

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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- Outstanding Combination of dc Precision and AC Performance:**

Unity-Gain Bandwidth . . . 15 MHz Typ

$V_n$  . . . . . 3.3 nV/ $\sqrt{\text{Hz}}$  at  $f = 10$  Hz Typ,  
2.5 nV/ $\sqrt{\text{Hz}}$  at  $f = 1$  kHz Typ

$V_{IO}$  . . . . . 25  $\mu\text{V}$  Max

$A_{VD}$  . . . . . 45 V/ $\mu\text{V}$  Typ With  $R_L = 2$  k $\Omega$ ,  
19 V/ $\mu\text{V}$  Typ With  $R_L = 600$   $\Omega$

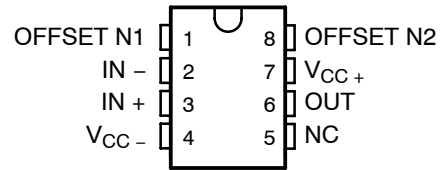
- Available in Standard-Pinout Small-Outline Package
- Output Features Saturation Recovery Circuitry
- Macromodels and Statistical information

### description

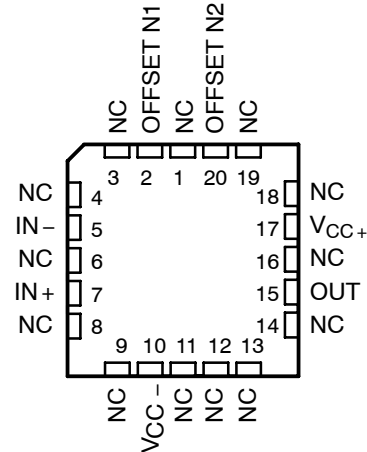
The TLE20x7 and TLE20x7A contain innovative circuit design expertise and high-quality process control techniques to produce a level of ac performance and dc precision previously unavailable in single operational amplifiers. Manufactured using Texas Instruments state-of-the-art Excalibur process, these devices allow upgrades to systems that use lower-precision devices.

In the area of dc precision, the TLE20x7 and TLE20x7A offer maximum offset voltages of 100  $\mu\text{V}$  and 25  $\mu\text{V}$ , respectively, common-mode rejection ratio of 131 dB (typ), supply voltage rejection ratio of 144 dB (typ), and dc gain of 45 V/ $\mu\text{V}$  (typ).

D, JG, OR P PACKAGE  
(TOP VIEW)



FK PACKAGE  
(TOP VIEW)



### AVAILABLE OPTIONS

| $T_A$          | $V_{IOmax}$ AT 25°C | PACKAGED DEVICES               |                            |                            |                          | CHIP FORM <sup>‡</sup> (Y) |
|----------------|---------------------|--------------------------------|----------------------------|----------------------------|--------------------------|----------------------------|
|                |                     | SMALL OUTLINE <sup>†</sup> (D) | CHIP CARRIER (FK)          | CERAMIC DIP (JG)           | PLASTIC DIP (P)          |                            |
| 0°C to 70°C    | 25 $\mu\text{V}$    | TLE2027ACD<br>TLE2037ACD       | —<br>—                     | —<br>—                     | TLE2027ACP<br>TLE2037ACP | TLE2027Y<br>TLE2037Y       |
|                | 100 $\mu\text{V}$   | TLE2027CD<br>TLE2037CD         | —<br>—                     | —<br>—                     | TLE2027CP<br>TLE2037CP   | TLE2027Y<br>TLE2037Y       |
| –40°C to 105°C | 25 $\mu\text{V}$    | TLE2027AID<br>TLE2037AID       | —<br>—                     | —<br>—                     | TLE2027AIP<br>TLE2037AIP | —                          |
|                | 100 $\mu\text{V}$   | TLE2027ID<br>TLE2037ID         | —<br>—                     | —<br>—                     | TLE2027IP<br>TLE2037IP   | —                          |
| –55°C to 125°C | 25 $\mu\text{V}$    | TLE2027AMD<br>TLE2037AMD       | TLE2027AMFK<br>TLE2037AMFK | TLE2027AMJG<br>TLE2037AMJG | TLE2027AMP<br>TLE2037AMP | —                          |
|                | 100 $\mu\text{V}$   | TLE2027MD<br>TLE2037MD         | TLE2027MFK<br>TLE2037MFK   | TLE2027MJG<br>TLE2037MJG   | TLE2027MP<br>TLE2037MP   | —                          |

<sup>†</sup> The D packages are available taped and reeled. Add R suffix to device type (e.g., TLE2027ACDR).

<sup>‡</sup> Chip forms are tested at 25°C only.



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# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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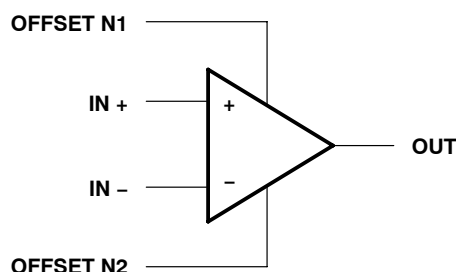
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### description (continued)

The ac performance of the TLE2027 and TLE2037 is highlighted by a typical unity-gain bandwidth specification of 15 MHz, 55° of phase margin, and noise voltage specifications of 3.3 nV/ $\sqrt{\text{Hz}}$  and 2.5 nV/ $\sqrt{\text{Hz}}$  at frequencies of 10 Hz and 1 kHz respectively. The TLE2037 and TLE2037A have been decompensated for faster slew rate ( $-7.5 \text{ V}/\mu\text{s}$ , typical) and wider bandwidth (50 MHz). To ensure stability, the TLE2037 and TLE2037A should be operated with a closed-loop gain of 5 or greater.

Both the TLE20x7 and TLE20x7A are available in a wide variety of packages, including the industry-standard 8-pin small-outline version for high-density system applications. The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from  $-40^\circ\text{C}$  to  $105^\circ\text{C}$ . The M-suffix devices are characterized for operation over the full military temperature range of  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

### symbol

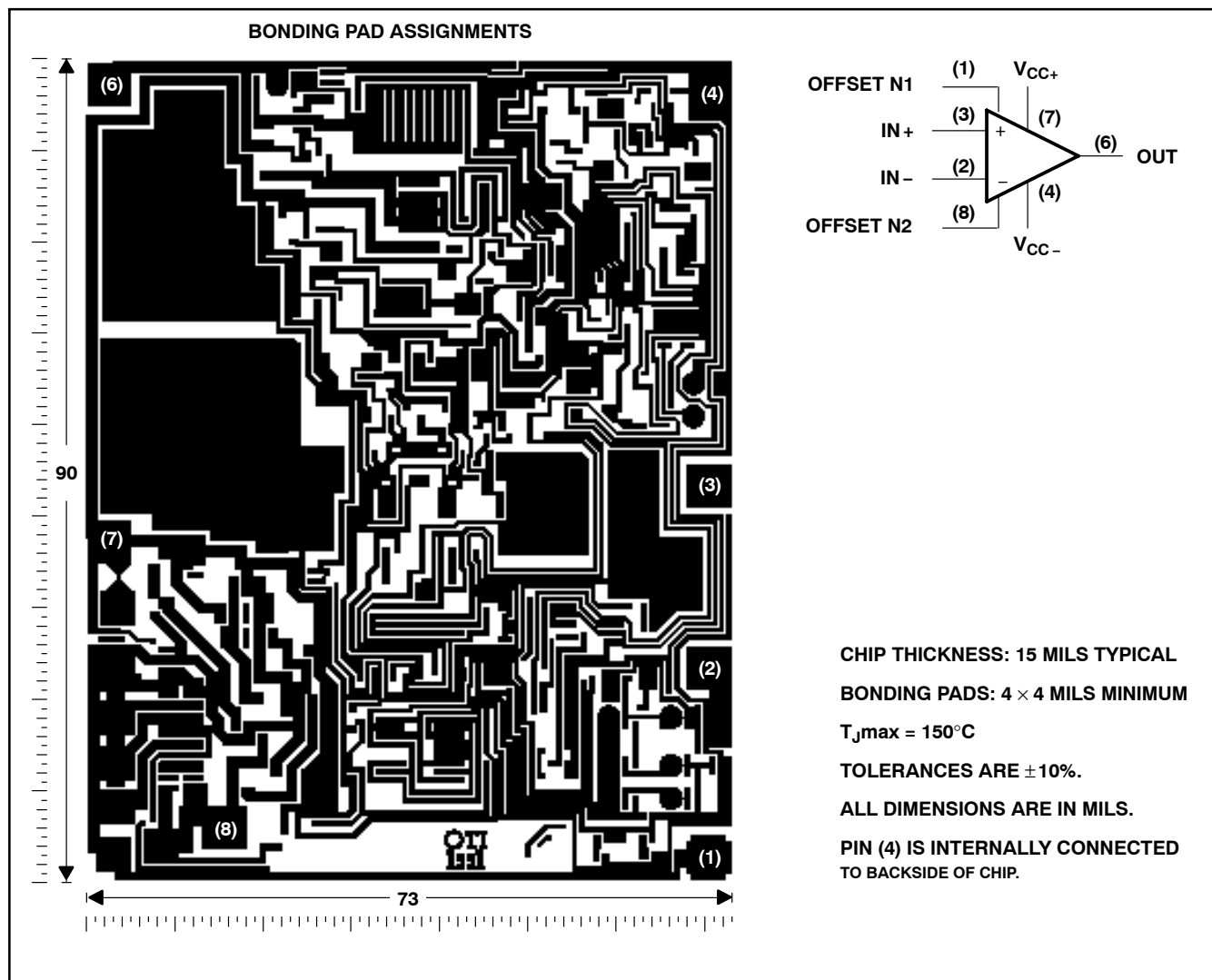


# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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## TLE202xY chip information

This chip, when properly assembled, displays characteristics similar to the TLE202xC. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. The chip may be mounted with conductive epoxy or a gold-silicon preform.



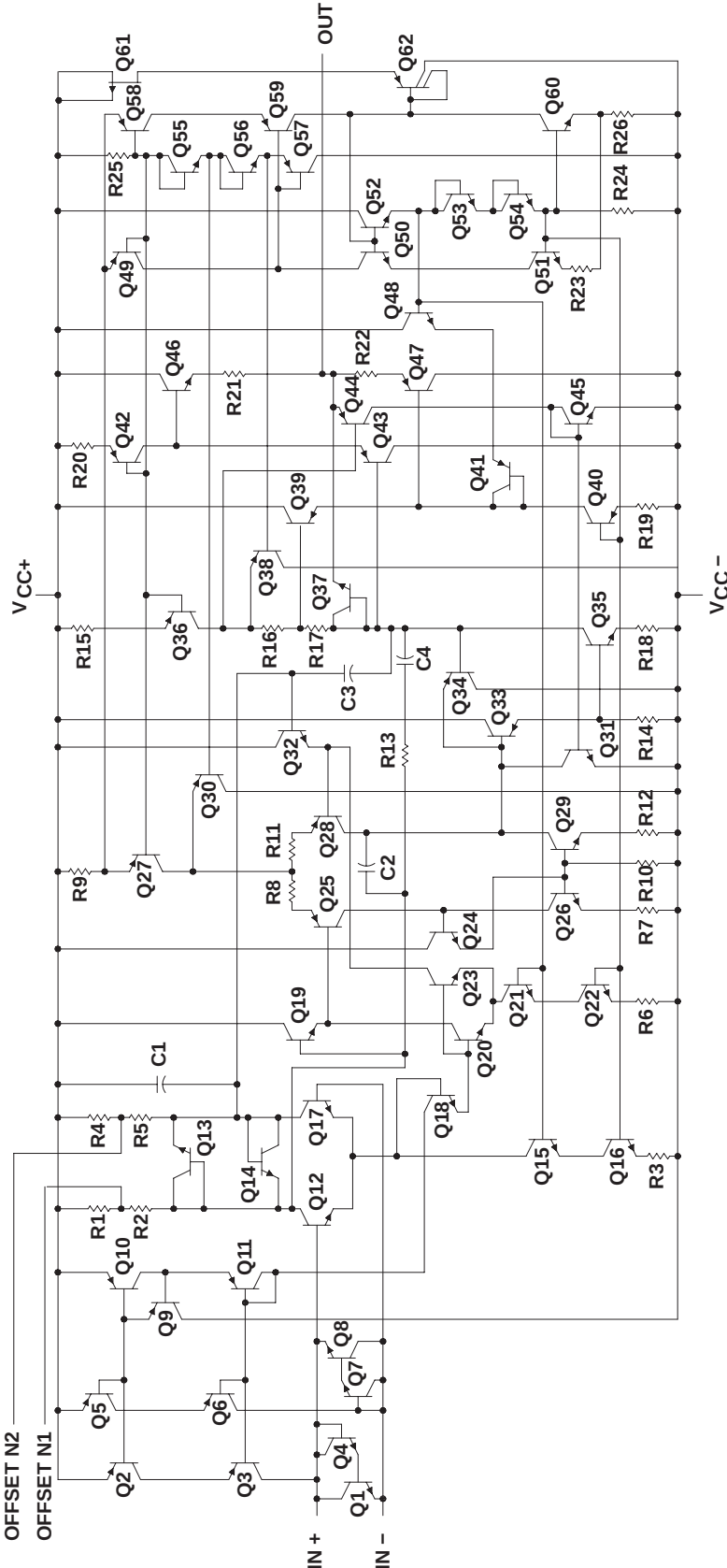
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equivalent schematic



| ACTUAL DEVICE COMPONENT COUNT |         |         |  |
|-------------------------------|---------|---------|--|
| COMPONENT                     | TLE2027 | TLE2037 |  |
| Transistors                   | 61      | 61      |  |
| Resistors                     | 26      | 26      |  |
| epiFET                        | 1       | 1       |  |
| Capacitors                    | 4       | 4       |  |

**TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y**  
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**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)                            | $\pm 1.2$ V                  |
| Input voltage range, $V_I$ (any input)                                       | $V_{CC\pm}$                  |
| Input current, $I_I$ (each Input)                                            | $\pm 1$ mA                   |
| Output current, $I_O$                                                        | $\pm 50$ mA                  |
| Total current into $V_{CC+}$                                                 | 50 mA                        |
| Total current out of $V_{CC-}$                                               | 50 mA                        |
| Duration of short-circuit current at (or below) 25°C (see Note 3)            | unlimited                    |
| Continuous total power dissipation                                           | See Dissipation Rating Table |
| Operating free-air temperature range, $T_A$ : C suffix                       | 0°C to 70°C                  |
| I suffix                                                                     | – 40°C to 105°C              |
| M suffix                                                                     | – 55°C to 125°C              |
| Storage temperature range, $T_{stg}$                                         | – 65°C to 150°C              |
| Case temperature for 60 seconds, $T_C$ : FK package                          | 260°C                        |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or P package | 260°C                        |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG 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  $IN-$ . Excessive current flows if a differential input voltage in excess of approximately  $\pm 1.2$  V is applied between the inputs unless some limiting resistance is used.
  3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

**DISSIPATION RATING TABLE**

| PACKAGE | $T_A \leq 25^\circ\text{C}$<br>POWER RATING | DERATING FACTOR<br>ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$<br>POWER RATING | $T_A = 105^\circ\text{C}$<br>POWER RATING | $T_A = 125^\circ\text{C}$<br>POWER RATING |
|---------|---------------------------------------------|---------------------------------------------------|------------------------------------------|-------------------------------------------|-------------------------------------------|
| D       | 725 mW                                      | 5.8 mW/°C                                         | 464 mW                                   | 261 mW                                    | 145 mW                                    |
| FK      | 1375 mW                                     | 11.0 mW/°C                                        | 880 mW                                   | 495 mW                                    | 275 mW                                    |
| JG      | 1050 mW                                     | 8.4 mW/°C                                         | 672 mW                                   | 378 mW                                    | 210 mW                                    |
| P       | 1000 mW                                     | 8.0 mW/°C                                         | 640 mW                                   | 360 mW                                    | 200 mW                                    |

**recommended operating conditions**

|                                       |                                    | C SUFFIX |          | I SUFFIX |          | M SUFFIX |          | UNIT |
|---------------------------------------|------------------------------------|----------|----------|----------|----------|----------|----------|------|
|                                       |                                    | MIN      | MAX      | MIN      | MAX      | MIN      | MAX      |      |
| Supply voltage, $V_{CC\pm}$           |                                    | $\pm 4$  | $\pm 19$ | $\pm 4$  | $\pm 19$ | $\pm 4$  | $\pm 19$ | V    |
| Common-mode input voltage, $V_{IC}$   | $T_A = 25^\circ\text{C}$           | – 11     | 11       | – 11     | 11       | – 11     | 11       | V    |
|                                       | $T_A = \text{Full range}^\ddagger$ | – 10.5   | 10.5     | – 10.4   | 10.4     | – 10.2   | 10.2     |      |
| Operating free-air temperature, $T_A$ |                                    | 0        | 70       | – 40     | 105      | – 55     | 125      | °C   |

<sup>‡</sup> Full range is 0°C to 70°C for C-suffix devices, – 40°C to 105°C for I-suffix devices, and – 55°C to 125°C for M-suffix devices.

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

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**TLE20x7C 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> | TLE20x7C      |           |               | TLE20x7AC |       |     | UNIT |
|-------------------|-----------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------|---------------|-----------|---------------|-----------|-------|-----|------|
|                   |                                                                       |                                                                  |                             | MIN           | TYP       | MAX           | MIN       | TYP   | MAX |      |
| V <sub>IO</sub>   | Input offset voltage                                                  | V <sub>IC</sub> = 0,      R <sub>S</sub> = 50 Ω                  | 25°C                        | 20    100     |           | 10    25      |           | μV    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 145           |           | 70            |           |       |     |      |
| α <sub>VIO</sub>  | Temperature coefficient of input offset voltage                       |                                                                  | Full range                  | 0.4    1      |           | 0.2    1      |           | μV/°C |     |      |
|                   | Input offset voltage long-term drift (see Note 4)                     |                                                                  | 25°C                        | 0.006    1    |           | 0.006    1    |           | μV/mo |     |      |
| I <sub>IO</sub>   | Input offset current                                                  |                                                                  | 25°C                        | 6    90       |           | 6    90       |           | nA    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 150           |           | 150           |           |       |     |      |
| I <sub>IB</sub>   | Input bias current                                                    |                                                                  | 25°C                        | 15    90      |           | 15    90      |           | nA    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 150           |           | 150           |           |       |     |      |
| V <sub>ICR</sub>  | Common-mode input voltage range                                       | R <sub>S</sub> = 50 Ω                                            | 25°C                        | -11 to 11     | -13 to 13 | -11 to 11     | -13 to 13 | V     |     |      |
|                   |                                                                       |                                                                  | Full range                  | -10.5 to 10.5 |           | -10.5 to 10.5 |           |       |     |      |
| V <sub>OM</sub> + | Maximum positive peak output voltage swing                            | R <sub>L</sub> = 600 Ω                                           | 25°C                        | 10.5          | 12.9      | 10.5          | 12.9      | V     |     |      |
|                   |                                                                       |                                                                  | Full range                  | 10            |           | 10            |           |       |     |      |
|                   |                                                                       | R <sub>L</sub> = 2 kΩ                                            | 25°C                        | 12            | 13.2      | 12            | 13.2      |       |     |      |
|                   |                                                                       |                                                                  | Full range                  | 11            |           | 11            |           |       |     |      |
| V <sub>OM</sub> - | Maximum negative peak output voltage swing                            | R <sub>L</sub> = 600 Ω                                           | 25°C                        | -10.5         | -13       | -10.5         | -13       | V     |     |      |
|                   |                                                                       |                                                                  | Full range                  | -10           |           | -10           |           |       |     |      |
|                   |                                                                       | R <sub>L</sub> = 2 kΩ                                            | 25°C                        | -12           | -13.5     | -12           | -13.5     |       |     |      |
|                   |                                                                       |                                                                  | Full range                  | -11           |           | -11           |           |       |     |      |
| A <sub>VD</sub>   | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±11 V,    R <sub>L</sub> = 2 kΩ                 | 25°C                        | 5             | 45        | 10            | 45        | V/μV  |     |      |
|                   |                                                                       | V <sub>O</sub> = ±10 V,    R <sub>L</sub> = 2 kΩ                 | Full range                  | 2             |           | 4             |           |       |     |      |
|                   |                                                                       | V <sub>O</sub> = ±10 V,    R <sub>L</sub> = 1 kΩ                 | 25°C                        | 3.5           | 38        | 8             | 38        |       |     |      |
|                   |                                                                       |                                                                  | Full range                  | 1             |           | 2.5           |           |       |     |      |
|                   |                                                                       | V <sub>O</sub> = ±10 V,    R <sub>L</sub> = 600 Ω                | 25°C                        | 2             | 19        | 5             | 19        |       |     |      |
|                   |                                                                       |                                                                  | Full range                  | 0.5           |           | 2             |           |       |     |      |
| C <sub>i</sub>    | Input capacitance                                                     |                                                                  | 25°C                        | 8             |           | 8             |           | pF    |     |      |
| z <sub>o</sub>    | Open-loop output impedance                                            | I <sub>O</sub> = 0                                               | 25°C                        | 50            |           | 50            |           | Ω     |     |      |
| CMRR              | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,<br>R <sub>S</sub> = 50 Ω | 25°C                        | 100           | 131       | 117           | 131       | dB    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 98            |           | 114           |           |       |     |      |
| k <sub>SVR</sub>  | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±4 V to ±18 V,<br>R <sub>S</sub> = 50 Ω       | 25°C                        | 94            | 144       | 110           | 144       | dB    |     |      |
|                   |                                                                       | V <sub>CC±</sub> = ±4 V to ±18 V,<br>R <sub>S</sub> = 50 Ω       | Full range                  | 92            |           | 106           |           |       |     |      |
| I <sub>CC</sub>   | Supply current                                                        | V <sub>O</sub> = 0,      No load                                 | 25°C                        | 3.8    5.3    |           | 3.8    5.3    |           | mA    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 5.6           |           | 5.6           |           |       |     |      |

$^\dagger$  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.

**TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y**  
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**TLE20x7C operating characteristics at specified free-air temperature,  $V_{CC} \pm = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise specified)**

| PARAMETER   |                                               | TEST CONDITIONS                                                                                                          |         | TLE20x7C         |     |     | TLE20x7AC        |     |                        | UNIT             |
|-------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|---------|------------------|-----|-----|------------------|-----|------------------------|------------------|
|             |                                               |                                                                                                                          |         | MIN              | TYP | MAX | MIN              | TYP | MAX                    |                  |
| SR          | Slew rate at unity gain                       | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ ,<br>See Figure 1                                                    | TLE2027 | 1.7              | 2.8 |     | 1.7              | 2.8 |                        | V/ $\mu\text{s}$ |
|             |                                               |                                                                                                                          | TLE2037 | 6                | 7.5 |     | 6                | 7.5 |                        |                  |
|             |                                               | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ ,<br>$T_A = 0^\circ\text{C}$ to $70^\circ\text{C}$ ,<br>See Figure 1 | TLE2027 | 1.2              |     |     | 1.2              |     |                        |                  |
|             |                                               |                                                                                                                          | TLE2037 | 5                |     |     | 5                |     |                        |                  |
| $V_n$       | Equivalent input noise voltage (see Figure 2) | $R_S = 20\text{ }\Omega$ ,<br>$f = 10\text{ Hz}$                                                                         |         | 3.3              | 8   |     | 3.3              | 4.5 | nV/ $\sqrt{\text{Hz}}$ |                  |
|             |                                               | $R_S = 20\text{ }\Omega$ ,<br>$f = 1\text{ kHz}$                                                                         |         | 2.5              | 4.5 |     | 2.5              | 3.8 |                        |                  |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage   | $f = 0.1\text{ Hz}$ to $10\text{ Hz}$                                                                                    |         | 50               | 250 |     | 50               | 130 | nV                     |                  |
| $I_n$       | Equivalent input noise current                | $f = 10\text{ Hz}$                                                                                                       |         | 10               | 25  |     | 10               | 25  | pA/ $\sqrt{\text{Hz}}$ |                  |
|             |                                               | $f = 1\text{ kHz}$                                                                                                       |         | 0.8              | 1.8 |     | 0.8              | 1.8 |                        |                  |
| THD         | Total harmonic distortion                     | $V_O = +10\text{ V}$ ,<br>$A_{VD} = 1$ ,<br>See Note 5                                                                   | TLE2027 | < 0.002%         |     |     | < 0.002%         |     |                        |                  |
|             |                                               | $V_O = +10\text{ V}$ ,<br>$A_{VD} = 5$ ,<br>See Note 5                                                                   | TLE2037 | < 0.002%         |     |     | < 0.002%         |     |                        |                  |
| $B_1$       | Unity-gain bandwidth (see Figure 3)           | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$                                                                      | TLE2027 | 9 <sup>(6)</sup> | 13  |     | 9 <sup>(6)</sup> | 13  | MHz                    |                  |
| GBW         | Gain bandwidth product                        | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$                                                                      | TLE2037 | 35               | 50  |     | 35               | 50  |                        |                  |
| $B_{OM}$    | Maximum output-swing bandwidth                | $R_L = 2\text{ k}\Omega$                                                                                                 | TLE2027 | 30               |     |     | 30               |     | kHz                    |                  |
|             |                                               |                                                                                                                          | TLE2037 | 80               |     |     | 80               |     |                        |                  |
| $\phi_m$    | Phase margin at unity gain (see Figure 3)     | $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$                                                                      | TLE2027 | 55°              |     |     | 55°              |     |                        |                  |
|             |                                               |                                                                                                                          | TLE2037 | 50°              |     |     | 50°              |     |                        |                  |

NOTE 5: Measured distortion of the source used in the analysis was 0.002%.

NOTE 6: This parameter is not production tested

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## EXCALIBUR LOW-NOISE HIGH-SPEED

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**TLE20x7I 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> | TLE20x7I      |           |               | TLE20x7AI |       |     | UNIT |
|-------------------|-----------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------|---------------|-----------|---------------|-----------|-------|-----|------|
|                   |                                                                       |                                                                  |                             | MIN           | TYP       | MAX           | MIN       | TYP   | MAX |      |
| V <sub>IO</sub>   | Input offset voltage                                                  | V <sub>IC</sub> = 0, R <sub>S</sub> = 50 Ω                       | 25°C                        | 20            | 100       | 10            | 25        | μV    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 180           |           |               | 105       |       |     |      |
| α <sub>VIO</sub>  | Temperature coefficient of input offset voltage                       |                                                                  | Full range                  | 0.4           | 1         | 0.2           | 1         | μV/°C |     |      |
|                   | Input offset voltage long-term drift (see Note 4)                     |                                                                  | 25°C                        | 0.006         | 1         | 0.006         | 1         | μV/mo |     |      |
| I <sub>IO</sub>   | Input offset current                                                  |                                                                  | 25°C                        | 6             | 90        | 6             | 90        | nA    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 150           |           |               | 150       |       |     |      |
| I <sub>IB</sub>   | Input bias current                                                    |                                                                  | 25°C                        | 15            | 90        | 15            | 90        | nA    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 150           |           |               | 150       |       |     |      |
| V <sub>ICR</sub>  | Common-mode input voltage range                                       | R <sub>S</sub> = 50 Ω                                            | 25°C                        | –11 to 11     | –13 to 13 | –11 to 11     | –13 to 13 | V     |     |      |
|                   |                                                                       |                                                                  | Full range                  | –10.4 to 10.4 |           | –10.4 to 10.4 |           |       |     |      |
| V <sub>OM</sub> + | Maximum positive peak output voltage swing                            | R <sub>L</sub> = 600 Ω                                           | 25°C                        | 10.5          | 12.9      | 10.5          | 12.9      | V     |     |      |
|                   |                                                                       |                                                                  | Full range                  | 10            |           |               | 10        |       |     |      |
|                   |                                                                       | R <sub>L</sub> = 2 kΩ                                            | 25°C                        | 12            | 13.2      | 12            | 13.2      |       |     |      |
|                   |                                                                       |                                                                  | Full range                  | 11            |           |               | 11        |       |     |      |
| V <sub>OM</sub> – | Maximum negative peak output voltage swing                            | R <sub>L</sub> = 600 Ω                                           | 25°C                        | –10.5         | –13       | –10.5         | –13       | V     |     |      |
|                   |                                                                       |                                                                  | Full range                  | –10           |           |               | –10       |       |     |      |
|                   |                                                                       | R <sub>L</sub> = 2 kΩ                                            | 25°C                        | –12           | –13.5     | –12           | –13.5     |       |     |      |
|                   |                                                                       |                                                                  | Full range                  | –11           |           |               | –11       |       |     |      |
| A <sub>VD</sub>   | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±11 V, R <sub>L</sub> = 2 kΩ                    | 25°C                        | 5             | 45        | 10            | 45        | V/μV  |     |      |
|                   |                                                                       | V <sub>O</sub> = ±10 V, R <sub>L</sub> = 2 kΩ                    | Full range                  | 2             |           |               | 3.5       |       |     |      |
|                   |                                                                       | V <sub>O</sub> = ±10 V, R <sub>L</sub> = 1 kΩ                    | 25°C                        | 3.5           | 38        | 8             | 38        |       |     |      |
|                   |                                                                       |                                                                  | Full range                  | 1             |           |               | 2.2       |       |     |      |
|                   |                                                                       | V <sub>O</sub> = ±10 V, R <sub>L</sub> = 600 Ω                   | 25°C                        | 2             | 19        | 5             | 19        |       |     |      |
|                   |                                                                       |                                                                  | Full range                  | 0.5           |           |               | 1.1       |       |     |      |
| C <sub>i</sub>    | Input capacitance                                                     |                                                                  | 25°C                        | 8             |           |               | 8         | pF    |     |      |
| z <sub>o</sub>    | Open-loop output impedance                                            | I <sub>O</sub> = 0                                               | 25°C                        | 50            |           |               | 50        | Ω     |     |      |
| CMRR              | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,<br>R <sub>S</sub> = 50 Ω | 25°C                        | 100           | 131       | 117           | 131       | dB    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 96            |           |               | 113       |       |     |      |
| k <sub>SVR</sub>  | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±4 V to ±18 V,<br>R <sub>S</sub> = 50 Ω       | 25°C                        | 94            | 144       | 110           | 144       | dB    |     |      |
|                   |                                                                       | V <sub>CC±</sub> = ±4 V to ±18 V,<br>R <sub>S</sub> = 50 Ω       | Full range                  | 90            |           |               | 105       |       |     |      |
| I <sub>CC</sub>   | Supply current                                                        | V <sub>O</sub> = 0, No load                                      | 25°C                        | 3.8           | 5.3       | 3.8           | 5.3       | mA    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 5.6           |           |               | 5.6       |       |     |      |

$^\dagger$  Full range is –40°C to 105°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.

**TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
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**TLE20x7I operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise specified)**

| PARAMETER          | TEST CONDITIONS                               |                                                                                                       | TLE20x7I |                  |     | TLE20x7AI |                  |     | UNIT   |        |
|--------------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------|----------|------------------|-----|-----------|------------------|-----|--------|--------|
|                    |                                               |                                                                                                       | MIN      | TYP              | MAX | MIN       | TYP              | MAX |        |        |
| SR                 | Slew rate at unity gain                       | R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF,<br>See Figure 1                                    | TLE2027  | 1.7              | 2.8 |           | 1.7              | 2.8 | V/μs   |        |
|                    |                                               | TLE2037                                                                                               | 6        | 7.5              |     | 6         | 7.5              |     |        |        |
|                    |                                               | R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF,<br>T <sub>A</sub> = −40°C to 85°C,<br>See Figure 1 | TLE2027  | 1.1              |     |           | 1.1              |     |        |        |
|                    |                                               | TLE2037                                                                                               | 4.7      |                  |     | 4.7       |                  |     |        |        |
| V <sub>n</sub>     | Equivalent input noise voltage (see Figure 2) | R <sub>S</sub> = 20 Ω, f = 10 Hz                                                                      |          | 3.3              | 8   |           | 3.3              | 4.5 | nV/√Hz |        |
|                    |                                               | R <sub>S</sub> = 20 Ω, f = 1 kHz                                                                      |          | 2.5              | 4.5 |           | 2.5              | 3.8 |        |        |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage   | f = 0.1 Hz to 10 Hz                                                                                   |          |                  | 50  | 250       |                  | 50  | 130    | nV     |
| I <sub>n</sub>     | Equivalent input noise current                | f = 10 Hz                                                                                             |          |                  | 10  | 25        |                  | 10  | 25     | pA/√Hz |
|                    |                                               | f = 1 kHz                                                                                             |          |                  | 0.8 | 1.8       |                  | 0.8 | 1.8    |        |
| THD                | Total harmonic distortion                     | V <sub>O</sub> = +10 V,<br>A <sub>VD</sub> = 1,<br>See Note 5                                         | TLE2027  | < 0.002%         |     |           | < 0.002%         |     |        |        |
|                    |                                               | V <sub>O</sub> = +10 V,<br>A <sub>VD</sub> = 5,<br>See Note 5                                         | TLE2037  | < 0.002%         |     |           | < 0.002%         |     |        |        |
| B <sub>1</sub>     | Unity-gain bandwidth (see Figure 3)           | R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF                                                     | TLE2027  | 9 <sup>(6)</sup> | 13  |           | 9 <sup>(6)</sup> | 13  | MHz    |        |
| GBW                | Gain bandwidth product                        | R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF                                                     | TLE2037  | 35               | 50  |           | 35               | 50  |        |        |
| B <sub>OM</sub>    | Maximum output-swing bandwidth                | R <sub>L</sub> = 2 kΩ                                                                                 | TLE2027  | 30               |     |           | 30               |     |        | kHz    |
|                    |                                               |                                                                                                       | TLE2037  | 80               |     |           | 80               |     |        |        |
| ϕ <sub>m</sub>     | Phase margin at unity gain (see Figure 3)     | R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF                                                     | TLE2027  | 55°              |     |           | 55°              |     |        |        |
|                    |                                               |                                                                                                       | TLE2037  | 50°              |     |           | 50°              |     |        |        |

NOTE 5: Measured distortion of the source used in the analysis was 0.002%.

NOTE 6: This parameter is not production tested.

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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**TLE20x7M 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> | TLE20x7M      |           |               | TLE20x7AM |       |     | UNIT |
|-------------------|-----------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------|---------------|-----------|---------------|-----------|-------|-----|------|
|                   |                                                                       |                                                                  |                             | MIN           | TYP       | MAX           | MIN       | TYP   | MAX |      |
| V <sub>IO</sub>   | Input offset voltage                                                  | V <sub>IC</sub> = 0,      R <sub>S</sub> = 50 Ω                  | 25°C                        | 20            | 100       | 10            | 25        | μV    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 200           |           |               | 105       |       |     |      |
| α <sub>VIO</sub>  | Temperature coefficient of input offset voltage                       |                                                                  | Full range                  | 0.4           | 1*        | 0.2           | 1*        | μV/°C |     |      |
|                   | Input offset voltage long-term drift (see Note 4)                     |                                                                  | 25°C                        | 0.006         | 1*        | 0.006         | 1*        | μV/mo |     |      |
| I <sub>IO</sub>   | Input offset current                                                  |                                                                  | 25°C                        | 6             | 90        | 6             | 90        | nA    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 150           |           |               | 150       |       |     |      |
| I <sub>IB</sub>   | Input bias current                                                    |                                                                  | 25°C                        | 15            | 90        | 15            | 90        | nA    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 150           |           |               | 150       |       |     |      |
| V <sub>ICR</sub>  | Common-mode input voltage range                                       | R <sub>S</sub> = 50 Ω                                            | 25°C                        | –11 to 11     | –13 to 13 | –11 to 11     | –13 to 13 | V     |     |      |
|                   |                                                                       |                                                                  | Full range                  | –10.3 to 10.3 |           | –10.4 to 10.4 |           |       |     |      |
| V <sub>OM</sub> + | Maximum positive peak output voltage swing                            | R <sub>L</sub> = 600 Ω                                           | 25°C                        | 10.5          | 12.9      | 10.5          | 12.9      | V     |     |      |
|                   |                                                                       |                                                                  | Full range                  | 10            |           |               | 10        |       |     |      |
|                   |                                                                       | R <sub>L</sub> = 2 kΩ                                            | 25°C                        | 12            | 13.2      | 12            | 13.2      |       |     |      |
|                   |                                                                       |                                                                  | Full range                  | 11            |           |               | 11        |       |     |      |
| V <sub>OM</sub> – | Maximum negative peak output voltage swing                            | R <sub>L</sub> = 600 Ω                                           | 25°C                        | –10.5         | –13       | –10.5         | –13       | V     |     |      |
|                   |                                                                       |                                                                  | Full range                  | –10           |           |               | –10       |       |     |      |
|                   |                                                                       | R <sub>L</sub> = 2 kΩ                                            | 25°C                        | –12           | –13.5     | –12           | –13.5     |       |     |      |
|                   |                                                                       |                                                                  | Full range                  | –11           |           |               | –11       |       |     |      |
| A <sub>VD</sub>   | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±11 V, R <sub>L</sub> = 2 kΩ                    | 25°C                        | 5             | 45        | 10            | 45        | V/μV  |     |      |
|                   |                                                                       | V <sub>O</sub> = ±10 V, R <sub>L</sub> = 2 kΩ                    | Full range                  | 2.5           |           |               | 3.5       |       |     |      |
|                   |                                                                       | V <sub>O</sub> = ±10 V, R <sub>L</sub> = 1 kΩ                    | 25°C                        | 3.5           | 38        | 8             | 38        |       |     |      |
|                   |                                                                       | Full range                                                       | 1.8                         |               |           | 2.2           |           |       |     |      |
|                   |                                                                       | V <sub>O</sub> = ±10 V, R <sub>L</sub> = 600 Ω                   | 25°C                        | 2             | 19        | 5             | 19        |       |     |      |
| C <sub>i</sub>    | Input capacitance                                                     |                                                                  | 25°C                        | 8             |           |               | 8         |       | pF  |      |
| z <sub>o</sub>    | Open-loop output impedance                                            | I <sub>O</sub> = 0                                               | 25°C                        | 50            |           |               | 50        |       | Ω   |      |
| CMRR              | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> ,<br>R <sub>S</sub> = 50 Ω | 25°C                        | 100           | 131       | 117           | 131       | dB    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 96            |           |               | 113       |       |     |      |
| k <sub>SVR</sub>  | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±4 V to ±18 V,<br>R <sub>S</sub> = 50 Ω       | 25°C                        | 94            | 144       | 110           | 144       | dB    |     |      |
|                   |                                                                       | V <sub>CC±</sub> = ±4 V to ±18 V,<br>R <sub>S</sub> = 50 Ω       | Full range                  | 90            |           |               | 105       |       |     |      |
| I <sub>CC</sub>   | Supply current                                                        | V <sub>O</sub> = 0,      No load                                 | 25°C                        | 3.8           | 5.3       | 3.8           | 5.3       | mA    |     |      |
|                   |                                                                       |                                                                  | Full range                  | 5.6           |           |               | 5.6       |       |     |      |

\* On products compliant to MIL-PRF-38535, this parameter is not production tested.

† 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.

**TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y**  
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**TLE20x7M operating characteristics at specified free-air temperature,  $V_{CC} \pm = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$  (unless otherwise specified)**

| PARAMETER          |                                               | TEST CONDITIONS                                                                                        |         | TLE20x7M |     |      | TLE20x7AM |     |        | UNIT   |
|--------------------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------|---------|----------|-----|------|-----------|-----|--------|--------|
|                    |                                               |                                                                                                        |         | MIN      | TYP | MAX  | MIN       | TYP | MAX    |        |
| SR                 | Slew rate at unity gain                       | R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF,<br>See Figure 1                                     | TLE2027 | 1.7      | 2.8 |      | 1.7       | 2.8 |        | V/μs   |
|                    |                                               |                                                                                                        | TLE2037 | 6*       | 7.5 |      | 6*        | 7.5 |        |        |
|                    |                                               | R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF,<br>T <sub>A</sub> = −55°C to 125°C,<br>See Figure 1 | TLE2027 | 1        |     |      | 1         |     |        |        |
|                    |                                               |                                                                                                        | TLE2037 | 4.4*     |     |      | 4.4*      |     |        |        |
| V <sub>n</sub>     | Equivalent input noise voltage (see Figure 2) | R <sub>S</sub> = 20 Ω, f = 10 Hz                                                                       |         | 3.3      | 8*  |      | 3.3       | 8*  | nV/√Hz |        |
|                    |                                               | R <sub>S</sub> = 20 Ω, f = 1 kHz                                                                       |         | 2.5      | 4*  |      | 2.5       | 4*  |        |        |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage   | f = 0.1 Hz to 10 Hz                                                                                    |         |          | 225 | 375* |           | 225 | 375*   | nV     |
| I <sub>n</sub>     | Equivalent input noise current                | f = 10 Hz                                                                                              |         |          | 25  |      |           | 25  |        | pA/√Hz |
|                    |                                               | f = 1 kHz                                                                                              |         |          | 2.5 |      |           | 2.5 |        |        |
| THD                | Total harmonic distortion                     | V <sub>O</sub> = +10 V,<br>A <sub>VD</sub> = 1,<br>See Note 5                                          | TLE2027 | < 0.002% |     |      | < 0.002%  |     |        |        |
|                    |                                               | V <sub>O</sub> = +10 V,<br>A <sub>VD</sub> = 5,<br>See Note 5                                          | TLE2037 | < 0.002% |     |      | < 0.002%  |     |        |        |
| B <sub>1</sub>     | Unity-gain bandwidth (see Figure 3)           | R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF                                                      | TLE2027 | 7*       | 13  |      | 9*        | 13  |        | MHz    |
|                    |                                               |                                                                                                        | TLE2037 | 35       | 50  |      | 35        | 50  |        |        |
| B <sub>OM</sub>    | Maximum output-swing bandwidth                | R <sub>L</sub> = 2 kΩ                                                                                  | TLE2027 | 30       |     |      | 30        |     |        | kHz    |
|                    |                                               |                                                                                                        | TLE2037 | 80       |     |      | 80        |     |        |        |
| ϕ <sub>m</sub>     | Phase margin at unity gain (see Figure 3)     | R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF                                                      | TLE2027 | 55°      |     |      | 55°       |     |        |        |
|                    |                                               |                                                                                                        | TLE2037 | 50°      |     |      | 50°       |     |        |        |

\* On products compliant to MIL-PRF-38535, this parameter is not production tested.

NOTE 5: Measured distortion of the source used in the analysis was 0.002%.

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

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### TLE20x7Y electrical characteristics, $V_{CC\pm} = \pm 15\text{ V}$ , $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| PARAMETER                                                                       | TEST CONDITIONS                                                           | TLE20x7Y |                 |     | UNIT                    |
|---------------------------------------------------------------------------------|---------------------------------------------------------------------------|----------|-----------------|-----|-------------------------|
|                                                                                 |                                                                           | MIN      | TYP             | MAX |                         |
| $V_{IO}$ Input offset voltage                                                   | $V_{IC} = 0$ , $R_S = 50\ \Omega$                                         |          | 20              |     | $\mu\text{V}$           |
| Input offset voltage long-term drift (see Note 4)                               |                                                                           |          | 0.006           |     | $\mu\text{V}/\text{mo}$ |
| $I_{IO}$ Input offset current                                                   |                                                                           |          | 6               |     | nA                      |
| $I_{IB}$ Input bias current                                                     |                                                                           |          | 15              |     | nA                      |
| $V_{ICR}$ Common-mode input voltage range                                       | $R_S = 50\ \Omega$                                                        |          | -13<br>to<br>13 |     | V                       |
| $V_{OM+}$ Maximum positive peak output voltage swing                            | $R_L = 600\ \Omega$                                                       |          | 12.9            |     | V                       |
|                                                                                 | $R_L = 2\ \text{k}\Omega$                                                 |          | 13.2            |     |                         |
| $V_{OM-}$ Maximum negative peak output voltage swing                            | $R_L = 600\ \Omega$                                                       |          | -13             |     | V                       |
|                                                                                 | $R_L = 2\ \text{k}\Omega$                                                 |          | -13.5           |     |                         |
| $A_{VD}$ Large-signal differential voltage amplification                        | $V_O = \pm 11\text{ V}$ , $R_L = 2\ \text{k}\Omega$                       |          | 45              |     | V/ $\mu\text{V}$        |
|                                                                                 | $V_O = \pm 10\text{ V}$ , $R_L = 1\ \text{k}\Omega$                       |          | 38              |     |                         |
|                                                                                 | $V_O = \pm 10\text{ V}$ , $R_L = 600\ \Omega$                             |          | 19              |     |                         |
| $C_i$ Input capacitance                                                         |                                                                           |          | 8               |     | pF                      |
| $z_o$ Open-loop output impedance                                                | $I_O = 0$                                                                 |          | 50              |     | $\Omega$                |
| CMRR Common-mode rejection ratio                                                | $V_{IC} = V_{ICR\text{min}}$ ,<br>$R_S = 50\ \Omega$                      |          | 131             |     | dB                      |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 4\text{ V}$ to $\pm 18\text{ V}$ ,<br>$R_S = 50\ \Omega$ |          | 144             |     | dB                      |
| $I_{CC}$ Supply current                                                         | $V_O = 0$ , No load                                                       |          | 3.8             |     | mA                      |

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.

**TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y**  
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**TLE20x7Y operating characteristics at specified free-air temperature,  $V_{CC} \pm = \pm 15\text{ V}$**

| PARAMETER          |                                               | TEST CONDITIONS                                                 |         | TLE20x7Y |     |     | UNIT   |
|--------------------|-----------------------------------------------|-----------------------------------------------------------------|---------|----------|-----|-----|--------|
|                    |                                               |                                                                 |         | MIN      | TYP | MAX |        |
| SR                 | Slew rate at unity gain                       | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF,<br>See Figure 1 | TLE2027 | 2.8      |     |     | V/μs   |
|                    |                                               |                                                                 | TLE2037 | 7.5      |     |     |        |
| V <sub>n</sub>     | Equivalent input noise voltage (see Figure 2) | R <sub>S</sub> = 20 Ω, f = 10 Hz                                |         | 3.3      |     |     | nV/√Hz |
|                    |                                               | R <sub>S</sub> = 20 Ω, f = 1 kHz                                |         | 2.5      |     |     |        |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage   | f = 0.1 Hz to 10 Hz                                             |         | 50       |     |     | nV     |
| I <sub>n</sub>     | Equivalent input noise current                | f = 10 Hz                                                       |         | 10       |     |     | pA/√Hz |
|                    |                                               | f = 1 kHz                                                       |         | 0.8      |     |     |        |
| THD                | Total harmonic distortion                     | V <sub>O</sub> = +10 V, A <sub>VD</sub> = 1,<br>See Note 5      | TLE2027 | <0.002%  |     |     |        |
|                    |                                               | V <sub>O</sub> = +10 V, A <sub>VD</sub> = 5,<br>See Note 5      | TLE2037 | <0.002%  |     |     |        |
| B <sub>1</sub>     | Unity-gain bandwidth (see Figure 3)           | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF                  | TLE2027 | 13       |     |     | MHz    |
|                    |                                               |                                                                 | TLE2037 | 50       |     |     |        |
| B <sub>OM</sub>    | Maximum output-swing bandwidth                | R <sub>L</sub> = 2 kΩ                                           | TLE2027 | 30       |     |     | kHz    |
|                    |                                               |                                                                 | TLE2037 | 80       |     |     |        |
| φ <sub>m</sub>     | Phase margin at unity gain (see Figure 3)     | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF                  | TLE2027 | 55°      |     |     |        |
|                    |                                               |                                                                 | TLE2037 | 50°      |     |     |        |

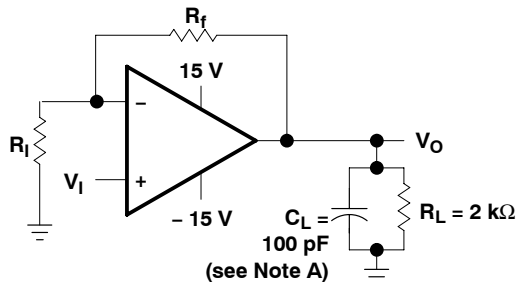
NOTE 5: Measured distortion of the source used in the analysis was 0.002%.

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

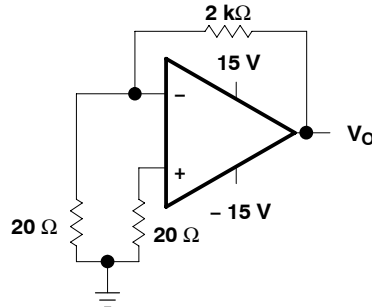
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### PARAMETER MEASUREMENT INFORMATION

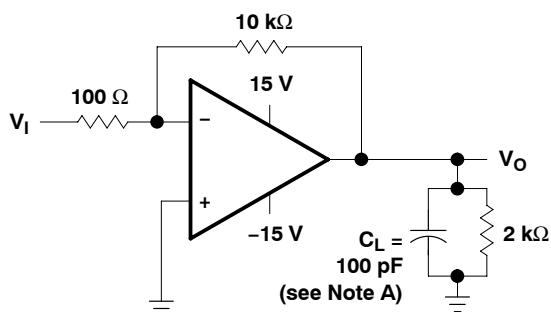


NOTE A:  $C_L$  includes fixture capacitance.

**Figure 1. Slew-Rate Test Circuit**

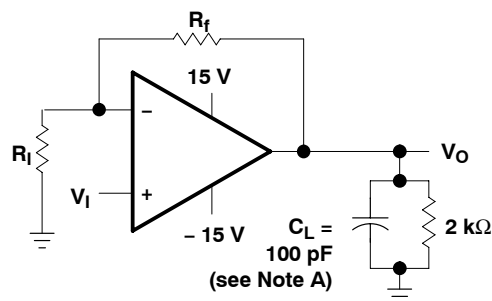


**Figure 2. Noise-Voltage Test Circuit**



NOTE A:  $C_L$  includes fixture capacitance.

**Figure 3. Unity-Gain Bandwidth and Phase-Margin Test Circuit (TLE2027 Only)**



NOTES: A.  $C_L$  includes fixture capacitance.  
B. For the TLE2037 and TLE2037A,  $A_{VD}$  must be  $\geq 5$ .

**Figure 4. Small-Signal Pulse-Response Test Circuit**

## typical values

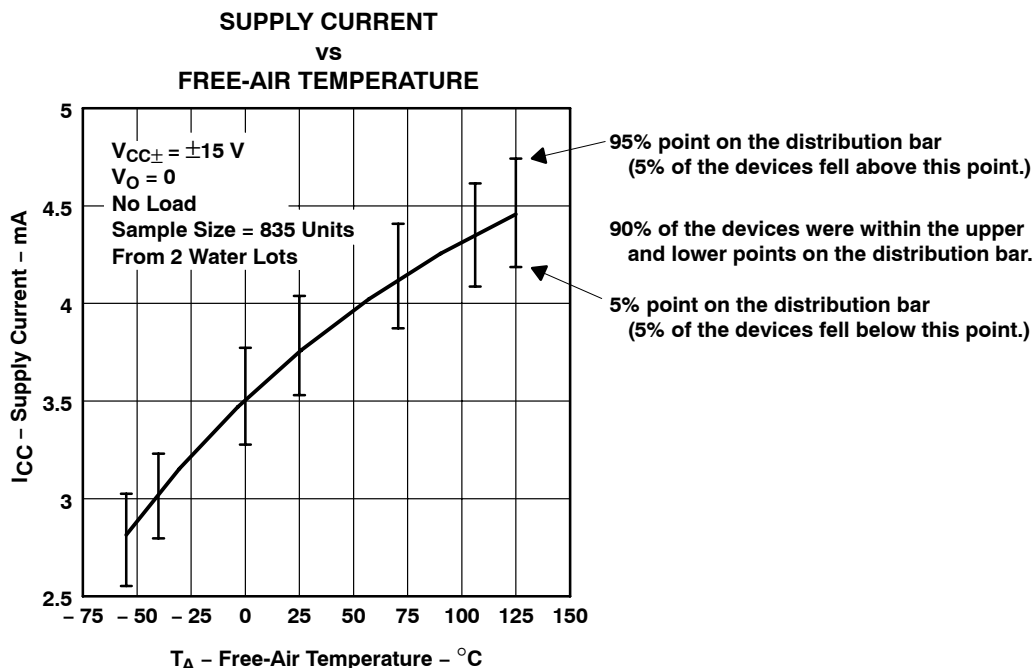
Typical values presented in this data sheet represent the median (50% point) of device parametric performance.

## initial estimates of parameter distributions

In the ongoing program of improving data sheets and supplying more information to our customers, Texas Instruments has added an estimate of not only the typical values but also the spread around these values. These are in the form of distribution bars that show the 95% (upper) points and the 5% (lower) points from the characterization of the initial wafer lots of this new device type (see Figure 5). The distribution bars are shown at the points where data was actually collected. The 95% and 5% points are used instead of  $\pm 3$  sigma since some of the distributions are not true Gaussian distributions.

The number of units tested and the number of different wafer lots used are on all of the graphs where distribution bars are shown. As noted in Figure 5, there were a total of 835 units from two wafer lots. In this case, there is a good estimate for the within-lot variability and a possibly poor estimate of the lot-to-lot variability. This is always the case on newly released products since there can only be data available from a few wafer lots.

The distribution bars are not intended to replace the minimum and maximum limits in the electrical tables. Each distribution bar represents 90% of the total units tested at a specific temperature. While 10% of the units tested fell outside any given distribution bar, this should not be interpreted to mean that the same individual devices fell outside every distribution bar.



**Figure 5. Sample Graph With Distribution Bars**

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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### TYPICAL CHARACTERISTICS

Table of Graphs

|                 |                                                 |                               | FIGURE  |
|-----------------|-------------------------------------------------|-------------------------------|---------|
| $V_{IO}$        | Input offset voltage                            | Distribution                  | 6, 7    |
| $\Delta V_{IO}$ | Input offset voltage change                     | vs Time after power on        | 8, 9    |
| $I_{IO}$        | Input offset current                            | vs Free-air temperature       | 10      |
| $I_{IB}$        | Input bias current                              | vs Free-air temperature       | 11      |
|                 |                                                 | vs Common-mode input voltage  | 12      |
| $I_I$           | Input current                                   | vs Differential input voltage | 13      |
| $V_{O(PP)}$     | Maximum peak-to-peak output voltage             | vs Frequency                  | 14, 15  |
| $V_{OM}$        | Maximum (positive/negative) peak output voltage | vs Load resistance            | 16, 17  |
|                 |                                                 | vs Free-air temperature       | 18, 19  |
| $A_{VD}$        | Large-signal differential voltage amplification | vs Supply voltage             | 20      |
|                 |                                                 | vs Load resistance            | 21      |
|                 |                                                 | vs Frequency                  | 22 – 25 |
|                 |                                                 | vs Free-air temperature       | 26      |
| $z_o$           | Output impedance                                | vs Frequency                  | 27      |
| CMRR            | Common-mode rejection ratio                     | vs Frequency                  | 28      |
| $k_{SVR}$       | Supply-voltage rejection ratio                  | vs Frequency                  | 29      |
| $I_{OS}$        | Short-circuit output current                    | vs Supply voltage             | 30, 31  |
|                 |                                                 | vs Elapsed time               | 32, 33  |
|                 |                                                 | vs Free-air temperature       | 34, 35  |
| $I_{CC}$        | Supply current                                  | vs Supply voltage             | 36      |
|                 |                                                 | vs Free-air temperature       | 37      |
|                 | Voltage-follower pulse response                 | Small signal                  | 38, 40  |
|                 |                                                 | Large signal                  | 39, 41  |
| $V_n$           | Equivalent input noise voltage                  | vs Frequency                  | 42      |
|                 | Noise voltage (referred to input)               | Over 10-second interval       | 43      |
| $B_1$           | Unity-gain bandwidth                            | vs Supply voltage             | 44      |
|                 |                                                 | vs Load capacitance           | 45      |
|                 | Gain bandwidth product                          | vs Supply voltage             | 46      |
|                 |                                                 | vs Load capacitance           | 47      |
| SR              | Slew rate                                       | vs Free-air temperature       | 48, 49  |
| $\phi_m$        | Phase margin                                    | vs Supply voltage             | 50, 51  |
|                 |                                                 | vs Load capacitance           | 52, 53  |
|                 |                                                 | vs Free-air temperature       | 54, 55  |
|                 | Phase shift                                     | vs Frequency                  | 22 – 25 |

## TYPICAL CHARACTERISTICS

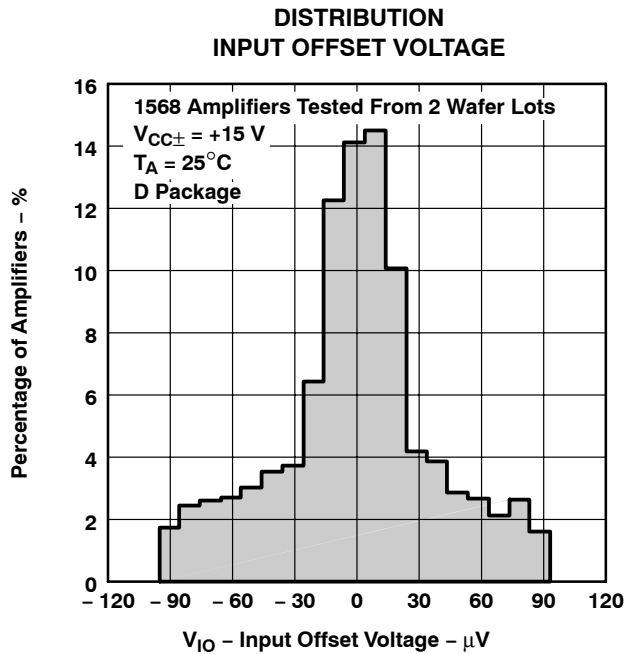


Figure 6

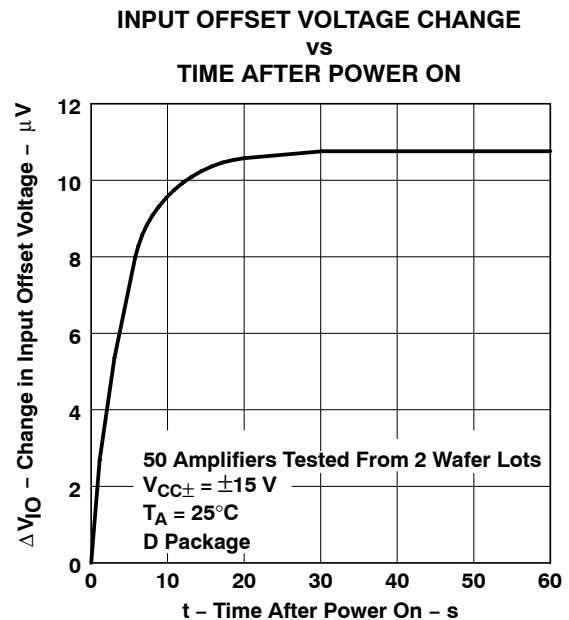


Figure 7

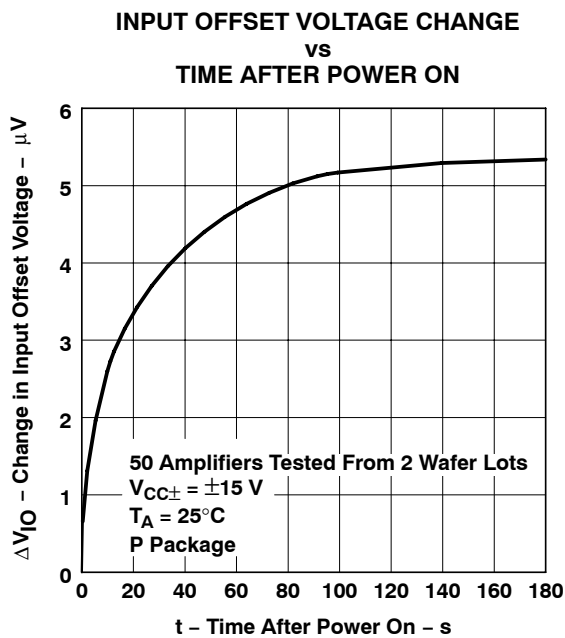


Figure 8

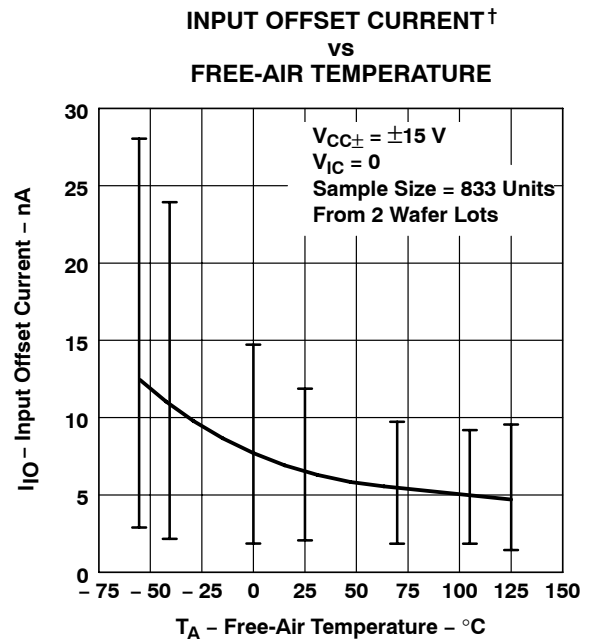


Figure 9

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

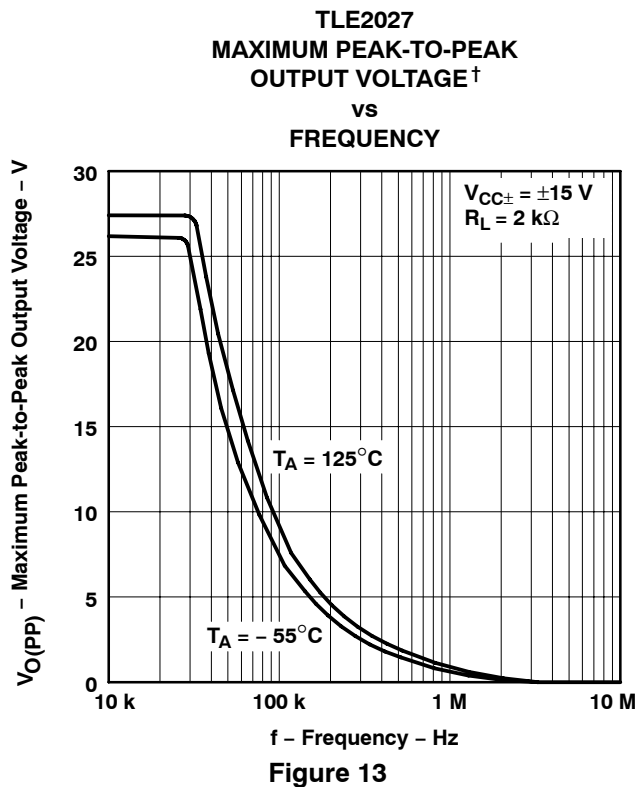
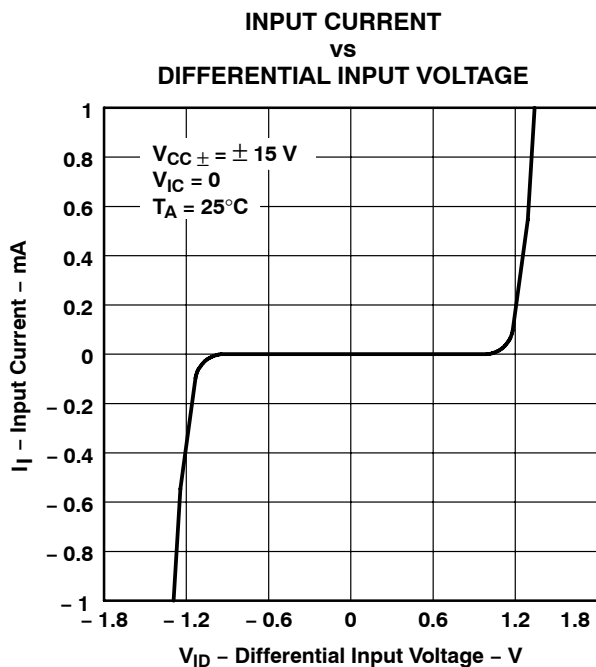
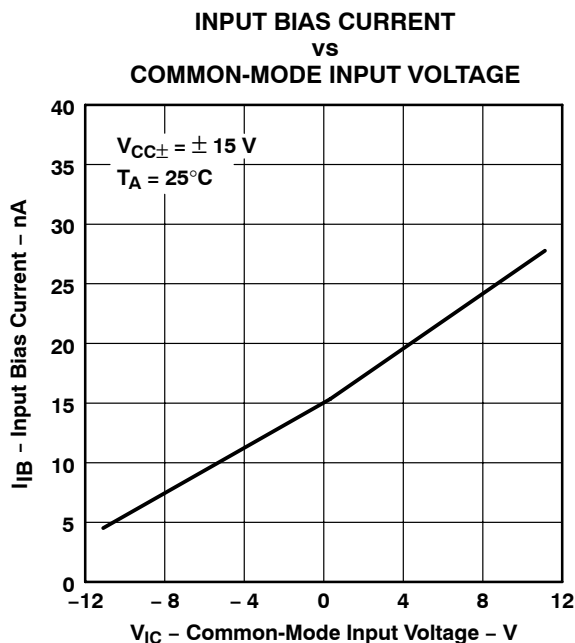
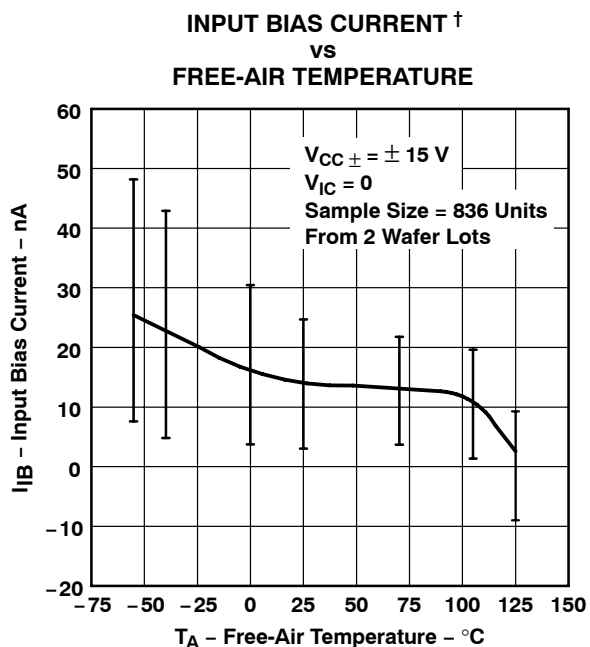
# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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### TYPICAL CHARACTERISTICS



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

## TYPICAL CHARACTERISTICS

**TLE2037**  
**MAXIMUM PEAK-TO-PEAK**  
**OUTPUT VOLTAGE<sup>†</sup>**  
**vs**  
**FREQUENCY**

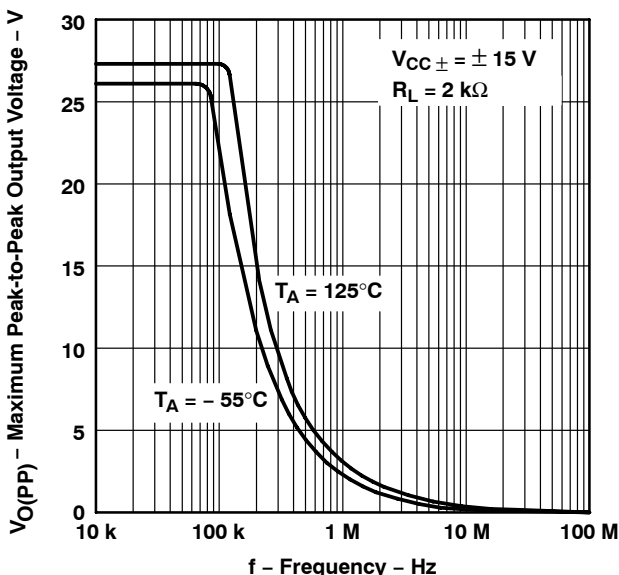


Figure 14

**MAXIMUM POSITIVE PEAK**  
**OUTPUT VOLTAGE**  
**vs**  
**LOAD RESISTANCE**

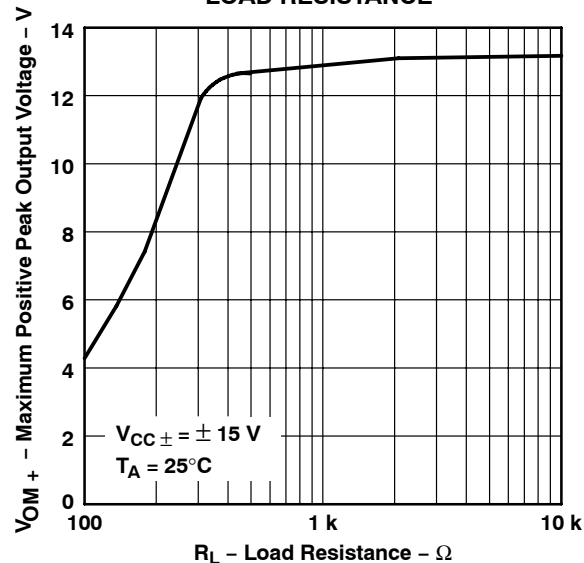


Figure 15

**MAXIMUM NEGATIVE PEAK**  
**OUTPUT VOLTAGE**  
**vs**  
**LOAD RESISTANCE**

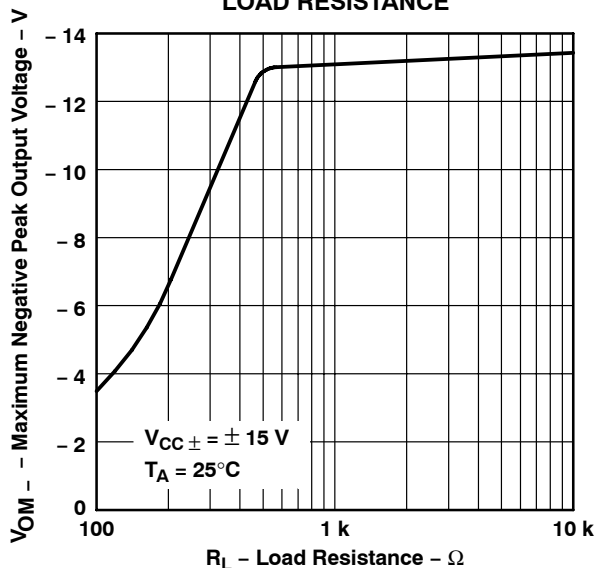


Figure 16

**MAXIMUM POSITIVE PEAK**  
**OUTPUT VOLTAGE<sup>†</sup>**  
**vs**  
**FREE-AIR TEMPERATURE**

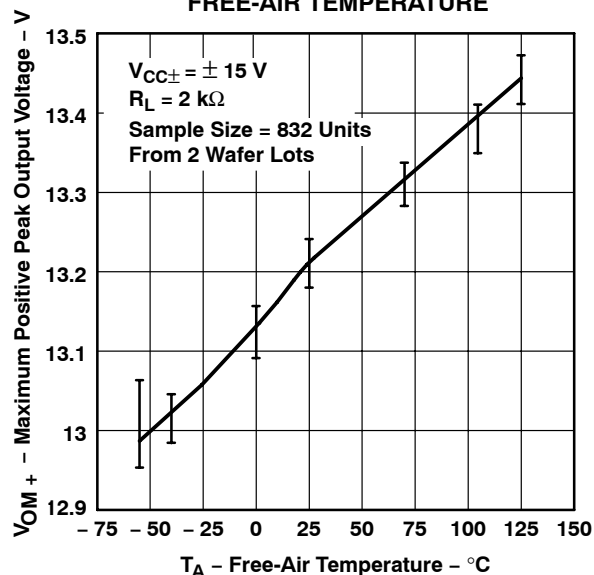


Figure 17

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

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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### TYPICAL CHARACTERISTICS

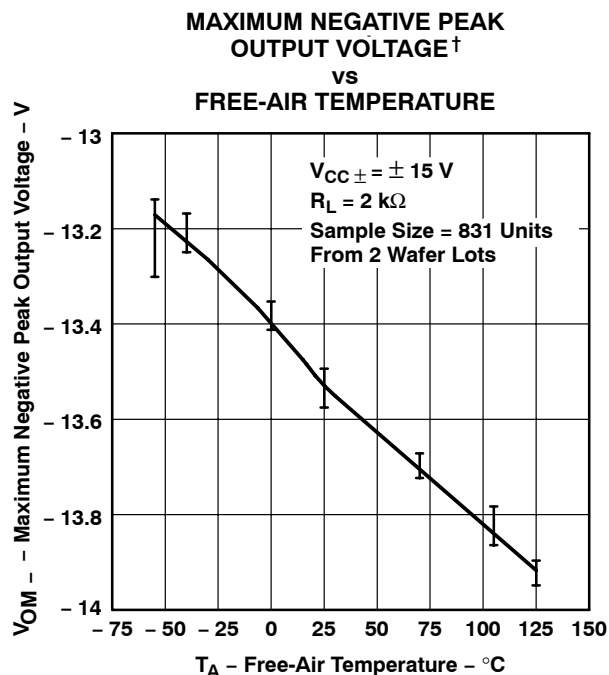


Figure 18

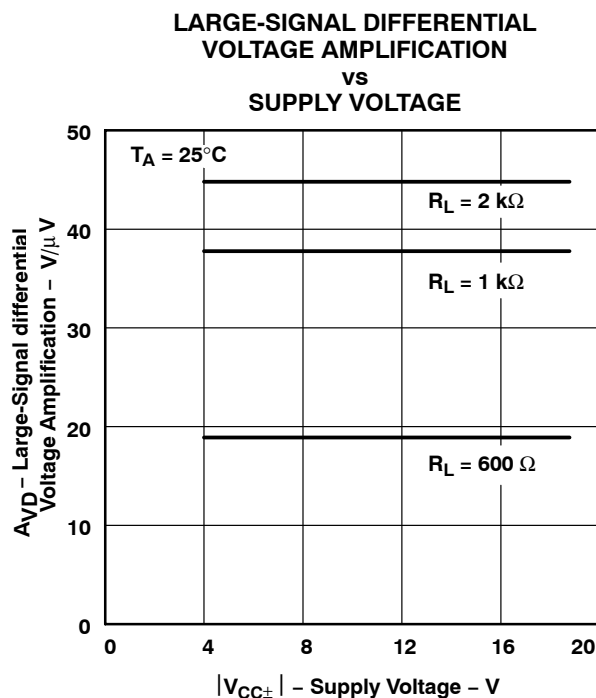


Figure 19

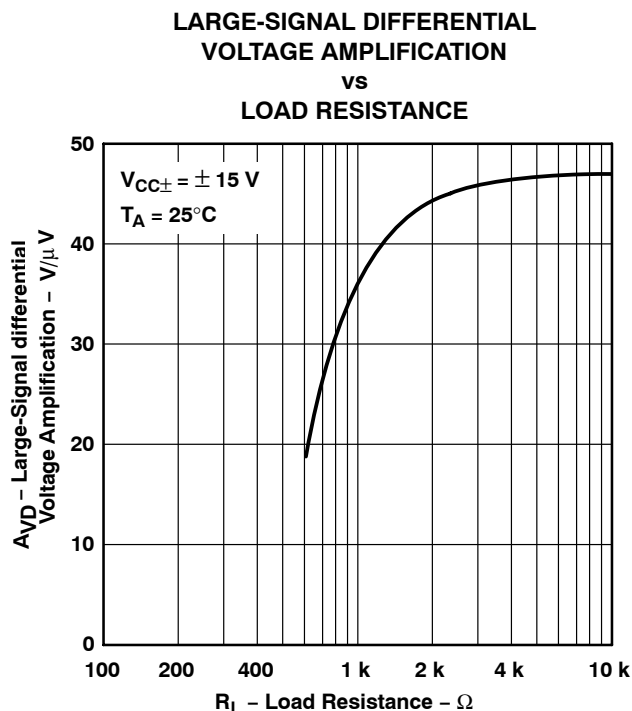


Figure 20

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

## TYPICAL CHARACTERISTICS

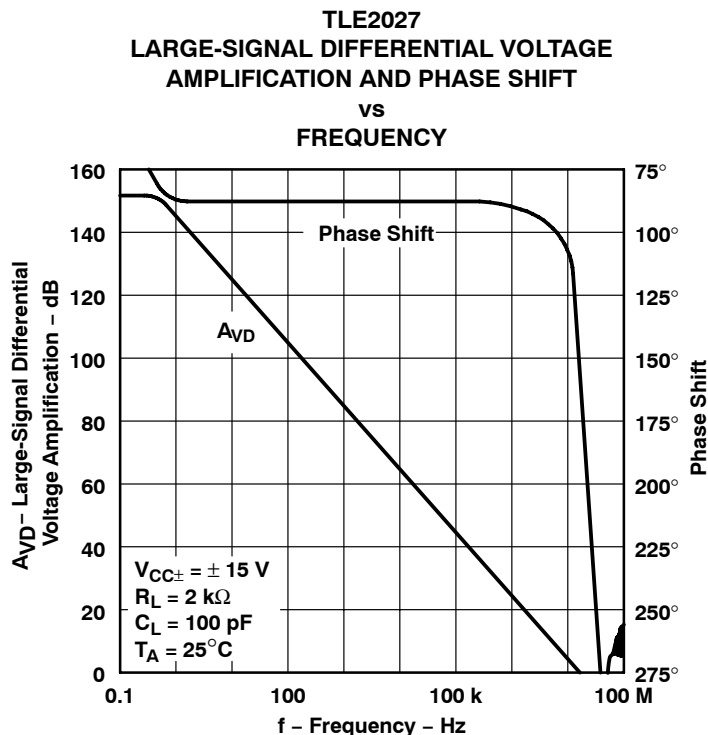


Figure 21

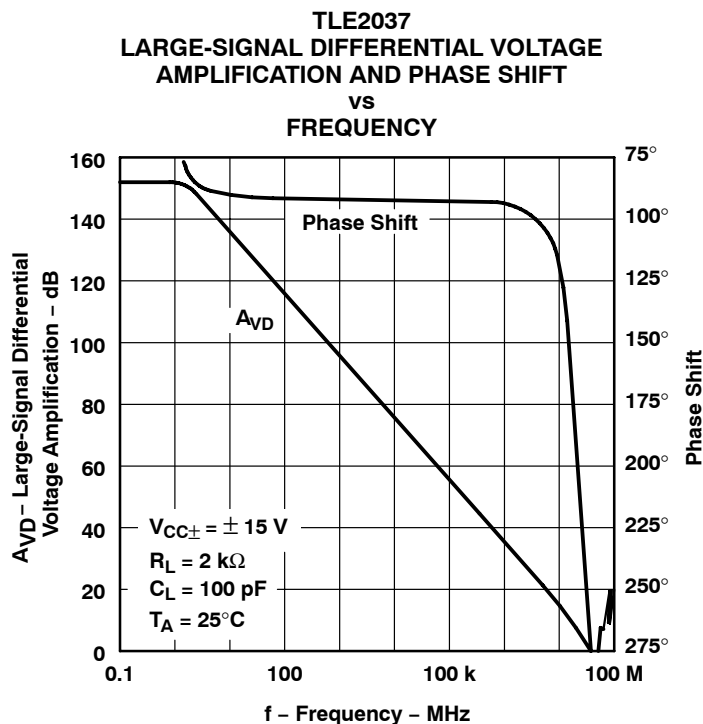


Figure 22

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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## TYPICAL CHARACTERISTICS

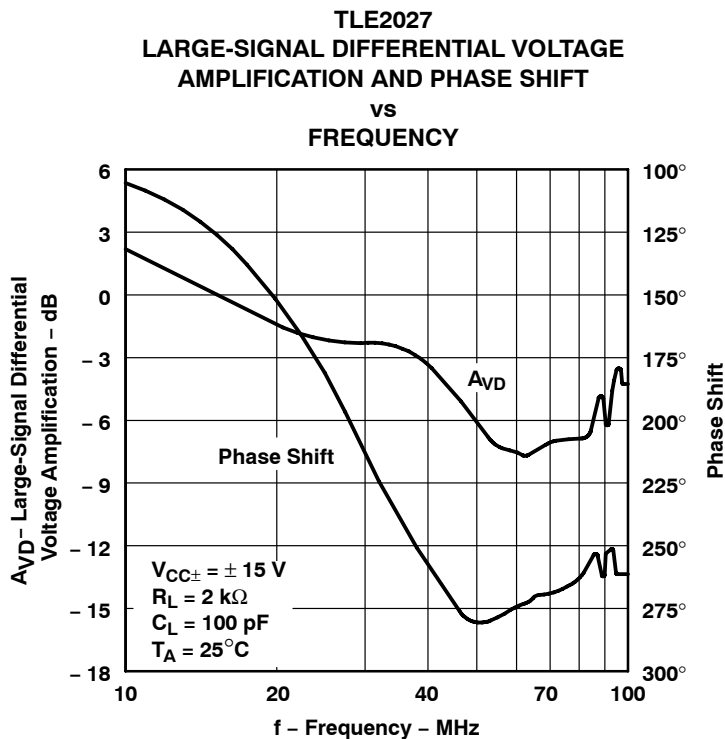


Figure 23

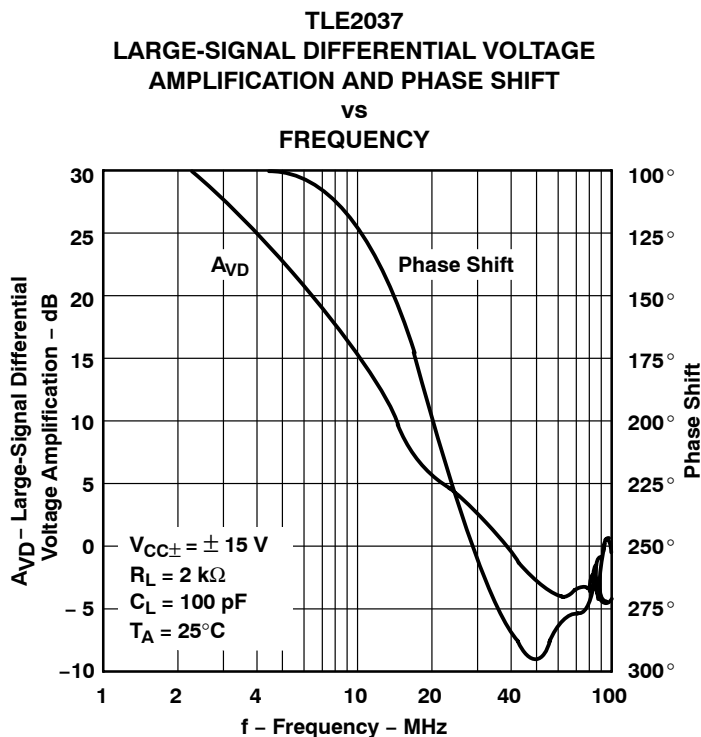


Figure 24

## TYPICAL CHARACTERISTICS

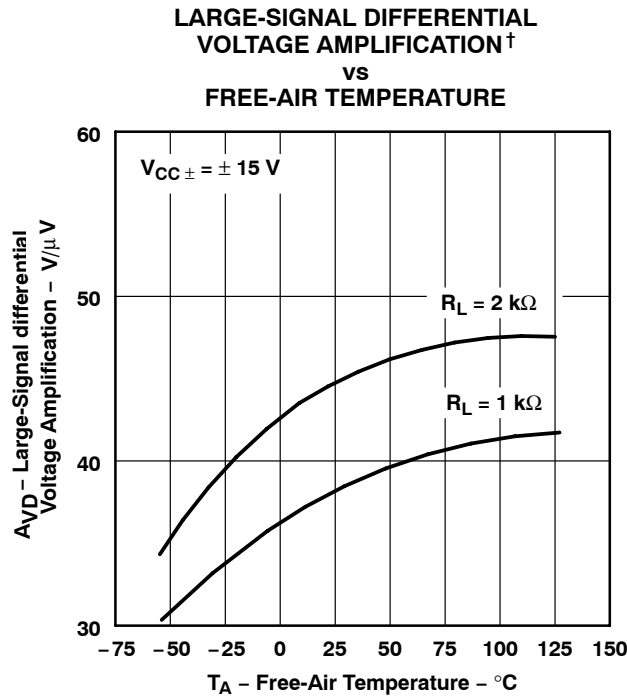
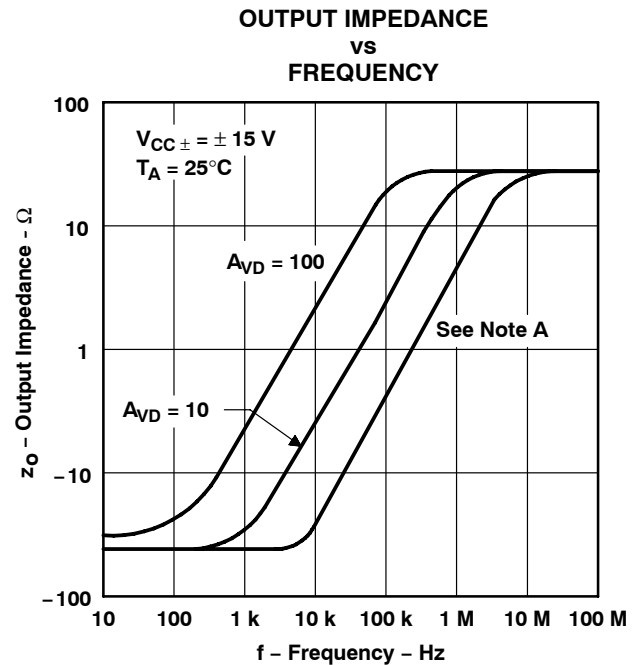


Figure 25



NOTE A: For this curve, the TLE2027 is  $A_{VD} = 1$  and the TLE2037 is  $A_{VD} = 5$ .

Figure 26

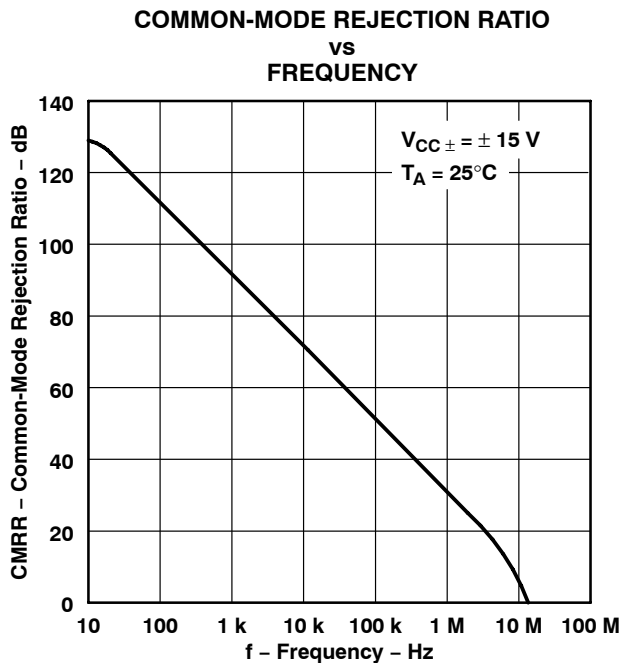


Figure 27

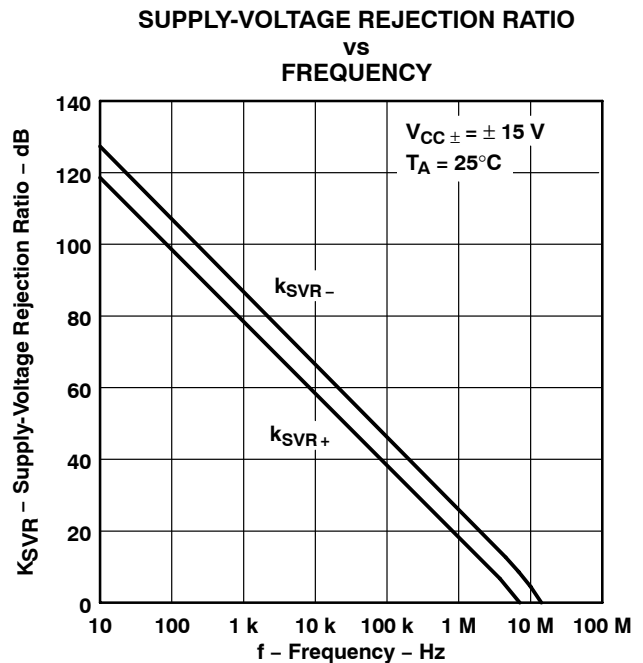


Figure 28

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

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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### TYPICAL CHARACTERISTICS

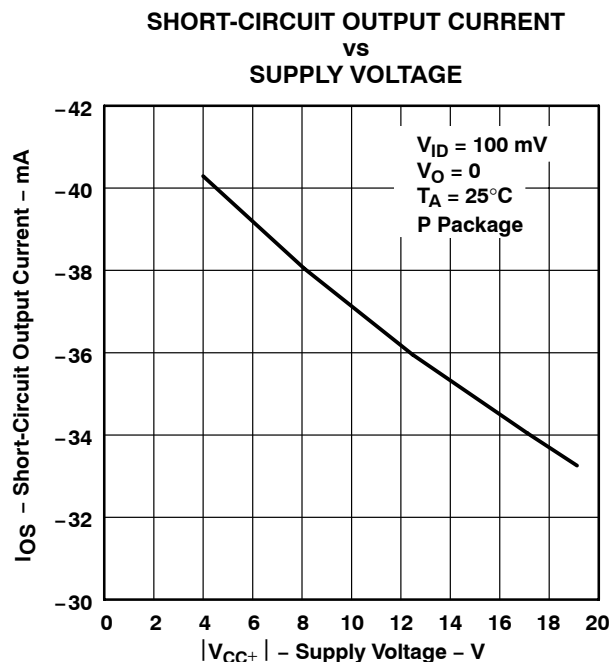


Figure 29

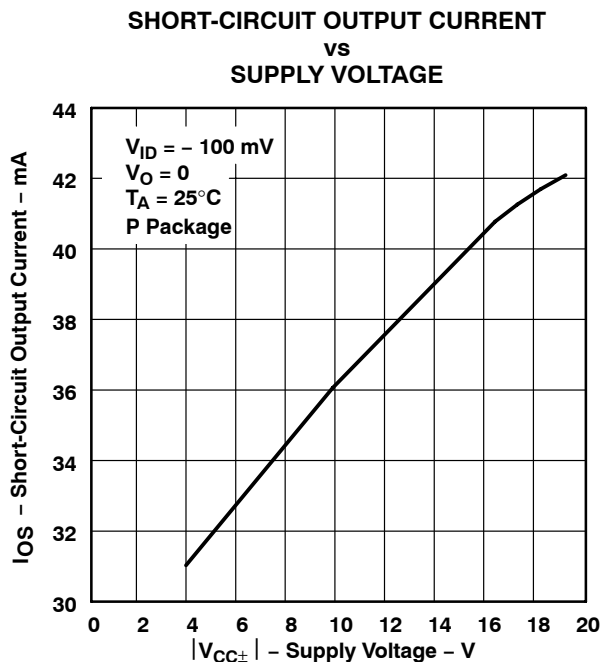


Figure 30

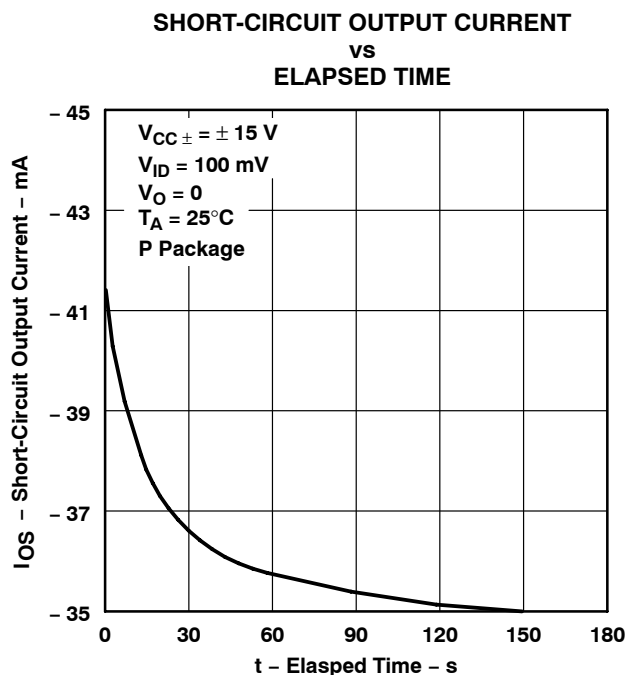


Figure 31

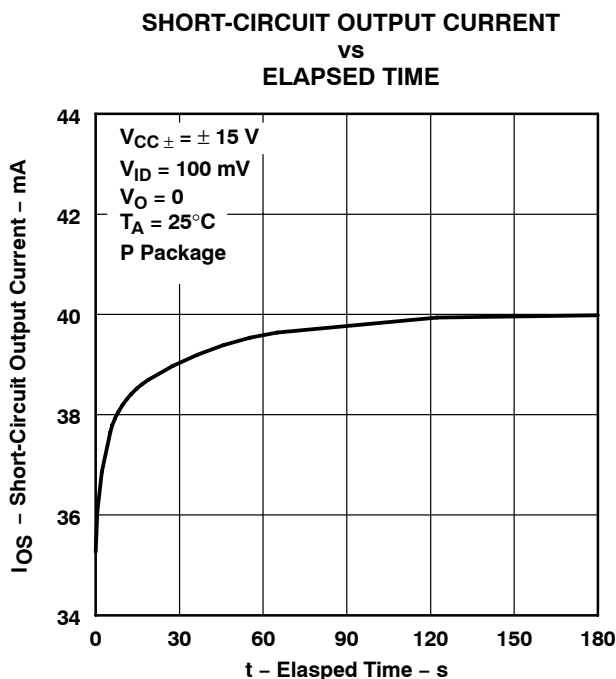


Figure 32

# TYPICAL CHARACTERISTICS

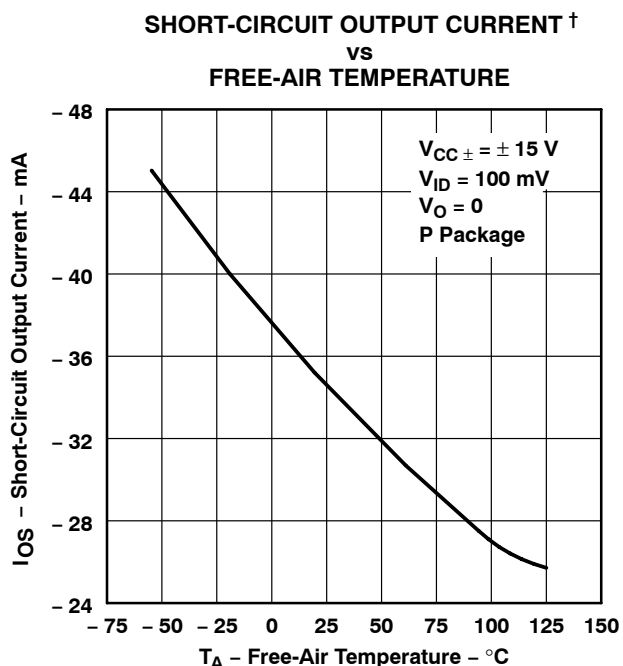


Figure 33

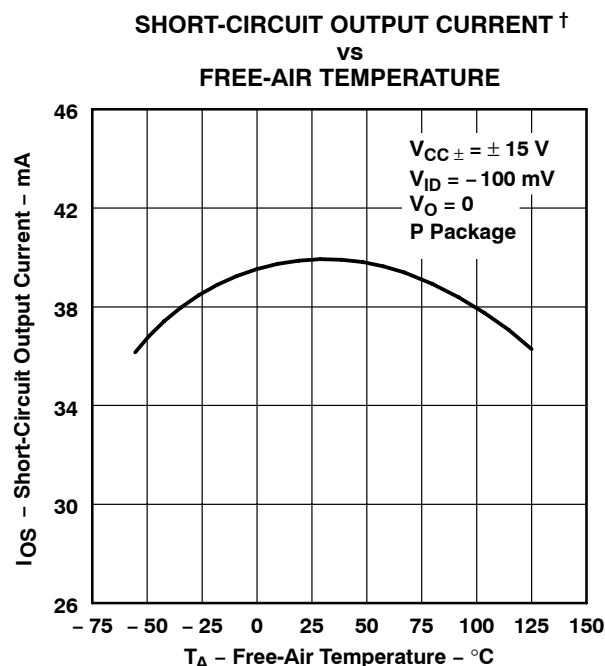


Figure 34

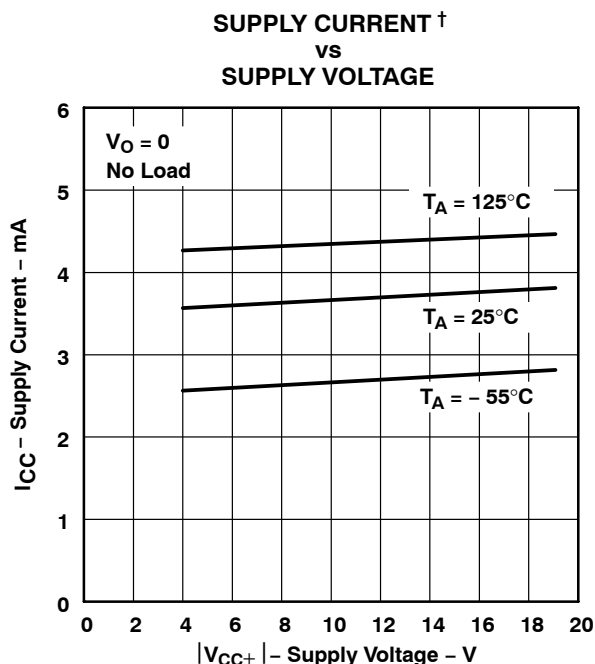


Figure 35

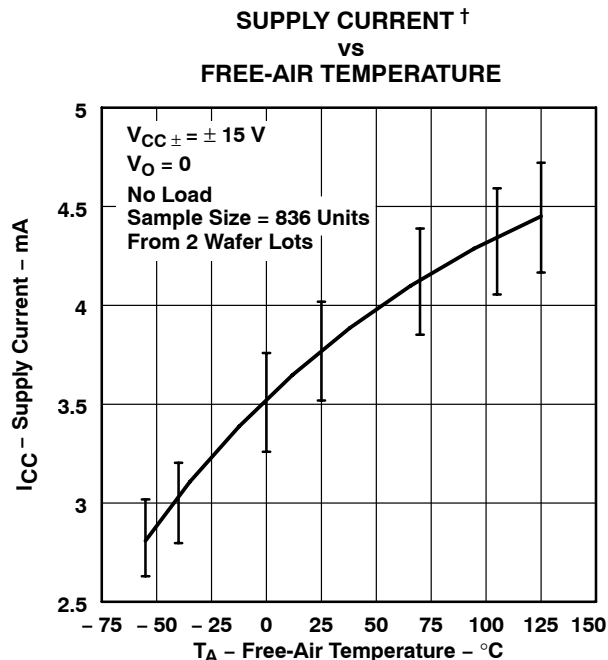


Figure 36

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

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

## PRECISION OPERATIONAL AMPLIFIERS

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### TYPICAL CHARACTERISTICS

**TLE2027**  
VOLTAGE-FOLLOWER  
SMALL-SIGNAL  
PULSE RESPONSE

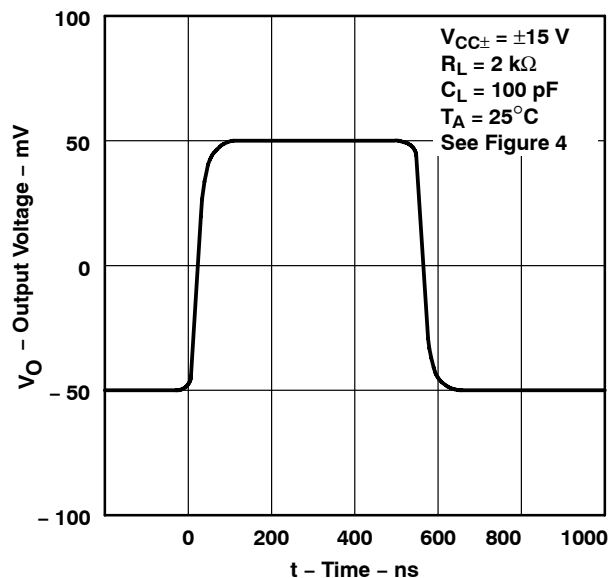


Figure 37

**TLE2027**  
VOLTAGE-FOLLOWER  
LARGE-SIGNAL  
PULSE RESPONSE

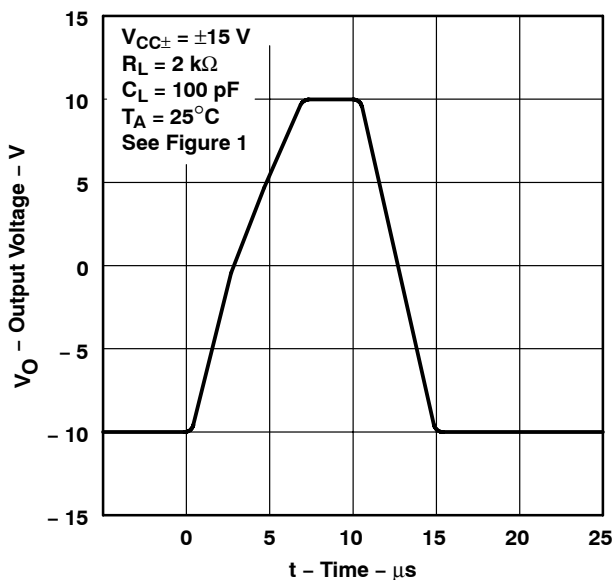


Figure 38

**TLE2037**  
VOLTAGE-FOLLOWER  
SMALL-SIGNAL  
PULSE RESPONSE

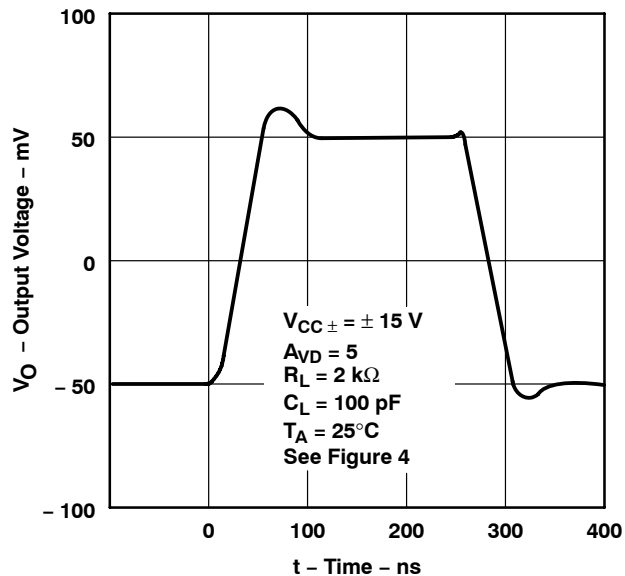


Figure 39

**TLE2037**  
VOLTAGE-FOLLOWER  
LARGE-SIGNAL  
PULSE RESPONSE

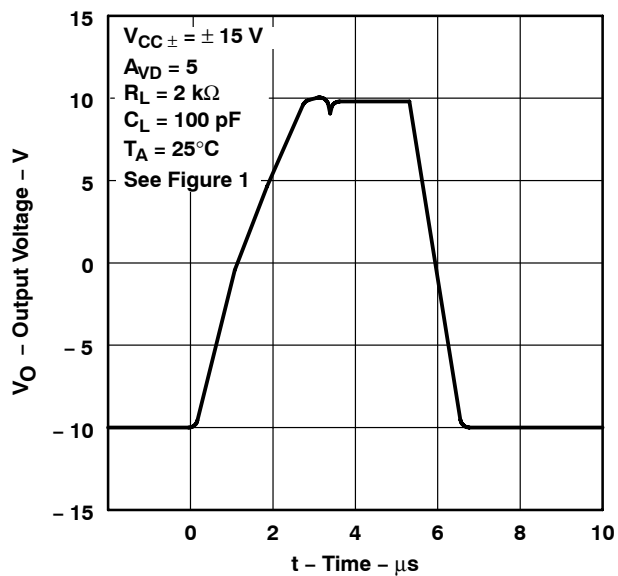


Figure 40

## TYPICAL CHARACTERISTICS

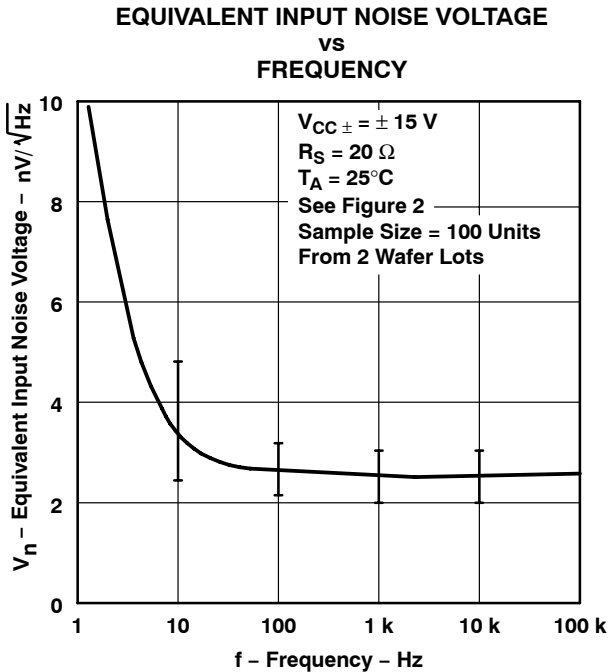


Figure 41

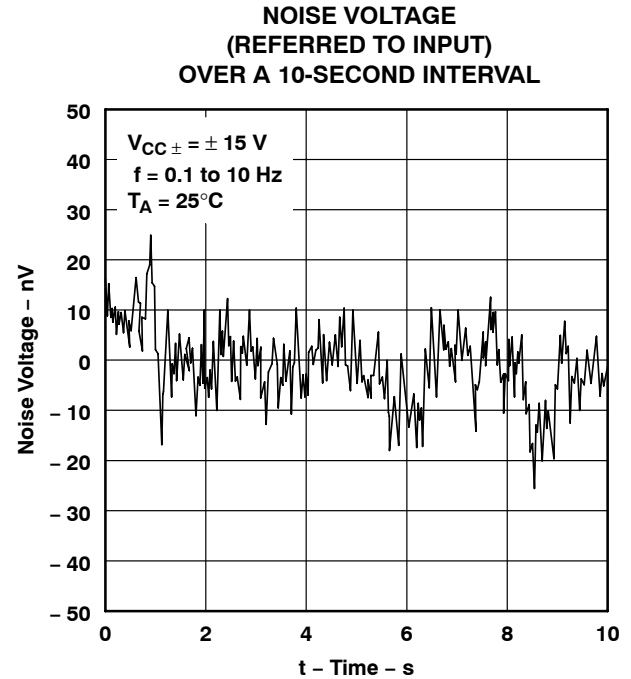


Figure 42

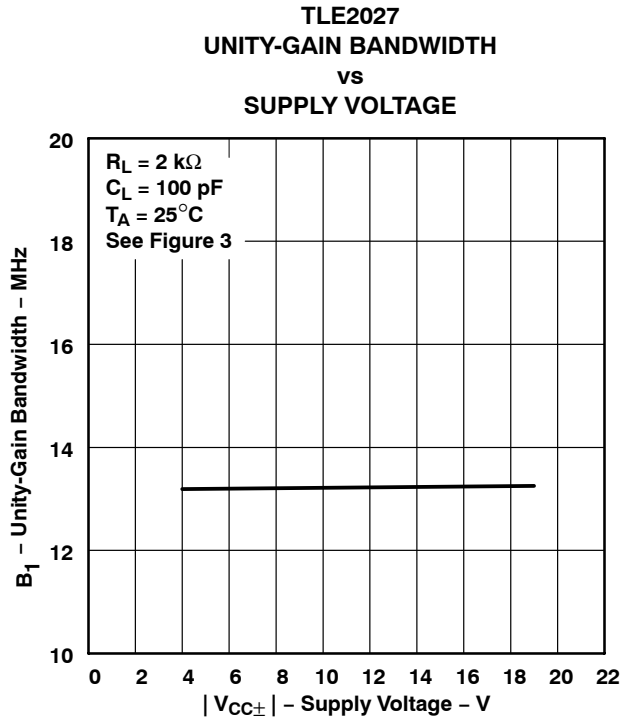


Figure 43

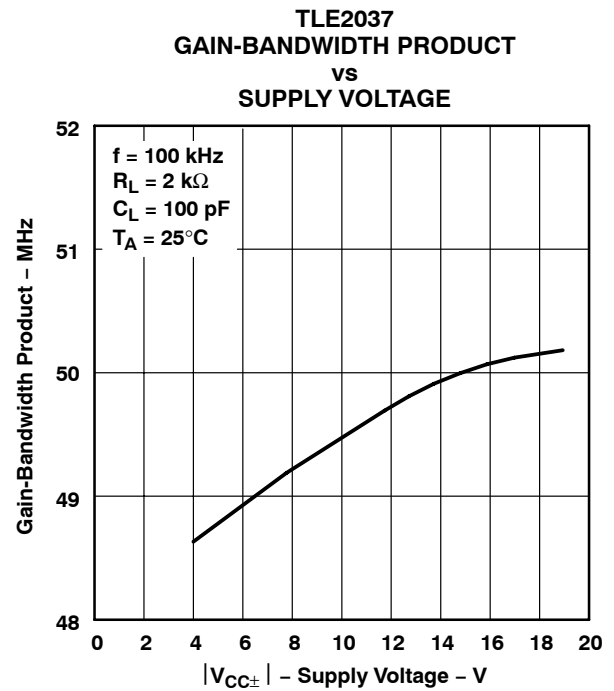


Figure 44

# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y

## EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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### TYPICAL CHARACTERISTICS

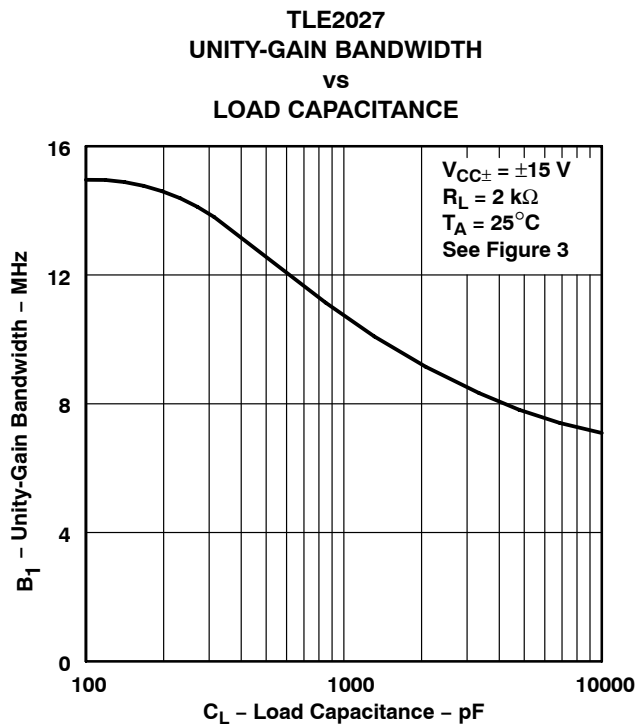


Figure 45

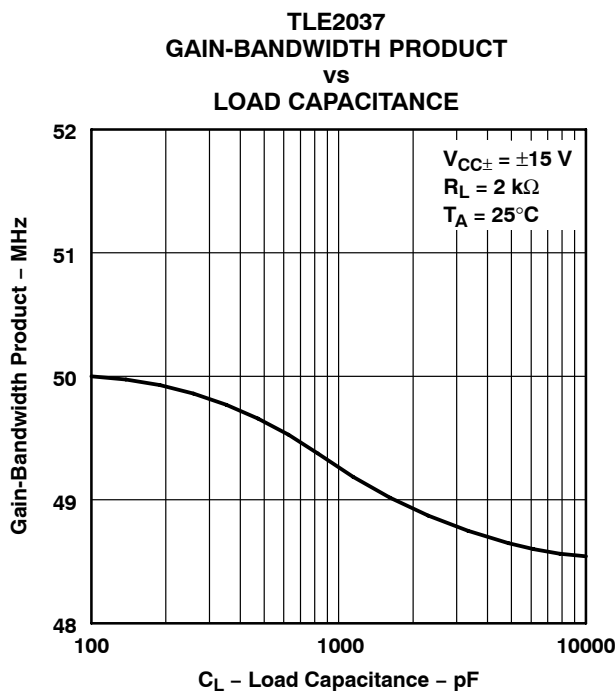


Figure 46

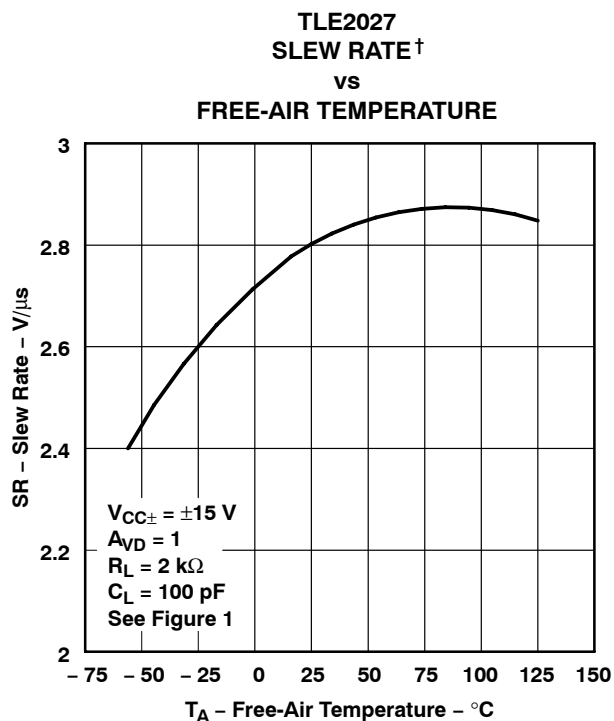


Figure 47

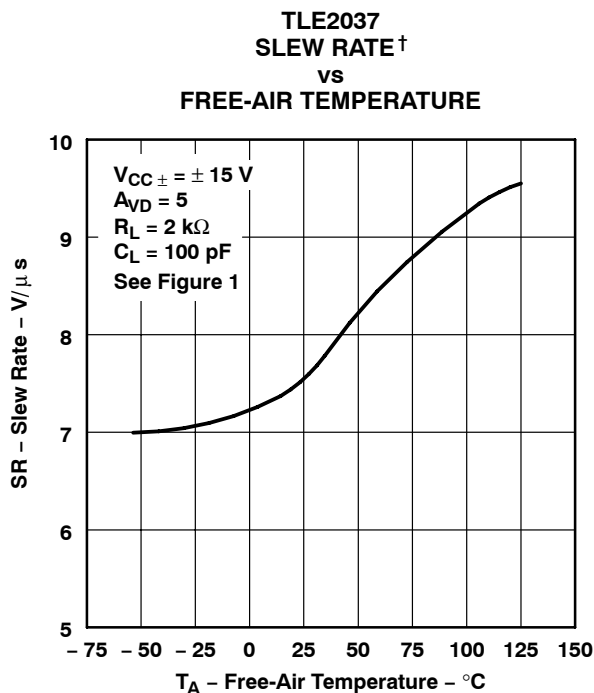


Figure 48

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

## TYPICAL CHARACTERISTICS

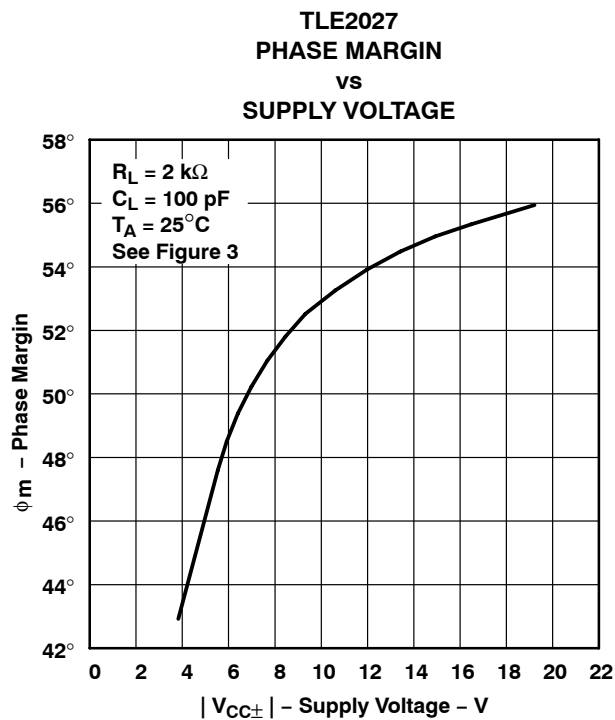


Figure 49

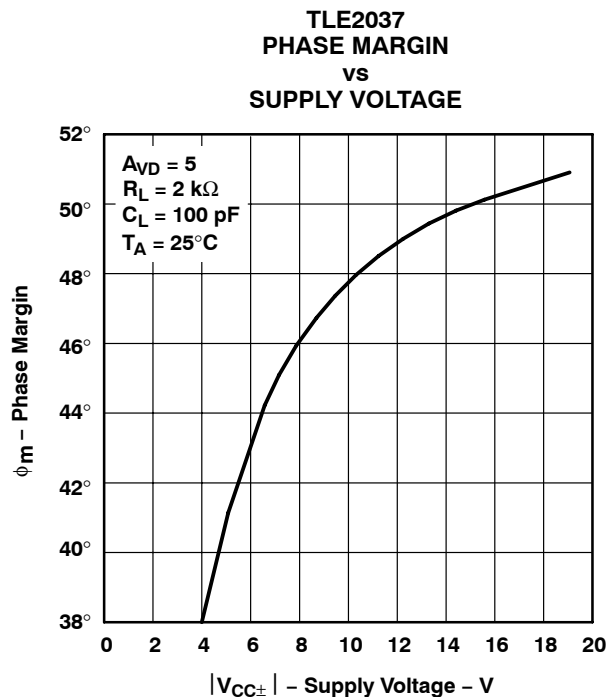


Figure 50

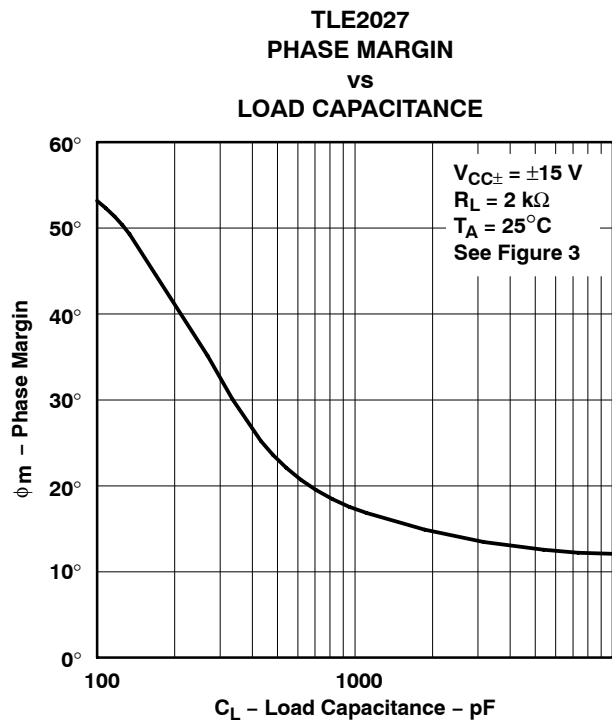


Figure 51

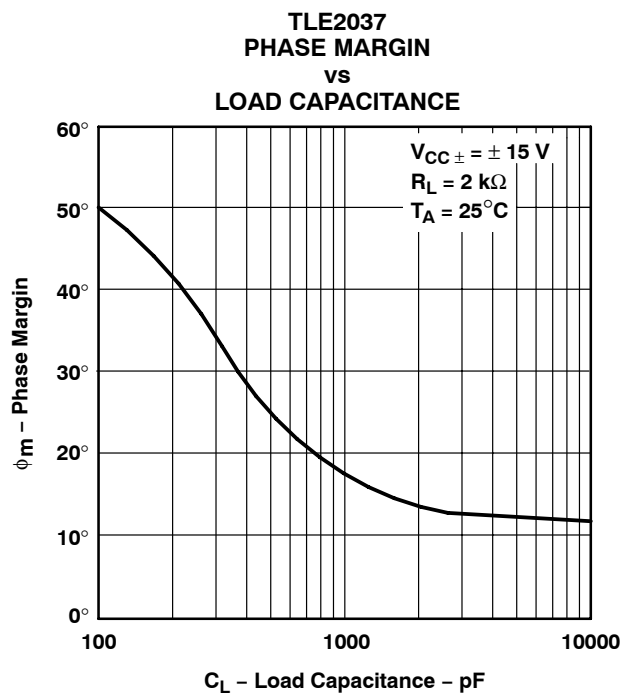
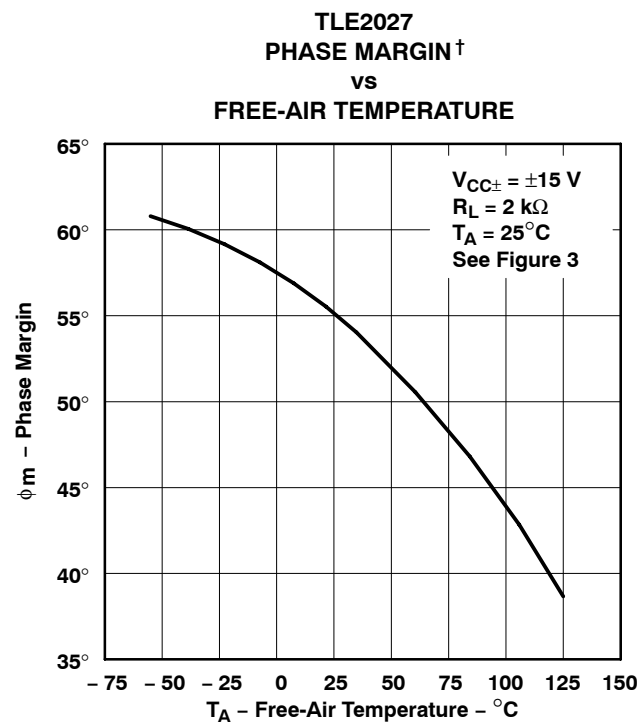


Figure 52

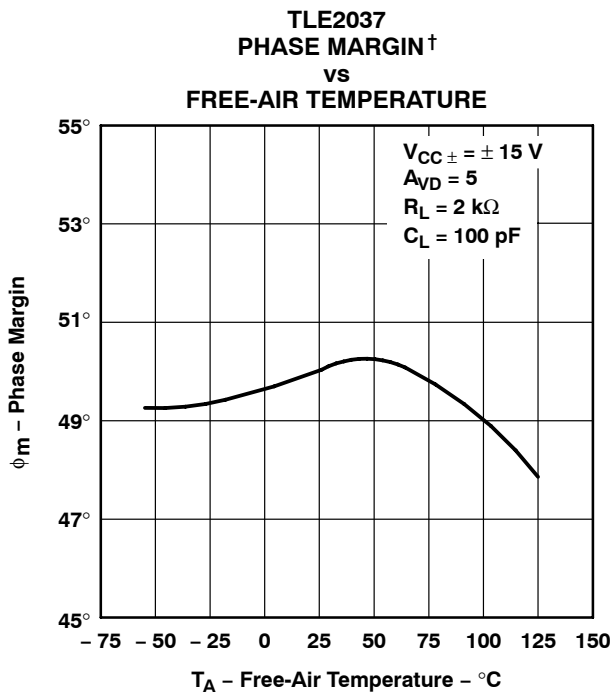
# TLE2027, TLE2037, TLE2027A, TLE2037A, TLE2027Y, TLE2037Y EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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## TYPICAL CHARACTERISTICS



**Figure 53**



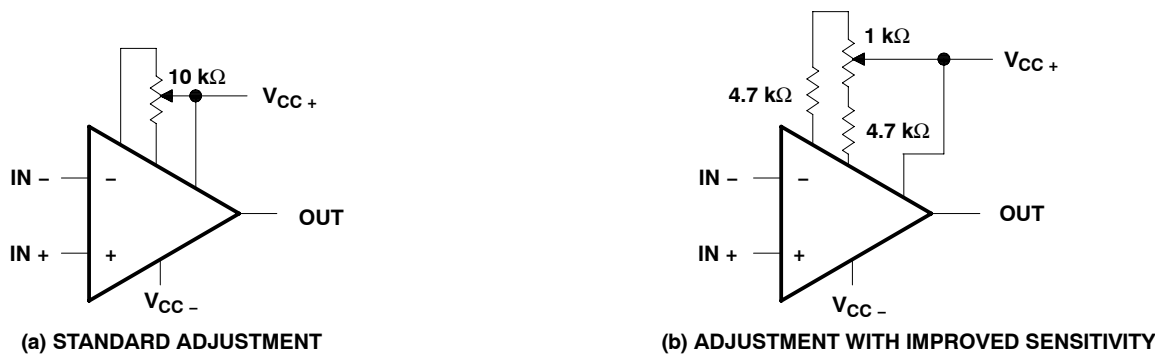
**Figure 54**

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

## APPLICATION INFORMATION

### input offset voltage nulling

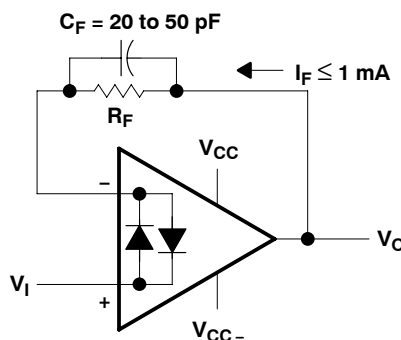
The TLE2027 and TLE2037 series offers external null pins that can be used to further reduce the input offset voltage. The circuits of Figure 55 can be connected as shown if the feature is desired. If external nulling is not needed, the null pins may be left disconnected.



**Figure 55. Input Offset Voltage Nulling Circuits**

### voltage-follower applications

The TLE2027 circuitry includes input-protection diodes to limit the voltage across the input transistors; however, no provision is made in the circuit to limit the current if these diodes are forward biased. This condition can occur when the device is operated in the voltage-follower configuration and driven with a fast, large-signal pulse. It is recommended that a feedback resistor be used to limit the current to a maximum of 1 mA to prevent degradation of the device. Also, this feedback resistor forms a pole with the input capacitance of the device. For feedback resistor values greater than 10 kΩ, this pole degrades the amplifier phase margin. This problem can be alleviated by adding a capacitor (20 pF to 50 pF) in parallel with the feedback resistor (see Figure 56).



**Figure 56. Voltage Follower**

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## macromodel information

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

*P*Spice and *P*arts are trademarks of MicroSim Corporation.

## APPLICATION INFORMATION

### macromodel information (continued)

```
.subckt TLE2027 1 2 3 4 5
*
c1      11  12  4.003E-12
c2      6   7   20.00E-12
dc      5   53  dz
de      54  5   dz
dlp     90  91  dz
dln     92  90  dx
dp      4   3   dz
egnd    99  0   poly(2) (3,0)
(4,0) 0 5 .5
fb      7   99  poly(5) vb vc
ve vlp vln 0 954.8E6 -1E9 1E9 1E9
-1E9
ga      6   0   11  12
2.062E-3
gcm     0   6   10  99
531.3E-12
iee     10  4   dc 56.01E-6
hlim    90  0   vlim 1K
ql      11  2   13 qx

q2      12  1   14 qx
r2      6   9   100.0E3
rc1     3   11  530.5
rc2     3   12  530.5
re1     13  10  -393.2
re2     14  10  -393.2
ree     10  99  3.571E6
ro1     8   5   25
ro2     7   99  25
rp      3   4   8.013E3
vb      9   0   dc 0
vc      3   53  dc 2.400
ve      54  4   dc 2.100
vlim    7   8   dc 0
vlp     91  0   dc 40
vln     0   92  dc 40
.modeldx D(Is=800.0E-18)
.modelqx NPN(Is=800.0E-18
Bf=7.000E3)
.ends
```

**Figure 58. TLE2027 Macromodel Subcircuit**

```
.subckt TLE2037 1 2 3 4 5
*
c1      11  12  4.003E-12
c2      6   7   7.500E-12
dc      5   53  dz
de      54  5   dz
dlp     90  91  dz
dln     92  90  dx
dp      4   3   dz
egnd    99  0   poly(2) (3,0)
(4,0) 0 .5 .5
fb      7   99  poly(5) vb vc
ve vip vln 0 923.4E6 A800E6
800E6 800E6 A800E6
ga      6   0   11  12 2.121E-3
gcm     0   6   10  99 597.7E-12
iee     10  4   dc 56.26E-6
hlim    90  0   vlim 1K
ql      11  2   13 qx

q2      12  1   14 qz
r2      6   9   100.0E3
rc1     3   11  471.5
rc2     3   12  471.5
re1     13  10  A448
re2     14  10  A448
ree     10  99  3.555E6
ro1     8   5   25
ro2     7   99  25
rp      3   4   8.013E3
vb      9   0   dc 0
vc      3   53  dc 2.400
ve      54  4   dc 2.100
vlim    7   8   dc 0
vlp     91  0   dc 40
vln     0   92  dc 40
.model  dxD(Is=800.0E-18)
.model  qxNPN(Is=800.0E-18
Bf=7.031E3)
.ends
```

**Figure 59. TLE2037 Macromodel Subcircuit**

REVISION HISTORY

Changes from Revision B (October 2006) to Revision C

- Changed values of  $V_n$ ,  $V_{N(PP)}$ , and  $I_n$  ..... 11

## PACKAGING INFORMATION

| Orderable part number           | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)                 |
|---------------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|-------------------------------------|
| <a href="#">5962-9089601M2A</a> | Active        | Production           | LCCC (FK)   20 | 55   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-<br>9089601M2A<br>TLE2027MFKB  |
| <a href="#">5962-9089601MPA</a> | Active        | Production           | CDIP (JG)   8  | 50   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 9089601MPA<br>TLE2027M              |
| <a href="#">5962-9089603Q2A</a> | Active        | Production           | LCCC (FK)   20 | 55   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-<br>9089603Q2A<br>TLE2027AMFKB |
| <a href="#">5962-9089603QPA</a> | Active        | Production           | CDIP (JG)   8  | 50   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 9089603QPA<br>TLE2027AM             |
| <a href="#">TLE2027AMD</a>      | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2027AM                              |
| <a href="#">TLE2027AMD.A</a>    | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2027AM                              |
| <a href="#">TLE2027AMFKB</a>    | Active        | Production           | LCCC (FK)   20 | 55   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-<br>9089603Q2A<br>TLE2027AMFKB |
| <a href="#">TLE2027AMFKB.A</a>  | Active        | Production           | LCCC (FK)   20 | 55   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-<br>9089603Q2A<br>TLE2027AMFKB |
| <a href="#">TLE2027AMJG</a>     | Active        | Production           | CDIP (JG)   8  | 50   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | TLE2027<br>AMJG                     |
| <a href="#">TLE2027AMJG.A</a>   | Active        | Production           | CDIP (JG)   8  | 50   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | TLE2027<br>AMJG                     |
| <a href="#">TLE2027AMJGB</a>    | Active        | Production           | CDIP (JG)   8  | 50   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 9089603QPA<br>TLE2027AM             |
| <a href="#">TLE2027AMJGB.A</a>  | Active        | Production           | CDIP (JG)   8  | 50   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 9089603QPA<br>TLE2027AM             |
| <a href="#">TLE2027CD</a>       | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -            | 2027C                               |
| <a href="#">TLE2027CD.A</a>     | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | 0 to 70      | 2027C                               |
| <a href="#">TLE2027CDR</a>      | Active        | Production           | SOIC (D)   8   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | 0 to 70      | 2027C                               |
| <a href="#">TLE2027CDR.A</a>    | Active        | Production           | SOIC (D)   8   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | 0 to 70      | 2027C                               |
| <a href="#">TLE2027ID</a>       | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -            | 2027I                               |
| <a href="#">TLE2027ID.A</a>     | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | 0 to 70      | 2027I                               |
| <a href="#">TLE2027IDR</a>      | Active        | Production           | SOIC (D)   8   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -            | 2027I                               |

| Orderable part number        | Status<br>(1) | Material type<br>(2) | Package   Pins | Package qty   Carrier | RoHS<br>(3) | Lead finish/<br>Ball material<br>(4) | MSL rating/<br>Peak reflow<br>(5) | Op temp (°C) | Part marking<br>(6)                |
|------------------------------|---------------|----------------------|----------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|------------------------------------|
| TLE2027IDR.A                 | Active        | Production           | SOIC (D)   8   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | 0 to 70      | 2027I                              |
| <a href="#">TLE2027MD</a>    | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2027M                              |
| TLE2027MD.A                  | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2027M                              |
| <a href="#">TLE2027MFKB</a>  | Active        | Production           | LCCC (FK)   20 | 55   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-<br>9089601M2A<br>TLE2027MFKB |
| TLE2027MFKB.A                | Active        | Production           | LCCC (FK)   20 | 55   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 5962-<br>9089601M2A<br>TLE2027MFKB |
| <a href="#">TLE2027MJGB</a>  | Active        | Production           | CDIP (JG)   8  | 50   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 9089601MPA<br>TLE2027M             |
| TLE2027MJGB.A                | Active        | Production           | CDIP (JG)   8  | 50   TUBE             | No          | SNPB                                 | N/A for Pkg Type                  | -55 to 125   | 9089601MPA<br>TLE2027M             |
| <a href="#">TLE2037AMD</a>   | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2037AM                             |
| TLE2037AMD.A                 | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2037AM                             |
| <a href="#">TLE2037AMDG4</a> | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2037AM                             |
| TLE2037AMDG4.A               | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2037AM                             |
| <a href="#">TLE2037CD</a>    | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -            | 2037C                              |
| TLE2037CD.A                  | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2037C                              |
| <a href="#">TLE2037CDR</a>   | Active        | Production           | SOIC (D)   8   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -            | 2037C                              |
| TLE2037CDR.A                 | Active        | Production           | SOIC (D)   8   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2037C                              |
| <a href="#">TLE2037ID</a>    | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -            | 2037I                              |
| TLE2037ID.A                  | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2037I                              |
| <a href="#">TLE2037IDR</a>   | Active        | Production           | SOIC (D)   8   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -            | 2037I                              |
| TLE2037IDR.A                 | Active        | Production           | SOIC (D)   8   | 2500   LARGE T&R      | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2037I                              |
| <a href="#">TLE2037MD</a>    | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2037M                              |
| TLE2037MD.A                  | Active        | Production           | SOIC (D)   8   | 75   TUBE             | Yes         | NIPDAU                               | Level-1-260C-UNLIM                | -55 to 125   | 2037M                              |

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

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

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

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

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

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

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

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**OTHER QUALIFIED VERSIONS OF TLE2027, TLE2027M, TLE2037A :**

- Catalog : [TLE2027](#)
- Automotive : [TLE2037A-Q1](#)
- Enhanced Product : [TLE2027-EP](#), [TLE2027-EP](#)
- Military : [TLE2027M](#)

**NOTE: Qualified Version Definitions:**

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

- Enhanced Product - Supports Defense, Aerospace and Medical Applications
- 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 |
|------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLE2027CDR | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2027IDR | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2037CDR | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLE2037IDR | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device     | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLE2027CDR | SOIC         | D               | 8    | 2500 | 353.0       | 353.0      | 32.0        |
| TLE2027IDR | SOIC         | D               | 8    | 2500 | 353.0       | 353.0      | 32.0        |
| TLE2037CDR | SOIC         | D               | 8    | 2500 | 353.0       | 353.0      | 32.0        |
| TLE2037IDR | SOIC         | D               | 8    | 2500 | 353.0       | 353.0      | 32.0        |

**TUBE**


\*All dimensions are nominal

| Device          | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|-----------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| 5962-9089601M2A | FK           | LCCC         | 20   | 55  | 506.98 | 12.06  | 2030   | NA     |
| 5962-9089603Q2A | FK           | LCCC         | 20   | 55  | 506.98 | 12.06  | 2030   | NA     |
| TLE2027AMD      | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2027AMD.A    | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2027AMFKB    | FK           | LCCC         | 20   | 55  | 506.98 | 12.06  | 2030   | NA     |
| TLE2027AMFKB.A  | FK           | LCCC         | 20   | 55  | 506.98 | 12.06  | 2030   | NA     |
| TLE2027CD       | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2027CD       | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| TLE2027CD.A     | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| TLE2027CD.A     | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2027ID       | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2027ID       | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| TLE2027ID.A     | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| TLE2027ID.A     | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2027MD       | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2027MD.A     | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2027MFKB     | FK           | LCCC         | 20   | 55  | 506.98 | 12.06  | 2030   | NA     |
| TLE2027MFKB.A   | FK           | LCCC         | 20   | 55  | 506.98 | 12.06  | 2030   | NA     |
| TLE2037AMD      | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2037AMD.A    | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2037AMDG4    | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2037AMDG4.A  | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2037CD       | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2037CD       | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| TLE2037CD.A     | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| TLE2037CD.A     | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2037ID       | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2037ID       | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |
| TLE2037ID.A     | D            | SOIC         | 8    | 75  | 507    | 8      | 3940   | 4.32   |

---

| Device      | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|-------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| TLE2037ID.A | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2037MD   | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |
| TLE2037MD.A | D            | SOIC         | 8    | 75  | 505.46 | 6.76   | 3810   | 4      |

## GENERIC PACKAGE VIEW

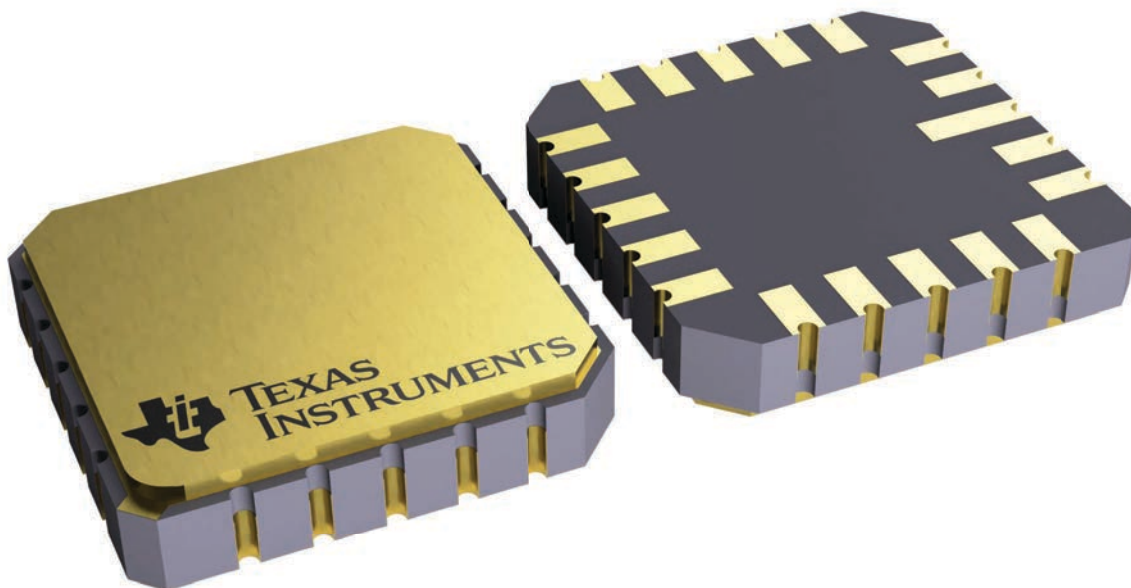
**FK 20**

**LCCC - 2.03 mm max height**

8.89 x 8.89, 1.27 mm pitch

LEADLESS CERAMIC CHIP CARRIER

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



4229370VA\



## PACKAGE OUTLINE

**SOIC - 1.75 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT



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.

**D0008A**

**SOIC - 1.75 mm max height**

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:8X



## SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

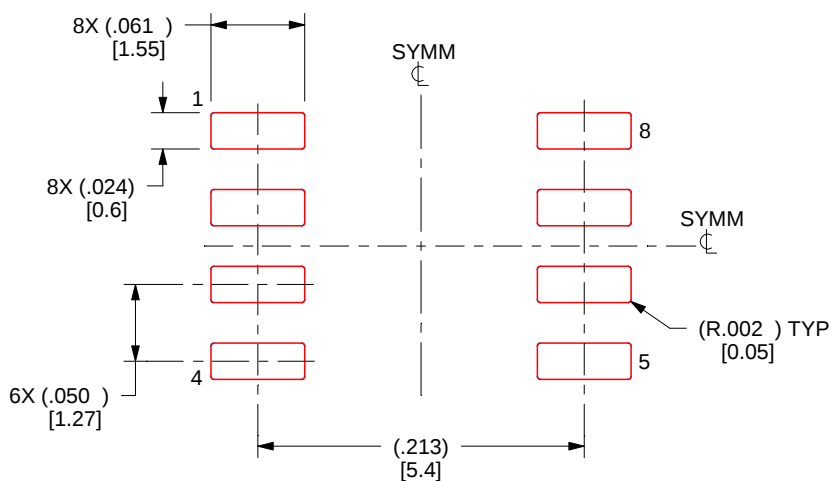
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## 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

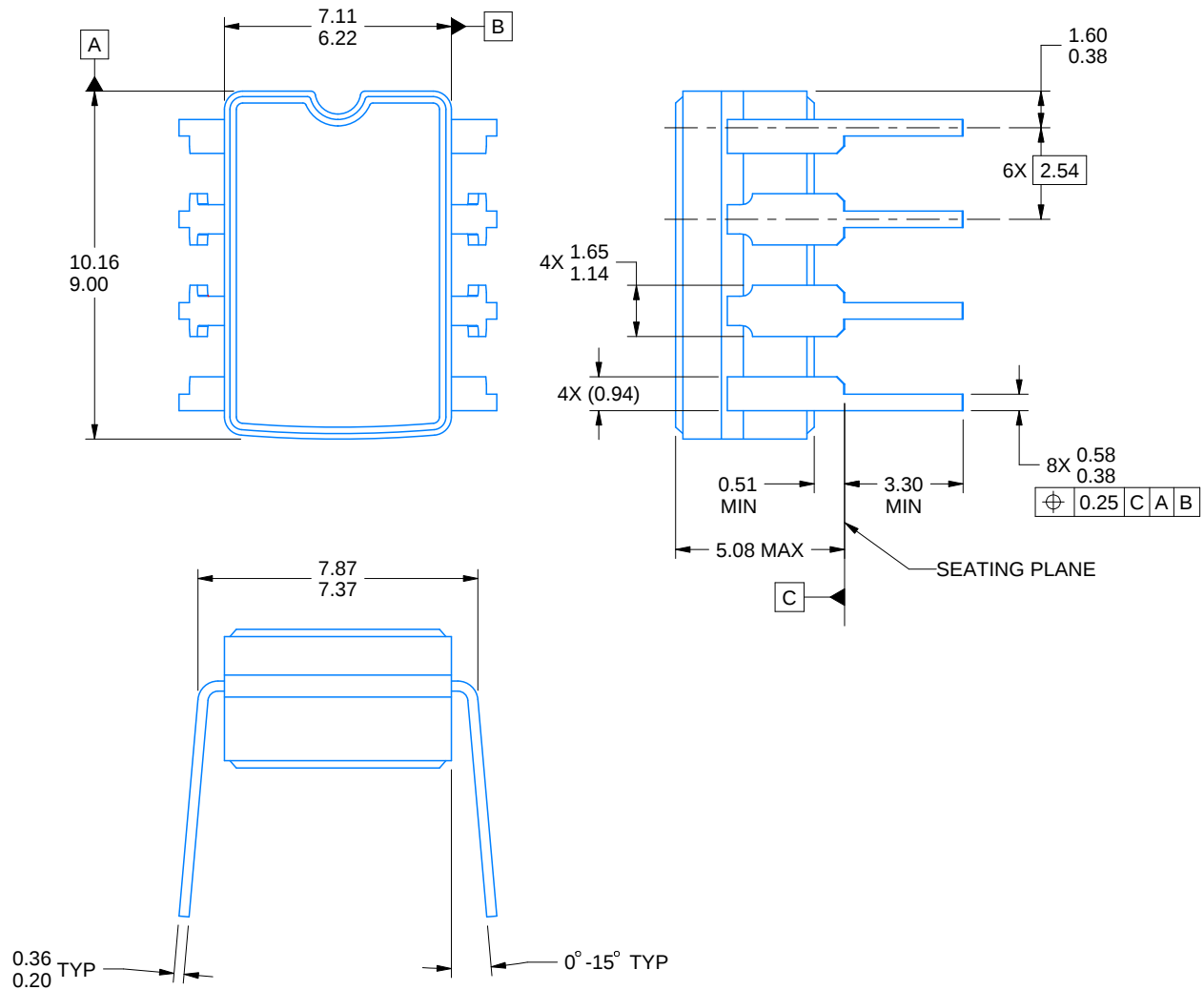
4214825/C 02/2019

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.

**JG0008A****PACKAGE OUTLINE****CDIP - 5.08 mm max height**

CERAMIC DUAL IN-LINE PACKAGE



4230036/A 09/2023

**NOTES:**

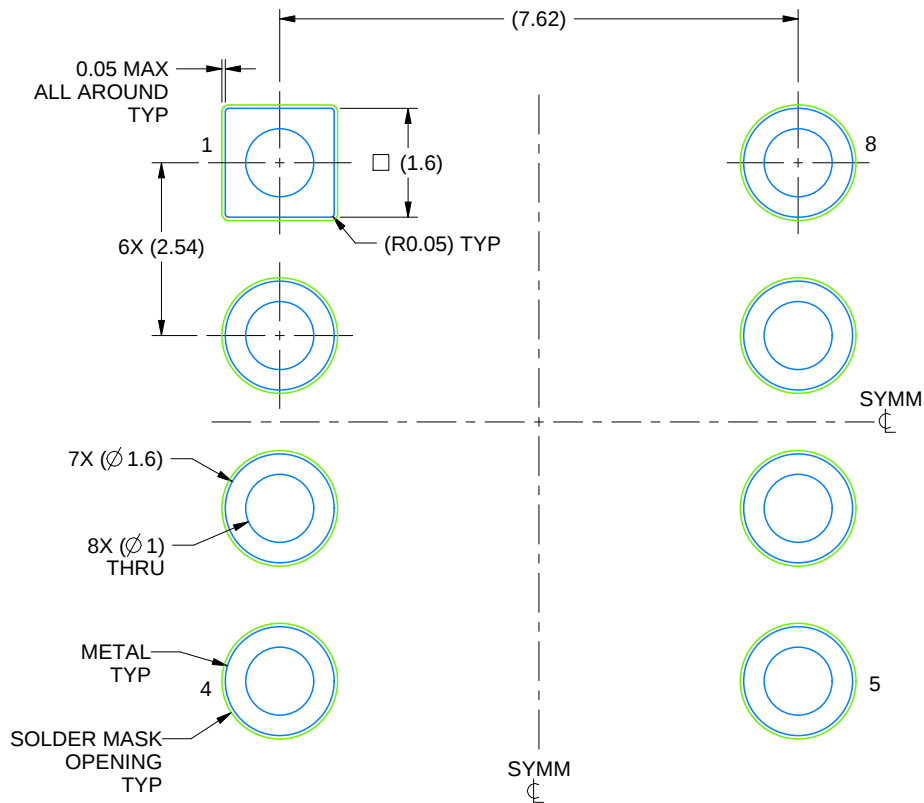
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package can be hermetically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification.
5. Falls within MIL STD 1835 GDIP1-T8

# EXAMPLE BOARD LAYOUT

JG0008A

CDIP - 5.08 mm max height

CERAMIC DUAL IN-LINE PACKAGE



LAND PATTERN EXAMPLE  
NON SOLDER MASK DEFINED  
SCALE: 9X

4230036/A 09/2023

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