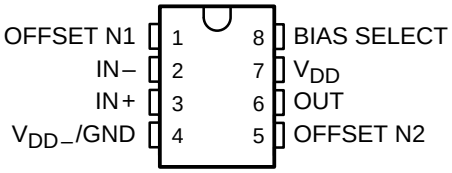
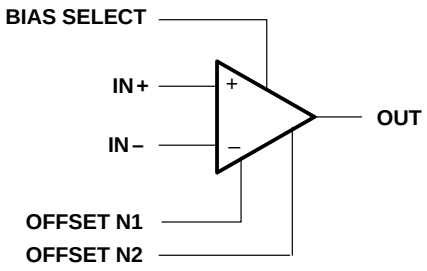
- **Wide Range of Supply Voltages 1.4-V to 16-V**
- **True Single-Supply Operation**
- **Common-Mode Input Voltage Range Includes the Negative Rail**
- **Low Noise . . . 30 nV/$\sqrt{Hz}$ Typ at 1-kHz (High Bias)**
- **ESD Protection Exceeds 2000 V Per MIL-STD-833C, Method 3015.1**

D OR P PACKAGE
(TOP VIEW)



symbol



description

The TLC251C, TLC251AC, and TLC251BC are low-cost, low-power programmable operational amplifiers designed to operate with single or dual supplies. Unlike traditional metal-gate CMOS operational amplifiers, these devices utilize Texas Instruments silicon-gate LinCMOS™ process, giving them stable input offset voltages without sacrificing the advantages of metal-gate CMOS. This series of parts is available in selected grades of input offset voltage and can be nulled with one external potentiometer. Because the input common-mode range extends to the negative rail and the power consumption is extremely low, this family is ideally suited for battery-powered or energy-conserving applications. A bias-select pin can be used to program one of three ac performance and power-dissipation levels to suit the application. The series features operation down to a 1.4-V supply and is stable at unity gain.

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.

Because of the extremely high input impedance and low input bias and offset currents, applications for the TLC251C 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. Remote and inaccessible equipment applications are possible using the low-voltage and low-power capabilities of the TLC251C series.

In addition, by driving the bias-select input with a logic signal from a microprocessor, these operational amplifiers can have software-controlled performance and power consumption. The TLC251C series is well suited to solve the difficult problems associated with single battery and solar cell-powered applications.

The TLC251C series is characterized for operation from 0°C to 70°C.

AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES		CHIP FORM (Y)
		SMALL OUTLINE (D)	PLASTIC DIP (P)	
0°C to 70°C	10 mV	TLC251CD	TLC251CP	TLC251Y
	5 mV	TLC251ACD	TLC251ACP	—
	2 mV	TLC251BCD	TLC251BCP	—

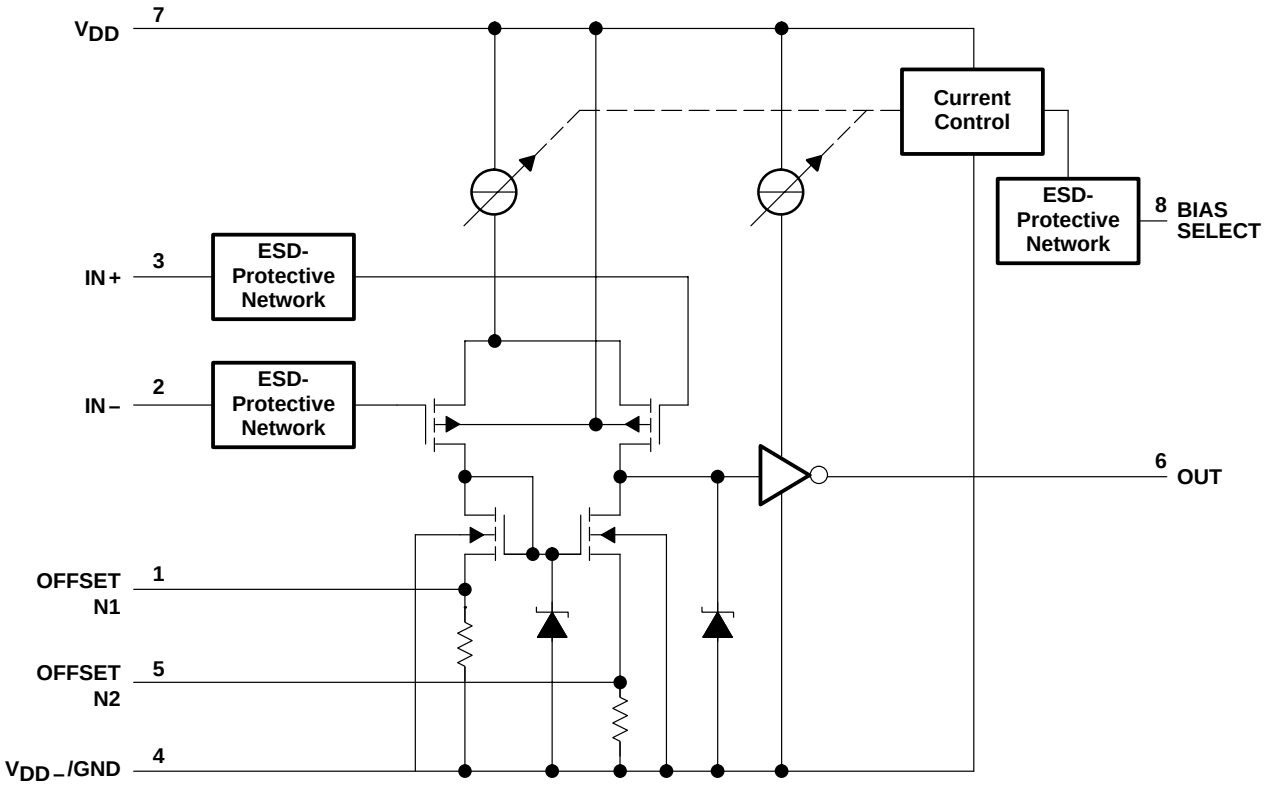
The D package is available taped and reeled. Add the suffix R to the device type (e.g., TLC251CDR). Chips are tested at 25°C.

LinCMOS is a trademark of Texas Instruments.

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.

Copyright © 2001, Texas Instruments Incorporated

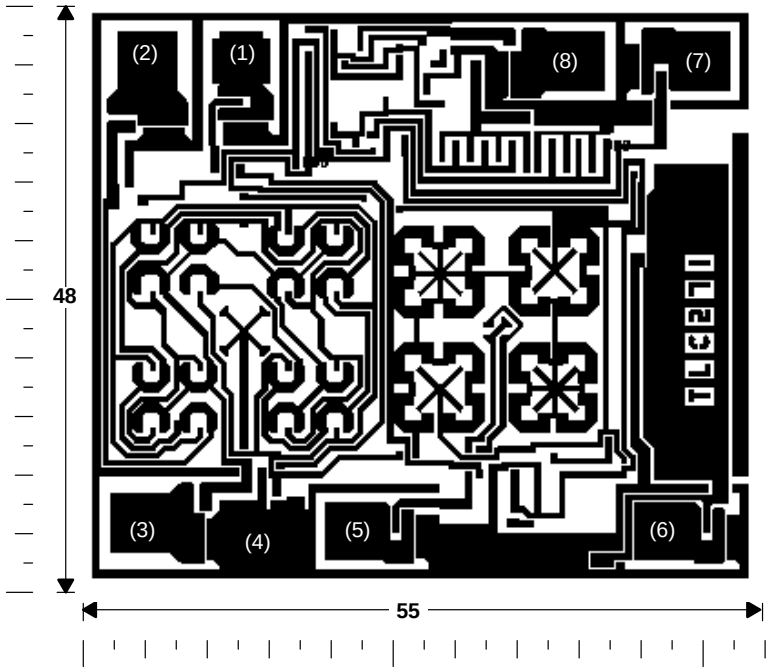
schematic

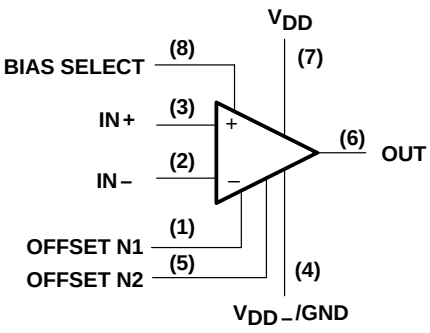

VDD
7
Current Control
ESD-Protective Network
8
BIAS SELECT
IN+
3
ESD-Protective Network
IN–
2
ESD-Protective Network
6
OUT
OFFSET N1
1
OFFSET N2
5
VDD–/GND
4

TLC251Y chip information

These chips, properly assembled, display characteristics similar to the TLC251C. 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

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
Bias-select voltage		See Application Information		

HIGH-BIAS MODE

electrical characteristics at specified free-air temperature

PARAMETER			TEST CONDITIONS	T_A†	TLC251C, TLC251AC, TLC251BC						UNIT
					V_{DD} = 5 V			V_{DD} = 10 V			
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	TLC251C	V_O = 1.4 V, V_{IC} = 0 V, R_S = 50 Ω, R_L = 10 kΩ	25°C		1.1	10		1.1	10	mV
				Full range			12			12	
		TLC251AC		25°C		0.9	5		0.9	5	
				Full range			6.5			6.5	
		TLC251BC		25°C		0.34	2		0.39	2	
				Full range			3			3	
α_{VIO}	Average temperature coefficient of input offset voltage			25°C to 70°C		1.8			2		μV/°C
I_{IO}	Input offset current (see Note 4)		$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$	25°C		0.1	60		0.1	60	pA
				70°C		7	300		7	300	
I_{IB}	Input bias current (see Note 4)		$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$	25°C		0.6	60		0.7	60	pA
				70°C		40	600		50	600	
V_{ICR}	Common-mode input voltage range (see Note 5)			25°C	−0.2 to 4	−0.3 to 4.2		−0.2 to 9	−0.3 to 9.2		V
				Full range	−0.2 to 3.5			−0.2 to 8.5			V
V_{OH}	High-level output voltage		V_{ID} = 100 mV, R_L = 10 kΩ	25°C	3.2	3.8		8	8.5		V
				0°C	3	3.8		7.8	8.5		
				70°C	3	3.8		7.8	8.4		
V_{OL}	Low-level output voltage		V_{ID} = −100 mV, I_{OL} = 0	25°C		0	50		0	50	mV
				0°C		0	50		0	50	
				70°C		0	50		0	50	
A_{VD}	Large-signal differential voltage amplification		R_L = 10 kΩ, See Note 6	25°C	5	23		10	36		V/mV
				0°C	4	27		7.5	42		
				70°C	4	20		7.5	32		
CMRR	Common-mode rejection ratio		$V_{IC} = V_{ICR}$min	25°C	65	80		65	85		dB
				0°C	60	84		60	88		
				70°C	60	85		60	88		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)		V_{DD} = 5 V to 10 V, V_O = 1.4 V	25°C	65	95		65	95		dB
				0°C	60	94		60	94		
				70°C	60	96		60	96		
$I_{I(SEL)}$	Input current (BIAS SELECT)		$V_{I(SEL)}$ = 0	25°C		−1.4			−1.9		μA
I_{DD}	Supply current		$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$, No load	25°C		675	1600		950	2000	μA
				0°C		775	1800		1125	2200	
				70°C		575	1300		750	1700	

† 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.
6. At V_{DD} = 5 V, V_O = 0.25 V to 2 V; at V_{DD} = 10 V, V_O = 1 V to 6 V.

HIGH-BIAS MODE

operating characteristics, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS			T_A	TLC251C, TLC251AC, TLC251BC			UNIT
						MIN	TYP	MAX	
SR	Slew rate at unity gain	R_L = 10 kΩ,	C_L = 20 pF	$V_{I(PP)}$ = 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		25°C		25		nV/√Hz
B_{OM}	Maximum output-swing bandwidth	$V_O = V_{OH}$,	C_L = 20 pF,	R_L = 10 kΩ	25°C		320		kHz
					0°C		340		
					70°C		260		
B_1	Unity-gain bandwidth	V_I = 10 mV,	C_L = 20 pF		25°C		1.7		MHz
					0°C		2		
					70°C		1.3		
ϕ_m	Phase margin	V_I = 10 mV,	f = B_1,	C_L = 20 pF	25°C		46°		
					0°C		47°		
					70°C		44°		

operating characteristics, V_{DD} = 10 V

PARAMETER		TEST CONDITIONS			T_A	TLC251C, TLC251AC, TLC251BC			UNIT
						MIN	TYP	MAX	
SR	Slew rate at unity gain	R_L = 10 kΩ,	C_L = 20 pF	$V_{I(PP)}$ = 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		25°C		25		nV/√Hz
B_{OM}	Maximum output-swing bandwidth	$V_O = V_{OH}$,	C_L = 20 pF,	R_L = 10 kΩ	25°C		200		kHz
					0°C		220		
					70°C		140		
B_1	Unity-gain bandwidth	V_I = 10 mV,	C_L = 20 pF		25°C		2.2		MHz
					0°C		2.5		
					70°C		1.8		
ϕ_m	Phase margin	V_I = 10 mV,	f = B_1,	C_L = 20 pF	25°C		49°		
					0°C		50°		
					70°C		46°		

MEDIUM-BIAS MODE

electrical characteristics at specified free-air temperature

PARAMETER			TEST CONDITIONS	T_A†	TLC251C, TLC251AC, TLC251BC						UNIT
					V_{DD} = 5 V			V_{DD} = 10 V			
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	TLC251C	V_O = 1.4 V, V_{IC} = 0 V, R_S = 50 Ω, R_L = 10 kΩ	25°C		1.1	10		1.1	10	mV
				Full range			12			12	
		TLC251AC		25°C		0.9	5		0.9	5	
				Full range			6.5			6.5	
		TLC251BC		25°C		0.34	2		0.39	2	
				Full range			3			3	
α_{VIO}	Average temperature coefficient of input offset voltage			25°C to 70°C		1.7			2.1		μV/°C
I_{IO}	Input offset current (see Note 4)		$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$	25°C		0.1	60		0.1	60	pA
				70°C		7	300		7	300	
I_{IB}	Input bias current (see Note 4)		$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$	25°C		0.6	60		0.7	60	pA
				70°C		40	600		50	600	
V_{ICR}	Common-mode input voltage range (see Note 5)			25°C	−0.2 to 4	−0.3 to 4.2		−0.2 to 9	−0.3 to 9.2		V
				Full range	−0.2 to 3.5			−0.2 to 8.5			V
V_{OH}	High-level output voltage		V_{ID} = 100 mV, R_L = 10 kΩ	25°C	3.2	3.9		8	8.7		V
				0°C	3	3.9		7.8	8.7		
				70°C	3	4		7.8	8.7		
V_{OL}	Low-level output voltage		V_{ID} = −100 mV, I_{OL} = 0	25°C		0	50		0	50	mV
				0°C		0	50		0	50	
				70°C		0	50		0	50	
A_{VD}	Large-signal differential voltage amplification		R_L = 10 kΩ, See Note 6	25°C	25	170		25	275		V/mV
				0°C	15	200		15	320		
				70°C	15	140		15	230		
CMRR	Common-mode rejection ratio		$V_{IC} = V_{ICR}$min	25°C	65	91		65	94		dB
				0°C	60	91		60	94		
				70°C	60	92		60	94		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)		V_{DD} = 5 V to 10 V, V_O = 1.4 V	25°C	70	93		70	93		dB
				0°C	60	92		60	92		
				70°C	60	94		60	94		
$I_{I(SEL)}$	Input current (BIAS SELECT)		$V_{I(SEL)} = V_{DD}/2$	25°C		−130			−160		nA
I_{DD}	Supply current		$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$, No load	25°C		105	280		143	300	μA
				0°C		125	320		173	400	
				70°C		85	220		110	280	

† 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.
6. At V_{DD} = 5 V, V_O = 0.25 V to 2 V; at V_{DD} = 10 V, V_O = 1 V to 6 V.

MEDIUM-BIAS MODE

operating characteristics, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS			T_A	TLC251C, TLC251AC, TLC251BC			UNIT
						MIN	TYP	MAX	
SR	Slew rate at unity gain	R_L = 100 kΩ,	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		25°C		32		nV/√Hz
B_{OM}	Maximum output-swing bandwidth	$V_O = V_{OH}$,	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		25°C		525		kHz
					0°C		600		
					70°C		400		
ϕ_m	Phase margin	V_I = 10 mV,	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	TLC251C, TLC251AC, TLC251BC			UNIT
						MIN	TYP	MAX	
SR	Slew rate at unity gain	R_L = 100 kΩ,	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		25°C		32		nV/√Hz
B_{OM}	Maximum output-swing bandwidth	$V_O = V_{OH}$,	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		25°C		635		kHz
					0°C		710		
					70°C		510		
ϕ_m	Phase margin	V_I = 10 mV,	f = B_1,	C_L = 20 pF	25°C		43°		
					0°C		44°		
					70°C		42°		

LOW-BIAS MODE

electrical characteristics at specified free-air temperature

PARAMETER			TEST CONDITIONS	T_A†	TLC251C, TLC251AC, TLC251BC						UNIT
					V_{DD} = 5 V			V_{DD} = 10 V			
					MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	TLC251C	V_O = 1.4 V, V_{IC} = 0 V, R_S = 50 Ω, R_L = 10 MΩ	25°C		1.1	10		1.1	10	mV
				Full range			12			12	
		TLC251AC		25°C		0.9	5		0.9	5	
				Full range			6.5			6.5	
		TLC251BC		25°C		0.24	2		0.26	2	
				Full range			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 (see Note 4)		$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$	25°C		0.1	60		0.1	60	pA
				70°C		7	300		7	300	
I_{IB}	Input bias current (see Note 4)		$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$	25°C		0.6	60		0.7	60	pA
				70°C		40	600		50	600	
V_{ICR}	Common-mode input voltage range (see Note 5)			25°C	−0.2 to 4	−0.3 to 4.2		−0.2 to 9	−0.3 to 9.2		V
				Full range	−0.2 to 3.5			−0.2 to 8.5			V
V_{OH}	High-level output voltage		V_{ID} = 100 mV, R_L = 1 MΩ	25°C	3.2	4.1		8	8.9		V
				0°C	3	4.1		7.8	8.9		
				70°C	3	4.2		7.8	8.9		
V_{OL}	Low-level output voltage		V_{ID} = −100 mV, I_{OL} = 0	25°C		0	50		0	50	mV
				0°C		0	50		0	50	
				70°C		0	50		0	50	
A_{VD}	Large-signal differential voltage amplification		R_L = 1 MΩ, See Note 6	25°C	50	520		50	870		V/mV
				0°C	50	700		50	1030		
				70°C	50	380		50	660		
CMRR	Common-mode rejection ratio		$V_{IC} = V_{ICR}$min	25°C	65	94		65	97		dB
				0°C	60	95		60	97		
				70°C	60	95		60	97		
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$)		V_{DD} = 5 V to 10 V, V_O = 1.4 V	25°C	70	97		70	97		dB
				0°C	60	97		60	97		
				70°C	60	98		60	98		
$I_{I(SEL)}$	Input current (BIAS SELECT)		$V_{I(SEL)} = V_{DD}$	25°C		65			95		nA
I_{DD}	Supply current		$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$, No load	25°C		10	17		14	23	μA
				0°C		12	21		18	33	
				70°C		8	14		11	20	

† 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.
6. At V_{DD} = 5 V, V_O = 0.25 V to 2 V; at V_{DD} = 10 V, V_O = 1 V to 6 V.

LOW-BIAS MODE

operating characteristics, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS			T_A	TLC251C, TLC251AC, TLC251BC			UNIT
						MIN	TYP	MAX	
SR	Slew rate at unity gain	R_L = 1 MΩ,	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		25°C		68		nV/√Hz
B_{OM}	Maximum output-swing bandwidth	$V_O = V_{OH}$,	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		25°C		85		kHz
					0°C		100		
					70°C		65		
ϕ_m	Phase margin	V_I = 10 mV,	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	TLC251C, TLC251AC, TLC251BC			UNIT
						MIN	TYP	MAX	
SR	Slew rate at unity gain	R_L = 1 MΩ,	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		25°C		68		nV/√Hz
B_{OM}	Maximum output-swing bandwidth	$V_O = V_{OH}$,	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		25°C		110		kHz
					0°C		125		
					70°C		90		
ϕ_m	Phase margin	V_I = 10 mV,	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} = 1.4 V

PARAMETER			TEST CONDITIONS†		T_A‡	BIAS	TLC251C, TLC251AC, TLC251BC			UNIT
							MIN	TYP	MAX	
V_{IO}	Input offset voltage	TLC251C	V_O = 0.2 V,	R_S = 50 Ω	25°C	Any			10	mV
					Full range				12	
		TLC251AC			25°C	Any			5	
					Full range				6.5	
		TLC251BC			25°C	Any			2	
					Full range				3	
α_{VIO}	Average temperature coefficient of input offset voltage				25°C to 70°C	Any		1		µV/°C
I_{IO}	Input offset current		V_O = 0.2 V		25°C	Any		1	60	pA
					Full range				300	
I_{IB}	Input bias current		V_O = 0.2 V		25°C	Any		1	60	pA
					Full range				600	
V_{ICR}	Common-mode input voltage range				25°C	Any	0 to 0.2			V
V_{OM}	Peak output voltage swing§		V_{ID} = 100 mV		25°C	Any	450	700		mV
A_{VD}	Large-signal differential voltage amplification		V_O = 100 to 300 mV,	R_S = 50 Ω	25°C	Low		20		
						High		10		
CMRR	Common-mode rejection ratio		R_S = 50 Ω, V_{IC} = V_{ICR}min	V_O = 0.2 V,	25°C	Any	60	77		dB
I_{DD}	Supply current		V_O = 0.2 V,	No load	25°C	Low		5	17	µA
						High		150	190	

† 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 values: for low bias, R_L = 1 MΩ, for medium bias, R_L = 100 kΩ, and for high bias, R_L = 10 kΩ.
‡ Full range is 0°C to 70°C.
§ The output swings to the potential of V_{DD-}/GND.

operating characteristics, V_{DD} = 1.4 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	BIAS	TLC251C, TLC251AC, TLC251BC			UNIT
				MIN	TYP	MAX	
B_1	Unity-gain bandwidth	C_L = 100 pF	Low		12		kHz
			High		12		
SR	Slew rate at unity gain	See Figure 1	Low		0.001		V/µs
			High		0.1		
	Overshoot factor	See Figure 1	Low		35%		
			High		30%		

electrical characteristics, V_{DD} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	TLC251Y									UNIT
			HIGH-BIAS MODE			MEDIUM-BIAS MODE			LOW-BIAS MODE			
			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, R_L†		1.1	10		1.1	10		1.1	10	mV
α_{VIO}	Average temperature coefficient of input offset voltage			1.8			1.7			1.1		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, R_L†	3.2	3.8		3.2	3.9		3.2	4.1		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, R_L†	5	23		25	170		50	480		V/mV
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min	65	80		65	91		65	94		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	93		70	97		dB
$I_{I(SEL)}$	Input current (BIAS SELECT)	$V_{I(SEL)} = V_{DD}/2$		−1.4			−0.13			0.065		μA
I_{DD}	Supply current	$V_O = V_{DD}/2$, $V_{IC} = V_{DD}/2$, No load		675	1600		105	280		10	17	μA

† For high-bias mode, R_L = 10 kΩ; for medium-bias mode, R_L = 100 kΩ; and for low-bias mode, R_L = 1 MΩ.

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, T_A = 25°C

PARAMETER		TEST CONDITIONS		TLC251Y									UNIT
				HIGH-BIAS MODE			MEDIUM-BIAS MODE			LOW-BIAS MODE			
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	R_L†, C_L = 20 pF	$V_{I(PP)}$ = 1 V		3.6			0.43			0.03		V/μs
			$V_{I(PP)}$ = 2.5 V		2.9			0.40			0.03		
V_n	Equivalent input noise voltage	f = 1 kHz,	R_S = 20 Ω		25			32			68		nV/√Hz
B_{OM}	Maximum output swing bandwidth	$V_O = V_{OH}$, R_L = 10 kΩ	C_L = 20 pF,		320			55			4.5		kHz
B_1	Unity-gain bandwidth	V_I = 10 mV,	C_L = 20 pF		1700			525			65		kHz
ϕ_m	Phase margin	f = B_1, C_L = 20 pF	V_I = 10 mV,		46°			40°			34°		

† For high-bias mode, R_L = 10 kΩ; for medium-bias mode, R_L = 100 kΩ; and for low-bias mode, R_L = 1 MΩ.

PARAMETER MEASUREMENT INFORMATION

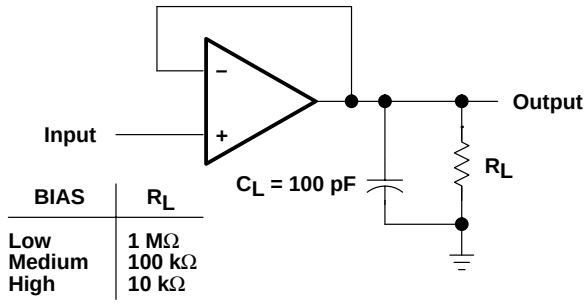


Figure 1. Unity-Gain Amplifier

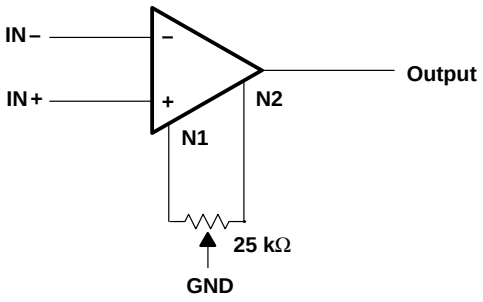


Figure 2. Input Offset Voltage Null Circuit

TYPICAL CHARACTERISTICS

Table of Graphs

				FIGURE
I_{DD}	Supply current		vs Bias-select voltage vs Supply voltage vs Free-air temperature	3 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

TYPICAL CHARACTERISTICS

SUPPLY CURRENT vs BIAS-SELECT VOLTAGE

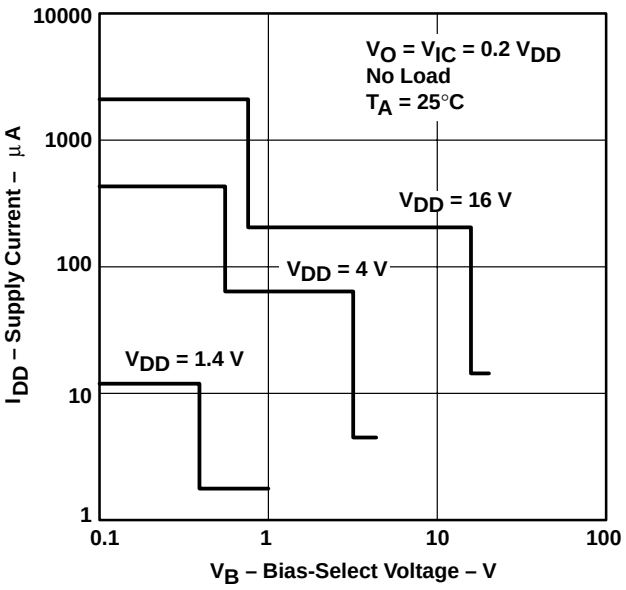


Figure 3

SUPPLY CURRENT vs SUPPLY VOLTAGE

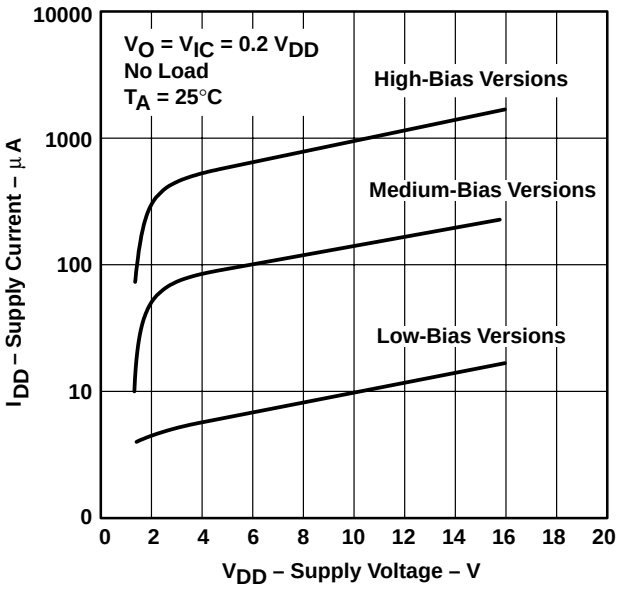


Figure 4

SUPPLY CURRENT vs FREE-AIR TEMPERATURE

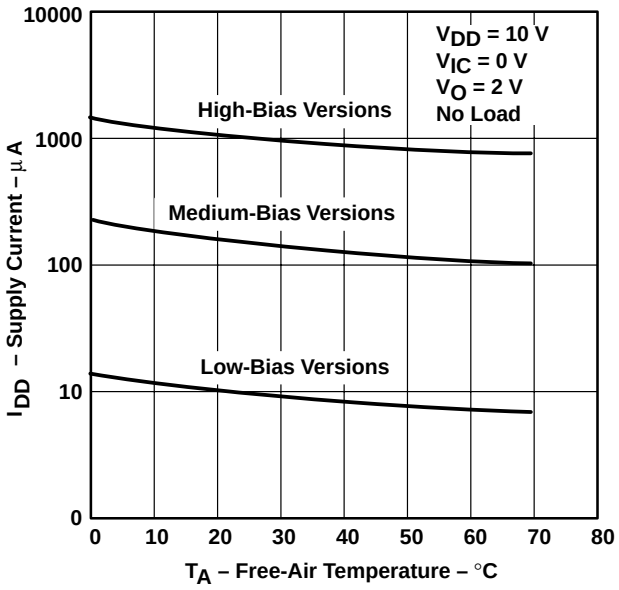


Figure 5

TYPICAL CHARACTERISTICS

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

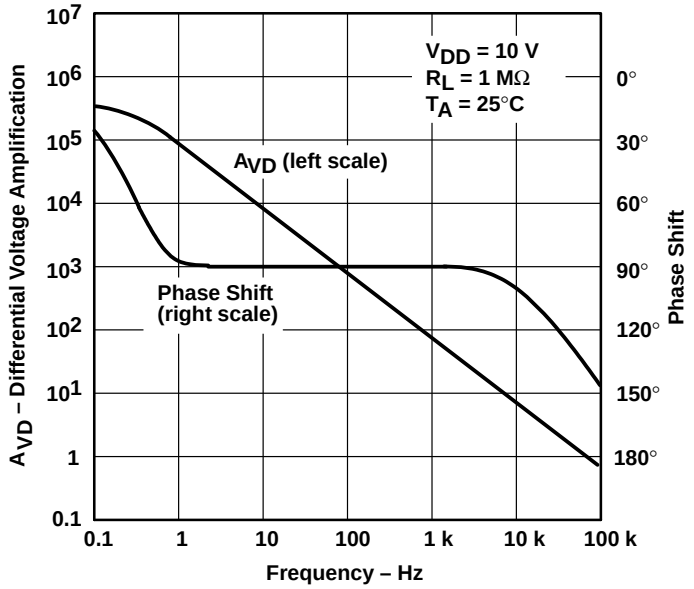


Figure 6

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

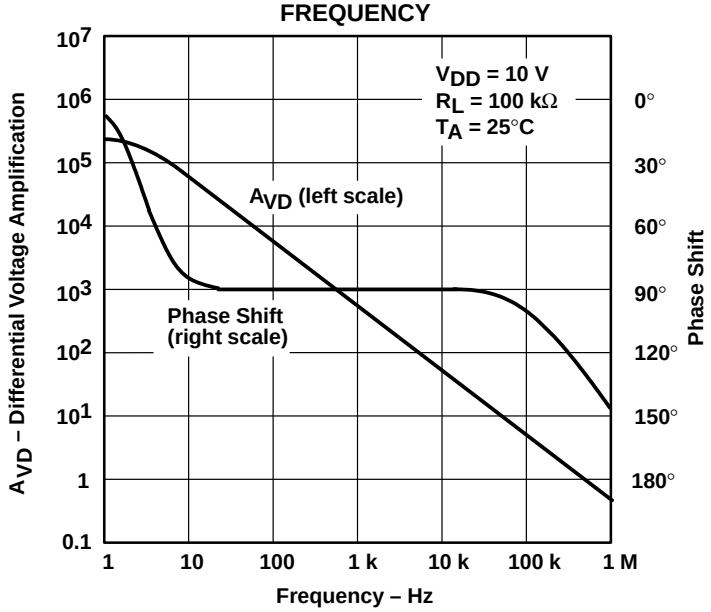


Figure 7

TYPICAL CHARACTERISTICS

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

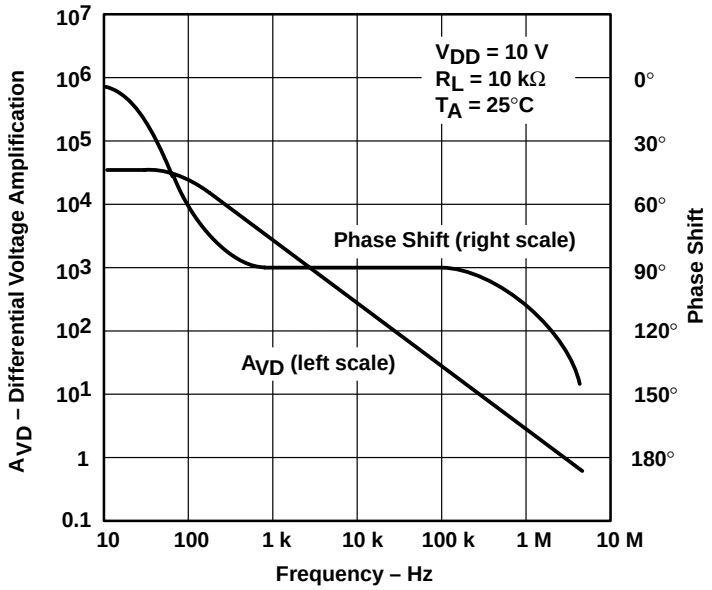


Figure 8

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.

APPLICATION INFORMATION

using BIAS SELECT

The TLC251 has a terminal called BIAS SELECT that allows the selection of one of three I_{DD} conditions (10, 150, and 1000 μA typical). This allows the user to trade-off power and ac performance. As shown in the typical supply current (I_{DD}) versus supply voltage (V_{DD}) curves (Figure 4), the I_{DD} varies only slightly from 4 V to 16 V. Below 4 V, the I_{DD} varies more significantly. Note that the I_{DD} values in the medium- and low-bias modes at V_{DD} = 1.4 V are typically 2 μA, and in the high mode are typically 12 μA. The following table shows the recommended BIAS SELECT connections at V_{DD} = 10 V.

BIAS MODE	AC PERFORMANCE	BIAS SELECT CONNECTION†	TYPICAL I_{DD}‡
Low	Low	V_{DD}	10 μA
Medium	Medium	0.8 V to 9.2 V	150 μA
High	High	Ground pin	1000 μA

† Bias selection may also be controlled by external circuitry to conserve power, etc. For information regarding BIAS SELECT, see Figure 3 in the typical characteristics curves.

‡ For I_{DD} characteristics at voltages other than 10 V, see Figure 4 in the typical characteristics curves.

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.

input offset nulling

The TLC251C series offers external offset null control. Nulling may be achieved by adjusting a 25-kΩ potentiometer connected between the offset null terminals with the wiper connected to the device V_{DD-}/GND pin as shown in Figure 2. The amount of nulling range varies with the bias selection. At an I_{DD} setting of 1000 μA (high bias), the nulling range allows the maximum offset specified to be trimmed to zero. In low or medium bias or when the amplifier is used below 4 V, total nulling may not be possible for all units.

supply configurations

Even though the TLC251C series is characterized for single-supply operation, it can be used effectively in a split-supply configuration when 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.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TLC251ACD	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	251AC
TLC251ACD.A	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	251AC
TLC251ACP	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	TLC251ACP
TLC251ACP.A	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	TLC251ACP
TLC251BCP	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	TLC251BCP
TLC251BCP.A	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	TLC251BCP
TLC251CD	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	251C
TLC251CD.A	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	251C
TLC251CDR	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	251C
TLC251CDR.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	251C
TLC251CP	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	TLC251CP
TLC251CP.A	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	TLC251CP
TLC251CPE4	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	0 to 70	TLC251CP

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

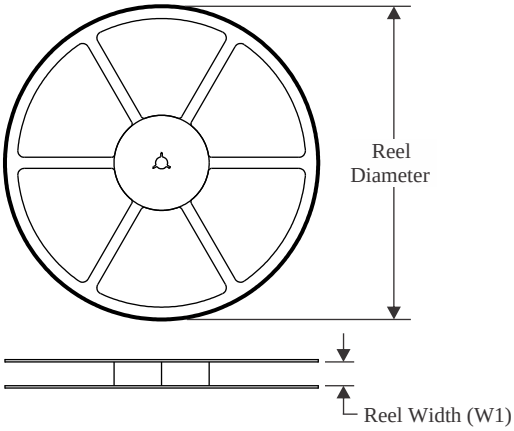
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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

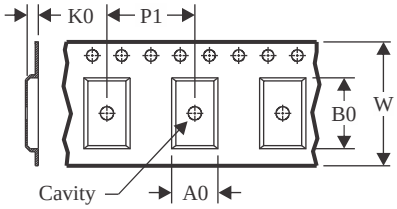
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

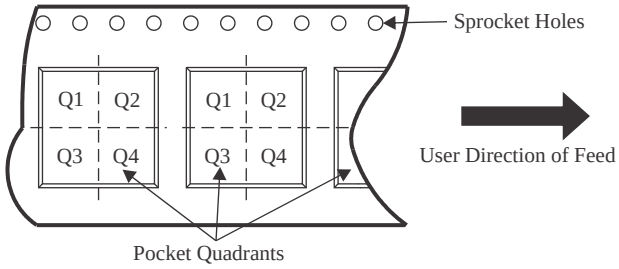


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

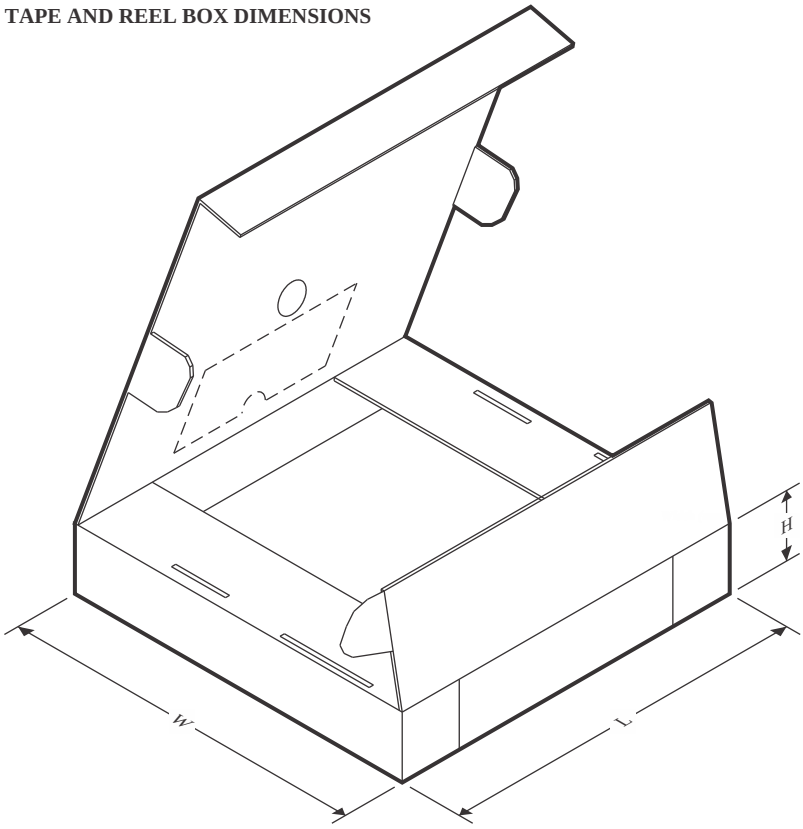
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TLC251CDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

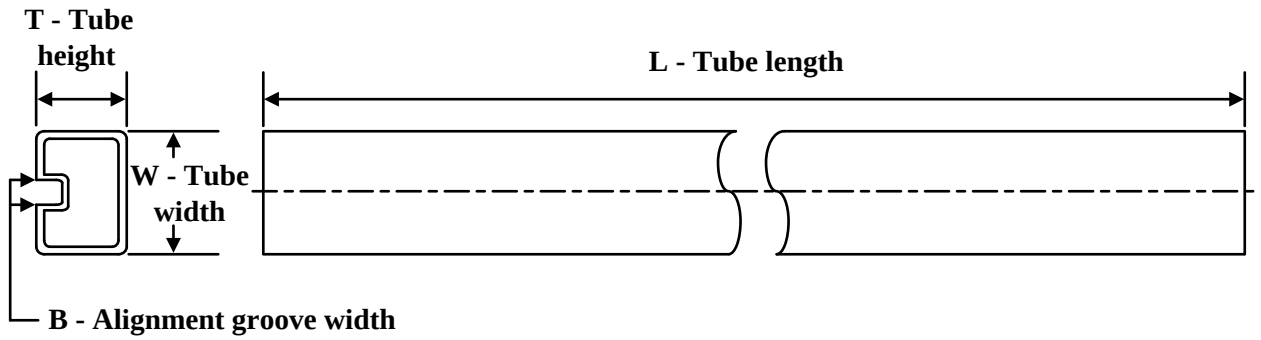
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLC251CDR	SOIC	D	8	2500	340.5	338.1	20.6

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
TLC251ACD	D	SOIC	8	75	507	8	3940	4.32
TLC251ACD	D	SOIC	8	75	505.46	6.76	3810	4
TLC251ACD.A	D	SOIC	8	75	507	8	3940	4.32
TLC251ACD.A	D	SOIC	8	75	505.46	6.76	3810	4
TLC251ACP	P	PDIP	8	50	506	13.97	11230	4.32
TLC251ACP.A	P	PDIP	8	50	506	13.97	11230	4.32
TLC251BCP	P	PDIP	8	50	506	13.97	11230	4.32
TLC251BCP.A	P	PDIP	8	50	506	13.97	11230	4.32
TLC251CD	D	SOIC	8	75	507	8	3940	4.32
TLC251CD	D	SOIC	8	75	505.46	6.76	3810	4
TLC251CD.A	D	SOIC	8	75	505.46	6.76	3810	4
TLC251CD.A	D	SOIC	8	75	507	8	3940	4.32
TLC251CP	P	PDIP	8	50	506	13.97	11230	4.32
TLC251CP.A	P	PDIP	8	50	506	13.97	11230	4.32
TLC251CPE4	P	PDIP	8	50	506	13.97	11230	4.32

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you fully indemnify TI and its representatives against any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale, TI’s General Quality Guidelines, or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products. Unless TI explicitly designates a product as custom or customer-specified, TI products are standard, catalog, general purpose devices.

TI objects to and rejects any additional or different terms you may propose.

Copyright © 2026, Texas Instruments Incorporated

Last updated 10/2025