



# THE DATASHEET OF TLE2064CDR

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

SLOS193B – FEBRUARY 1997 – REVISED MAY 2004

- **2× Bandwidth (2 MHz) of the TL06x and TL03x Operational Amplifiers**
- **Low Supply Current . . . 290 μA/Ch Typ**
- **On-chip Offset Voltage Trimming for Improved DC Performance**
- **High Output Drive, Specified into 100-Ω 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 Texas Instruments 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 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-Ω 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 Instruments TLV2432 and TLV2442 CMOS operational amplifiers are excellent choices to consider.



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# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

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#### TLE2061 AVAILABLE OPTIONS

| PACKAGED DEVICES |                                |                          |                         |                        |                       |                |                             |
|------------------|--------------------------------|--------------------------|-------------------------|------------------------|-----------------------|----------------|-----------------------------|
| T <sub>A</sub>   | V <sub>IO</sub> max<br>AT 25°C | SMALL<br>OUTLINE†<br>(D) | CHIP<br>CARRIER<br>(FK) | CERAMIC<br>DIP<br>(JG) | PLASTIC<br>DIP<br>(P) | TSSOP‡<br>(PW) | CERAMIC<br>FLAT PACK<br>(U) |
| 0°C to 70°C      | 500 μV                         | —                        | —                       | —                      | —                     | —              | —                           |
|                  | 1.5 mV                         | TLE2061ACD               | —                       | —                      | TLE2061ACP            | —              | —                           |
|                  | 3 mV                           | TLE2061CD                | —                       | —                      | TLE2061CP             | TLE2061CPWLE   | —                           |
| –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            | —                     | —              | TLE2061AMU                  |
|                  | 3 mV                           | TLE2061MD                | TLE2061MFK              | TLE2061MJG             | —                     | —              | TLE2061MU                   |

† 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).

#### TLE2062 AVAILABLE OPTIONS

| PACKAGED DEVICES     |                                |                       |                      |                     |                    |                             |
|----------------------|--------------------------------|-----------------------|----------------------|---------------------|--------------------|-----------------------------|
| T <sub>A</sub>       | V <sub>IO</sub> max<br>AT 25°C | SMALL OUTLINE†<br>(D) | CHIP CARRIER<br>(FK) | CERAMIC DIP<br>(JG) | PLASTIC DIP<br>(P) | CERAMIC<br>FLAT PACK<br>(U) |
| 0°C<br>to<br>70°C    | 1 mV                           | TLE2062BCD            | —                    | —                   | TLE2062BCP         | —                           |
|                      | 2 mV                           | TLE2062ACD            | —                    | —                   | TLE2062ACP         | —                           |
|                      | 4 mV                           | TLE2062CD             | —                    | —                   | TLE2062CP          | —                           |
| –40°C<br>to<br>85°C  | 1 mV                           | TLE2062BID            | —                    | —                   | TLE2062BIP         | —                           |
|                      | 2 mV                           | TLE2062AID            | —                    | —                   | TLE2062AIP         | —                           |
|                      | 4 mV                           | TLE2062ID             | —                    | —                   | TLE2062IP          | —                           |
| –55°C<br>to<br>125°C | 1 mV                           | TLE2062BMD            | —                    | TLE2062BMJG         | —                  | —                           |
|                      | 2 mV                           | TLE2062AMD            | TLE2062AMFK          | TLE2062AMJG         | —                  | TLE2062AMU                  |
|                      | 4 mV                           | TLE2062MD             | TLE2062MFK           | TLE2062MJG          | —                  | TLE2062MU                   |

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

#### TLE2064 AVAILABLE OPTIONS

| PACKAGED DEVICES     |                                |                       |                      |                    |                    |                             |
|----------------------|--------------------------------|-----------------------|----------------------|--------------------|--------------------|-----------------------------|
| T <sub>A</sub>       | V <sub>IO</sub> max<br>AT 25°C | SMALL OUTLINE†<br>(D) | CHIP CARRIER<br>(FK) | CERAMIC DIP<br>(J) | PLASTIC DIP<br>(N) | CERAMIC<br>FLAT PACK<br>(W) |
| 0°C<br>to<br>70°C    | 2 mV                           | —                     | —                    | —                  | TLE2064BCN         | —                           |
|                      | 4 mV                           | TLE2064ACD            | —                    | —                  | TLE2064ACN         | —                           |
|                      | 6 mV                           | TLE2064CD             | —                    | —                  | TLE2064CN          | —                           |
| –40°C<br>to<br>85°C  | 2 mV                           | —                     | —                    | —                  | TLE2064BIN         | —                           |
|                      | 4 mV                           | TLE2064AID            | —                    | —                  | TLE2064AIN         | —                           |
|                      | 6 mV                           | TLE2064ID             | —                    | —                  | TLE2064IN          | —                           |
| –55°C<br>to<br>125°C | 2 mV                           | —                     | TLE2064BMFK          | TLE2064BMJ         | —                  | —                           |
|                      | 4 mV                           | TLE2064AMD            | TLE2064AMFK          | TLE2064AMJ         | —                  | TLE2064AMW                  |
|                      | 6 mV                           | TLE2064MD             | TLE2064MFK           | TLE2064MJ          | —                  | TLE2064MW                   |

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

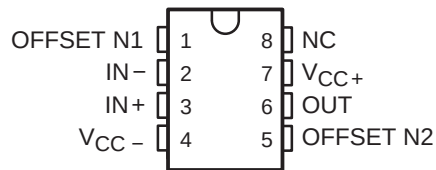


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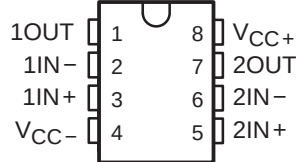
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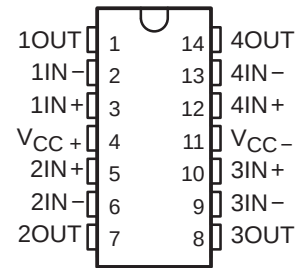
**TLE2061, TLE2061A, AND TLE2061B**  
**D, DB, JG, P, OR PW PACKAGE**  
**(TOP VIEW)**



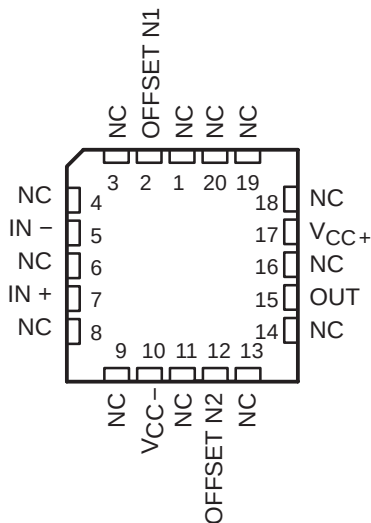
**TLE2062, TLE2062A, TLE2062B**  
**D, JG, OR P PACKAGE**  
**(TOP VIEW)**



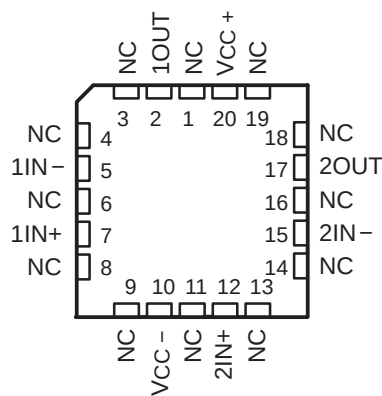
**TLE2064, TLE2064A, TLE2064B**  
**D, J, N, OR W PACKAGE**  
**(TOP VIEW)**



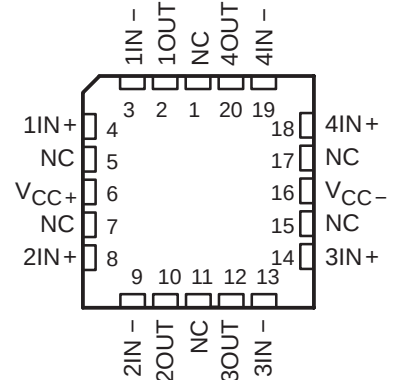
**TLE2061M, TLE2061AM, TLE2061BM**  
**FK PACKAGE**  
**(TOP VIEW)**



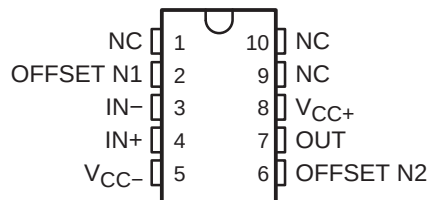
**TLE2062M, TLE2062AM, TLE2062BM**  
**FK PACKAGE**  
**(TOP VIEW)**



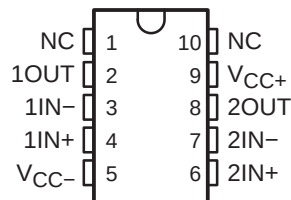
**TLE2064M, TLE2064AM, TLE2064BM**  
**FK PACKAGE**  
**(TOP VIEW)**



**TLE2061 AND TLE2061A**  
**U PACKAGE**  
**(TOP VIEW)**



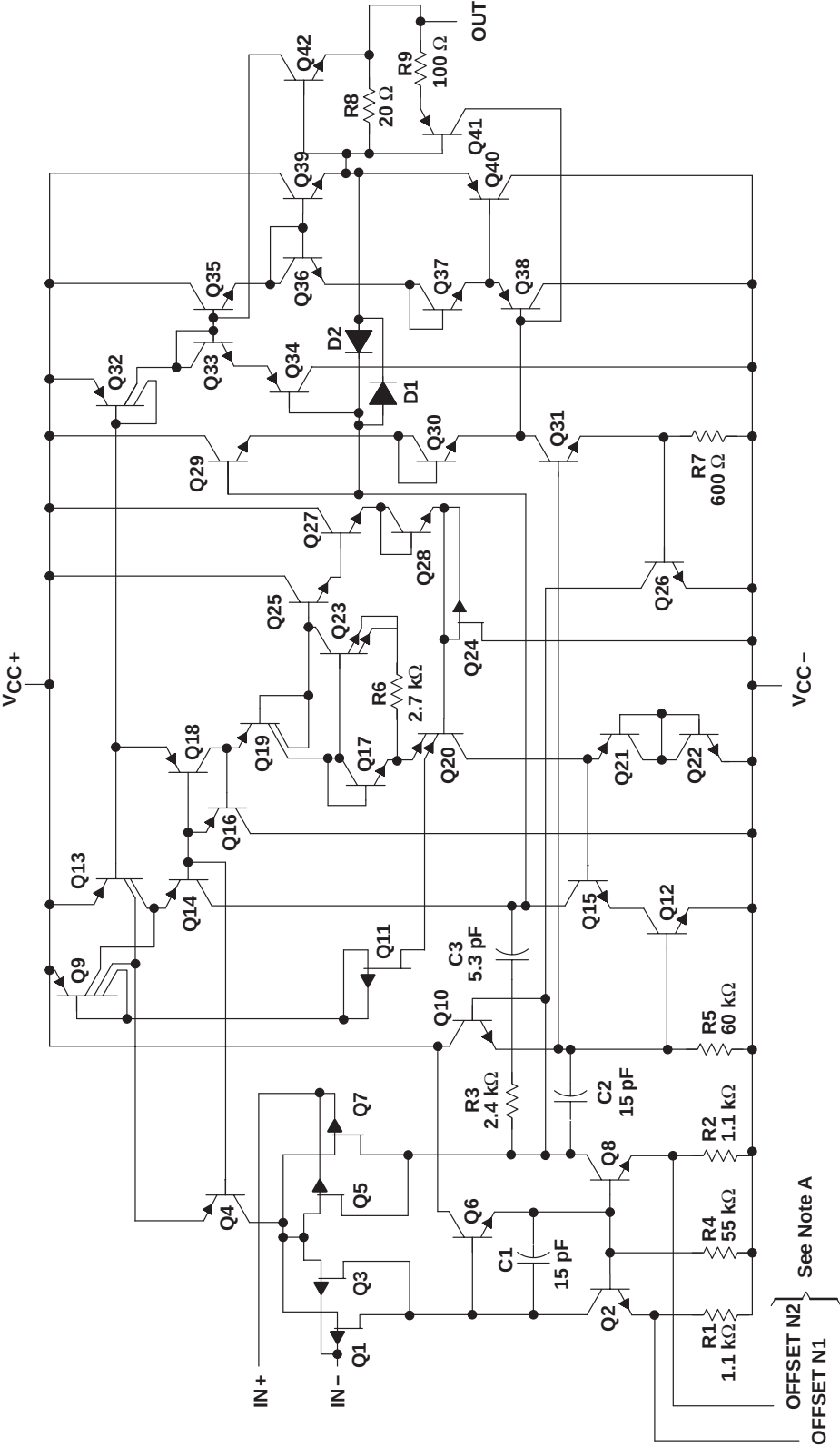
**TLE2062 AND TLE2062A**  
**U PACKAGE**  
**(TOP VIEW)**



NC – No internal connection

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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       |  |

**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>**

|                                                                                   |                |
|-----------------------------------------------------------------------------------|----------------|
| 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      |
| Package thermal impedance, $\theta_{JA}$ (see Notes 4 and 5): D package (8-pin)   | 97.1°C/W       |
| D package (14-pin)                                                                | 86.2°C/W       |
| N package                                                                         | 79.7°C/W       |
| P package                                                                         | 84.6°C/W       |
| PW package                                                                        | 113°C/W        |
| Package thermal impedance, $\theta_{JC}$ (see Notes 4 and 5): FK package          | 5.6°C/W        |
| J package                                                                         | 15.1°C/W       |
| JG package                                                                        | 14.5°C/W       |
| U package                                                                         | 14.7°C/W       |
| W package                                                                         | 10°C/W         |
| 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, U, or W package | 300°C          |

<sup>†</sup> 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.
  4. Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.
  5. The package thermal impedance is calculated in accordance with JESD 51-7 (plastic) or MIL-STD-883 Method 1012 (ceramic).

**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   | –1.6     | 4   | V    |
|                                       | $V_{CC\pm} = \pm 15 \text{ V}$ | –11      | 13  | –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,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**

| PARAMETER                                                                              |                    | TEST CONDITIONS                                                 | T <sub>A</sub> <sup>†</sup> | TLE2061C<br>TLE2061AC<br>TLE2061BC |      |       | UNIT |
|----------------------------------------------------------------------------------------|--------------------|-----------------------------------------------------------------|-----------------------------|------------------------------------|------|-------|------|
|                                                                                        |                    |                                                                 |                             | MIN                                | TYP  | MAX   |      |
| V <sub>IO</sub> Input offset voltage                                                   | TLE2061C           | V <sub>IC</sub> = 0,                      R <sub>S</sub> = 50 Ω | 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                                |      |       |      |
| α <sub>VIO</sub> Temperature coefficient of input offset voltage                       |                    |                                                                 | Full range                  | 6                                  |      | μV/°C |      |
| Input offset voltage long-term drift (see Note 4)                                      |                    |                                                                 | 25°C                        | 0.04                               |      | μV/mo |      |
| I <sub>IO</sub> Input offset current                                                   |                    |                                                                 | 25°C                        | 1                                  |      | pA    |      |
|                                                                                        |                    |                                                                 | Full range                  | 0.8                                |      | nA    |      |
| I <sub>IB</sub> Input bias current                                                     |                    |                                                                 | 25°C                        | 3                                  |      | pA    |      |
|                                                                                        |                    |                                                                 | Full range                  | 2                                  |      | nA    |      |
| V <sub>ICR</sub> Common-mode input voltage range                                       |                    | 25°C                                                            | –1.6<br>to<br>4             | –2<br>to<br>6                      | V    |       |      |
|                                                                                        |                    | Full range                                                      | –1.6<br>to<br>4             |                                    | V    |       |      |
| V <sub>OM+</sub> Maximum positive peak output voltage swing                            |                    | R <sub>L</sub> = 10 kΩ                                          | 25°C                        | 3.5                                | 3.7  | V     |      |
|                                                                                        |                    | R <sub>L</sub> = 100 Ω                                          | Full range                  | 3.3                                |      |       |      |
|                                                                                        |                    |                                                                 | 25°C                        | 2.5                                | 3.1  |       |      |
|                                                                                        |                    |                                                                 | Full range                  | 2                                  |      |       |      |
| V <sub>OM–</sub> Maximum negative peak output voltage swing                            |                    | R <sub>L</sub> = 10 kΩ                                          | 25°C                        | –3.7                               | –3.9 | V     |      |
|                                                                                        |                    | R <sub>L</sub> = 100 Ω                                          | Full range                  | –3.3                               |      |       |      |
|                                                                                        |                    |                                                                 | 25°C                        | –2.5                               | –2.7 |       |      |
|                                                                                        |                    |                                                                 | Full range                  | –2                                 |      |       |      |
| A <sub>VD</sub> Large-signal differential voltage amplification                        |                    | V <sub>O</sub> = ±2.8 V,    R <sub>L</sub> = 10 kΩ              | 25°C                        | 15                                 | 80   | V/mV  |      |
|                                                                                        |                    |                                                                 | Full range                  | 2                                  |      |       |      |
|                                                                                        |                    | V <sub>O</sub> = 0 to 2 V,    R <sub>L</sub> = 100 Ω            | 25°C                        | 0.75                               | 45   |       |      |
|                                                                                        |                    |                                                                 | Full range                  | 0.5                                |      |       |      |
|                                                                                        |                    | V <sub>O</sub> = 0 to –2 V,   R <sub>L</sub> = 100 Ω            | 25°C                        | 0.5                                | 3    |       |      |
|                                                                                        |                    |                                                                 | Full range                  | 0.25                               |      |       |      |
| r <sub>i</sub> Input resistance                                                        |                    | 25°C                                                            | 10 <sup>12</sup>            |                                    | Ω    |       |      |
| c <sub>i</sub> Input capacitance                                                       |                    | 25°C                                                            | 4                           |                                    | pF   |       |      |
| z <sub>O</sub> Open-loop output impedance                                              | I <sub>O</sub> = 0 | 25°C                                                            | 280                         |                                    | Ω    |       |      |
| CMRR      Common-mode rejection ratio                                                  |                    | V <sub>IC</sub> = V <sub>ICRmin</sub> , R <sub>S</sub> = 50 Ω   | 25°C                        | 65                                 | 82   | dB    |      |
|                                                                                        |                    | Full range                                                      | 65                          |                                    |      |       |      |
| k <sub>SVR</sub> Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) |                    | V <sub>CC±</sub> = ±5 V to ±15 V,<br>R <sub>S</sub> = 50 Ω      | 25°C                        | 75                                 | 93   | dB    |      |
|                                                                                        |                    | Full range                                                      | 75                          |                                    |      |       |      |

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

NOTE 6: 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     | $T_A^\dagger$ | TLE2061C<br>TLE2061AC<br>TLE2061BC |     |     | UNIT          |
|------------------------------------------------------------------------|---------------------|---------------|------------------------------------|-----|-----|---------------|
|                                                                        |                     |               | MIN                                | TYP | MAX |               |
| $I_{CC}$ 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  |     | $\mu\text{A}$ |

$^\dagger$  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                                                                              | $T_A^\dagger$ | TLE2061C<br>TLE2061AC<br>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    |     | $\text{V}/\mu\text{s}$       |
|                                                         |                                                                                              | Full range    | 2.1                                |        |     |                              |
| $V_n$ Equivalent input noise voltage (see Figure 2)     | $f = 10\text{ Hz}$ , $R_S = 20\text{ }\Omega$                                                | 25°C          |                                    | 59     | 100 | $\text{nV}/\sqrt{\text{Hz}}$ |
|                                                         | $f = 1\text{ kHz}$ , $R_S = 20\text{ }\Omega$                                                |               |                                    | 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    |     | $\mu\text{V}$                |
| $I_n$ Equivalent input noise current                    | $f = 1\text{ kHz}$                                                                           | 25°C          |                                    | 1      |     | $\text{fA}/\sqrt{\text{Hz}}$ |
| THD Total harmonic distortion                           | $A_{VD} = 2$ , $f = 10\text{ kHz}$ ,<br>$V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$ | 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    |     | $\text{MHz}$                 |
|                                                         | $R_L = 100\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            |               |                                    | 1.3    |     |                              |
| $t_s$ Settling time                                     | 0.1%                                                                                         | 25°C          |                                    | 5      |     | $\mu\text{s}$                |
|                                                         | 0.01%                                                                                        |               |                                    | 10     |     |                              |
| $B_{OM}$ Maximum output-swing bandwidth                 | $A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$                                                     | 25°C          |                                    | 140    |     | $\text{kHz}$                 |
| $\phi_m$ Phase margin at unity gain (see Figure 3)      | $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$                                            | 25°C          |                                    | 58°    |     |                              |
|                                                         | $R_L = 100\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            |               |                                    | 75°    |     |                              |

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

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

SLOS193B – FEBRUARY 1997 – REVISED MAY 2004

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

| PARAMETER                                                                              |                                                                  | TEST CONDITIONS                                                  | T <sub>A</sub> <sup>†</sup> | TLE2061C<br>TLE2061AC<br>TLE2061BC |     |       | UNIT |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------|------------------------------------|-----|-------|------|
|                                                                                        |                                                                  |                                                                  |                             | MIN                                | TYP | MAX   |      |
| V <sub>IO</sub> Input offset voltage                                                   | TLE2061C                                                         | V <sub>IC</sub> = 0,                      R <sub>S</sub> = 50 kΩ | 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                                  |     |       |      |
| α <sub>VIO</sub> Temperature coefficient of input offset voltage                       |                                                                  |                                                                  | Full range                  | 6                                  |     | μV/°C |      |
| Input offset voltage long-term drift (see Note 4)                                      |                                                                  |                                                                  | 25°C                        | 0.04                               |     | μV/mo |      |
| I <sub>IO</sub> Input offset current                                                   |                                                                  |                                                                  | 25°C                        | 2                                  |     | pA    |      |
|                                                                                        |                                                                  |                                                                  | Full range                  | 1                                  |     | nA    |      |
| I <sub>IB</sub> Input bias current                                                     |                                                                  |                                                                  | 25°C                        | 4                                  |     | pA    |      |
|                                                                                        |                                                                  |                                                                  | Full range                  | 3                                  |     | nA    |      |
| V <sub>ICR</sub> Common-mode input voltage range                                       |                                                                  | 25°C                                                             | -11<br>to<br>13             | -12<br>to<br>16                    |     | V     |      |
|                                                                                        |                                                                  | Full range                                                       | -11<br>to<br>13             |                                    |     | V     |      |
| V <sub>OM+</sub> Maximum positive peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                                                             | 13.2                        | 13.7                               |     | V     |      |
|                                                                                        |                                                                  | Full range                                                       | 13                          |                                    |     |       |      |
|                                                                                        | R <sub>L</sub> = 600 Ω                                           | 25°C                                                             | 12.5                        | 13.2                               |     |       |      |
|                                                                                        |                                                                  | Full range                                                       | 12                          |                                    |     |       |      |
| V <sub>OM-</sub> Maximum negative peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                                                             | -13.2                       | -13.7                              |     | V     |      |
|                                                                                        |                                                                  | Full range                                                       | -13                         |                                    |     |       |      |
|                                                                                        | R <sub>L</sub> = 600 Ω                                           | 25°C                                                             | -12.5                       | -13                                |     |       |      |
|                                                                                        |                                                                  | Full range                                                       | -12                         |                                    |     |       |      |
| A <sub>VD</sub> Large-signal differential voltage amplification                        | V <sub>O</sub> = ±10 V,      R <sub>L</sub> = 10 kΩ              | 25°C                                                             | 30                          | 230                                |     | V/mV  |      |
|                                                                                        |                                                                  | Full range                                                       | 20                          |                                    |     |       |      |
|                                                                                        | V <sub>O</sub> = 0 to 8 V,      R <sub>L</sub> = 600 Ω           | 25°C                                                             | 25                          | 100                                |     |       |      |
|                                                                                        |                                                                  | Full range                                                       | 10                          |                                    |     |       |      |
|                                                                                        | V <sub>O</sub> = 0 to -8 V,    R <sub>L</sub> = 600 Ω            | 25°C                                                             | 3                           | 25                                 |     |       |      |
|                                                                                        |                                                                  | Full range                                                       | 1                           |                                    |     |       |      |
| r <sub>i</sub> Input resistance                                                        |                                                                  | 25°C                                                             | 10 <sup>12</sup>            |                                    | Ω   |       |      |
| c <sub>i</sub> Input capacitance                                                       |                                                                  | 25°C                                                             | 4                           |                                    | pF  |       |      |
| z <sub>o</sub> Open-loop output impedance                                              | I <sub>O</sub> = 0                                               | 25°C                                                             | 280                         |                                    | Ω   |       |      |
| CMRR      Common-mode rejection ratio                                                  | V <sub>IC</sub> = V <sub>ICRmin</sub> ,    R <sub>S</sub> = 50 Ω | 25°C                                                             | 72                          | 90                                 |     | dB    |      |
|                                                                                        |                                                                  | Full range                                                       | 70                          |                                    |     |       |      |
| k <sub>SVR</sub> Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±5 V to ±15 V,<br>R <sub>S</sub> = 50 Ω       | 25°C                                                             | 75                          | 93                                 |     | dB    |      |
|                                                                                        |                                                                  | Full range                                                       | 75                          |                                    |     |       |      |

<sup>†</sup> 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.



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

| PARAMETER                                                              | TEST CONDITIONS     | $T_A^\dagger$ | TLE2061C<br>TLE2061AC<br>TLE2061BC |     |     | UNIT    |
|------------------------------------------------------------------------|---------------------|---------------|------------------------------------|-----|-----|---------|
|                                                                        |                     |               | MIN                                | TYP | MAX |         |
| $I_{CC}$ 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  |     | $\mu A$ |

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

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

| PARAMETER                                               | TEST CONDITIONS                                                          | $T_A^\dagger$ | TLE2061C<br>TLE2061AC<br>TLE2061BC |        |     | 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, $R_S = 20$ $\Omega$                                         |               |                                    | 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                           | $A_{VD} = 2$ , $f = 10$ kHz,<br>$V_{O(PP)} = 2$ V, $R_L = 10$ k $\Omega$ | 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                                    |               |                                    | 1.5    |     |                 |
| $t_s$ Settling time                                     | 0.1%                                                                     | 25°C          |                                    | 5      |     | $\mu s$         |
|                                                         | 0.01%                                                                    |               |                                    | 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                                    |               |                                    | 70°    |     |                 |

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

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

SLOS193B – FEBRUARY 1997 – REVISED MAY 2004

TLE2061I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$  (unless otherwise noted)

| PARAMETER                                                        |                                                                       | TEST CONDITIONS                                                  | T <sub>A</sub> <sup>†</sup> | TLE2061I , TLE2061AI<br>TLE2061BI |      |       | UNIT |
|------------------------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------|-----------------------------------|------|-------|------|
|                                                                  |                                                                       |                                                                  |                             | MIN                               | TYP  | MAX   |      |
| V <sub>IO</sub>                                                  | Input offset voltage                                                  | V <sub>IC</sub> = 0,<br>R <sub>S</sub> = 50 Ω                    | 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                               |      |       |      |
| αV <sub>IO</sub> Temperature coefficient of input offset voltage |                                                                       |                                                                  | Full range                  | 6                                 |      | μV/°C |      |
| Input offset voltage long-term drift (see Note 4)                |                                                                       |                                                                  | 25°C                        | 0.04                              |      | μV/mo |      |
| I <sub>IO</sub>                                                  | Input offset current                                                  |                                                                  | 25°C                        | 1                                 |      | pA    |      |
|                                                                  |                                                                       |                                                                  | Full range                  | 2                                 |      | nA    |      |
| I <sub>IB</sub>                                                  | Input bias current                                                    |                                                                  | 25°C                        | 3                                 |      | pA    |      |
|                                                                  |                                                                       |                                                                  | Full range                  | 4                                 |      | nA    |      |
| V <sub>ICR</sub>                                                 | Common-mode input voltage range                                       | 25°C                                                             | -1.6 to 4                   | -2 to 6                           |      | V     |      |
|                                                                  |                                                                       | Full range                                                       | -1.6 to 4                   |                                   | V    |       |      |
| V <sub>OM+</sub>                                                 | Maximum positive peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                        | 3.5                               | 3.7  | V     |      |
|                                                                  |                                                                       |                                                                  | Full range                  | 3.1                               |      |       |      |
|                                                                  |                                                                       | R <sub>L</sub> = 100 Ω                                           | 25°C                        | 2.5                               | 3.1  |       |      |
|                                                                  |                                                                       |                                                                  | Full range                  | 2                                 |      |       |      |
| V <sub>OM-</sub>                                                 | Maximum negative peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                        | -3.7                              | -3.9 | V     |      |
|                                                                  |                                                                       |                                                                  | Full range                  | -3.1                              |      |       |      |
|                                                                  |                                                                       | R <sub>L</sub> = 100 Ω                                           | 25°C                        | -2.5                              | -2.7 |       |      |
|                                                                  |                                                                       |                                                                  | Full range                  | -2                                |      |       |      |
| A <sub>VD</sub>                                                  | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±2.8 V,<br>R <sub>L</sub> = 10 kΩ               | 25°C                        | 15                                | 80   | V/mV  |      |
|                                                                  |                                                                       |                                                                  | Full range                  | 2                                 |      |       |      |
|                                                                  |                                                                       | V <sub>O</sub> = 0 to 2 V,<br>R <sub>L</sub> = 100 Ω             | 25°C                        | 0.75                              | 45   |       |      |
|                                                                  |                                                                       |                                                                  | Full range                  | 0.5                               |      |       |      |
|                                                                  |                                                                       | V <sub>O</sub> = 0 to -2 V,<br>R <sub>L</sub> = 100 Ω            | 25°C                        | 0.5                               | 3    |       |      |
|                                                                  |                                                                       |                                                                  | Full range                  | 0.25                              |      |       |      |
| r <sub>i</sub>                                                   | Input resistance                                                      |                                                                  | 25°C                        | 10 <sup>12</sup>                  |      | Ω     |      |
| c <sub>i</sub>                                                   | Input capacitance                                                     |                                                                  | 25°C                        | 4                                 |      | pF    |      |
| z <sub>O</sub>                                                   | Open-loop output impedance                                            | I <sub>O</sub> = 0                                               | 25°C                        | 280                               |      | Ω     |      |
| CMRR                                                             | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,<br>R <sub>S</sub> = 50 Ω | 25°C                        | 65                                | 82   | dB    |      |
|                                                                  |                                                                       |                                                                  | Full range                  | 65                                |      |       |      |
| k <sub>SVR</sub>                                                 | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±5 V to ±15 V,<br>R <sub>S</sub> = 50 Ω       | 25°C                        | 75                                | 93   | dB    |      |
|                                                                  |                                                                       |                                                                  | Full range                  | 65                                |      |       |      |
| I <sub>CC</sub>                                                  | Supply current                                                        | V <sub>O</sub> = 0,<br>No load                                   | 25°C                        | 280                               | 325  | μA    |      |
|                                                                  |                                                                       |                                                                  | Full range                  | 350                               |      |       |      |
| ΔI <sub>CC</sub>                                                 | Supply-current change over operating temperature range                |                                                                  | Full range                  | 29                                |      | μA    |      |

$^\dagger$  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.



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

| PARAMETER                                               | TEST CONDITIONS                                                                              | $T_A^\dagger$ | TLE2061I<br>TLE2061AI<br>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                      | $A_{VD} = 2$ , $f = 10\text{ kHz}$ ,<br>$V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$ | 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°    |     |        |

<sup>†</sup> Full range is –40°C to 85°C.

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

SLOS193B – FEBRUARY 1997 – REVISED MAY 2004

**TLE2061I electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                         |                                                                       | TEST CONDITIONS                                                  | T <sub>A</sub> <sup>†</sup> | TLE2061I, TLE2061AI<br>TLE2061BI |       |       | UNIT |
|---------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------|----------------------------------|-------|-------|------|
|                                                   |                                                                       |                                                                  |                             | MIN                              | TYP   | MAX   |      |
| V <sub>IO</sub>                                   | Input offset voltage                                                  | V <sub>IC</sub> = 0,<br>R <sub>S</sub> = 50 Ω                    | 25°C                        | 0.6                              |       | 3     | mV   |
|                                                   |                                                                       |                                                                  | Full range                  | 4.3                              |       |       |      |
|                                                   |                                                                       |                                                                  | 25°C                        | 0.5                              |       | 1.5   |      |
|                                                   |                                                                       |                                                                  | Full range                  | 2.9                              |       |       |      |
|                                                   |                                                                       |                                                                  | 25°C                        | 0.3                              |       | 0.5   |      |
|                                                   |                                                                       |                                                                  | Full range                  | 1.3                              |       |       |      |
| αV <sub>IO</sub>                                  | Temperature coefficient of input offset voltage                       |                                                                  | Full range                  | 6                                |       | μV/°C |      |
| Input offset voltage long-term drift (see Note 4) |                                                                       |                                                                  | 25°C                        | 0.04                             |       | μV/mo |      |
| I <sub>IO</sub>                                   | Input offset current                                                  |                                                                  | 25°C                        | 2                                |       | pA    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 3                                |       | nA    |      |
| I <sub>IB</sub>                                   | Input bias current                                                    |                                                                  | 25°C                        | 4                                |       | pA    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 5                                |       | nA    |      |
| V <sub>ICR</sub>                                  | Common-mode input voltage range                                       | 25°C                                                             | –11 to 13                   | –12 to 16                        |       | V     |      |
|                                                   |                                                                       | Full range                                                       | –11 to 13                   |                                  | V     |       |      |
| V <sub>OM+</sub>                                  | Maximum positive peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                        | 13.2                             | 13.7  | V     |      |
|                                                   |                                                                       |                                                                  | Full range                  | 13                               |       |       |      |
|                                                   |                                                                       | R <sub>L</sub> = 600 Ω                                           | 25°C                        | 12.5                             | 13.2  | V     |      |
|                                                   |                                                                       |                                                                  | Full range                  | 12                               |       |       |      |
| V <sub>OM–</sub>                                  | Maximum negative peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                        | –13.2                            | –13.7 | V     |      |
|                                                   |                                                                       |                                                                  | Full range                  | –13                              |       |       |      |
|                                                   |                                                                       | R <sub>L</sub> = 600 Ω                                           | 25°C                        | –12.5                            | –13   | V     |      |
|                                                   |                                                                       |                                                                  | Full range                  | –12                              |       |       |      |
| A <sub>VD</sub>                                   | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±10 V,<br>R <sub>L</sub> = 10 kΩ                | 25°C                        | 30                               | 230   | V/mV  |      |
|                                                   |                                                                       |                                                                  | Full range                  | 20                               |       |       |      |
|                                                   |                                                                       | V <sub>O</sub> = 0 to 8 V,<br>R <sub>L</sub> = 600 Ω             | 25°C                        | 25                               | 100   |       |      |
|                                                   |                                                                       |                                                                  | Full range                  | 10                               |       |       |      |
|                                                   |                                                                       | V <sub>O</sub> = 0 to –8 V,<br>R <sub>L</sub> = 600 Ω            | 25°C                        | 3                                | 25    |       |      |
|                                                   |                                                                       |                                                                  | Full range                  | 01                               |       |       |      |
| r <sub>i</sub>                                    | Input resistance                                                      |                                                                  | 25°C                        | 10 <sup>12</sup>                 |       | Ω     |      |
| c <sub>i</sub>                                    | Input capacitance                                                     |                                                                  | 25°C                        | 4                                |       | pF    |      |
| z <sub>o</sub>                                    | Open-loop output impedance                                            | I <sub>O</sub> = 0                                               | 25°C                        | 280                              |       | Ω     |      |
| CMRR                                              | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,<br>R <sub>S</sub> = 50 Ω | 25°C                        | 72                               | 90    | dB    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 65                               |       |       |      |
| k <sub>SVR</sub>                                  | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±5 V to ±15 V,<br>R <sub>S</sub> = 50 Ω       | 25°C                        | 75                               | 93    | dB    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 65                               |       |       |      |
| I <sub>CC</sub>                                   | Supply current                                                        | V <sub>O</sub> = 0,<br>No load                                   | 25°C                        | 290                              | 350   | μA    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 375                              |       |       |      |
| ΔI <sub>CC</sub>                                  | Supply-current change over operating temperature range                |                                                                  | Full range                  | 34                               |       | μA    |      |

<sup>†</sup> 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.



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

| PARAMETER                                               | TEST CONDITIONS                                                                              | $T_A^\dagger$ | TLE2061I<br>TLE2061AI<br>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)     | $f = 10\text{ Hz}$ , $R_S = 20\text{ }\Omega$                                                | 25°C          |                                    | 70     | 100 | nV/√Hz |
|                                                         | $f = 1\text{ kHz}$ , $R_S = 20\text{ }\Omega$                                                |               |                                    | 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                      | $A_{VD} = 2$ , $f = 10\text{ kHz}$ ,<br>$V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$ | 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    |
|                                                         | $R_L = 600\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            |               |                                    | 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°    |     |        |
|                                                         | $R_L = 600\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            |               |                                    | 70°    |     |        |

<sup>†</sup> Full range is –40°C to 85°C.

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

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

| PARAMETER                                                        |                                                 | TEST CONDITIONS                                                           | T <sub>A</sub> <sup>†</sup>                         | TLE2061M<br>TLE2061AM<br>TLE2061BM |      |       | UNIT |
|------------------------------------------------------------------|-------------------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------|------------------------------------|------|-------|------|
|                                                                  |                                                 |                                                                           |                                                     | MIN                                | TYP  | MAX   |      |
| V <sub>IO</sub>                                                  | Input offset voltage                            | V <sub>IC</sub> = 0,      R <sub>S</sub> = 50 Ω                           | 25°C                                                | 0.8    3.1                         |      | mV    |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 6                                  |      |       |      |
|                                                                  |                                                 |                                                                           | 25°C                                                | 0.6    2.6                         |      |       |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 4.6                                |      |       |      |
|                                                                  |                                                 |                                                                           | 25°C                                                | 0.5    1.9                         |      |       |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 3.1                                |      |       |      |
| αV <sub>IO</sub> Temperature coefficient of input offset voltage |                                                 |                                                                           | Full range                                          | 6                                  |      | μV/°C |      |
| Input offset voltage long-term drift (see Note 4)                |                                                 |                                                                           | 25°C                                                | 0.04                               |      | μV/mo |      |
| I <sub>IO</sub>                                                  | Input offset current                            |                                                                           | 25°C                                                | 1                                  |      | pA    |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 15                                 |      | nA    |      |
| I <sub>IB</sub>                                                  | Input bias current                              |                                                                           | 25°C                                                | 3                                  |      | pA    |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 30                                 |      | nA    |      |
| V <sub>ICR</sub>                                                 | Common-mode input voltage range                 | 25°C                                                                      | -1.6<br>to<br>4                                     | -2<br>to<br>6                      | V    |       |      |
|                                                                  |                                                 | Full range                                                                | -1.6<br>to<br>4                                     |                                    | V    |       |      |
| V <sub>OM+</sub>                                                 | Maximum positive peak output voltage swing      | R <sub>L</sub> = 10 kΩ                                                    | 25°C                                                | 3.5                                | 3.7  | V     |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 3                                  |      |       |      |
|                                                                  |                                                 | R <sub>L</sub> = 600 Ω                                                    | 25°C                                                | 2.5                                | 3.6  |       |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 2                                  |      |       |      |
|                                                                  |                                                 | R <sub>L</sub> = 100 Ω                                                    | 25°C                                                | 2.5                                | 3.1  |       |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 2                                  |      |       |      |
| V <sub>OM-</sub>                                                 | Maximum negative peak output voltage swing      | R <sub>L</sub> = 10 kΩ                                                    | 25°C                                                | -3.5                               | -3.9 | V     |      |
|                                                                  |                                                 |                                                                           | Full range                                          | -3                                 |      |       |      |
|                                                                  |                                                 | FK and JG packages<br>R <sub>L</sub> = 600 Ω                              | 25°C                                                | -2.5                               | -3.5 |       |      |
|                                                                  |                                                 |                                                                           | Full range                                          | -2                                 |      |       |      |
|                                                                  |                                                 | D and P packages<br>R <sub>L</sub> = 100 Ω                                | 25°C                                                | -2.5                               | -2.7 |       |      |
|                                                                  |                                                 |                                                                           | Full range                                          | -2                                 |      |       |      |
| A <sub>VD</sub>                                                  | Large-signal differential voltage amplification | V <sub>O</sub> = ±2.8 V,    R <sub>L</sub> = 10 kΩ                        | 25°C                                                | 15                                 | 80   | V/mV  |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 2                                  |      |       |      |
|                                                                  |                                                 | FK and JG packages<br>V <sub>O</sub> = 0 to 2.5 V, R <sub>L</sub> = 600 Ω | 25°C                                                | 1                                  | 65   |       |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 0.5                                |      |       |      |
|                                                                  |                                                 |                                                                           | V <sub>O</sub> = 0 to -2.5 V,R <sub>L</sub> = 600 Ω | 25°C                               | 1    |       | 16   |
|                                                                  |                                                 |                                                                           |                                                     | Full range                         | 0.5  |       |      |
|                                                                  |                                                 | D and P packages<br>V <sub>O</sub> = 0 to 2 V,    R <sub>L</sub> = 100 Ω  | 25°C                                                | 0.75                               | 45   |       |      |
|                                                                  |                                                 |                                                                           | Full range                                          | 0.5                                |      |       |      |
|                                                                  |                                                 |                                                                           | V <sub>O</sub> = 0 to -2 V, R <sub>L</sub> = 100 Ω  | 25°C                               | 0.5  |       | 3    |
|                                                                  |                                                 |                                                                           |                                                     | Full range                         | 0.25 |       |      |

$^\dagger$  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  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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

| PARAMETER       |                                                                     | TEST CONDITIONS                                           | $T_A$ †    | TLE2061M<br>TLE2061AM<br>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                                         | $V_{IC} = V_{ICRmin}$ ,<br>$R_S = 50 \Omega$              | 25°C       | 65                                 | 82               |     | dB   |
|                 |                                                                     |                                                           | Full range | 60                                 |                  |     |      |
| $k_{SVR}$       | Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5$ V to $\pm 15$ V,<br>$R_S = 50 \Omega$ | 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,  $V_{CC\pm} = \pm 5$  V,  $T_A = 25^\circ\text{C}$**

| PARAMETER   |                                               | TEST CONDITIONS                                                                                 | TLE2061M<br>TLE2061AM<br>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     |     | $\text{nV}/\sqrt{\text{Hz}}$ |
|             |                                               | $f = 1 \text{ kHz}$ , $R_S = 20 \Omega$                                                         |                                    | 43     |     |                              |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage   | $f = 0.1 \text{ Hz}$ to $10 \text{ Hz}$                                                         |                                    | 1.1    |     | μV                           |
| $I_n$       | Equivalent input noise current                | $f = 1 \text{ kHz}$                                                                             |                                    | 1      |     | $\text{fA}/\sqrt{\text{Hz}}$ |
| THD         | Total harmonic distortion                     | $A_{VD} = 2$ , $f = 10 \text{ kHz}$ ,<br>$V_{O(PP)} = 2 \text{ V}$ , $R_L = 10 \text{ k}\Omega$ |                                    | 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

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

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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 <sub>A</sub> <sup>†</sup> | TLE2061M ,TLE2061AM<br>TLE2061BM |        |       | UNIT |
|---------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------|----------------------------------|--------|-------|------|
|                                                   |                                                                       |                                                                  |                             | MIN                              | TYP    | MAX   |      |
| V <sub>IO</sub>                                   | Input offset voltage                                                  | V <sub>IC</sub> = 0,<br>R <sub>S</sub> = 50 Ω                    | 25°C                        | 0.6                              |        | 3     | mV   |
|                                                   |                                                                       |                                                                  | Full range                  | 6                                |        |       |      |
|                                                   |                                                                       |                                                                  | 25°C                        | 0.5                              |        | 1.5   |      |
|                                                   |                                                                       |                                                                  | Full range                  | 3.6                              |        |       |      |
|                                                   |                                                                       |                                                                  | 25°C                        | 0.3                              |        | 0.5   |      |
|                                                   |                                                                       |                                                                  | Full range                  | 1.7                              |        |       |      |
| αV <sub>IO</sub>                                  | Temperature coefficient of input offset voltage                       |                                                                  | Full range                  | 6                                |        | μV/°C |      |
| Input offset voltage long-term drift (see Note 4) |                                                                       |                                                                  | 25°C                        | 0.04                             |        | μV/mo |      |
| I <sub>IO</sub>                                   | Input offset current                                                  |                                                                  | 25°C                        | 2                                |        | pA    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 20                               |        | nA    |      |
| I <sub>IB</sub>                                   | Input bias current                                                    |                                                                  | 25°C                        | 4                                |        | pA    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 40                               |        | nA    |      |
| V <sub>ICR</sub>                                  | Common-mode input voltage range                                       | 25°C                                                             | – 11 to 13                  | – 12 to 16                       | V      |       |      |
|                                                   |                                                                       | Full range                                                       | – 11 to 13                  |                                  | V      |       |      |
| V <sub>OM+</sub>                                  | Maximum positive peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                        | 13                               | 13.7   | V     |      |
|                                                   |                                                                       |                                                                  | Full range                  | 12.5                             |        |       |      |
|                                                   |                                                                       | R <sub>L</sub> = 600 Ω                                           | 25°C                        | 12.5                             | 13.2   |       |      |
|                                                   |                                                                       |                                                                  | Full range                  | 12                               |        |       |      |
| V <sub>OM–</sub>                                  | Maximum negative peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                        | – 13                             | – 13.7 | V     |      |
|                                                   |                                                                       |                                                                  | Full range                  | – 12.5                           |        |       |      |
|                                                   |                                                                       | R <sub>L</sub> = 600 Ω                                           | 25°C                        | – 12.5                           | – 13   |       |      |
|                                                   |                                                                       |                                                                  | Full range                  | – 12                             |        |       |      |
| A <sub>VD</sub>                                   | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±10 V,<br>R <sub>L</sub> = 10 kΩ                | 25°C                        | 30                               | 230    | V/mV  |      |
|                                                   |                                                                       |                                                                  | Full range                  | 20                               |        |       |      |
|                                                   |                                                                       | V <sub>O</sub> = 0 to 8 V,<br>R <sub>L</sub> = 600 Ω             | 25°C                        | 25                               | 100    |       |      |
|                                                   |                                                                       |                                                                  | Full range                  | 7                                |        |       |      |
|                                                   |                                                                       | V <sub>O</sub> = 0 to – 8 V,<br>R <sub>L</sub> = 600 Ω           | 25°C                        | 3                                | 25     |       |      |
|                                                   |                                                                       |                                                                  | Full range                  | 1                                |        |       |      |
| r <sub>i</sub>                                    | Input resistance                                                      |                                                                  | 25°C                        | 10 <sup>12</sup>                 |        | Ω     |      |
| c <sub>i</sub>                                    | Input capacitance                                                     |                                                                  | 25°C                        | 4                                |        | pF    |      |
| z <sub>0</sub>                                    | Open-loop output impedance                                            | I <sub>O</sub> = 0                                               | 25°C                        | 280                              |        | Ω     |      |
| CMRR                                              | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,<br>R <sub>S</sub> = 50 Ω | 25°C                        | 72                               | 90     | dB    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 65                               |        |       |      |
| k <sub>SVR</sub>                                  | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±5 V to ±15 V,<br>R <sub>S</sub> = 50 Ω       | 25°C                        | 75                               | 93     | dB    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 65                               |        |       |      |

$^\dagger$  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  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

**TLE206x, TLE206xA, TLE206xB**  
**EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE**  
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**TLE2061M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted) (continue)**

| PARAMETER                                                              | TEST CONDITIONS     | $T_A^\dagger$ | TLE2061M, TLE2061AM<br>TLE2061BM |     |     | UNIT    |
|------------------------------------------------------------------------|---------------------|---------------|----------------------------------|-----|-----|---------|
|                                                                        |                     |               | MIN                              | TYP | MAX |         |
| $I_{CC}$ 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    |                                  | 46  |     | $\mu A$ |

$^\dagger$  Full range is  $-55^\circ C$  to  $125^\circ C$ .

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

| PARAMETER                                               | TEST CONDITIONS                                                                              | $T_A^\dagger$ | TLE2061M<br>TLE2061AM<br>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    |     | $V/\mu s$      |
|                                                         |                                                                                              | Full range    | 1.8                                |        |     |                |
| $V_n$ Equivalent input noise voltage (see Figure 2)     | $f = 10\text{ Hz}$ , $R_S = 20\text{ }\Omega$                                                | 25°C          |                                    | 70     |     | $nV/\sqrt{Hz}$ |
|                                                         | $f = 1\text{ kHz}$ , $R_S = 20\text{ }\Omega$                                                | 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    |     | $\mu V$        |
| $I_n$ Equivalent input noise current                    | $f = 1\text{ kHz}$                                                                           | 25°C          |                                    | 1.1    |     | $fA/\sqrt{Hz}$ |
| THD Total harmonic distortion                           | $A_{VD} = 2$ , $f = 10\text{ kHz}$ ,<br>$V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$ | 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            |
|                                                         | $R_L = 600\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            | 25°C          |                                    | 1.5    |     |                |
| $t_s$ Settling time                                     | 0.1%                                                                                         | 25°C          |                                    | 5      |     | $\mu s$        |
|                                                         | 0.01%                                                                                        | 25°C          |                                    | 10     |     |                |
| $B_{OM}$ Maximum output-swing bandwidth                 | $A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$                                                     | 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°    |     |                |
|                                                         | $R_L = 600\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            | 25°C          |                                    | 70°    |     |                |

$^\dagger$  Full range is  $-55^\circ C$  to  $125^\circ C$ .



# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

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

| PARAMETER                                                                  | TEST CONDITIONS                                                           | TLE2061Y        |                  |     | UNIT                    |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------|-----------------|------------------|-----|-------------------------|
|                                                                            |                                                                           | MIN             | TYP              | MAX |                         |
| $V_{IO}$ Input offset voltage                                              | $V_{IC} = 0, \quad R_S = 50 \Omega$                                       |                 | 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<br>to<br>13 | -12<br>to<br>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                   | $V_O = \pm 10 \text{ V}, \quad R_L = 10 \text{ k}\Omega$                  | 30              | 230              |     | V/mV                    |
|                                                                            | $V_O = 0 \text{ to } 8 \text{ V}, \quad R_L = 600 \Omega$                 | 25              | 100              |     |                         |
|                                                                            | $V_O = 0 \text{ to } -8 \text{ V}, \quad R_L = 600 \Omega$                | 3               | 25               |     |                         |
| $r_i$ Input resistance                                                     |                                                                           |                 | 10 <sup>12</sup> |     | $\Omega$                |
| $c_i$ Input capacitance                                                    |                                                                           |                 | 4                |     | pF                      |
| $z_o$ Open-loop output impedance                                           | $I_O = 0$                                                                 |                 | 280              |     | $\Omega$                |
| CMRR Common-mode rejection ratio                                           | $R_S = 50 \Omega, \quad V_{IC} = V_{ICR\text{min}}$                       | 72              | 90               |     | dB                      |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V}, \quad R_S = 50 \Omega$ | 75              | 93               |     | dB                      |
| $I_{CC}$ Supply current                                                    | $V_O = 0, \quad \text{No load}$                                           |                 | 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 $V_{CC\pm} = \pm 15$ V, $T_A = 25^\circ\text{C}$

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



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

| PARAMETER                                                                              |                                                                  | TEST CONDITIONS                                                 | T <sub>A</sub> <sup>†</sup> | TLE2062C<br>TLE2062AC<br>TLE2062BC |      |       | UNIT |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------|------------------------------------|------|-------|------|
|                                                                                        |                                                                  |                                                                 |                             | MIN                                | TYP  | MAX   |      |
| V <sub>IO</sub> Input offset voltage                                                   | TLE2062C                                                         | V <sub>IC</sub> = 0,                      R <sub>S</sub> = 50 Ω | 25°C                        | 1                                  | 5    | mV    |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 5.9                                |      |       |      |
|                                                                                        | TLE2062AC                                                        |                                                                 | 25°C                        | 0.9                                | 4    |       |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 4.9                                |      |       |      |
|                                                                                        | TLE2062BC                                                        |                                                                 | 25°C                        | 0.7                                | 3    |       |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 3.9                                |      |       |      |
| α <sub>VIO</sub> Temperature coefficient of input offset voltage                       |                                                                  |                                                                 | Full range                  | 6                                  |      | μV/°C |      |
| Input offset voltage long-term drift (see Note 4)                                      |                                                                  |                                                                 | 25°C                        | 0.04                               |      | μV/mo |      |
| I <sub>IO</sub> Input offset current                                                   |                                                                  |                                                                 | 25°C                        | 1                                  |      | pA    |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 0.8                                |      | nA    |      |
| I <sub>IB</sub> Input bias current                                                     |                                                                  |                                                                 | 25°C                        | 3                                  |      | pA    |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 2                                  |      | nA    |      |
| V <sub>ICR</sub> Common-mode input voltage range                                       |                                                                  | 25°C                                                            | −1.6<br>to<br>4             | −2<br>to<br>6                      | V    |       |      |
|                                                                                        |                                                                  | Full range                                                      | −1.6<br>to<br>4             |                                    | V    |       |      |
| V <sub>OM+</sub> Maximum positive peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                                                            | 3.5                         | 3.7                                | V    |       |      |
|                                                                                        |                                                                  | Full range                                                      | 3.3                         |                                    |      |       |      |
|                                                                                        | R <sub>L</sub> = 100 Ω                                           | 25°C                                                            | 2.5                         | 3.1                                |      |       |      |
|                                                                                        |                                                                  | Full range                                                      | 2                           |                                    |      |       |      |
| V <sub>OM−</sub> Maximum negative peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                                                            | −3.7                        | −3.9                               | V    |       |      |
|                                                                                        |                                                                  | Full range                                                      | −3.3                        |                                    |      |       |      |
|                                                                                        | R <sub>L</sub> = 100 Ω                                           | 25°C                                                            | −2.5                        | −2.7                               |      |       |      |
|                                                                                        |                                                                  | Full range                                                      | −2                          |                                    |      |       |      |
| A <sub>VD</sub> Large-signal differential voltage amplification                        | V <sub>O</sub> = ± 2.8 V,      R <sub>L</sub> = 10 kΩ            | 25°C                                                            | 15                          | 80                                 | V/mV |       |      |
|                                                                                        |                                                                  | Full range                                                      | 2                           |                                    |      |       |      |
|                                                                                        | V <sub>O</sub> = 0 to 2 V,      R <sub>L</sub> = 100 Ω           | 25°C                                                            | 0.75                        | 45                                 |      |       |      |
|                                                                                        |                                                                  | Full range                                                      | 0.5                         |                                    |      |       |      |
|                                                                                        | V <sub>O</sub> = 0 to −2 V,      R <sub>L</sub> = 100 Ω          | 25°C                                                            | 0.5                         | 3                                  |      |       |      |
|                                                                                        |                                                                  | Full range                                                      | 0.25                        |                                    |      |       |      |
| r <sub>i</sub> Input resistance                                                        |                                                                  | 25°C                                                            | 10 <sup>12</sup>            |                                    | Ω    |       |      |
| c <sub>i</sub> Input capacitance                                                       |                                                                  | 25°C                                                            | 4                           |                                    | pF   |       |      |
| z <sub>O</sub> Open-loop output impedance                                              | I <sub>O</sub> = 0                                               | 25°C                                                            | 560                         |                                    | Ω    |       |      |
| CMRR      Common-mode rejection ratio                                                  | V <sub>IC</sub> = V <sub>ICRmin</sub> ,    R <sub>S</sub> = 50 Ω | 25°C                                                            | 65                          | 82                                 | dB   |       |      |
|                                                                                        |                                                                  | Full range                                                      | 65                          |                                    |      |       |      |
| k <sub>SVR</sub> Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ± 5 V to ± 15 V,<br>R <sub>S</sub> = 50 Ω     | 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.

**TLE206x, TLE206xA, TLE206xB**  
**EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE**  
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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     | $T_A^\dagger$ | TLE2062C<br>TLE2062AC<br>TLE2062BC |     |     | UNIT |
|------------------------------------------------------------------------|---------------------|---------------|------------------------------------|-----|-----|------|
|                                                                        |                     |               | MIN                                | TYP | MAX |      |
| $I_{CC}$ Supply current                                                | $V_O = 0$ , No load | 25°C          |                                    | 560 | 620 | μA   |
|                                                                        |                     | Full range    |                                    |     | 635 |      |
| $\Delta I_{CC}$ Supply-current change over operating temperature range |                     | Full range    |                                    | 26  |     | μA   |

$^\dagger$  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                                               | $T_A^\dagger$ | TLE2062C<br>TLE2062AC<br>TLE2062BC |        |     | UNIT   |
|---------------------------------------------------------|---------------------------------------------------------------|---------------|------------------------------------|--------|-----|--------|
|                                                         |                                                               |               | MIN                                | TYP    | MAX |        |
| SR Slew rate at unity gain (see Figure 1)               | $R_L = 10$ kΩ, $C_L = 100$ pF                                 | 25°C          | 2.2                                | 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          |                                    | 59     | 100 | nV/√Hz |
|                                                         | $f = 1$ kHz, $R_S = 20$ Ω                                     | 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    |     | μV     |
| $I_n$ Equivalent input noise current                    | $f = 1$ kHz                                                   | 25°C          |                                    | 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          |                                    | 1.8    |     | MHz    |
|                                                         | $R_L = 100$ Ω, $C_L = 100$ pF                                 | 25°C          |                                    | 1.3    |     |        |
| 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          |                                    | 140    |     | kHz    |
| $\phi_m$ Phase margin at unity gain (see Figure 3)      | $R_L = 10$ kΩ, $C_L = 100$ pF                                 | 25°C          |                                    | 58°    |     |        |
|                                                         | $R_L = 100$ Ω, $C_L = 100$ pF                                 | 25°C          |                                    | 75°    |     |        |

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

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

| PARAMETER                                                                              |                                                                  | TEST CONDITIONS                                                 | T <sub>A</sub> <sup>†</sup> | TLE2062C<br>TLE2062AC<br>TLE2062BC |       |       | UNIT |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------|------------------------------------|-------|-------|------|
|                                                                                        |                                                                  |                                                                 |                             | MIN                                | TYP   | MAX   |      |
| V <sub>IO</sub> Input offset voltage                                                   | TLE2062C                                                         | V <sub>IC</sub> = 0,                      R <sub>S</sub> = 50 Ω | 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                                |       |       |      |
| α <sub>VIO</sub> Temperature coefficient of input offset voltage                       |                                                                  |                                                                 | Full range                  | 6                                  |       | μV/°C |      |
| Input offset voltage long-term drift (see Note 4)                                      |                                                                  |                                                                 | 25°C                        | 0.04                               |       | μV/mo |      |
| I <sub>IO</sub> Input offset current                                                   |                                                                  |                                                                 | 25°C                        | 2                                  |       | pA    |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 1                                  |       | nA    |      |
| I <sub>IB</sub> Input bias current                                                     |                                                                  |                                                                 | 25°C                        | 4                                  |       | pA    |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 3                                  |       | nA    |      |
| V <sub>ICR</sub> Common-mode input voltage range                                       |                                                                  | 25°C                                                            | -11<br>to<br>13             | -12<br>to<br>16                    |       | V     |      |
|                                                                                        |                                                                  | Full range                                                      | -11<br>to<br>13             |                                    |       | V     |      |
| V <sub>OM+</sub> Maximum positive peak output voltage swing                            |                                                                  | R <sub>L</sub> = 10 kΩ                                          | 25°C                        | 13.2                               | 13.7  | V     |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 13                                 |       |       |      |
|                                                                                        |                                                                  | R <sub>L</sub> = 600 Ω                                          | 25°C                        | 12.5                               | 13.2  |       |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 12                                 |       |       |      |
| V <sub>OM-</sub> Maximum negative peak output voltage swing                            |                                                                  | R <sub>L</sub> = 10 kΩ                                          | 25°C                        | -13.2                              | -13.7 | V     |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | -13                                |       |       |      |
|                                                                                        |                                                                  | R <sub>L</sub> = 600 Ω                                          | 25°C                        | -12.5                              | -13   |       |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | -12                                |       |       |      |
| A <sub>VD</sub> Large-signal differential voltage amplification                        |                                                                  | V <sub>O</sub> = ± 10 V,      R <sub>L</sub> = 10 kΩ            | 25°C                        | 30                                 | 230   | V/mV  |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 20                                 |       |       |      |
|                                                                                        |                                                                  | V <sub>O</sub> = 0 to 8 V,      R <sub>L</sub> = 600 Ω          | 25°C                        | 25                                 | 100   |       |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 10                                 |       |       |      |
|                                                                                        |                                                                  | V <sub>O</sub> = 0 to -8 V,      R <sub>L</sub> = 600 Ω         | 25°C                        | 3                                  | 25    |       |      |
|                                                                                        |                                                                  |                                                                 | Full range                  | 1                                  |       |       |      |
| r <sub>i</sub> Input resistance                                                        |                                                                  | 25°C                                                            | 10 <sup>12</sup>            |                                    | Ω     |       |      |
| c <sub>i</sub> Input capacitance                                                       |                                                                  | 25°C                                                            | 4                           |                                    | pF    |       |      |
| z <sub>0</sub> Open-loop output impedance                                              | I <sub>O</sub> = 0                                               | 25°C                                                            | 560                         |                                    | Ω     |       |      |
| CMRR      Common-mode rejection ratio                                                  | V <sub>IC</sub> = V <sub>ICRmin</sub> ,    R <sub>S</sub> = 50 Ω | 25°C                                                            | 72                          | 90                                 | dB    |       |      |
|                                                                                        |                                                                  | Full range                                                      | 70                          |                                    |       |       |      |
| k <sub>SVR</sub> Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ± 5 V to ± 15 V,<br>R <sub>S</sub> = 50 Ω     | 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  $T_A = 150^\circ C$  extrapolated to  $T_A = 25^\circ C$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

**TLE206x, TLE206xA, TLE206xB**  
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**μPOWER OPERATIONAL AMPLIFIERS**

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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      | $T_A^\dagger$ | TLE2062C<br>TLE2062AC<br>TLE2062BC |     |     | UNIT |
|------------------------------------------------------------------------|----------------------|---------------|------------------------------------|-----|-----|------|
|                                                                        |                      |               | MIN                                | TYP | MAX |      |
| $I_{CC}$ Supply current                                                | $V_O = 0$ V, No load | 25°C          |                                    | 625 | 690 | μA   |
|                                                                        |                      | Full range    |                                    |     | 715 |      |
| $\Delta I_{CC}$ Supply-current change over operating temperature range |                      | Full range    |                                    | 36  |     | μA   |

$^\dagger$  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                                               | $T_A^\dagger$ | TLE2062C<br>TLE2062AC<br>TLE2062BC |        |     | 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    | 2.5                                |        |     |        |
| $V_n$ 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                                     | 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    |     | 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, $C_L = 10$ 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°    |     |        |

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

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

| PARAMETER                                         |                                                                       | TEST CONDITIONS                                                  | T <sub>A</sub> <sup>†</sup> | TLE2062I<br>TLE2062AI<br>TLE2062BI |      |       | UNIT |
|---------------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------|------------------------------------|------|-------|------|
|                                                   |                                                                       |                                                                  |                             | MIN                                | TYP  | MAX   |      |
| V <sub>IO</sub>                                   | Input offset voltage                                                  | V <sub>IC</sub> = 0,                    R <sub>S</sub> = 50 Ω    | 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                                |      |       |      |
| α <sub>VIO</sub>                                  | Temperature coefficient of input offset voltage                       |                                                                  | Full range                  | 6                                  |      | μV/°C |      |
| Input offset voltage long-term drift (see Note 4) |                                                                       |                                                                  | 25°C                        | 0.04                               |      | μV/mo |      |
| I <sub>IO</sub>                                   | Input offset current                                                  |                                                                  | 25°C                        | 1                                  |      | pA    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 2                                  |      | nA    |      |
| I <sub>IB</sub>                                   | Input bias current                                                    |                                                                  | 25°C                        | 3                                  |      | pA    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 4                                  |      | nA    |      |
| V <sub>ICR</sub>                                  | Common-mode input voltage range                                       | 25°C                                                             | -1.6<br>to<br>4             | -2<br>to<br>6                      | V    |       |      |
|                                                   |                                                                       | Full range                                                       | -1.6<br>to<br>4             |                                    | V    |       |      |
| V <sub>OM+</sub>                                  | Maximum positive peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                        | 3.5                                | 3.7  | V     |      |
|                                                   |                                                                       |                                                                  | Full range                  | 3.1                                |      |       |      |
|                                                   |                                                                       | R <sub>L</sub> = 100 Ω                                           | 25°C                        | 2.5                                | 3.1  |       |      |
|                                                   |                                                                       |                                                                  | Full range                  | 2                                  |      |       |      |
| V <sub>OM-</sub>                                  | Maximum negative peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                        | -3.7                               | -3.9 | V     |      |
|                                                   |                                                                       |                                                                  | Full range                  | -3.1                               |      |       |      |
|                                                   |                                                                       | R <sub>L</sub> = 100 Ω                                           | 25°C                        | -2.5                               | -2.7 |       |      |
|                                                   |                                                                       |                                                                  | Full range                  | -2                                 |      |       |      |
| A <sub>VD</sub>                                   | Large-signal differential voltage amplification                       | V <sub>O</sub> = ± 2.8 V,    R <sub>L</sub> = 10 kΩ              | 25°C                        | 15                                 | 80   | V/mV  |      |
|                                                   |                                                                       |                                                                  | Full range                  | 2                                  |      |       |      |
|                                                   |                                                                       | V <sub>O</sub> = 0 to 2 V,    R <sub>L</sub> = 100 Ω             | 25°C                        | 0.75                               | 45   |       |      |
|                                                   |                                                                       |                                                                  | Full range                  | 0.5                                |      |       |      |
|                                                   |                                                                       | V <sub>O</sub> = 0 to -2 V,    R <sub>L</sub> = 100 Ω            | 25°C                        | 0.5                                | 3    |       |      |
|                                                   |                                                                       |                                                                  | Full range                  | 0.25                               |      |       |      |
| r <sub>i</sub>                                    | Input resistance                                                      |                                                                  | 25°C                        | 10 <sup>12</sup>                   |      | Ω     |      |
| c <sub>i</sub>                                    | Input capacitance                                                     |                                                                  | 25°C                        | 4                                  |      | pF    |      |
| z <sub>O</sub>                                    | Open-loop output impedance                                            | I <sub>O</sub> = 0                                               | 25°C                        | 560                                |      | Ω     |      |
| CMRR                                              | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,    R <sub>S</sub> = 50 Ω | 25°C                        | 65                                 | 82   | dB    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 65                                 |      |       |      |
| k <sub>SVR</sub>                                  | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ± 5 V to ± 15 V,<br>R <sub>S</sub> = 50 Ω     | 25°C                        | 75                                 | 93   | dB    |      |
|                                                   |                                                                       |                                                                  | Full range                  | 65                                 |      |       |      |

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

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**  
**EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE**  
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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     | $T_A^\dagger$ | TLE2062I<br>TLE2062AI<br>TLE2062BI |     |     | UNIT |
|------------------------------------------------------------------------|---------------------|---------------|------------------------------------|-----|-----|------|
|                                                                        |                     |               | MIN                                | TYP | MAX |      |
| $I_{CC}$ Supply current                                                | $V_O = 0$ , No load | 25°C          |                                    | 560 | 620 | μA   |
|                                                                        |                     | Full range    |                                    |     | 640 |      |
| $\Delta I_{CC}$ Supply-current change over operating temperature range |                     | Full range    |                                    | 54  |     | μA   |

$^\dagger$  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                                                                              | $T_A^\dagger$ | TLE2062I<br>TLE2062AI<br>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    |     | V/μs   |
|                                                         |                                                                                              | Full range    | 1.7                                |        |     |        |
| $V_n$ Equivalent input noise voltage (see Figure 2)     | $f = 10\text{ Hz}$ , $R_S = 20\text{ }\Omega$                                                | 25°C          |                                    | 59     | 100 | nV/√Hz |
|                                                         | $f = 1\text{ kHz}$ , $R_S = 20\text{ }\Omega$                                                | 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    |     | μV     |
| $I_n$ Equivalent input noise current                    | $f = 1\text{ kHz}$                                                                           | 25°C          |                                    | 1      |     | fA/√Hz |
| THD Total harmonic distortion                           | $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$ ,<br>$A_{VD} = 2$ , $f = 10\text{ kHz}$ | 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    |
|                                                         | $R_L = 100\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            | 25°C          |                                    | 1.3    |     |        |
| 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          |                                    | 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°    |     |        |
|                                                         | $R_L = 100\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            | 25°C          |                                    | 75°    |     |        |

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

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

| PARAMETER                                                                              |                                                                  | TEST CONDITIONS                                               | T <sub>A</sub> <sup>†</sup> | TLE2062I<br>TLE2062AI<br>TLE2062BI |      |       | UNIT |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------|-----------------------------|------------------------------------|------|-------|------|
|                                                                                        |                                                                  |                                                               |                             | MIN                                | TYP  | MAX   |      |
| V <sub>IO</sub> Input offset voltage                                                   | TLE2062I                                                         | V <sub>IC</sub> = 0,                    R <sub>S</sub> = 50 Ω | 25°C                        | 0.9      4                         |      | mV    |      |
|                                                                                        |                                                                  |                                                               | Full range                  | 5.3                                |      |       |      |
|                                                                                        | TLE2062AI                                                        |                                                               | 25°C                        | 0.8      2                         |      |       |      |
|                                                                                        |                                                                  |                                                               | Full range                  | 3.3                                |      |       |      |
|                                                                                        | TLE2062BI                                                        |                                                               | 25°C                        | 0.5      1                         |      |       |      |
|                                                                                        |                                                                  |                                                               | Full range                  | 2.3                                |      |       |      |
| α <sub>VIO</sub> Temperature coefficient of input offset voltage                       |                                                                  |                                                               | Full range                  | 6                                  |      | μV/°C |      |
| Input offset voltage long-term drift (see Note 4)                                      |                                                                  |                                                               | 25°C                        | 0.04                               |      | μV/mo |      |
| I <sub>IO</sub> Input offset current                                                   |                                                                  |                                                               | 25°C                        | 2                                  |      | pA    |      |
|                                                                                        |                                                                  |                                                               | Full range                  | 3                                  |      | nA    |      |
| I <sub>IB</sub> Input bias current                                                     |                                                                  |                                                               | 25°C                        | 4                                  |      | pA    |      |
|                                                                                        |                                                                  |                                                               | Full range                  | 5                                  |      | nA    |      |
| V <sub>ICR</sub> Common-mode input voltage range                                       |                                                                  | 25°C                                                          | -11<br>to<br>13             | -12<br>to<br>16                    | V    |       |      |
|                                                                                        |                                                                  | Full range                                                    | -11<br>to<br>13             |                                    | V    |       |      |
| V <sub>OM+</sub> Maximum positive peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                                                          | 13.2                        | 13.7                               | V    |       |      |
|                                                                                        |                                                                  | Full range                                                    | 13                          |                                    |      |       |      |
|                                                                                        | R <sub>L</sub> = 600 Ω                                           | 25°C                                                          | 12.5                        | 13.2                               |      |       |      |
|                                                                                        |                                                                  | Full range                                                    | 12                          |                                    |      |       |      |
| V <sub>OM-</sub> Maximum negative peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           | 25°C                                                          | -13.2                       | -13.7                              | V    |       |      |
|                                                                                        |                                                                  | Full range                                                    | -13                         |                                    |      |       |      |
|                                                                                        | R <sub>L</sub> = 600 Ω                                           | 25°C                                                          | -12.5                       | -13                                |      |       |      |
|                                                                                        |                                                                  | Full range                                                    | -12                         |                                    |      |       |      |
| A <sub>VD</sub> Large-signal differential voltage amplification                        | V <sub>O</sub> = ± 10 V,      R <sub>L</sub> = 10 kΩ             | 25°C                                                          | 30                          | 230                                | V/mV |       |      |
|                                                                                        |                                                                  | Full range                                                    | 20                          |                                    |      |       |      |
|                                                                                        | V <sub>O</sub> = 0 to 8 V,      R <sub>L</sub> = 600 Ω           | 25°C                                                          | 25                          | 100                                |      |       |      |
|                                                                                        |                                                                  | Full range                                                    | 10                          |                                    |      |       |      |
|                                                                                        | V <sub>O</sub> = 0 to -8 V,      R <sub>L</sub> = 600 Ω          | 25°C                                                          | 3                           | 25                                 |      |       |      |
|                                                                                        |                                                                  | Full range                                                    | 1                           |                                    |      |       |      |
| r <sub>i</sub> Input resistance                                                        |                                                                  | 25°C                                                          | 10 <sup>12</sup>            |                                    | Ω    |       |      |
| c <sub>i</sub> Input capacitance                                                       |                                                                  | 25°C                                                          | 4                           |                                    | pF   |       |      |
| z <sub>O</sub> Open-loop output impedance                                              | I <sub>O</sub> = 0                                               | 25°C                                                          | 560                         |                                    | Ω    |       |      |
| CMRR      Common-mode rejection ratio                                                  | V <sub>IC</sub> = V <sub>ICRmin</sub> ,    R <sub>S</sub> = 50 Ω | 25°C                                                          | 72                          | 90                                 | dB   |       |      |
|                                                                                        |                                                                  | Full range                                                    | 65                          |                                    |      |       |      |
| k <sub>SVR</sub> Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ± 5 V to ± 15 V,<br>R <sub>S</sub> = 50 Ω     | 25°C                                                          | 75                          | 93                                 | dB   |       |      |
|                                                                                        |                                                                  | Full range                                                    | 65                          |                                    |      |       |      |

$^\dagger$  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**  
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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     | $T_A^\dagger$ | TLE2062I<br>TLE2062AI<br>TLE2062BI |     |     | UNIT |
|------------------------------------------------------------------------|---------------------|---------------|------------------------------------|-----|-----|------|
|                                                                        |                     |               | MIN                                | TYP | MAX |      |
| $I_{CC}$ Supply current                                                | $V_O = 0$ , No load | 25°C          |                                    | 625 | 690 | μA   |
|                                                                        |                     | Full range    |                                    |     | 720 |      |
| $\Delta I_{CC}$ Supply-current change over operating temperature range |                     | Full range    |                                    | 74  |     | μA   |

$^\dagger$  Full range is –40°C to 85°C.

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

| PARAMETER                                               | TEST CONDITIONS                                               | $T_A^\dagger$ | TLE2062I<br>TLE2062AI<br>TLE2062BI |        |     | 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                                     | 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    |     | 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°    |     |        |

$^\dagger$  Full range is –40°C to 85°C.

**TLE206x, TLE206xA, TLE206xB**  
**EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE**  
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**TLE2062M electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5\text{ V}$**

| PARAMETER                                                            |                       | TEST CONDITIONS                                                 | T <sub>A</sub> <sup>†</sup>                                     | TLE2062M<br>TLE2062AM<br>TLE2062BM |               |       | UNIT |
|----------------------------------------------------------------------|-----------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|------------------------------------|---------------|-------|------|
|                                                                      |                       |                                                                 |                                                                 | MIN                                | TYP           | MAX   |      |
| V <sub>IO</sub> Input offset voltage                                 | TLE2062M              | V <sub>IC</sub> = 0,                      R <sub>S</sub> = 50 Ω | 25°C                                                            | 1                                  | 5             | mV    |      |
|                                                                      |                       |                                                                 | Full range                                                      |                                    | 7             |       |      |
|                                                                      | TLE2062AM             |                                                                 | 25°C                                                            | 0.9                                | 4             |       |      |
|                                                                      |                       |                                                                 | Full range                                                      |                                    | 6             |       |      |
|                                                                      | TLE2062BM             |                                                                 | 25°C                                                            | 0.7                                | 3             |       |      |
|                                                                      |                       |                                                                 | Full range                                                      |                                    | 5             |       |      |
| α <sub>VIO</sub> Temperature coefficient of input offset voltage     |                       |                                                                 | Full range                                                      | 6                                  |               | μV/°C |      |
| Input offset voltage long-term drift (see Note 4)                    |                       |                                                                 | 25°C                                                            | 0.04                               |               | μV/mo |      |
| I <sub>IO</sub> Input offset current                                 |                       |                                                                 | 25°C                                                            | 1                                  |               | pA    |      |
|                                                                      |                       |                                                                 | Full range                                                      |                                    | 15            | nA    |      |
| I <sub>IB</sub> Input bias current                                   |                       |                                                                 | 25°C                                                            | 3                                  |               | pA    |      |
|                                                                      |                       |                                                                 | Full range                                                      |                                    | 30            | nA    |      |
| V <sub>ICR</sub> Common-mode input voltage range                     |                       |                                                                 | 25°C                                                            | −1.6<br>to<br>4                    | −2<br>to<br>6 | V     |      |
|                                                                      |                       |                                                                 | Full range                                                      | −1.6<br>to<br>4                    |               | V     |      |
| V <sub>OM</sub> +      Maximum positive peak output<br>voltage swing |                       | R <sub>L</sub> = 10 kΩ                                          | 25°C                                                            | 3.5                                | 3.7           | V     |      |
|                                                                      |                       |                                                                 | Full range                                                      | 3                                  |               |       |      |
|                                                                      | FK and JG<br>packages | R <sub>L</sub> = 600 Ω                                          | 25°C                                                            | 2.5                                | 3.6           |       |      |
|                                                                      |                       |                                                                 | Full range                                                      | 2                                  |               |       |      |
|                                                                      | D and P<br>packages   | R <sub>L</sub> = 100 Ω                                          | 25°C                                                            | 2.5                                | 3.1           |       |      |
|                                                                      |                       |                                                                 | Full range                                                      | 2                                  |               |       |      |
| V <sub>OM</sub> −      Maximum negative peak output<br>voltage swing |                       | R <sub>L</sub> = 10 kΩ                                          | 25°C                                                            | −3.5                               | −3.9          | V     |      |
|                                                                      |                       |                                                                 | Full range                                                      | −3                                 |               |       |      |
|                                                                      | FK and JG<br>packages | R <sub>L</sub> = 600 Ω                                          | 25°C                                                            | −2.5                               | −3.5          |       |      |
|                                                                      |                       |                                                                 | Full range                                                      | −2                                 |               |       |      |
|                                                                      | D and P<br>packages   | R <sub>L</sub> = 100 Ω                                          | 25°C                                                            | −2.5                               | −2.7          |       |      |
|                                                                      |                       |                                                                 | Full range                                                      | −2                                 |               |       |      |
| A <sub>VD</sub> Large-signal differential voltage<br>amplification   |                       | V <sub>O</sub> = ±2.8 V,              R <sub>L</sub> = 10 kΩ    | 25°C                                                            | 15                                 | 80            | V/mV  |      |
|                                                                      |                       |                                                                 | Full range                                                      | 2                                  |               |       |      |
|                                                                      | FK and JG<br>packages | V <sub>O</sub> = 0 to 2.5 V,      R <sub>L</sub> = 600 Ω        | 25°C                                                            | 1                                  | 65            |       |      |
|                                                                      |                       |                                                                 | Full range                                                      | 0.5                                |               |       |      |
|                                                                      |                       | V <sub>O</sub> = 0 to −2.5 V,      R <sub>L</sub> = 600 Ω       | 25°C                                                            | 1                                  | 16            |       |      |
|                                                                      |                       |                                                                 | Full range                                                      | 0.5                                |               |       |      |
|                                                                      | D and P<br>packages   | V <sub>O</sub> = 0 to 2 V,              R <sub>L</sub> = 100 Ω  | 25°C                                                            | 0.75                               | 45            |       |      |
|                                                                      |                       |                                                                 | Full range                                                      | 0.5                                |               |       |      |
|                                                                      |                       |                                                                 | V <sub>O</sub> = 0 to −2 V,              R <sub>L</sub> = 100 Ω | 25°C                               | 0.5           |       | 3    |
|                                                                      |                       |                                                                 |                                                                 | Full range                         | 0.25          |       |      |

$^\dagger$  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

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

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

| PARAMETER       |                                                                         | TEST CONDITIONS                                           | $T_A^\dagger$ | TLE2062M<br>TLE2062AM<br>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                                             | $V_{IC} = V_{ICRmin}$<br>$R_S = 50 \Omega$                | 25°C          | 65                                 | 82               |     | dB   |
|                 |                                                                         |                                                           | Full range    | 60                                 |                  |     |      |
| $k_{SVR}$       | Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ )     | $V_{CC\pm} = \pm 5$ V to $\pm 15$ V,<br>$R_S = 50 \Omega$ | 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   |

<sup>†</sup> Full range is –55°C to 125°C.

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

| PARAMETER   |                                               | TEST CONDITIONS                                                                                 | TLE2062M<br>TLE2062AM<br>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/ $\sqrt{\text{Hz}}$ |
|             |                                               | $f = 1 \text{ kHz}$ , $R_S = 20 \Omega$                                                         |                                    | 43     |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage   | $f = 0.1 \text{ Hz to } 10 \text{ Hz}$                                                          |                                    | 1.1    |     | μV                     |
| $I_n$       | Equivalent input noise current                | $f = 1 \text{ kHz}$                                                                             |                                    | 1      |     | fA/ $\sqrt{\text{Hz}}$ |
| THD         | Total harmonic distortion                     | $V_{O(PP)} = 2 \text{ V}$ , $R_L = 10 \text{ k}\Omega$ ,<br>$A_{VD} = 2$ , $f = 10 \text{ kHz}$ |                                    | 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°    |     |                        |

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

| PARAMETER                                                                              |           | TEST CONDITIONS                                                    | T <sub>A</sub> <sup>†</sup> | TLE2062M<br>TLE2062AM<br>TLE2062BM |                 |       | UNIT |
|----------------------------------------------------------------------------------------|-----------|--------------------------------------------------------------------|-----------------------------|------------------------------------|-----------------|-------|------|
|                                                                                        |           |                                                                    |                             | MIN                                | TYP             | MAX   |      |
| V <sub>IO</sub> Input offset voltage                                                   | TLE2062M  | V <sub>IC</sub> = 0,                      R <sub>S</sub> = 50 Ω    | 25°C                        | 0.9                                |                 | 4     | mV   |
|                                                                                        |           |                                                                    | Full range                  | 6                                  |                 |       |      |
|                                                                                        | TLE2062AM |                                                                    | 25°C                        | 0.8                                |                 | 2     |      |
|                                                                                        |           |                                                                    | Full range                  | 4                                  |                 |       |      |
|                                                                                        | TLE2062BM |                                                                    | 25°C                        | 0.5                                |                 | 1     |      |
|                                                                                        |           |                                                                    | Full range                  | 3                                  |                 |       |      |
| α <sub>VIO</sub> Temperature coefficient of input offset voltage                       |           |                                                                    | Full range                  | 6                                  |                 | μV/°C |      |
| Input offset voltage long-term drift (see Note 4)                                      |           |                                                                    | 25°C                        | 0.04                               |                 | μV/mo |      |
| I <sub>IO</sub> Input offset current                                                   |           |                                                                    | 25°C                        | 2                                  |                 | pA    |      |
|                                                                                        |           |                                                                    | Full range                  | 20                                 |                 | nA    |      |
| I <sub>IB</sub> Input bias current                                                     |           |                                                                    | 25°C                        | 4                                  |                 | pA    |      |
|                                                                                        |           |                                                                    | Full range                  | 40                                 |                 | nA    |      |
| V <sub>ICR</sub> Common-mode input voltage range                                       |           |                                                                    | 25°C                        | −11<br>to<br>13                    | −12<br>to<br>16 | V     |      |
|                                                                                        |           |                                                                    | Full range                  | −11<br>to<br>13                    |                 | V     |      |
| V <sub>OM+</sub> Maximum positive peak output voltage swing                            |           | R <sub>L</sub> = 10 kΩ                                             | 25°C                        | 13                                 | 13.7            | V     |      |
|                                                                                        |           |                                                                    | Full range                  | 12.5                               |                 |       |      |
|                                                                                        |           | R <sub>L</sub> = 600 Ω                                             | 25°C                        | 12.5                               | 13.2            |       |      |
|                                                                                        |           |                                                                    | Full range                  | 11                                 |                 |       |      |
| V <sub>OM−</sub> Maximum negative peak output voltage swing                            |           | R <sub>L</sub> = 10 kΩ                                             | 25°C                        | −13                                | −13.7           | V     |      |
|                                                                                        |           |                                                                    | Full range                  | −12.5                              |                 |       |      |
|                                                                                        |           | R <sub>L</sub> = 600 Ω                                             | 25°C                        | −12.5                              | −13             |       |      |
|                                                                                        |           |                                                                    | Full range                  | −11                                |                 |       |      |
| A <sub>VD</sub> Large-signal differential voltage amplification                        |           | V <sub>O</sub> = ± 10 V,      R <sub>L</sub> = 10 kΩ               | 25°C                        | 30                                 | 230             | V/mV  |      |
|                                                                                        |           |                                                                    | Full range                  | 20                                 |                 |       |      |
|                                                                                        |           | V <sub>O</sub> = 0 to 8 V,      R <sub>L</sub> = 600 Ω             | 25°C                        | 25                                 | 100             |       |      |
|                                                                                        |           |                                                                    | Full range                  | 7                                  |                 |       |      |
|                                                                                        |           | V <sub>O</sub> = 0 to −8 V,      R <sub>L</sub> = 600 Ω            | 25°C                        | 3                                  | 25              |       |      |
|                                                                                        |           |                                                                    | Full range                  | 1                                  |                 |       |      |
| r <sub>i</sub> Input resistance                                                        |           | 25°C                                                               | 10 <sup>12</sup>            |                                    |                 | Ω     |      |
| c <sub>i</sub> Input capacitance                                                       |           | 25°C                                                               | 4                           |                                    |                 | pF    |      |
| z <sub>0</sub> Open-loop output impedance                                              |           | I <sub>O</sub> = 0                                                 | 25°C                        | 560                                |                 |       | Ω    |
| CMRR      Common-mode rejection ratio                                                  |           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,      R <sub>S</sub> = 50 Ω | 25°C                        | 72                                 | 90              | dB    |      |
|                                                                                        |           |                                                                    | Full range                  | 65                                 |                 |       |      |
| k <sub>SVR</sub> Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) |           | V <sub>CC±</sub> = ± 5 V to ± 15 V,<br>R <sub>S</sub> = 50 Ω       | 25°C                        | 75                                 | 93              | dB    |      |
|                                                                                        |           |                                                                    | Full range                  | 65                                 |                 |       |      |

$^\dagger$  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

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

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

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

$^\dagger$  Full range is  $-55^\circ C$  to  $125^\circ C$ .

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

| PARAMETER                                               | TEST CONDITIONS                                                                              | $T_A^\dagger$ | TLE2062M<br>TLE2062AM<br>TLE2062BM |        |     | UNIT           |
|---------------------------------------------------------|----------------------------------------------------------------------------------------------|---------------|------------------------------------|--------|-----|----------------|
|                                                         |                                                                                              |               | MIN                                | TYP    | MAX |                |
| SR Slew rate at unity gain (see Figure 1)               | $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$                                            | 25°C          | 2                                  | 3.4    |     | $V/\mu s$      |
|                                                         |                                                                                              | Full range    | 1.8                                |        |     |                |
| $V_n$ Equivalent input noise voltage (see Figure 2)     | $f = 10\text{ Hz}$ , $R_S = 20\text{ }\Omega$                                                | 25°C          |                                    | 70     |     | $nV/\sqrt{Hz}$ |
|                                                         | $f = 1\text{ kHz}$ , $R_S = 20\text{ }\Omega$                                                | 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    |     | $\mu V$        |
| $I_n$ Equivalent input noise current                    | $f = 1\text{ kHz}$                                                                           | 25°C          |                                    | 1.1    |     | $fA/\sqrt{Hz}$ |
| THD Total harmonic distortion                           | $V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$ ,<br>$A_{VD} = 2$ , $f = 10\text{ kHz}$ | 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          |                                    | 2      |     | MHz            |
|                                                         | $R_L = 600\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            | 25°C          |                                    | 1.5    |     |                |
| Settling time                                           | 0.1%                                                                                         | 25°C          |                                    | 5      |     | $\mu s$        |
|                                                         | 0.01%                                                                                        | 25°C          |                                    | 10     |     |                |
| $B_{OM}$ Maximum output-swing bandwidth                 | $A_{VD} = 1$ , $R_L = 10\text{ k}\Omega$                                                     | 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°    |     |                |
|                                                         | $R_L = 600\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            | 25°C          |                                    | 70°    |     |                |

$^\dagger$  Full range is  $-55^\circ C$  to  $125^\circ C$ .



**TLE2062Y electrical characteristics at  $V_{CC\pm} = \pm 15$  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                      |
| $\alpha_{VIO}$ 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<br>to<br>13 | -12<br>to<br>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                   | $V_O = \pm 10$ V, $R_L = 10\ \text{k}\Omega$               | 30              | 230             |     | V/mV                    |
|                                                                            | $V_O = 0$ to 8 V, $R_L = 600\ \Omega$                      | 25              | 100             |     |                         |
|                                                                            | $V_O = 0$ to -8 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 ( $\Delta V_{CC}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5$ V to $\pm 15$ V,<br>$R_S = 50\ \Omega$ | 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  $V_{CC\pm} = \pm 15$  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   | 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 | $f = 0.1\ \text{Hz}$ 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                           | $V_{O(PP)} = 2$ V, $R_L = 10\ \text{k}\Omega$ ,<br>$A_{VD} = 2$ , $f = 10\ \text{kHz}$ |          | 0.025% |     |                              |
| $B_1$ Unity-gain bandwidth (see Figure 3)               | $R_L = 10\ \text{k}\Omega$ , $C_L = 100\ \text{pF}$                                    |          | 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

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

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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 <sub>A</sub> <sup>†</sup> | TLE2064C<br>TLE2064AC<br>TLE2064BC |      |      | UNIT  |
|---------------------------------------------------|-----------------------------------------------------------------------|--------------------------------------------------------------------|-----------------------------|------------------------------------|------|------|-------|
|                                                   |                                                                       |                                                                    |                             | MIN                                | TYP  | MAX  |       |
| V <sub>IO</sub>                                   | Input offset voltage                                                  | V <sub>IC</sub> = 0,      R <sub>S</sub> = 50 Ω                    | 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                                |      |      |       |
| α <sub>VIO</sub>                                  | Temperature coefficient of input offset voltage                       |                                                                    | 25°C                        | 6                                  |      |      | μV/°C |
| Input offset voltage long-term drift (see Note 4) |                                                                       |                                                                    | Full range                  | 0.04                               |      |      | μV/mo |
| I <sub>IO</sub>                                   | Input offset current                                                  |                                                                    | 25°C                        | 1                                  |      |      | pA    |
|                                                   |                                                                       |                                                                    | Full range                  | 0.8                                |      |      | nA    |
| I <sub>IB</sub>                                   | Input bias current                                                    |                                                                    | 25°C                        | 3                                  |      |      | pA    |
|                                                   |                                                                       |                                                                    | Full range                  | 2                                  |      |      | nA    |
| V <sub>ICR</sub>                                  | Common-mode input voltage range                                       | 25°C                                                               | -1.6<br>to<br>4             | -2<br>to<br>6                      |      | V    |       |
|                                                   |                                                                       | Full range                                                         | -1.6<br>to<br>4             |                                    |      | V    |       |
| V <sub>OM+</sub>                                  | Maximum positive peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                             | 25°C                        | 3.5                                | 3.7  | V    |       |
|                                                   |                                                                       |                                                                    | Full range                  | 3.3                                |      |      |       |
|                                                   |                                                                       | R <sub>L</sub> = 100 Ω                                             | 25°C                        | 2.5                                | 3.1  |      |       |
|                                                   |                                                                       |                                                                    | Full range                  | 2                                  |      |      |       |
| V <sub>OM-</sub>                                  | Maximum negative peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                             | 25°C                        | -3.7                               | -3.9 | V    |       |
|                                                   |                                                                       |                                                                    | Full range                  | -3.3                               |      |      |       |
|                                                   |                                                                       | R <sub>L</sub> = 100 Ω                                             | 25°C                        | -2.5                               | -2.7 |      |       |
|                                                   |                                                                       |                                                                    | Full range                  | -2                                 |      |      |       |
| A <sub>VD</sub>                                   | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±2.8 V,      R <sub>L</sub> = 10 kΩ               | 25°C                        | 15                                 | 80   | V/mV |       |
|                                                   |                                                                       |                                                                    | Full range                  | 2                                  |      |      |       |
|                                                   |                                                                       | V <sub>O</sub> = 0 to 2 V,      R <sub>L</sub> = 100 Ω             | 25°C                        | 0.75                               | 45   |      |       |
|                                                   |                                                                       |                                                                    | Full range                  | 0.5                                |      |      |       |
|                                                   |                                                                       | V <sub>O</sub> = 0 to -2 V,      R <sub>L</sub> = 100 Ω            | 25°C                        | 0.5                                | 3    |      |       |
|                                                   |                                                                       |                                                                    | Full range                  | 0.15                               |      |      |       |
| r <sub>i</sub>                                    | Input resistance                                                      |                                                                    | 25°C                        | 10 <sup>12</sup>                   |      | Ω    |       |
| c <sub>i</sub>                                    | Input capacitance                                                     |                                                                    | 25°C                        | 4                                  |      | pF   |       |
| z <sub>o</sub>                                    | Open-loop output impedance                                            | I <sub>O</sub> = 0                                                 | 25°C                        | 560                                |      | Ω    |       |
| CMRR                                              | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,      R <sub>S</sub> = 50 Ω | 25°C                        | 65                                 | 82   | dB   |       |
|                                                   |                                                                       |                                                                    | Full range                  | 65                                 |      |      |       |
| k <sub>SVR</sub>                                  | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±5 V to ±15 V,<br>R <sub>S</sub> = 50 Ω         | 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.

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

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

| PARAMETER                                                                                | TEST CONDITIONS               | $T_A^\dagger$ | TLE2064C<br>TLE2064AC<br>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                                                    | $A_{VD} = 1000$ , $f = 1$ kHz | 25°C          |                                    | 120  |     | dB   |

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

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

| PARAMETER                                               | TEST CONDITIONS                                               | $T_A^\dagger$ | TLE2064C<br>TLE2064AC<br>TLE2064BC |        |     | UNIT   |
|---------------------------------------------------------|---------------------------------------------------------------|---------------|------------------------------------|--------|-----|--------|
|                                                         |                                                               |               | MIN                                | TYP    | MAX |        |
| SR Slew rate at unity gain (see Figure 1)               | $R_L = 10$ kΩ, $C_L = 100$ pF                                 | 25°C          | 2.2                                | 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          |                                    | 59     | 100 | nV/√Hz |
|                                                         | $f = 1$ kHz, $R_S = 20$ Ω                                     |               |                                    | 43     | 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      |     | fA/√Hz |
| THD Total harmonic distortion                           | $A_{VD} = 2$ , $f = 10$ kHz, $V_{O(PP)} = 2$ V, $R_L = 10$ kΩ | 25°C          |                                    | 0.025% |     |        |
| $B_1$ Unity-gain bandwidth (see Figure 3)               | $R_L = 10$ kΩ, $C_L = 100$ pF                                 | 25°C          |                                    | 1.8    |     | MHz    |
|                                                         | $R_L = 100$ Ω, $C_L = 100$ pF                                 |               |                                    | 1.3    |     |        |
| $t_s$ Settling time                                     | $\epsilon = 0.1\%$                                            | 25°C          |                                    | 5      |     | μs     |
|                                                         | $\epsilon = 0.01\%$                                           |               |                                    | 10     |     |        |
| $B_{OM}$ Maximum output-swing bandwidth                 | $A_{VD} = 1$ , $R_L = 10$ kΩ                                  | 25°C          |                                    | 140    |     | kHz    |
| $\phi_m$ Phase margin at unity gain (see Figure 3)      | $R_L = 10$ kΩ, $C_L = 100$ pF                                 | 25°C          |                                    | 58°    |     |        |
|                                                         | $R_L = 100$ Ω, $C_L = 100$ pF                                 |               |                                    | 75°    |     |        |

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

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

SLOS193B – FEBRUARY 1997 – REVISED MAY 2004

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

| PARAMETER                                                        |                                                                        | TEST CONDITIONS                                                         | T <sub>A</sub> <sup>†</sup> | TLE2064C<br>TLE2064AC<br>TLE2064BC |       |       | UNIT |
|------------------------------------------------------------------|------------------------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------|------------------------------------|-------|-------|------|
|                                                                  |                                                                        |                                                                         |                             | MIN                                | TYP   | MAX   |      |
| V <sub>IO</sub>                                                  | Input offset voltage                                                   | V <sub>IC</sub> = 0,                      R <sub>S</sub> = 50 Ω         | 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                                  |       |       |      |
| α <sub>VIO</sub> Temperature coefficient of input offset voltage |                                                                        |                                                                         | 25°C                        | 6                                  |       | μV/°C |      |
| Input offset voltage long-term drift (see Note 4)                |                                                                        |                                                                         | Full range                  | 0.04                               |       | μV/mo |      |
| I <sub>IO</sub> Input offset current                             |                                                                        |                                                                         | 25°C                        | 2                                  |       | pA    |      |
|                                                                  |                                                                        |                                                                         | Full range                  | 1                                  |       | nA    |      |
| I <sub>IB</sub> Input bias current                               |                                                                        |                                                                         | 25°C                        | 4                                  |       | pA    |      |
|                                                                  |                                                                        |                                                                         | Full range                  | 3                                  |       | nA    |      |
| V <sub>ICR</sub>                                                 | Common-mode input voltage range                                        | 25°C                                                                    | -11<br>to<br>13             | -12<br>to<br>16                    |       | V     |      |
|                                                                  |                                                                        | Full range                                                              | -11<br>to<br>13             |                                    |       | V     |      |
| V <sub>OM+</sub>                                                 | Maximum positive peak output voltage swing                             | R <sub>L</sub> = 10 kΩ                                                  | 25°C                        | 13.2                               | 13.7  | V     |      |
|                                                                  |                                                                        |                                                                         | Full range                  | 13                                 |       |       |      |
|                                                                  |                                                                        | R <sub>L</sub> = 600 Ω                                                  | 25°C                        | 12.5                               | 13.2  |       |      |
|                                                                  |                                                                        |                                                                         | Full range                  | 12                                 |       |       |      |
| V <sub>OM-</sub>                                                 | Maximum negative peak output voltage swing                             | R <sub>L</sub> = 10 kΩ                                                  | 25°C                        | -13.2                              | -13.7 | V     |      |
|                                                                  |                                                                        |                                                                         | Full range                  | -13                                |       |       |      |
|                                                                  |                                                                        | R <sub>L</sub> = 600 Ω                                                  | 25°C                        | -12.5                              | -13   |       |      |
|                                                                  |                                                                        |                                                                         | Full range                  | -12                                |       |       |      |
| A <sub>VD</sub>                                                  | Large-signal differential voltage amplification                        | V <sub>O</sub> = ±10 V,                      R <sub>L</sub> = 10 kΩ     | 25°C                        | 30                                 | 230   | V/mV  |      |
|                                                                  |                                                                        |                                                                         | Full range                  | 20                                 |       |       |      |
|                                                                  |                                                                        | V <sub>O</sub> = 0 to 8 V,                      R <sub>L</sub> = 600 Ω  | 25°C                        | 25                                 | 100   |       |      |
|                                                                  |                                                                        |                                                                         | Full range                  | 10                                 |       |       |      |
|                                                                  |                                                                        | V <sub>O</sub> = 0 to -8 V,                      R <sub>L</sub> = 600 Ω | 25°C                        | 3                                  | 25    |       |      |
|                                                                  |                                                                        |                                                                         | Full range                  | 1                                  |       |       |      |
| r <sub>i</sub>                                                   | Input resistance                                                       |                                                                         | 25°C                        | 10 <sup>12</sup>                   |       | Ω     |      |
| c <sub>i</sub>                                                   | Input capacitance                                                      |                                                                         | 25°C                        | 4                                  |       | pF    |      |
| z <sub>o</sub>                                                   | Open-loop output impedance                                             | I <sub>O</sub> = 0                                                      | 25°C                        | 560                                |       | Ω     |      |
| CMRR                                                             | Common-mode rejection ratio                                            | V <sub>IC</sub> = V <sub>ICRmin</sub> ,    R <sub>S</sub> = 50 Ω        | 25°C                        | 72                                 | 90    | dB    |      |
|                                                                  |                                                                        |                                                                         | Full range                  | 70                                 |       |       |      |
| k <sub>SVR</sub>                                                 | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> / ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±5 V to ±15 V,<br>R <sub>S</sub> = 50 Ω              | 25°C                        | 75                                 | 93    | dB    |      |
|                                                                  |                                                                        |                                                                         | Full range                  | 75                                 |       |       |      |

<sup>†</sup> 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.

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

| PARAMETER                                                                                | TEST CONDITIONS   |             | $T_A^\dagger$ | TLE2064C<br>TLE2064AC<br>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                                                    | $A_{VD} = 1000$ , | $f = 1$ kHz | 25°C          |                                    | 120 |     | dB   |

<sup>†</sup> Full range is 0°C to 70°C.

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

| PARAMETER          |                                               | TEST CONDITIONS                                   |                                       | T <sub>A</sub> <sup>†</sup> | TLE2064C<br>TLE2064AC<br>TLE2064BC |     |     | UNIT   |
|--------------------|-----------------------------------------------|---------------------------------------------------|---------------------------------------|-----------------------------|------------------------------------|-----|-----|--------|
|                    |                                               |                                                   |                                       |                             | MIN                                | TYP | MAX |        |
| SR                 | Slew rate at unity gain (see Figure 1)        | R <sub>L</sub> = 10 kΩ,                           | C <sub>L</sub> = 100 pF               | 25°C                        | 2.6                                | 3.4 |     | V/μs   |
|                    |                                               |                                                   |                                       | Full range                  | 2.5                                |     |     |        |
| V <sub>n</sub>     | Equivalent input noise voltage (see Figure 2) | f = 10 Hz,                                        | R <sub>S</sub> = 20 Ω                 | 25°C                        | 70                                 |     | 100 | nV/√Hz |
|                    |                                               | f = 1 kHz,                                        | R <sub>S</sub> = 20 Ω                 |                             | 40                                 |     | 60  |        |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage   | f = 0.1 Hz to 10 Hz                               |                                       | 25°C                        | 1.1                                |     |     | μV     |
| I <sub>n</sub>     | Equivalent input noise current                | f = 1 kHz                                         |                                       | 25°C                        | 1                                  |     |     | fA/√Hz |
| THD                | Total harmonic distortion                     | A <sub>VD</sub> = 2,<br>V <sub>O(PP)</sub> = 2 V, | f = 10 kHz,<br>R <sub>L</sub> = 10 kΩ | 25°C                        | 0.025%                             |     |     |        |
| B <sub>1</sub>     | Unity-gain bandwidth (see Figure 3)           | R <sub>L</sub> = 10 kΩ,                           | C <sub>L</sub> = 100 pF               | 25°C                        | 2                                  |     |     | MHz    |
|                    |                                               | R <sub>L</sub> = 600 Ω,                           | C <sub>L</sub> = 100 pF               |                             | 1.5                                |     |     |        |
| t <sub>s</sub>     | Settling time                                 | ε = 0.1%                                          |                                       | 25°C                        | 5                                  |     |     | μs     |
|                    |                                               | ε = 0.01%                                         |                                       |                             | 10                                 |     |     |        |
| B <sub>OM</sub>    | Maximum output-swing bandwidth                | A <sub>VD</sub> = 1,                              | R <sub>L</sub> = 10 kΩ                | 25°C                        | 40                                 |     |     | kHz    |
| φ <sub>m</sub>     | Phase margin at unity gain (see Figure 3)     | R <sub>L</sub> = 10 kΩ,                           | C <sub>L</sub> = 100 pF               | 25°C                        | 50°                                |     |     |        |
|                    |                                               | R <sub>L</sub> = 600 Ω,                           | C <sub>L</sub> = 100 pF               |                             | 70°                                |     |     |        |

<sup>†</sup> Full range is 0°C to 70°C.

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

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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 <sub>A</sub> <sup>†</sup> | TLE2064I<br>TLE2064AI<br>TLE2064BI |                 | UNIT          |     |
|---------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------|------------------------------------|-----------------|---------------|-----|
|                                                   |                                                                       |                                                                 |                             | MIN                                | TYP             |               | MAX |
| V <sub>IO</sub>                                   | Input offset voltage                                                  | TLE2064I                                                        | 25°C                        | 1.2                                | 7               | mV            |     |
|                                                   |                                                                       |                                                                 | Full range                  | 8.3                                |                 |               |     |
|                                                   |                                                                       |                                                                 | TLE2064AI                   | 25°C                               | 1.2             |               | 6   |
|                                                   |                                                                       |                                                                 |                             | Full range                         | 7.3             |               |     |
|                                                   |                                                                       |                                                                 | TLE2064BI                   | 25°C                               | 0.8             |               | 3.5 |
|                                                   |                                                                       |                                                                 |                             | Full range                         | 4.8             |               |     |
| α <sub>VIO</sub>                                  | Temperature coefficient of input offset voltage                       | V <sub>IC</sub> = 0,      R <sub>S</sub> = 50 Ω                 | 25°C                        | 6                                  |                 | μV/°C         |     |
| Input offset voltage long-term drift (see Note 4) |                                                                       |                                                                 | Full range                  | 0.04                               |                 | μV/mo         |     |
| I <sub>IO</sub>                                   | Input offset current                                                  |                                                                 | 25°C                        | 1                                  |                 | pA            |     |
|                                                   |                                                                       |                                                                 | Full range                  | 2                                  |                 | nA            |     |
| I <sub>IB</sub>                                   | Input bias current                                                    |                                                                 | 25°C                        | 3                                  |                 | pA            |     |
|                                                   |                                                                       |                                                                 | Full range                  | 4                                  |                 | nA            |     |
| V <sub>ICR</sub>                                  | Common-mode input voltage range                                       |                                                                 |                             | 25°C                               | −1.6<br>to<br>4 | −2<br>to<br>6 | V   |
|                                                   |                                                                       |                                                                 |                             | Full range                         | −1.6<br>to<br>4 |               | V   |
| V <sub>OM+</sub>                                  | Maximum positive peak output voltage swing                            |                                                                 | R <sub>L</sub> = 10 kΩ      | 25°C                               | 3.5             | 3.7           | V   |
|                                                   |                                                                       |                                                                 |                             | Full range                         | 3.1             |               |     |
|                                                   |                                                                       | R <sub>L</sub> = 100 Ω                                          | 25°C                        | 2.5                                | 3.1             |               |     |
|                                                   |                                                                       |                                                                 | Full range                  | 2                                  |                 |               |     |
| V <sub>OM−</sub>                                  | Maximum negative peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                          | 25°C                        | −3.7                               | −3.9            | V             |     |
|                                                   |                                                                       |                                                                 | Full range                  | −3.1                               |                 |               |     |
|                                                   |                                                                       | R <sub>L</sub> = 100 Ω                                          | 25°C                        | −2.5                               | −2.7            |               |     |
|                                                   |                                                                       |                                                                 | Full range                  | −2                                 |                 |               |     |
| A <sub>VD</sub>                                   | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±2.8 V,    R <sub>L</sub> = 10 kΩ              | 25°C                        | 15                                 | 80              | V/mV          |     |
|                                                   |                                                                       |                                                                 | Full range                  | 2                                  |                 |               |     |
|                                                   |                                                                       | V <sub>O</sub> = 0 to 2 V,    R <sub>L</sub> = 100 Ω            | 25°C                        | 0.75                               | 45              |               |     |
|                                                   |                                                                       |                                                                 | Full range                  | 0.5                                |                 |               |     |
|                                                   |                                                                       | V <sub>O</sub> = 0 to −2 V,   R <sub>L</sub> = 100 Ω            | 25°C                        | 0.5                                | 3               |               |     |
|                                                   |                                                                       |                                                                 | Full range                  | 0.15                               |                 |               |     |
| r <sub>i</sub>                                    | Input resistance                                                      |                                                                 | 25°C                        | 10 <sup>12</sup>                   |                 | Ω             |     |
| c <sub>i</sub>                                    | Input capacitance                                                     |                                                                 | 25°C                        | 4                                  |                 | pF            |     |
| z <sub>o</sub>                                    | Open-loop output impedance                                            | I <sub>O</sub> = 0                                              | 25°C                        | 560                                |                 | Ω             |     |
| CMRR                                              | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,   R <sub>S</sub> = 50 Ω | 25°C                        | 65                                 | 82              | dB            |     |
|                                                   |                                                                       |                                                                 | Full range                  | 65                                 |                 |               |     |
| k <sub>SVR</sub>                                  | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±5 V to ±15 V,<br>R <sub>S</sub> = 50 Ω      | 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.

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

| PARAMETER                                                                                | TEST CONDITIONS               | $T_A^\dagger$ | TLE2064I<br>TLE2064AI<br>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                                                    | $A_{VD} = 1000$ , $f = 1$ kHz | 25°C          |                                    | 120  |     | dB   |

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

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

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

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

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

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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 <sub>A</sub> <sup>†</sup> | TLE2064I<br>TLE2064AI<br>TLE2064BI |                 |       | UNIT  |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------|------------------------------------|-----------------|-------|-------|
|                                                                                        |                                                                  |                                                                 |                             | MIN                                | TYP             | MAX   |       |
| V <sub>IO</sub> Input offset voltage                                                   | TLE2064I                                                         | V <sub>IC</sub> = 0,                      R <sub>S</sub> = 50 Ω | 25°C                        | 0.9                                | 6               | mV    |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | 7.3                                |                 |       |       |
|                                                                                        | TLE2064AI                                                        |                                                                 | 25°C                        | 0.9                                | 4               |       |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | 5.3                                |                 |       |       |
|                                                                                        | TLE2064BI                                                        |                                                                 | 25°C                        | 0.7                                | 2               |       |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | 3.3                                |                 |       |       |
| α <sub>VIO</sub> Temperature coefficient of input offset voltage                       |                                                                  |                                                                 | 25°C                        | 6                                  |                 | μV/°C |       |
| Input offset voltage long-term drift (see Note 4)                                      |                                                                  |                                                                 |                             | Full range                         | 0.04            |       | μV/mo |
| I <sub>IO</sub> Input offset current                                                   |                                                                  |                                                                 |                             | 25°C                               | 2               |       | pA    |
|                                                                                        |                                                                  |                                                                 |                             | Full range                         | 3               |       | nA    |
| I <sub>IB</sub> Input bias current                                                     |                                                                  |                                                                 |                             | 25°C                               | 4               |       | pA    |
|                                                                                        |                                                                  |                                                                 |                             | Full range                         | 5               |       | nA    |
| V <sub>ICR</sub> Common-mode input voltage range                                       |                                                                  |                                                                 | 25°C                        | −11<br>to<br>13                    | −12<br>to<br>16 | V     |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | −11<br>to<br>13                    |                 | V     |       |
| V <sub>OM+</sub> Maximum positive peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           |                                                                 | 25°C                        | 13.2                               | 13.7            | V     |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | 13                                 |                 |       |       |
|                                                                                        | R <sub>L</sub> = 600 Ω                                           |                                                                 | 25°C                        | 12.5                               | 13.2            |       |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | 12                                 |                 |       |       |
| V <sub>OM−</sub> Maximum negative peak output voltage swing                            | R <sub>L</sub> = 10 kΩ                                           |                                                                 | 25°C                        | −13.2                              | −13.7           | V     |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | −13                                |                 |       |       |
|                                                                                        | R <sub>L</sub> = 600 Ω                                           |                                                                 | 25°C                        | −12.5                              | −13             |       |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | −12                                |                 |       |       |
| A <sub>VD</sub> Large-signal differential voltage amplification                        | V <sub>O</sub> = ±10 V,      R <sub>L</sub> = 10 kΩ              |                                                                 | 25°C                        | 30                                 | 230             | V/mV  |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | 20                                 |                 |       |       |
|                                                                                        | V <sub>O</sub> = 0 to 8 V,      R <sub>L</sub> = 600 Ω           |                                                                 | 25°C                        | 25                                 | 100             |       |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | 10                                 |                 |       |       |
|                                                                                        | V <sub>O</sub> = 0 to −8 V,      R <sub>L</sub> = 600 Ω          |                                                                 | 25°C                        | 3                                  | 25              |       |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | 1                                  |                 |       |       |
| r <sub>i</sub> Input resistance                                                        |                                                                  |                                                                 | 25°C                        | 10 <sup>12</sup>                   |                 | Ω     |       |
| c <sub>i</sub> Input capacitance                                                       |                                                                  |                                                                 | 25°C                        | 4                                  |                 | pF    |       |
| z <sub>o</sub> Open-loop output impedance                                              | I <sub>O</sub> = 0                                               |                                                                 | 25°C                        | 560                                |                 | Ω     |       |
| CMRR      Common-mode rejection ratio                                                  | V <sub>IC</sub> = V <sub>ICRmin</sub> ,    R <sub>S</sub> = 50 Ω |                                                                 | 25°C                        | 72                                 | 90              | dB    |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | 65                                 |                 |       |       |
| k <sub>SVR</sub> Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±5 V to ±15 V,<br>R <sub>S</sub> = 50 Ω       |                                                                 | 25°C                        | 75                                 | 93              | dB    |       |
|                                                                                        |                                                                  |                                                                 | Full range                  | 65                                 |                 |       |       |

$^\dagger$  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.

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

| PARAMETER                                                                                | TEST CONDITIONS               | $T_A^\dagger$ | TLE2064I<br>TLE2064AI<br>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   |

$^\dagger$  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                                                  | $T_A^\dagger$ | TLE2064I<br>TLE2064AI<br>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,<br>$R_L = 10$ 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°    |     |        |

$^\dagger$  Full range is – 40°C to 85°C.

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

SLOS193B – FEBRUARY 1997 – REVISED MAY 2004

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

| PARAMETER                                         |                                                 | TEST CONDITIONS                                                             | T <sub>A</sub> <sup>†</sup> | TLE2064M<br>TLE2064AM<br>TLE2064BM |         |      | UNIT |  |
|---------------------------------------------------|-------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------|------------------------------------|---------|------|------|--|
|                                                   |                                                 |                                                                             |                             | MIN                                | TYP     | MAX  |      |  |
| V <sub>IO</sub>                                   | Input offset voltage                            | V <sub>IC</sub> = 0,      R <sub>S</sub> = 50 Ω                             | 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                                |         |      |      |  |
| α <sub>VIO</sub>                                  | Temperature coefficient of input offset voltage |                                                                             | 25°C                        | 6                                  | μV/°C   |      |      |  |
| Input offset voltage long-term drift (see Note 4) |                                                 |                                                                             | Full range                  | 0.04                               | μV/mo   |      |      |  |
| I <sub>IO</sub>                                   | Input offset current                            |                                                                             | 25°C                        | 1                                  | pA      |      |      |  |
|                                                   |                                                 |                                                                             | Full range                  | 15                                 |         | nA   |      |  |
|                                                   |                                                 |                                                                             | 25°C                        | 3                                  | pA      |      |      |  |
| I <sub>IB</sub>                                   | Input bias current                              |                                                                             | Full range                  | 30                                 |         | nA   |      |  |
| V <sub>ICR</sub>                                  | Common-mode input voltage range                 |                                                                             | 25°C                        | −1.6 to 4                          | −2 to 6 | V    |      |  |
|                                                   |                                                 |                                                                             | Full range                  | −1.6 to 4                          |         | V    |      |  |
| V <sub>OM+</sub>                                  | Maximum positive peak output voltage swing      | R <sub>L</sub> = 10 kΩ                                                      | 25°C                        | 3.5                                | 3.7     | V    |      |  |
|                                                   |                                                 |                                                                             | Full range                  | 3                                  |         |      |      |  |
|                                                   |                                                 | FK and J packages<br>R <sub>L</sub> = 600 Ω                                 | 25°C                        | 2.5                                | 3.6     |      |      |  |
|                                                   |                                                 |                                                                             | Full range                  | 2                                  |         |      |      |  |
|                                                   |                                                 | D and N packages<br>R <sub>L</sub> = 100 Ω                                  | 25°C                        | 2.5                                | 3.1     |      |      |  |
|                                                   |                                                 |                                                                             | Full range                  | 2                                  |         |      |      |  |
| V <sub>OM−</sub>                                  | Maximum negative peak output voltage swing      | R <sub>L</sub> = 10 kΩ                                                      | 25°C                        | −3.5                               | −3.9    | V    |      |  |
|                                                   |                                                 |                                                                             | Full range                  | −3                                 |         |      |      |  |
|                                                   |                                                 | FK and J packages<br>R <sub>L</sub> = 600 Ω                                 | 25°C                        | −2.5                               | −3.5    |      |      |  |
|                                                   |                                                 |                                                                             | Full range                  | −2                                 |         |      |      |  |
|                                                   |                                                 | D and N packages<br>R <sub>L</sub> = 100 Ω                                  | 25°C                        | −2.5                               | −2.7    |      |      |  |
|                                                   |                                                 |                                                                             | Full range                  | −2                                 |         |      |      |  |
| A <sub>VD</sub>                                   | Large-signal differential voltage amplification | V <sub>O</sub> = ±2.8 V,      R <sub>L</sub> = 10 kΩ                        | 25°C                        | 15                                 | 80      | V/mV |      |  |
|                                                   |                                                 |                                                                             | Full range                  | 2                                  |         |      |      |  |
|                                                   |                                                 | FK and J packages<br>V <sub>O</sub> = 0 to 2.5 V,    R <sub>L</sub> = 600 Ω | 25°C                        | 1                                  | 65      |      |      |  |
|                                                   |                                                 |                                                                             | Full range                  | 0.5                                |         |      |      |  |
|                                                   |                                                 | V <sub>O</sub> = 0 to −2.5 V,    R <sub>L</sub> = 600 Ω                     | 25°C                        | 1                                  | 16      |      |      |  |
|                                                   |                                                 |                                                                             | Full range                  | 0.5                                |         |      |      |  |
|                                                   |                                                 |                                                                             |                             |                                    |         |      |      |  |
|                                                   |                                                 |                                                                             |                             |                                    |         |      |      |  |

$^\dagger$  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  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

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

| PARAMETER       |                                                                          | TEST CONDITIONS                                         | $T_A^\dagger$ | TLE2064M<br>TLE2064AM<br>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          |                                    | $10^{12}$ |     | $\Omega$ |
| $c_i$           | 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    | 60                                 |           |     |          |
| $k_{SVR}$       | 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                                 |           |     |          |
| $I_{CC}$        | 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                                |           |     | $\mu A$  |
| $V_{O1}/V_{O2}$ | Crosstalk attenuation                                                    | $A_{VD} = 1000$ , $f = 1$ kHz                           | 25°C          |                                    | 120       |     | dB       |

$^\dagger$  Full range is -55°C to 125°C.

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

| PARAMETER   |                                               | TEST CONDITIONS                                                                              | TLE2064M<br>TLE2064AM<br>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 $10\ \text{Hz}$                                                      |                                    | 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                                 | $\varepsilon = 0.1\%$                                                                        |                                    | 5      |     | $\mu\text{s}$          |
|             |                                               | $\varepsilon = 0.01\%$                                                                       |                                    | 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

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

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

| PARAMETER                                         |                                                                        | TEST CONDITIONS                                                    | T <sub>A</sub> <sup>†</sup> | TLE2064M<br>TLE2064AM<br>TLE2064BM |           |       | UNIT |
|---------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------|-----------------------------|------------------------------------|-----------|-------|------|
|                                                   |                                                                        |                                                                    |                             | MIN                                | TYP       | MAX   |      |
| V <sub>IO</sub>                                   | Input offset voltage                                                   | TLE2064M                                                           | 25°C                        | 0.9                                | 6         | mV    |      |
|                                                   |                                                                        |                                                                    | Full range                  | 8                                  |           |       |      |
|                                                   |                                                                        |                                                                    | TLE2064AM                   | 25°C                               | 0.9       |       | 4    |
|                                                   |                                                                        |                                                                    |                             | Full range                         | 6         |       |      |
|                                                   |                                                                        |                                                                    | TLE2064BM                   | 25°C                               | 0.7       |       | 2    |
|                                                   |                                                                        |                                                                    |                             | Full range                         | 4         |       |      |
| α <sub>VIO</sub>                                  | Temperature coefficient of input offset voltage                        | V <sub>IC</sub> = 0,      R <sub>S</sub> = 50 Ω                    | 25°C                        | 6                                  |           | μV/°C |      |
| Input offset voltage long-term drift (see Note 4) |                                                                        |                                                                    | Full range                  | 0.04                               |           | μV/mo |      |
| I <sub>IO</sub>                                   | Input offset current                                                   |                                                                    | 25°C                        | 2                                  |           | pA    |      |
|                                                   |                                                                        |                                                                    | Full range                  | 20                                 |           | nA    |      |
| I <sub>IB</sub>                                   | Input bias current                                                     |                                                                    | 25°C                        | 4                                  |           | pA    |      |
|                                                   |                                                                        |                                                                    | Full range                  | 40                                 |           | nA    |      |
| V <sub>ICR</sub>                                  | Common-mode input voltage range                                        |                                                                    | 25°C                        | –11 to 13                          | –12 to 16 | V     |      |
|                                                   |                                                                        |                                                                    | Full range                  | –11 to 13                          |           | V     |      |
| V <sub>OM+</sub>                                  | Maximum positive peak output voltage swing                             | R <sub>L</sub> = 10 kΩ                                             | 25°C                        | 13                                 | 13.7      | V     |      |
|                                                   |                                                                        |                                                                    | Full range                  | 12.5                               |           |       |      |
|                                                   |                                                                        | R <sub>L</sub> = 600 Ω                                             | 25°C                        | 12.5                               | 13.2      |       |      |
|                                                   |                                                                        |                                                                    | Full range                  | 12                                 |           |       |      |
| V <sub>OM–</sub>                                  | Maximum negative peak output voltage swing                             | R <sub>L</sub> = 10 kΩ                                             | 25°C                        | –13                                | –13.7     | V     |      |
|                                                   |                                                                        |                                                                    | Full range                  | –12.5                              |           |       |      |
|                                                   |                                                                        | R <sub>L</sub> = 600 Ω                                             | 25°C                        | –13                                | –13       |       |      |
|                                                   |                                                                        |                                                                    | Full range                  | –12.5                              |           |       |      |
| A <sub>VD</sub>                                   | Large-signal differential voltage amplification                        | V <sub>O</sub> = ±10 V,      R <sub>L</sub> = 10 kΩ                | 25°C                        | 30                                 | 230       | V/mV  |      |
|                                                   |                                                                        |                                                                    | Full range                  | 20                                 |           |       |      |
|                                                   |                                                                        | V <sub>O</sub> = 0 to 8 V,      R <sub>L</sub> = 600 Ω             | 25°C                        | 25                                 | 100       |       |      |
|                                                   |                                                                        |                                                                    | Full range                  | 7                                  |           |       |      |
|                                                   |                                                                        | V <sub>O</sub> = 0 to –8 V,      R <sub>L</sub> = 600 Ω            | 25°C                        | 3                                  | 25        |       |      |
|                                                   |                                                                        |                                                                    | Full range                  | 1                                  |           |       |      |
| r <sub>i</sub>                                    | Input resistance                                                       |                                                                    | 25°C                        | 10 <sup>12</sup>                   |           | Ω     |      |
| c <sub>i</sub>                                    | Input capacitance                                                      |                                                                    | 25°C                        | 4                                  |           | pF    |      |
| z <sub>o</sub>                                    | Open-loop output impedance                                             | I <sub>O</sub> = 0                                                 | 25°C                        | 560                                |           | Ω     |      |
| CMRR                                              | Common-mode rejection ratio                                            | V <sub>IC</sub> = V <sub>ICRmin</sub> ,      R <sub>S</sub> = 50 Ω | 25°C                        | 72                                 | 90        | dB    |      |
|                                                   |                                                                        |                                                                    | Full range                  | 65                                 |           |       |      |
| k <sub>SVR</sub>                                  | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> / ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±5 V to ±15 V,      R <sub>S</sub> = 50 Ω       | 25°C                        | 75                                 | 93        | dB    |      |
|                                                   |                                                                        |                                                                    | Full range                  | 65                                 |           |       |      |

$^\dagger$  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  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.



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

| PARAMETER                                                                                | TEST CONDITIONS               | $T_A^\dagger$ | TLE2064M<br>TLE2064AM<br>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                                                    | $A_{VD} = 1000$ , $f = 1$ kHz | 25°C          |                                    | 120  |     | dB   |

$^\dagger$  Full range is – 55°C to 125°C.

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

| PARAMETER                                               | TEST CONDITIONS                                                  | $T_A^\dagger$ | TLE2064M<br>TLE2064AM<br>TLE2064BM |        |     | 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    | 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                                        |               |                                    | 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                           | $A_{VD} = 2$ , $f = 10$ kHz,<br>$V_{O(PP)} = 2$ V, $R_L = 10$ kΩ | 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°    |     |        |

$^\dagger$  Full range is – 55°C to 125°C.

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### μPOWER OPERATIONAL AMPLIFIERS

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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                      |
| $\propto V_{IO}$ 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<br>to<br>13 | -12<br>to<br>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               |     | V                       |
| $A_{VD}$ 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 <sup>12</sup> |     | $\Omega$                |
| $c_i$ Input capacitance                                                         |                                                                          |                 | 4                |     | pF                      |
| $z_o$ Open-loop output impedance                                                | $I_O = 0$                                                                |                 | 560              |     | $\Omega$                |
| CMRR Common-mode rejection ratio                                                | $R_S = 50\ \Omega$ ,<br>$V_{IC} = V_{ICR\text{min}}$                     | 72              | 90               |     | dB                      |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5\text{ V to } \pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$ | 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                      |

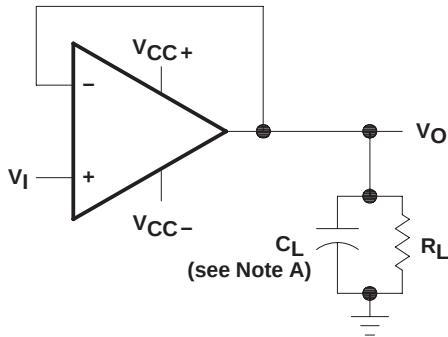
NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at  $T_A = 150^\circ\text{C}$  extrapolated to  $T_A = 25^\circ\text{C}$  using the Arrhenius equation and assuming an activation energy of 0.96 eV.

#### 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 | $f = 0.1\text{ Hz to }10\text{ Hz}$                                                          |          | 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                           | $A_{VD} = 2$ , $f = 10\text{ kHz}$ ,<br>$V_{O(PP)} = 2\text{ V}$ , $R_L = 10\text{ k}\Omega$ |          | 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**

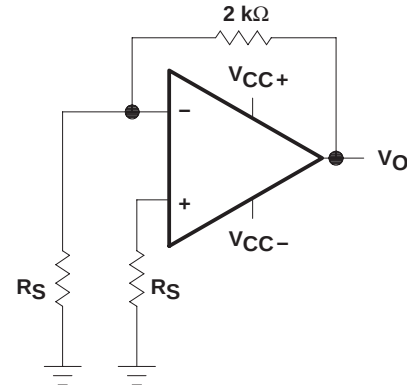
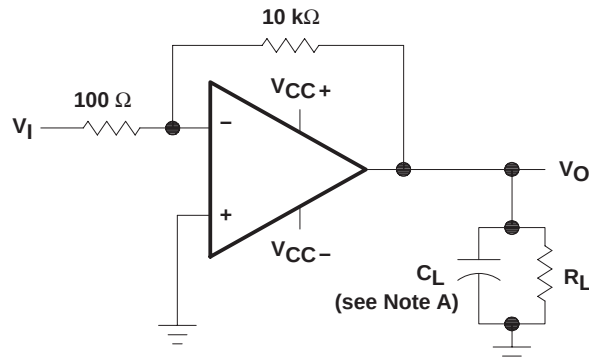


**Figure 2. Noise-Voltage Test Circuit**



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.

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

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**TYPICAL CHARACTERISTICS**

**Table of Graphs**

|             |                                                 |                                                                     | <b>FIGURE</b>            |
|-------------|-------------------------------------------------|---------------------------------------------------------------------|--------------------------|
| $V_{IO}$    | Input offset voltage                            | Distribution                                                        | 4, 5, 6                  |
| $I_{IB}$    | Input bias current                              | vs Common-mode input voltage<br>vs Free-air temperature             | 7<br>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<br>vs Supply voltage                              | 10, 11<br>12, 13, 14     |
| $V_{O(PP)}$ | Maximum peak-to-peak output voltage             | vs Frequency<br>vs Load resistance                                  | 15, 16<br>17             |
| $A_{VD}$    | Large-signal differential voltage amplification | vs Frequency<br>vs Free-air temperature                             | 18<br>19                 |
| $I_{OS}$    | Short-circuit output current                    | vs Elapsed time<br>vs Free-air temperature                          | 20<br>21                 |
| $z_o$       | Output impedance                                | vs Frequency                                                        | 22, 23                   |
| CMRR        | Common-mode rejection ratio                     | vs Frequency                                                        | 24                       |
| $I_{CC}$    | Supply current                                  | vs Supply voltage<br>vs Free-air temperature                        | 25, 26, 27<br>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<br>vs Free-air temperature                        | 39<br>40                 |
| $\phi_m$    | Phase margin                                    | vs Supply voltage<br>vs Load capacitance<br>vs Free-air temperature | 41<br>42<br>43           |
|             | Phase shift                                     | vs Frequency                                                        | 18                       |

## TYPICAL CHARACTERISTICS

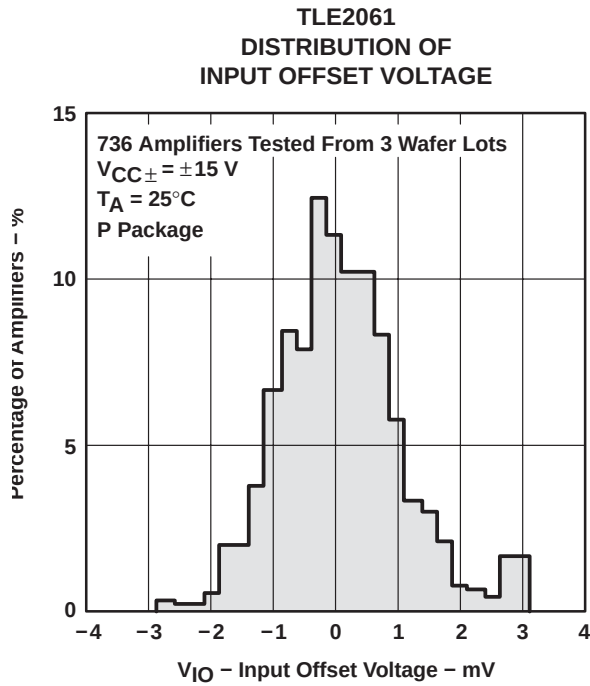


Figure 4

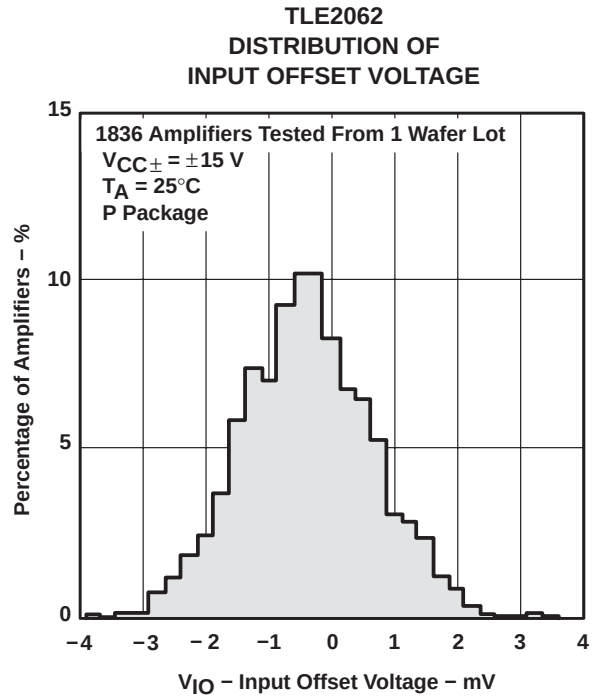


Figure 5

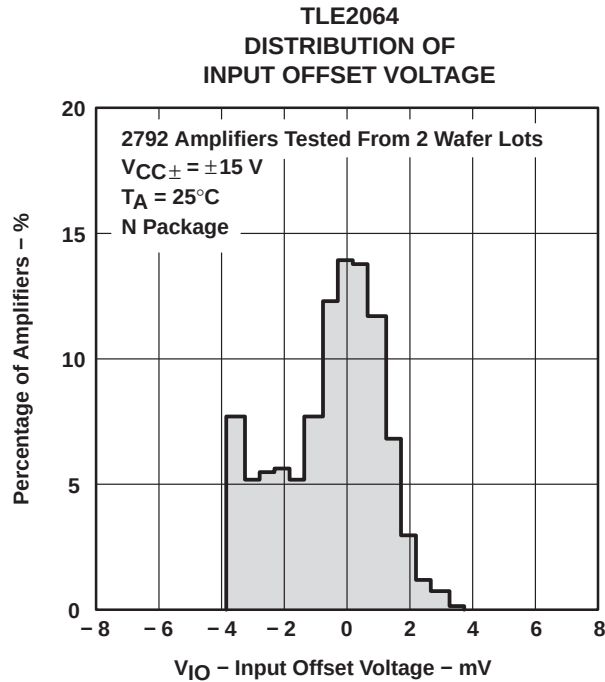


Figure 6

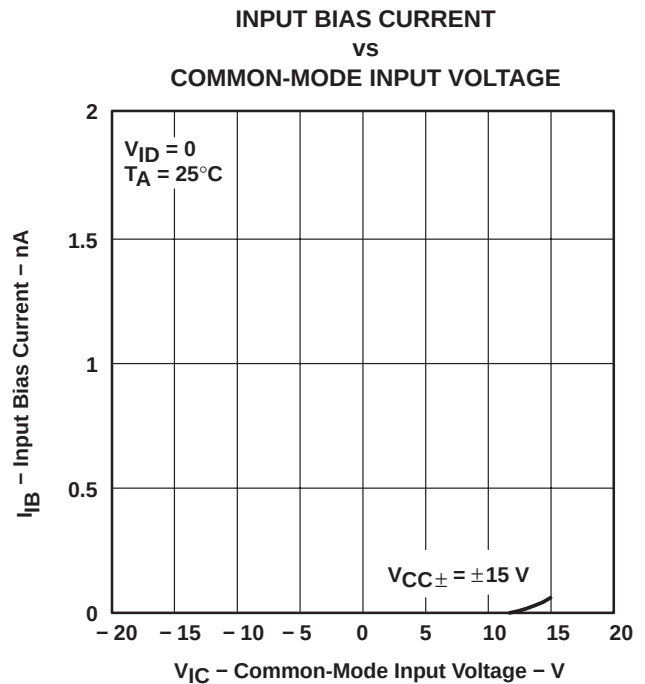


Figure 7

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### $\mu$ POWER OPERATIONAL AMPLIFIERS

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#### TYPICAL CHARACTERISTICS†

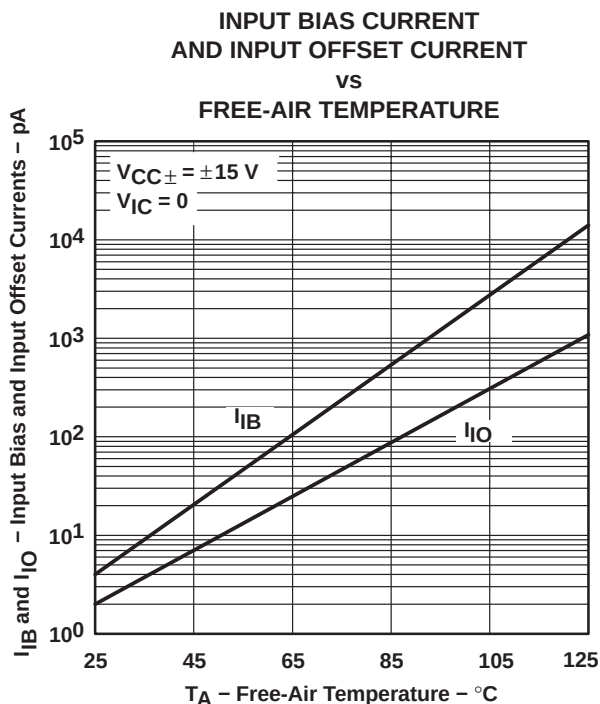


Figure 8

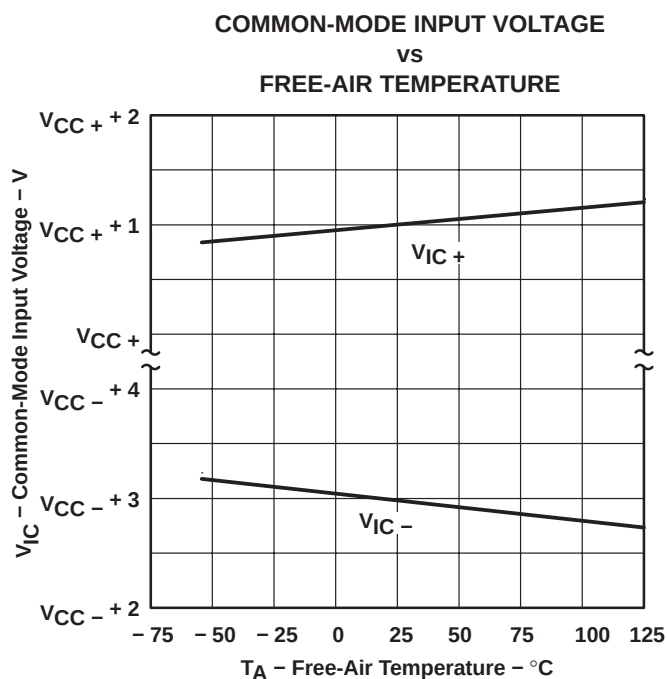


Figure 9

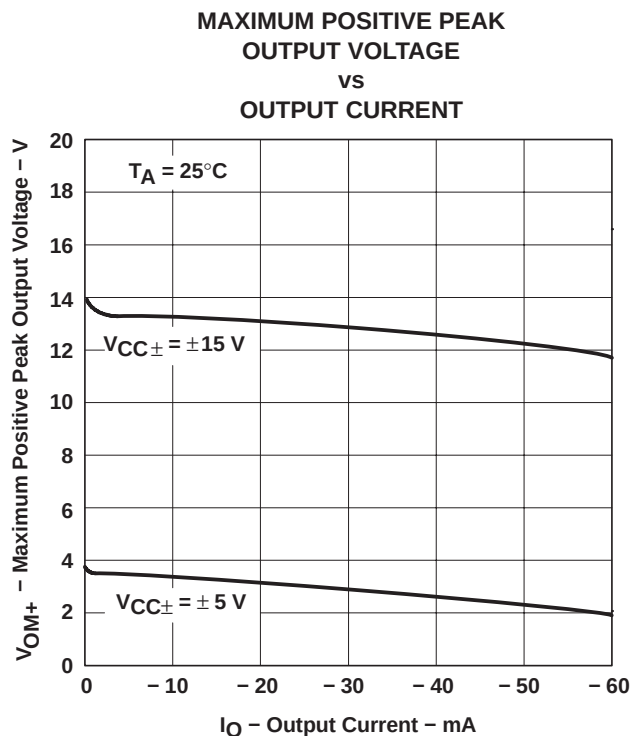


Figure 10

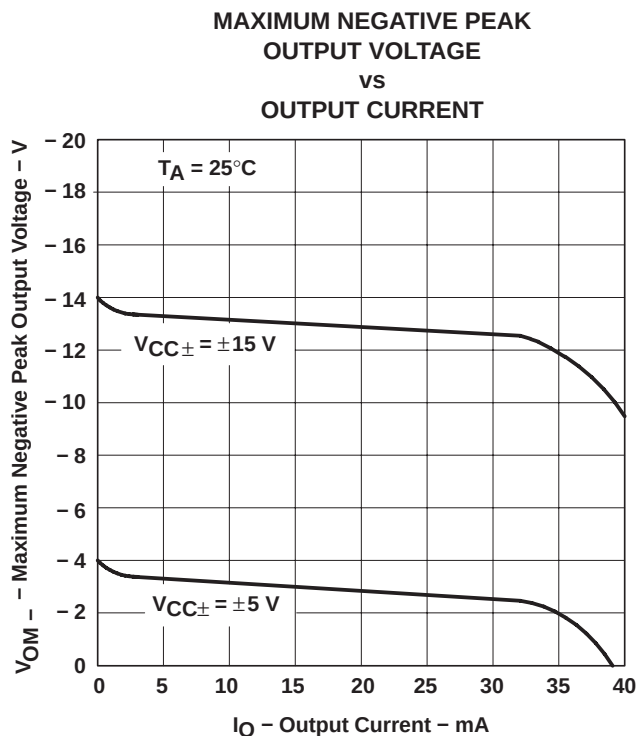


Figure 11

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

## TYPICAL CHARACTERISTICS

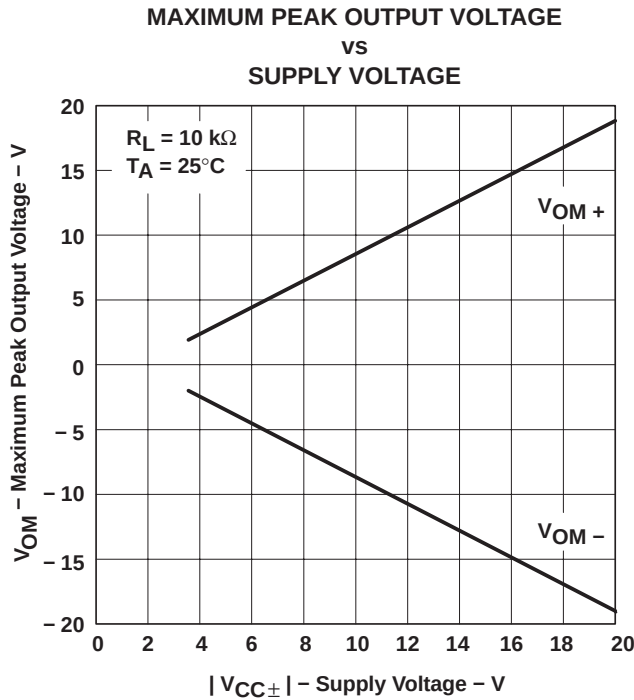


Figure 12

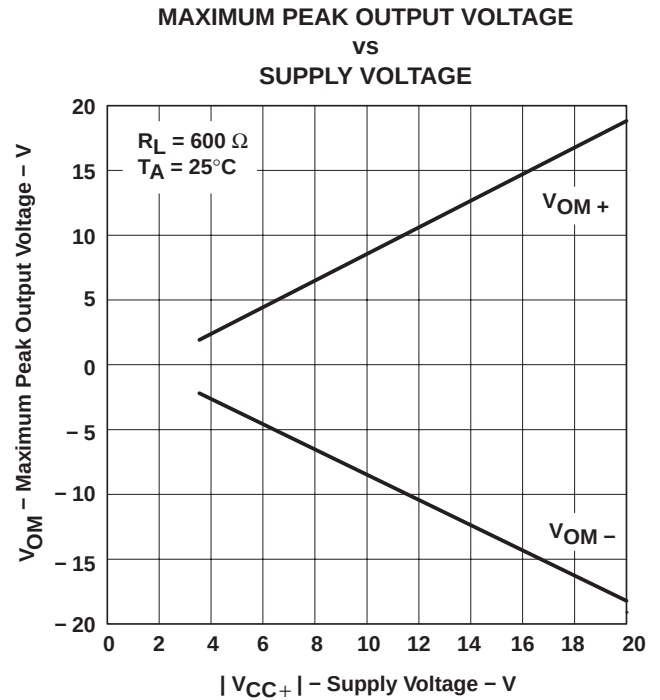


Figure 13

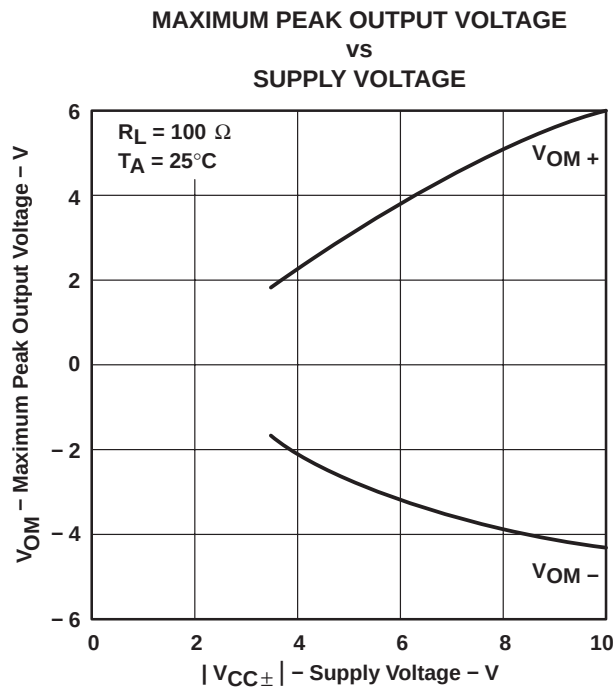


Figure 14

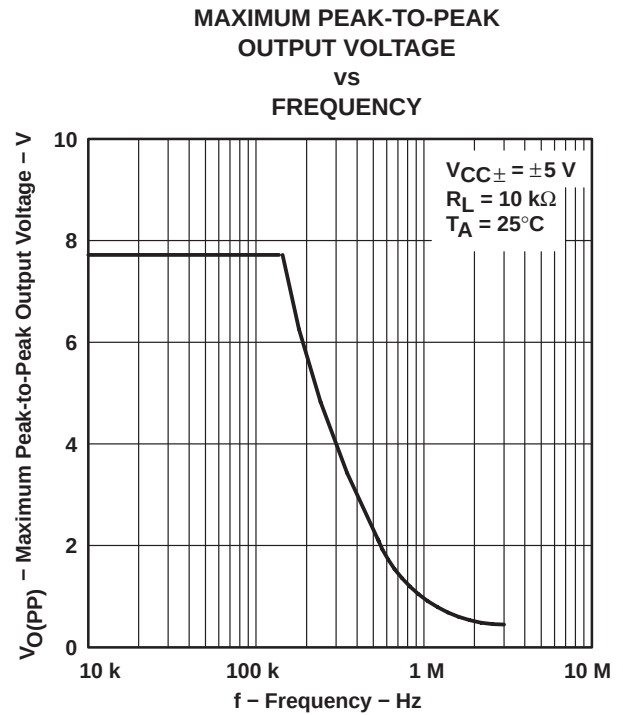


Figure 15

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### $\mu$ POWER OPERATIONAL AMPLIFIERS

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#### TYPICAL CHARACTERISTICS†

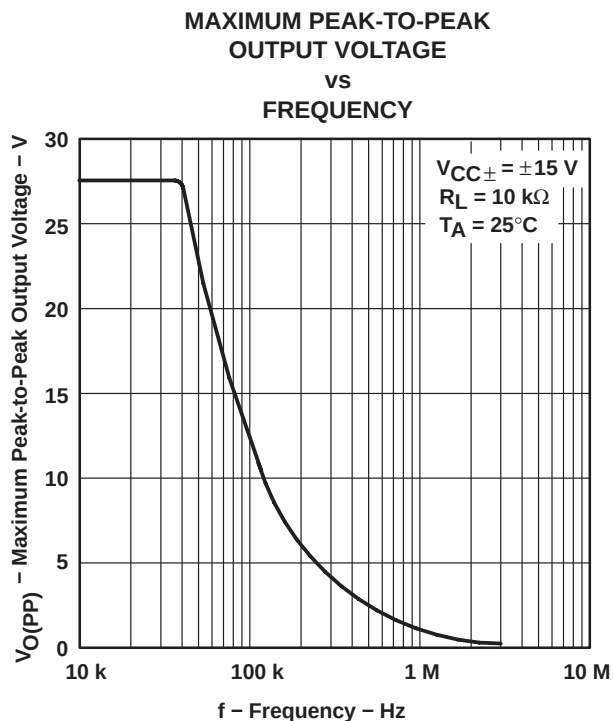


Figure 16

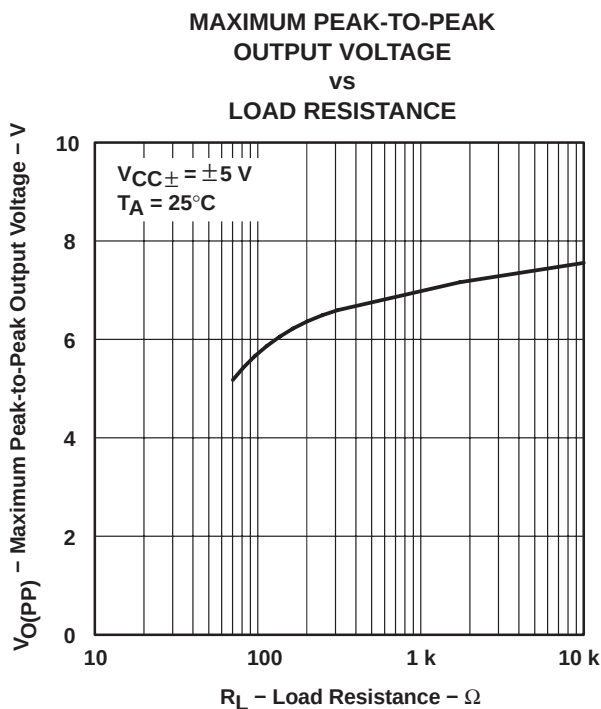


Figure 17

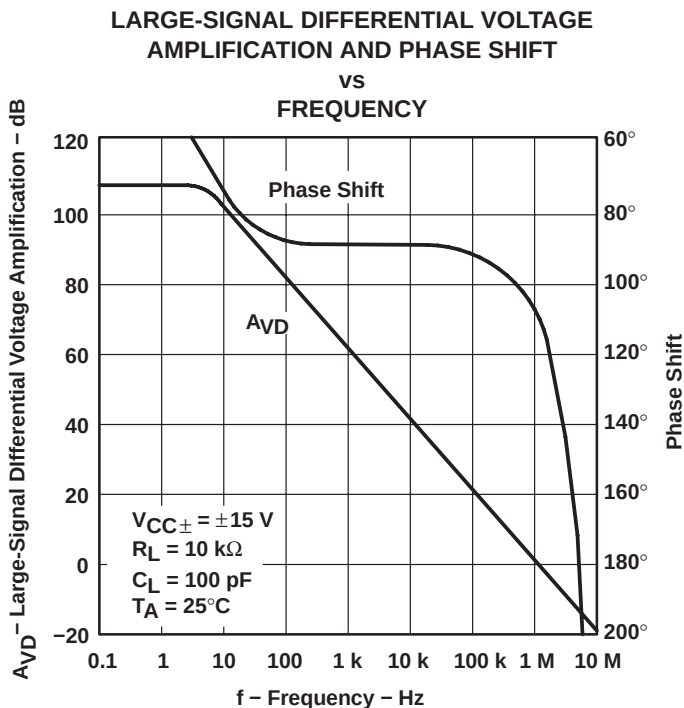


Figure 18

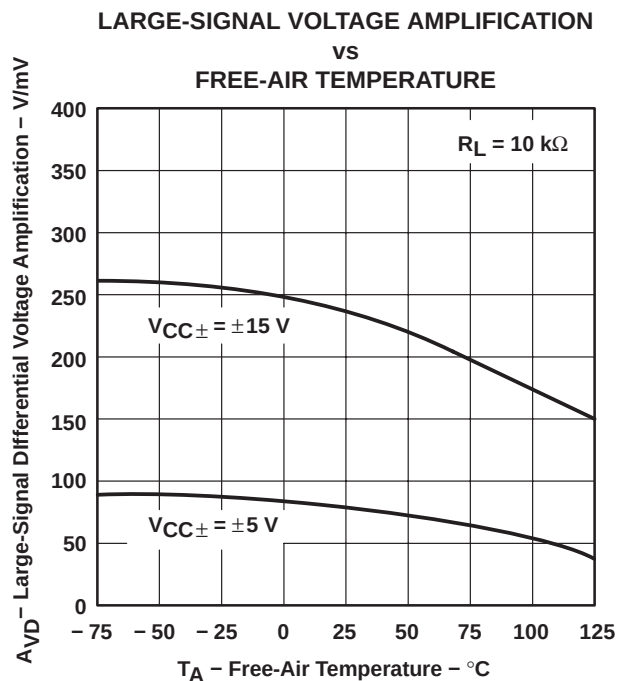
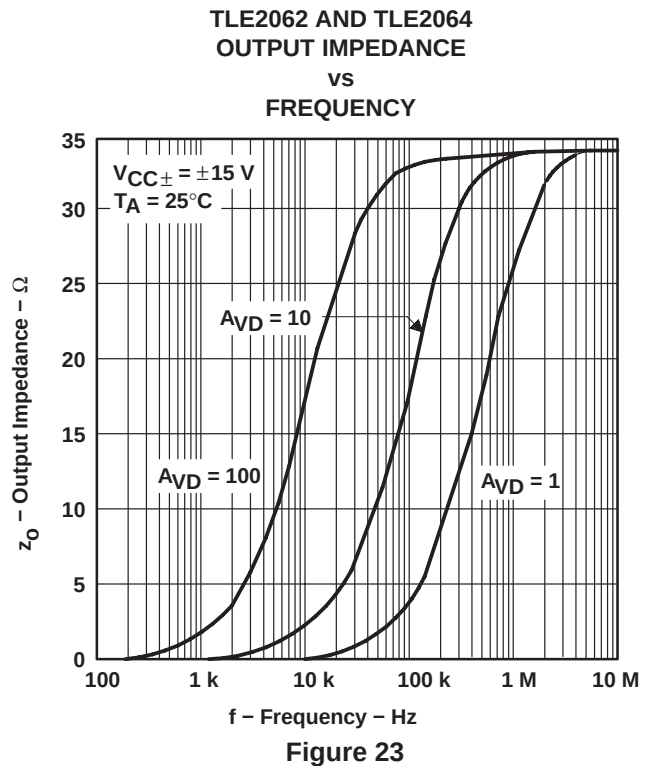
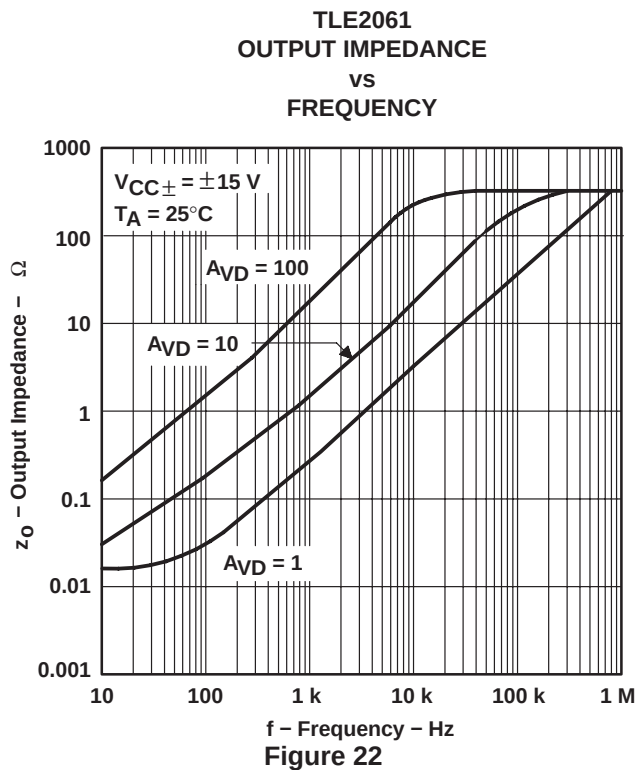
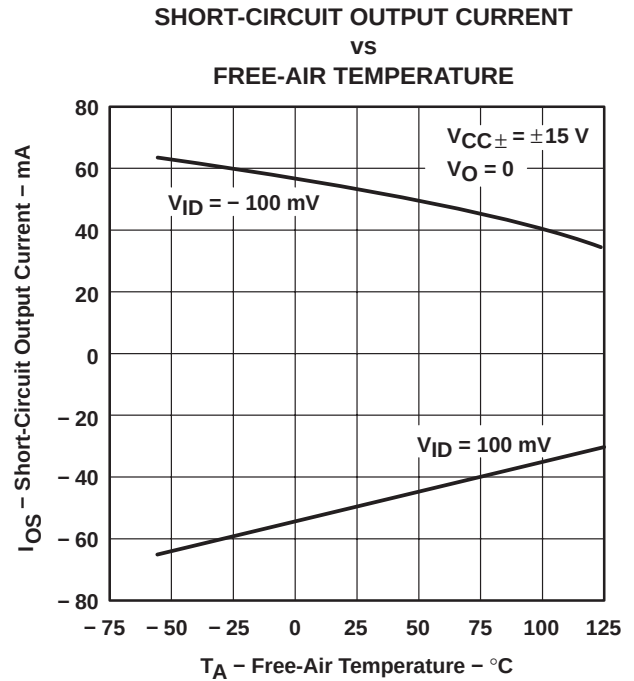
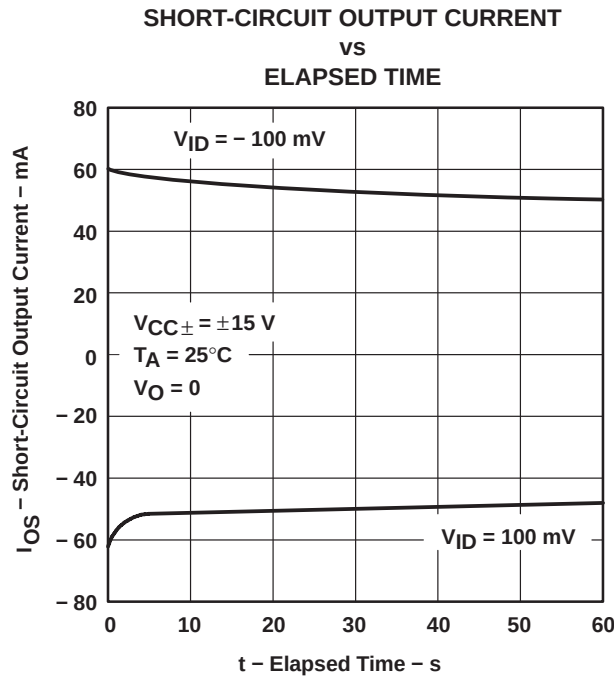


Figure 19

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

## TYPICAL CHARACTERISTICS†



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

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### $\mu$ POWER OPERATIONAL AMPLIFIERS

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#### TYPICAL CHARACTERISTICS†

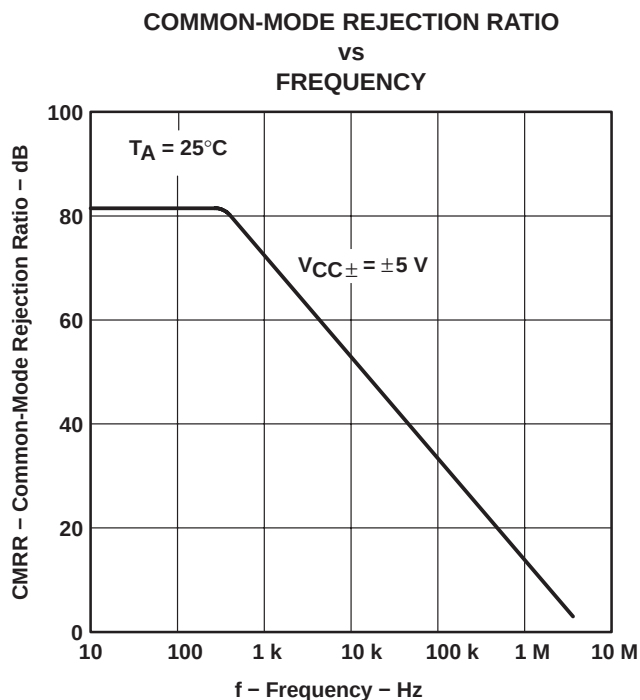


Figure 24

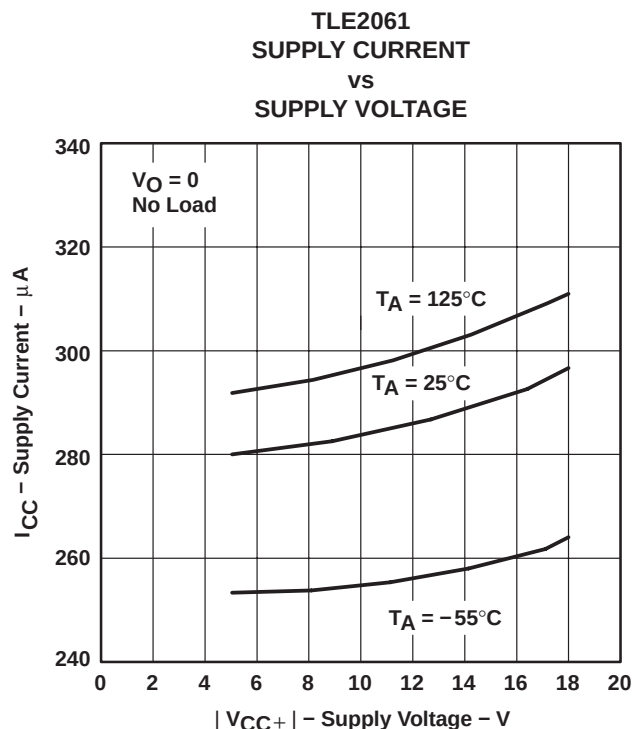


Figure 25

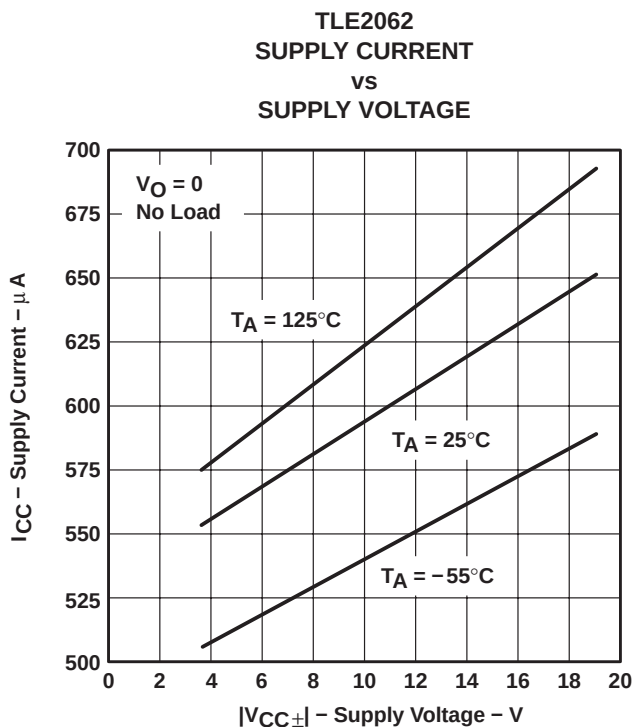


Figure 26

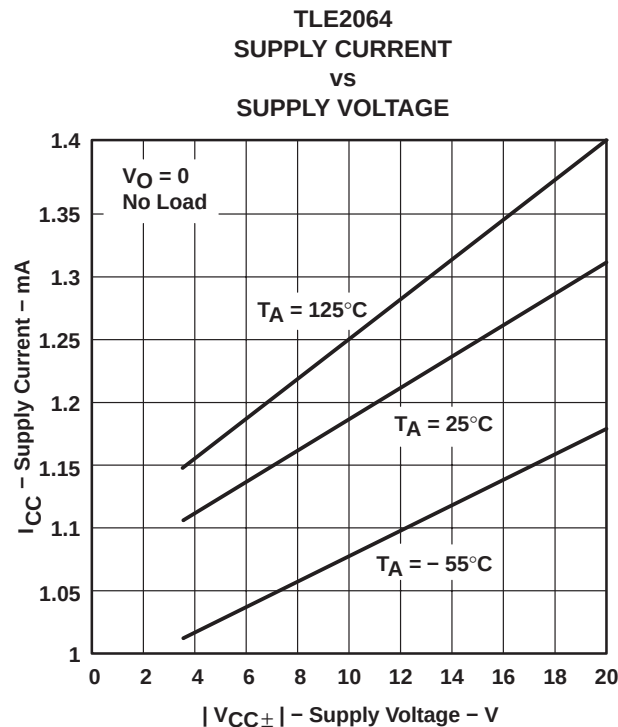
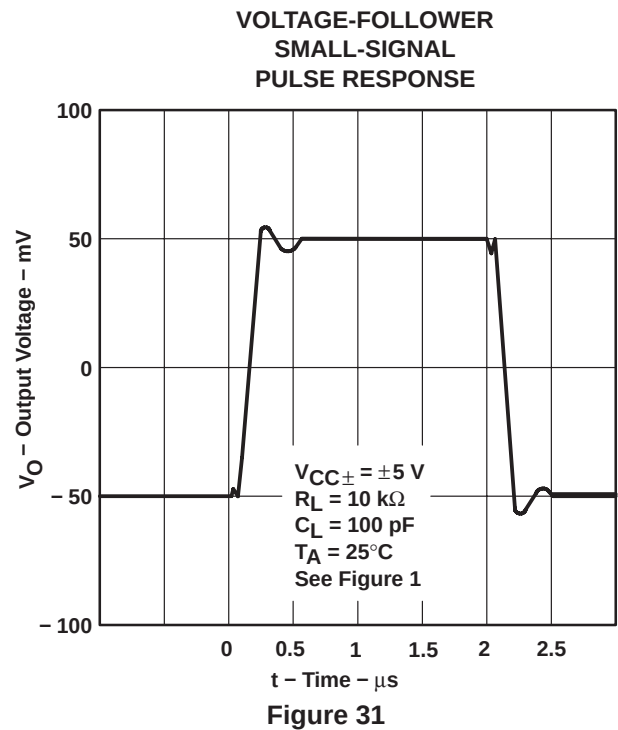
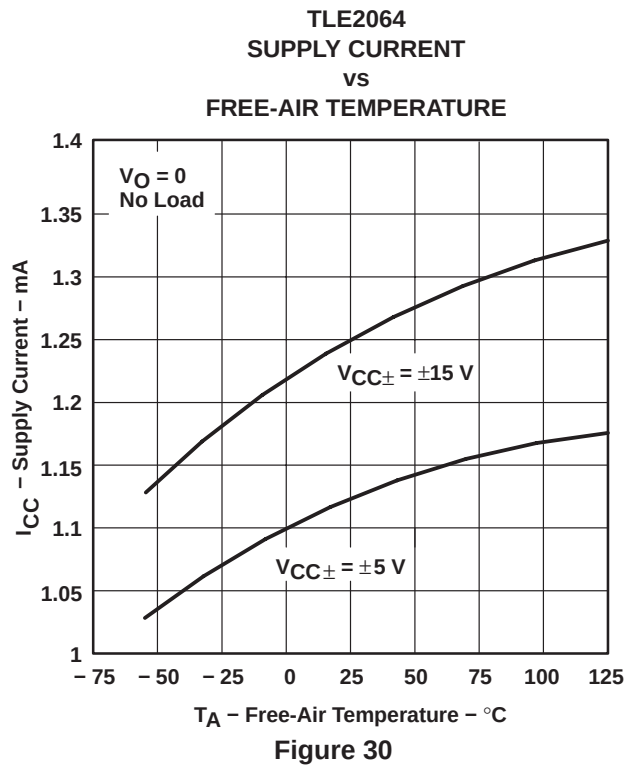
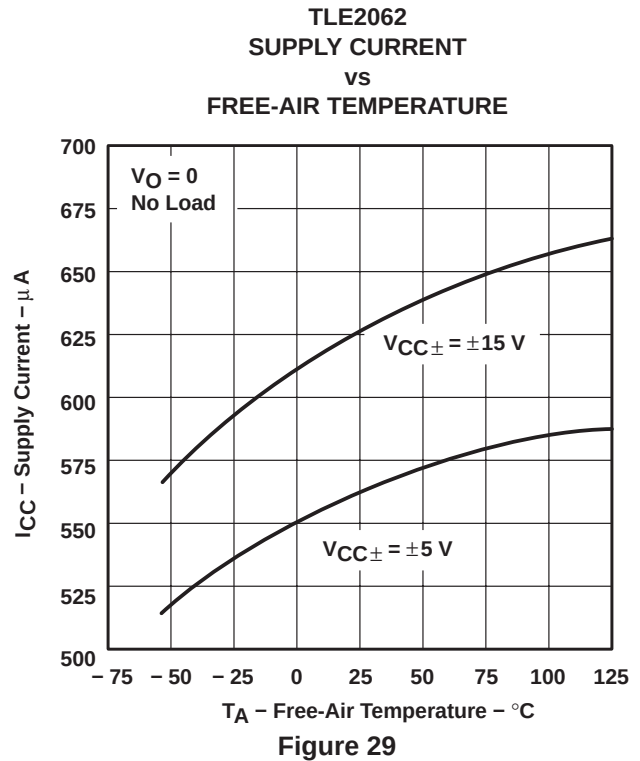
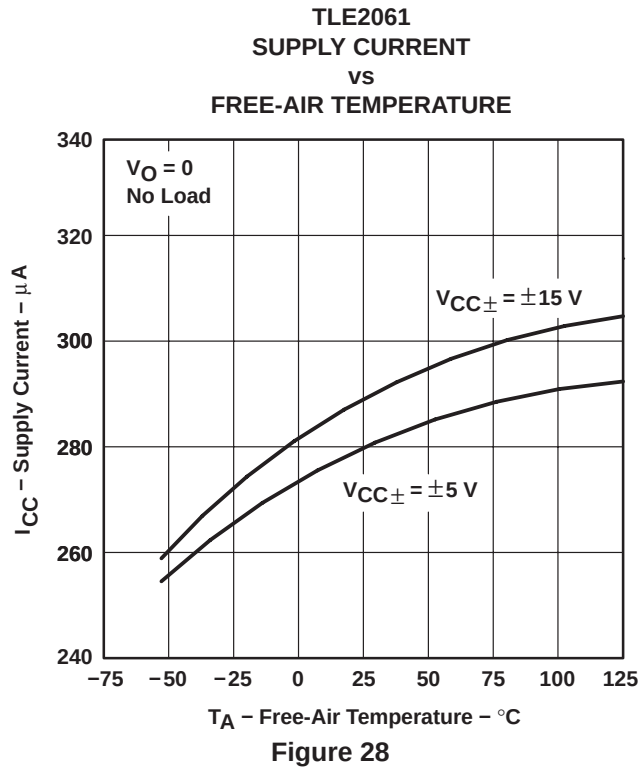


Figure 27

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

## TYPICAL CHARACTERISTICS†



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

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

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## TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER  
SMALL-SIGNAL  
PULSE RESPONSE

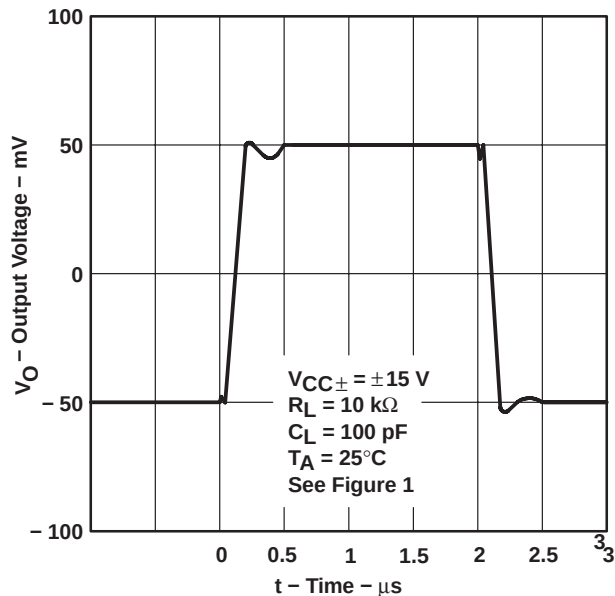


Figure 32

VOLTAGE-FOLLOWER  
LARGE-SIGNAL  
PULSE RESPONSE

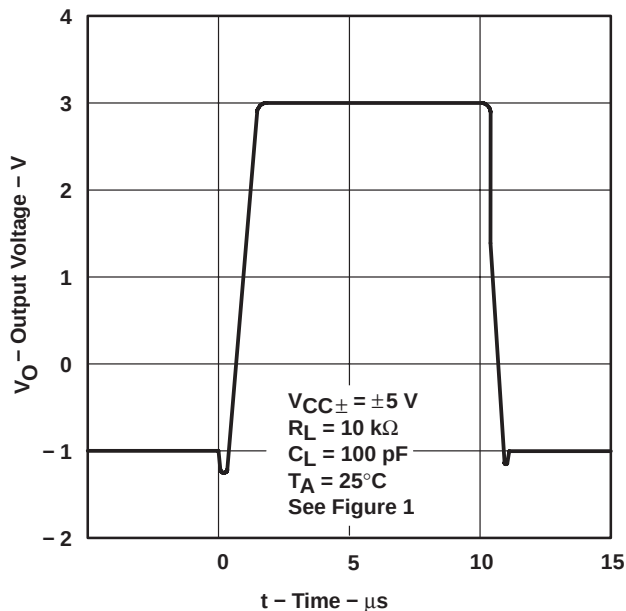


Figure 33

VOLTAGE-FOLLOWER  
LARGE-SIGNAL  
PULSE RESPONSE

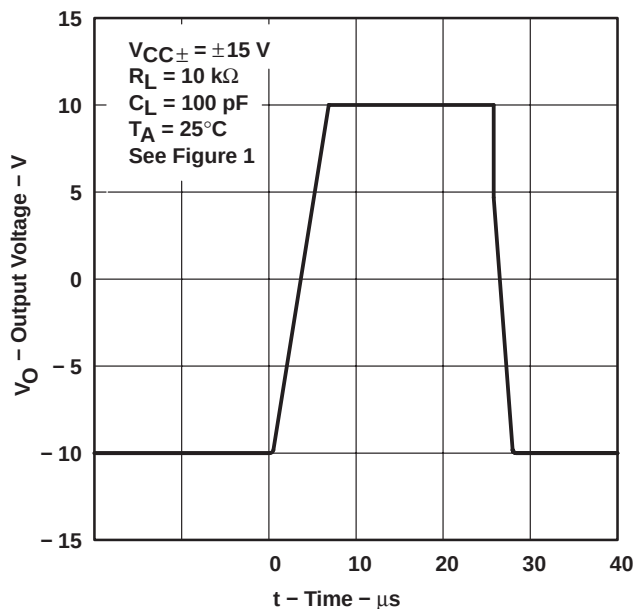


Figure 34

NOISE VOLTAGE  
(REFERRED TO INPUT)  
0.1 TO 10 Hz

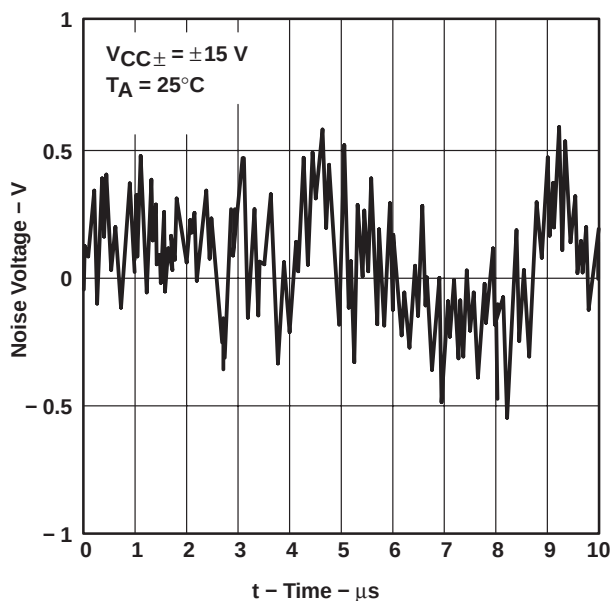


Figure 35

## TYPICAL CHARACTERISTICS

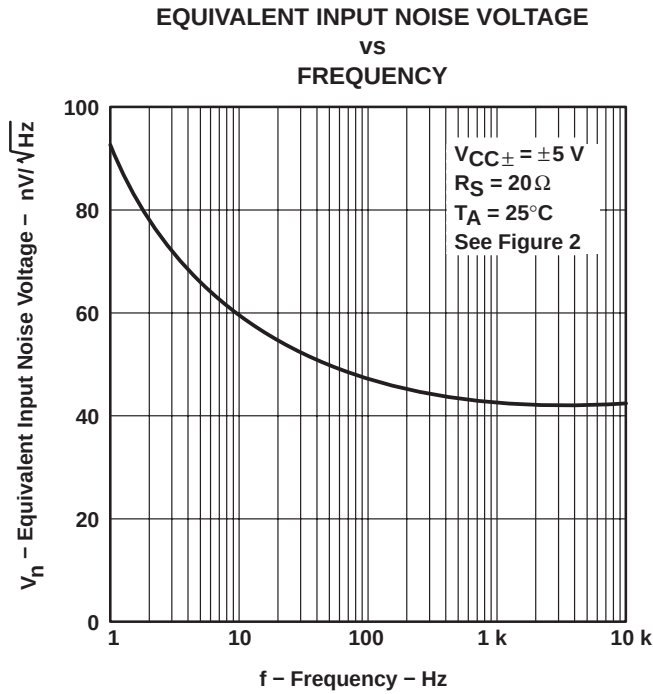


Figure 36

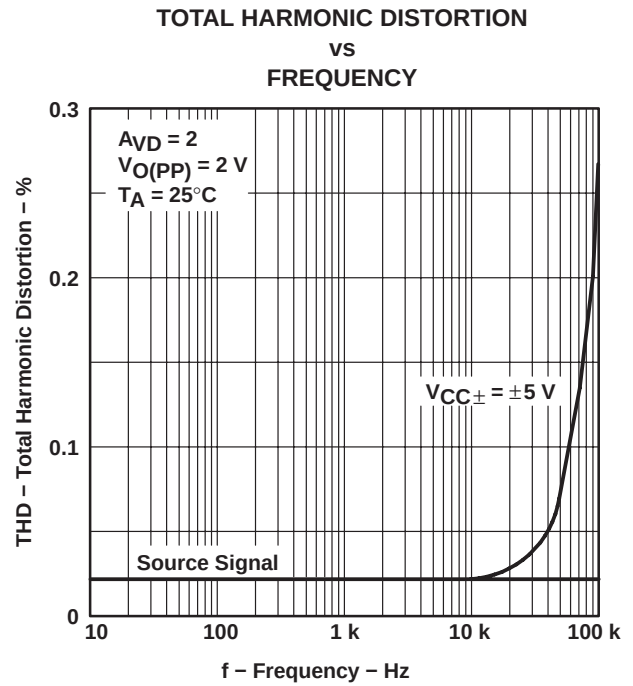


Figure 37

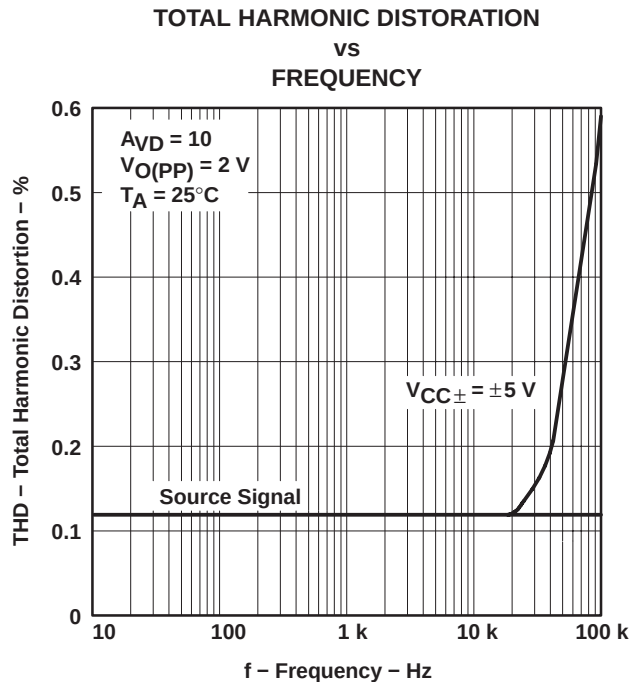


Figure 38

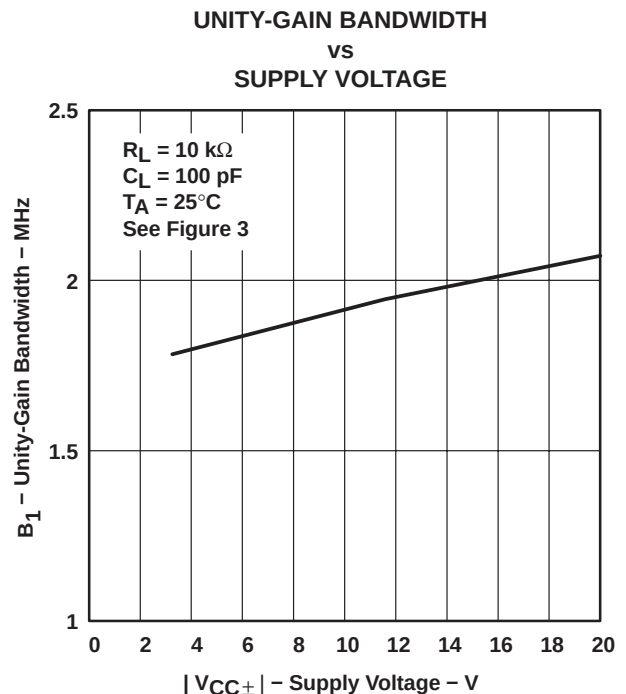


Figure 39

# TLE206x, TLE206xA, TLE206xB

## EXCALIBUR JFET-INPUT HIGH-OUTPUT-DRIVE

### $\mu$ POWER OPERATIONAL AMPLIFIERS

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#### TYPICAL CHARACTERISTICS†

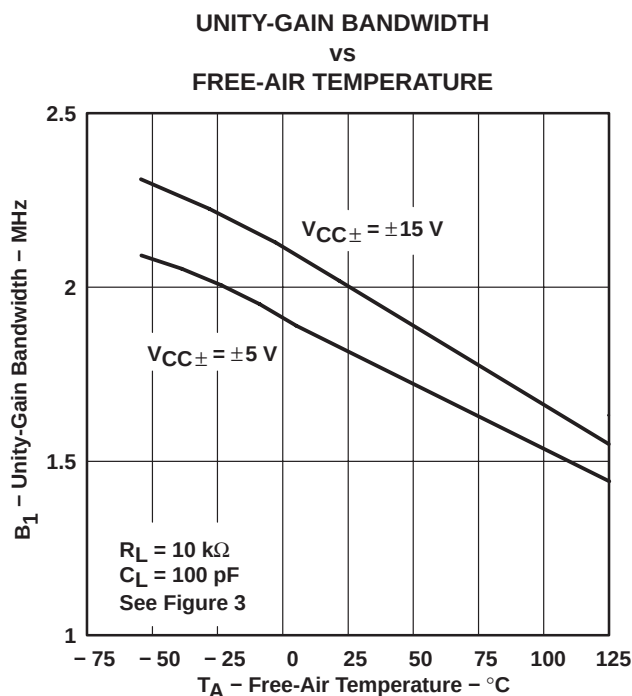


Figure 40

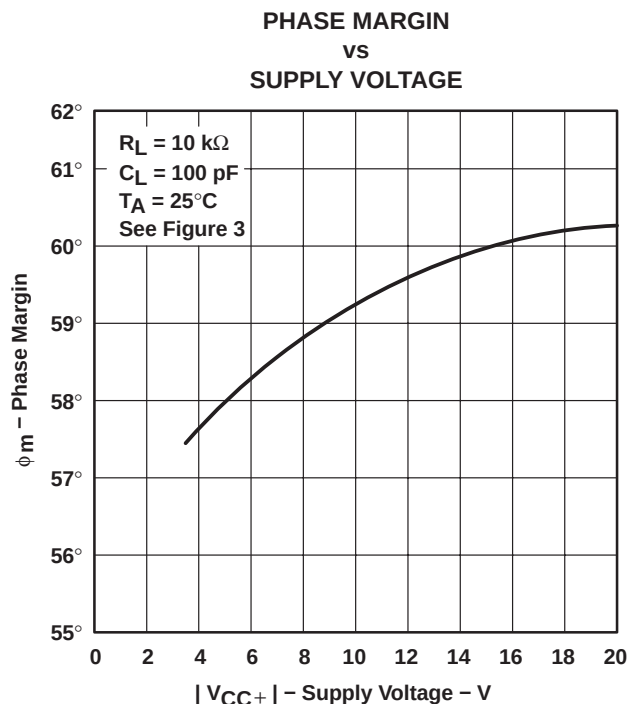


Figure 41

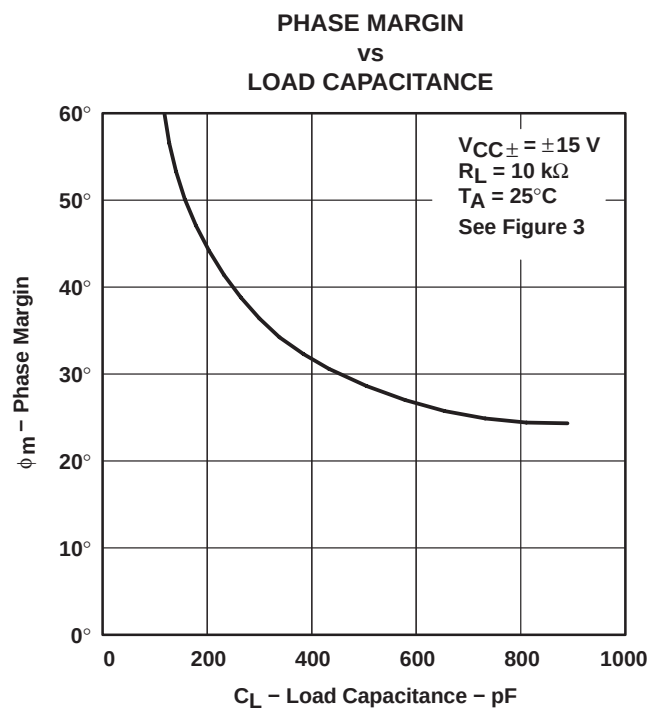


Figure 42

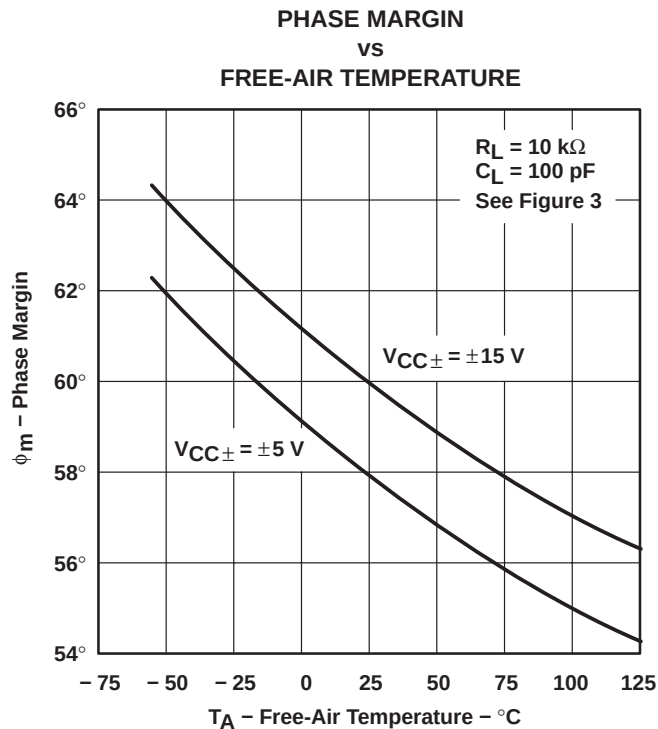


Figure 43

† 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.

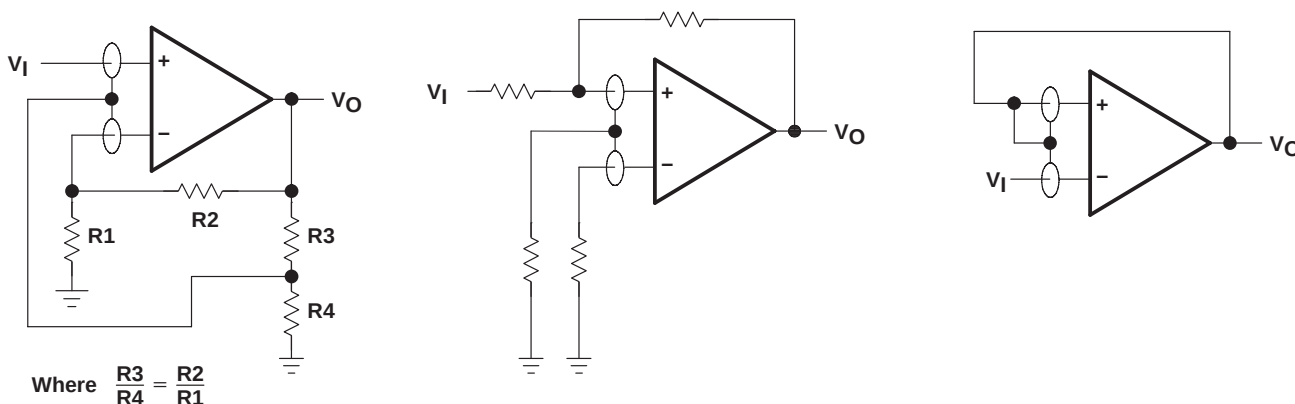


Figure 44. Use of Guard Rings

### 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.

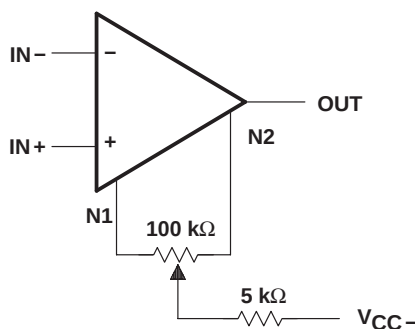


Figure 45. Input Offset Voltage Nulling

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

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## 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 the 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).

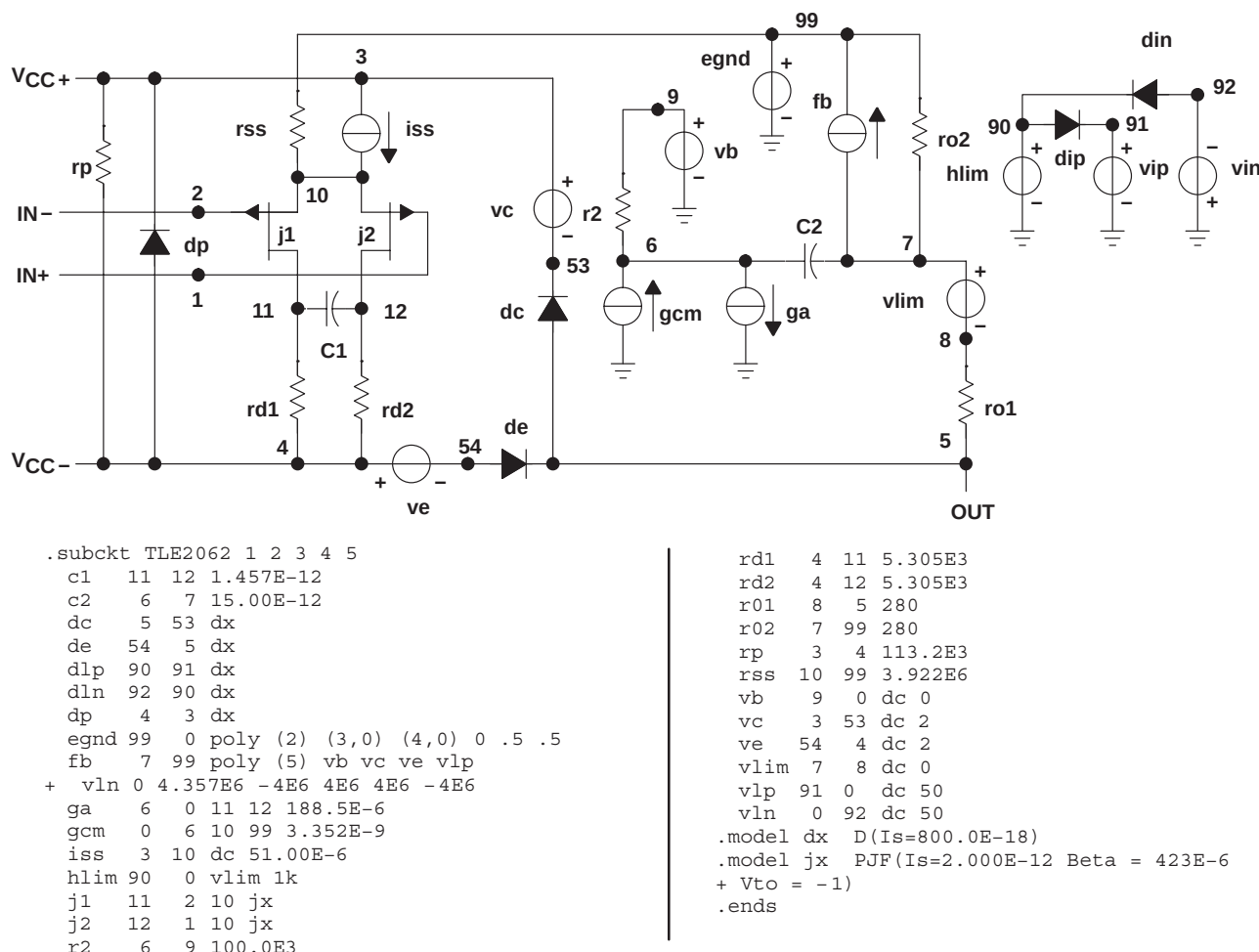


Figure 46. Boyle Macromodel and Subcircuit

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**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)                 | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|-------------------------|----------------------|--------------|-----------------------------------------|-------------------------|
| 5962-9080701M2A  | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD             | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9080701M2A<br>TLE2061MFKB      | <a href="#">Samples</a> |
| 5962-9080701MPA  | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD             | A42                     | N / A for Pkg Type   | -55 to 125   | 9080701MPA<br>TLE2061M                  | <a href="#">Samples</a> |
| 5962-9080702Q2A  | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD             | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9080702Q2A<br>TLE2061<br>AMFKB | <a href="#">Samples</a> |
| 5962-9080702QPA  | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD             | A42                     | N / A for Pkg Type   | -55 to 125   | 9080702QPA<br>TLE2061AM                 | <a href="#">Samples</a> |
| 5962-9080703QPA  | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD             | A42                     | N / A for Pkg Type   | -55 to 125   | 9080703QPA<br>TLE2061BM                 | <a href="#">Samples</a> |
| 5962-9080801MPA  | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD             | A42                     | N / A for Pkg Type   | -55 to 125   | 9080801MPA<br>TLE2062M                  | <a href="#">Samples</a> |
| 5962-9080803QPA  | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD             | A42                     | N / A for Pkg Type   | -55 to 125   | 9080803QPA<br>TLE2062BM                 | <a href="#">Samples</a> |
| 5962-9080901M2A  | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD             | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9080901M2A<br>TLE2064<br>MFKB  | <a href="#">Samples</a> |
| 5962-9080901MCA  | ACTIVE        | CDIP         | J                  | 14   | 1              | TBD             | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-9080901MC<br>A<br>TLE2064MJB       | <a href="#">Samples</a> |
| 5962-9080902M2A  | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD             | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9080902M2A<br>TLE2064A<br>MFKB | <a href="#">Samples</a> |
| 5962-9080902MDA  | ACTIVE        | CFP          | W                  | 14   | 1              | TBD             | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-9080902MD<br>A<br>TLE2064AMWB      | <a href="#">Samples</a> |
| 5962-9080903Q2A  | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD             | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9080903Q2A<br>TLE2064<br>BMFKB | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)                 | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-----------------------------------------|-------------------------|
| 5962-9080903QCA  | ACTIVE        | CDIP         | J                  | 14   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-9080903QC<br>A<br>TLE2064BMJB      | <a href="#">Samples</a> |
| TLE2061ACD       | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2061AC                                  | <a href="#">Samples</a> |
| TLE2061ACP       | ACTIVE        | PDIP         | P                  | 8    | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | TLE2061AC                               | <a href="#">Samples</a> |
| TLE2061ACPE4     | ACTIVE        | PDIP         | P                  | 8    | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | TLE2061AC                               | <a href="#">Samples</a> |
| TLE2061AID       | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2061AI                                  | <a href="#">Samples</a> |
| TLE2061AIP       | ACTIVE        | PDIP         | P                  | 8    | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | -40 to 85    | TLE2061AI                               | <a href="#">Samples</a> |
| TLE2061AIPe4     | ACTIVE        | PDIP         | P                  | 8    | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | -40 to 85    | TLE2061AI                               | <a href="#">Samples</a> |
| TLE2061AMFKB     | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD                        | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9080702Q2A<br>TLE2061<br>AMFKB | <a href="#">Samples</a> |
| TLE2061AMJGB     | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 9080702QPA<br>TLE2061AM                 | <a href="#">Samples</a> |
| TLE2061BMJGB     | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 9080703QPA<br>TLE2061BM                 | <a href="#">Samples</a> |
| TLE2061CD        | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2061C                                   | <a href="#">Samples</a> |
| TLE2061CDR       | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2061C                                   | <a href="#">Samples</a> |
| TLE2061CDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2061C                                   | <a href="#">Samples</a> |
| TLE2061CP        | ACTIVE        | PDIP         | P                  | 8    | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | TLE2061CP                               | <a href="#">Samples</a> |
| TLE2061ID        | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2061I                                   | <a href="#">Samples</a> |
| TLE2061IDR       | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2061I                                   | <a href="#">Samples</a> |
| TLE2061IDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2061I                                   | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)            | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|------------------------------------|-------------------------|
| TLE2061IP        | ACTIVE        | PDIP         | P                  | 8    | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | -40 to 85    | TLE2061IP                          | <a href="#">Samples</a> |
| TLE2061MD        | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | 2061M                              | <a href="#">Samples</a> |
| TLE2061MDG4      | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | 2061M                              | <a href="#">Samples</a> |
| TLE2061MFKB      | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD                        | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9080701M2A<br>TLE2061MFKB | <a href="#">Samples</a> |
| TLE2061MJGB      | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 9080701MPA<br>TLE2061M             | <a href="#">Samples</a> |
| TLE2062ACD       | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2062AC                             | <a href="#">Samples</a> |
| TLE2062ACDG4     | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2062AC                             | <a href="#">Samples</a> |
| TLE2062ACDR      | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2062AC                             | <a href="#">Samples</a> |
| TLE2062AID       | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2062AI                             | <a href="#">Samples</a> |
| TLE2062AIDG4     | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2062AI                             | <a href="#">Samples</a> |
| TLE2062AIDR      | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2062AI                             | <a href="#">Samples</a> |
| TLE2062AMD       | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | 2062AM                             | <a href="#">Samples</a> |
| TLE2062AMDG4     | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | 2062AM                             | <a href="#">Samples</a> |
| TLE2062AMDR      | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | 2062AM                             | <a href="#">Samples</a> |
| TLE2062AMJG      | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | TLE2062<br>AMJG                    | <a href="#">Samples</a> |
| TLE2062BMJG      | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | TLE2062<br>BMJG                    | <a href="#">Samples</a> |
| TLE2062BMJGB     | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 9080803QPA<br>TLE2062BM            | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| TLE2062CD        | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2062C                   | <a href="#">Samples</a> |
| TLE2062CDR       | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2062C                   | <a href="#">Samples</a> |
| TLE2062CDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2062C                   | <a href="#">Samples</a> |
| TLE2062CP        | ACTIVE        | PDIP         | P                  | 8    | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | TLE2062CP               | <a href="#">Samples</a> |
| TLE2062ID        | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2062I                   | <a href="#">Samples</a> |
| TLE2062IDG4      | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2062I                   | <a href="#">Samples</a> |
| TLE2062IDR       | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2062I                   | <a href="#">Samples</a> |
| TLE2062IP        | ACTIVE        | PDIP         | P                  | 8    | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | -40 to 85    | TLE2062IP               | <a href="#">Samples</a> |
| TLE2062IPE4      | ACTIVE        | PDIP         | P                  | 8    | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | -40 to 85    | TLE2062IP               | <a href="#">Samples</a> |
| TLE2062MD        | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | 2062M                   | <a href="#">Samples</a> |
| TLE2062MDG4      | ACTIVE        | SOIC         | D                  | 8    | 75             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | 2062M                   | <a href="#">Samples</a> |
| TLE2062MJG       | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | TLE2062MJG              | <a href="#">Samples</a> |
| TLE2062MJGB      | ACTIVE        | CDIP         | JG                 | 8    | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 9080801MPA<br>TLE2062M  | <a href="#">Samples</a> |
| TLE2064ACD       | ACTIVE        | SOIC         | D                  | 14   | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | 2064AC                  | <a href="#">Samples</a> |
| TLE2064ACDR      | ACTIVE        | SOIC         | D                  | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   |              | 2064AC                  | <a href="#">Samples</a> |
| TLE2064ACN       | ACTIVE        | PDIP         | N                  | 14   | 25             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   |              | TLE2064ACN              | <a href="#">Samples</a> |
| TLE2064ACNE4     | ACTIVE        | PDIP         | N                  | 14   | 25             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   |              | TLE2064ACN              | <a href="#">Samples</a> |
| TLE2064AID       | ACTIVE        | SOIC         | D                  | 14   | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2064AI                  | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)                 | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-----------------------------------------|-------------------------|
| TLE2064AIDG4     | ACTIVE        | SOIC         | D                  | 14   | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | 2064AI                                  | <a href="#">Samples</a> |
| TLE2064AIDR      | ACTIVE        | SOIC         | D                  | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   |              | 2064AI                                  | <a href="#">Samples</a> |
| TLE2064AMD       | ACTIVE        | SOIC         | D                  | 14   | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | 2064AM                                  | <a href="#">Samples</a> |
| TLE2064AMDG4     | ACTIVE        | SOIC         | D                  | 14   | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   |              | 2064AM                                  | <a href="#">Samples</a> |
| TLE2064AMDR      | ACTIVE        | SOIC         | D                  | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | 2064AM                                  | <a href="#">Samples</a> |
| TLE2064AMDRG4    | ACTIVE        | SOIC         | D                  | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   |              | 2064AM                                  | <a href="#">Samples</a> |
| TLE2064AMFKB     | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD                        | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9080902M2A<br>TLE2064A<br>MFKB | <a href="#">Samples</a> |
| TLE2064AMJ       | ACTIVE        | CDIP         | J                  | 14   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | TLE2064AMJ                              | <a href="#">Samples</a> |
| TLE2064AMWB      | ACTIVE        | CFP          | W                  | 14   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-9080902MD<br>A<br>TLE2064AMWB      | <a href="#">Samples</a> |
| TLE2064BMFKB     | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD                        | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9080903Q2A<br>TLE2064<br>BMFKB | <a href="#">Samples</a> |
| TLE2064BMJ       | ACTIVE        | CDIP         | J                  | 14   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | TLE2064BMJ                              | <a href="#">Samples</a> |
| TLE2064BMJB      | ACTIVE        | CDIP         | J                  | 14   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-9080903QC<br>A<br>TLE2064BMJB      | <a href="#">Samples</a> |
| TLE2064CD        | ACTIVE        | SOIC         | D                  | 14   | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | TLE2064C                                | <a href="#">Samples</a> |
| TLE2064CDG4      | ACTIVE        | SOIC         | D                  | 14   | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | TLE2064C                                | <a href="#">Samples</a> |
| TLE2064CDR       | ACTIVE        | SOIC         | D                  | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | TLE2064C                                | <a href="#">Samples</a> |
| TLE2064CDRG4     | ACTIVE        | SOIC         | D                  | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | 0 to 70      | TLE2064C                                | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5)                | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|----------------------------------------|-------------------------|
| TLE2064CN        | ACTIVE        | PDIP         | N                  | 14   | 25             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | TLE2064CN                              | <a href="#">Samples</a> |
| TLE2064CNE4      | ACTIVE        | PDIP         | N                  | 14   | 25             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | 0 to 70      | TLE2064CN                              | <a href="#">Samples</a> |
| TLE2064ID        | ACTIVE        | SOIC         | D                  | 14   | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | TLE2064I                               | <a href="#">Samples</a> |
| TLE2064IDR       | ACTIVE        | SOIC         | D                  | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | TLE2064I                               | <a href="#">Samples</a> |
| TLE2064IDRG4     | ACTIVE        | SOIC         | D                  | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 85    | TLE2064I                               | <a href="#">Samples</a> |
| TLE2064IN        | ACTIVE        | PDIP         | N                  | 14   | 25             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | -40 to 85    | TLE2064IN                              | <a href="#">Samples</a> |
| TLE2064INE4      | ACTIVE        | PDIP         | N                  | 14   | 25             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | N / A for Pkg Type   | -40 to 85    | TLE2064IN                              | <a href="#">Samples</a> |
| TLE2064MD        | ACTIVE        | SOIC         | D                  | 14   | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | TLE2064M                               | <a href="#">Samples</a> |
| TLE2064MDG4      | ACTIVE        | SOIC         | D                  | 14   | 50             | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   |              | T2064M                                 | <a href="#">Samples</a> |
| TLE2064MDR       | ACTIVE        | SOIC         | D                  | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -55 to 125   | TLE2064M                               | <a href="#">Samples</a> |
| TLE2064MDRG4     | ACTIVE        | SOIC         | D                  | 14   | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   |              | T2064M                                 | <a href="#">Samples</a> |
| TLE2064MFKB      | ACTIVE        | LCCC         | FK                 | 20   | 1              | TBD                        | POST-PLATE              | N / A for Pkg Type   | -55 to 125   | 5962-<br>9080901M2A<br>TLE2064<br>MFKB | <a href="#">Samples</a> |
| TLE2064MJ        | ACTIVE        | CDIP         | J                  | 14   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | TLE2064MJ                              | <a href="#">Samples</a> |
| TLE2064MJB       | ACTIVE        | CDIP         | J                  | 14   | 1              | TBD                        | A42                     | N / A for Pkg Type   | -55 to 125   | 5962-9080901MC<br>A<br>TLE2064MJB      | <a href="#">Samples</a> |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of  $\leq 1000$ ppm threshold. Antimony trioxide based flame retardants must also meet the  $\leq 1000$ ppm threshold requirement.

<sup>(3)</sup> MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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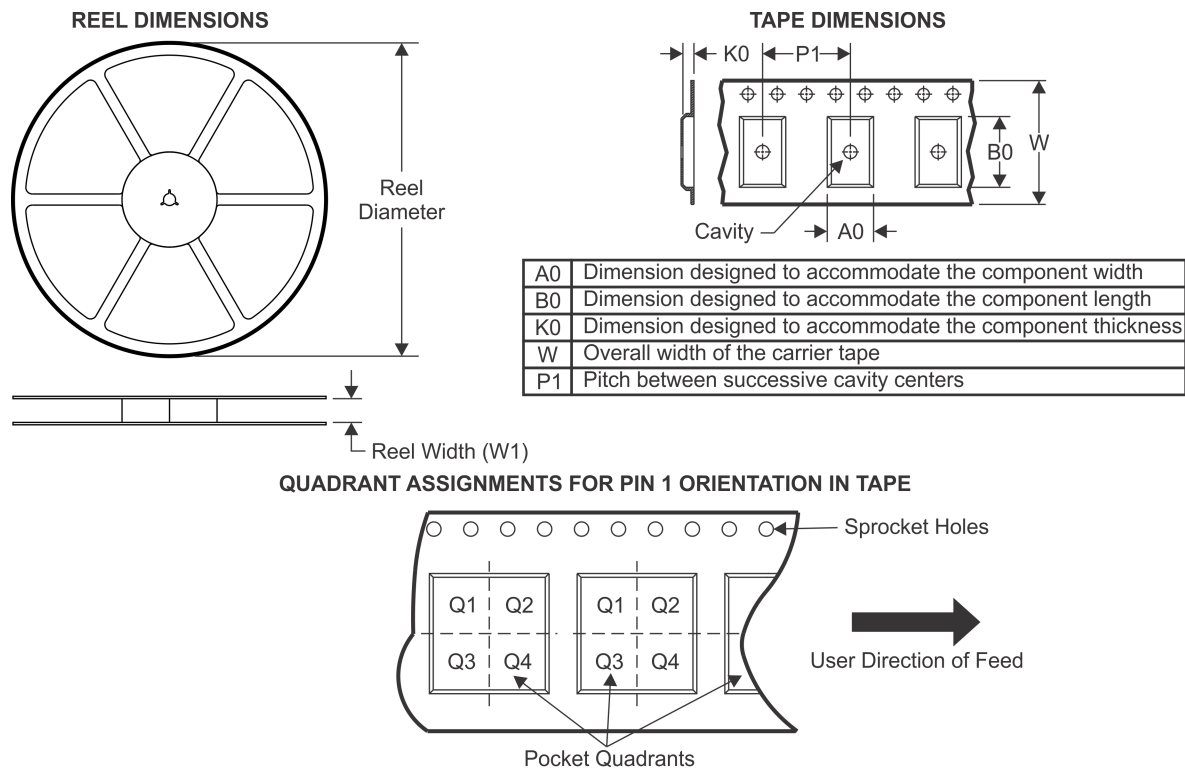
**OTHER QUALIFIED VERSIONS OF TLE2061, TLE2061A, TLE2061AM, TLE2061M, TLE2062, TLE2062A, TLE2062AM, TLE2062M, TLE2064, TLE2064A, TLE2064AM, TLE2064M :**

• Catalog: [TLE2061A](#), [TLE2061](#), [TLE2062A](#), [TLE2062](#), [TLE2064A](#), [TLE2064](#)

• Military: [TLE2061M](#), [TLE2061AM](#), [TLE2062M](#), [TLE2062AM](#), [TLE2064M](#), [TLE2064AM](#)

NOTE: Qualified Version Definitions:

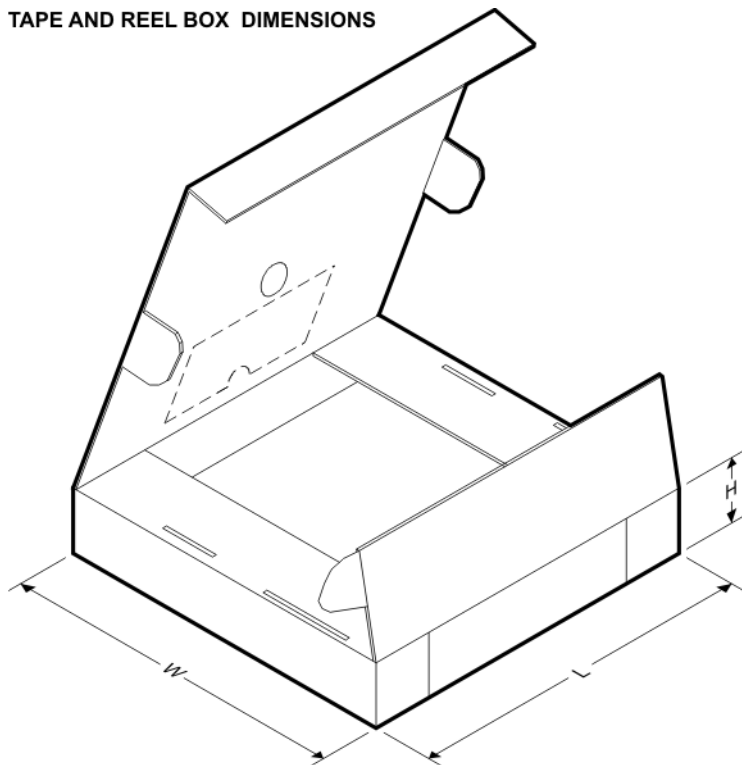
- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device      | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLE2061CDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2061IDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2062ACDR | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2062AIDR | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2062AMDR | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2062CDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2062IDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2064ACDR | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLE2064AIDR | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLE2064AMDR | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLE2064CDR  | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLE2064IDR  | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLE2064MDR  | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



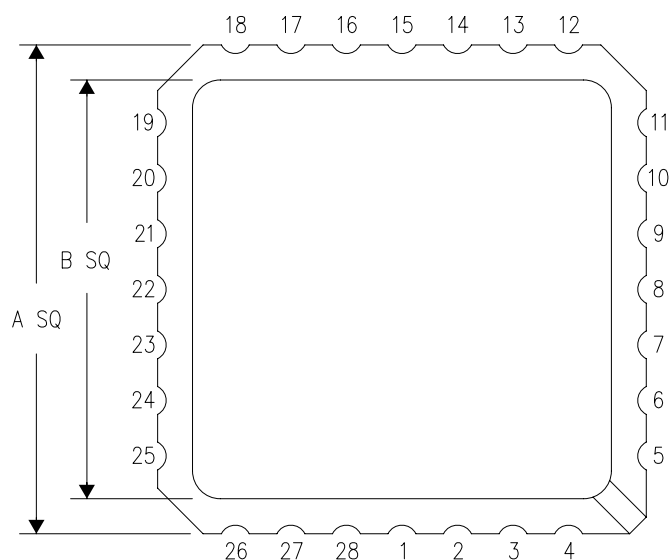
\*All dimensions are nominal

| Device      | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLE2061CDR  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2061IDR  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2062ACDR | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2062AIDR | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2062AMDR | SOIC         | D               | 8    | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2062CDR  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2062IDR  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLE2064ACDR | SOIC         | D               | 14   | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2064AIDR | SOIC         | D               | 14   | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2064AMDR | SOIC         | D               | 14   | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2064CDR  | SOIC         | D               | 14   | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2064IDR  | SOIC         | D               | 14   | 2500 | 350.0       | 350.0      | 43.0        |
| TLE2064MDR  | SOIC         | D               | 14   | 2500 | 350.0       | 350.0      | 43.0        |

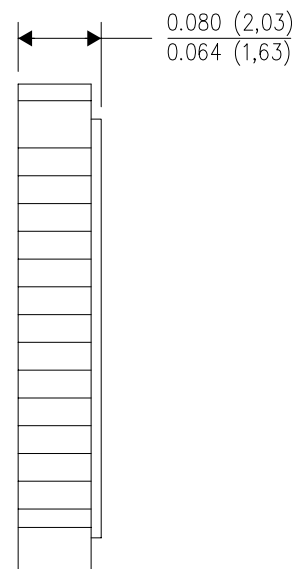
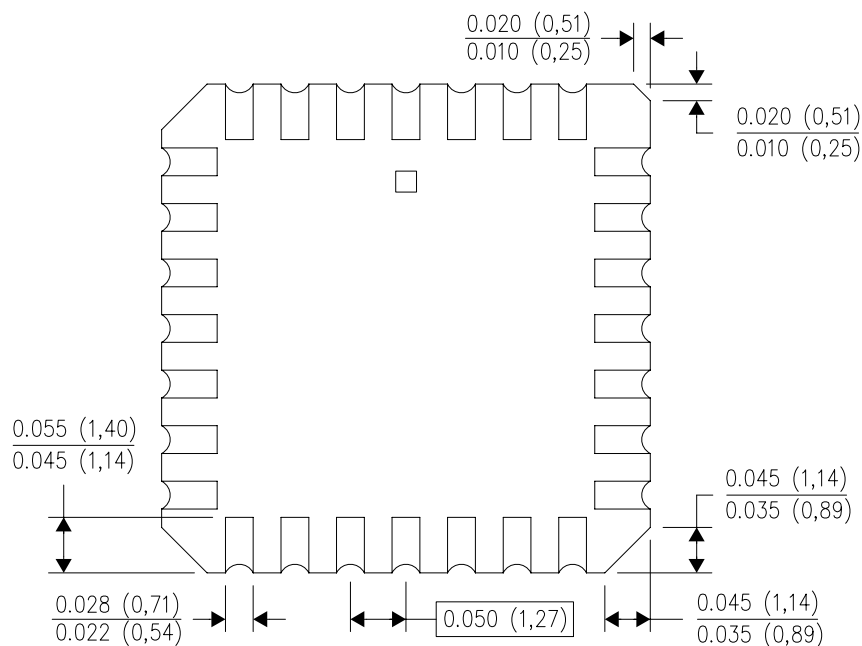
FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN

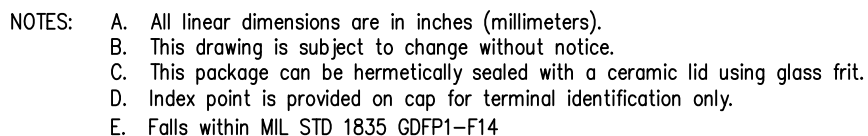


| NO. OF<br>TERMINALS<br>** | A                |                  | B                |                  |
|---------------------------|------------------|------------------|------------------|------------------|
|                           | MIN              | MAX              | MIN              | MAX              |
| 20                        | 0.342<br>(8,69)  | 0.358<br>(9,09)  | 0.307<br>(7,80)  | 0.358<br>(9,09)  |
| 28                        | 0.442<br>(11,23) | 0.458<br>(11,63) | 0.406<br>(10,31) | 0.458<br>(11,63) |
| 44                        | 0.640<br>(16,26) | 0.660<br>(16,76) | 0.495<br>(12,58) | 0.560<br>(14,22) |
| 52                        | 0.740<br>(18,78) | 0.761<br>(19,32) | 0.495<br>(12,58) | 0.560<br>(14,22) |
| 68                        | 0.938<br>(23,83) | 0.962<br>(24,43) | 0.850<br>(21,6)  | 0.858<br>(21,8)  |
| 84                        | 1.141<br>(28,99) | 1.165<br>(29,59) | 1.047<br>(26,6)  | 1.063<br>(27,0)  |



4040140/D 01/11

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - Falls within JEDEC MS-004

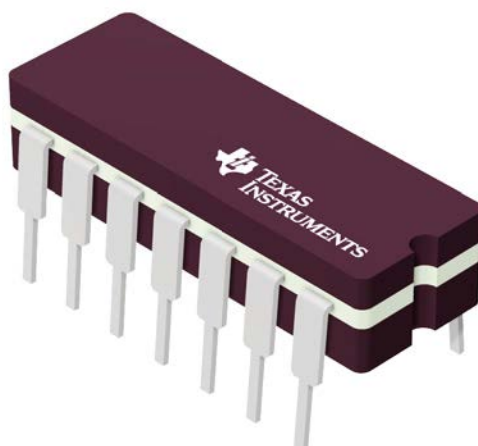


**J 14**

## GENERIC PACKAGE VIEW

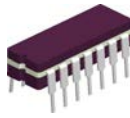
**CDIP - 5.08 mm max height**

CERAMIC DUAL IN LINE PACKAGE

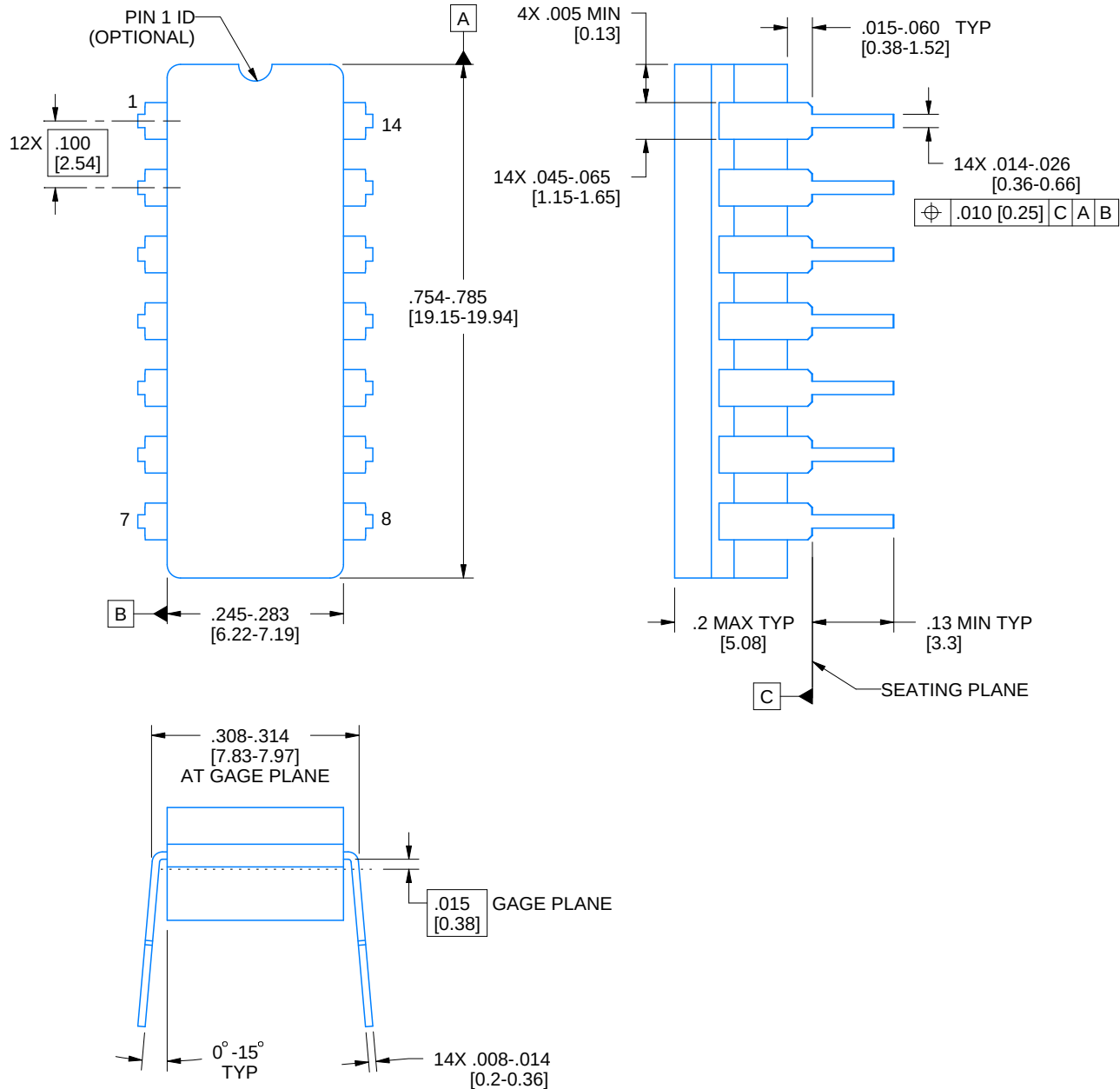


Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4040083-5/G

**J0014A****PACKAGE OUTLINE****CDIP - 5.08 mm max height**

CERAMIC DUAL IN LINE PACKAGE



4214771/A 05/2017

**NOTES:**

1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermetically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification only and on press ceramic glass frit seal only.
5. Falls within MIL-STD-1835 and GDIP1-T14.



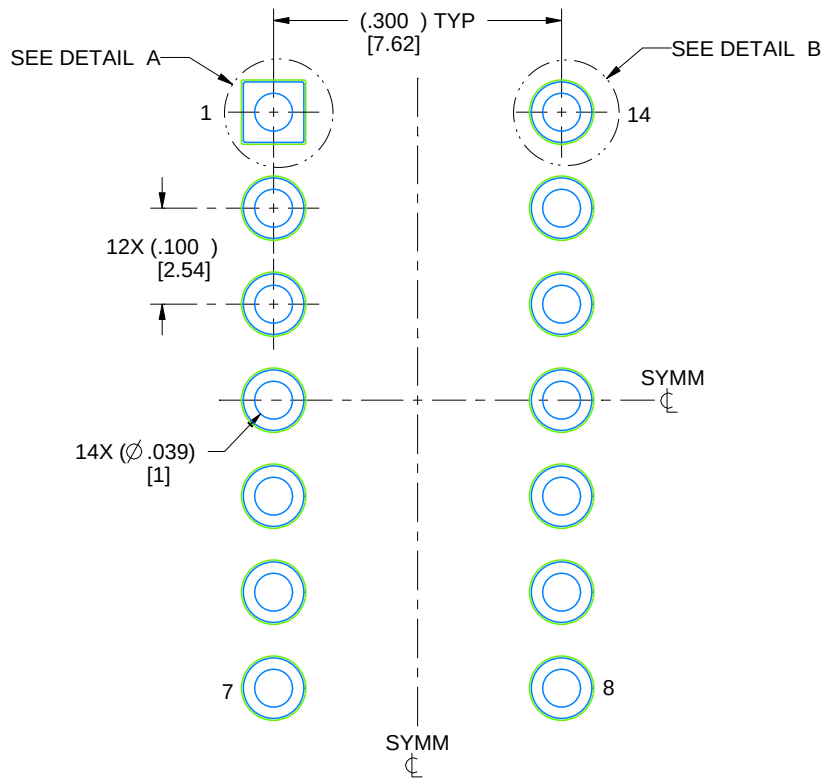
**TEXAS  
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# EXAMPLE BOARD LAYOUT

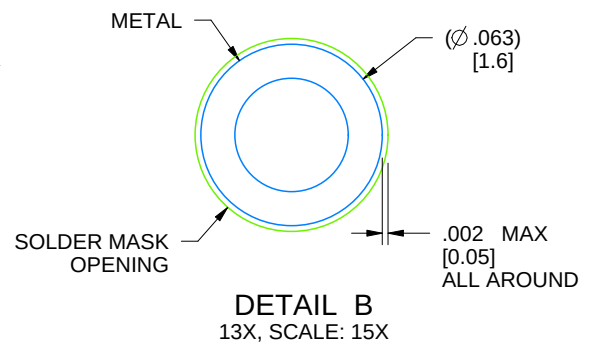
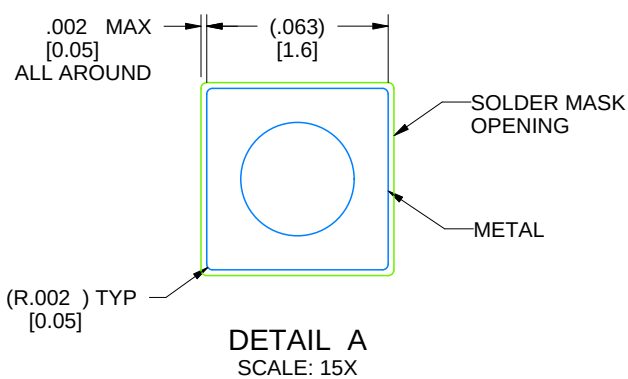
J0014A

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



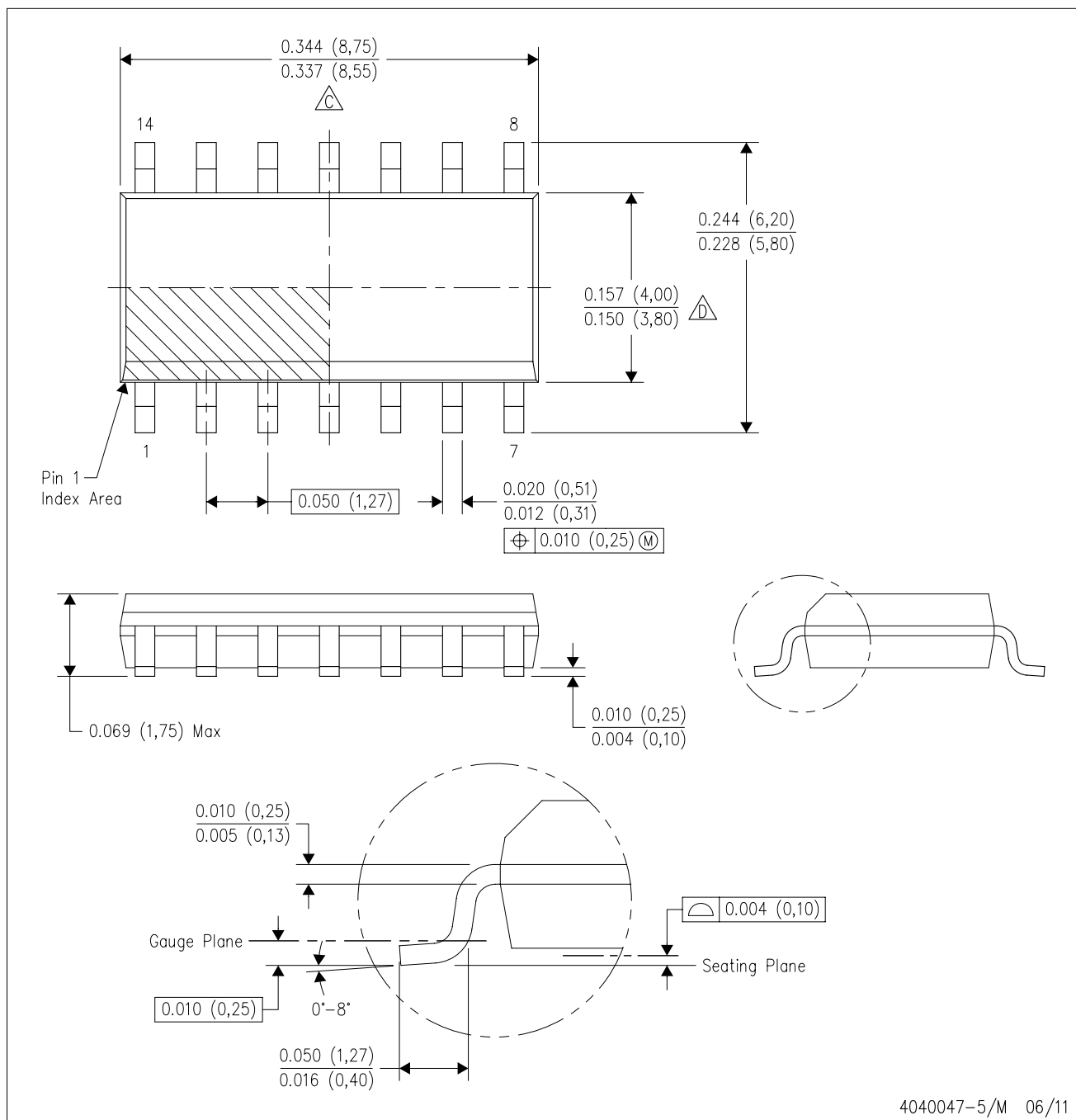
LAND PATTERN EXAMPLE  
NON-SOLDER MASK DEFINED  
SCALE: 5X



4214771/A 05/2017

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



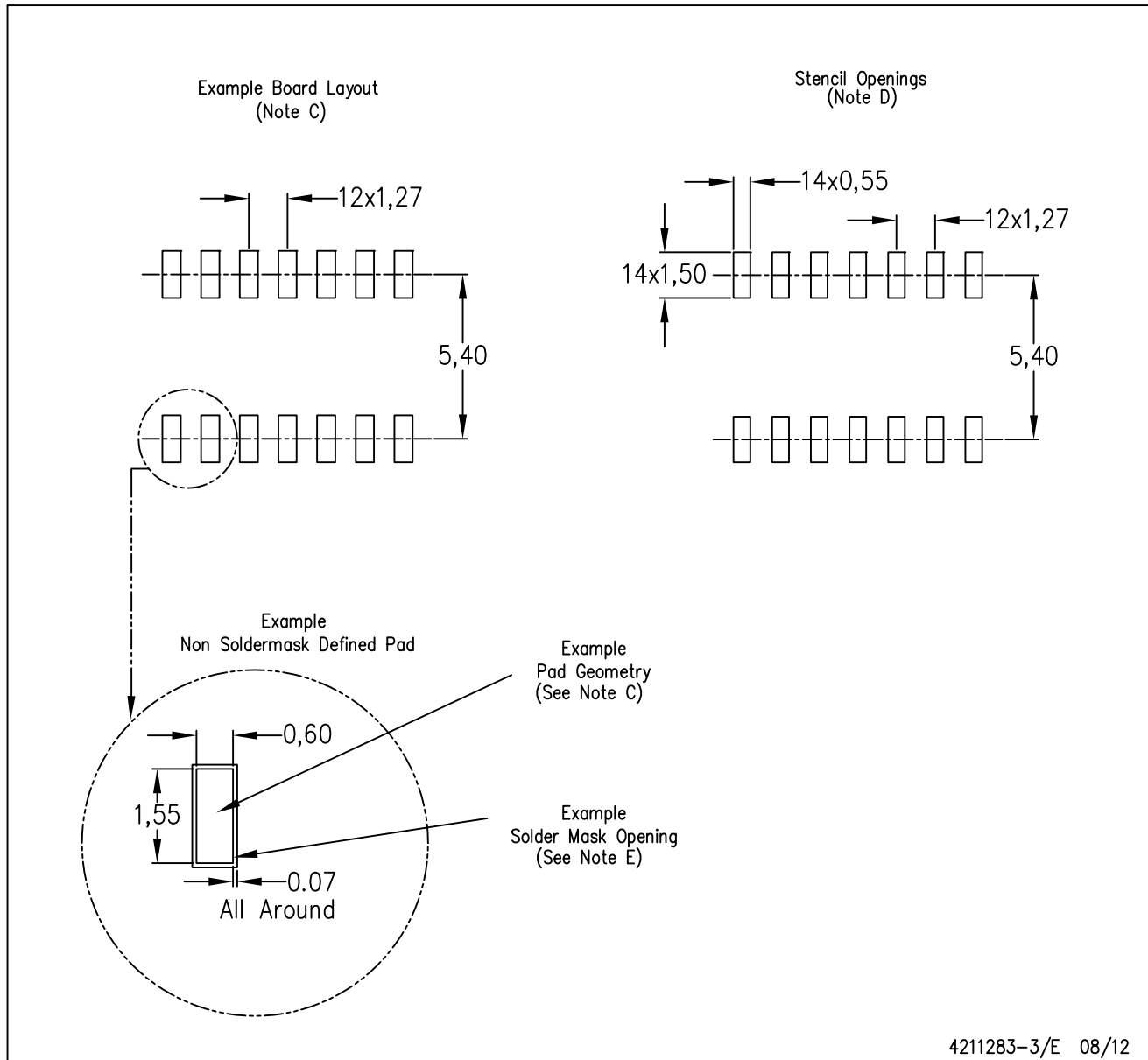
4040047-5/M 06/11

NOTES:

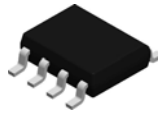
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
- D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
- E. Reference JEDEC MS-012 variation AB.

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

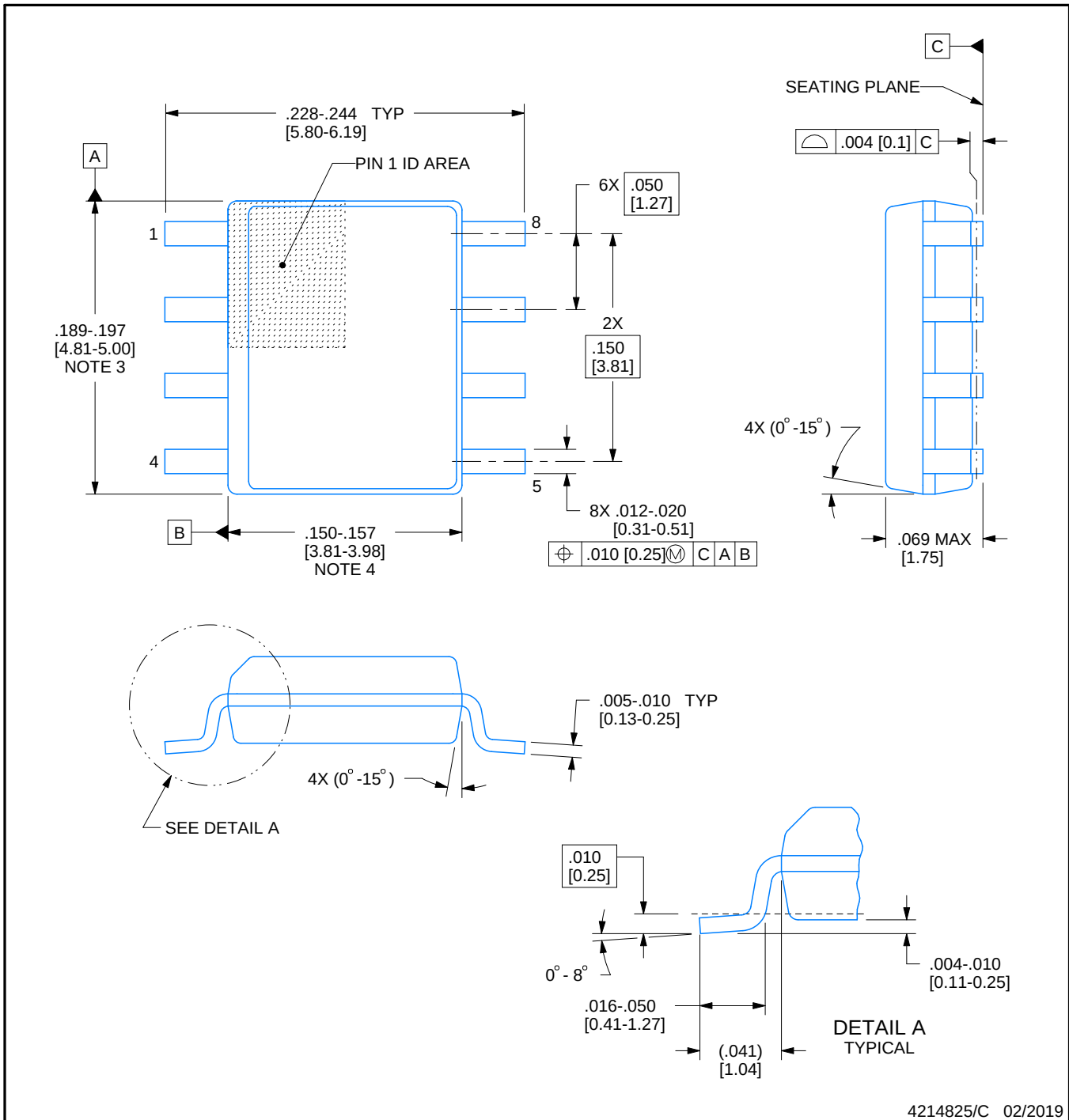


**D0008A**

# PACKAGE OUTLINE

**SOIC - 1.75 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

## NOTES:

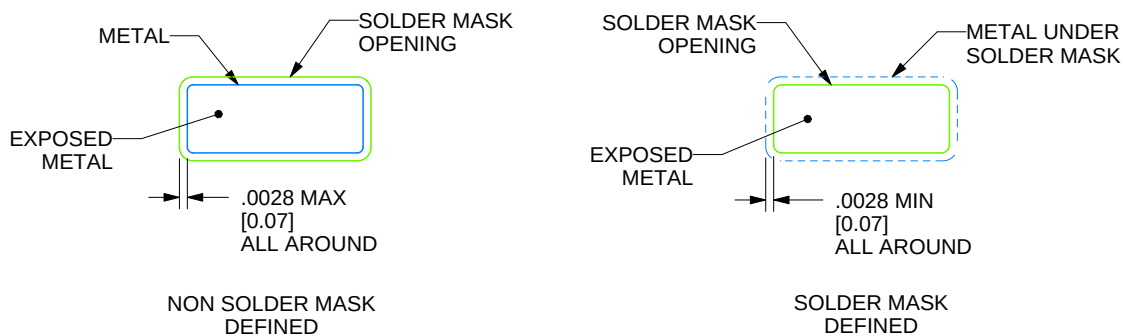
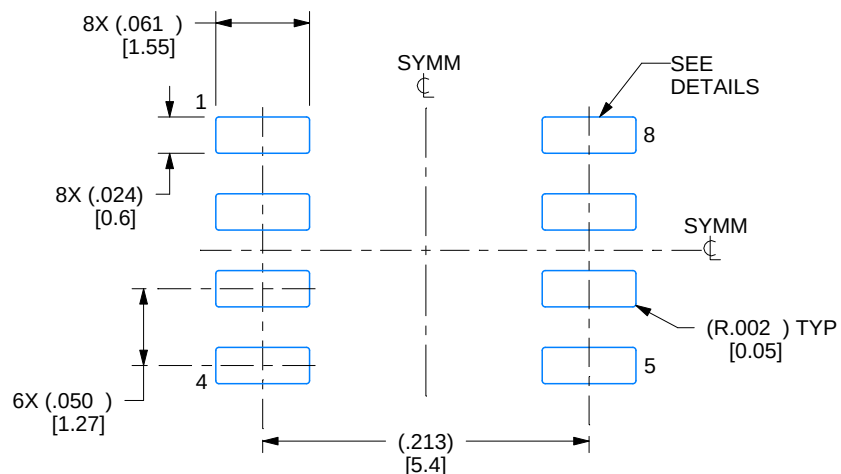
1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

# EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

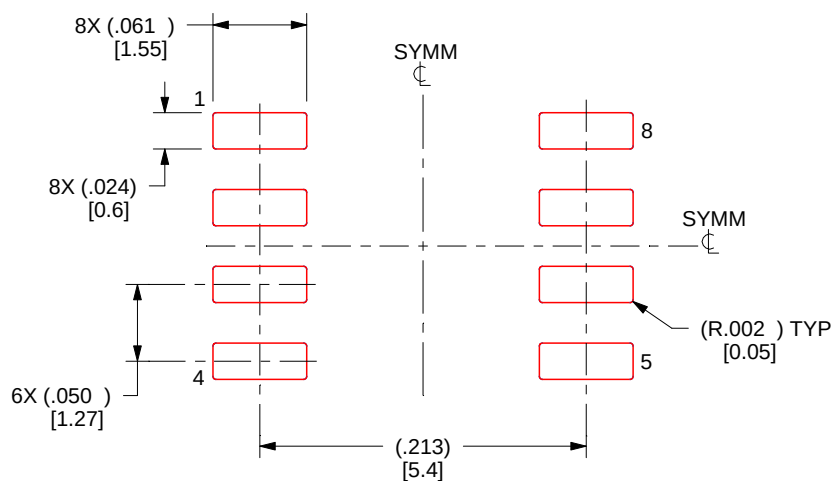
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.125 MM] THICK STENCIL  
SCALE:8X

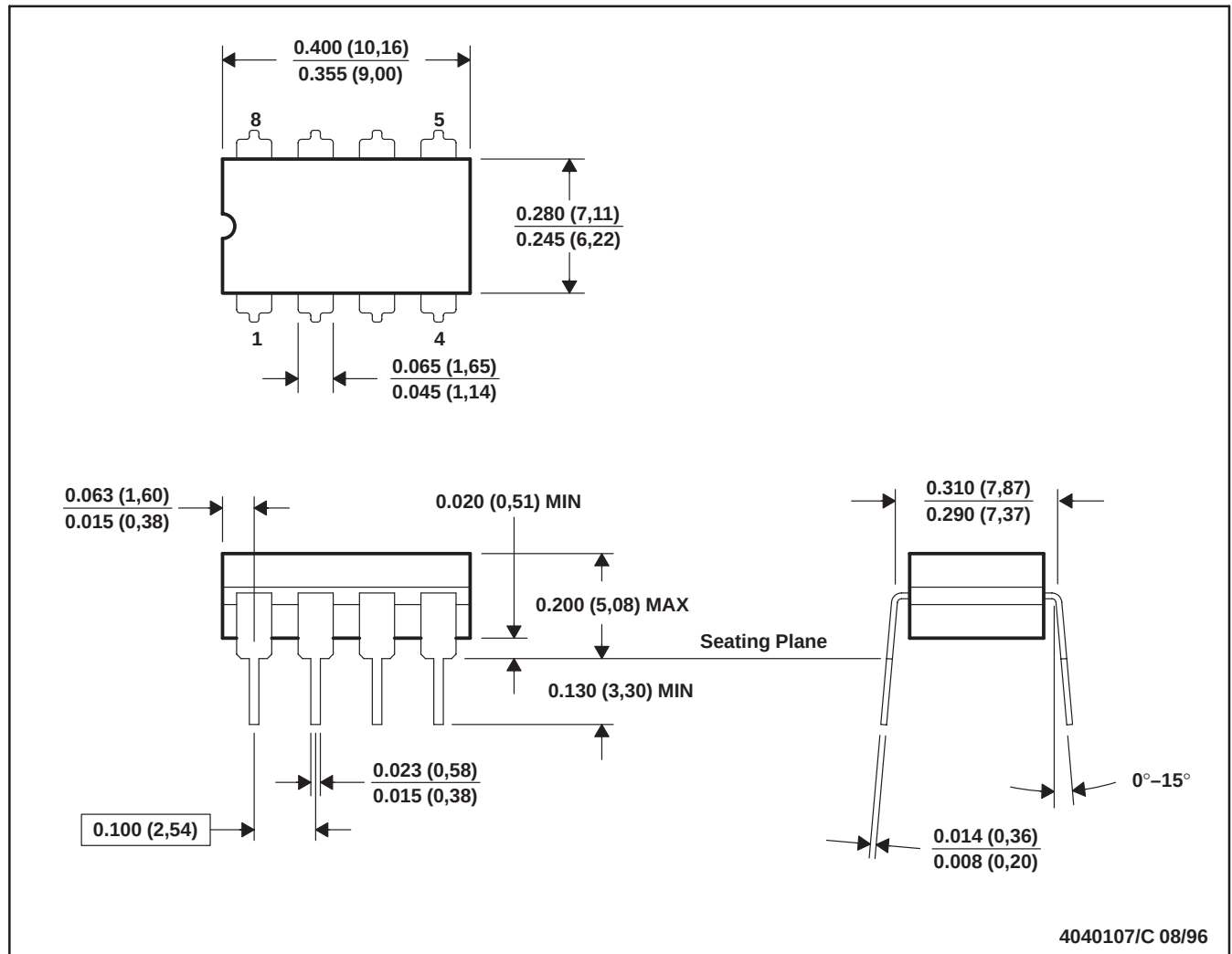
4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

## JG (R-GDIP-T8)

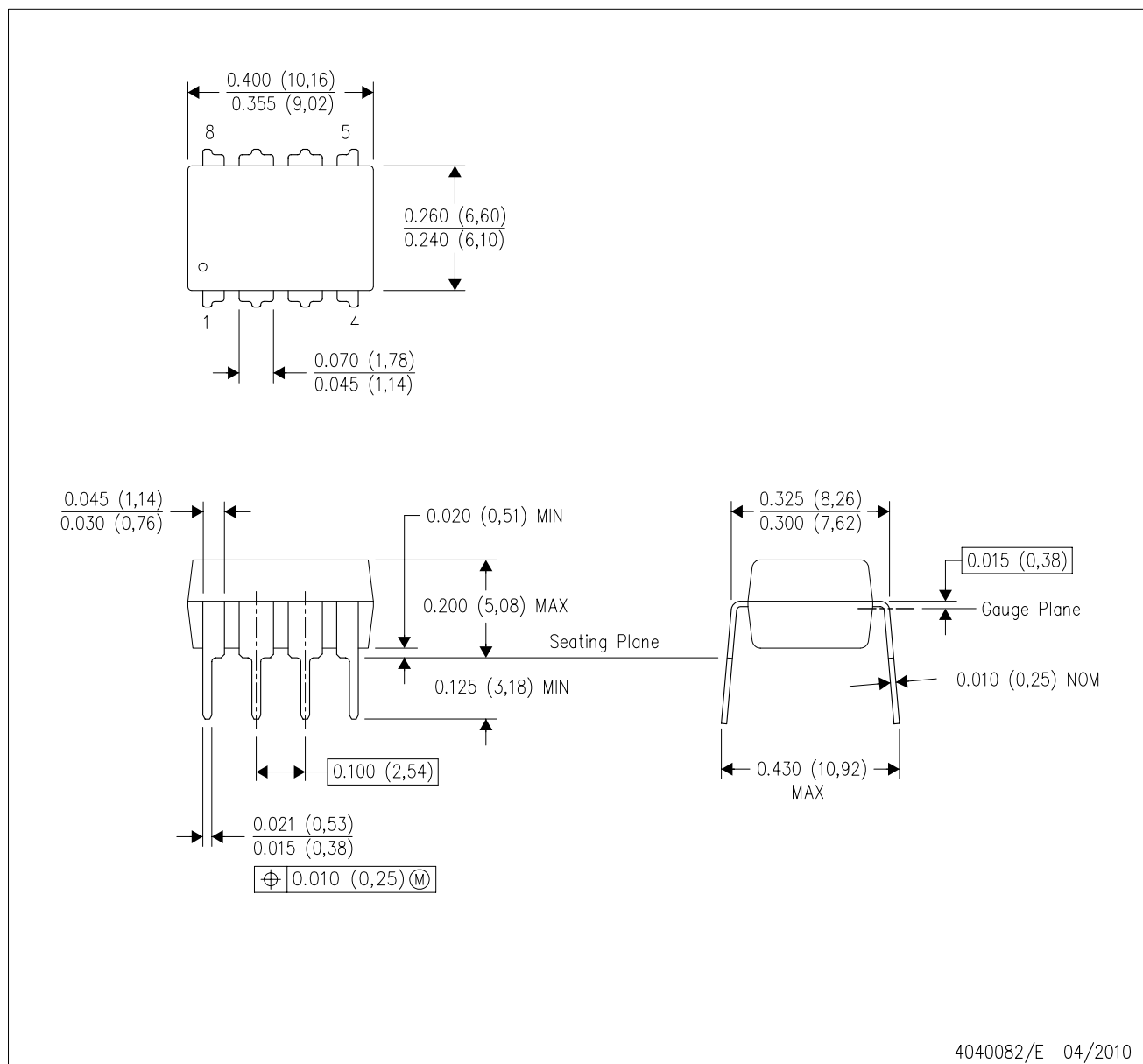
## CERAMIC DUAL-IN-LINE



- 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.
  - E. Falls within MIL STD 1835 GDIP1-T8

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE

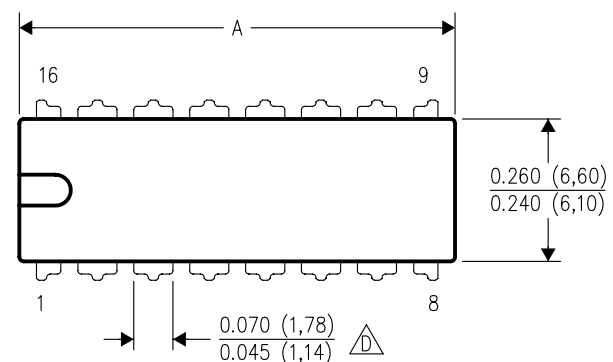


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

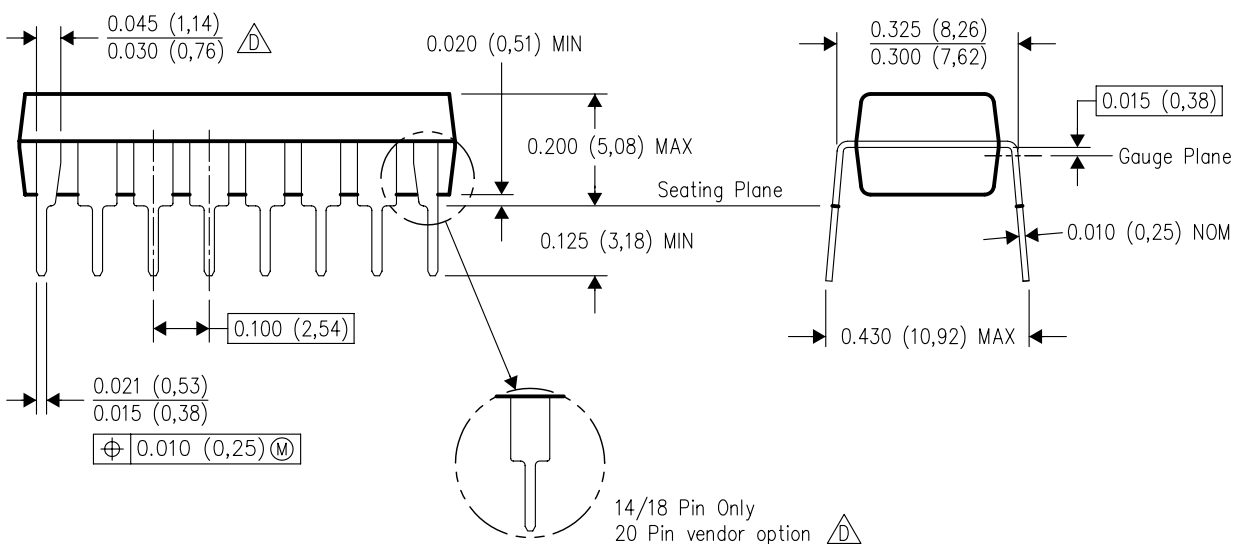
N (R-PDIP-T\*\*)

16 PINS SHOWN

## PLASTIC DUAL-IN-LINE PACKAGE



| PINS **<br>DIM      | 14               | 16               | 18               | 20               |
|---------------------|------------------|------------------|------------------|------------------|
| A MAX               | 0.775<br>(19,69) | 0.775<br>(19,69) | 0.920<br>(23,37) | 1.060<br>(26,92) |
| A MIN               | 0.745<br>(18,92) | 0.745<br>(18,92) | 0.850<br>(21,59) | 0.940<br>(23,88) |
| MS-001<br>VARIATION | AA               | BB               | AC               | AD               |



4040049/E 12/2002

NOTES:

- A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.
-  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).  
 The 20 pin end lead shoulder width is a vendor option, either half or full width.

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