

# TLE206x, TLE206xA, TLE206xB, TLE206xY EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE $\mu$ POWER OPERATIONAL AMPLIFIERS

SLOS193A – FEBRUARY 1997 – REVISED MARCH 1998

- **2 $\times$  Bandwidth (2 MHz) of the TL06x and TL03x Operational Amplifiers**
- **Low Supply Current . . . 290  $\mu$ A/Ch Typ**
- **On-chip Offset Voltage Trimming for Improved DC Performance**
- **High Output Drive, Specified into 100- $\Omega$  Loads**
- **Lower Noise Floor Than Earlier Generations of Low-Power BiFETs**

## description

The TLE206x series of low-power JFET-input operational amplifiers doubles the bandwidth of the earlier generation TL06x and TL03x BiFET families without significantly increasing power consumption. Texas Instruments Excalibur process also delivers a lower noise floor than the TL06x and TL03x. On-chip zener trimming of offset voltage yields precision grades for dc-coupled applications. The TL206x devices are pin-compatible with other TI BiFETs; they can be used to double the bandwidth of TL06x and TL03x circuits, or to reduce power consumption of TL05x, TL07x, and TL08x circuits by nearly 90%.

BiFET operational amplifiers offer the inherently-higher input impedance of the JFET-input transistors, without sacrificing the output drive associated with bipolar amplifiers. This makes them better suited for interfacing with high-impedance sensors or very low-level ac signals. They also feature inherently better ac response than bipolar or CMOS devices having comparable power consumption. The TLE206x family features a high-output-drive circuit capable of driving 100- $\Omega$  loads at supplies as low as  $\pm 5$  V. This makes them uniquely suited for driving transformer loads in modems and other applications requiring good ac characteristics, low power, and high output drive.

Because BiFET operational amplifiers are designed for use with dual power supplies, care must be taken to observe common-mode input voltage limits and output swing when operating from a single supply. DC biasing of the input signal is required and loads should be terminated to a virtual ground node at mid-supply. Texas Instruments TLE2426 integrated virtual ground generator is useful when operating BiFET amplifiers from single supplies.

The TLE206x are fully specified at  $\pm 15$  V and  $\pm 5$  V. For operation in low-voltage and/or single-supply systems, Texas Instruments LinCMOS families of operational amplifiers (TLC- and TLV-prefixes) are recommended. When moving from BiFET to CMOS amplifiers, particular attention should be paid to slew rate and bandwidth requirements, and output loading. The Texas Instrument TLV2432 and TLV2442 CMOS operational amplifiers are excellent choices to consider.



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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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# TLE206x, TLE206xA, TLE206xB, TLE206xY EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE μPOWER OPERATIONAL AMPLIFIERS

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## TLE2061 AVAILABLE OPTIONS

PACKAGED DEVICES							CHIP FORM§ (Y)
T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	TSSOP‡ (PW)	
0°C to 70°C	500 μV	—	—	—	—	—	—
	1.5 mV	TLE2061ACD	—	—	TLE2061ACP	—	—
	3 mV	TLE2061CD	—	—	TLE2061CP	TLE2061CPWLE	TLE2061Y
–40°C to 85°C	500 μV	—	—	—	—	—	—
	1.5 mV	TLE2061AID	—	—	TLE2061AIP	—	—
	3 mV	TLE2061ID	—	—	TLE2061IP	—	—
–55°C to 125°C	500 μV	—	—	TLE2061BMJG	—	—	—
	1.5 mV	TLE2061AMD	TLE2061AMFK	TLE2061AMJG	TLE2061AMP	—	—
	3 mV	TLE2061MD	TLE2061MFK	TLE2061MJG	TLE2061MP	—	—

† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLE2061ACDR). Chips are tested at 25°C.

‡ The PW package is available left-end taped and reeled (indicated by the LE suffix on the device type (e.g., TLE2061CPWLE)).

§ Chip forms are tested at 25°C only.

## TLE2062 AVAILABLE OPTIONS

PACKAGED DEVICES						CHIP FORM‡ (Y)
T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	
0°C to 70°C	1 mV	TLE2062BCD	—	—	TLE2062BCP	—
	2 mV	TLE2062ACD	—	—	TLE2062ACP	—
	4 mV	TLE2062CD	—	—	TLE2062CP	TLE2062Y
–40°C to 85°C	1 mV	TLE2062BID	—	—	TLE2062BIP	—
	2 mV	TLE2062AID	—	—	TLE2062AIP	—
	4 mV	TLE2062ID	—	—	TLE2062IP	—
–55°C to 125°C	1 mV	TLE2062BMD	TLE2062BMFK	TLE2062BMJG	TLE2062BMP	—
	2 mV	TLE2062AMD	TLE2062AMFK	TLE2062AMJG	TLE2062AMP	—
	4 mV	TLE2062MD	TLE2062MFK	TLE2062MJG	TLE2062MP	—

† The D packages are available taped and reeled. Add R suffix to device type (e.g., TLE2062ACDR).

‡ Chip forms are tested at 25°C only.

## TLE2064 AVAILABLE OPTIONS

PACKAGED DEVICES						CHIP FORM‡ (Y)
T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	SMALL OUTLINE† (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	
0°C to 70°C	2 mV	—	—	—	TLE2064BCN	—
	4 mV	TLE2064ACD	—	—	TLE2064ACN	—
	6 mV	TLE2064CD	—	—	TLE2064CN	TLE2064Y
–40°C to 85°C	2 mV	—	—	—	TLE2064BIN	—
	4 mV	TLE2064AID	—	—	TLE2064AIN	—
	6 mV	TLE2064ID	—	—	TLE2064IN	—
–55°C to 125°C	2 mV	—	—	TLE2064BMJ	TLE2064BMN	—
	4 mV	TLE2064AMD	TLE2064AMFK	TLE2064AMJ	TLE2064AMN	—
	6 mV	TLE2064MD	TLE2064MFK	TLE2064MJ	TLE2064MN	—

† The D packages are available taped and reeled. Add R suffix to device type, (e.g., TLE2064ACDR).

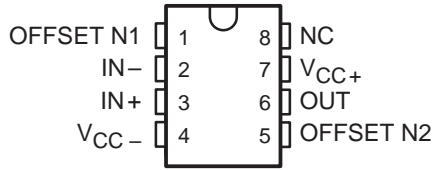
‡ Chip forms are tested at 25°C only.



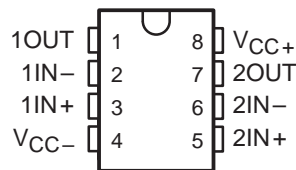
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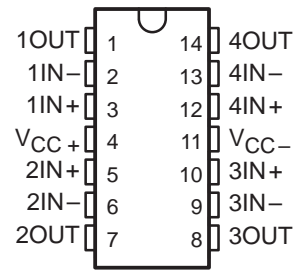
**TLE2061, TLE2061A, AND TLE2061B  
D, DB, JG, P, OR PW PACKAGE  
(TOP VIEW)**



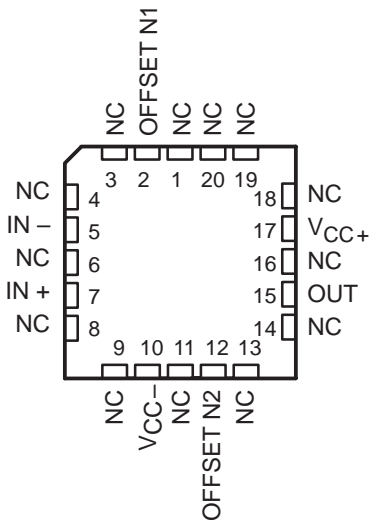
**TLE2062, TLE2062A, TLE2062B  
D, JG, OR P PACKAGE  
(TOP VIEW)**



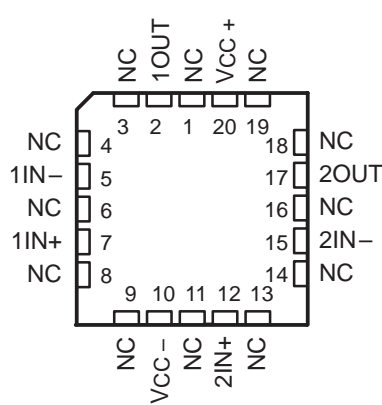
**TLE2064, TLE2064A, TLE2064B  
D, J, OR N PACKAGE  
(TOP VIEW)**



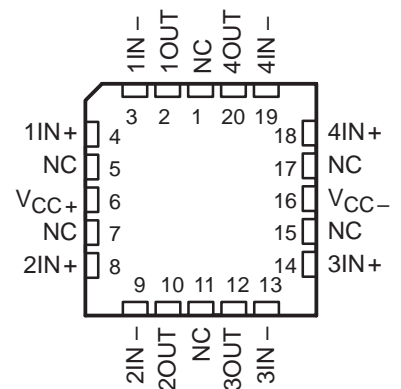
**TLE2061M, TLE2061AM, TLE2061BM  
FK PACKAGE  
(TOP VIEW)**



**TLE2062M, TLE2062AM, TLE2062BM  
FK PACKAGE  
(TOP VIEW)**



**TLE2064M, TLE2064AM, TLE2064BM  
FK PACKAGE  
(TOP VIEW)**



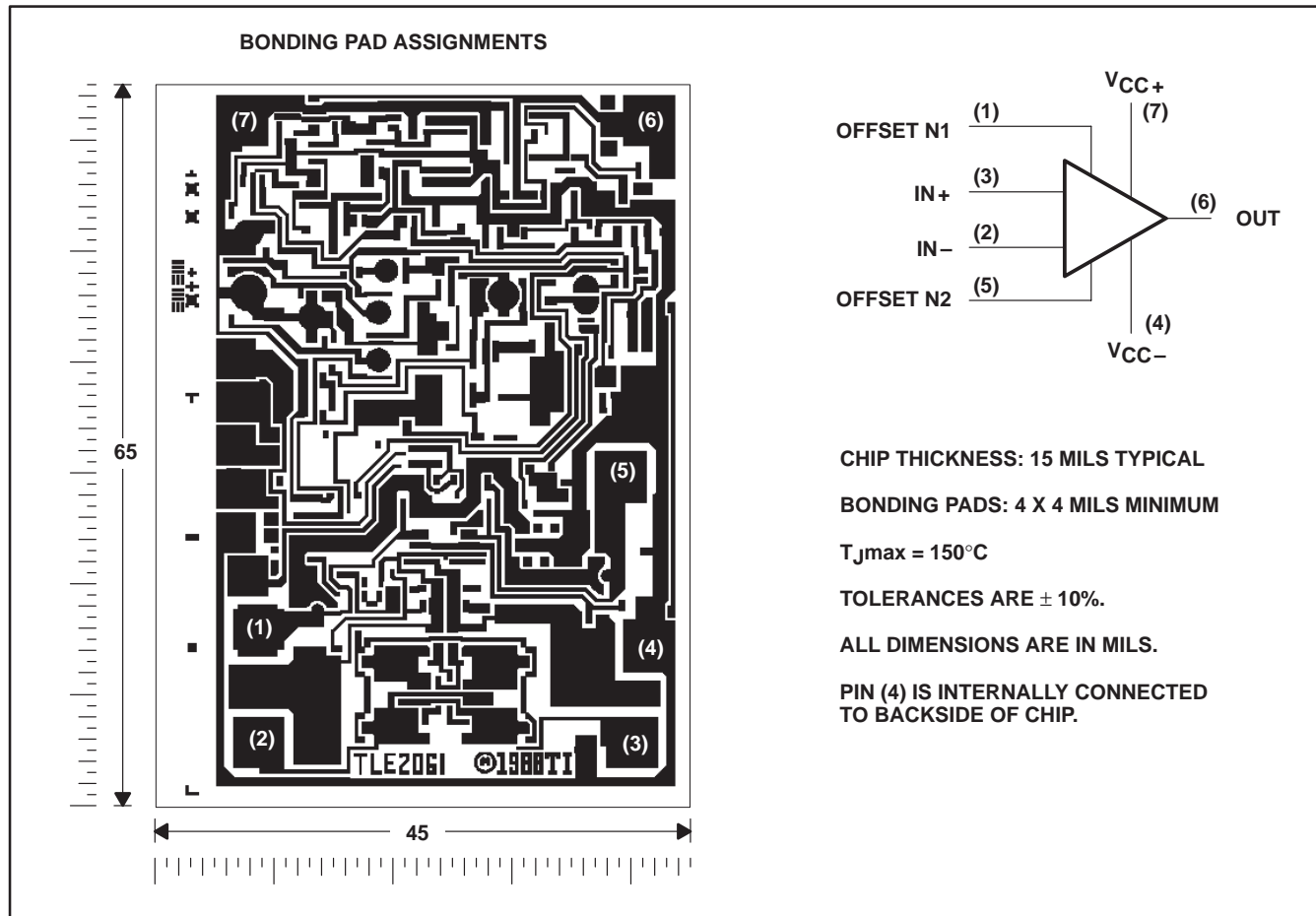
NC – No internal connection

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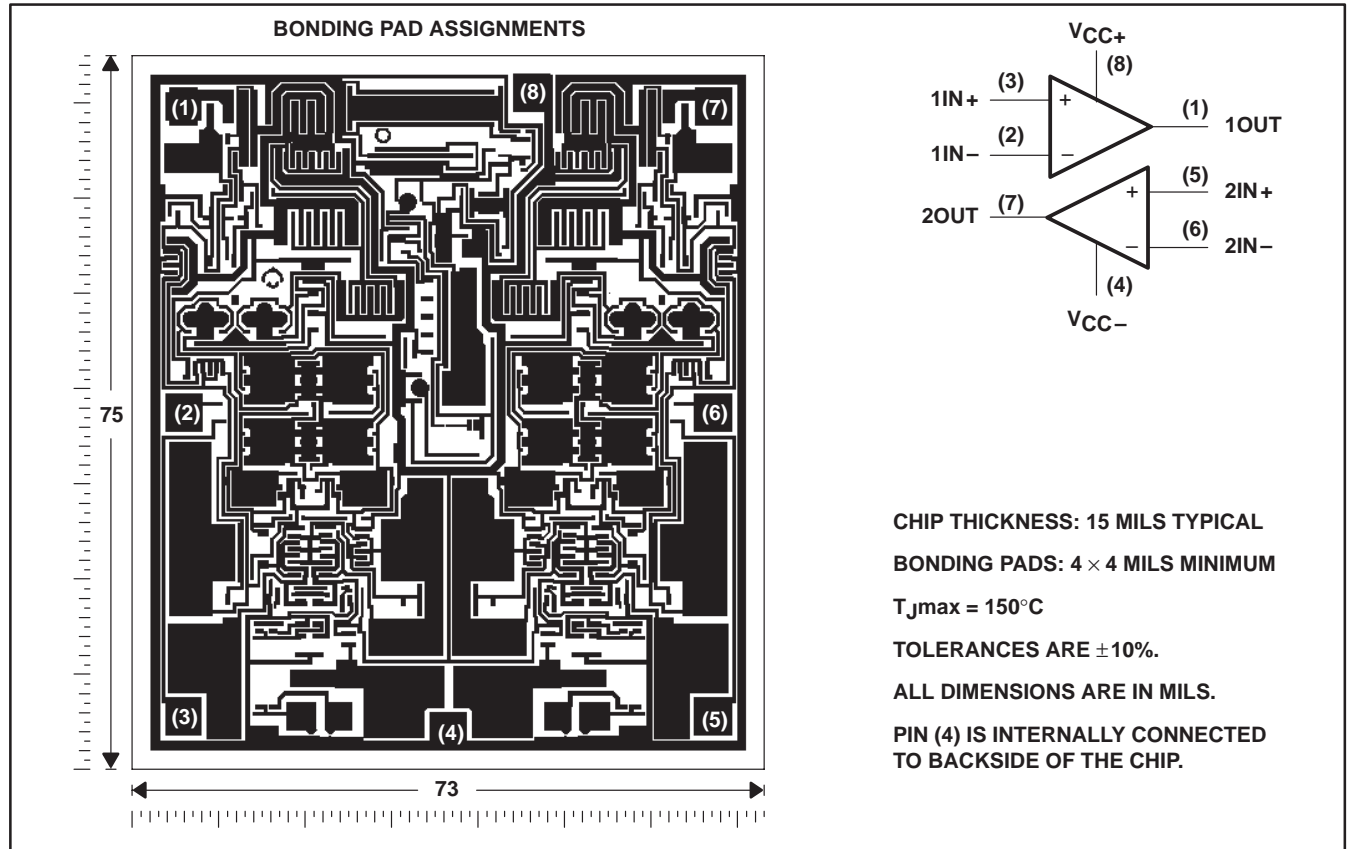
**TLE2061Y chip information**

This chip, when properly assembled, displays characteristics similar to the TLE2061. 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.



### TLE2062Y chip information

This chip, when properly assembled, displays characteristics similar to the TLE2062. 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.

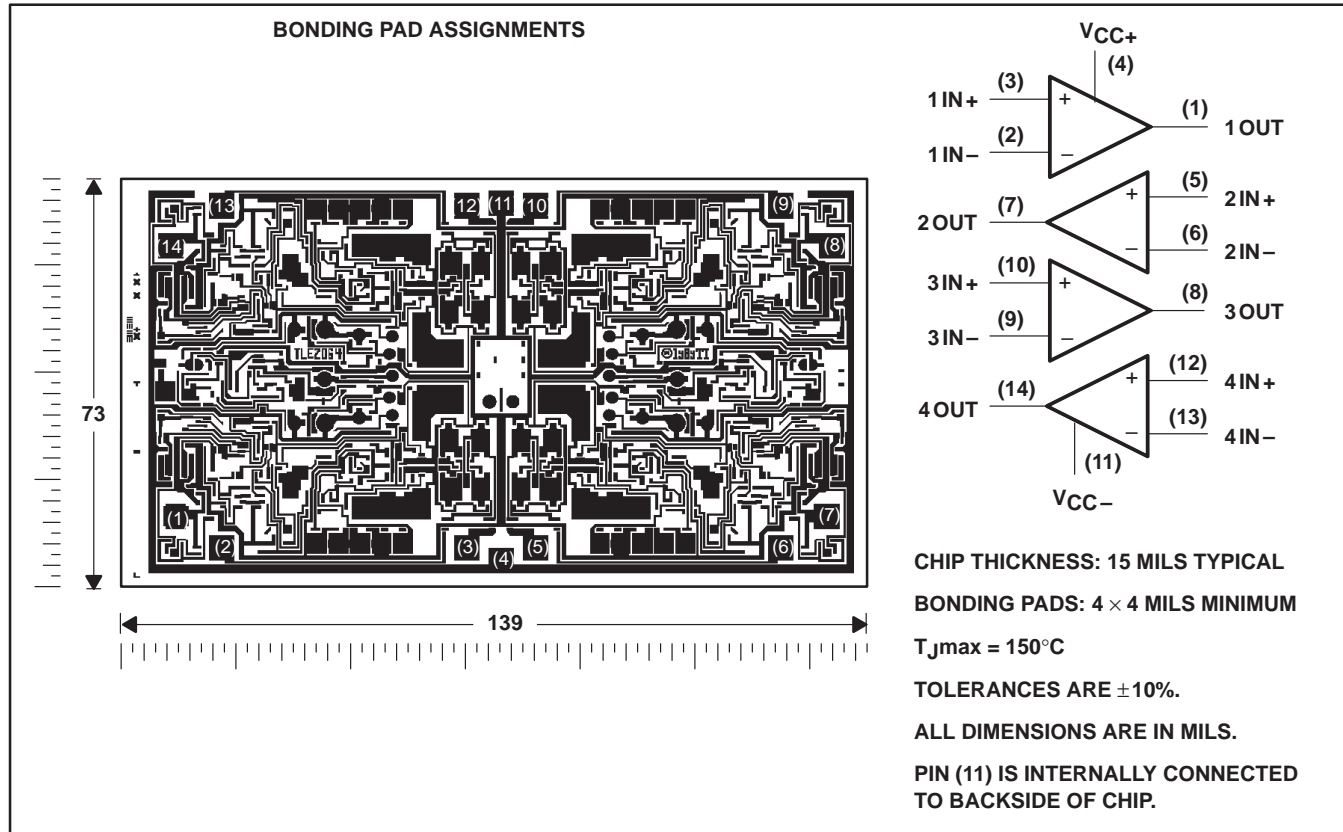


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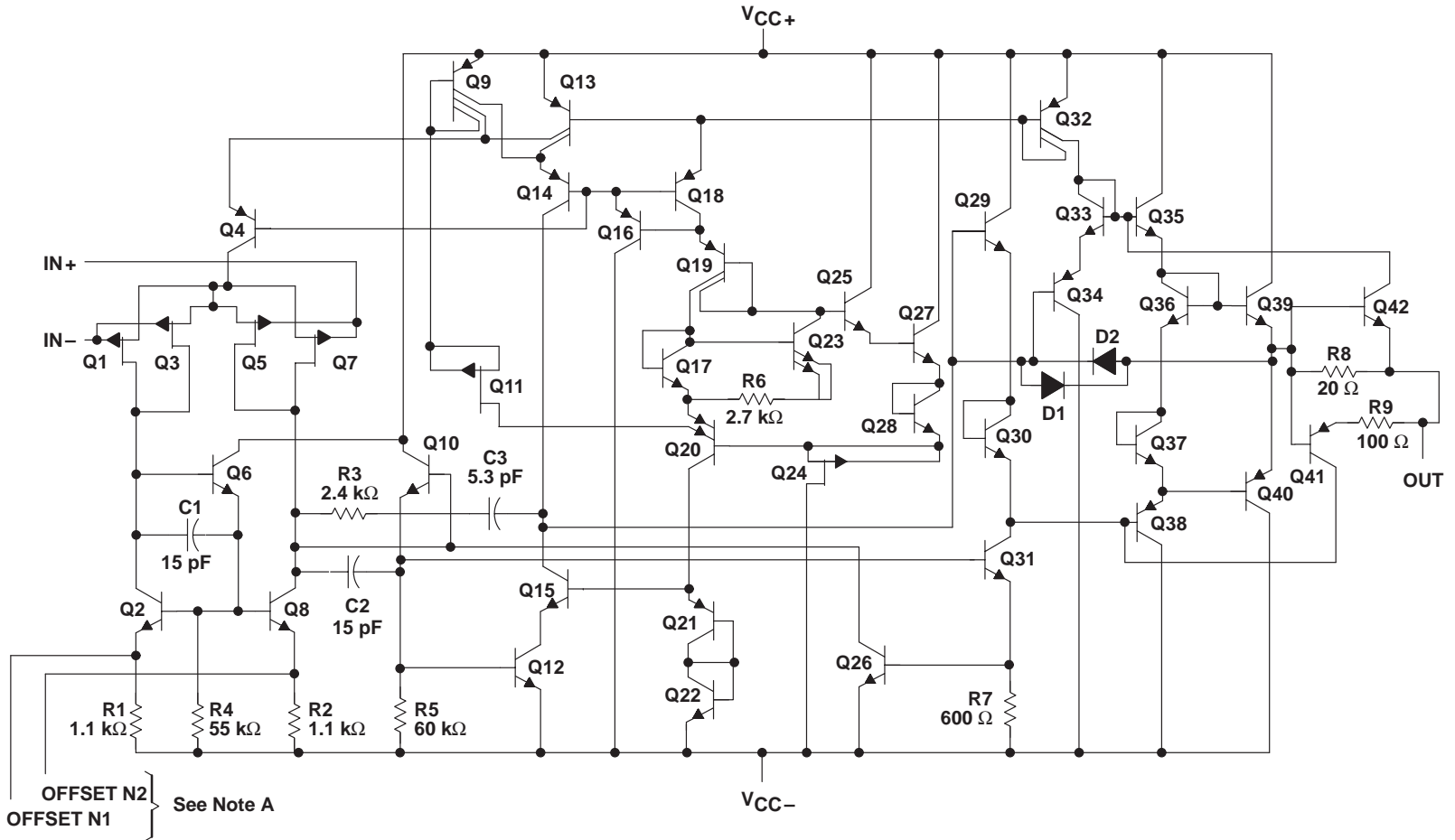
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## TLE2064Y chip information

This chip, when properly assembled, displays characteristics similar to the TLE2064. 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.



equivalent schematic (each channel)



NOTES: A. OFFSET N1 AND OFFSET N2 are only available on the TLE2061x devices.  
 B. Component values are nominal.

ACTUAL DEVICE COMPONENT COUNT			
COMPONENT	TLE2061	TLE2062	TLE2064
Transistors	43	42	42
Resistors	9	9	9
Diodes	1	2	2
Capacitors	3	3	3

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, $V_{CC+}$ (see Note 1)	19 V
Supply voltage, $V_{CC-}$	-19 V
Differential input voltage, $V_{ID}$ (see Note 2)	±38 V
Input voltage range, $V_I$ (any input)	± $V_{CC}$
Input current, $I_I$ (each input)	±1 mA
Output current, $I_O$	±80 mA
Total current into $V_{CC+}$	80 mA
Total current out of $V_{CC-}$	-80 mA
Duration of short-circuit current at (or below) 25°C (see Note 3)	unlimited
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$ : C suffix	0°C to 70°C
I suffix	-40°C to 85°C
M suffix	-55°C to 125°C
Storage temperature range	-65°C to 150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, P, or PW package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package	300°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES:
1. All voltage values, except differential voltages, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .
  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 that the maximum dissipation rating is not exceeded.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D-8	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
D-14	950 mW	7.6 mW/°C	608 mW	494 mW	190 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
J	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
N	1150 mW	9.2 mW/°C	736 mW	598 mW	230 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW	200 mW
PW	525 mW	4.2 mW/°C	336 mW	—	—

## recommended operating conditions

	C SUFFIX		I SUFFIX		M SUFFIX		UNIT
	MIN	MAX	MIN	MAX	MIN	MAX	
Supply voltage, $V_{CC\pm}$	±3.5	±18	±3.5	±18	±3.5	±18	V
Common-mode input voltage, $V_{IC}$	$V_{CC\pm} = \pm 5\text{ V}$		-1.6	4	-1.6	4	V
	$V_{CC\pm} = \pm 15\text{ V}$		-11	13	-11	13	
Operating free-air temperature, $T_A$	0	70	-40	85	-55	125	°C





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**TLE2061C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A^\dagger$	TLE2061C TLE2061AC TLE2061BC			UNIT	
				MIN	TYP	MAX		
$V_{IO}$ Input offset voltage	TLE2061C	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	0.8	3.1	mV		
			Full range	4				
	TLE2061AC		25°C	0.6	2.6			
			Full range	3.5				
	TLE2061BC		25°C	0.5	1.9			
			Full range	2.4				
	$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage			Full range	6		$\mu\text{V}/^\circ\text{C}$	
	Input offset voltage long-term drift (see Note 4)			25°C	0.04		$\mu\text{V}/\text{mo}$	
$I_{IO}$ Input offset current		25°C	1		pA			
		Full range	0.8		nA			
$I_{IB}$ Input bias current		25°C	3		pA			
		Full range	2		nA			
$V_{ICR}$ Common-mode input voltage range		25°C	-1.6 to 4	-2 to 6	V			
		Full range	-1.6 to 4		V			
$V_{OM+}$ Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	3.5	3.7	V			
		Full range	3.3					
	$R_L = 100\ \Omega$	25°C	2.5	3.1				
		Full range	2					
$V_{OM-}$ Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	-3.7	-3.9	V			
		Full range	-3.3					
	$R_L = 100\ \Omega$	25°C	-2.5	-2.7				
		Full range	-2					
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 2.8\ \text{V}, R_L = 10\ \text{k}\Omega$	25°C	15	80	V/mV			
		Full range	2					
	$V_O = 0\ \text{to}\ 2\ \text{V}, R_L = 100\ \Omega$	25°C	0.75	45				
		Full range	0.5					
	$V_O = 0\ \text{to}\ -2\ \text{V}, R_L = 100\ \Omega$	25°C	0.5	3				
		Full range	0.25					
$r_i$ Input resistance		25°C	$10^{12}$		$\Omega$			
$c_i$ Input capacitance		25°C	4		pF			
$z_o$ Open-loop output impedance	$I_O = 0$	25°C	280		$\Omega$			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}, R_S = 50\ \Omega$	25°C	65	82	dB			
		Full range	65					
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V}\ \text{to}\ \pm 15\ \text{V}, R_S = 50\ \Omega$	25°C	75	93	dB			
		Full range	75					

$^\dagger$  Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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**TLE2061C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2061C TLE2061AC TLE2061BC			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current	$V_O = 0$ , No load	25°C		280	325	μA
		Full range			350	
$\Delta I_{CC}$ Supply-current change over operating temperature range		Full range		29		μA

† Full range is 0°C to 70°C.

**TLE2061C operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2061C TLE2061AC TLE2061BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2.2	3.4		V/μs
		Full range	2.1			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	25°C		59	100	$nV/\sqrt{\text{Hz}}$
	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$			43	60	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		1.1		μV
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	25°C		1		$fA/\sqrt{\text{Hz}}$
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10\text{ kHz}$ , $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	25°C		0.025%		
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		1.8		MHz
	$R_L = 100\ \Omega$ , $C_L = 100\text{ pF}$			1.3		
$t_s$ Settling time	0.1%	25°C		5		μs
	0.01%			10		
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	25°C		140		kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		58°		
	$R_L = 100\ \Omega$ , $C_L = 100\text{ pF}$			75°		

† Full range is 0°C to 70°C.



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**TLE2061C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2061C TLE2061AC TLE2061BC			UNIT		
				MIN	TYP	MAX			
$V_{IO}$ Input offset voltage	TLE2061C	$V_{IC} = 0, R_S = 50 \text{ k}\Omega$	25°C	0.6		3	mV		
			Full range			3.9			
	TLE2061AC		25°C	0.5		1.5			
			Full range			2.5			
	TLE2061BC		25°C	0.3		0.5			
			Full range			1			
	$\alpha_{VIO}$ Temperature coefficient of input offset voltage			Full range	6				$\mu\text{V}/^\circ\text{C}$
	Input offset voltage long-term drift (see Note 4)			25°C	0.04				$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current		25°C	2			pA			
		Full range			1	nA			
$I_{IB}$ Input bias current		25°C	4			pA			
		Full range			3	nA			
$V_{ICR}$ Common-mode input voltage range		25°C	-11 to 13	-12 to 16		V			
		Full range	-11 to 13			V			
$V_{OM+}$ Maximum positive peak output voltage swing	$R_L = 10 \text{ k}\Omega$	25°C	13.2	13.7		V			
		Full range	13						
	$R_L = 600 \Omega$	25°C	12.5	13.2					
		Full range	12						
$V_{OM-}$ Maximum negative peak output voltage swing	$R_L = 10 \text{ k}\Omega$	25°C	-13.2	-13.7		V			
		Full range	-13						
	$R_L = 600 \Omega$	25°C	-12.5	-13					
		Full range	-12						
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 10 \text{ V}, R_L = 10 \text{ k}\Omega$	25°C	30	230		V/mV			
		Full range	20						
	$V_O = 0 \text{ to } 8 \text{ V}, R_L = 600 \Omega$	25°C	25	100					
		Full range	10						
	$V_O = 0 \text{ to } -8 \text{ V}, R_L = 600 \Omega$	25°C	3	25					
		Full range	1						
$r_i$ Input resistance		25°C	$10^{12}$		$\Omega$				
$c_i$ Input capacitance		25°C	4		pF				
$z_o$ Open-loop output impedance	$I_O = 0$	25°C	280		$\Omega$				
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, R_S = 50 \Omega$	25°C	72	90		dB			
		Full range	70						
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V}, R_S = 50 \Omega$	25°C	75	93		dB			
		Full range	75						

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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**TLE2061C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$  (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2061C TLE2061AC TLE2061BC			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current	$V_O = 0$ , No load	25°C		290	350	μA
		Full range			375	
$\Delta I_{CC}$ Supply-current change over operating temperature range		Full range		34		μA

† Full range is 0°C to 70°C.

**TLE2061C operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2061C TLE2061AC TLE2061BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2.6	3.4		V/μs
		Full range	2.5			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	25°C		70	100	nV/√Hz
	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$			40	60	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		1.1		μV
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	25°C		1.1		fA/√Hz
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10\text{ kHz}$ , $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	25°C		0.025%		
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		2		MHz
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$			1.5		
$t_s$ Settling time	0.1%	25°C		5		μs
	0.01%			10		
BOM Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	25°C		40		kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		60°		
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$			70°		

† Full range is 0°C to 70°C.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE20611 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE20611, TLE2061AI TLE2061BI			UNIT		
				MIN	TYP	MAX			
$V_{IO}$	Input offset voltage	$V_{IC} = 0,$ $R_S = 50\ \Omega$	25°C	0.8	3.1	mV			
			Full range		4.4				
			25°C	0.6	2.6				
			Full range		3.9				
			25°C	0.5	1.9				
			Full range		2.7				
			$\alpha_{VIO}$	Temperature coefficient of input offset voltage	Full range		6		$\mu\text{V}/^\circ\text{C}$
				Input offset voltage long-term drift (see Note 4)	25°C		0.04		$\mu\text{V}/\text{mo}$
					25°C		1		pA
$I_{IO}$	Input offset current	Full range		2	nA				
$I_{IB}$	Input bias current	25°C	3		pA				
		Full range		4	nA				
$V_{ICR}$	Common-mode input voltage range		25°C	-1.6 to 4	-2 to 6	V			
			Full range	-1.6 to 4		V			
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	3.5	3.7	V			
			Full range	3.1					
			25°C	2.5	3.1				
			Full range	2					
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	-3.7	-3.9	V			
			Full range	-3.1					
			25°C	-2.5	-2.7				
			Full range	-2					
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 2.8\ \text{V},$ $R_L = 10\ \text{k}\Omega$	25°C	15	80	V/mV			
			Full range	2					
		$V_O = 0\ \text{to}\ 2\ \text{V},$ $R_L = 100\ \Omega$	25°C	0.75	45				
			Full range	0.5					
		$V_O = 0\ \text{to}\ -2\ \text{V},$ $R_L = 100\ \Omega$	25°C	0.5	3				
			Full range	0.25					
$r_i$	Input resistance		25°C		$10^{12}$	$\Omega$			
$c_i$	Input capacitance		25°C		4	pF			
$z_o$	Open-loop output impedance	$I_O = 0$	25°C		280	$\Omega$			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}},$ $R_S = 50\ \Omega$	25°C	65	82	dB			
			Full range	65					
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V to } \pm 15\ \text{V},$ $R_S = 50\ \Omega$	25°C	75	93	dB			
			Full range	65					
$I_{CC}$	Supply current	$V_O = 0,$ No load	25°C	280	325	$\mu\text{A}$			
			Full range		350				
$\Delta I_{CC}$	Supply-current change over operating temperature range		Full range	29		$\mu\text{A}$			

† Full range is  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2061I operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2061I TLE2061AI TLE2061BI			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2.2	3.4		V/μs
		Full range	1.7			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	25°C		59	100	nV/√Hz
	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$			43	60	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		1.1		μV
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	25°C		1		fA/√Hz
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10\text{ kHz}$ , $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	25°C		0.025%		
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		1.8		MHz
	$R_L = 100\ \Omega$ , $C_L = 100\text{ pF}$			1.3		
$t_s$ Settling time	0.1%	25°C		5		μs
	0.01%			10		
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	25°C		140		kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		58°		
	$R_L = 100\ \Omega$ , $C_L = 100\text{ pF}$			75°		

† Full range is –40°C to 85°C.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE20611 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE20611, TLE2061AI TLE2061BI			UNIT				
				MIN	TYP	MAX					
$V_{IO}$	Input offset voltage						mV				
								TLE20611	25°C	0.6	3
									Full range		4.3
								TLE2061AI	25°C	0.5	1.5
									Full range		2.9
								TLE2061BI	25°C	0.3	0.5
$\alpha_{VIO}$	Temperature coefficient of input offset voltage	$V_{IC} = 0,$ $R_S = 50 \Omega$					$\mu V/^\circ C$				
	Input offset voltage long-term drift (see Note 4)						25°C	0.04	$\mu V/mo$		
$I_{IO}$	Input offset current						25°C	2	pA		
							Full range		3	nA	
$I_{IB}$	Input bias current						25°C	4	pA		
							Full range		5	nA	
$V_{ICR}$	Common-mode input voltage range						25°C	-11 to 13	-12 to 16	V	
							Full range	-11 to 13		V	
$V_{OM+}$	Maximum positive peak output voltage swing						V				
								$R_L = 10 \text{ k}\Omega$	25°C	13.2	13.7
									Full range	13	
								$R_L = 600 \Omega$	25°C	12.5	13.2
$V_{OM-}$	Maximum negative peak output voltage swing						V				
								$R_L = 10 \text{ k}\Omega$	25°C	-13.2	-13.7
									Full range	-13	
								$R_L = 600 \Omega$	25°C	-12.5	-13
$A_{VD}$	Large-signal differential voltage amplification						V/mV				
								$V_O = \pm 10 \text{ V},$ $R_L = 10 \text{ k}\Omega$	25°C	30	230
									Full range	20	
								$V_O = 0 \text{ to } 8 \text{ V},$ $R_L = 600 \Omega$	25°C	25	100
									Full range	10	
								$V_O = 0 \text{ to } -8 \text{ V},$ $R_L = 600 \Omega$	25°C	3	25
$r_i$	Input resistance						$\Omega$				
$c_i$	Input capacitance						pF				
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	280			$\Omega$				
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin},$ $R_S = 50 \Omega$					25°C	72	90	dB	
							Full range	65			
kSVR	Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V},$ $R_S = 50 \Omega$					25°C	75	93	dB	
							Full range	65			
$I_{CC}$	Supply current	$V_O = 0,$ No load					25°C	290	350	$\mu A$	
							Full range		375		
$\Delta I_{CC}$	Supply-current change over operating temperature range						Full range	34		$\mu A$	

† Full range is -40°C to 85°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ C$  extrapolated to  $T_A = 25^\circ C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2061I operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2061I TLE2061AI TLE2061BI			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2.6	3.4		V/μs
		Full range	2.1			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	25°C		70	100	nV/√Hz
	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$			40	60	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C	1.1		μV	
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	25°C	1.1		fA/√Hz	
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10\text{ kHz}$ , $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	25°C	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2		MHz	
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$		1.5			
$t_s$ Settling time	0.1%	25°C	5		μs	
	0.01%		10			
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	25°C	40		kHz	
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	60°			
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$		70°			

† Full range is –40°C to 85°C.





**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2061M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2061M TLE2061AM TLE2061BM			UNIT	
				MIN	TYP	MAX		
$V_{IO}$ Input offset voltage	TLE2061M	$V_{IC} = 0, R_S = 50 \Omega$	25°C	0.8	3.1	mV		
			Full range	6				
			25°C	0.6	2.6			
	Full range		4.6					
	TLE2061AM		25°C	0.5	1.9			
	Full range		3.1					
	TLE2061BM		Full range	6				
	$\alpha V_{IO}$ Temperature coefficient of input offset voltage		Full range	0.04			$\mu V/^\circ C$	
	Input offset voltage long-term drift (see Note 4)		25°C	1			$\mu V/mo$	
$I_{IO}$ Input offset current		25°C	1		pA			
		Full range	15		nA			
		Full range	3		pA			
$I_{IB}$ Input bias current		25°C	3		pA			
		Full range	30		nA			
		Full range	30		nA			
$V_{ICR}$ Common-mode input voltage range		25°C	-1.6 to 4	-2 to 6	V			
		Full range	-1.6 to 4		V			
$V_{OM+}$ Maximum positive peak output voltage swing		$R_L = 10 k\Omega$	25°C	3.5	3.7	V		
			Full range	3				
			25°C	2.5	3.6			
			Full range	2				
			$R_L = 600 \Omega$	25°C	2.5		3.1	
			Full range	2				
$V_{OM-}$ Maximum negative peak output voltage swing		$R_L = 10 k\Omega$	25°C	-3.5	-3.9	V		
			Full range	-3				
			FK and JG packages	25°C	-2.5		-3.5	
			Full range	-2				
			D and P packages	25°C	-2.5		-2.7	
			Full range	-2				
$A_{VD}$ Large-signal differential voltage amplification		$V_O = \pm 2.8 V, R_L = 10 k\Omega$	25°C	15	80	V/mV		
			Full range	2				
			FK and JG packages	$V_O = 0$ to 2.5 V, $R_L = 600 \Omega$	25°C		1	65
				Full range	0.5			
				$V_O = 0$ to -2.5 V, $R_L = 600 \Omega$	25°C		1	16
				Full range	0.5			
			D and P packages	$V_O = 0$ to 2 V, $R_L = 100 \Omega$	25°C		0.75	45
				Full range	0.5			
				$V_O = 0$ to -2 V, $R_L = 100 \Omega$	25°C		0.5	3
				Full range	0.25			

† Full range is -55°C to 125°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ C$  extrapolated to  $T_A = 25^\circ C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2061M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2061M TLE2061AM TLE2061BM			UNIT
			MIN	TYP	MAX	
$r_i$ Input resistance		25°C	10 <sup>12</sup>			Ω
$c_i$ Input capacitance		25°C	4			pF
$z_o$ Open-loop output impedance	$I_O = 0$	25°C	280			Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$ , $R_S = 50\ \Omega$	25°C	65	82		dB
		Full range	60			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\text{ V to } \pm 15\text{ V}$ , $R_S = 50\ \Omega$	25°C	75	93		dB
		Full range	65			
$I_{CC}$ Supply current	$V_O = 0$ , No load	25°C	280	325		μA
		Full range	350			
$\Delta I_{CC}$ Supply-current change over operating temperature range		Full range	39			μA

† Full range is -55°C to 125°C.

**TLE2061M operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

PARAMETER	TEST CONDITIONS	TLE2061M TLE2061AM TLE2061BM			UNIT
		MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	3.4			V/μs
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	59			nV/√Hz
	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$	43			
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to } 10\text{ Hz}$	1.1			μV
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	1			fA/√Hz
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10\text{ kHz}$ , $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	1.8			MHz
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	1.3			
$t_s$ Settling time	0.1%	5			μs
	0.01%	10			
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	140			kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	58°			
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	75°			



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2061M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2061M, TLE2061AM TLE2061BM			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage		25°C	TLE2061M		mV	
				Full range			
				TLE2061AM			
				Full range			
				TLE2061BM			
				Full range			
$\alpha_{VIO}$	Temperature coefficient of input offset voltage	$V_{IC} = 0$ , $R_S = 50 \Omega$	Full range	6		$\mu V/^\circ C$	
	Input offset voltage long-term drift (see Note 4)			25°C	0.04		$\mu V/mo$
$I_{IO}$	Input offset current			25°C	2		pA
				Full range	20		nA
$I_{IB}$	Input bias current			25°C	4		pA
				Full range	40		nA
$V_{ICR}$	Common-mode input voltage range	25°C	-11 to 13	-12 to 16	V		
		Full range	-11 to 13		V		
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10 \text{ k}\Omega$	25°C	13	13.7	V	
			Full range	12.5			
		$R_L = 600 \Omega$	25°C	12.5	13.2		
			Full range	12			
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10 \text{ k}\Omega$	25°C	-13	-13.7	V	
			Full range	-12.5			
		$R_L = 600 \Omega$	25°C	-12.5	-13		
			Full range	-12			
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 10 \text{ V}$ , $R_L = 10 \text{ k}\Omega$	25°C	30	230	V/mV	
			Full range	20			
		$V_O = 0 \text{ to } 8 \text{ V}$ , $R_L = 600 \Omega$	25°C	25	100		
			Full range	7			
		$V_O = 0 \text{ to } -8 \text{ V}$ , $R_L = 600 \Omega$	25°C	3	25		
			Full range	1			
$r_i$	Input resistance		25°C	$10^{12}$		$\Omega$	
$c_i$	Input capacitance		25°C	4		pF	
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	280		$\Omega$	
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$ , $R_S = 50 \Omega$	25°C	72	90	dB	
			Full range	65			
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ )	$V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V}$ , $R_S = 50 \Omega$	25°C	75	93	dB	
			Full range	65			

† Full range is -55°C to 125°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ C$  extrapolated to  $T_A = 25^\circ C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2061M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$  (unless otherwise noted) (continue)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2061M, TLE2061AM TLE2061BM			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current	$V_O = 0$ , No load	25°C	290		350	μA
		Full range			375	
$\Delta I_{CC}$ Supply-current change over operating temperature range		Full range	46			μA

† Full range is –55°C to 125°C.

**TLE2061M operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2061M TLE2061AM TLE2061BM			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2	3.4		V/μs
		Full range	1.8			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	25°C	70		nV/√Hz	
	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$	25°C	40			
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C	1.1		μV	
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	25°C	1.1		fA/√Hz	
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10\text{ kHz}$ , $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	25°C	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2		MHz	
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	25°C	1.5			
$t_s$ Settling time	0.1%	25°C	5		μs	
	0.01%	25°C	10			
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	25°C	40		kHz	
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	60°			
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	25°C	70°			

† Full range is –55°C to 125°C.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2061Y electrical characteristics at  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	TLE2061Y			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0$ , $R_S = 50\ \Omega$		0.6	3	mV
$\alpha V_{IO}$ Input offset voltage long-term drift (see Note 4)			0.04		$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current			2		pA
$I_{IB}$ Input bias current			4		pA
$V_{ICR}$ Common-mode input voltage range		-11 to 13	-12 to 16		V
$V_{OM+}$ Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	13.2	13.7		V
	$R_L = 600\ \Omega$	12.5	13.2		
$V_{OM-}$ Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	-13.2	-13.7		V
	$R_L = 600\ \Omega$	-12.5	-13		
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 10\ \text{V}$ , $R_L = 10\ \text{k}\Omega$	30	230		V/mV
	$V_O = 0\ \text{to}\ 8\ \text{V}$ , $R_L = 600\ \Omega$	25	100		
	$V_O = 0\ \text{to}\ -8\ \text{V}$ , $R_L = 600\ \Omega$	3	25		
$r_i$ Input resistance			$10^{12}$		$\Omega$
$c_i$ Input capacitance			4		pF
$z_o$ Open-loop output impedance	$I_O = 0$		280		$\Omega$
CMRR Common-mode rejection ratio	$R_S = 50\ \Omega$ , $V_{IC} = V_{ICR\text{min}}$	72	90		dB
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V to } \pm 15\ \text{V}$ , $R_S = 50\ \Omega$	75	93		dB
$I_{CC}$ Supply current	$V_O = 0$ , No load		290	350	$\mu\text{A}$

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

**TLE2061Y operating characteristics at  $V_{CC\pm} = \pm 15\ \text{V}$ ,  $T_A = 25^\circ\text{C}$**

PARAMETER	TEST CONDITIONS	TLE2061Y			UNIT
		MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$	2.6	3.4		V/ $\mu\text{s}$
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\ \text{Hz}$ , $R_S = 20\ \Omega$		70		nV/ $\sqrt{\text{Hz}}$
	$f = 1\ \text{kHz}$ , $R_S = 20\ \Omega$		40		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\ \text{Hz to } 10\ \text{Hz}$		1.1		$\mu\text{V}$
$I_n$ Equivalent input noise current	$f = 1\ \text{Hz}$		1.1		fA/ $\sqrt{\text{Hz}}$
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10\ \text{kHz}$ , $V_{O(PP)} = 2\ \text{V}$ , $R_L = 10\ \text{k}\Omega$		0.025%		
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$		2		MHz
	$R_L = 600\ \Omega$ , $C_L = 100\ \text{pF}$		1.5		
$t_s$ Settling time	0.1%		5		$\mu\text{s}$
	0.01%		10		
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\ \text{k}\Omega$		40		kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$		60°		
	$R_L = 600\ \Omega$ , $C_L = 100\ \text{pF}$		70°		



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**TLE2062C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2062C TLE2062AC TLE2062BC			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	1	5	mV	
			Full range	5.9			
			25°C	0.9	4		
			Full range	4.9			
			25°C	0.7	3		
			Full range	3.9			
$\alpha_{VIO}$	Temperature coefficient of input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	Full range	6		$\mu\text{V}/^\circ\text{C}$	
	Input offset voltage long-term drift (see Note 4)		25°C	0.04		$\mu\text{V}/\text{mo}$	
$I_{IO}$	Input offset current		25°C	1		pA	
			Full range	0.8		nA	
$I_{IB}$	Input bias current		25°C	3		pA	
			Full range	2		nA	
$V_{ICR}$	Common-mode input voltage range		25°C	-1.6 to 4	-2 to 6	V	
			Full range	-1.6 to 4		V	
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	3.5	3.7	V	
			Full range	3.3			
		$R_L = 100\ \Omega$	25°C	2.5	3.1		
			Full range	2			
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	-3.7	-3.9	V	
			Full range	-3.3			
		$R_L = 100\ \Omega$	25°C	-2.5	-2.7		
			Full range	-2			
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 2.8\ \text{V}, R_L = 10\ \text{k}\Omega$	25°C	15	80	V/mV	
			Full range	2			
		$V_O = 0\ \text{to}\ 2\ \text{V}, R_L = 100\ \Omega$	25°C	0.75	45		
			Full range	0.5			
		$V_O = 0\ \text{to}\ -2\ \text{V}, R_L = 100\ \Omega$	25°C	0.5	3		
			Full range	0.25			
$r_i$	Input resistance		25°C	$10^{12}$		$\Omega$	
$c_i$	Input capacitance		25°C	4		pF	
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	560		$\Omega$	
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}, R_S = 50\ \Omega$	25°C	65	82	dB	
			Full range	65			
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V}\ \text{to}\ \pm 15\ \text{V}, R_S = 50\ \Omega$	25°C	75	93	dB	
			Full range	75			

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2062C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062C TLE2062AC TLE2062BC			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current	$V_O = 0$ , No load	25°C		560	620	$\mu A$
		Full range		635		
$\Delta I_{CC}$ Supply-current change over operating temperature range		Full range		26		$\mu A$

† Full range is 0°C to 70°C.

**TLE2062C operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062C TLE2062AC TLE2062BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10$ k $\Omega$ , $C_L = 100$ pF	25°C	2.2	3.4	$V/\mu s$	
		Full range	2.1			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10$ Hz, $R_S = 20$ $\Omega$	25°C		59	100	$nV/\sqrt{Hz}$
	$f = 1$ kHz, $R_S = 20$ $\Omega$	25°C		43	60	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1$ Hz to 10 Hz	25°C		1.1		$\mu V$
$I_n$ Equivalent input noise current	$f = 1$ kHz	25°C		1		$fA/\sqrt{Hz}$
THD Total harmonic distortion	$V_{O(PP)} = 2$ V, $R_L = 10$ k $\Omega$ , $A_{VD} = 2$ , $f = 10$ kHz	25°C	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10$ k $\Omega$ , $C_L = 100$ pF	25°C	1.8			MHz
	$R_L = 100$ $\Omega$ , $C_L = 100$ pF	25°C	1.3			
Settling time	0.1%	25°C	5			$\mu s$
	0.01%	25°C	10			
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10$ k $\Omega$	25°C	140			kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10$ k $\Omega$ , $C_L = 100$ pF	25°C	58°			
	$R_L = 100$ $\Omega$ , $C_L = 100$ pF	25°C	75°			

† Full range is 0°C to 70°C.

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**TLE2062C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2062C TLE2062AC TLE2062BC			UNIT	
				MIN	TYP	MAX		
$V_{IO}$ Input offset voltage	TLE2062C	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	0.9	4	mV		
			Full range		4.9			
	TLE2062AC		25°C	0.8	2			
			Full range		2.9			
TLE2062BC	25°C		0.5	1				
	Full range			1.9				
$\alpha_{V_{IO}}$ Temperature coefficient of input offset voltage				Full range	6			$\mu\text{V}/^\circ\text{C}$
Input offset voltage long-term drift (see Note 4)				25°C	0.04			$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current			25°C	2		pA		
			Full range		1	nA		
$I_{IB}$ Input bias current			25°C	4		pA		
			Full range		3	nA		
$V_{ICR}$ Common-mode input voltage range				25°C	-11 to 13	-12 to 16	V	
				Full range	-11 to 13		V	
$V_{OM+}$ Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$			25°C	13.2	13.7	V	
				Full range	13			
	$R_L = 600\ \Omega$	25°C		12.5	13.2			
		Full range		12				
$V_{OM-}$ Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C		-13.2	-13.7	V		
		Full range		-13				
	$R_L = 600\ \Omega$	25°C	-12.5	-13				
		Full range	-12					
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 10\ \text{V}, R_L = 10\ \text{k}\Omega$	25°C	30	230	V/mV			
		Full range	20					
	$V_O = 0\ \text{to}\ 8\ \text{V}, R_L = 600\ \Omega$	25°C	25	100				
		Full range	10					
	$V_O = 0\ \text{to}\ -8\ \text{V}, R_L = 600\ \Omega$	25°C	3	25				
		Full range	1					
$r_i$ Input resistance		25°C		$10^{12}$	$\Omega$			
$c_i$ Input capacitance		25°C		4	pF			
$z_o$ Open-loop output impedance	$I_O = 0$	25°C		560	$\Omega$			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}, R_S = 50\ \Omega$	25°C	72	90	dB			
		Full range	70					
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V}\ \text{to}\ \pm 15\ \text{V}, R_S = 50\ \Omega$	25°C	75	93	dB			
		Full range	75					

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.





**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2062C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062C TLE2062AC TLE2062BC			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current	$V_O = 0$ V, No load	25°C	625	690	$\mu$ A	
		Full range	715			
$\Delta I_{CC}$ Supply-current change over operating temperature range		Full range	36		$\mu$ A	

† Full range is 0°C to 70°C.

**TLE2062C operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062C TLE2062AC TLE2062BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10$ k $\Omega$ , $C_L = 100$ pF	25°C	2.6	3.4	$V/\mu$ s	
		Full range	2.5			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10$ Hz, $R_S = 20$ $\Omega$	25°C	70	100	$nV/\sqrt{Hz}$	
	$f = 1$ kHz, $R_S = 20$ $\Omega$	25°C	40	60		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1$ Hz to 10 Hz	25°C	1.1		$\mu$ V	
$I_n$ Equivalent input noise current	$f = 1$ kHz	25°C	1.1		$fA/\sqrt{Hz}$	
THD Total harmonic distortion	$V_{O(PP)} = 2$ V, $R_L = 10$ k $\Omega$ , $A_{VD} = 2$ , $f = 10$ kHz	25°C	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10$ k $\Omega$ , $C_L = 100$ pF	25°C	2		MHz	
	$R_L = 600$ $\Omega$ , $C_L = 100$ pF	25°C	1.5			
Settling time	0.1%	25°C	5		$\mu$ s	
	0.01%	25°C	10			
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10$ k $\Omega$	25°C	40		kHz	
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10$ k $\Omega$ , $C_L = 100$ pF	25°C	60°			
	$R_L = 600$ $\Omega$ , $C_L = 100$ pF	25°C	70°			

† Full range is 0°C to 70°C.

**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2062I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2062I TLE2062AI TLE2062BI			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	1	5	mV	
			Full range	6.3			
			25°C	0.9	4		
			Full range	5.3			
			25°C	0.7	3		
			Full range	4.3			
$\alpha_{VIO}$	Temperature coefficient of input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	Full range	6		$\mu\text{V}/^\circ\text{C}$	
	Input offset voltage long-term drift (see Note 4)		25°C	0.04		$\mu\text{V}/\text{mo}$	
$I_{IO}$	Input offset current		25°C	1		pA	
			Full range	2		nA	
$I_{IB}$	Input bias current		25°C	3		pA	
			Full range	4		nA	
$V_{ICR}$	Common-mode input voltage range		25°C	-1.6 to 4	-2 to 6	V	
			Full range	-1.6 to 4		V	
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	3.5	3.7	V	
			Full range	3.1			
		$R_L = 100\ \Omega$	25°C	2.5	3.1		
			Full range	2			
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	-3.7	-3.9	V	
			Full range	-3.1			
		$R_L = 100\ \Omega$	25°C	-2.5	-2.7		
			Full range	-2			
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 2.8\ \text{V}, R_L = 10\ \text{k}\Omega$	25°C	15	80	V/mV	
			Full range	2			
		$V_O = 0\ \text{to}\ 2\ \text{V}, R_L = 100\ \Omega$	25°C	0.75	45		
			Full range	0.5			
		$V_O = 0\ \text{to}\ -2\ \text{V}, R_L = 100\ \Omega$	25°C	0.5	3		
			Full range	0.25			
$r_i$	Input resistance		25°C	10 <sup>12</sup>		$\Omega$	
$c_i$	Input capacitance		25°C	4		pF	
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	560		$\Omega$	
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, R_S = 50\ \Omega$	25°C	65	82	dB	
			Full range	65			
kSVR	Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V}\ \text{to}\ \pm 15\ \text{V}, R_S = 50\ \Omega$	25°C	75	93	dB	
			Full range	65			

† Full range is  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2062I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062I TLE2062AI TLE2062BI			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current	$V_O = 0$ , No load	25°C		560	620	$\mu\text{A}$
		Full range		640		
$\Delta I_{CC}$ Supply-current change over operating temperature range		Full range		54		$\mu\text{A}$

† Full range is  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ .

**TLE2062I operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062I TLE2062AI TLE2062BI			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2.2	3.4	$\text{V}/\mu\text{s}$	
		Full range	1.7			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	25°C		59	100	$\text{nV}/\sqrt{\text{Hz}}$
	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$	25°C		43	60	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz}$ to $10\text{ Hz}$	25°C		1.1		$\mu\text{V}$
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	25°C		1		$\text{fA}/\sqrt{\text{Hz}}$
THD Total harmonic distortion	$V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $A_{VD} = 2$ , $f = 10\text{ kHz}$	25°C	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	1.8			MHz
	$R_L = 100\ \Omega$ , $C_L = 100\text{ pF}$	25°C	1.3			
Settling time	0.1%	25°C	5			$\mu\text{s}$
	0.01%	25°C	10			
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	25°C	140			kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	58°			
	$R_L = 100\ \Omega$ , $C_L = 100\text{ pF}$	25°C	75°			

† Full range is  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ .

**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2062I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2062I TLE2062AI TLE2062BI			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	0.9	4	mV	
			Full range	5.3			
			25°C	0.8	2		
			Full range	3.3			
			25°C	0.5	1		
			Full range	2.3			
$\alpha_{VIO}$	Temperature coefficient of input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	Full range	6		$\mu\text{V}/^\circ\text{C}$	
	Input offset voltage long-term drift (see Note 4)		25°C	0.04		$\mu\text{V}/\text{mo}$	
$I_{IO}$	Input offset current		25°C	2		pA	
			Full range	3		nA	
$I_{IB}$	Input bias current		25°C	4		pA	
			Full range	5		nA	
$V_{ICR}$	Common-mode input voltage range		25°C	-11 to 13	-12 to 16	V	
			Full range	-11 to 13		V	
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	13.2	13.7	V	
			Full range	13			
		$R_L = 600\ \Omega$	25°C	12.5	13.2		
			Full range	12			
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	-13.2	-13.7	V	
			Full range	-13			
		$R_L = 600\ \Omega$	25°C	-12.5	-13		
			Full range	-12			
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 10\ \text{V}, R_L = 10\ \text{k}\Omega$	25°C	30	230	V/mV	
			Full range	20			
		$V_O = 0\ \text{to}\ 8\ \text{V}, R_L = 600\ \Omega$	25°C	25	100		
			Full range	10			
		$V_O = 0\ \text{to}\ -8\ \text{V}, R_L = 600\ \Omega$	25°C	3	25		
			Full range	1			
$r_i$	Input resistance		25°C	10 <sup>12</sup>	$\Omega$		
$c_i$	Input capacitance		25°C	4	pF		
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	560	$\Omega$		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, R_S = 50\ \Omega$	25°C	72	90	dB	
			Full range	65			
kSVR	Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V to } \pm 15\ \text{V}, R_S = 50\ \Omega$	25°C	75	93	dB	
			Full range	65			

† Full range is -40°C to 85°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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**TLE2062I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062I TLE2062AI TLE2062BI			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current	$V_O = 0$ , No load	25°C		625	690	$\mu A$
		Full range			720	
$\Delta I_{CC}$ Supply-current change over operating temperature range		Full range		74		$\mu A$

† Full range is  $-40^\circ C$  to  $85^\circ C$ .

**TLE2062I operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062I TLE2062AI TLE2062BI			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10$ k $\Omega$ , $C_L = 100$ pF	25°C	2.6	3.4		V/ $\mu s$
		Full range	2.1			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10$ Hz, $R_S = 20$ $\Omega$	25°C		70	100	nV/ $\sqrt{Hz}$
	$f = 1$ kHz, $R_S = 20$ $\Omega$	25°C		40	60	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1$ Hz to 10 Hz	25°C		1.1		$\mu V$
$I_n$ Equivalent input noise current	$f = 1$ kHz	25°C		1.1		fA/ $\sqrt{Hz}$
THD Total harmonic distortion	$V_{O(PP)} = 2$ V, $R_L = 10$ k $\Omega$ , $A_{VD} = 2$ , $f = 10$ kHz	25°C		0.025%		
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10$ k $\Omega$ , $C_L = 100$ pF	25°C		2		MHz
	$R_L = 600$ $\Omega$ , $C_L = 100$ pF	25°C		1.5		
Settling time	0.1%	25°C		5		$\mu s$
	0.01%	25°C		10		
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10$ k $\Omega$	25°C		40		kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10$ k $\Omega$ , $C_L = 100$ pF	25°C		60°		
	$R_L = 600$ $\Omega$ , $C_L = 100$ pF	25°C		70°		

† Full range is  $-40^\circ C$  to  $85^\circ C$ .

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**TLE2062M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2062M TLE2062AM TLE2062BM			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_{IC} = 0,$ $R_S = 50\ \Omega$	25°C	1		5	mV
			Full range	7			
			25°C	0.9		4	
			Full range	6			
			25°C	0.7		3	
			Full range	5			
$\alpha_{VIO}$	Temperature coefficient of input offset voltage		Full range	6		$\mu\text{V}/^\circ\text{C}$	
	Input offset voltage long-term drift (see Note 4)		25°C	0.04		$\mu\text{V}/\text{mo}$	
$I_{IO}$	Input offset current		25°C	1		pA	
			Full range	15		nA	
$I_{IB}$	Input bias current		25°C	3		pA	
			Full range	30		nA	
$V_{ICR}$	Common-mode input voltage range		25°C	-1.6 to 4	-2 to 6	V	
			Full range	-1.6 to 4		V	
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	3.5	3.7	V	
			Full range	3			
		FK and JG packages $R_L = 600\ \Omega$	25°C	2.5	3.6		
			Full range	2			
		D and P packages $R_L = 100\ \Omega$	25°C	2.5	3.1		
			Full range	2			
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	-3.5	-3.9	V	
			Full range	-3			
		FK and JG packages $R_L = 600\ \Omega$	25°C	-2.5	-3.5		
			Full range	-2			
		D and P packages $R_L = 100\ \Omega$	25°C	-2.5	-2.7		
			Full range	-2			
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 2.8\ \text{V},$ $R_L = 10\ \text{k}\Omega$	25°C	15	80	V/mV	
			Full range	2			
		FK and JG packages $V_O = 0\ \text{to}\ 2.5\ \text{V},$ $R_L = 600\ \Omega$	25°C	1	65		
			Full range	0.5			
			25°C	1	16		
			Full range	0.5			
		D and P packages $V_O = 0\ \text{to}\ 2\ \text{V},$ $R_L = 100\ \Omega$	25°C	0.75	45		
			Full range	0.5			
			25°C	0.5	3		
			Full range	0.25			

† Full range is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2062M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062M TLE2062AM TLE2062BM			UNIT
			MIN	TYP	MAX	
$r_i$ Input resistance		25°C	10 <sup>12</sup>			Ω
$c_i$ Input capacitance		25°C	4			pF
$z_o$ Open-loop output impedance	$I_O = 0$	25°C	560			Ω
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$ $R_S = 50\ \Omega$	25°C	65	82		dB
		Full range	60			
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\text{ V to } \pm 15\text{ V}$ , $R_S = 50\ \Omega$	25°C	75	93		dB
		Full range	65			
$I_{CC}$ Supply current (two amplifiers)	$V_O = 0$ , No load	25°C	560	620		μA
		Full range	650			
$\Delta I_{CC}$ Supply-current change over operating temperature range (two amplifiers)		Full range	72			μA

† Full range is –55°C to 125°C.

**TLE2062M operating characteristics at specified free-air temperature,  $T_A = 25^\circ\text{C}$ ,  $V_{CC\pm} = \pm 5\text{ V}$**

PARAMETER	TEST CONDITIONS	TLE2062M TLE2062AM TLE2062BM			UNIT
		MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	3.4			V/μs
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	59			nV/√Hz
	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$	43			
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to } 10\text{ Hz}$	1.1			μV
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	1			fA/√Hz
THD Total harmonic distortion	$V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $A_{VD} = 2$ , $f = 10\text{ kHz}$	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	1.8			MHz
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	1.3			
Settling time	0.1%	5			μs
	0.01%	10			
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	140			kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	58°			
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	75°			

**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2062M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2062M TLE2062AM TLE2062BM			UNIT	
				MIN	TYP	MAX		
$V_{IO}$ Input offset voltage	TLE2062M	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	0.9	4	mV		
			Full range	6				
			25°C	0.8	2			
	TLE2062AM		Full range	4				
			25°C	0.5	1			
			Full range	3				
	$\alpha_{VIO}$ Temperature coefficient of input offset voltage		Input offset voltage long-term drift (see Note 4)	Full range	6		$\mu\text{V}/^\circ\text{C}$	
				25°C	0.04		$\mu\text{V}/\text{mo}$	
	$I_{IO}$ Input offset current			25°C	2		pA	
Full range		20		nA				
$I_{IB}$ Input bias current		25°C	4		pA			
		Full range	40		nA			
$V_{ICR}$ Common-mode input voltage range		25°C	-11 to 13	-12 to 16	V			
		Full range	-11 to 13		V			
$V_{OM+}$ Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	13	13.7	V			
		Full range	12.5					
	$R_L = 600\ \Omega$	25°C	12.5	13.2				
		Full range	11					
$V_{OM-}$ Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	-13	-13.7	V			
		Full range	-12.5					
	$R_L = 600\ \Omega$	25°C	-12.5	-13				
		Full range	-11					
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 10\ \text{V}, R_L = 10\ \text{k}\Omega$	25°C	30	230	V/mV			
		Full range	20					
	$V_O = 0\ \text{to}\ 8\ \text{V}, R_L = 600\ \Omega$	25°C	25	100				
		Full range	7					
	$V_O = 0\ \text{to}\ -8\ \text{V}, R_L = 600\ \Omega$	25°C	3	25				
		Full range	1					
$r_i$ Input resistance		25°C	$10^{12}$		$\Omega$			
$c_i$ Input capacitance		25°C	4		pF			
$z_o$ Open-loop output impedance	$I_O = 0$	25°C	560		$\Omega$			
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}, R_S = 50\ \Omega$	25°C	72	90	dB			
		Full range	65					
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V}\ \text{to}\ \pm 15\ \text{V}, R_S = 50\ \Omega$	25°C	75	93	dB			
		Full range	65					

† Full range is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.





**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2062M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062M TLE2062AM TLE2062BM			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current	$V_O = 0$ , No load	25°C		625	690	μA
		Full range			730	
$\Delta I_{CC}$ Supply-current change over operating temperature range		Full range		97		μA

† Full range is –55°C to 125°C.

**TLE2062M operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2062M TLE2062AM TLE2062BM			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10$ kΩ, $C_L = 100$ pF	25°C	2	3.4		V/μs
		Full range	1.8			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10$ Hz, $R_S = 20$ Ω	25°C		70		nV/√Hz
	$f = 1$ kHz, $R_S = 20$ Ω	25°C		40		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1$ Hz to 10 Hz	25°C		1.1		μV
$I_n$ Equivalent input noise current	$f = 1$ kHz	25°C		1.1		fA/√Hz
THD Total harmonic distortion	$V_{O(PP)} = 2$ V, $R_L = 10$ kΩ, $A_{VD} = 2$ , $f = 10$ kHz	25°C		0.025%		
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10$ kΩ, $C_L = 100$ pF	25°C		2		MHz
	$R_L = 600$ Ω, $C_L = 100$ pF	25°C		1.5		
Settling time	0.1%	25°C		5		μs
	0.01%	25°C		10		
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10$ kΩ	25°C		40		kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10$ kΩ, $C_L = 100$ pF	25°C		60°		
	$R_L = 600$ Ω, $C_L = 100$ pF	25°C		70°		

† Full range is –55°C to 125°C.

**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2062Y electrical characteristics at  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	TLE2062Y			UNIT
		MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = 0$ , $R_S = 50\ \Omega$		0.9	4	mV
$\alpha V_{IO}$ Input offset voltage long-term drift (see Note 4)			0.04		$\mu\text{V}/\text{mo}$
$I_{IO}$ Input offset current			2		pA
$I_{IB}$ Input bias current			4		pA
$V_{ICR}$ Common-mode input voltage range		-11 to 13	-12 to 16		V
$V_{OM+}$ Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	13.2	13.7		V
	$R_L = 600\ \Omega$	12.5	13.2		
$V_{OM-}$ Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	-13.2	-13.7		V
	$R_L = 600\ \Omega$	-12.5	-13		
$A_{VD}$ Large-signal differential voltage amplification	$V_O = \pm 10\ \text{V}$ , $R_L = 10\ \text{k}\Omega$	30	230		V/mV
	$V_O = 0\ \text{to}\ 8\ \text{V}$ , $R_L = 600\ \Omega$	25	100		
	$V_O = 0\ \text{to}\ -8\ \text{V}$ , $R_L = 600\ \Omega$	3	25		
$r_i$ Input resistance			$10^{12}$		$\Omega$
$c_i$ Input capacitance			4		pF
$z_o$ Open-loop output impedance	$I_O = 0$		560		$\Omega$
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR\text{min}}$ , $R_S = 50\ \Omega$	72	90		dB
$k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC}/\Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V}\ \text{to}\ \pm 15\ \text{V}$ , $R_S = 50\ \Omega$	75	93		dB
$I_{CC}$ Supply current	$V_O = 0$ , No load		625	690	$\mu\text{A}$

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

**TLE2062Y operating characteristics at  $V_{CC\pm} = \pm 15\ \text{V}$ ,  $T_A = 25^\circ\text{C}$**

PARAMETER	TEST CONDITIONS	TLE2062Y			UNIT
		MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$	2.6	3.4	4	$\text{V}/\mu\text{s}$
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\ \text{Hz}$ , $R_S = 20\ \Omega$		70		$\text{nV}/\sqrt{\text{Hz}}$
	$f = 1\ \text{kHz}$ , $R_S = 20\ \Omega$		40		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\ \text{Hz}\ \text{to}\ 10\ \text{Hz}$		1.1		$\mu\text{V}$
$I_n$ Equivalent input noise current	$f = 1\ \text{Hz}$		1.1		$\text{fA}/\sqrt{\text{Hz}}$
THD Total harmonic distortion	$V_{O(PP)} = 2\ \text{V}$ , $A_{VD} = 2$ , $R_L = 10\ \text{k}\Omega$ , $f = 10\ \text{kHz}$		0.025%		
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$		2		MHz
	$R_L = 600\ \Omega$ , $C_L = 100\ \text{pF}$		1.5		
Settling time	0.1%		5		$\mu\text{s}$
	0.01%		10		
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\ \text{k}\Omega$		40		kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$		60°		
	$R_L = 600\ \Omega$ , $C_L = 100\ \text{pF}$		70°		



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2064C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2064C TLE2064AC TLE2064BC			UNIT	
				MIN	TYP	MAX		
$V_{IO}$	Input offset voltage	$V_{IC} = 0$ , $R_S = 50 \Omega$	25°C	1.2	7	mV		
			Full range	7.9				
			25°C	1.2	6			
			Full range	6.9				
			25°C	0.8	3.5			
			Full range	4.4				
			$\alpha_{VIO}$	Temperature coefficient of input offset voltage	25°C		6	$\mu V/^\circ C$
				Input offset voltage long-term drift (see Note 4)	Full range		0.04	$\mu V/mo$
			$I_{IO}$	Input offset current	25°C		1	pA
					Full range		0.8	nA
			$I_{IB}$	Input bias current	25°C		3	pA
					Full range		2	nA
$V_{ICR}$	Common-mode input voltage range		25°C	-1.6 to 4	-2 to 6	V		
			Full range	-1.6 to 4		V		
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10 k\Omega$	25°C	3.5	3.7	V		
			Full range	3.3				
			25°C	2.5	3.1			
			Full range	2				
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10 k\Omega$	25°C	-3.7	-3.9	V		
			Full range	-3.3				
			25°C	-2.5	-2.7			
			Full range	-2				
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 2.8$ V, $R_L = 10 k\Omega$	25°C	15	80	V/mV		
			Full range	2				
		$V_O = 0$ to 2 V, $R_L = 100 \Omega$	25°C	0.75	45			
			Full range	0.5				
		$V_O = 0$ to -2 V, $R_L = 100 \Omega$	25°C	0.5	3			
			Full range	0.15				
$r_i$	Input resistance		25°C	$10^{12}$	$\Omega$			
$c_i$	Input capacitance		25°C	4	pF			
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	560	$\Omega$			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$ , $R_S = 50 \Omega$	25°C	65	82	dB		
			Full range	65				
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ )	$V_{CC\pm} = \pm 5$ V to $\pm 15$ V, $R_S = 50 \Omega$	25°C	75	93	dB		
			Full range	75				

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ C$  extrapolated to  $T_A = 25^\circ C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
**EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE**  
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**TLE2064C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2064C TLE2064AC TLE2064BC			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current (four amplifiers)	$V_O = 0$ , No load	25°C	1.12	1.3	mA	
		Full range	1.3			
$\Delta I_{CC}$ Supply-current change over operating temperature range (four amplifiers)		Full range	52		μA	
$V_{O1}/V_{O2}$ Crosstalk attenuation	$A_{VD} = 1000$ , $f = 1\text{ kHz}$	25°C	120		dB	

† Full range is 0°C to 70°C.

**TLE2064C operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2064C TLE2064AC TLE2064BC			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2.2	3.4	V/μs	
		Full range	2.1			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	25°C	59	100	nV/√Hz	
	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$		43	60		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C	1.1		μV	
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	25°C	1		fA/√Hz	
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10\text{ kHz}$ , $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	25°C	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	1.8		MHz	
	$R_L = 100\ \Omega$ , $C_L = 100\text{ pF}$		1.3			
$t_s$ Settling time	$\epsilon = 0.1\%$	25°C	5		μs	
	$\epsilon = 0.01\%$		10			
BOM Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	25°C	140		kHz	
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	58°			
	$R_L = 100\ \Omega$ , $C_L = 100\text{ pF}$		75°			

† Full range is 0°C to 70°C.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2064C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2064C TLE2064AC TLE2064BC			UNIT			
				MIN	TYP	MAX				
$V_{IO}$	Input offset voltage	$V_{IC} = 0, R_S = 50 \Omega$	25°C	0.9		6	mV			
				Full range				6.9		
			25°C	0.9		4				
				Full range				4.9		
			25°C	0.7		2				
				Full range				4		
			$\alpha_{VIO}$ Temperature coefficient of input offset voltage		$V_{IC} = 0, R_S = 50 \Omega$	25°C		6		$\mu V/^\circ C$
			Input offset voltage long-term drift (see Note 4)			Full range		0.04		$\mu V/mo$
			$I_{IO}$	Input offset current	$V_{IC} = 0, R_S = 50 \Omega$	25°C		2		pA
Full range	1					nA				
$I_{IB}$	Input bias current	$V_{IC} = 0, R_S = 50 \Omega$	25°C	4		pA				
			Full range	3		nA				
$V_{ICR}$	Common-mode input voltage range		25°C	-11 to 13	-12 to 16	V				
			Full range	-11 to 13		V				
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10 k\Omega$	25°C	13.2	13.7	V				
			Full range				13			
		$R_L = 600 \Omega$	25°C	12.5	13.2					
			Full range				12			
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10 k\Omega$	25°C	-13.2	-13.7	V				
			Full range				-13			
		$R_L = 600 \Omega$	25°C	-12.5	-13					
			Full range				-12			
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 10$ V, $R_L = 10 k\Omega$	25°C	30	230	V/mV				
			Full range				20			
		$V_O = 0$ to 8 V, $R_L = 600 \Omega$	25°C	25	100					
			Full range				10			
		$V_O = 0$ to -8 V, $R_L = 600 \Omega$	25°C	3	25					
			Full range				1			
$r_i$	Input resistance		25°C	$10^{12}$		$\Omega$				
$c_i$	Input capacitance		25°C	4		pF				
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	560		$\Omega$				
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, R_S = 50 \Omega$	25°C	72	90	dB				
			Full range				70			
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ )	$V_{CC\pm} = \pm 5$ V to $\pm 15$ V, $R_S = 50 \Omega$	25°C	75	93	dB				
			Full range				75			

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ C$  extrapolated to  $T_A = 25^\circ C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2064C electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$  (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS		$T_A$ †	TLE2064C TLE2064AC TLE2064BC			UNIT
				MIN	TYP	MAX	
$I_{CC}$ Supply current (four amplifiers)	$V_O = 0,$	No load	25°C	1.25	1.4	mA	
			Full range	1.5			
$\Delta I_{CC}$ Supply-current change over operating temperature range (four amplifiers)			Full range	72	μA		
$V_{O1}/V_{O2}$ Crosstalk attenuation	$A_{VD} = 1000,$	$f = 1\text{ kHz}$	25°C	120		dB	

† Full range is 0°C to 70°C.

**TLE2064C operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$**

PARAMETER	TEST CONDITIONS		$T_A$ †	TLE2064C TLE2064AC TLE2064BC			UNIT
				MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega,$	$C_L = 100\text{ pF}$	25°C	2.6	3.4	V/μs	
			Full range	2.5			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz},$	$R_S = 20\ \Omega$	25°C	70	100	nV/√Hz	
	$f = 1\text{ kHz},$	$R_S = 20\ \Omega$		40	60		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }10\text{ Hz}$		25°C	1.1		μV	
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$		25°C	1		fA/√Hz	
THD Total harmonic distortion	$A_{VD} = 2,$ $V_{O(PP)} = 2\text{ V},$	$f = 10\text{ kHz},$ $R_L = 10\text{ k}\Omega$	25°C	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega,$	$C_L = 100\text{ pF}$	25°C	2		MHz	
	$R_L = 600\ \Omega,$	$C_L = 100\text{ pF}$		1.5			
$t_s$ Settling time	$\epsilon = 0.1\%$		25°C	5		μs	
	$\epsilon = 0.01\%$			10			
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1,$	$R_L = 10\text{ k}\Omega$	25°C	40		kHz	
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega,$	$C_L = 100\text{ pF}$	25°C	50°			
	$R_L = 600\ \Omega,$	$C_L = 100\text{ pF}$		70°			

† Full range is 0°C to 70°C.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2064I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A^\dagger$	TLE2064I TLE2064AI TLE2064BI			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	1.2	7	mV	
			Full range	8.3			
			25°C	1.2	6		
			Full range	7.3			
			25°C	0.8	3.5		
			Full range	4.8			
$\alpha_{VIO}$	Temperature coefficient of input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	6		$\mu\text{V}/^\circ\text{C}$	
	Input offset voltage long-term drift (see Note 4)		Full range	0.04		$\mu\text{V}/\text{mo}$	
$I_{IO}$	Input offset current	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	1		pA	
			Full range	2		nA	
$I_{IB}$	Input bias current		25°C	3		pA	
			Full range	4		nA	
$V_{ICR}$	Common-mode input voltage range		25°C	-1.6 to 4	-2 to 6		V
			Full range	-1.6 to 4			V
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	3.5	3.7	V	
			Full range	3.1			
		$R_L = 100\ \Omega$	25°C	2.5	3.1		
			Full range	2			
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	-3.7	-3.9	V	
			Full range	-3.1			
		$R_L = 100\ \Omega$	25°C	-2.5	-2.7		
			Full range	-2			
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 2.8\ \text{V}, R_L = 10\ \text{k}\Omega$	25°C	15	80	V/mV	
			Full range	2			
		$V_O = 0\ \text{to}\ 2\ \text{V}, R_L = 100\ \Omega$	25°C	0.75	45		
			Full range	0.5			
		$V_O = 0\ \text{to}\ -2\ \text{V}, R_L = 100\ \Omega$	25°C	0.5	3		
			Full range	0.15			
$r_i$	Input resistance		25°C	$10^{12}$		$\Omega$	
$c_i$	Input capacitance		25°C	4		pF	
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	560		$\Omega$	
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, R_S = 50\ \Omega$	25°C	65	82	dB	
			Full range	65			
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V}\ \text{to}\ \pm 15\ \text{V}, R_S = 50\ \Omega$	25°C	75	93	dB	
			Full range	65			

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2064I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2064I TLE2064AI TLE2064BI			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current (four amplifiers)	$V_O = 0$ , No load	25°C	1.12		1.3	mA
		Full range			1.3	
$\Delta I_{CC}$ Supply-current change over operating temperature range (four amplifiers)		Full range	108			μA
$V_{O1}/V_{O2}$ Crosstalk attenuation	$A_{VD} = 1000$ , $f = 1\text{ kHz}$	25°C	120			dB

† Full range is –40°C to 85°C.

**TLE2064I operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2064I TLE2064AI TLE2064BI			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2.2	3.4		V/μs
		Full range	1.7			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	25°C	59		100	nV/√Hz
	$f = 1\text{ kHz}$ , $f = 1\text{ kHz}$ ,		43		60	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz}$ to $10\text{ Hz}$	25°C	1.1			μV
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	25°C	1			fA/√Hz
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10\text{ kHz}$ , $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	25°C	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	1.8			MHz
	$R_L = 100\ \Omega$ , $C_L = 100\text{ pF}$		1.3			
$t_s$ Settling time	$\epsilon = 0.1\%$	25°C	5			μs
	$\epsilon = 0.01\%$		10			
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	25°C	140			kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	58°			
	$R_L = 100\ \Omega$ , $C_L = 100\text{ pF}$		75°			

† Full range is –40°C to 85°C.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2064I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2064I TLE2064AI TLE2064BI			UNIT	
				MIN	TYP	MAX		
$V_{IO}$	Input offset voltage	$V_{IC} = 0, \quad R_S = 50 \Omega$	25°C	0.9	6	mV		
			Full range	7.3				
			25°C	0.9	4			
			Full range	5.3				
			25°C	0.7	2			
			Full range	3.3				
			$\alpha_{VIO}$	Temperature coefficient of input offset voltage	25°C		6	$\mu V/^\circ C$
				Input offset voltage long-term drift (see Note 4)	Full range		0.04	$\mu V/mo$
$I_{IO}$	Input offset current	25°C	2	pA				
		Full range	3		nA			
$I_{IB}$	Input bias current	25°C	4	pA				
		Full range	5		nA			
$V_{ICR}$	Common-mode input voltage range		25°C	-11 to 13	-12 to 16	V		
			Full range	-11 to 13		V		
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10 \text{ k}\Omega$	25°C	13.2	13.7	V		
			Full range	13				
			25°C	12.5	13.2			
			Full range	12				
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10 \text{ k}\Omega$	25°C	-13.2	-13.7	V		
			Full range	-13				
			25°C	-12.5	-13			
			Full range	-12				
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 10 \text{ V}, \quad R_L = 10 \text{ k}\Omega$	25°C	30	230	V/mV		
			Full range	20				
		$V_O = 0 \text{ to } 8 \text{ V}, \quad R_L = 600 \Omega$	25°C	25	100			
			Full range	10				
		$V_O = 0 \text{ to } -8 \text{ V}, \quad R_L = 600 \Omega$	25°C	3	25			
			Full range	1				
$r_i$	Input resistance		25°C	$10^{12}$		$\Omega$		
$c_i$	Input capacitance		25°C	4		pF		
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	560		$\Omega$		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, \quad R_S = 50 \Omega$	25°C	72	90	dB		
			Full range	65				
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ )	$V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V}, \quad R_S = 50 \Omega$	25°C	75	93	dB		
			Full range	65				

† Full range is -40°C to 85°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ C$  extrapolated to  $T_A = 25^\circ C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2064I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2064I TLE2064AI TLE2064BI			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current (four amplifiers)	$V_O = 0$ , No load	25°C	1.25		1.4	mA
		Full range	1.5			
$\Delta I_{CC}$ Supply-current change over operating temperature range (four amplifiers)		Full range	148			μA
$V_{O1}/V_{O2}$ Crosstalk attenuation	$A_{VD} = 1000$ , $f = 1$ kHz	25°C	120			dB

† Full range is – 40°C to 85°C.

**TLE2064I operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2064I TLE2064AI TLE2064BI			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10$ kΩ, $C_L = 100$ pF	25°C	2.6	3.4		V/μs
		Full range	2.1			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10$ Hz, $R_S = 20$ Ω,	25°C	70		100	nV/√Hz
	$f = 1$ kHz, $R_S = 20$ Ω		40		60	
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1$ Hz to 10 Hz	25°C	1.1			μV
$I_n$ Equivalent input noise current	$f = 1$ kHz	25°C	1.1			fA/√Hz
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10$ kHz, $R_L = 10$ kΩ, $V_{O(PP)} = 2$ V,	25°C	0.025%			
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10$ kΩ, $C_L = 100$ pF	25°C	2			MHz
	$R_L = 600$ Ω, $C_L = 100$ pF		1.5			
$t_s$ Settling time	$\epsilon = 0.1\%$	25°C	5			μs
	$\epsilon = 0.01\%$		10			
$B_{OM}$ Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10$ kΩ	25°C	40			kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10$ kΩ, $C_L = 100$ pF	25°C	60°			
	$R_L = 600$ Ω, $C_L = 100$ pF		70°			

† Full range is – 40°C to 85°C.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2064M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2064M TLE2064AM TLE2064BM			UNIT		
				MIN	TYP	MAX			
$V_{IO}$	Input offset voltage	$V_{IC} = 0, R_S = 50\ \Omega$	25°C	1.2	7	mV			
			Full range	9					
			25°C	1.2	6				
			Full range	8					
			25°C	0.8	3.5				
			Full range	5.5					
			$\alpha_{VIO}$	Temperature coefficient of input offset voltage	25°C		6	$\mu\text{V}/^\circ\text{C}$	
				Input offset voltage long-term drift (see Note 4)	Full range		0.04	$\mu\text{V}/\text{mo}$	
			$I_{IO}$	Input offset current	25°C		1	pA	
$I_{IB}$	Input bias current	25°C	3	pA					
		Full range	30	nA					
$V_{ICR}$	Common-mode input voltage range	25°C	-1.6 to 4	-2 to 6	V				
		Full range	-1.6 to 4		V				
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	3.5	3.7	V			
			Full range	3					
		FK and J packages $R_L = 600\ \Omega$	25°C	2.5	3.6				
			Full range	2					
		D and N packages $R_L = 100\ \Omega$	25°C	2.5	3.1				
			Full range	2					
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	25°C	-3.5	-3.9	V			
			Full range	-3					
		FK and J packages $R_L = 600\ \Omega$	25°C	-2.5	-3.5				
			Full range	-2					
		D and N packages $R_L = 100\ \Omega$	25°C	-2.5	-2.7				
			Full range	-2					
		$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 2.8\ \text{V}, R_L = 10\ \text{k}\Omega$	25°C		15	80	V/mV
					Full range		2		
FK and J packages $V_O = 0\ \text{to}\ 2.5\ \text{V}, R_L = 600\ \Omega$	25°C			1	65				
	Full range			0.5					
FK and J packages $V_O = 0\ \text{to}\ -2.5\ \text{V}, R_L = 600\ \Omega$	25°C			1	16				
	Full range			0.5					

† Full range is  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
**EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE**  
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**TLE2064M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted) continued)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2064M TLE2064AM TLE2064BM			UNIT
				MIN	TYP	MAX	
$A_{VD}$	Large-signal differential voltage amplification	$V_O = 0$ to 2 V, $R_L = 100\ \Omega$	25°C	0.75	45	V/mV	
			Full range	0.25			
		$V_O = 0$ to -2 V, $R_L = 100\ \Omega$	25°C	0.4	3		
			Full range	0.15			
$r_i$	Input resistance		25°C	10 <sup>12</sup>		$\Omega$	
$c_i$	Input capacitance		25°C	4		pF	
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	560		$\Omega$	
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$ , $R_S = 50\ \Omega$	25°C	65	82	dB	
			Full range	60			
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\text{ V}$ to $\pm 15\text{ V}$ , $R_S = 50\ \Omega$	25°C	75	93	dB	
			Full range	65			
$I_{CC}$	Supply current (four amplifiers)	$V_O = 0$ , No load	25°C	1.12	1.3	mA	
			Full range		1.3		
$\Delta I_{CC}$	Supply-current change over operating temperature range (four amplifiers)		Full range	144		$\mu\text{A}$	
$V_{O1}/V_{O2}$	Crosstalk attenuation	$A_{VD} = 1000$ , $f = 1\text{ kHz}$	25°C	120		dB	

† Full range is -55°C to 125°C.

**TLE2064M operating characteristics,  $V_{CC\pm} = \pm 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

PARAMETER		TEST CONDITIONS	TLE2064M TLE2064AM TLE2064BM			UNIT
			MIN	TYP	MAX	
SR	Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	3.4			V/ $\mu\text{s}$
$V_n$	Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	59			nV/ $\sqrt{\text{Hz}}$
		$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$	43			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz}$ to 10 Hz	1.1			$\mu\text{V}$
$I_n$	Equivalent input noise current	$f = 1\text{ kHz}$	1			fA/ $\sqrt{\text{Hz}}$
THD	Total harmonic distortion	$A_{VD} = 2$ , $f = 10\text{ kHz}$ , $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	0.025%			
$B_1$	Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	1.8			MHz
		$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	1.3			
$t_s$	Settling time	$\epsilon = 0.1\%$	5			$\mu\text{s}$
		$\epsilon = 0.01\%$	10			
BOM	Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	140			kHz
$\phi_m$	Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	58°			
		$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$	75°			



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
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**TLE2064M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	$T_A$ †	TLE2064M TLE2064AM TLE2064BM			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_{IC} = 0, R_S = 50 \Omega$	25°C	0.9	6	mV	
			Full range		8		
			25°C	0.9	4		
			Full range		6		
			25°C	0.7	2		
			Full range		4		
$\alpha_{VIO}$	Temperature coefficient of input offset voltage	$V_{IC} = 0, R_S = 50 \Omega$	25°C	6	$\mu V/^\circ C$		
	Input offset voltage long-term drift (see Note 4)		Full range	0.04	$\mu V/mo$		
$I_{IO}$	Input offset current	$V_{IC} = 0, R_S = 50 \Omega$	25°C	2	pA		
			Full range	20	nA		
$I_{IB}$	Input bias current	$V_{IC} = 0, R_S = 50 \Omega$	25°C	4	pA		
			Full range	40	nA		
$V_{ICR}$	Common-mode input voltage range		25°C	-11 to 13	-12 to 16	V	
			Full range	-11 to 13		V	
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10 k\Omega$	25°C	13	13.7	V	
			Full range	12.5			
		$R_L = 600 \Omega$	25°C	12.5	13.2		
			Full range	12			
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10 k\Omega$	25°C	-13	-13.7	V	
			Full range	-12.5			
		$R_L = 600 \Omega$	25°C	-13	-13		
			Full range	-12.5			
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 10$ V, $R_L = 10 k\Omega$	25°C	30	230	V/mV	
			Full range	20			
		$V_O = 0$ to 8 V, $R_L = 600 \Omega$	25°C	25	100		
			Full range	7			
		$V_O = 0$ to -8 V, $R_L = 600 \Omega$	25°C	3	25		
			Full range	1			
$r_i$	Input resistance		25°C	$10^{12}$	$\Omega$		
$c_i$	Input capacitance		25°C	4	pF		
$z_o$	Open-loop output impedance	$I_O = 0$	25°C	560	$\Omega$		
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}, R_S = 50 \Omega$	25°C	72	90	dB	
			Full range	65			
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ )	$V_{CC\pm} = \pm 5$ V to $\pm 15$ V, $R_S = 50 \Omega$	25°C	75	93	dB	
			Full range	65			

† Full range is -55°C to 125°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ C$  extrapolated to  $T_A = 25^\circ C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
**EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE**  
**μPOWER OPERATIONAL AMPLIFIERS**

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**TLE2064M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$  (unless otherwise noted) (continued)**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2064M TLE2064AM TLE2064BM			UNIT
			MIN	TYP	MAX	
$I_{CC}$ Supply current (four amplifiers)	$V_O = 0$ , No load	25°C		1.25	1.4	mA
		Full range			1.5	
$\Delta I_{CC}$ Supply-current change over operating temperature range (four amplifiers)		Full range		194		μA
$V_{O1}/V_{O2}$ Crosstalk attenuation	$A_{VD} = 1000$ , $f = 1\text{ kHz}$	25°C		120		dB

† Full range is – 55°C to 125°C.

**TLE2064M operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$**

PARAMETER	TEST CONDITIONS	$T_A$ †	TLE2064M TLE2064AM TLE2064BM			UNIT
			MIN	TYP	MAX	
SR Slew rate at unity gain (see Figure 1)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C	2.6	3.4		V/μs
		Full range	1.8			
$V_n$ Equivalent input noise voltage (see Figure 2)	$f = 10\text{ Hz}$ , $R_S = 20\ \Omega$	25°C		70		$nV/\sqrt{\text{Hz}}$
	$f = 1\text{ kHz}$ , $R_S = 20\ \Omega$			40		
$V_{N(PP)}$ Peak-to-peak equivalent input noise voltage	$f = 0.1\text{ Hz to }10\text{ Hz}$	25°C		1.1		μV
$I_n$ Equivalent input noise current	$f = 1\text{ kHz}$	25°C		1.1		$fA/\sqrt{\text{Hz}}$
THD Total harmonic distortion	$A_{VD} = 2$ , $f = 10\text{ kHz}$ , $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$	25°C		0.025%		
$B_1$ Unity-gain bandwidth (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		2		MHz
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$			1.5		
$t_s$ Settling time	$\epsilon = 0.1\%$	25°C		5		μs
	$\epsilon = 0.01\%$			10		
BOM Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$	25°C		40		kHz
$\phi_m$ Phase margin at unity gain (see Figure 3)	$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$	25°C		60°		
	$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$			70°		

† Full range is – 55°C to 125°C.



**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
**EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE**  
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**TLE2064Y electrical characteristics at  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)**

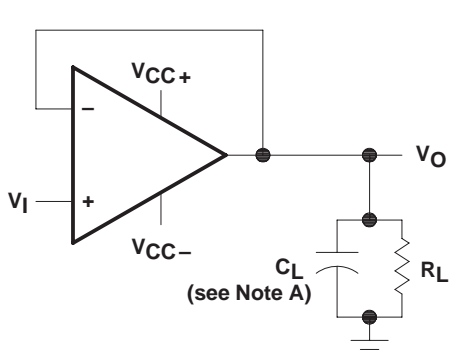
PARAMETER		TEST CONDITIONS	TLE2064Y			UNIT
			MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_{IC} = 0$ , $R_S = 50\ \Omega$		0.9	6	mV
$\infty V_{IO}$	Input offset voltage long-term drift (see Note 4)			0.04		$\mu\text{V}/\text{mo}$
$I_{IO}$	Input offset current			2		pA
$I_{IB}$	Input bias current			4		pA
$V_{ICR}$	Common-mode input voltage range		-11 to 13	-12 to 16		V
$V_{OM+}$	Maximum positive peak output voltage swing	$R_L = 10\ \text{k}\Omega$	13.2	13.7		V
		$R_L = 600\ \Omega$	12.5	13.2		
$V_{OM-}$	Maximum negative peak output voltage swing	$R_L = 10\ \text{k}\Omega$	-13.2	-13.7		V
		$R_L = 600\ \Omega$	12.5	13		
$A_{VD}$	Large-signal differential voltage amplification	$V_O = \pm 10\ \text{V}$ , $R_L = 10\ \text{k}\Omega$	30	230		V/mV
		$V_O = 0\ \text{to}\ 8\ \text{V}$ , $R_L = 600\ \Omega$	25	100		
		$V_O = 0\ \text{to}\ -8\ \text{V}$ , $R_L = 600\ \Omega$	3	25		
$r_i$	Input resistance		$10^{12}$			$\Omega$
$c_i$	Input capacitance		4			pF
$z_o$	Open-loop output impedance	$I_O = 0$	560			$\Omega$
CMRR	Common-mode rejection ratio	$R_S = 50\ \Omega$ , $V_{IC} = V_{ICR\text{min}}$	72	90		dB
$k_{SVR}$	Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ )	$V_{CC\pm} = \pm 5\ \text{V}\ \text{to}\ \pm 15\ \text{V}$ , $R_S = 50\ \Omega$	75	93		dB
$I_{CC}$	Supply current	$V_O = 0$ , No load	1.25	1.4		mA
$V_{O1}/V_{O2}$	Crosstalk attenuation	$A_{VD} = 1000$ , $f = 1\ \text{kHz}$	120			dB

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

**TLE2064Y operating characteristics at  $V_{CC\pm} = \pm 15\ \text{V}$ ,  $T_A = 25^\circ\text{C}$**

PARAMETER		TEST CONDITIONS	TLE2064Y			UNIT
			MIN	TYP	MAX	
SR	Slew rate at unity gain (see Figure 1)	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$	2.6	3.4		V/ $\mu\text{s}$
$V_n$	Equivalent input noise voltage (see Figure 2)	$f = 10\ \text{Hz}$ , $R_S = 20\ \Omega$	70			$\text{nV}/\sqrt{\text{Hz}}$
		$f = 1\ \text{kHz}$ , $R_S = 20\ \Omega$	40			
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	$f = 0.1\ \text{Hz}\ \text{to}\ 10\ \text{Hz}$	1.1			$\mu\text{V}$
$I_n$	Equivalent input noise current	$f = 1\ \text{kHz}$	1.1			$\text{fA}/\sqrt{\text{Hz}}$
THD	Total harmonic distortion	$A_{VD} = 2$ , $f = 10\ \text{kHz}$ , $V_{O(PP)} = 2\ \text{V}$ , $R_L = 10\ \text{k}\Omega$	0.025%			
$B_1$	Unity-gain bandwidth (see Figure 3)	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$	2			MHz
		$R_L = 600\ \Omega$ , $C_L = 100\ \text{pF}$	1.5			
$t_s$	Settling time	$\epsilon = 0.1\%$	5			$\mu\text{s}$
		$\epsilon = 0.01\%$	10			
$B_{OM}$	Maximum output-swing bandwidth	$A_{VD} = 1$ , $R_L = 10\ \text{k}\Omega$	40			kHz
$\phi_m$	Phase margin at unity gain (see Figure 3)	$R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$	60°			
		$R_L = 600\ \Omega$ , $C_L = 100\ \text{pF}$	70°			

PARAMETER MEASUREMENT INFORMATION



NOTE A:  $C_L$  includes fixture capacitance.

Figure 1. Slew-Rate Test Circuit

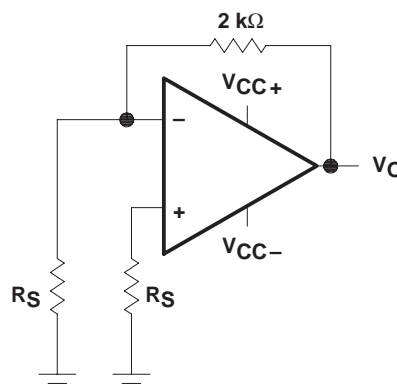
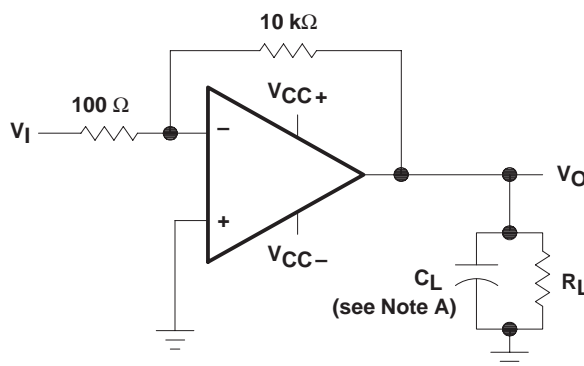


Figure 2. Noise-Voltage Test Circuit



NOTE A:  $C_L$  includes fixture capacitance.

Figure 3. Unity-Gain Bandwidth and Phase-Margin Test Circuit

typical values

Typical values presented in this data sheet represent the median (50% point) of device parametric performance.

input bias and offset current

At the picoampere bias current level typical of the TLE206x, TLE2064xA, and TLE206xB, accurate measurement of the bias current becomes difficult. Not only does this measurement require a picoammeter, but test socket leakages can easily exceed the actual device bias currents. To accurately measure these small currents, Texas Instruments uses a two-step process. The socket leakage is measured using picoammeters with bias voltages applied but with no device in the socket. The device is then inserted into the socket, and a second test that measures both the socket leakage and the device input bias current is performed. The two measurements are then subtracted algebraically to determine the bias current of the device.



## TYPICAL CHARACTERISTICS

**Table of Graphs**

		FIGURE
$V_{IO}$	Input offset voltage	Distribution 4, 5, 6
$I_{IB}$	Input bias current	vs Common-mode input voltage vs Free-air temperature 7 8
$I_{IO}$	Input offset current	vs Free-air temperature 8
$V_{ICR}$	Common-mode input voltage	vs Free-air temperature 9
$V_{OM}$	Maximum peak output voltage	vs Output current vs Supply voltage 10, 11 12, 13, 14
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency vs Load resistance 15, 16 17
$A_{VD}$	Large-signal differential voltage amplification	vs Frequency vs Free-air temperature 18 19
$I_{OS}$	Short-circuit output current	vs Elapsed time vs Free-air temperature 20 21
$z_o$	Output impedance	vs Frequency 22, 23
CMRR	Common-mode rejection ratio	vs Frequency 24
$I_{CC}$	Supply current	vs Supply voltage vs Free-air temperature 25, 26, 27 28, 29, 30
	Voltage-follower small-signal pulse response	vs Time 31, 32
	Voltage-follower large-signal pulse response	vs Time 33, 34
	Noise voltage (referred to input)	0.1 to 10 Hz 35
$V_n$	Equivalent input noise voltage	vs Frequency 36
THD	Total harmonic distortion	vs Frequency 37, 38
$B_1$	Unity-gain bandwidth	vs Supply voltage vs Free-air temperature 39 40
$\phi_m$	Phase margin	vs Supply voltage vs Load capacitance vs Free-air temperature 41 42 43
	Phase shift	vs Frequency 18

TYPICAL CHARACTERISTICS

TLE2061  
 DISTRIBUTION OF  
 INPUT OFFSET VOLTAGE

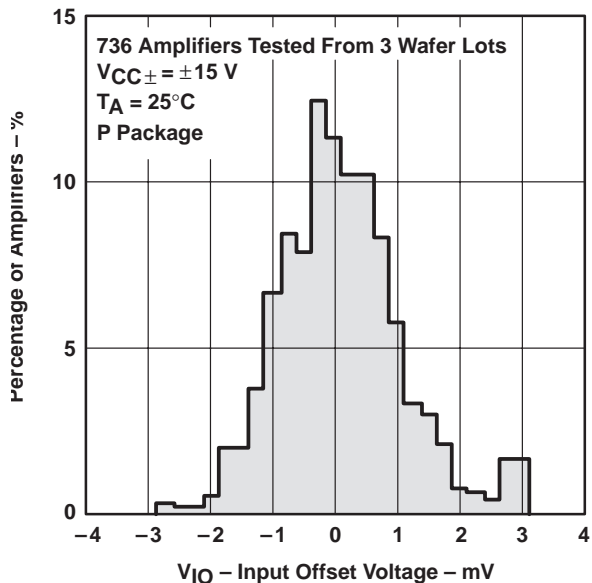


Figure 4

TLE2062  
 DISTRIBUTION OF  
 INPUT OFFSET VOLTAGE

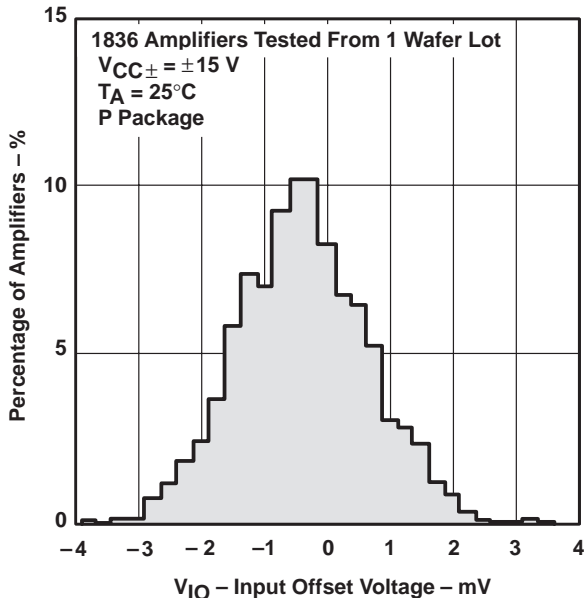


Figure 5

TLE2064  
 DISTRIBUTION OF  
 INPUT OFFSET VOLTAGE

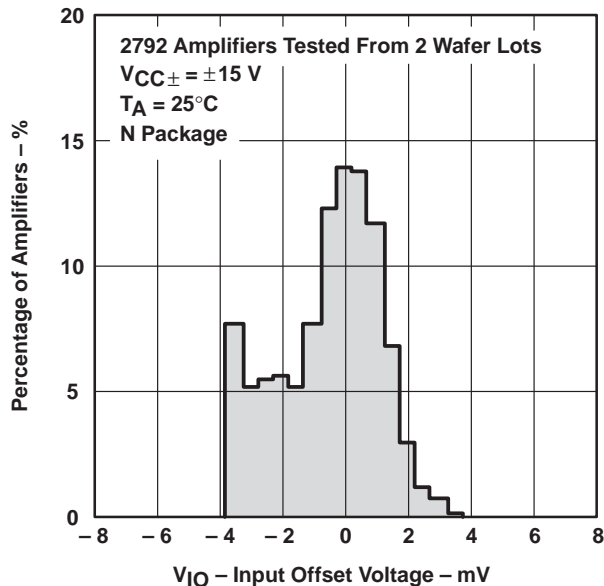


Figure 6

INPUT BIAS CURRENT  
 vs  
 COMMON-MODE INPUT VOLTAGE

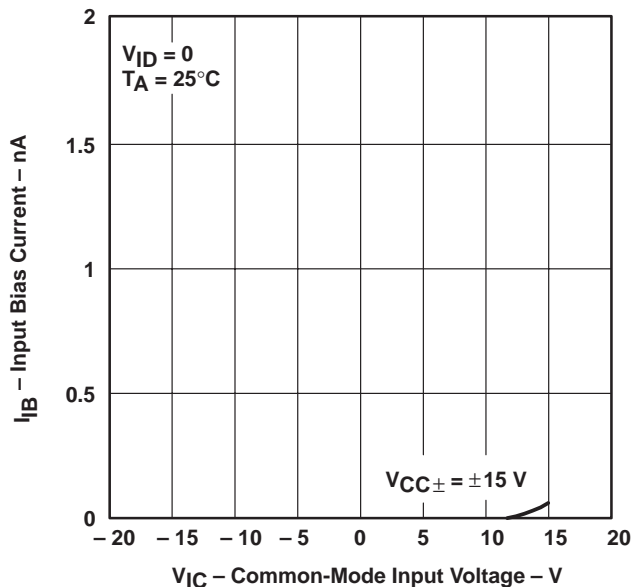
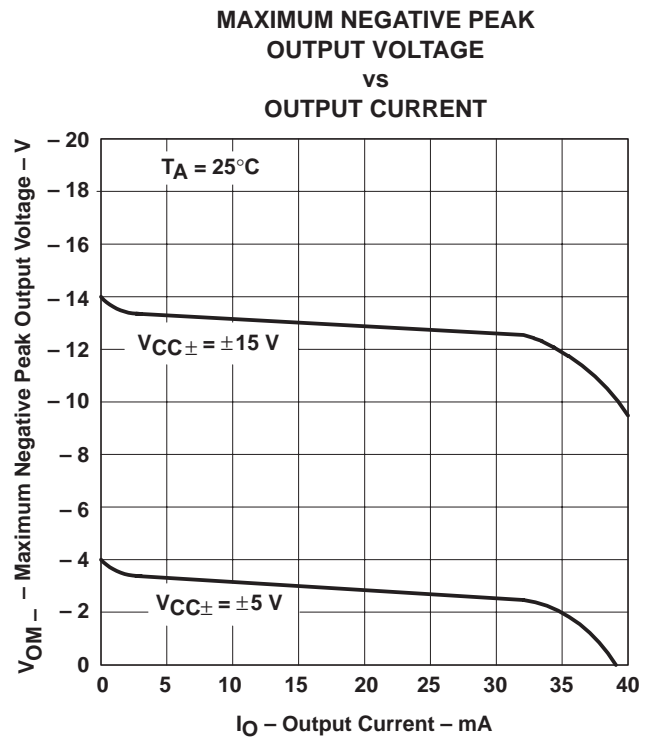
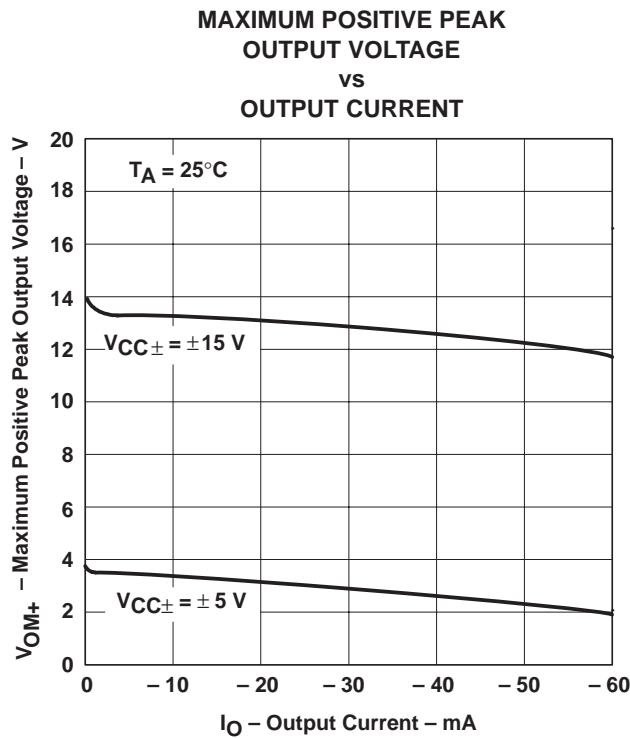
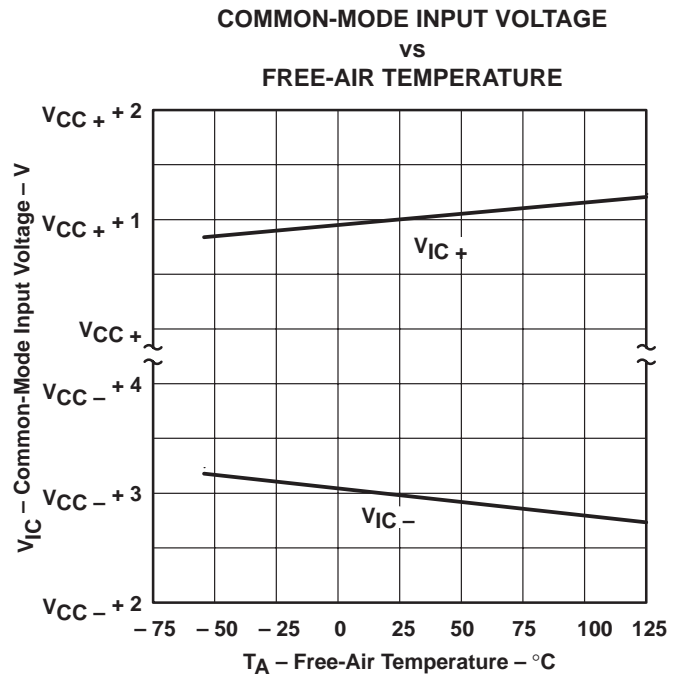
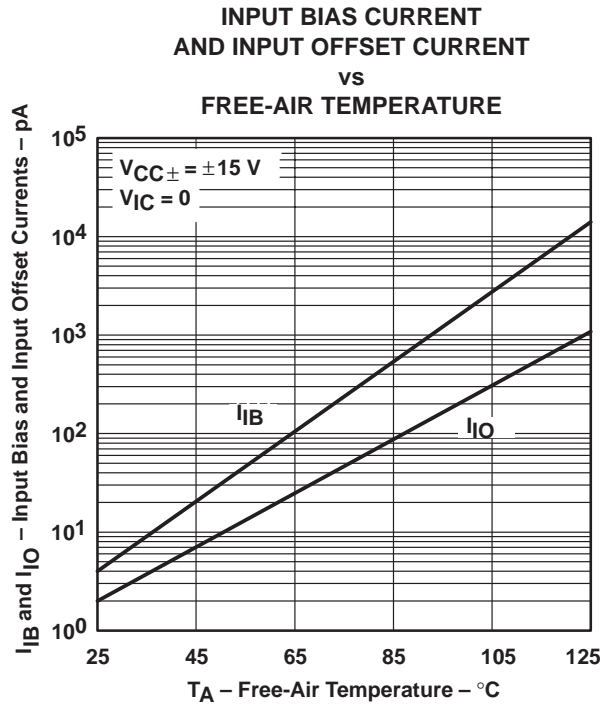


Figure 7

TYPICAL CHARACTERISTICS†



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

TYPICAL CHARACTERISTICS

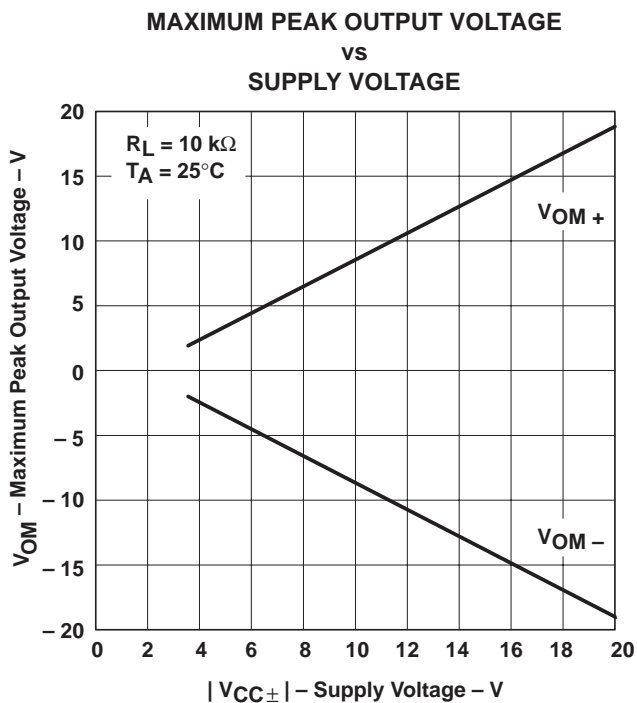


Figure 12

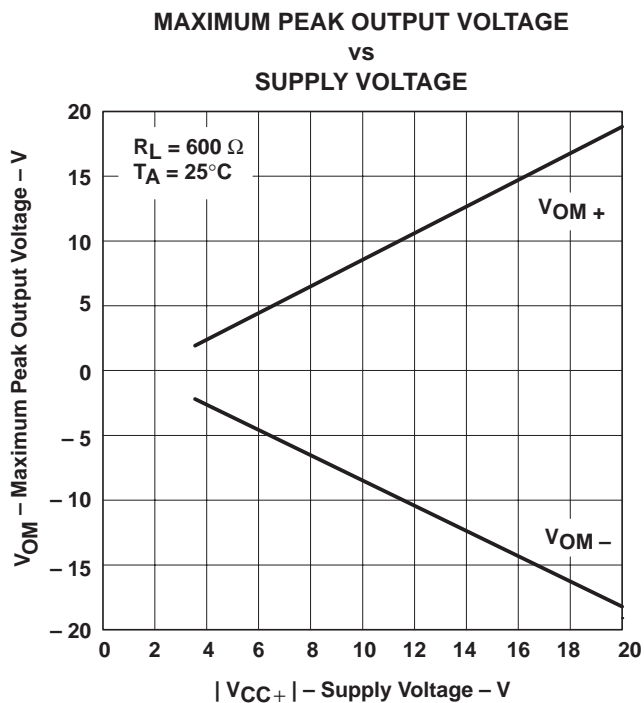


Figure 13

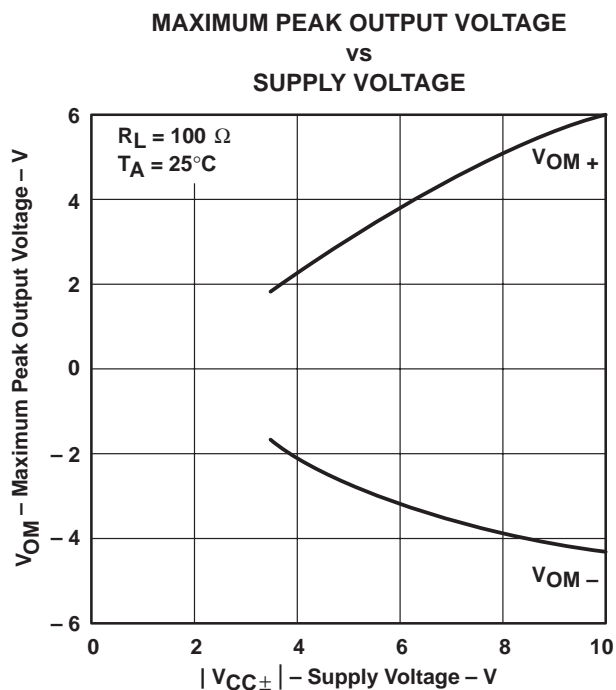


Figure 14

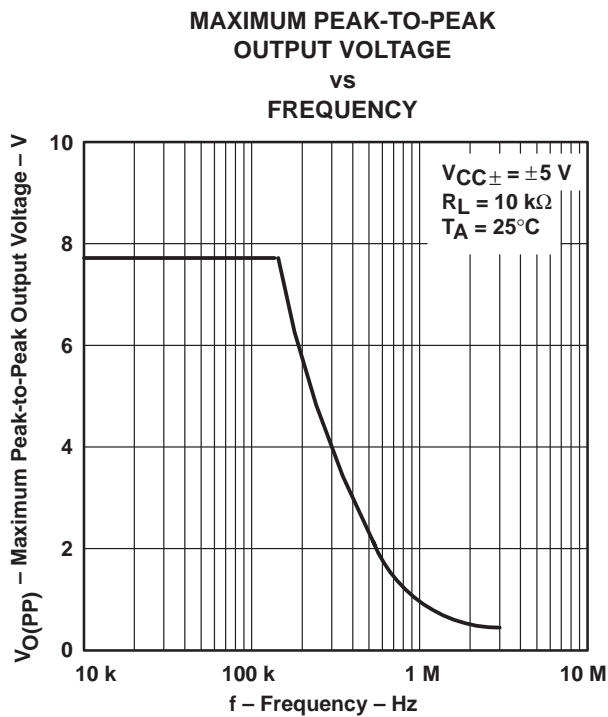


Figure 15

TYPICAL CHARACTERISTICS†

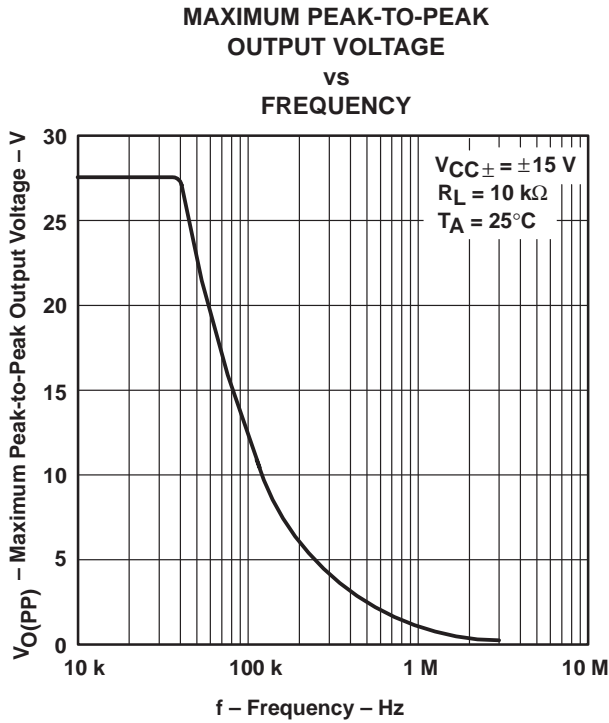


Figure 16

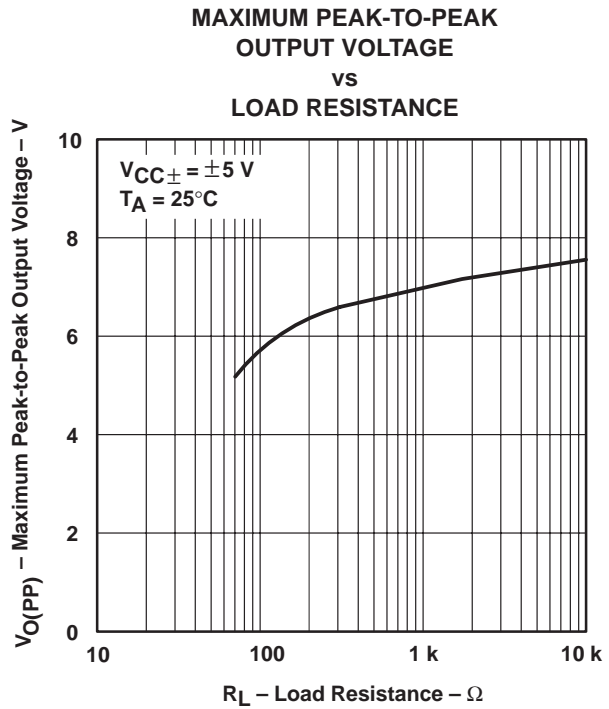


Figure 17

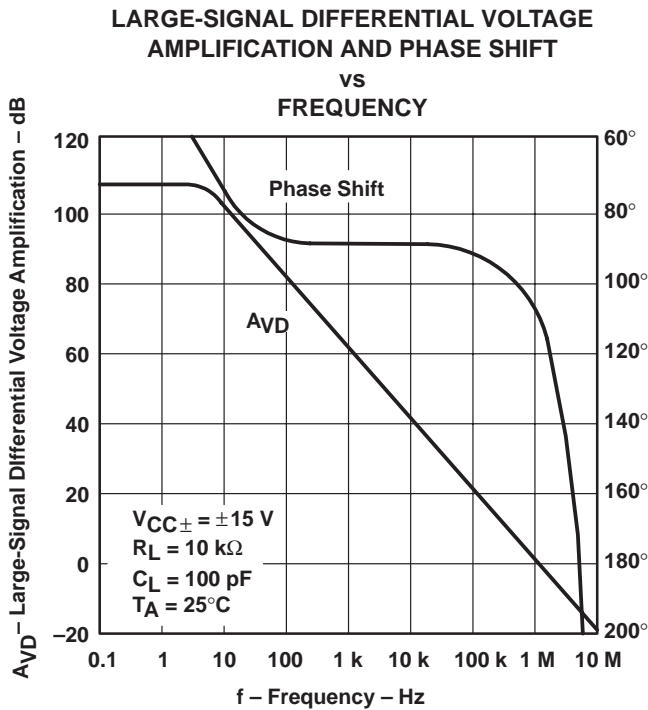


Figure 18

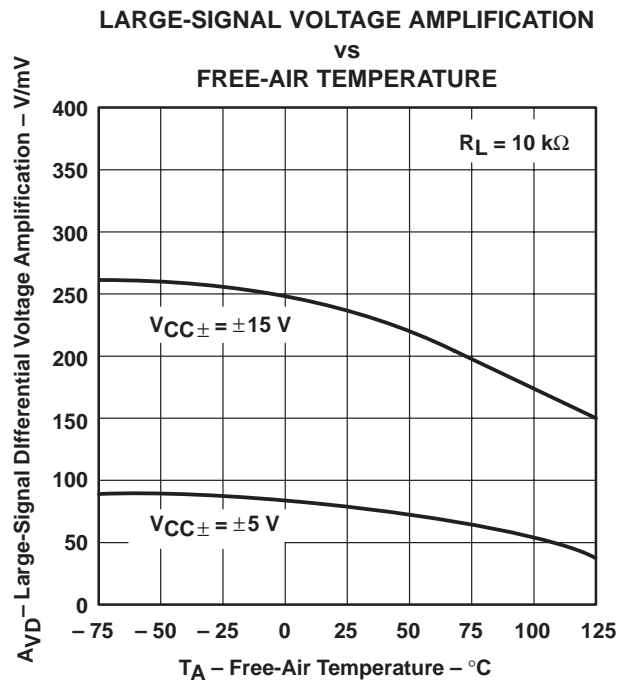


Figure 19

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

TYPICAL CHARACTERISTICS†

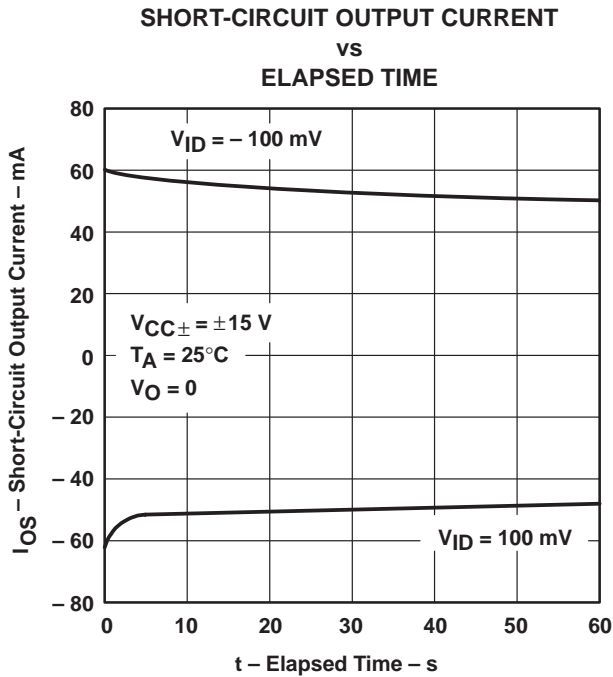


Figure 20

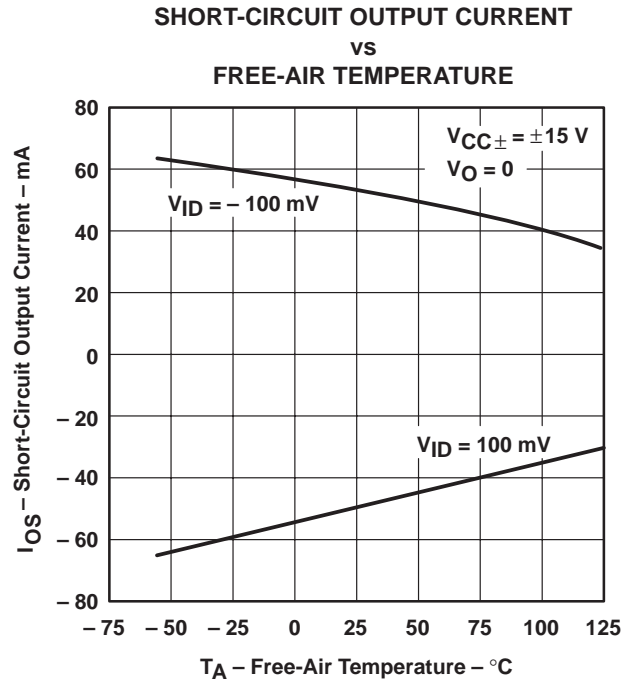


Figure 21

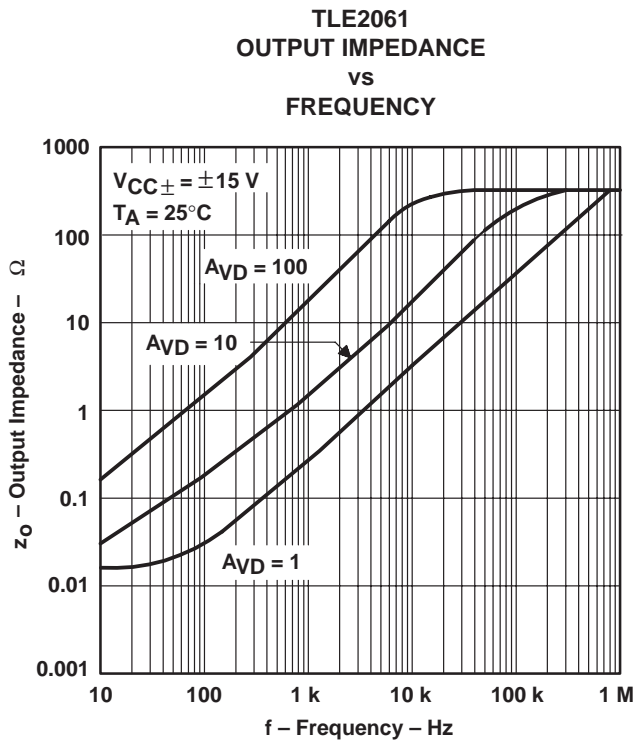


Figure 22

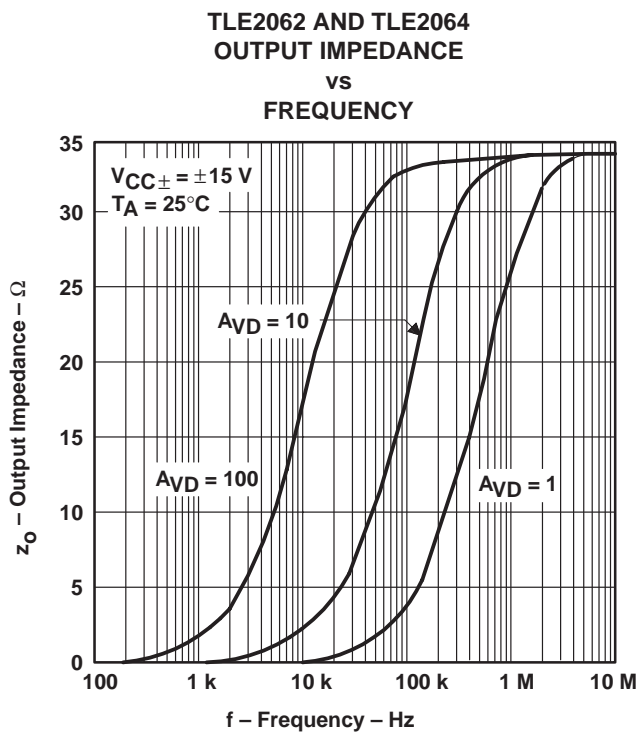


Figure 23

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

TYPICAL CHARACTERISTICS†

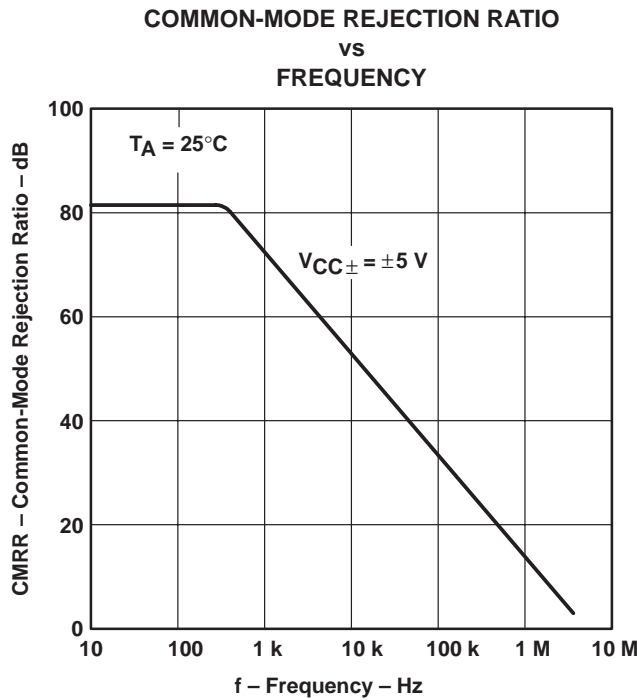


Figure 24

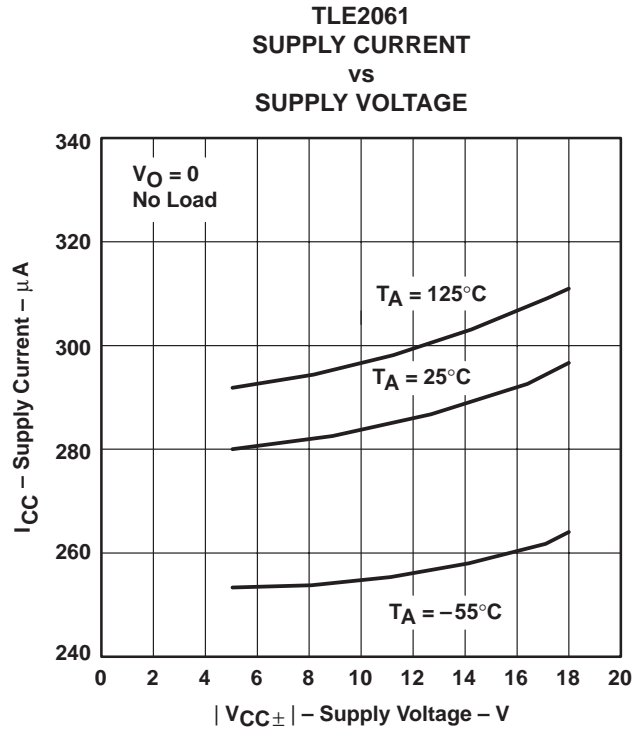


Figure 25

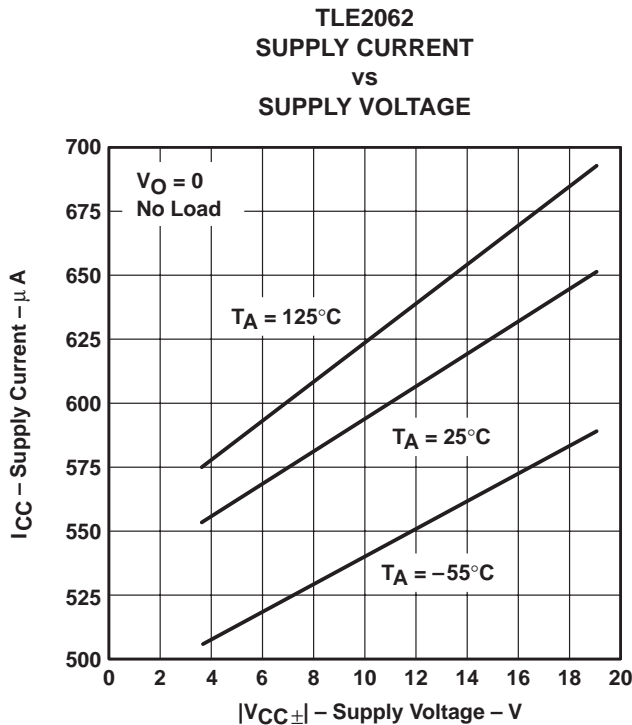


Figure 26

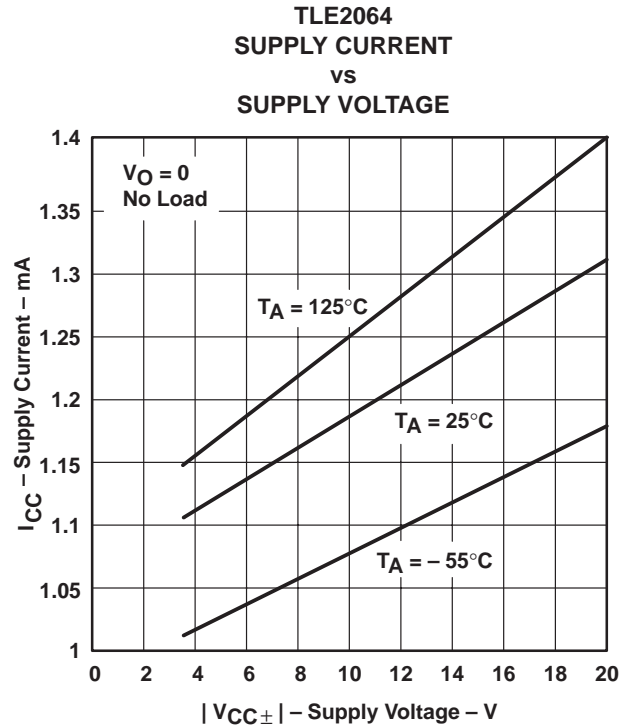


Figure 27

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

TLE206x, TLE206xA, TLE206xB, TLE206xY  
 EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE  
 μPOWER OPERATIONAL AMPLIFIERS

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TYPICAL CHARACTERISTICS†

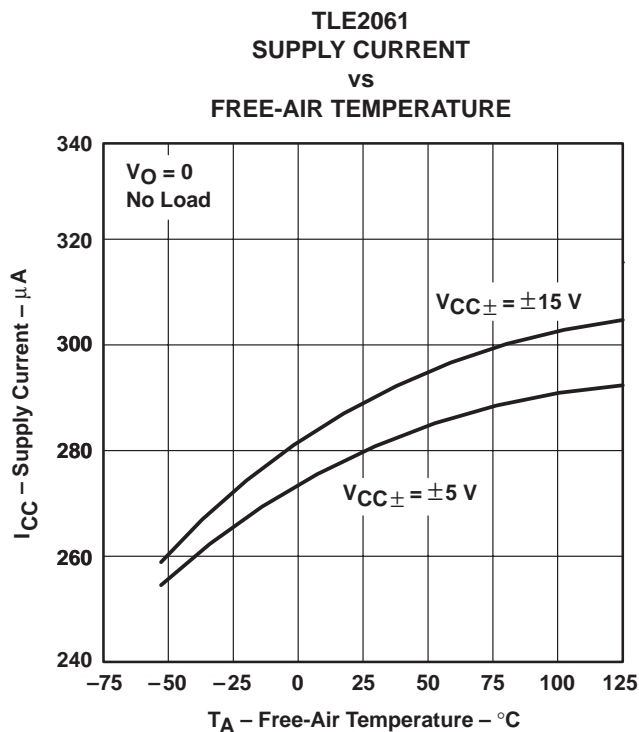


Figure 28

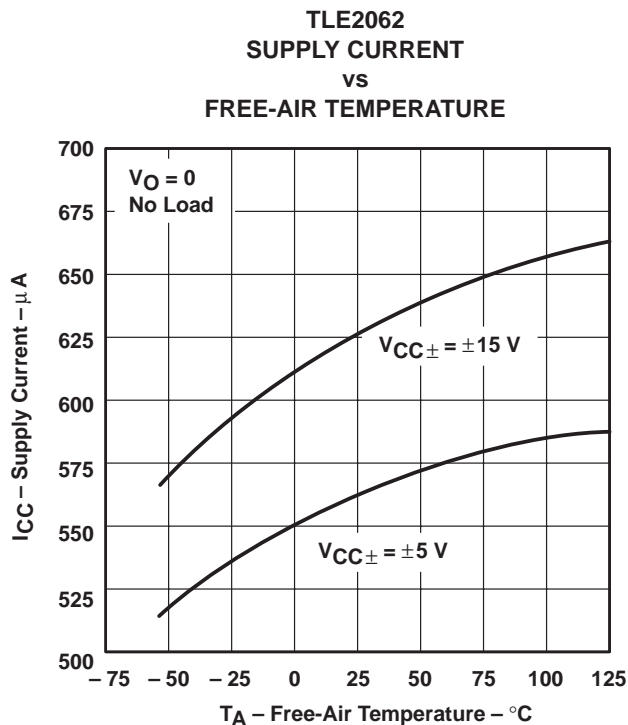


Figure 29

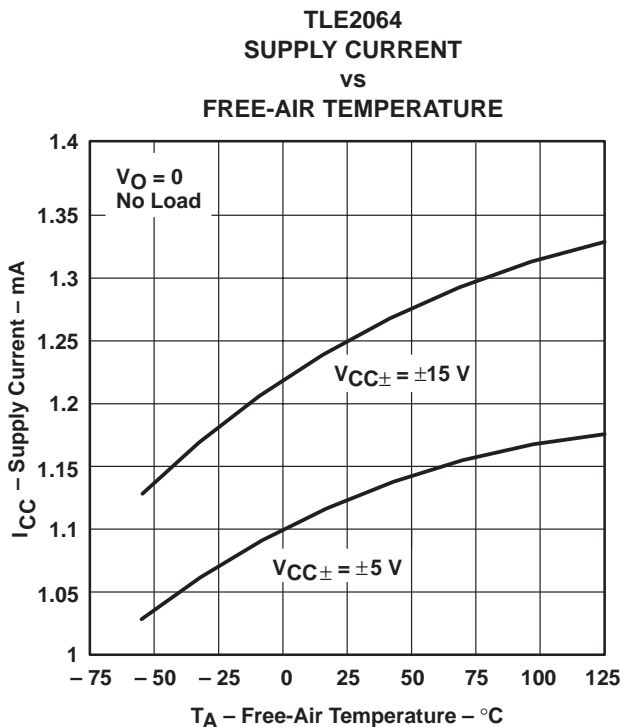


Figure 30

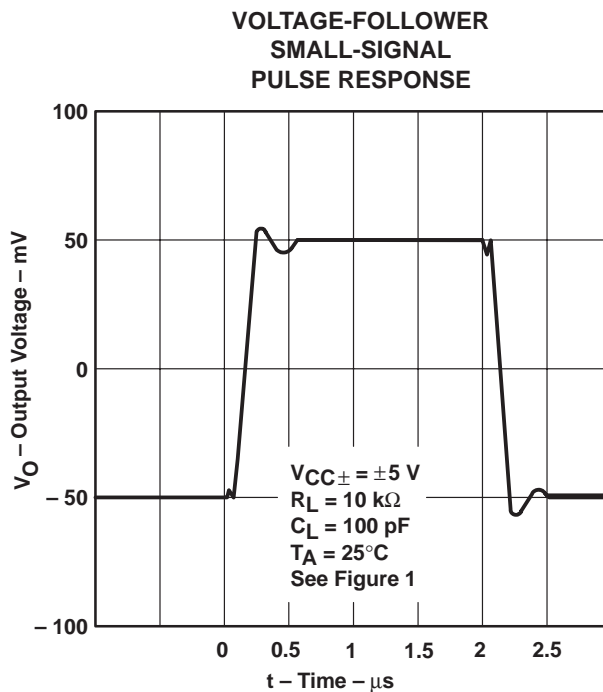


Figure 31

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





TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER  
 SMALL-SIGNAL  
 PULSE RESPONSE

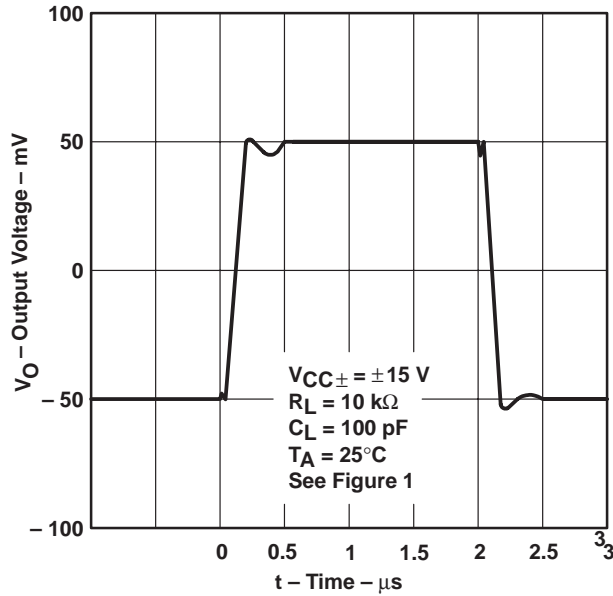


Figure 32

VOLTAGE-FOLLOWER  
 LARGE-SIGNAL  
 PULSE RESPONSE

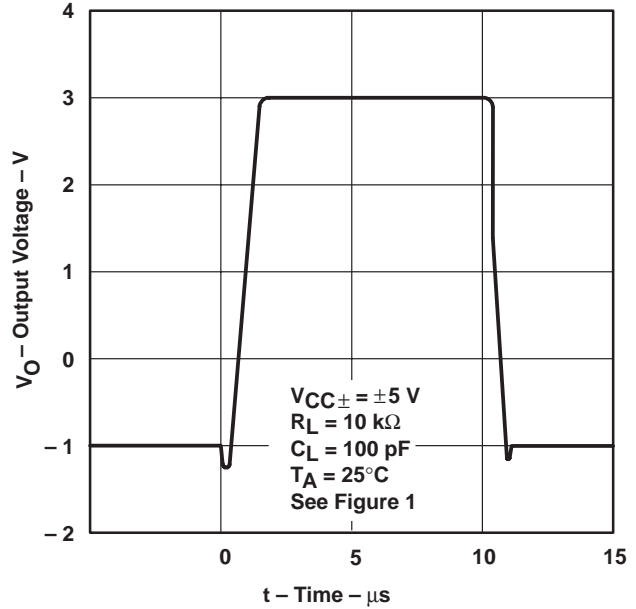


Figure 33

VOLTAGE-FOLLOWER  
 LARGE-SIGNAL  
 PULSE RESPONSE

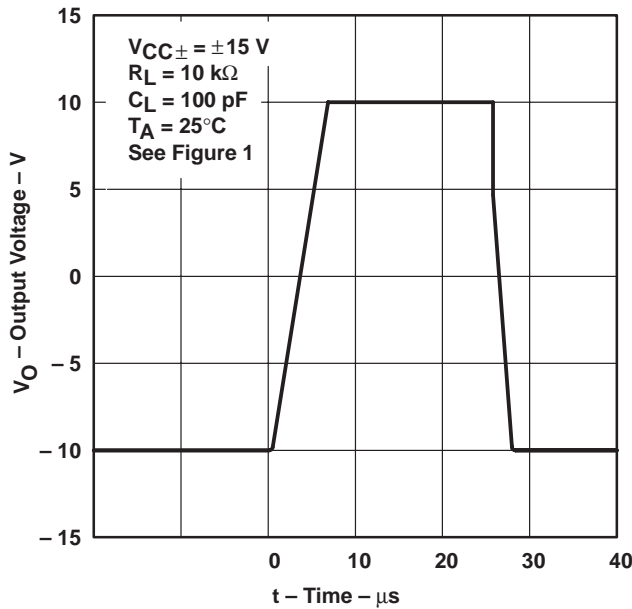


Figure 34

NOISE VOLTAGE  
 (REFERRED TO INPUT)  
 0.1 TO 10 Hz

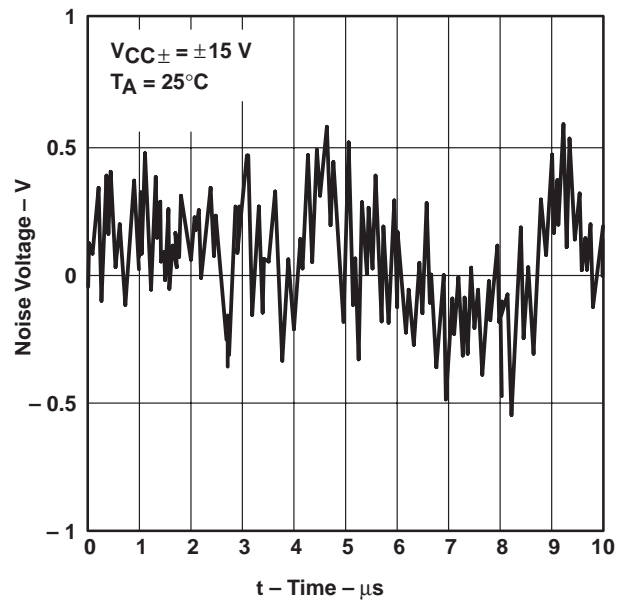


Figure 35

TYPICAL CHARACTERISTICS

EQUIVALENT INPUT NOISE VOLTAGE  
 VS  
 FREQUENCY

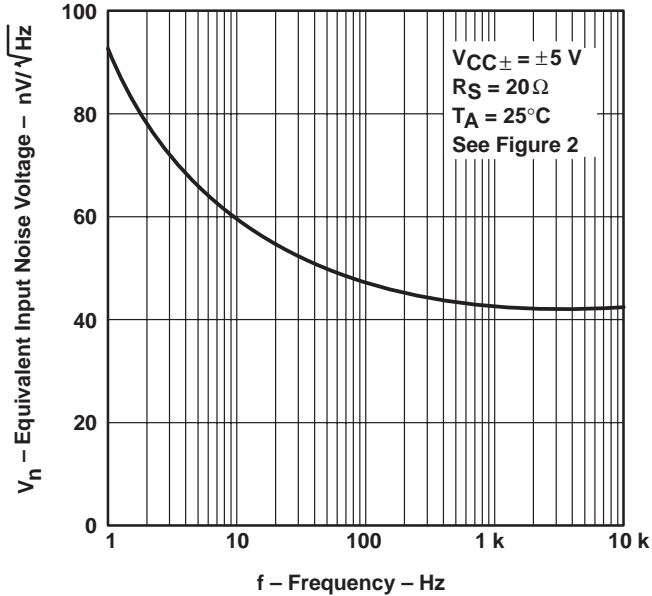


Figure 36

TOTAL HARMONIC DISTORTION  
 VS  
 FREQUENCY

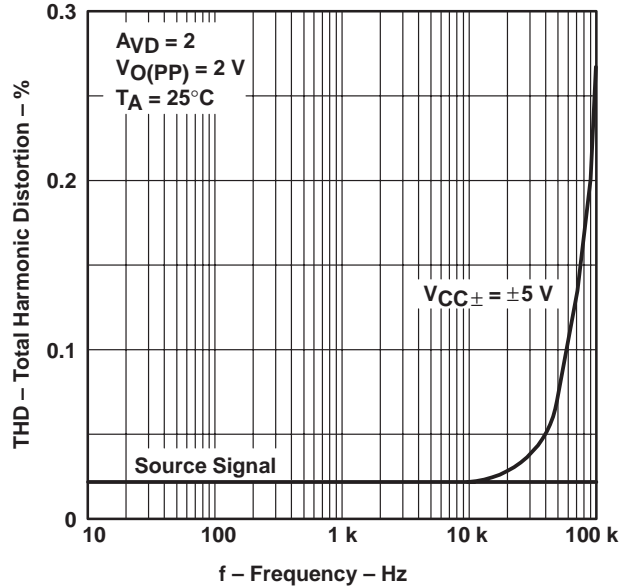


Figure 37

TOTAL HARMONIC DISTORTION  
 VS  
 FREQUENCY

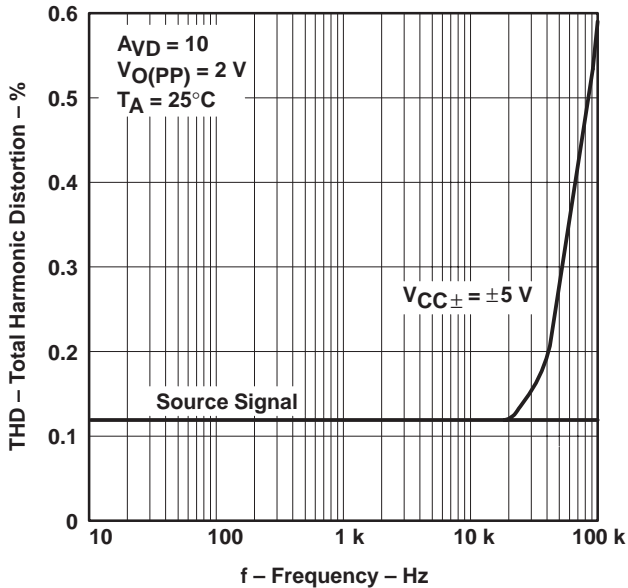


Figure 38

UNITY-GAIN BANDWIDTH  
 VS  
 SUPPLY VOLTAGE

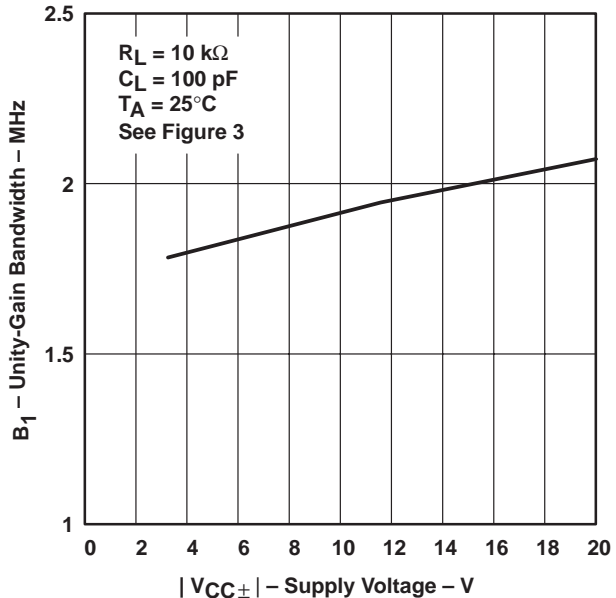
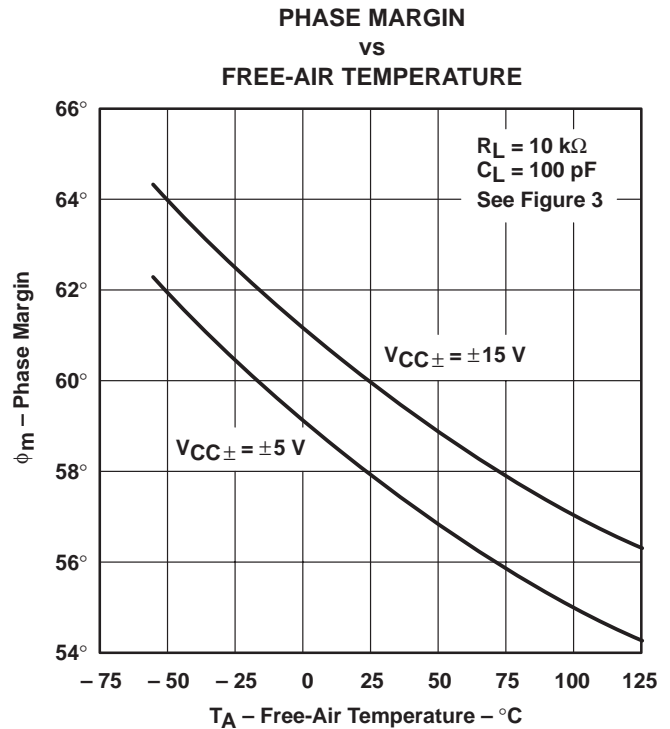
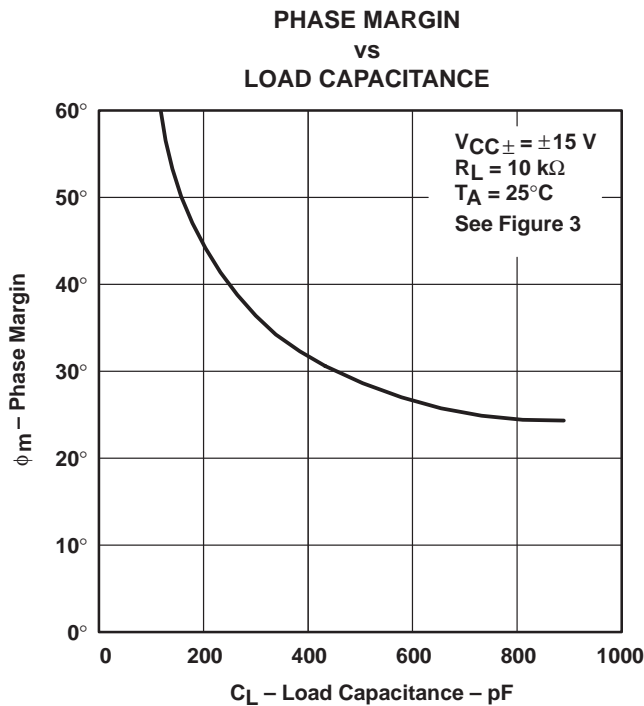
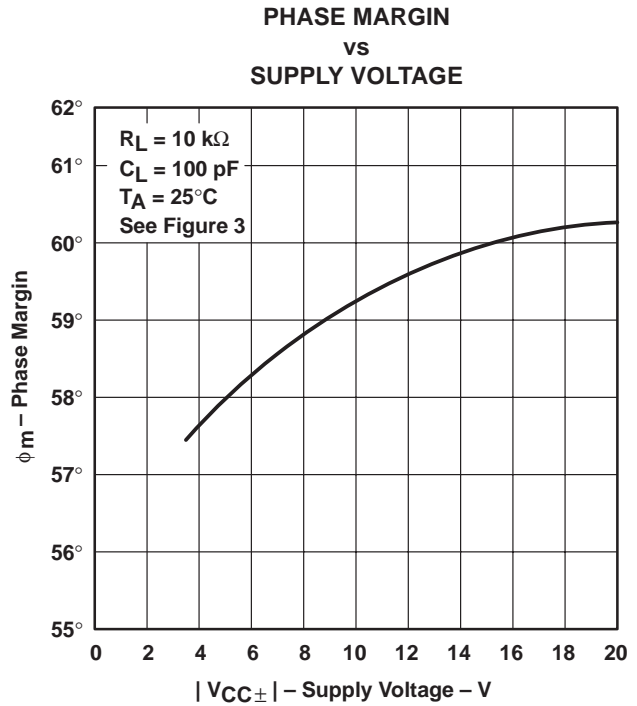
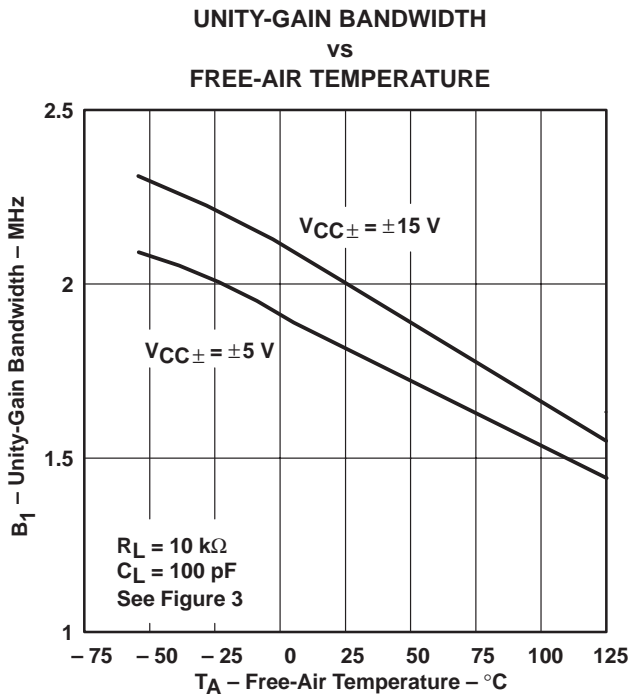


Figure 39

TYPICAL CHARACTERISTICS†



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

APPLICATION INFORMATION

input characteristics

The TLE206x, TLE206xA, and TLE206xB are specified with a minimum and a maximum input voltage that if exceeded at either input could cause the device to malfunction. Because of the extremely high input impedance and resulting low bias current requirements, the TLE206x, TLE206xA, and TLE206xB are well suited for low-level signal processing; however, leakage currents on printed-circuit boards and sockets can easily exceed bias current requirements and cause degradation in system performance. It is good practice to include guard rings around inputs (see Figure 44). These guards should be driven from a low-impedance source at the same voltage level as the common-mode input.

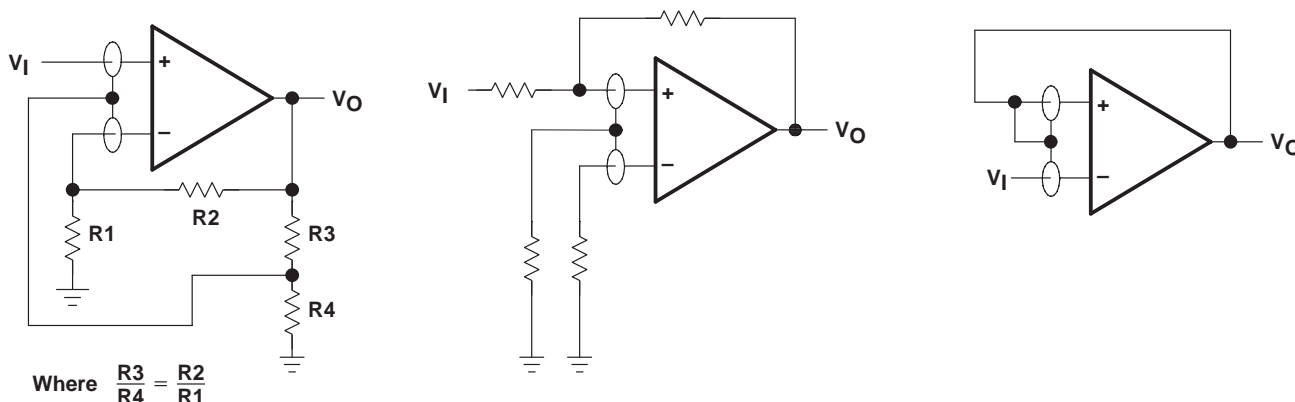


Figure 44. Use of Guard Rings

TLE2061 input offset voltage nulling

The TLE2061 series offers external null pins that can be used to further reduce the input offset voltage. The circuit of Figure 45 can be connected as shown if the feature is desired. When external nulling is not needed, the null pins may be left unconnected.

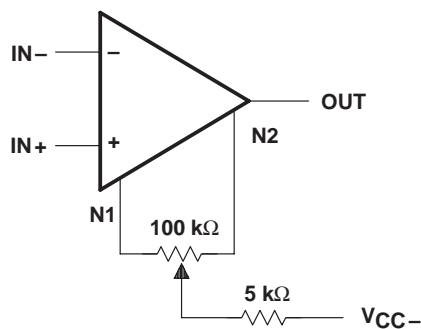


Figure 45. Input Offset Voltage Nulling

APPLICATION INFORMATION

macromodel information

Macromodel information provided was derived using Microsim *Parts*™, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 5) and subcircuit in Figure 46 were generated using the TLE206x typical electrical and operating characteristics at 25°C. Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

- Maximum positive output voltage swing
- Maximum negative output voltage swing
- Slew rate
- Quiescent power dissipation
- Input bias current
- Open-loop voltage amplification
- Unity-gain frequency
- Common-mode rejection ratio
- Phase margin
- DC output resistance
- AC output resistance
- Short-circuit output current limit

NOTE 5: G. R. Boyle, B. M. Cohn, D. O. Pederson, and J. E. Solomon, "Macromodeling of Integrated Circuit Operational Amplifiers", *IEEE Journal of Solid-State Circuits*, SC-9, 353 (1974).

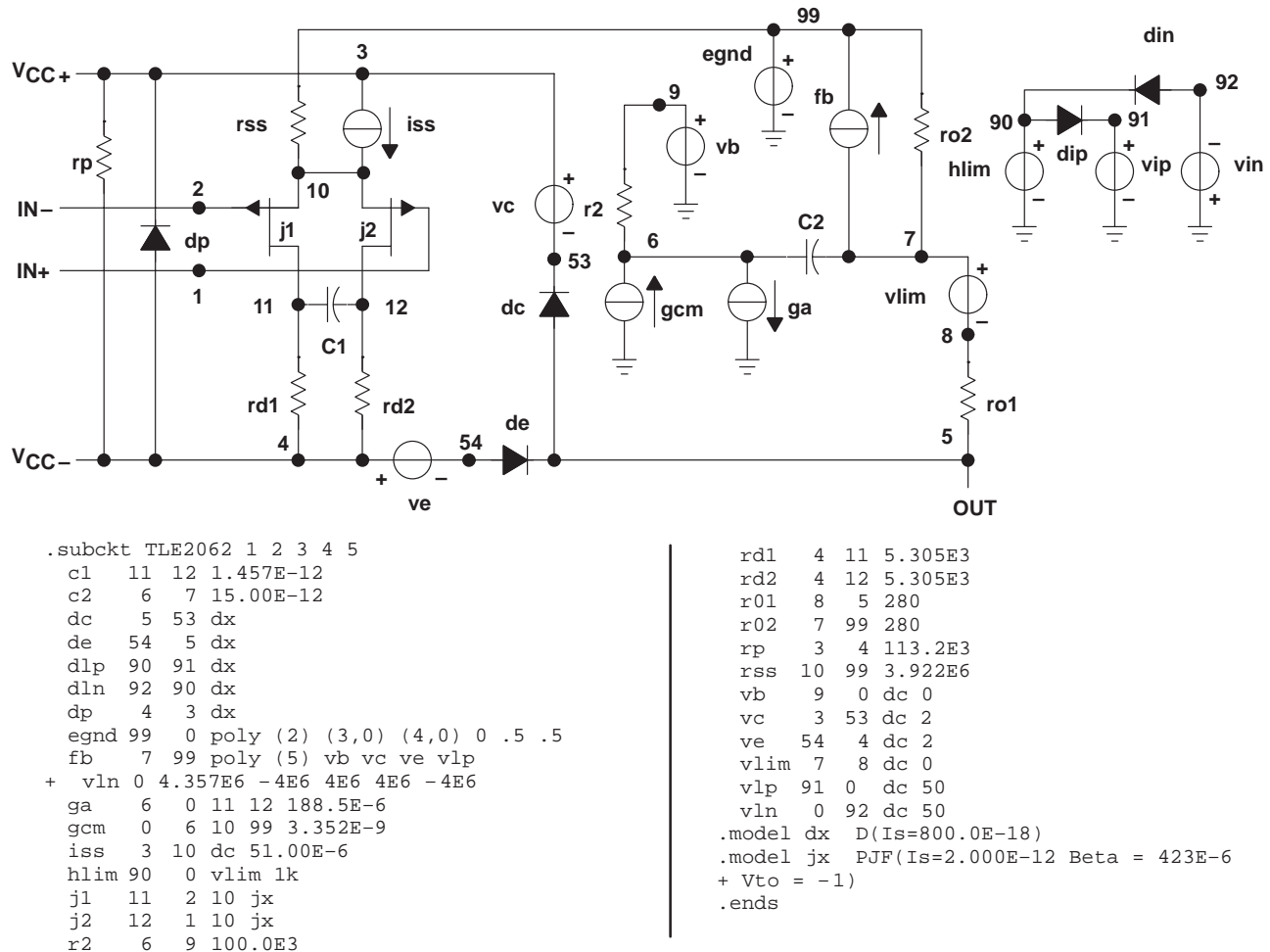


Figure 46. Boyle Macromodel and Subcircuit

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TLE206x, TLE206xA, TLE206xB, TLE206xY  
 EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE  
 μPOWER OPERATIONAL AMPLIFIERS

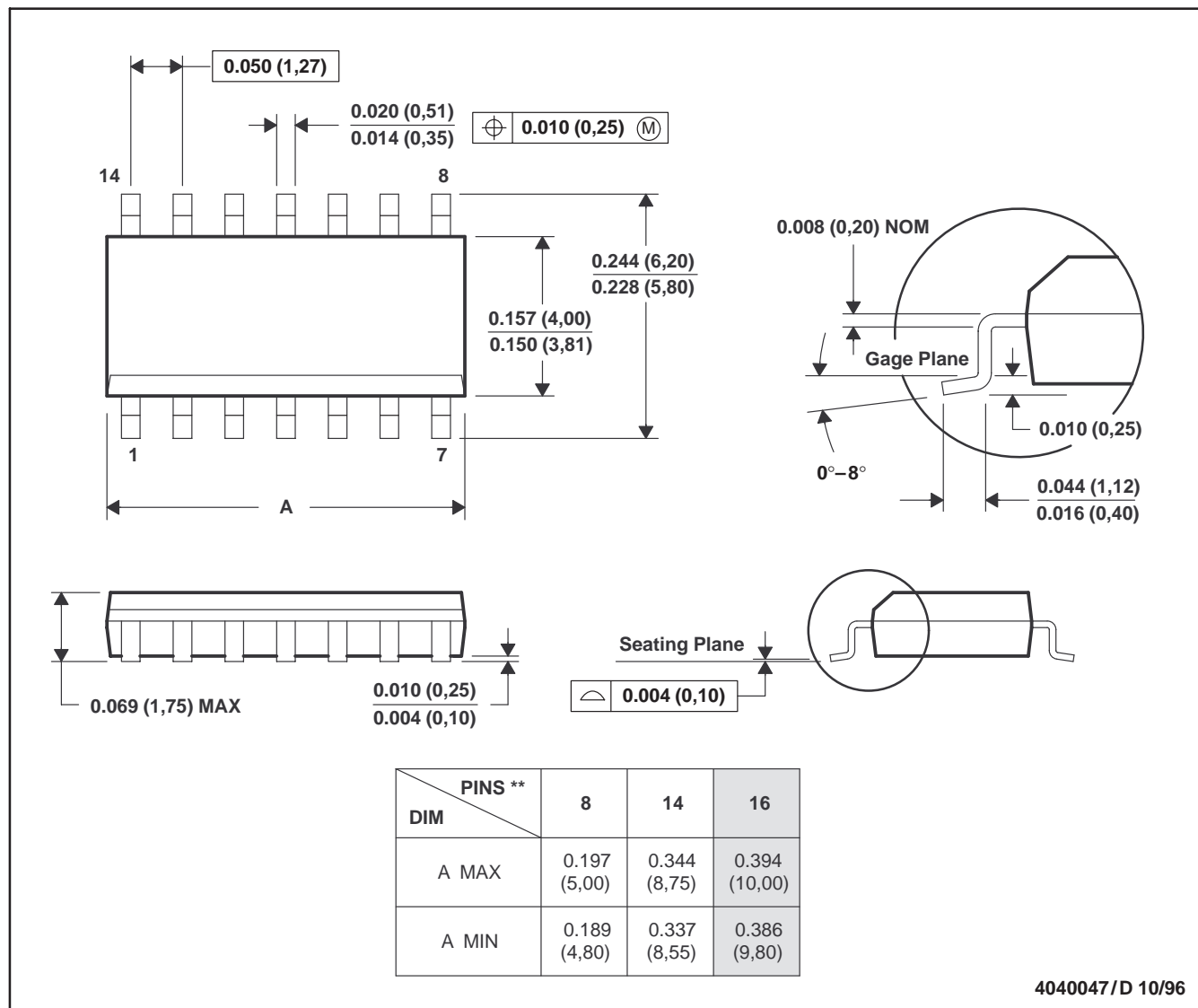
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MECHANICAL INFORMATION

D (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



- 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

4040047/D 10/96

TLE206x, TLE206xA, TLE206xB, TLE206xY  
EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE  
μPOWER OPERATIONAL AMPLIFIERS

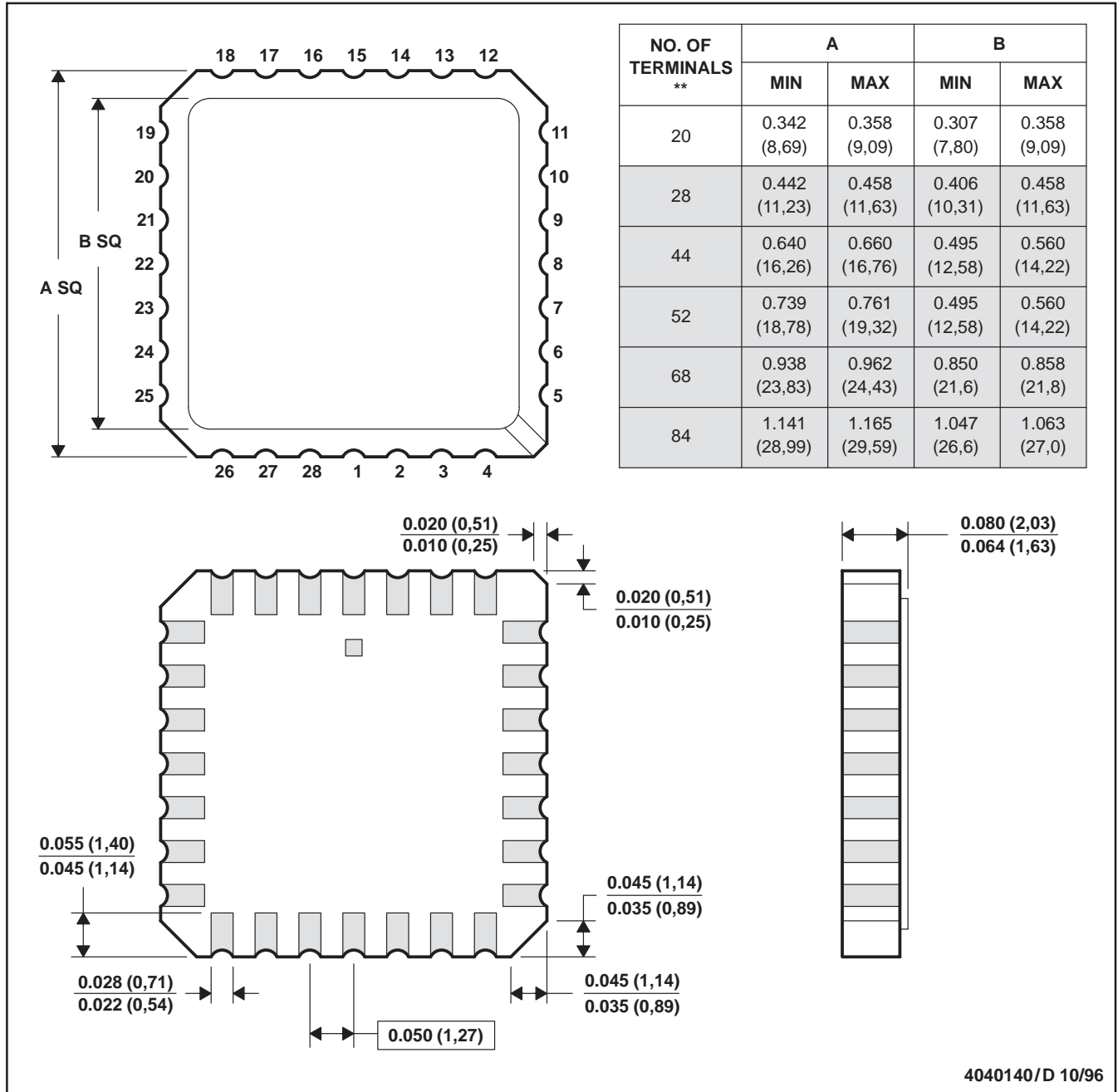
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MECHANICAL INFORMATION

FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a metal lid.  
 D. The terminals are gold plated.  
 E. Falls within JEDEC MS-004

**TLE206x, TLE206xA, TLE206xB, TLE206xY**  
**EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE**  
**μPOWER OPERATIONAL AMPLIFIERS**

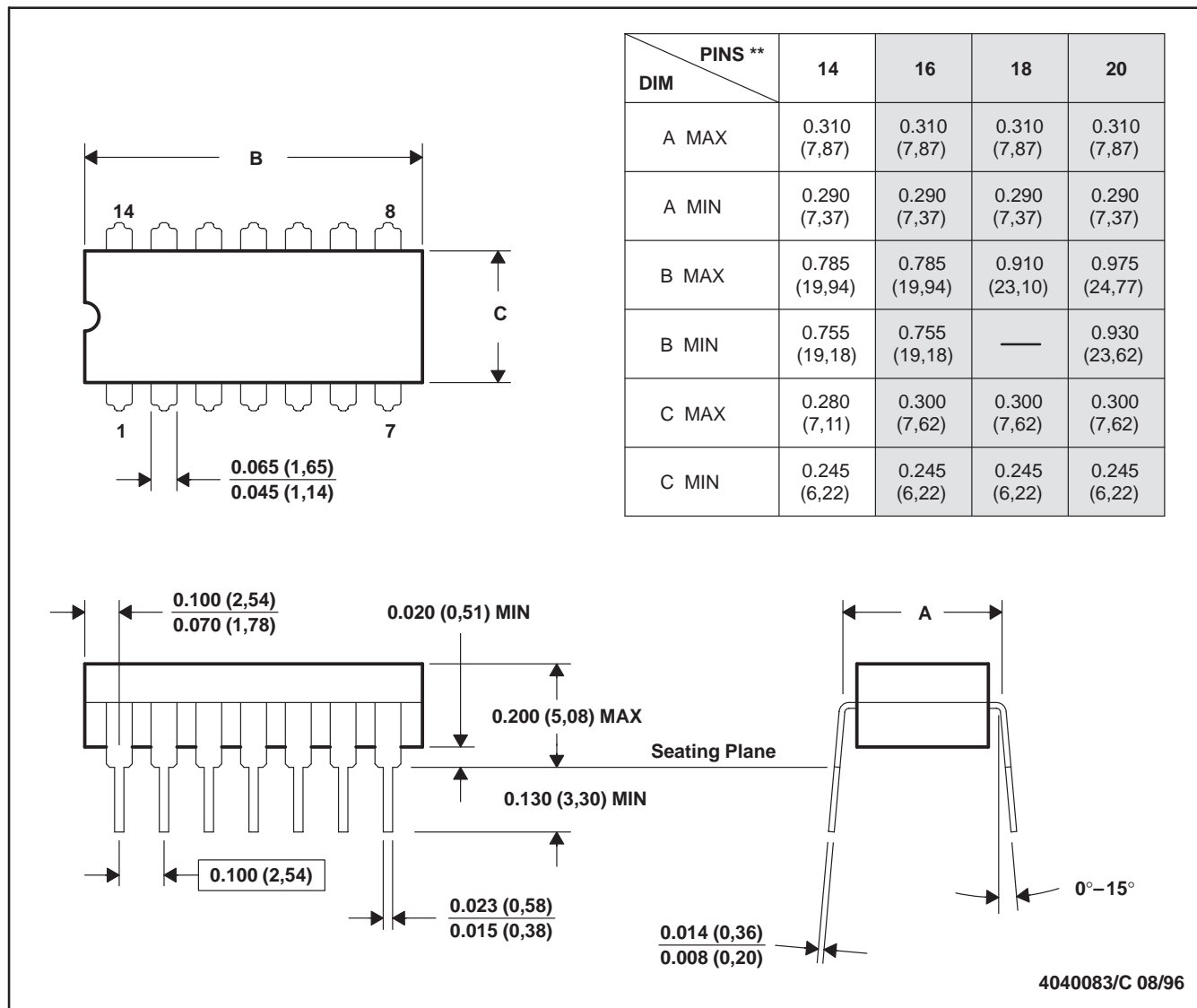
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**MECHANICAL INFORMATION**

**J (R-GDIP-T\*\*)**

**CERAMIC DUAL-IN-LINE PACKAGE**

14 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.  
 E. Falls within MIL-STD-1835 GDIP1-T14, GDIP1-T16, GDIP1-T18, and GDIP1-T20



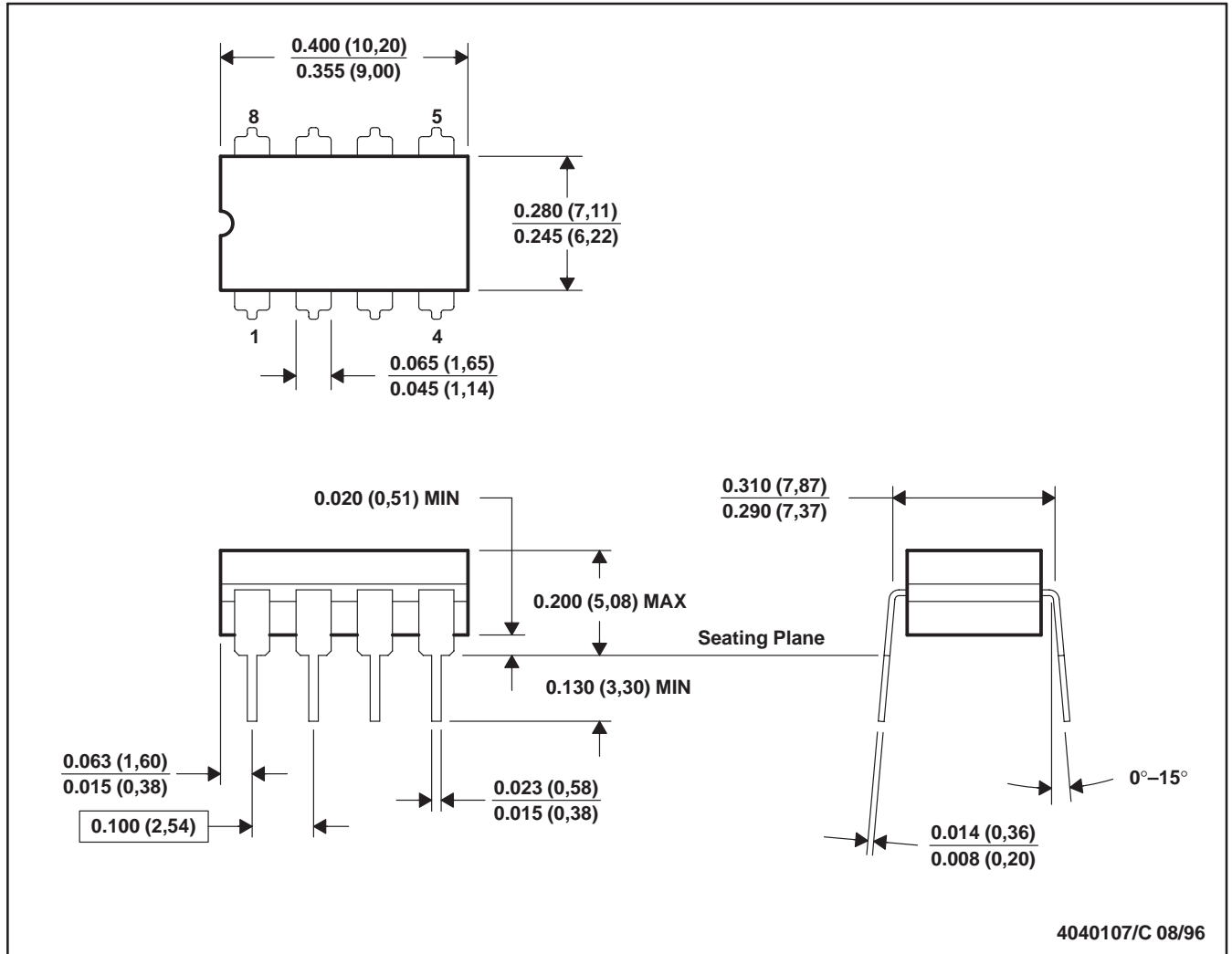
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MECHANICAL INFORMATION

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE PACKAGE



4040107/C 08/96

- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.  
 E. Falls within MIL-STD-1835 GDIP1-T8

TLE206x, TLE206xA, TLE206xB, TLE206xY  
 EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE  
 μPOWER OPERATIONAL AMPLIFIERS

SLOS193A – FEBRUARY 1997 – REVISED MARCH 1998

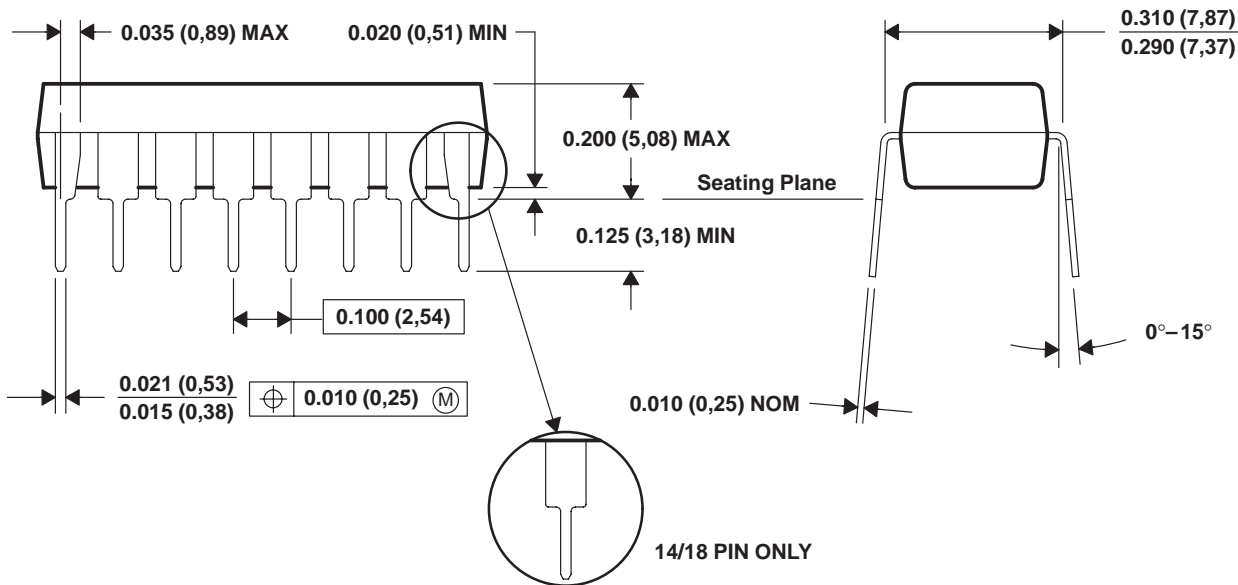
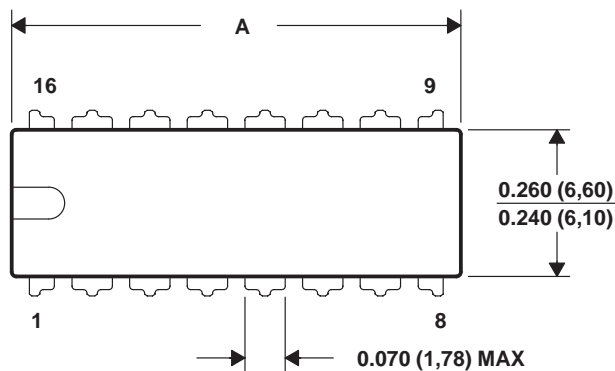
MECHANICAL INFORMATION

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PIN SHOWN

DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	0.975 (24,77)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)



4040049/C 08/95

- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001 (20 pin package is shorter than MS-001.)

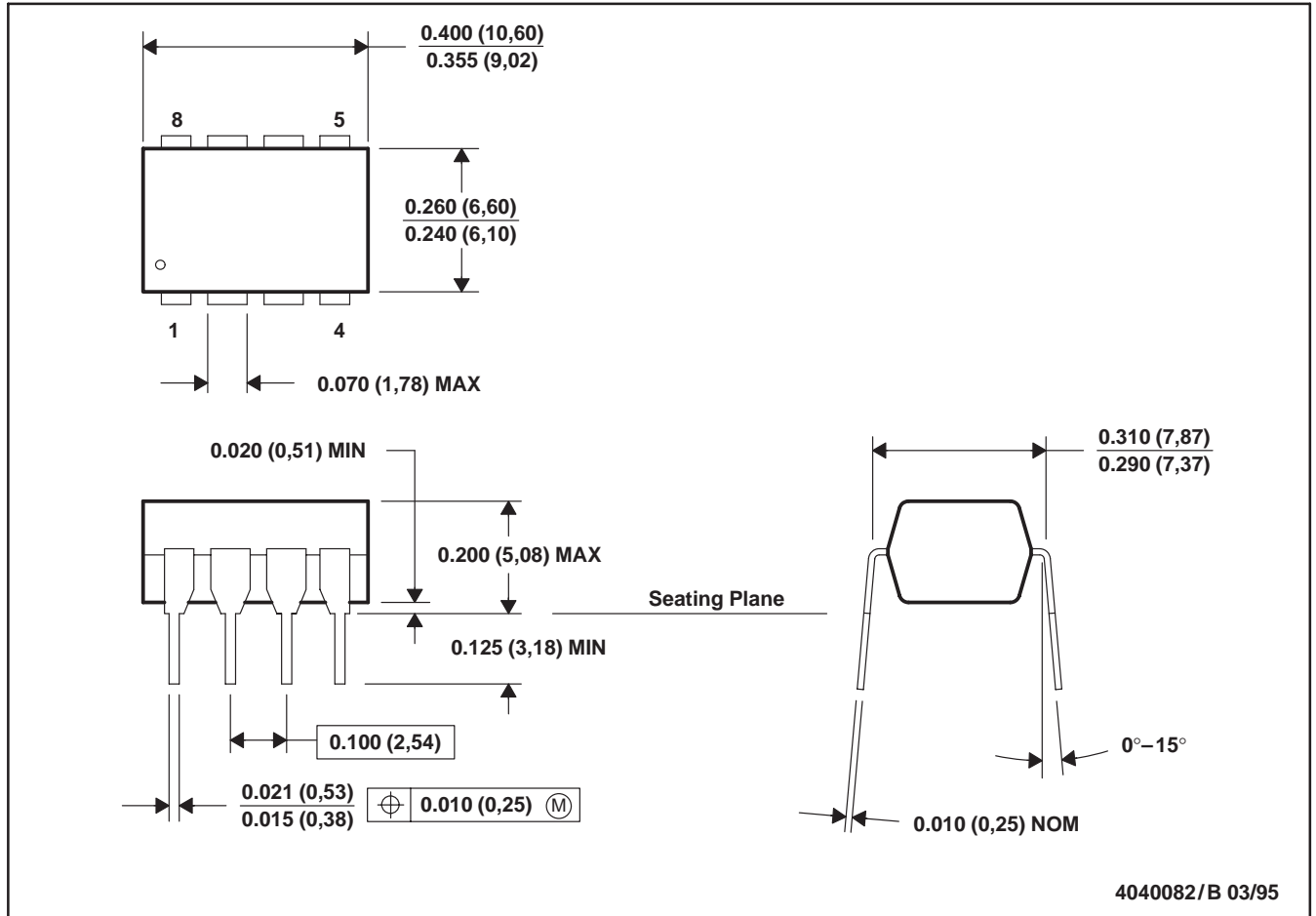


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MECHANICAL INFORMATION

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



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

TLE206x, TLE206xA, TLE206xB, TLE206xY  
 EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE  
 μPOWER OPERATIONAL AMPLIFIERS

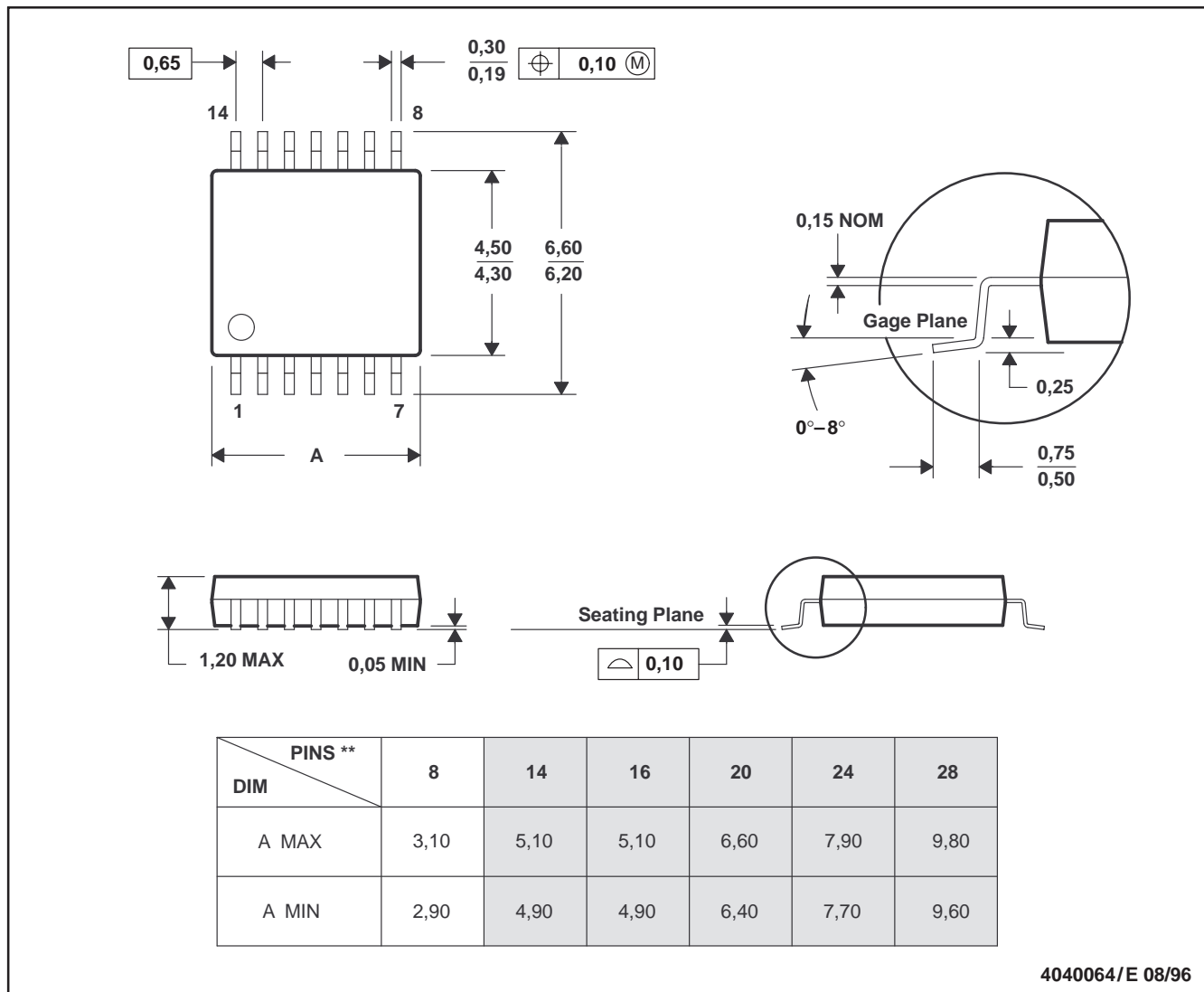
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MECHANICAL INFORMATION

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



4040064/E 08/96

- 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

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