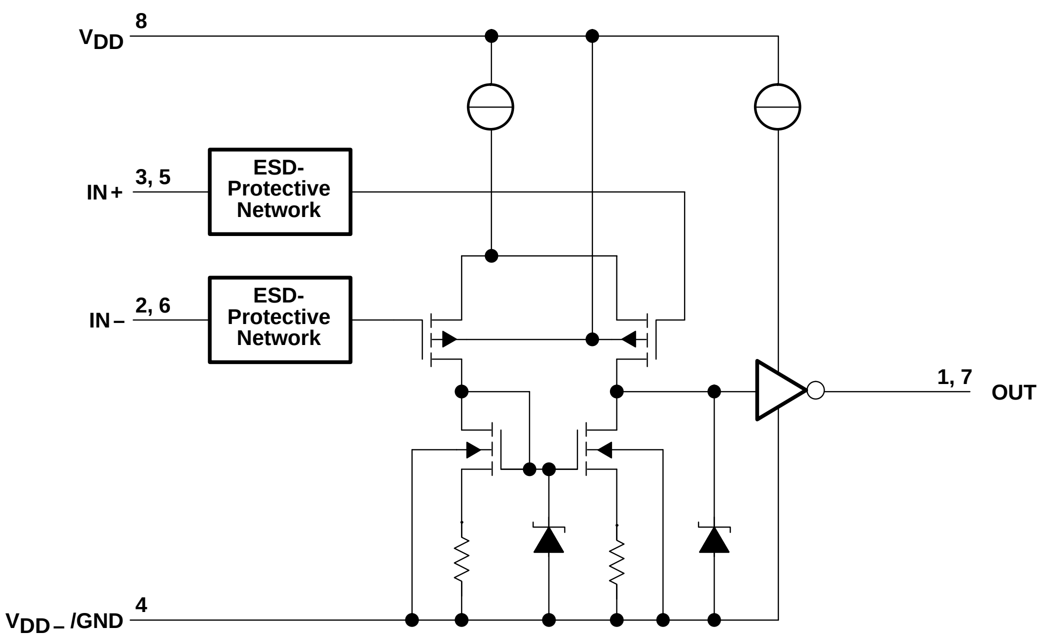
The D package is available taped and reeled. Add the suffix R to the device type (e.g., TLC252CDR). Chips are tested at 25°C.

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.

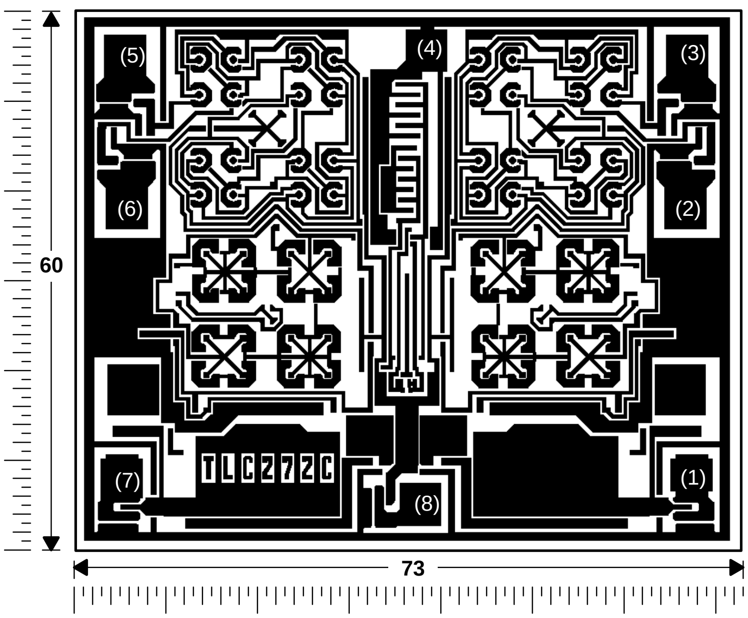
equivalent schematic (each amplifier)

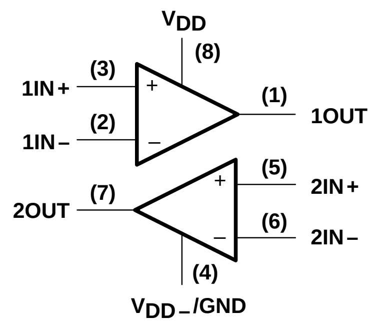


TLC252Y, TLC25L2Y, and TLC25M2Y chip information

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.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

T_{JMAX} = 150°C

TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

PIN (4) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

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	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW
P	1000 mW	8.0 mW/°C	640 mW
PW	525 mW	4.2 mW/°C	336 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

electrical characteristics at specified free-air temperature, V_{DD} = 1.4 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	TLC25_2C	V_O = 0.2 V, R_S = 50 Ω	25°C			10			10			10	mV
				0°C to 70°C			12			12			12	
		TLC25_2AC		25°C			5			5			5	
				0°C to 70°C			6.5			6.5			6.5	
		TLC25_2BC		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		µV/°C
I_{IO}	Input offset current		V_O = 0.2 V	25°C		1	60		1	60		1	60	pA
				0°C to 70°C			300			300			300	
I_{IB}	Input bias current		V_O = 0.2 V	25°C		1	60		1	60		1	60	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 mV	25°C	450	700		450	700		450	700		mV
A_{VD}	Large-signal differential voltage amplification		V_O = 100 to 300 mV, R_S = 50 Ω	25°C		10			20			20		V/mV
CMRR	Common-mode rejection ratio		V_O = 0.2 V, $V_{IC} = V_{ICR}$min	25°C	60	77		60	77		60	77		dB
I_{DD}	Supply current		V_O = 0.2 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 MΩ, for medium bias R_L = 100 kΩ, and for high bias R_L = 10 kΩ.
‡ The output swings to the potential of V_{DD-}/GND.

operating characteristics, V_{DD} = 1.4 V, T_A = 25°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 dB, C_L = 10 pF, R_S = 50 Ω		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%		

electrical characteristics at specified free-air temperature, V_{DD} = 5 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 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 10 kΩ	25°C		1.1	10	mV
					Full range			12	
		TLC252AC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 10 kΩ	25°C		0.9	5	
					Full range			6.5	
		TLC252BC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 10 kΩ	25°C		0.23	2	
					Full range			3	
α_{VIO}	Average temperature coefficient of input offset voltage				25°C to 70°C		1.8		µV/°C
I_{IO}	Input offset current (see Note 4)		V_O = 2.5 V,	V_{IC} = 2.5 V	25°C		0.1	60	pA
					70°C		7	300	
I_{IB}	Input bias current (see Note 4)		V_O = 2.5 V,	V_{IC} = 2.5 V	25°C		0.6	60	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 mV,	R_L = 10 kΩ	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 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 V to 2 V,	R_L = 10 kΩ	25°C	5	23		V/mV
					0°C	4	27		
					70°C	4	20		
CMRR	Common-mode rejection ratio		$V_{IC} = V_{ICR}$min		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 V to 10 V,	V_O = 1.4 V	25°C	65	95		dB
					0°C	60	94		
					70°C	60	96		
I_{DD}	Supply current (two amplifiers)		V_O = 2.5 V, No load	V_{IC} = 2.5 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.

electrical characteristics at specified free-air temperature, V_{DD} = 10 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 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 10 kΩ	25°C		1.1	10	mV
					Full range			12	
		TLC252AC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 10 kΩ	25°C		0.9	5	
					Full range			6.5	
		TLC252BC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 10 kΩ	25°C		0.29	2	
					Full range			3	
α_{VIO}	Average temperature coefficient of input offset voltage				25°C to 70°C		2		μV/°C
I_{IO}	Input offset current (see Note 4)		V_O = 2.5 V,	V_{IC} = 2.5 V	25°C		0.1	60	pA
					70°C		7	300	
I_{IB}	Input bias current (see Note 4)		V_O = 2.5 V,	V_{IC} = 2.5 V	25°C		0.6	60	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 mV,	R_L = 10 kΩ	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 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 V to 6 V,	R_L = 10 kΩ	25°C	10	36		V/mV
					0°C	7.5	42		
					70°C	7.5	32		
CMRR	Common-mode rejection ratio		$V_{IC} = V_{ICR}$min		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 V to 10 V,	V_O = 1.4 V	25°C	65	95		dB
					0°C	60	94		
					70°C	60	96		
I_{DD}	Supply current (two amplifiers)		V_O = 5 V, No load	V_{IC} = 5 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.

operating characteristics, V_{DD} = 5 V

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

operating characteristics, V_{DD} = 10 V

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

electrical characteristics at specified free-air temperature, V_{DD} = 5 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 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 1 MΩ	25°C		1.1	10	mV
					Full range			12	
		TLC252AC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 1 MΩ	25°C		0.9	5	
					Full range			6.5	
		TLC252BC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 1 MΩ	25°C		0.204	2	
					Full range			3	
α_{VIO}	Average temperature coefficient of input offset voltage				25°C to 70°C		1.1		µV/°C
I_{IO}	Input offset current (see Note 4)		V_O = 2.5 V,	V_{IC} = 2.5 V	25°C		0.1	60	pA
					70°C		7	300	
I_{IB}	Input bias current (see Note 4)		V_O = 2.5 V,	V_{IC} = 2.5 V	25°C		0.6	60	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 mV,	R_L = 1 MΩ	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 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 V to 2 V,	R_L = 1 MΩ	25°C	50	700		V/mV
					0°C	50	700		
					70°C	50	380		
CMRR	Common-mode rejection ratio		$V_{IC} = V_{ICR}$min		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 V to 10 V,	V_O = 1.4 V	25°C	70	97		dB
					0°C	60	97		
					70°C	60	98		
I_{DD}	Supply current (two amplifiers)		V_O = 2.5 V, No load	V_{IC} = 2.5 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.

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

PARAMETER			TEST CONDITIONS		T_A†	TLC25L2C TLC25L2AC TLC25L2BC MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	TLC252C	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 1 MΩ	25°C		1.1	10	mV
					Full range			12	
		TLC252AC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 1 MΩ	25°C		0.9	5	
					Full range			6.5	
		TLC252BC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 1 MΩ	25°C		0.235	2	
					Full range			3	
α_{VIO}	Average temperature coefficient of input offset voltage				25°C to 70°C		1		μV/°C
I_{IO}	Input offset current (see Note 4)		V_O = 5 V,	V_{IC} = 5 V	25°C		0.1	60	pA
					70°C		8	300	
I_{IB}	Input bias current (see Note 4)		V_O = 5 V,	V_{IC} = 5 V	25°C		0.7	60	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 mV,	R_L = 1 MΩ	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 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 V to 6 V,	R_L = 1 MΩ	25°C	50	860		V/mV
					0°C	50	1025		
					70°C	50	660		
CMRR	Common-mode rejection ratio		$V_{IC} = V_{ICR}min$		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 V to 10 V,	V_O = 1.4 V	25°C	70	97		dB
					0°C	60	97		
					70°C	60	98		
I_{DD}	Supply current (two amplifiers)		V_O = 5 V, No load	V_{IC} = 5 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.

operating characteristics, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS			T_A	TLC25L2C TLC25L2AC TLC25L2BC MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	R_L = 1 MΩ, See Figure 1	C_L = 20 pF,	$V_{I(PP)}$ = 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	$V_O = V_{OH}$, See Figure	C_L = 20 pF,	R_L = 1 MΩ,	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, See Figure 3	f = B_1,	C_L = 20 pF,	25°C		34°		
					0°C		36°		
					70°C		30°		

operating characteristics, V_{DD} = 10 V

PARAMETER		TEST CONDITIONS			T_A	TLC25L2C TLC25L2AC TLC25L2BC MIN	TYP	MAX	UNIT
SR	Slew rate at unity gain	R_L = 1 MΩ, See Figure 1	C_L = 20 pF,	$V_{I(PP)}$ = 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	$V_O = V_{OH}$, See Figure 1	C_L = 20 pF,	R_L = 1 MΩ,	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, See Figure 3	f = B_1,	C_L = 20 pF,	25°C		38°		
					0°C		40°		
					70°C		34°		

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

PARAMETER			TEST CONDITIONS		T_A†	TLC25M2C, TLC25M2AC, TLC25M2BC MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	TLC252C	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 100 kΩ	25°C		1.1	10	mV
					Full range			12	
		TLC252AC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 100 kΩ	25°C		0.9	5	
					Full range			6.5	
		TLC252BC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 100 kΩ	25°C		0.22	2	
					Full range			3	
α_{VIO}	Average temperature coefficient of input offset voltage				25°C to 70°C		1.7		μV/°C
I_{IO}	Input offset current (see Note 4)		V_O = 2.5 V,	V_{IC} = 2.5 V	25°C		0.1	60	pA
					70°C		7	300	
I_{IB}	Input bias current (see Note 4)		V_O = 2.5 V,	V_{IC} = 2.5 V	25°C		0.6	60	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 mV,	R_L = 100 kΩ	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 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 V to 2 V,	R_L = 100 kΩ	25°C	25	170		V/mV
					0°C	15	200		
					70°C	15	140		
CMRR	Common-mode rejection ratio		$V_{IC} = V_{ICR}$min		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 V to 10 V,	V_O = 1.4 V	25°C	70	93		dB
					0°C	60	92		
					70°C	60	94		
I_{DD}	Supply current (two amplifiers)		V_O = 2.5 V, No load	V_{IC} = 2.5 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.

electrical characteristics at specified free-air temperature, V_{DD} = 10 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 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 100 kΩ	25°C		1.1	10	mV
					Full range			12	
		TLC252AC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 100 kΩ	25°C		0.9	5	
					Full range			6.5	
		TLC252BC	V_O = 1.4 V, R_S = 50 Ω,	V_{IC} = 0, R_L = 100 kΩ	25°C		0.224	2	
					Full range			3	
α_{VIO}	Average temperature coefficient of input offset voltage				25°C to 70°C		2.1		μV/°C
I_{IO}	Input offset current (see Note 4)		V_O = 5 V,	V_{IC} = 5 V	25°C		0.1	60	pA
					70°C		7	300	
I_{IB}	Input bias current (see Note 4)		V_O = 5 V,	V_{IC} = 5 V	25°C		0.7	60	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 mV,	R_L = 100 kΩ	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 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 V to 6 V,	R_L = 100 kΩ	25°C	25	275		V/mV
					0°C	15	320		
					70°C	15	230		
CMRR	Common-mode rejection ratio		$V_{IC} = V_{ICR}$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 V to 10 V,	V_O = 1.4 V	25°C	70	93		dB
					0°C	60	92		
					70°C	60	94		
I_{DD}	Supply current (two amplifiers)		V_O = 5 V, No load	V_{IC} = 5 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.

operating characteristics, V_{DD} = 5 V

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

operating characteristics, V_{DD} = 10 V

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

electrical characteristics, V_{DD} = 5 V, T_A = 25°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 V, V_{IC} = 0 V, R_S = 50 Ω, 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		μV/°C
I_{IO}	Input offset current (see Note 4)	$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$		0.1	60		0.1	60		0.1	60	pA
I_{IB}	Input bias current (see Note 4)	$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$		0.6	60		0.6	60		0.6	60	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 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 mV, I_{OL} = 0		0	50		0	50		0	50	mV
A_{VD}	Large-signal differential voltage amplification	V_O = 0.25 V, See Note 6	5	23		50	700		25	170		V/mV
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}min$	65	80		65	94		65	91		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 5 V to 10 V, V_O = 1.4 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 V, T_A = 25°C

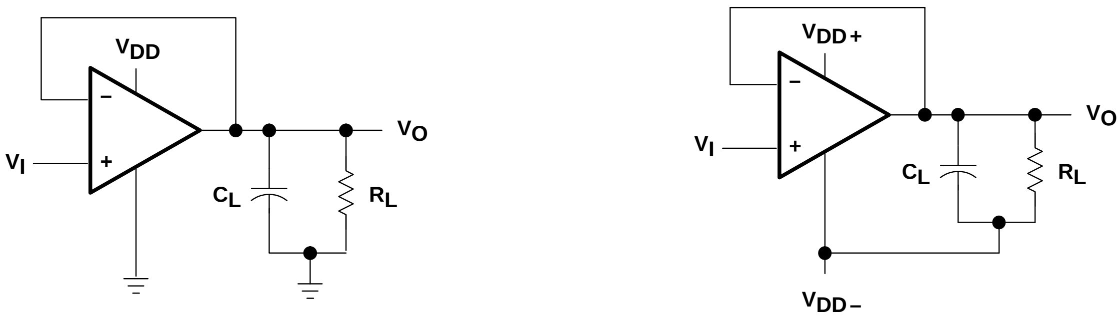
PARAMETER		TEST CONDITIONS		TLC252Y			TLC25L2Y			TLC25M2Y			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
	Slew rate at unity gain	C_L = 20 pF, See Note 6	$V_{I(PP)}$ = 1 V		3.6			0.03			0.43		V/μs
			$V_{I(PP)}$ = 2.5 V		2.9			0.03			0.40		
V_n	Equivalent input noise voltage	f = 1 kHz,	R_S = 20 Ω		2.5			68			32		nV/√Hz
B_{OM}	Maximum output-swing bandwidth	$V_O = V_{OH}$, R_L = 10 kΩ	C_L = 20 pF,		320			5			55		kHz
B_1	Unity-gain bandwidth	V_I = 10 mV,	C_L = 20 pF		1.7			0.085			0.525		MHz
ϕ_m	Phase margin	f = B_1, C_L = 20 pF	V_I = 10 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 MΩ; for medium-bias mode, R_L = 100 kΩ, and for high-bias mode, R_L = 10 kΩ.

PARAMETER MEASUREMENT INFORMATION

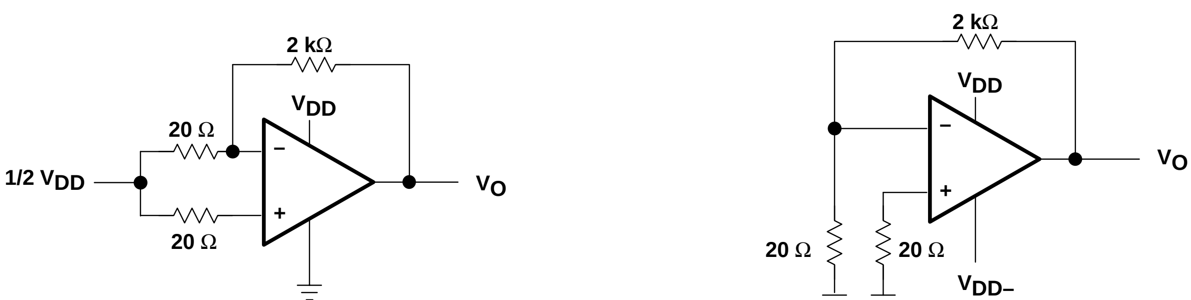
single-supply versus split-supply test circuits

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.



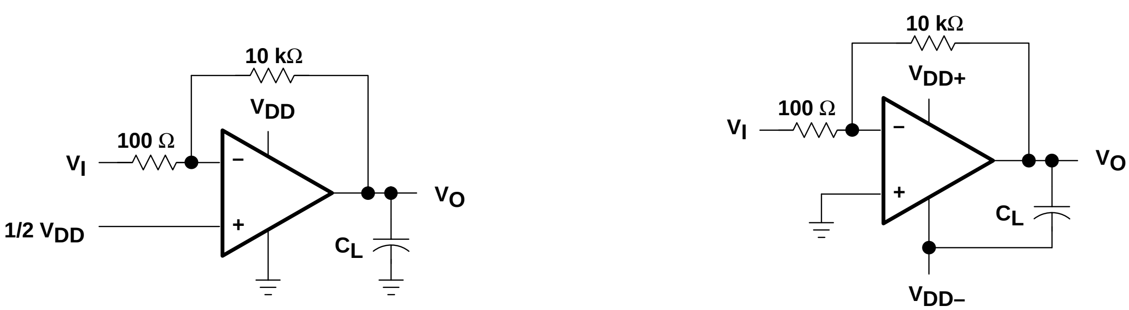
(a) SINGLE SUPPLY (b) SPLIT SUPPLY

Figure 1. Unity-Gain Amplifier



(a) SINGLE SUPPLY (a) SPLIT SUPPLY

Figure 2. Noise-Test Circuit



(a) SINGLE SUPPLY (a) SPLIT SUPPLY

Figure 3. Gain-of-100 Inverting Amplifier

TYPICAL CHARACTERISTICS

Table of Graphs

				FIGURE
I_{DD}	Supply current		vs Supply voltage vs Free-air temperature	4 5
A_{VD}	Large-signal differential voltage amplification	Low bias	vs Frequency	6
		Medium bias	vs Frequency	7
		High bias	vs Frequency	8
	Phase shift	Low bias	vs Frequency	6
		Medium bias	vs Frequency	7
		High bias	vs Frequency	8

SUPPLY CURRENT vs SUPPLY VOLTAGE

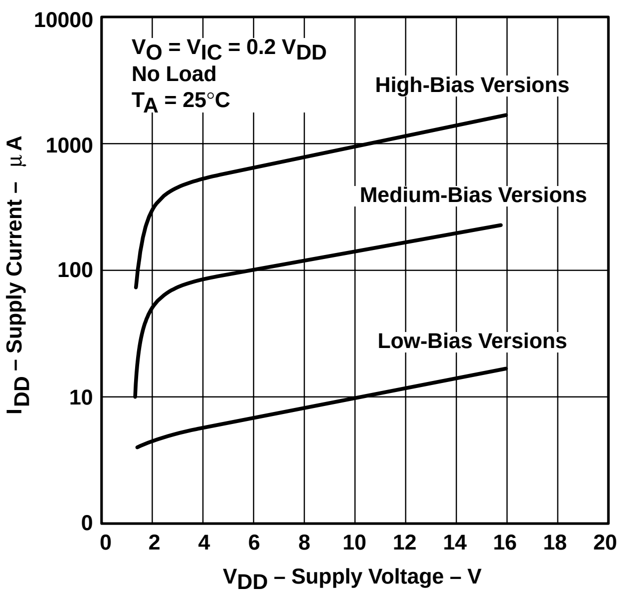


Figure 4

SUPPLY CURRENT vs FREE-AIR TEMPERATURE

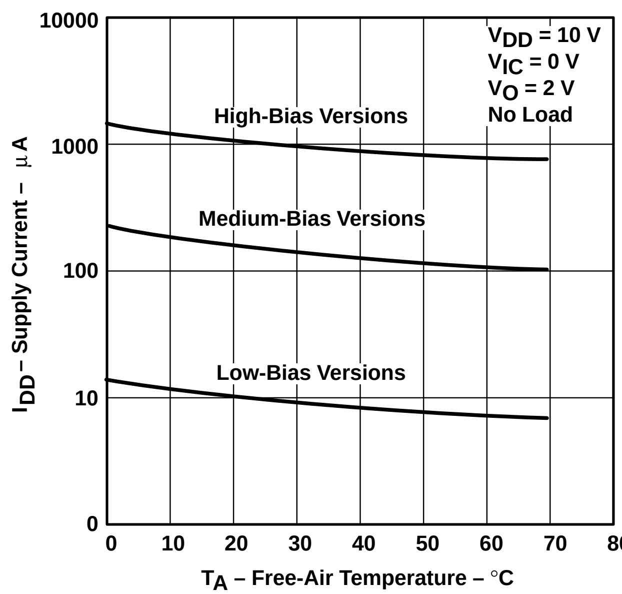


Figure 5

TYPICAL CHARACTERISTICS

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

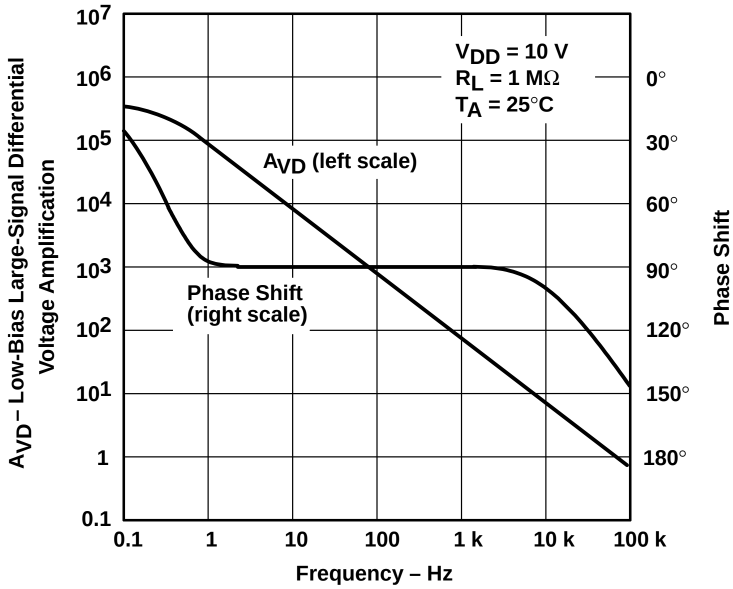


Figure 6

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

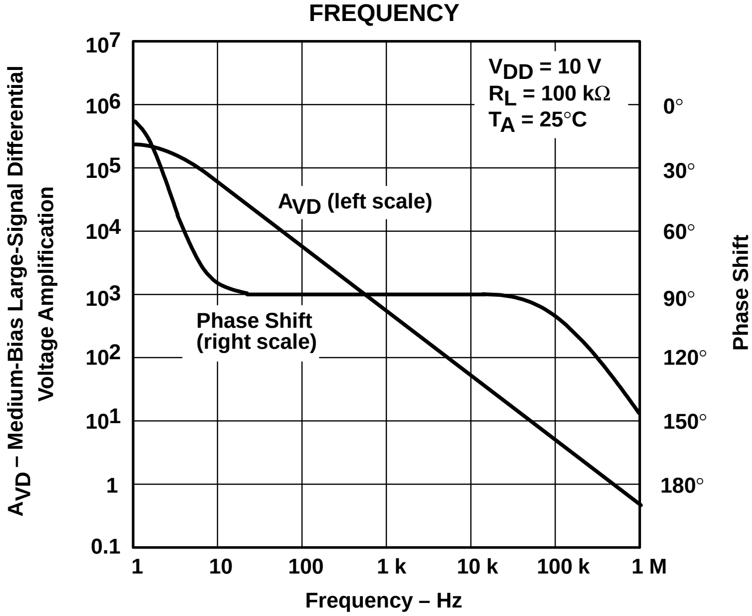


Figure 7

TYPICAL CHARACTERISTICS

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

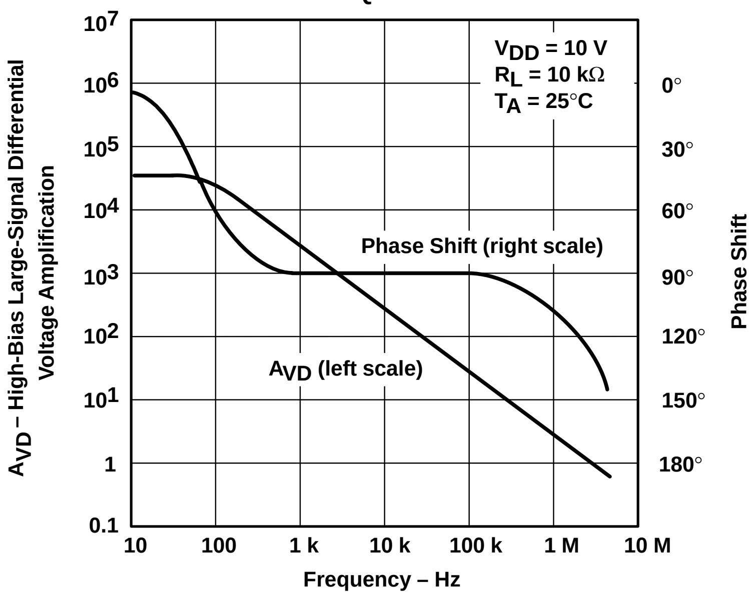


Figure 8

APPLICATION INFORMATION

latch-up avoidance

Junction-isolated CMOS circuits have an inherent parasitic PNPN 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.

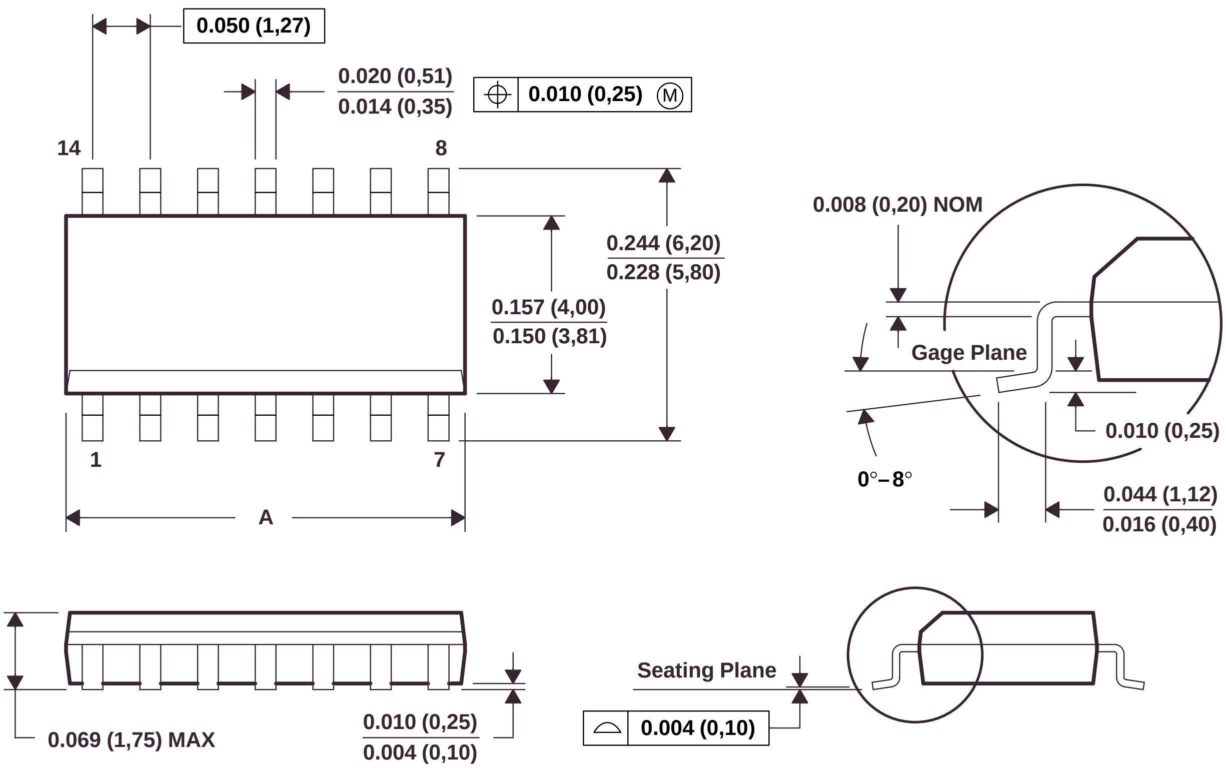
circuit layout precautions

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.

MECHANICAL DATA

D (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN

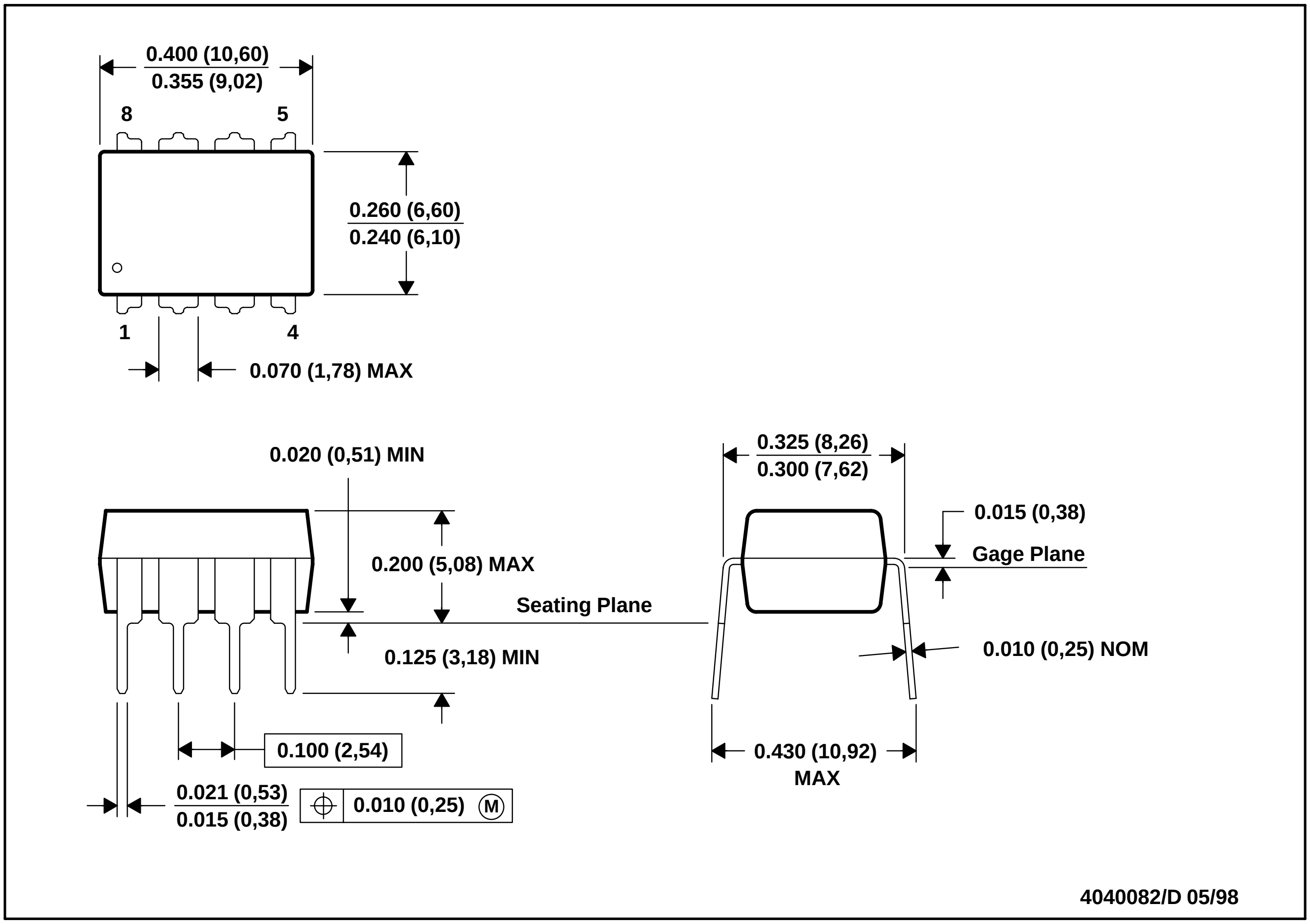


DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

4040047/D 10/96

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
D. Falls within JEDEC MS-012

P (R-PDIP-T8) **PLASTIC DUAL-IN-LINE**



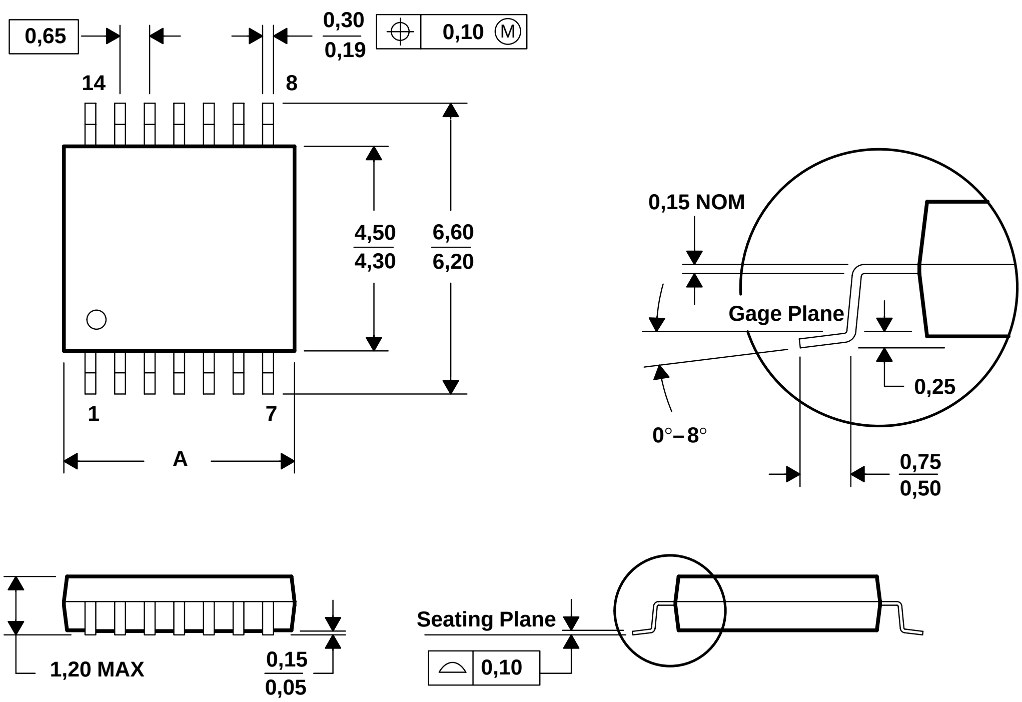
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

For the latest package information, go to http://www.ti.com/sc/docs/package/pkg_info.htm

MECHANICAL DATA

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

For the latest package information, go to http://www.ti.com/sc/docs/package/pkg_info.htm

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TLC252ACD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC252ACP	OBSOLETE	SOIC	D	8		None	Call TI	Call TI
TLC252BCD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC252BCDR	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC252BCP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC252CD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC252CDR	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC252CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC252CPSR	ACTIVE	SO	PS	8	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC252CPW	ACTIVE	TSSOP	PW	8	150	None	CU NIPDAU	Level-1-220C-UNLIM
TLC252CPWR	ACTIVE	TSSOP	PW	8	2000	None	CU NIPDAU	Level-1-220C-UNLIM
TLC25L2ACD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC25L2ACDR	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC25L2ACP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC25L2BCD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC25L2BCDR	PREVIEW	SOIC	D	8	2500	None	Call TI	Call TI
TLC25L2BCP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC25L2CD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC25L2CDR	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC25L2CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC25L2CPSR	ACTIVE	SO	PS	8	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC25L2CPW	ACTIVE	TSSOP	PW	8	150	None	CU NIPDAU	Level-1-220C-UNLIM
TLC25L2CPWR	ACTIVE	TSSOP	PW	8	2000	None	CU NIPDAU	Level-1-220C-UNLIM
TLC25M2ACD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC25M2ACP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC25M2BCD	OBSOLETE	SOIC	D	8		None	Call TI	Call TI
TLC25M2BCP	OBSOLETE	PDIP	P	8		None	Call TI	Call TI
TLC25M2CD	ACTIVE	SOIC	D	8	75	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM

Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
TLC25M2CDR	ACTIVE	SOIC	D	8	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC25M2CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
TLC25M2CPSR	ACTIVE	SO	PS	8	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1YEAR/ Level-1-220C-UNLIM
TLC25M2CPW	ACTIVE	TSSOP	PW	8	150	None	CU NIPDAU	Level-1-220C-UNLIM
TLC25M2CPWLE	OBSOLETE	TSSOP	PW	8		None	Call TI	Call TI
TLC25M2CPWR	ACTIVE	TSSOP	PW	8	2000	None	CU NIPDAU	Level-1-220C-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 - May not be currently available - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
None: Not yet available Lead (Pb-Free).
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.
Green (RoHS & no Sb/Br): TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDECindustry standard classifications, and peak solder temperature.

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Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265